REPORT ON PROPOSALS

THE MECHANICAL TECHNICAL COMMITTEE REPORT ON PROPOSALS FOR PUBLIC REVIEW AND COMMENT
Information on IAPMO Codes and Standards Development

1. Applicable Regulations. The primary rules governing the processing of the Uniform Plumbing Code and Uniform Mechanical Code are the IAPMO Regulations Governing Committee Projects (RGCP). Other applicable rules include Bylaws, Assembly Consideration Session Rules, Technical Meeting Convention Rules, Guide for the Conduct of Participants in the IAPMO Codes and Standards Development Process, and the Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council. For copies of these documents, contact the Code Development Department at IAPMO World Headquarters at 4755 E. Philadelphia Street, Ontario, CA 91761-2816 USA, or at 909-472-4100. These documents are also available at the IAPMO website at www.iapmo.org.

The following is general information on the IAPMO process. All participants, however, should refer to the actual rules and regulations for a full understanding of this process and for the criteria that govern participation.

2. Technical Committee Report (TCR). The Technical Committee Report is defined as the Report of the Technical Committee and Technical Correlating Committee (if any) consisting of the Report on Proposals (ROP), as modified by the Report on Comments (ROC), published by the Association (see 1-4 of RGCP).

3. Report on Proposals (ROP). The ROP is defined as “a report to the Association on the actions taken by Technical Committees and/or Technical Correlating Committees, accompanied by a ballot statement and one or more proposals on text for a new Document or to amend an existing Document” (see 1-4 of RGCP). The ROP and the ROC together comprise the Technical Committee Report. Anyone who does not pursue an issue as a proposed amendment of the Association Meeting will be considered as having their objection resolved.

4. Assembly Comment. The Assembly Consideration Session, held during the second year of the code development cycle, will be held during IAPMO’s annual conference from September 26 – 30, 2021 being held virtually. The Assembly Consideration Session is scheduled for September 28, 2021. Anyone in the Assembly who objects to an action of the Technical Committee, as published in the ROP, may make a motion in accordance with Section 4-4.3.1.2 of the RGCP and, if such motion is sustained by majority vote, both the TC action established by a letter ballot and the Assembly’s action, which shall be considered as a comment in accordance with Section 4-4.3.1, shall be included in the ROC.

5. Report on Comments (ROC). The ROC is defined as “a report to the Association on the actions taken by Technical Committees and/or Technical Correlating Committees accompanied by a ballot statement and one or more comments resulting from public review of the Report on Proposals (ROP)” (see 1-4 of RGCP). The ROP and the ROC together constitute the Technical Committee Report. Anyone who does not pursue an issue, either in person or by designated representative in accordance with Section 4-5.4(c) of the RGCP, as a proposed amendment of the Association Meeting will be considered as having their objection resolved.

6. Association Amendments. The Technical Committee Reports, consisting of the ROP and ROC, will be presented at the Association Technical Meeting Convention for action. This meeting, held during the final year of the code development cycle, will be held during IAPMO’s annual conference from September 11 - 15, 2022, in Charlotte, North Carolina. Amending motions made to the Technical Committee Reports may be made only at the Association Technical Meeting Convention in accordance with 4-5 and other applicable sections of the RGCP. Amending motions may be made in person or by a designated representative in accordance with Section 4-5.4(c) of the RGCP. Objections are deemed to be resolved if not pursued at this level.

7. Council Appeals. Anyone can appeal to the Standards Council concerning procedural or substantive matters related to the development, content, or issuance of any Document of the Association or on matters within the purview of the authority of the Council. Such appeals must be in written form and filed with the Secretary of the Standards Council (see 1-6 of RGCP). Time constraints for filing an appeal must be in accordance with 1-6.2 of the RGCP. Objections are deemed to be resolved if not pursued at this level.

8. Document Issuance. The Standards Council is the issuer of the Uniform Plumbing Code and Uniform Mechanical Code. The Council acts on the issuance of a Document within sixty days from the date of the recommendation from the Association Technical Meeting Convention, unless this period is extended by the Council (see 4-7 of RGCP).

9. Petitions to the Board of Directors. The Standards Council has been delegated the responsibility for the administration of the codes and standards development process and the issuance of documents. However, where extraordinary circumstances requiring the intervention of the Board of Directors exist, the Board of Directors may take any action necessary to fulfill its obligations to preserve the integrity of the IAPMO codes and standards development process. The rules for petitioning the Board of Directors can be found in the Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council and in 1-7 of the RGCP.
To: IAPMO Members and Other Interested Parties

Date: September 2021

Enclosed is your 2021 Report on Proposals (ROP). These proposals were presented to the Mechanical Technical Committee who met via Virtual Webinar on May 17 – 21, 2021.

At the Annual Education and Business Conference, which will be held September 26 – 30, 2021 Virtually via Zoom, IAPMO members and others attending the conference will have the opportunity to discuss and debate these proposals during the Assembly Consideration Session.

All comments for consideration by the Technical Committee should be submitted to IAPMO by January 4, 2022.

On May 4 - 5, 2022, the Technical Committee will consider all of the comments received in response to the actions contained within the ROP and will vote on whether to modify any of their previous actions.

Thereafter, from September 11 – 15, 2022, IAPMO will be holding its 93rd Annual Education and Business Conference in Charlotte, North Carolina. The IAPMO voting membership present at that conference will then vote on the actions taken by the Technical Committee during the Technical Meeting Convention. Please visit the IAPMO web site at www.iapmo.org for more information on the consensus code development process and timeline.

Following the ROP is a preprint of the Uniform Mechanical Code, as it would appear in the event that all of the proposals accepted by the Mechanical Technical Committee in May 2021 are ultimately approved for inclusion in the final version of the 2024 edition of the Uniform Mechanical Code. This preprint is provided to you as a courtesy. All changes are tentative and subject to revision. This document is not to be considered the final version of the 2024 Uniform Mechanical Code. Specific authorization from IAPMO is required for republication or quotation.

**THE BALLOT RESULTS ON ALL COMMITTEE ACTIONS ON PROPOSALS PASSED EXCEPT FOR THE FOLLOWING TEN ACTIONS:**

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In accordance with Section 4-3.5.2 where the technical committee actions failed to achieve the necessary 2/3 affirmative vote, a public comment is requested for each proposal listed above. All proposals listed above shall be reconsidered by the technical committee as an automatic public comment.
<table>
<thead>
<tr>
<th>NAME</th>
<th>REPRESENTATION</th>
<th>CLASSIFICATION</th>
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<tbody>
<tr>
<td>Harvey Kreitenberg, Chair</td>
<td>Harvey Kreitenberg &amp; Associates</td>
<td>Special Expert</td>
</tr>
<tr>
<td>Michael Hyde</td>
<td>State of Idaho-Division of Building Safety</td>
<td>Enforcing Authority</td>
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<tr>
<td>Rawand Aranyan, Principal</td>
<td>City of Los Angeles Department of Building &amp; Safety</td>
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<td>Shawn Hargis, Alternate</td>
<td>4Leaf, Inc.</td>
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<td>Bob Adler</td>
<td>IAPMO</td>
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<tr>
<td>Brian Fenty</td>
<td>Self</td>
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<td>John Heine</td>
<td>Heine Plumbing &amp; Heating</td>
<td>Installer/Maintainer</td>
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<tr>
<td>Chuck White</td>
<td>PHCC – National Association</td>
<td>Installer/Maintainer</td>
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<tr>
<td>Sarah Aguilar</td>
<td>Cieri Plumbing &amp; Heating</td>
<td>Installer/Maintainer</td>
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<tr>
<td>Bob Wiseman, Principal</td>
<td>Air Conditioning Contractors of America (ACCA)</td>
<td>Installer/Maintainer</td>
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<tr>
<td>David Gans, Ex-Officio*</td>
<td>CA State Pipe Trades Council</td>
<td>Labor</td>
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<td>Mat Hattich, Alternate</td>
<td>UA Local 342</td>
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<tr>
<td>David Dias, Principal</td>
<td>United Association</td>
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<td>Mike Afonso, Alternate</td>
<td>Air Distribution Institute (ADI)</td>
<td>Manufacturer</td>
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<td>Randy Young, Principal</td>
<td>Sheet Metal &amp; Fittings Association (PPFA)</td>
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<td>Robert Kukas, Alternate</td>
<td>Plastic Pipe &amp; Fittings Association (PPFA)</td>
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<td>Richard Benkowski, Principal</td>
<td>Copper Development Association (CDA)</td>
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<td>Robert Vlices, Alternate</td>
<td>Air Duct Council</td>
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<td>Chris Van Rite, Principal</td>
<td>Sheet Metal &amp; Air Conditioning Contractors’ National Association (SMACNA)</td>
<td>Research/Standards/ Test Lab</td>
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<td>NEMIC</td>
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<td>National Fire Protection Association (NFPA)</td>
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<td>Tim Orris, Alternate</td>
<td>Air Movement and Control Association International (AMCA)</td>
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<tr>
<td>Phil Trafford</td>
<td>American Society of Heating, Refrigerating &amp; Air-Conditioning Engineers (ASHRAE)</td>
<td>Research/Standards/ Test Lab</td>
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<tr>
<td>April Trafford</td>
<td>Donald F. Dickerson Associates</td>
<td>Special Expert</td>
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<td>Donald Cary Smith</td>
<td>Sound Geothermal Corporation</td>
<td>Special Expert</td>
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<tr>
<td>Lance MacNevin</td>
<td>Plastics Pipe Institute (PPI)</td>
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<td>Phil Ribbs</td>
<td>PHR Consultants</td>
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<td>Julius Ballanco</td>
<td>National ITC Corporation</td>
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<tr>
<td>DJ Berger, Principal</td>
<td>John Dehn, Principal*</td>
<td>Consumer</td>
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<tr>
<td>Luis Reyes, Alternate</td>
<td>TAG Engineering &amp; Code Consulting</td>
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<td>Bob Sewell, Principal</td>
<td>Lescure Company</td>
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<tr>
<td>Andrew Davie, Alternate</td>
<td>Mesa Energy Systems Inc.</td>
<td>User</td>
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<tr>
<td>Don Taylor</td>
<td>Dittmann Plumbing</td>
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<tr>
<td>Jay Egg, Principal</td>
<td>Egg Geothermal Consulting</td>
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<tr>
<td>Kristy Egg, Alternate</td>
<td>IAPMO Staff</td>
<td>User</td>
</tr>
</tbody>
</table>

The above listed TC Members are in order of classification (see far right column).
FORM FOR COMMENTS ON IAPMO UPC/UMC COMMITTEE DOCUMENTS-2021

NOTE: All Comments MUST be received by 5:00 PM PST on January 4, 2022

PLEASE USE SEPARATE FORM FOR EACH COMMENT

Forms to be submitted electronically and accessed at the following:
https://codes.iapmo.org/form_comments_upc_umc_2024.aspx

Date ___________ Name ___________________________ Tel. No. _______________________
Organization __________________________________________ Email Address __________________
Street Address ___________________________ City ___________________________ State ____ Zip. ___________

Please Indicate Organization Represented (if any) _________________________________________________

Recommendation:

Check one (see instructions)
☐ Add new text
☐ Revise text
☐ Delete text without substitution

Section number: ________________ Code:  UPC ☐  UMC ☐

Comment on Proposal Item number: ________________________________

Proposed Text [Note: Proposed text must be in legislative format i.e., using underscore to denote wording to be inserted (wording) and strike through to denote wording to be deleted (wording).]

Statement of Problem and Substantiation/Resolution:

Are you referencing standards in your comment? Check one ☐ Yes ☐ No

If yes, please provide two hard copies or one electronic copy with your comment. Please note that if a standard is referenced above in your comment you must submit such standard in order for your comment to be processed. If the standard is not received by the closing date, your comment is considered incomplete and will not be processed.

Where additional supplementary materials such as tests, research papers, or other documents need to be submitted, please provide supporting material electronically. Please note that if supporting material is not received by the closing date, it will not be accepted for review by the Technical Committee.

Copyright Assignment (This comment is original materials and is considered to be the submitter’s own idea based on, or as a result of, research and experience, and is not copied from another source).
I hereby irrevocably grant and assign IAPMO all and full rights in copyright, in this proposal. I understand and intend that I acquire no rights, including rights as a joint author, in any publication of IAPMO in which this comment in this or another similar or analogous form is used. I hereby warrant that I am the author of this comment and that I have full power and authority to enter into this copyright assignment.

☐ By checking this box, I affirm that I am, and agree to be legally bound by the above Copyright Assignment and the terms and conditions contained therein. I understand and intend that, by checking this box, I am creating an electronic signature that will, upon my submission of this form, have the same legal force and effect as a handwritten signature.

Note: If you are not the author of this comment (this text is copied from another source) please do not submit. The author of the comment must give copyright assignment (which is the submitter’s own idea based on or as a result of research, experience and is not copied from another source).

Patent Policy. IAPMO’s patent policy is to adhere fully to the ANSI patent policy. Every proponent of a code change proposal should familiarize him or herself with the ANSI patent policy which is available in its entirety at www.ansi.org/essentialrequirements. Upon receipt of a notice of an essential patent claim, IAPMO will coordinate with the claimant to ensure collection of the assurance(s) required by IAPMO’s adherence to the ANSI patent policy before the proposal that includes an essential patent claim is introduced into the code development process.
INSTRUCTIONS FOR SUBMITTING COMMENTS

PLEASE READ CAREFULLY

1. Check the appropriate box to indicate whether this comment recommends adding new text, revising existing text, or delete text without substitution (see examples below).
2. Enter the appropriate comment on proposal item number that the proposed text applies to.
3. In the space identified as “Proposed Text” indicate the exact wording you propose as new or revised text or the text you propose to be deleted.
4. In the space titled, “Statement of Problem and Substantiation/Resolution,” state the problem that will be resolved by your recommendation and give the specific reason for your comment.
5. Where referencing a standard in your comment, such standard needs to be submitted. Please provide two hard copies or one electronic copy with your comment. Please note that if the standard is not received by the closing date, your comment is considered incomplete and will not be processed.
6. Where additional supplementary materials such as tests, research papers, or other documents, need to be submitted, please provide supporting material electronically. Please note that if supporting material is not received by the closing date, it will not be accepted for review by the Technical Committee.
7. Check the box for copyright assignment. Please note if you are not the author of this comment (this text is copied from another source) please do not submit the proposed change. The author of the comment must give copyright assignment (which is the submitter’s own idea based on or as a result of research, experience and is not copied from another source).

Note: Content of Comments shall be in accordance with Section 4-4.5 of the IAPMO Regulations Governing Committee Projects of the UPC and UMC. Failure to comply with the above requirements will result in the comment not being processed. For further information on the standards process, please contact Code Development at 909-472-4111. For technical assistance, please call 909-230-5535 or 909-218-8122 or email alma.ramos@iapmo.org.

Please support IAPMO’s green initiative to remain paper free by providing the Proposed Monographs, Report on Proposals and Report on Comments in digital Adobe PDF. Note printed copies of the above referenced documents will not be available at the hearings.

Examples for applying charging statement for adding text, deleting text and revising text

Add new text as follows (applies only when adding a new section or all new text):
Water Service. Piping from the water main or source of water supply to the water distribution piping of the building or premises served irrespective of the water meter location.

Revise text as follows (applies when revising an existing section by deleting text, adding text or both as follows):
Building Supply. The pipe carrying potable water from the water meter or other source of water supply to the building or other point of use or distribution on the lot. Building supply shall also mean water service. Piping from the water main or source of water supply to the water distribution piping of the building or premises served irrespective of the water meter location.

Delete text without substitution (applies when deleting an entire section, table or both as follows):
302.0 Iron Pipe Size (IPS) Pipe. Iron, steel, brass and copper pipe shall be standard weight iron pipe size (IPS) pipe.
306.1 It shall be unlawful for any person to deposit, by any means whatsoever, into any plumbing fixture, floor drain, interceptor, sump, receptor, or device, which is connected to any drainage system, public sewer, private sewer, septic tank, or cesspool, any ashes; cinders; solids; rage; inflammable, poisonous, or explosive liquids or gas; oil; grease; or any other thing whatsoever that would, or could, cause damage to the drainage system or public sewer.
Assembly Consideration Session Rules

Adopted by the IAPMO Board of Directors on July 9, 2007 and approved by the Standards Council on June 19, 2007. Revision pending Standards Council approval.

The Assembly Consideration Session is an important step in developing a complete record to assist the Standards Council in determining the degree of consensus achieved. These Rules, or any part of same, may not be suspended. The transaction of business at the Assembly Consideration Session shall be governed, in order of precedence, first by the Regulations Governing Committee Projects (see especially section 4-4.3.1.1), second by these Rules, and third by Robert’s Rules of Order Revised.

1. **Meetings.** The Secretary of the Standards Council shall develop and publish in advance, an agenda for each Assembly Consideration Session. At the discretion of the Secretary, the meeting may take place in a single session or may be divided into more than one session. All items on the agenda scheduled for consideration at a session shall be completed before the adjournment of that session.

2. **Adjournment.** Adjournment of each session shall take place only upon completion of the scheduled agenda.

3. **Recess.** A session may be recessed at any time at the discretion of the Chair. A motion to recess shall be allowed at the discretion of the Chair.

4. **Question of Privilege.** Ruled on by the Chair.

5. **Call for Orders of the Day.** Any change to the published agenda is to be announced by the Chair at the commencement of the session.

6. **Lay on the Table.** Not allowed.

7. **Previous Question.** Requires a two-thirds vote of those present. For informational purposes prior to the vote, the Chair has the authority to ask if there is anyone who wishes to speak, who has not spoken, and who has something new to add. A successful motion of the previous question will close debate on the pending motion and bring it to an immediate vote.

8. **Limit or Extend Debate.** Each speaker is allowed ten minutes to present their arguments.

9. **Postpone.** Allowed.

10. **Commit or Refer.** Not allowed.

11. **Motions.** See Regulations Governing Committee Projects at section 4-4.3.1.1 and 4-4.3.1.2.

12. **Postpone Indefinitely.** Not allowed.
13. **Voting on Motions.** Except as otherwise provided in these rules, the vote on motions shall be taken by a show of hands or, when meeting virtually, via electronic voting. If the Chair is uncertain of the result of the vote, he or she can order a counting of the vote. A successful main motion requires a majority vote of those present.

14. **Point of Order.** Allowed.

15. **Appeal.** Decisions of the Chair can be appealed except as otherwise prohibited by these rules. The proper venue for appeal of these rules is by an appeal filed with the Standards Council.

16. **Suspend Rules.** Not allowed.

17. **Division of Question.** Allowable at the discretion of the Chair.

18. **Division of Assembly.** Not allowed.

19. **Parliamentary Inquiry or Point of Information.** Allowed.

20. **Withdraw Motion.** A motion can be withdrawn only by a majority vote of the members assembled.

21. **Take from the Table.** Not allowed.

22. **Visual Aids and Physical Simulations.** Visual aids and physical simulations of any kind are prohibited. Only verbal presentations are allowed.

23. **Distribution of Materials.** All materials distributed within the Association Technical Meeting room shall have prior approval by the secretary of the Standards Council. Only IAPMO staff shall be permitted to distribute such materials.

24. **Reconsider, Rescind, or Amend Something Previously Adopted.** Applicable only within the period of discussion of the specific document and prior to the final vote.
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<th>Item #</th>
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**Task Group Reports**
UMC A2L Task Group Report
UMC Legionella Task Group Report

**Technical Correlating Committee Report**

**2021 Uniform Mechanical Code Preprint**
Proposals

Item #: 001
UMC 2024 Section: 103.2

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

103.0 Duties and Powers of the Authority Having Jurisdiction.

103.2 Liability. The Authority Having Jurisdiction charged with the enforcement of this code, acting in good faith and without malice in the discharge of the Authority Having Jurisdiction’s duties, shall not thereby be rendered personally liable for damage that accrues to persons or property as a result of an act or by reason of an act or omission in the discharge of such duties. A suit brought against the Authority Having Jurisdiction or employee because of such act or omission performed in the enforcement of provisions of this code shall be defended by legal counsel provided by this jurisdiction until final termination of such proceedings. When the Authority Having Jurisdiction has not acted in good faith or has acted with malice, such jurisdiction shall be rendered liable.

SUBSTANTIATION:
While the AHJ has the authority to enforce this code, it does not allow a free reign to approve unauthorized, prohibited, hazardous, or otherwise unsafe systems to be installed. The AHJ or person(s) making such decisions should be held liable, including their jurisdictions. AHJs are government or private entities that have the force of law behind them. The AHJ may be a federal, state, local, or other regional department or individual such as a building official, fire chief, fire marshal, labor department, health department, or others having statutory authority.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The language is not relevant to the code and not needed as legal action is not the same as administration. It would be difficult to determine when a person has "not acted in good faith or malice." Making the jurisdiction liable is not feasible.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 002
UMC 2024  Section: 104.3.1

SUBMITTER: Adam Segura
Self

RECOMMENDATION:
Revise text

104.0 Permits.

104.3.1 Construction Documents. Construction documents, engineering calculations, diagrams, and other data shall be submitted in two or more sets, or in a digital format where permitted by the Authority Having Jurisdiction, with each application for a permit. The construction documents, computations, and specifications shall be prepared by, and the mechanical system designed by, a registered design professional. Construction documents shall be drawn to scale with clarity to identify that the intended work to be performed is in accordance with the code.

Exception: The Authority Having Jurisdiction shall be permitted to waive the submission of construction documents, calculations, or other data where the Authority Having Jurisdiction finds that the nature of the work applied for is such that reviewing of construction documents is not necessary to obtain compliance with the code.

SUBSTANTIATION:
While paper documentation is still used in the field, digital versions of documentation are also permitted by jurisdictions. The addition of this language will eliminate the paper documents from being printed where not necessary and will allow faster submission of documents where digital format is allowed and accepted.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 003
UMC 2024 Section: 104.4.5

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

104.0 Permits.

104.4 Permit Issuance. (remaining text unchanged)

104.4.5 Suspension or Revocation. The Authority Having Jurisdiction shall be permitted to, in writing, with written notification, to suspend or revoke a permit issued under the provisions of this code where the permit is issued in error or on the basis of incorrect information supplied or in violation of other ordinance or regulation of the jurisdiction.

SUBSTANTIATION:
The phrasing of Section 104.4.5 is being revised for clarity as the language is awkwardly written.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
CHAPTER 2
DEFINITIONS

203.0 – A –
Anodeless Riser. An assembly of steel-cased plastic pipe used to make the transition between plastic piping installed underground and metallic piping installed aboveground. [NFPA 54:3.3.4 3.3.3]

Appliance, Fan-Assisted Combustion System. An appliance equipped with an integral mechanical means to either draw or force products of combustion through the combustion chamber or heat exchanger. [NFPA 54:3.3.5.4 3.3.95.2]

Appliance Categorized Vent Diameter/Area. The minimum vent diameter/area permissible for Category I appliances to maintain a nonpositive vent static pressure when tested in accordance with nationally recognized standards. [NFPA 54:3.3.6 3.3.5]

204.0 – B –
Broiler. A general term including broilers, salamanders, barbecues, and other devices cooking primarily by radiated heat, excepting toasters. [NFPA 54:3.3.45 3.3.14]

205.0 – C –
Chimney. One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outdoors. [NFPA 54:3.3.48 3.3.17]

Chimney, Factory-Built. A chimney composed of listed factory-built components assembled in accordance with the manufacturer’s installation instructions to form the completed chimney. [NFPA 54:3.3.18.2 3.3.17.2]

Chimney, Masonry. A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units, or reinforced Portland cement concrete, lined with suitable chimney flue liners. [NFPA 54:3.3.18.3 3.3.17.3]

Chimney, Metal. A field-constructed chimney of metal. [NFPA 54:3.3.18.4 3.3.17.4]

Clothes Dryer. An appliance used to dry wet laundry by means of heat. [NFPA 54:3.3.19 3.3.18]

Clothes Dryer, Type 1. Primarily used in family living environment. May or may not be coin-operated for public use. [NFPA 54:3.3.19.1 3.3.18.1]

Clothes Dryer, Type 2. Used in business with direct intercourse of the function with the public. May or may not be operated by public or hired attendant. May or may not be coin-operated. [NFPA 54:3.3.19.2 3.3.18.2]

Combustion Chamber. The portion of an appliance within which combustion occurs. [NFPA 54:3.3.24 3.3.20]

Conversion Burner, Gas. A unit consisting of a burner and its controls utilizing gaseous fuel for installation in an appliance originally utilizing another fuel. [NFPA 54:3.3.47.2 3.3.16.2]

206.0 – D –
Direct Gas-Fired Nonrecirculating Industrial-Air-Heater Heating and Forced Ventilation Appliances for Commercial and Industrial Application. A nonrecirculating industrial air heater direct gas-fired heating and forced ventilation appliance in which all the products of combustion generated by the appliance are released into the outdoor airstream being heated. [NFPA 54:3.3.56.1 3.3.56.2]

Direct Gas-Fired Recirculating Industrial-Air-Heater Heating and Forced Ventilation Appliances for Commercial and Industrial Application. An air recirculating heater direct gas-fired heating and forced ventilation appliance in which all of the products of combustion generated by the appliance are released into the airstream being heated. [NFPA 54:3.3.56.2 3.3.56.4]
**Direct Vent Appliances.** Appliances that are constructed and installed so that all air for combustion is derived directly from the outdoors and all flue gases are discharged to the outdoors. [NFPA 54:3.3.5.3 3.3.4.2]

**Draft Hood.** A nonadjustable device built into an appliance, or made a part of the vent connector from an appliance, that is designed to:
1. Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
2. Prevent a backdraft from entering the appliance.
3. Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.31 3.3.30]

**Draft Hood.** A nonadjustable device built into an appliance, or made a part of the vent connector from an appliance, that is designed to:
1. Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
2. Prevent a backdraft from entering the appliance.
3. Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.31 3.3.30]

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1. Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
2. Prevent a backdraft from entering the appliance.
3. Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.31 3.3.30]

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1. Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
2. Prevent a backdraft from entering the appliance.
3. Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.31 3.3.30]

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1. Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
2. Prevent a backdraft from entering the appliance.
3. Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.31 3.3.30]

**Effective Ground-Fault Current Path.** An intentionally constructed, low impedance electrically conductive path designed and intended to carry current under ground-fault conditions from the point of a ground fault on a wiring system to the electrical supply source and that facilitates the operation of the overcurrent protective device or ground-fault detectors. [NFPA 54:3.3.33]

**Engineering Methods.** Design methods that rely on the application of mathematics, sciences, empirical evidence, and engineering principles. [NFPA 54:3.3.34]

**Excess Flow Valve (EFV).** A valve designed to activate when the fuel gas passing through it exceeds a prescribed flow rate. [NFPA 54:3.3.99.3 3.3.98.3]

**219.0 – Q –**

**Quick-Disconnect Device, Fuel Gas.** A hand-operated device that provides a means for connecting and disconnecting an appliance or an appliance connector to a gas supply and that is equipped with an automatic means to shut off the gas supply when the device is disconnected. [NFPA 54:3.3.28.3 3.3.27.3]

**224.0 – V –**

**Vent Offset.** An arrangement of two or more fittings and pipe installed for the purpose of locating a vertical section of vent pipe in a different but parallel plane with respect to an adjacent section of vertical vent pipe. [NFPA 54:3.3.102 3.3.101]

**Vented Appliance Categories.**

**Category I.** An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent. [NFPA 54:3.3.5.11.1 3.3.5.10.1]

**Category II.** An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that can cause excessive condensate production in the vent. [NFPA 54:3.3.5.11.2 3.3.5.10.2]

**Category III.** An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent. [NFPA 54:3.3.5.11.3 3.3.5.10.3]

**Category IV.** An appliance that operates with a positive vent static pressure and with a vent gas temperature that can cause excessive condensate production in the vent. [NFPA 54:3.3.5.11.4 3.3.5.10.4]

**SUBSTANTIATION:**
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 2 is being revised to the latest edition of NFPA 54-2021.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 005
UMC 2024  Section: Chapter 2

SUBMITTER: IAPMO Staff - Update Extracts
NFPA 96 Extract Update

RECOMMENDATION:
Revise text

204.0  – B –
Baffle Plate. An object placed in or near an appliance to change the direction or retard the flow of air, air-fuel mixtures, or flue gases. [NFPA 96:3.3.8]

205.0  – C –
Confined Space. A room or space having a volume less than 50 cubic feet per 1000 British thermal units per hour (Btu/h) (4.83 m³/kW) of the aggregate input rating of all fuel-burning appliances installed in that space. (NFPA 96:3.3.47.2)

208.0  – F –
Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with ASTM E119 or UL 263. [NFPA 96:3.3.25]

Fume Incinerators. Devices utilizing that use intense heat or fire to break down, oxidize, or both, vapors and odors contained in gases or air being exhausted into the atmosphere. ([NFPA 96:3.3.27])

214.0  – L –
Liquid-Tight. Constructed and performing in such a way that prevents manner as not to permit the passage of liquid at any temperature. [NFPA 96:3.3.35]

221.0  – S –
Solid Cooking Fuel. A Any solid, organic, consumable fuel such as briquettes, mesquite, hardwood, or charcoal. [NFPA 96:3.3.45]

Solvent. A substance (usually liquid) capable of dissolving or dispersing another substance; a chemical compound designed and used to convert solidified grease into a liquid or semiliquid state in order to facilitate a cleaning operation. [NFPA 96:3.3.46]

SUBSTANTIATION:
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 2 is being revised to the latest edition of NFPA 96-2021.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 006

UMC 2024  Section: 203.0

SUBMITTER:  Phil Pettit
              Control Air Conditioning Corporation
              Rep. Self

RECOMMENDATION:
Add new text

203.0   – A –

Air Exfiltration. Leakage of air from a conditioned space(s) to an unconditioned space(s) or to the outdoors through openings in the building envelope, often attributable to wind pressure, stack pressure, or positive pressurization of the building. Also known as air leakage.

Air Infiltration. Leakage of outdoor air or air from an unconditioned space(s) into a conditioned space(s) through openings in the building envelope, often attributable to wind pressure, stack pressure, or negative pressurization of the building. Also known as air leakage.

SUBSTANTIATION:
It is critical to understand the pressures that occur on buildings which cause air infiltration and exfiltration. There are three major pressures: wind pressure, stack pressure, and fan/building pressure. The added definitions address the types and causes of air infiltration and exfiltration.

(1) Wind pressure tends to pressurize a building positively on the side it is hitting, and as the wind goes around the corner of the building it speeds up considerably, creating especially strong negative pressure at the corners and less strong negative pressure on the rest of the building walls and roof. Wind pressure on buildings is significant in calculating energy or moisture-related air leakage in buildings.

(2) Stack effect can move large volumes of air through a building envelope. It is caused by a difference in atmospheric pressure at the top and bottom of a building due to temperature. Temperature variation causes a difference in the weight of the columns of air indoors vs. outdoors. In the winter, the warm air in a heated building is lighter (less dense) than the cold air outside the building. That warm air bubble wants to rise up and out. When it does, the flow of air leaving the top of the building draws cold air into cracks at the bottom. The reverse occurs in warm climates with air-conditioning.

(3) Fan pressure is caused by HVAC system pressurization. Fan pressures can create negative pressure on the building envelope, drawing in cool, dry air in the winter and hot, humid air in the summer. Alternatively, positive fan pressures push warm, moist air into the building envelope in the winter, depositing condensation on surfaces within wall and roof enclosures.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 007
UMC 2024  Section: 203.0

SUBMITTER: David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Revise text

203.0 – A –
Air-Handling Unit. A blower or fan used for the purpose of distributing supply air to a room, space, zone, or area.

SUBSTANTIATION:
The term “zone” is commonly used to describe an area served by an Air-Handling Unit (AHU). Therefore, along with the list of “room,” “space,” and “area,” the term “zone” is being added to clarify that an AHU also serves supply air to a “zone.”

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 008
UMC 2024  Section: 203.0

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Add new text

203.0  – A –
Air, Recirculated. Air that is removed from a conditioned space, mixed with outside air, and reused as supply air.

SUBSTANTIATION:
The term “recirculated air” is used in the code but is not currently defined. Recirculated air is air that was used to condition space and removed from the space, mixed with fresh outdoor air, and reused as supply air in either the space of origin or other conditioned space. Therefore, this definition clearly states what recirculated air is as it is used in the code.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

203.0  – A –
Air, Recirculated. Air that is removed from a conditioned space or zone, mixed with outside air, and reused as supply air.

COMMITTEE STATEMENT:
The definition is being modified to add "or zone" as the term is commonly used to describe a conditioned space. In addition, the phrase "mixed with outside air" is being removed as recirculated air is not always mixed with outside air.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 009

UMC 2024  Section: 203.0, 207.0, 218.0, E 503.6.5.3, E 503.6.5.4

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

203.0  – A –
Air, Return. Air from the conditioned area that is returned through ducts or plenums to the conditioning equipment for reconditioning.
Air, Supply. Air being conveyed to a conditioned area through ducts or plenums from a heat exchanger of a heating, cooling, absorption, or evaporative cooling system.

207.0  – E –
Evaporative Cooling System. Equipment intended or installed for the purpose of environmental cooling by an evaporative cooler from which the conditioned air is distributed through ducts or plenums to the conditioned area.

218.0  – P –
Portable Evaporative Cooler. An evaporative cooler that discharges the conditioned air directly into the conditioned area without the use of ducts and can be readily transported from place to place without dismantling any portion thereof.

E 503.6.5.3 System Balancing. Construction documents shall require that HVAC systems be balanced in accordance with generally accepted engineering standards. Construction documents shall require that a written balance report be provided to the building owner or the designated representative of the building owner for HVAC systems serving zones with a total conditioned area exceeding 5000 square feet (464.52 m²). ([ASHRAE 90.1:6.7.2.3.1])

E 503.6.5.4 System Commissioning. HVAC control systems shall be tested to ensure that control elements are calibrated, adjusted, and in proper working condition. For projects larger than 50 000 square feet (4645.15 m²) conditioned area, except warehouses and semiheated spaces, detailed instructions for commissioning HVAC systems shall be provided by the designer in plans and specifications. ([ASHRAE 90.1:6.7.2.4]).

(below shown for reference only)

205.0  – C –
Conditioned Space. An area, room, or space normally occupied and being heated or cooled for human comfort by any equipment.

SUBSTANTIATION:
This proposal changes all phrasing of “conditioned area” to “conditioned space” as there is no definition for “conditioned area” but there is a definition for “conditioned space.”

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:
203.0    – A –
Air, Return. Air from the conditioned space or zone that is returned through ducts or plenums to the conditioning equipment for reconditioning.
Air, Supply. Air being conveyed to a conditioned space or zone through ducts or plenums from a heat exchanger of a heating, cooling, absorption, or evaporative cooling system.

207.0    – E –
Evaporative Cooling System. Equipment intended or installed for the purpose of environmental cooling by an evaporative cooler from which the conditioned air is distributed through ducts or plenums to the conditioned space or zone.

218.0    – P –
Portable Evaporative Cooler. An evaporative cooler that discharges the conditioned air directly into the conditioned space or zone without the use of ducts and can be readily transported from place to place without dismantling any portion thereof.

E 503.6.5.3 System Balancing. Construction documents shall require that HVAC systems be balanced in accordance with generally accepted engineering standards. Construction documents shall require that a written balance report be provided to the building owner or the designated representative of the building owner for HVAC systems serving zones with a total conditioned space or zone exceeding 5000 square feet (464.52 m²). {ASHRAE 90.1:6.7.3.3.1}

E 503.6.5.4 System Commissioning. HVAC control systems shall be tested to ensure that control elements are calibrated, adjusted, and in proper working condition. For projects larger than 50 000 square feet (4645.15 m²) conditioned space or zone, except warehouses and semiheated spaces, detailed instructions for commissioning HVAC systems shall be provided by the designer in plans and specifications. {ASHRAE 90.1:6.7.2.4}

COMMITTEE STATEMENT:
A modification is being made to add the wording “or zone” wherever the term “conditioned space” is used. This will allow for consistency throughout the code.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 010
UMC 2024  Section: 203.0

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Add new text

203.0  – A –
Air, Transfer. Air that is relocated from one conditioned space to another space through ducts, plenums, or transfer grills.

SUBSTANTIATION:
The term “transfer air” is used in the UMC but is not defined. A definition is needed to clarify what transfer air is. The proposed term is clear and consistent with how the term “transfer air” is used in the industry.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

203.0  – A –
Air, Transfer. Air that is relocated from one conditioned space or zone to another space through ducts, plenums, or transfer grills.

COMMITTEE STATEMENT:
The modification adds “or zone” wherever the term “space” is shown for consistency as used in other places in the code.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 011
UMC 2024  Section: 203.0, 205.0, 206.0, 207.0, 218.0

SUBMITTER: David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Revise text

[The terms are being relocated only]

205.0 – C –
Closed Combustion Solid-Fuel-Burning Appliance. A heat-producing appliance that employs a combustion chamber that has no openings other than the flue collar, fuel-charging door, and adjustable openings provided to control the amount of combustion air that enters the combustion chamber.

206.0 – D –
Direct Vent Appliances. Appliances that are constructed and installed so that all air for combustion is derived directly from the outdoors and all flue gases are discharged to the outdoors. [NFPA 54:3.3.5.3]

207.0 – E –
Electric Heating Appliance. A device that produces heat energy to create a warm environment by the application of electric power to resistance elements, refrigerant compressors, or dissimilar material junctions.

218.0 – P –
Portable Heating Appliance. A heating appliance designed for environmental heating that may have a self-contained fuel supply and is not secured or attached to a building by any means other than by a factory-installed power supply cord.

203.0 – A –
Appliance. A device that utilizes an energy source to produce light, heat, power, refrigeration, air conditioning, or compressed fuel gas. This definition also shall include a vented decorative appliance.

Appliance, Closed Combustion Solid-Fuel-Burning. A heat-producing appliance that employs a combustion chamber that has no openings other than the flue collar, fuel-charging door, and adjustable openings provided to control the amount of combustion air that enters the combustion chamber.

Appliance, Direct Vent. Appliances that are constructed and installed so that all air for combustion is derived directly from the outdoors and all flue gases are discharged to the outdoors. [NFPA 54:3.3.4.2]

Appliance, Electric Heating. A device that produces heat energy to create a warm environment by the application of electric power to resistance elements, refrigerant compressors, or dissimilar material junctions.

Appliance, Portable Heating. A heating appliance designed for environmental heating that may have a self-contained fuel supply and is not secured or attached to a building by any means other than by a factory-installed power supply cord.

SUBSTANTIATION:
This code change relocates the definitions of "Closed Combustion Solid-Fuel-Burning Appliance," “Direct Vent Appliances,” “Electric Heating Appliance,” and “Portable Heating Appliance" to below “Appliance” for ease of locating the terms. Simple cleanup.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
An editorial revision has been made to reflect “Appliance,” in front of the defined terms, which is consistent with editorial modifications made to other items.
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
203.0 – A –
Appliance. A device that utilizes fuel or electricity as an energy source to produce light, heat, power, refrigeration, or air conditioning, or compressed fuel gas. This definition also shall include a-vented decorative appliances and electric storage or tankless water heaters.

SUBSTANTIATION:
The change removes enforceable language that is not permitted in a definition per the Manual of Style. The update also removes “compressed fuel gas” as it is used out of context and is now addressed under “fuel.”

Furthermore, the additional language to the “Appliance” definition reintroduces electric water heaters into the mechanical code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 013
UMC 2024  Section: 203.0

SUBMITTER: David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Add new text

203.0 – A –
Appliance. A device that utilizes an energy source to produce light, heat, power, refrigeration, air conditioning, or compressed fuel gas. This definition also shall include a vented decorative appliance.

Appliance, Vented. An appliance designed and installed in such a manner that all products of combustion are conveyed directly from the appliance to the outdoor atmosphere through an approved chimney or vent system.

SUBSTANTIATION:
This code change adds a definition for “Vented Appliance” as the term is used in the code but is currently not defined. The proposed definition clearly describes the term.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
An editorial revision has been made to reflect “Appliance, Vented” in the term title which is consistent with editorial modifications made to other items.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 014
UMC 2024  Section: 203.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

203.0 – A –
Authorized Personnel. Any person who is designated by the appointing authority.

SUBSTANTIATION:
A definition is being added for “Authorized Personnel” as the term is used several times in the code but not currently defined. See Sections 1104.4, 1106.10, 1106.11, 1112.11.2, 1305.1, and 1308.10.5.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as it is overly restrictive, and it is unclear who the “appointing authority” is.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 015
UMC 2024 Section: 204.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

204.0 – B –
Backflow. The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from sources other than its intended source.

SUBSTANTIATION:
A new definition for “Backflow” is being added as the term is currently used in the code but not defined. The definition correlates with the existing definition in the UPC.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 016

UMC 2024 Section: 203.0, 204.0, 210.0, 214.0, 215.0, 218.0, 221.0, 225.0

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

[The terms are being relocated only]

203.0 – A –
Automatic Boiler. A boiler equipped with certain controls and limit devices.

204.0 – B –
Boiler, High-Pressure. A boiler for generating steam at gauge pressures in excess of 15 psi (103 kPa), or for heating water to a temperature in excess of 250°F (121°C) or at a gauge pressure in excess of 160 psi (gauge pressure of 1103 kPa). [NFPA 211:3.3.14.2]

210.0 – H –
Hot-Water-Heating Boiler. A boiler having a volume exceeding 120 gallons (454 L), a heat input exceeding 200,000 Btu/h (58.6 kW), or an operating temperature exceeding 210°F (99°C) that provides hot water to be used externally to itself.

214.0 – L –
Low-Pressure Hot-Water-Heating Boiler. A boiler furnishing hot water at pressures not exceeding 160 psi (1103 kPa) and at temperatures not exceeding 250°F (121°C).

Low-Pressure Steam-Heating Boiler. A boiler furnishing steam at pressures not exceeding 15 psi (103 kPa).

215.0 – M –
Miniature Boiler. A power boiler having an internal shell diameter of 16 inches (406 mm) or less, a gross volume of 5 cubic feet (0.14 m³) or less, a heating surface of 20 square feet (1.86 m²) or less (not applicable to electric boilers), and not exceeding 100 psi (689 kPa).

218.0 – P –
Package Boiler. A class of boiler defined herein and shall be a boiler equipped and shipped complete with fuel-burning equipment, automatic controls and accessories, and mechanical draft equipment.

Power Boiler. A boiler in which steam is generated at pressures exceeding 15 psi (103 kPa).

Power Hot Water Boiler (High Temperature Water Boiler). A boiler used for heating water or liquid to a pressure exceeding 160 psi (1103 kPa) or to a temperature exceeding 250°F (121°C).

221.0 – S –
Steam-Heating Boiler. A boiler operated at pressures not exceeding 15 psi (103 kPa) for steam.

225.0 – W –
Water Heater or Hot-Water-Heating Boiler. An appliance designed primarily to supply hot water for domestic or commercial purposes and equipped with automatic controls limiting water temperature to a maximum of 210°F (99°C).
Boiler. A closed vessel used for heating water or liquid, or for generating steam or vapor by direct application of heat from combustible fuels or electricity.

**Boiler, Automatic.** A boiler equipped with certain controls and limit devices.

**Boiler, High-Pressure.** A boiler for generating steam at gauge pressures in excess of 15 psi (103 kPa), or for heating water to a temperature in excess of 250°F (121°C) or at a gauge pressure in excess of 160 psi (gauge pressure of 1103 kPa). [NFPA 211:3.3.14.2]

**Boiler, Hot-Water-Heating.** A boiler having a volume exceeding 120 gallons (454 L), a heat input exceeding 200,000 Btu/h (58.6 kW), or an operating temperature exceeding 210°F (99°C) that provides hot water to be used externally to itself.

**Boiler, Low-Pressure Hot-Water-Heating.** A boiler furnishing hot water at pressures not exceeding 160 psi (1103 kPa) and at temperatures not exceeding 250°F (121°C).

**Boiler, Low-Pressure Steam-Heating.** A boiler furnishing steam at pressures not exceeding 15 psi (103 kPa).

**Boiler, Miniature.** A power boiler having an internal shell diameter of 16 inches (406 mm) or less, a gross volume of 5 cubic feet (0.14 m³) or less, a heating surface of 20 square feet (1.86 m²) or less (not applicable to electric boilers), and not exceeding 100 psi (689 kPa).

**Boiler, Package.** A class of boiler defined herein and shall be a boiler equipped and shipped complete with fuel-burning equipment, automatic controls and accessories, and mechanical draft equipment.

**Boiler, Power.** A boiler in which steam is generated at pressures exceeding 15 psi (103 kPa).

**Boiler, Power Hot Water (High Temperature Water Boiler).** A boiler used for heating water or liquid to a pressure exceeding 160 psi (1103 kPa) or to a temperature exceeding 250°F (121°C).

**Boiler, Steam-Heating.** A boiler operated at pressures not exceeding 15 psi (103 kPa) for steam.

**Boiler, Water Heater or Hot-Water-Heating.** An appliance designed primarily to supply hot water for domestic or commercial purposes and equipped with automatic controls limiting water temperature to a maximum of 210°F (99°C).

**SUBSTANTIATION:**
This code change relocates the definitions relating to boilers below the definition of "Boiler" for ease of use in locating boiler-related terms.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**COMMITTEE STATEMENT:**
An editorial revision has been made to reflect “Boiler,” in front of the defined terms, which is consistent with editorial modifications made to other items.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 017
UMC 2024 Section: 205.0

SUBMITTER: Lance MacNevin, P.Eng.
Chair, UMC Radiant Cooling Working Group

RECOMMENDATION:
Revise text

205.0 – C –

Chilled Water. Water or fluid that is cooled below its ambient temperature via mechanical or other means for the purpose of removing excess heat from conditioned spaces or equipment via hydronic piping distribution.

SUBSTANTIATION:
The UMC Radiant Cooling Working Group was formed in January 2020 by members of ASHRAE TC 6.5, Radiant Heating and Cooling, to address concerns with existing UMC language in Section 1217.3. The working group met through a series of calls throughout 2020 to finalize the language submitted in this proposal.

Proposal 4:
A definition for Chilled Water does not currently exist in the Code. This new definition will assist users who may be unfamiliar with hydronic cooling and especially radiant cooling where there may be multiple temps.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The term "ambient" is ambiguous. The definition is confusing as it contains both "water" and "fluid," which is not clear. The term "fluid" can be a liquid or gas, which can be misinterpreted. The definition is needed but needs work to clarify the intent. Furthermore, there is insufficient technical justification to warrant the new definition.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 24 NEGATIVE: 5 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:
ARYAN: The definition is a bit unclear and needs to be reworded.
KOERBER: I believe a definition is warranted, although wording should be adjusted during the comment phase.
MACNEVIN: A definition for "Chilled Water" is needed for the UMC. An improved proposal will be submitted during public comment, based on feedback from the UMC hearing.
TRAFTON, A: Although the definition is flawed, I believe it is needed in the code as these systems are prevalent in HVAC systems.
TRAFTON, P: A definition is needed for "Chilled Water" as it is one of the more widely used systems that the UMC must address. While this one is a little flawed, I would strongly recommend amending it to get it in the Code.
Proposals

Item #: 018

UMC 2024  Section: 205.0

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

205.0  – C –
Conditioned Space. An area, room, or space normally occupied and being heated or cooled for human comfort by any appliance or equipment.

SUBSTANTIATION:
The definition of “conditioned space” should be revised as a conditioned space is not always "normally occupied" and is not always for "human comfort." For example, computer rooms or data rooms can be conditioned spaces, but are not used for human comfort, rather they are for maintaining suitable temperatures for the functionality of the computer equipment.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

205.0  – C –
Conditioned Space. An area, room, or space, or zone being heated or cooled by an appliance or equipment.

COMMITTEE STATEMENT:
A modification is being made to add the wording "or zone" after the term "space." This will allow for consistency throughout the code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 019

UMC 2024  Section: 206.0

SUBMITTER:  Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Add new text

206.0  – D –
Design Pressure. The maximum allowable pressure for which a specific part of a system is designed.

SUBSTANTIATION:
The UMC references the term “Design Pressure” throughout the code, however there is no definition. A definition is needed for clarity. The code change correlates with the USHGC. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The definition is being rejected as there are other purposes of “design pressure,” such as for refrigerant, and the proposed definition may cause confusion. The definition needs work to clarify the intent. Furthermore, this term is already defined in the UMC and will conflict with the existing definition.

Additionally, the Technical Committee disagrees with the the substantiation regarding the necessity for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

TRAFTON, P: I agree with Randy Young that this belongs in the Code, but currently, the definition is incomplete and not enforceable.

YOUNG: As a Committee member would I like to see this cleaned up, and possibly brought back either in comment form or next cycle.

EXPLANATION OF NEGATIVE:

TRAFTON, A: Although the definition is incomplete, I believe that this should be workshopped and added as many different systems require different pressure requirements.
Proposals

Item #: 020
UMC 2024  Section: 206.0

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Add new text

206.0  – D –
Direct Exchange (DX). A ground-source heat pump that circulates a refrigerant through a closed-loop system. Also known as direct expansion unit or direct expansion system.

SUBSTANTIATION:
The term Direct Exchange (DX) is used in both Appendix E and Appendix F of the UMC. The term is also known as direct expansion unit or direct expansion system. Therefore, a definition is being added to Chapter 2 that also correlates with the USHGC.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The definition is needed, however, should be rewritten to add reference to “direct geothermal exchange” which will better clarify the intent of the definition as used in the appendices. The proposed definition is better suited in Appendix E and Appendix F.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

YOUNG: A better, clearly defined definition would be a positive addition to the code if placed in Appendix E and F. I would like to see this brought back in either comment form or next cycle and with no reference to correlation.
Proposals

Item #: 021
UMC 2024  Section: 206.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

206.0  – D –
Drain. A pipe that carries waste or waterborne wastes in a building drainage system.

Drainage System. Includes all the piping within public or private premises that conveys sewage, storm water, or other liquid wastes to a legal point of disposal, but does not include the mains of a public sewer system or a public sewage treatment or disposal plant.

SUBSTANTIATION:
The new definitions are being added as the terms are currently used in the code but not defined. Furthermore, the definitions correlate with the existing definitions in the UPC.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the proposed definitions may cause confusion in the UMC. For example, there are drain lines in heating and cooling lines that do not carry waste.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 022
UMC 2024  Section: 206.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

206.0       – D –
**Dual Purpose Water Heater.** An appliance utilized as a heat source for both space heating and domestic hot water applications.

SUBSTANTIATION:
UMC Sections 1002.5, 1202.3, 1203.2, 1207.3, and 1219.1 reference Dual Purpose Water Heaters. Therefore, a definition for the term is being added to clarify what a dual purpose water is and the intent of the code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 18  NEGATIVE: 11  NOT RETURNED: 1 Heine

Note: Item # 022 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.

EXPLANATION OF NEGATIVE:

ARYAN: The definition is unclear and needs to be reworded.

BALLANCO: Seeing Michael Cudahy's comment, I would have to agree that this definition needs to be cleaned up. In my own house, I have a dual-purpose water heater that is only used for heating potable water. It is listed for both applications, but I chose to use it for only one application. Perhaps it should state, "that can be utilized."

CUDAHY: I think this needs "designed to be" or "intended to be" or anyone could use any water heater for the purpose and that could have consequences.

Dual Purpose Water Heater. An appliance "designed to be" utilized as a heat source for both space heating and domestic hot water applications.

FEEHAN: The language is not clear and needs to be corrected.

KOERBER: I agree that the definition could use more clarification to prevent potentially incorrect application.

MACNEVIN: Such a definition is needed, but the proposed definition should be revised during public comment as there are specific requirements for what is an appropriate "dual-purpose" water heater.

TERZIGNI: Cleaning up the language as suggested would be better. Fix in Public comment.

TRAFTON, A: I agree with Michael Cudahy. I have seen a water heater used improperly. These units are used extensively and we should be crystal clear in our definition.

TRAFTON, P: Definitely needs some adjustments as noted by several other members. Not currently clear.
The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UPC Item # 100 and UMC Item # 022 resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

206.0 – D –  
**Dual Purpose Water Heater.** An appliance intended to be a heat source for both space heating and domestic hot water applications.

**TCC ACTION:** ACCEPT AS SUBMITTED

**TCC STATEMENT:**
The definition of “Dual Purpose Water Heater” in UMC Item # 022 is being added to correlate with the action taken by the UPC TC for Item # 100. Additionally, UMC Item # 022 is being revised to correct an oversight by replacing the phrase “utilized as” to “intended to be.”

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for the definition of “Dual Purpose Water Heater” to correlate with the 2021 UPC by adding the definition.
Proposals

Item #: 023

UMC 2024 Section: 206.0, 207.0, 209.0, 218.0

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

[The terms are being relocated only]

207.0 – E –
Environmental Air Duct. Ducting used for conveying air at temperatures not exceeding 250°F (121°C) to or from occupied areas of any occupancy through other than heating or air-conditioning systems, such as ventilation for human usage, domestic kitchen range exhaust, bathroom exhaust ducts, and domestic-type clothes dryer exhaust ducts.

209.0 – G –
Grease Ducts. A containment system for the transportation of air and grease vapors that is designed and installed to reduce the possibility of the accumulation of combustible condensation and the occurrence of damage if a fire occurs within the system. [NFPA 96:3.3.20.2]

218.0 – P –
Product-Conveying Duct. Ducting used for conveying solid particulates, such as refuse, dust, fumes, and smoke; liquid particulate matter, such as spray residue, mists, and fogs; vapors, such as vapors from flammable or corrosive liquids; noxious and toxic gases; and air at temperatures exceeding 250°F (121°C).

206.0 – D –
Duct. A tube or conduit for transmission of air, fumes, vapors, or dust. This definition shall not include:
(1) A vent, vent connector, or chimney connector.
(2) A tube or conduit wherein the pressure of the air exceeds 1 psi (7 kPa).
(3) The air passages of listed self-contained systems.

Duct, Environmental Air. Ducting used for conveying air at temperatures not exceeding 250°F (121°C) to or from occupied areas of any occupancy through other than heating or air-conditioning systems, such as ventilation for human usage, domestic kitchen range exhaust, bathroom exhaust ducts, and domestic-type clothes dryer exhaust ducts.

Duct, Grease. A containment system for the transportation of air and grease vapors that is designed and installed to reduce the possibility of the accumulation of combustible condensation and the occurrence of damage if a fire occurs within the system. [NFPA 96:3.3.20.2]

Duct, Product-Conveying. Ducting used for conveying solid particulates, such as refuse, dust, fumes, and smoke; liquid particulate matter, such as spray residue, mists, and fogs; vapors, such as vapors from flammable or corrosive liquids; noxious and toxic gases; and air at temperatures exceeding 250°F (121°C).

SUBSTANTIATION:
This code change relocates the definitions of “Environmental Air Duct,” “Grease Ducts,” and “Product-Conveying Duct” to below “Duct” for ease of locating the terms. Simple cleanup.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
COMMITTEE STATEMENT:
An editorial revision has been made to reflect “Duct,” in front of the defined terms, which is consistent with editorial modifications made to other items.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 024
UMC 2024  Section: 206.0

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Add new text

206.0 – D –
Duct Sealing. The use of approved adhesives, gaskets, tape, mastics, or combination thereof to close openings in the surface of the ductwork, field erected plenums, equipment, and casings through which air leakage would occur, or the use of continuous welds.

SUBSTANTIATION:
There is currently no definition in the UMC for duct sealing.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 025

UMC 2024  Section: 206.0

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Add new text

206.0  – D –
Duct Sealing Classes.
Seal Class A. All transverse joints, longitudinal seams, duct wall, and screw penetrations.
Seal Class B. All transverse joints and longitudinal seams.
Seal Class C. Transverse joints.

SUBSTANTIATION:
I would like to add definitions for the various seal classes as outlined in SMACNA Duct Construction Standards. This is important to understand the joints and seams that shall be sealed to prevent air leakage in duct systems.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

206.0  – D –
Duct Sealing Classes.
Seal Class A. All transverse joints, longitudinal seams, and duct wall, and screw penetrations.
Seal Class B. All transverse joints and longitudinal seams.
Seal Class C. Transverse joints.

COMMITTEE STATEMENT:
The proposed language is being modified to remove “screw” from Seal Class A as there has been concern with enforcing screwed penetrations in the field.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

YOUNG: Screw penetrations should also be sealed as long as it would not render a component in the system inoperable, and when practical. I understand the amendment made on the floor during the TC meeting.
Proposals

Item #: 026
UMC 2024  Section: 207.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

207.0  – E –
Environmental Air Duct. Ducting used for conveying air at temperatures not exceeding 250°F (121°C) to or from occupied areas of any occupancy through other than heating or air-conditioning systems, such as ventilation for human usage, domestic kitchen range exhaust, bathroom exhaust ducts, locker room exhaust ducts, shower room exhaust ducts, janitor’s closet exhaust ducts, and domestic-type clothes dryer exhaust ducts.

SUBSTANTIATION:
There has been confusion for years about combining bathroom exhaust ducts with locker room exhaust ducts, shower room exhaust ducts, and/or janitor’s closet exhaust ducts. The proposed code change would eliminate confusion regarding which exhaust ducts are permitted to be interconnected.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

WHITE: The proposal engages in expanding list making. This leads users to think these are the only uses. I do not see how this definition accomplishes the clarification of which ducts may be combined as stated in the substantiation.
Proposals

Item #: 027

UMC 2024 Section: 207.0

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Add new text

207.0 – E –
Expansion Tank. A vessel used to protect closed systems from excessive fluid pressure.

SUBSTANTIATION:
The term “expansion tank” is used throughout the UMC along with provisions for such tanks. These types of tanks provide protection because they accept the increase in thermal fluid volume as a result of thermal expansion. They also assist in system startup and operation by acting as a mechanism which accepts entrained air. The provided definition is necessary as it pertains to various systems within the UMC and clarifies that these tanks are meant to protect such closed systems from excessive pressures.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

207.0 – E –
Expansion Tank. A vessel used to protect closed systems from excessive fluid pressure.

COMMITTEE STATEMENT:
The term “fluid” is being removed as the term is not necessary to describe an expansion tank and the pressure in an expansion tank may be caused by air or fluid. These tanks are meant to protect such closed systems from excessive pressure.

Additionally, the Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28 NEGATIVE: 1 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:

WHITE: I do not agree with the definition. The tank does not protect against excessive pressure, a relief valve does. The tank may limit pressure transients or allow for thermal expansion, but if a pressure reducing fill valve fails or is bypassed, the tank will not stop excessive pressure in the closed system.
Proposals

Item #: 028

UMC 2024  Section: 208.0

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Add new text

208.0  – F –
Fire Barrier. A fire-resistance-rated wall or assembly of materials designed to restrict the spread of fire in which continuity is maintained.

(below shown for reference only)

208.0  – F –
Fire Wall. A wall separating buildings or subdividing a building to prevent the spread of the fire and having a fire resistance rating and structural stability. [NFPA 96:3.3.26]
Fire Partition. An interior wall or partition of a building that separates two areas and serves to restrict the spread of fire but does not qualify as a fire wall.

SUBSTANTIATION:
The terms “fire wall” and “fire partition” are used and defined in the UMC. However, the term “fire barrier” is also used in the UMC but is not defined. This code change adds a clear definition for “fire barrier” for completeness in the code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 029
UMC 2024  Section: 208.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

208.0 – F –
Flue Collar. That portion of an appliance designed for the attachment of a draft hood, vent connector, or venting system. [NFPA 54:3.3.44]

SUBSTANTIATION:
A new definition for “Flue Collar” is being added as the term is currently used in the code but not defined. The definition correlates with NFPA 54 and the existing definition in the UPC.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 030
UMC 2024 Section: 208.0, 209.0, 214.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

208.0 – F –
Fuel Gas. Natural, manufactured, liquefied petroleum, or a mixture of these.

214.0 – L –
Liquefied Petroleum Gas (LP-Gas). Means and includes a material composed predominantly of any of the following hydrocarbons or mixtures of them: propane, propylene, butanes (normal butane or isobutane), and butylenes. When reference is made to liquefied petroleum gas in this code, it shall refer to liquefied petroleum gases in either the liquid or gaseous state.

209.0 – G –
Gas. A substance used as fuel, such as natural, liquefied petroleum (LP-Gas), and mixtures of these gases, with gas-air mixtures within the flammable range.

Fuel Gas. Natural, manufactured, liquefied petroleum, or a mixture of these.
Flue Gas. Products of combustion with excess air in appliance flues or heat exchangers.
Liquefied Petroleum Gas (LP-Gas). Means and includes a material composed predominantly of any of the following hydrocarbons or mixtures of them: propane, propylene, butanes (normal butane or isobutane), and butylenes. When reference is made to liquefied petroleum gas in this code, it shall refer to liquefied petroleum gases in either the liquid or gaseous state.
Utility Gas. See Fuel Gas.

SUBSTANTIATION:
Definitions are being added for “Gas,” “Flue Gas,” and “Utility Gas” to add clarity to the code. The definitions for the terms are consistent with industry standards. The definitions for “Fuel Gas” and “Liquefied Petroleum Gas (LP-Gas)” are being relocated to under the new definition of “Gas.”

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 27 NEGATIVE: 2 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:

WHITE: The proposal makes all gases flammable which is not true. The code makes use of inert gases such as nitrogen. I can support the sub-definitions, but the overall definition of gas is wrong even if you say "for the purposes of this code."

WISEMAN: I disagree with the definition.
Proposals

Item #: 031

UMC 2024  Section: 209.0

SUBMITTER: Karan Kapila
Self

RECOMMENDATION:
Revise text

209.0  — G —
Gas Piping. An installation of pipe, valves, or fittings that are used to convey fuel gas, installed on any premises or in a building, but shall not include:

(1) A portion of the service piping;  
(2) An approved piping connection 6 feet (1829 mm) or less in length between an existing gas outlet and a gas appliance in the same room with the outlet.

(below shown for reference only)

1302.0 Coverage of Piping System.
1302.1 General. Coverage of piping systems shall extend from the point of delivery to the appliance connections. For other than undiluted liquefied petroleum gas (LP-Gas) systems, the point of delivery shall be the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where no meter is provided. For undiluted LP-Gas systems, the point of delivery shall be considered to be the outlet of the final pressure regulator, exclusive of line gas regulators where no meter is installed. Where a meter is installed, the point of delivery shall be the outlet of the meter. [NFPA 54:1.1.1.1(A)]

1312.0 Appliance and Equipment Connections to Building Piping.
1312.3.1 Indoor. Indoor gas hose connectors shall be used only to connect laboratory, shop, and ironing appliances requiring mobility during operation and installed in accordance with the following:

(1) An appliance shutoff valve shall be installed where the connector is attached to the building piping.  
(2) The connector shall be of minimum length and shall not exceed 6 feet (1829 mm).  
(3) The connector shall not be concealed and shall not extend from one room to another or pass through wall partitions, ceilings, or floors. [NFPA 54:9.6.2(1)]

SUBSTANTIATION:
The change is removing the term “shall” from the definition for “Gas Piping” as the IAPMO Manual of Style indicates that definitions shall not be written in mandatory language.

The language in (1) in not necessary as it is already covered under the 1302.1 (General) indicating that gas piping systems extend from the point of delivery.

The change also removes (2), the “limit of 6 feet” and “within the same room” for gas connectors as it does not belong in a definition. Furthermore, the limit of 6 feet is already addressed in Section 1312.3.1 (Indoor) for nonmetallic gas hose connectors.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 032
UMC 2024  Section: 209.0

SUBMITTER: Phillip H Ribbs  
PHR Consultants

RECOMMENDATION:  
Add new text

209.0  – G –  
Grade. A reference plane representing the average finished ground level adjoining the building at exterior walls.

SUBSTANTIATION:
A new definition for “Grade” is being added as the term is currently used in the code but not defined.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 033
UMC 2024 Section: 209.0

SUBMITTER: Bruce A Pfeiffer
Retired - City of Topeka

RECOMMENDATION:
Add new text

209.0 – G –
Groundwater. Water that exists beneath the Earth's surface. Originating as rainfall or snow and ice melt, the precipitation infiltrates the soil replenishing the groundwater system. The water may remain below grade in aquifers or underground streams or make its way back to the surface to feed streams, rivers or lakes.

SUBSTANTIATION:
The term groundwater is used multiple times in the Code. A definition will clarify the intent of the applicable Code sections using the term.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

209.0 – G –
Groundwater. Water that exists beneath the Earth's surface. Originating as rainfall or snow and ice melt, the precipitation infiltrates the soil replenishing the groundwater system. The water may remain below grade in aquifers or underground streams or make its way back to the surface to feed streams, rivers or lakes.

COMMITTEE STATEMENT:
The Technical Committee modified the proposal to only keep the first sentence. The length of time and where the water originates from is irrelevant within the definition for "Groundwater." In addition, the language "originating as rainfall or snow and ice melt" is inaccurate as it is not all-inclusive of other water sources, such as water collected in aquifers.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 034
UMC 2024  Section: 210.0

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Add new text

210.0  – H –
Health Care Facility. An occupancy used for medical or other health-related treatment or care of four or more persons
where occupants are mostly incapable of self-preservation due to age, physical or mental disability, or because of
security measures not under the occupants’ control. They include hospitals, clinics, outpatient care centers, nursing
facilities, long-term care facilities, and specialized care centers. This definition shall include all waiting rooms, hallways,
private rooms, semiprivate rooms, and wards within health care facilities.

SUBSTANTIATION:
A definition for “Health Care Facility” is unaccounted for in the latest edition of the UMC. The proposed definition
addresses the health care industry use of the term while synchronizing with industry classifications, such as the Life
Safety Code. The U.S. health care infrastructure is a complex system of facilities. Specialized clinics and outpatient
centers have appeared to help ease the burden on hospitals, and more long-term care facilities are rising up to
accommodate patients who need months or years of assisted healing. These facilities collaborate to deliver high-
quality health care to patients and communities as a result of adhering to the Uniform Mechanical Code.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed term is commonly understood and does not need to be defined. Additionally, there is unnecessary
information provided in the definition that may create confusion and conflict with the use and meaning of the term by
some jurisdictions.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:
WHITE: Interesting to note that it is important to define "Grade." It is certainly a commonly used term that is well
understood, but there is no need to define "Health Care Facility," which undoubtedly has many variations. This should be
included in the code.
Proposals

Item #: 035

UMC 2024  Section: 205.0, 206.0, 210.0

SUBMITTER:  David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Revise text

[The terms are being relocated only]

205.0        – C –
Compensating Hood. A hood for commercial food heat-processing equipment that has an outside-air supply with air delivered below or within the hood. Where makeup air is diffused directly into the exhaust within the hood cavity, it becomes a short-circuit hood.

206.0        – D –
Draft Hood. A nonadjustable device built into an appliance, or made a part of the vent connector from an appliance, that is designed to:
(1) Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
(2) Prevent a backdraft from entering the appliance.
(3) Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.31]

210.0        – H –
Hood. An air-intake device connected to a mechanical exhaust system for collecting and removing grease-laden vapors, fumes, smoke, steam, heat, or odors from commercial food heat-processing equipment.

Hood, Compensating. A hood for commercial food heat-processing equipment that has an outside-air supply with air delivered below or within the hood. Where makeup air is diffused directly into the exhaust within the hood cavity, it becomes a short-circuit hood.

Hood, Draft. A nonadjustable device built into an appliance, or made a part of the vent connector from an appliance, that is designed to:
(1) Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
(2) Prevent a backdraft from entering the appliance.
(3) Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.31]

Fixed Baffle. A listed unitary exhaust hood design where the grease removal device is a nonremovable assembly that contains an integral fire-activated water-wash fire-extinguishing system listed for this purpose. [NFPA 96-2014:3.3.33.1]

Type I. A kitchen hood for collecting and removing grease and smoke.
Type II. A general kitchen hood for collecting and removing steam, vapor, heat, or odors.

SUBSTANTIATION:
This code change relocates the definitions of “Compensating Hood” and “Draft Hood” to below “Hoods” for ease of locating the terms. Simple cleanup.

COMMITTEE ACTION:  ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

**206.0 – D –**

**Draft Hood.** A nonadjustable device built into an appliance, or made a part of the vent connector from an appliance, that is designed to:

1. Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
2. Prevent a backdraft from entering the appliance.
3. Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.30]

**210.0 – H –**

**Hood.** An air-intake device connected to a mechanical exhaust system for collecting and removing grease-laden vapors, fumes, smoke, steam, heat, or odors from commercial food heat-processing equipment.

**Hood, Compensating.** A hood for commercial food heat-processing equipment that has an outside-air supply with air delivered below or within the hood. Where makeup air is diffused directly into the exhaust within the hood cavity, it becomes a short-circuit hood.

**Hood, Draft.** A nonadjustable device built into an appliance, or made a part of the vent connector from an appliance, that is designed to:

1. Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
2. Prevent a backdraft from entering the appliance.
3. Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.31]

**Hood, Fixed Baffle.** A listed unitary exhaust hood design where the grease removal device is a nonremovable assembly that contains an integral fire-activated water-wash fire-extinguishing system listed for this purpose. [NFPA 96-2014:3.3.33.1]

**Hood, Type I.** A kitchen hood for collecting and removing grease and smoke.

**Hood, Type II.** A general kitchen hood for collecting and removing steam, vapor, heat, or odors.

**COMMITTEE STATEMENT:**
The proposed definition relocation is being modified to move "draft hood" so that it is not a subcategory of "hood." Draft hoods do not belong under the definition of "hood," which references commercial food heat-processing equipment. A draft hood is a completely different type of hood, therefore, the proposed relocation is inappropriate. In addition, the other definitions left under "hood" are being editorially revised to indicate "hood," in front of the defined terms, which is consistent with other editorial modifications made to previous items.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**  
**AFFIRMATIVE:** 29  
**NOT RETURNED:** 1  
Heine
Proposals

Item #: 036
UMC 2024  Section: 210.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

210.0 — H —
Horizontal. A material that is installed in a horizontal position or which makes an angle of less than 45 degrees (0.79 rad) with the horizontal.

SUBSTANTIATION:
A definition is being added for the term “Horizontal” as there has been confusion regarding the term. The new definition is being added as the term is currently used in the code but not defined. The definition correlates with the existing definition of “Horizontal Pipe” in the UPC.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed definition is being rejected as it may not be applicable to all materials within the code and does not have the same meaning as the definition in the UPC for "Horizontal Pipe."

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 037
UMC 2024  Section: 212.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

212.0 – J –
Joint, Heat Fusion. A joint used in some thermoplastic systems to connect the pipe to fittings or pipe lengths to apply heat and pressure to the components to form a bond between the materials. This joining method includes butt-fusion, socket-fusion, and electro-fusion.

SUBSTANTIATION:
A new definition for “Heat Fusion Joint” is being added as it is currently used in the code but not defined. See Sections 1211.11, 1308.5.8.2, and F 201.6.2. Section F 104.4.1.1 lists butt-fusion, socket-fusion, and electro-fusion as acceptable heat fusion methods. The definition is based on the existing definition in the UPC with improvements.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

212.0 – J –
Joint, Heat Fusion. A joint used in some thermoplastic systems to connect the pipe to fittings or pipe lengths directly to one another by applying heat and pressure to the components to form a bond between the materials. This joining method includes butt-fusion, socket-fusion, and electro-fusion.

COMMITTEE STATEMENT:
The proposed definition is being modified to clarify that heat fusion joints connect the pipe to fittings or pipe lengths directly to one another by applying heat and pressure.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 037 and the 2021 UPC resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

212.0 – J –
Joint, Heat Fusion. A joint used in some thermoplastic systems to connect the pipe to fittings or pipe lengths directly to one another (butt-fusion) by applying heat and pressure to the components to form a bond between the materials. This joining method of joining pipe to fittings includes butt-fusion, socket-fusion, and electro-fusion, and saddle-fusion. This method of welding involves the application of heat and pressure to the components, allowing them to fuse together forming a bond between the pipe and fitting.
TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT:
The definition for “Joint, Heat Fusion” in UMC Item # 037 is being revised to correlate with the definition found in the 2021 UPC for “Heat-Fusion Weld Joints.”

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for the definition for “Joint, Heat Fusion” to correlate with the 2021 UPC.
Proposals

Item #: 038
UMC 2024  Section: 212.0

SUBMITTER: Donald (DJ) Berger
Self

RECOMMENDATION:
Revise text

212.0 – J –
Joint, **Press-Connect Elastomeric**, A permanent mechanical removable or non-removable joint consisting of an elastomeric seal or an elastomeric seal and corrosion-resistant grip ring. The joint is made with a pressing tool and jaw or ring approved by the fitting manufacturer.

SUBSTANTIATION:
The word “Press-Connect” describes one type of technology using elastomeric materials for the joint seal. By revising the definition with the word “Elastomeric” this definition may be expanded to include similar joining technologies employing an elastomeric material for its seal, e.g., push-fit, grooved, bolted, compression repair couplings, etc.

The words “permanent mechanical” are inconsistent with other “permanent” and “mechanical” joint definitions within this section of the 2021 UMC. By revising the definition with the removal of the phrase “The joint is made with a pressing tool and jaw or ring approved by the fitting manufacturer,” the definition would be inclusive of similar joining technologies employing elastomeric materials. This revision would provide additional consistency within the code as the 2021 UMC has specific sections that provide information on how joints are to be made.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

212.0 – J –
**Joint, Elastomeric**, A removable or non-removable joint consisting of an elastomeric seal or an elastomeric seal and corrosion-resistant grip ring.

Joint, **Press-Connect Elastomeric**. A removable or non-removable joint consisting of an elastomeric seal or an elastomeric seal and corrosion-resistant grip ring. See Joint, Elastomeric.

COMMITTEE STATEMENT:
The definition to “Joint, Press-Connect” is being modified as the term is still used in the code. A new definition for “Joint, Elastomeric” is being added which addresses the correct definition for these types of joints.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 12  NEGATIVE: 16  ABSTAIN: 1  NOT RETURNED: 1  Heine

Note: Item # 038 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.

EXPLANATION OF AFFIRMATIVE:

BERGER: Substantiation was provided for this proposal. The name of the existing definition is press-connect joint when it actually describes a press-connect fitting. There is a difference between a joint and a fitting. The new definition would better describe the sealing component of all fittings employing an elastomeric seal, including press-connect fittings.
Perhaps a letter writing campaign is the way to go when you want to override the decision of the Technical Committee.


EXPLANATION OF NEGATIVE:

ARYAN: The definition should stay as is.

BALLANCO: The proposed modification is incorrect. To identify all press-connect fittings as elastomeric fittings is not a correct way to define a press-connect fitting.

CUDAHY: This definition should stand as it was. These fittings are described in numerous standards and codes. The proposed revision of the definition of Press-Connect Joint will make the UPC and the UMC the only publications that lump together Press-Connect fittings with other types of mechanical joints. Changing the definition would completely confuse the industry when an established definition is already prevalent and include Press-Connect fittings, which are a permanent joining method, into the same category as Non-Permanent joining methods. Specific standards are written to address Press-Connect fittings (IAPMO PS 117 press-connections, ANSI LC-4/CSA 6.32 Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems, ASME B16.51 Copper and Copper Alloy Press-Connect Pressure Fittings, ASTM F3226 Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing System, to name a few. Also, NFPA 31, NFPA 54, NFPA 55, NFPA 58, CGA P-18, Uniform Plumbing Code, Uniform Mechanical Code, National Standard Plumbing Code, CSA B149.1, National Gas and Propane Code for Canada, and many other publications all directly reference Press-Connect fittings.

EGG, K: There is too little justification for the removal of press-connect fittings. These fittings have been a part of both the UL and UMC for more than a decade.

FEEHAN: This definition needs to stay as is. Most elastomeric seals are not removable and the proposal, as written, is incorrect.

GUNZNER: Press-connect fittings are specifically permitted by ASHRAE 15. AMCA supports consistency between related codes and standards, where applicable. These modifications would cause confusion and other disruptions. AMCA supports the work of the UMC A2L Task Group.

HYDE: I believe further research is required as it pertains to press-connect fittings prior to making such code changes.

KOERBER: No technical substantiation was required as it pertains to press-connect fittings prior to making such code changes.

KREITENBERG: No need to modify the definition.

MACNEVIN: The definition should not be changed as it is accurate. Changing the term to “elastomeric” is very open-ended and vague and will add confusion to the code.

TAYLOR: I feel the “press-connect joint” definition needs to stay as its own. I am fine with adding an elastomeric definition if people want. Press-connect joints are non-removable and permanent, so the definition as modified is incorrect and I must vote against this.

TRAFTON, A: Press-connect fittings have been used successfully for years in these systems. If we need to workshop the definition, fine, but I am also fine with it as it is.

TRAFTON, P: Press-connect belongs in the Code for refrigeration, however, the definition as proposed and as modified does not adequately provide for the proper use. I would agree that a little more research is needed for acceptable leak rate and testing.

VAN RITE: I do not agree with the text. This is an attempt to label any component in a refrigeration system that uses “Elastomeric” material as sub-standard, yet Elastomeric describes a wide range of materials that are approved for use in valves and other seals. This language is aimed at blocking the use of crimped connectors which are widely accepted and approved in other codes.

WHITE: No substantiation was provided with the proposal. Press-Connect is a proven method for installations.

WISEMAN: Press-connect fittings have been used successfully in the field for years. There was no evidence given to substantiate the claims that press-connect fittings leak more than an improper weld. The definition should not be changed.
EXPLANATION OF ABSTAIN:

TERZIGNI: Since this has become such a point of contention, I am continuing to research the matter further.
Proposals

Item #: 039
UMC 2024  Section: 214.0

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

214.0 – L –
Listed (Third Party Certified). Equipment or materials included in a list published by a listing agency (accredited conformity assessment body) that maintains periodic inspection of current production of listed equipment or materials and whose listing states either that the equipment or material complies with approved standards or has been tested and found suitable for use in a specified manner. Terms used to identify listed equipment, products, or materials include “listed,” “certified,” or other terms as determined appropriate by the listing agency.

SUBSTANTIATION:
The proposed revision to the definition for “Listed” recognizes that listing organizations may use other terms to identify “listed” equipment, products, or materials. An example of other terms used that meet the definition of “listed” include “certified.” The term “certified” is a more globally recognized term used by listing organizations compared to the term “listed.”

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
Terms are determined by the code and not by the listing agency. The language is already covered within the terminology provided for "Listing Agency."

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 040

UMC 2024  Section: 214.0

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Add new text

214.0 – L –
Load. The heat output of the storage during discharge. The product of the mass flowrate, specific thermal capacity, and temperature increase of the water or heat transfer fluid as it passes through a system.

SUBSTANTIATION:
A definition is needed in the UMC for the term “Load,” which is used in throughout the code. The change correlates with the USHGC. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed definition is not needed. The term is commonly understood without the provided definition. In addition, there are different types of loads (i.e. structural, heat, electrical) that should be specified. In addition the definition comes across as an equation and should be listed in the body of the code. Furthermore, a heat load can be either a decrease or increase in temperature.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 041
UMC 2024 Section: 214.0, 216.0, 316.12, 316.13

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

214.0 – L –
Limited-Combustible Material. Refers to a building construction material that does not comply with the definition of noncombustible material with limited burning characteristics that, in the form in which it is used, has a potential for combustion and does not comply with the definition of noncombustible material. Heat value not exceeding 3500 British thermal units per pound-force (Btu/lb) (8141 kJ/kg), where tested in accordance with NFPA 259, and includes either of the following:

(1) Materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of 1/8 of an inch (3.2 mm), that has a flame spread index not greater than 50.
(2) Materials, in the form and thickness used, having neither a flame spread index greater than 25 nor evidence of continued progressive combustion, and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread index greater than 25 nor evidence of continued progressive combustion, where tested in accordance with ASTM E84.

216.0 – N –
Noncombustible Material. As applied to building construction material, means a material that in the form in which it is used is either one of the following:

(1) A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials that are reported as passing ASTM E136 are considered noncombustible material.
(2) Material having a structural base of noncombustible material as defined in item 1 above, with a surfacing material not over 1/8 of an inch (3.2 mm) thick that has a flame spread index not higher than 50.

Noncombustible does not apply to surface finishes materials. Material required to be noncombustible for reduced clearances to flues, heating appliances, or other sources of high temperature shall refer to material in accordance with item 1 above. No material shall be classed as noncombustible that is subject to increase in combustibility or flame spread index beyond the limits herein established, through the effects of age, moisture, or other atmospheric condition.

316.0 Protection of Piping, Tubing, Materials, and Structures.

316.12 Limited-Combustible Material. Limited combustible material shall have a potential heat value not exceeding 3500 British thermal units per pound-force (Btu/lb) (8141 kJ/kg), where tested in accordance with NFPA 259, and shall include either of the following:

(1) Materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of 1/8 of an inch (3.2 mm), that has a flame spread index not greater than 50.
(2) Materials, in the form and thickness used, having neither a flame spread index greater than 25 nor evidence of continued progressive combustion, and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread index greater than 25 nor evidence of continued progressive combustion, where tested in accordance with ASTM E84.

316.13 Noncombustible Material. Noncombustible material shall meet one of the following:

(1) A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials that comply with the requirements of ASTM E136 shall be considered noncombustible material.
(2) Material having a structural base of noncombustible material as defined in item 1 above, with a surfacing material not over 1/8 of an inch (3.2 mm) thick that has a flame-spread index not higher than 50.

Noncombustible shall not apply to surface finish materials. Material required to be noncombustible for reduced clearances to flues, heating appliances, or other sources of high temperature shall refer to material in accordance with item 1 above. No material shall be classed as noncombustible that is subject to increase in combustibility or flame-spread index beyond the limits herein established through the effects of age, moisture, or other atmospheric conditions.

Note: ASTM E84, ASTM E136, and NFPA 259 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The definitions of Limited-Combustible Material and Noncombustible Material contain mandatory language. Requirements should not be located within definitions as definitions are not enforceable. Therefore, the current definitions should be relocated to the body of the code. Furthermore, the revised definitions are more concise and the appropriate standards for classifying such materials are better suited in Chapter 3.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The current language is needed to describe limited combustible and non-combustible materials. In addition, there are subtle changes which are not supported by technical merit in the substantiation. The proposed modifications of "limited combustible material" and "non-combustible material" are not consistent with the building code as written. It is important to be consistent with the building code to avoid conflicts between codes.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 042
UMC 2024 Section: 215.0

SUBMITTER: Shane Peters
City of Santa Monica

RECOMMENDATION:
Add new text

215.0 – M –
Mid-Story Guide. A support designed to keep piping in alignment, located half-way between floors or a floor and ceiling. (below shown for reference only)

<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>TYPES OF JOINTS</th>
<th>HORIZONTAL</th>
<th>VERTICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast</td>
<td>Lead and Oakum</td>
<td>5 feet, except 10 feet where 10 foot lengths are installed¹, ², ³</td>
<td>Base and each floor, not to exceed 15 feet</td>
</tr>
<tr>
<td></td>
<td>Compression Gasket</td>
<td>Every other joint, unless over 4 feet then support each joint¹, ², ³</td>
<td>Base and each floor, not to exceed 15 feet</td>
</tr>
<tr>
<td>Cast-Iron Hubless Shielded Coupling</td>
<td>Every other joint, unless over 4 feet then support each joint¹, ², ³</td>
<td>Base and each floor, not to exceed 15 feet</td>
<td></td>
</tr>
<tr>
<td>Copper &amp; Copper Alloys</td>
<td>Soldered, Brazed, Threaded, or Mechanical</td>
<td>11/2 inches and smaller, 6 feet; 2 inches and larger, 10 feet</td>
<td>Each floor, not to exceed 10 feet⁵</td>
</tr>
<tr>
<td>Steel Pipe for Water DWV</td>
<td>Threaded or Welded</td>
<td>3/4 inch and smaller, 10 feet; 1 inch and larger, 12 feet</td>
<td>Every other floor, not to exceed 25 feet⁵</td>
</tr>
<tr>
<td>Steel Pipe for Gas</td>
<td>Threaded or Welded</td>
<td>1/2 inch, 6 feet; 3/4 inch and 1 inch, 8 feet; 11/4 inches and larger, 10 feet</td>
<td>Base and each floor; provide mid-story guides; provide for expansion every 30 feet³</td>
</tr>
<tr>
<td>Schedule 40 PVC and ABS</td>
<td>Solvent Cemented</td>
<td>All sizes, 4 feet; allow for expansion every 30 feet³</td>
<td>Base and each floor; provide mid-story guides; provide for expansion every 30 feet³</td>
</tr>
<tr>
<td>CPVC</td>
<td>Solvent Cemented</td>
<td>1 inch and smaller, 3 feet; 11/4 inches and larger, 4 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
<tr>
<td>CPVC-AL-CPVC</td>
<td>Solvent Cemented</td>
<td>1/2 inch, 5 feet; ¾ inch, 65 inches; 1 inch, 6 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
<tr>
<td>Lead</td>
<td>Wiped or Burned</td>
<td>Continuous Support</td>
<td>Not to exceed 4 feet</td>
</tr>
<tr>
<td>Steel</td>
<td>Mechanical</td>
<td>In accordance with standards acceptable to the Authority Having Jurisdiction</td>
<td></td>
</tr>
<tr>
<td>PEX</td>
<td>Cold Expansion, Insert and Compression</td>
<td>1 inch and smaller, 32 inches; 11/4 inches and larger, 4 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
<tr>
<td>PEX-AL-PE</td>
<td>Metal insert and metal compression</td>
<td>1/2 inch ³/4 inch ¹ inch</td>
<td>All sizes 98 inches</td>
</tr>
<tr>
<td>PE-AL-PE</td>
<td>Metal insert and metal compression</td>
<td>1/2 inch ³/4 inch ¹ inch</td>
<td>All sizes 98 inches</td>
</tr>
<tr>
<td>PE-RT</td>
<td>Insert and Compression</td>
<td>1 inch and smaller, 32 inches; 11/4 inches and larger, 4 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>Fusion weld (socket, butt, saddle, electrofusion), threaded (metal threads only), or mechanical</td>
<td>1 inch and smaller, 32 inches; 11/4 inches and larger, 4 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
</tbody>
</table>
For SI unit: 1 inch = 25.4 mm, 1 foot = 304.8 mm

Notes:
1 Support adjacent to joint, not to exceed 18 inches (457 mm).
2 Brace not to exceed 40 feet (12 192 mm) intervals to prevent horizontal movement.
3 Support at each horizontal branch connection.
4 Hangers shall not be placed on the coupling.
5 Vertical water lines shall be permitted to be supported in accordance with recognized engineering principles with regard to expansion and contraction, where first approved by the Authority Having Jurisdiction.

SUBSTANTIATION:
The term is used several times in Table 313.3 but not defined in the code. This will assist the end user on the intent of such term.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

215.0 – M –
Mid-Story Guide. A support designed to keep piping in alignment, located mid-way between floors or a floor and ceiling.

COMMITTEE STATEMENT:
The proposed modification is necessary as a guide may not be located exactly half way.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Item #: 043
UMC 2024 Section: 218.0, 1406.3.3, Table 1701.1

SUBMITTER: Arnie Rodio
Self

RECOMMENDATION:
Revise text

218.0 – P –
PEL (Permissible Exposure Limit). The time-weighted average concentration [set by the U.S. Occupational Safety and Health Administration (OSHA)] for a normal 8-hour workday and a 40-hour workweek to which nearly all workers can be repeatedly exposed without adverse effect. Chemical manufacturers publish similar recommendations [e.g., acceptable exposure level (AEL), industrial exposure limit (IEL), or occupational exposure limit (OEL), depending on the company], generally for substances for which PEL has not been established. [ASHRAE 34.3] The maximum permitted time-weighted average exposures to be utilized are those published in 29 CFR 1910.1000.

1406.0 Pipe, Tubing, and Fittings.

1406.3 Special Requirements for HPP Gases. (remaining text unchanged)

1406.3.3 Gas-Detection System. Where hazardous production material gas is used or dispensed and the physiological warning properties of the gas are at a higher level than the accepted permissible exposure limit (PEL) of the gas, a continuous gas-monitoring system shall be provided to detect the presence of the short-term hazard condition. Where dispensing occurs and flammable gases or vapors are capable of being present in quantities in excess of 25 percent of the lower explosive limit (LEL), a continuous gas-monitoring system shall be connected to the emergency control station. The maximum permitted time-weighted average exposures to be utilized are those published in 29 CFR 1910.1000.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 CFR 1910.1000</td>
<td>Air Contaminants</td>
<td>Air Quality</td>
<td>1406.3.3</td>
</tr>
</tbody>
</table>

Note: 29 CFR 1910.1000 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The definition of "PEL (Permissible Exposure Limit)" contains mandatory language. Requirements should not be located within definitions. Therefore, the last sentence from the definition is being relocated to Section 1406.3.3 as the exposure limits for Toxic and Hazardous substances are listed in OSHA 29 CFR 1910.1000 Tables Z-1, Z-2, and Z-3.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

218.0 – P –
PEL (Permissible Exposure Limit). The time-weighted average concentration [set by the U.S. Occupational Safety and Health Administration (OSHA)] for a normal 8-hour workday and a 40-hour workweek to which nearly all workers can be repeatedly exposed without adverse effect. Chemical manufacturers publish similar recommendations [e.g., acceptable exposure level (AEL), industrial exposure limit (IEL), or occupational exposure limit (OEL), depending on the company], generally for substances for which PEL has not been established. [ASHRAE 34:3]

1406.0 Pipe, Tubing, and Fittings.

1406.3 Special Requirements for HPP Gases. (remaining text unchanged)

1406.3.3 Gas-Detection System. Where hazardous production material gas is used or dispensed and the physiological warning properties of the gas are at a higher level than the accepted permissible exposure limit (PEL) of the gas, a continuous gas-monitoring system shall be provided to detect the presence of the short-term hazard condition. Where dispensing occurs and flammable gases or vapors are capable of being present in quantities in excess of 25 percent of the lower explosive limit (LEL), a continuous gas-monitoring system shall be connected to the emergency control station. The maximum permitted time-weighted average exposures to be utilized are those shall be as published in 29 CFR 1910.1000.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
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<tbody>
<tr>
<td>29 CFR 1910.1000</td>
<td>Air Contaminants</td>
<td>Air Quality</td>
<td>1406.3.3</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

COMMITTEE STATEMENT:
The proposal is being modified to remove vague language and insert mandatory enforceable language regarding the CFR standard.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 044
UMC 2024  Section: 218.0

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Add new text

218.0 – P –
**Power Ventilator, Dryer Exhaust Duct.** A fan used to boost airflow through a clothes dryer duct. Also known as a dryer booster fan.

(below shown for reference only)

**504.4.2.1 Length Limitation.** Unless otherwise permitted or required by the dryer manufacturer’s instructions and approved by the Authority Having Jurisdiction, domestic dryer moisture exhaust ducts shall not exceed a total combined horizontal and vertical length of 14 feet (4267 mm), including two 90 degree (1.57 rad) elbows. A length of 2 feet (610 mm) shall be deducted for each 90 degree (1.57 rad) elbow in excess of two.

**Exception:** Where an exhaust duct power ventilator, in accordance with Section 504.4.2.3, is used, the maximum length of the dryer exhaust duct shall be permitted to be in accordance with the dryer exhaust duct power ventilator manufacturer’s installation instructions.

**504.4.2.3 Exhaust Duct Power Ventilators.** Dryer exhaust duct power ventilators for single residential clothes dryers shall be listed and labeled in accordance with UL 705 and installed in accordance with the manufacturer’s installation instructions.

**SUBSTANTIATION:**
A definition is being added for “power ventilators” for clothes dryers. The term is used in the code and clarity is needed as to what these devices are. Power ventilators for clothes dryers are referenced in the exception to Section 504.4.2.1 (Length Limitation) and Section 504.4.2.3 (Exhaust Duct Power Ventilators).

**COMMITTEE ACTION:** ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

218.0 – P –
**Power Ventilator, Dryer Exhaust Duct.** A fan used to boost airflow through a clothes dryer duct. **Also known as a dryer booster fan.**

**COMMITTEE STATEMENT:**
The definition is being modified to strike the last sentence. The reference to a “dryer booster fan” is not necessary for defining the term.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 045

UMC 2024 Section: 203.0, 210.0, 221.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

221.0 – S –
Supports. Supports, hangers, and anchors are devices for properly supporting and securing pipe, duct, and equipment.

203.0 – A –
Anchors. See Supports.

210.0 – H –
Hangers. See Supports.

(below shown for reference only)

1310.3.5 Hangers, Supports, and Anchors. Piping shall be supported with metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers, or building structural components, suitable for the size of piping, of adequate strength and quality, and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected appliances and equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58. [NFPA 54:7.2.6.1]

SUBSTANTIATION:
The new definitions are being added as the terms are currently used in the code but not defined. See Section 1310.3.5. The definitions correlate with the existing definitions in the UPC.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 046

UMC 2024 Section: 222.0

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Add new text

222.0 – T –
Thermosiphon. The natural circulation of fluids due to temperature differential.

SUBSTANTIATION:
Section 1212.10 references the term “thermosiphoning,” however there is no definition. A definition is needed for clarity. The code change correlates with the USHGC. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 047
UMC 2024 Section: 223.0, 802.10.1.1, 802.10.1.2

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

223.0 — U —
Unconditioned Space. An area, room, or space not being heated or cooled by any equipment.

802.10.1.1 Unconditioned Area Space. Where the vent connector used for an appliance having a draft hood or a Category I appliance is located in or passes through an unconditioned area space, attic, or crawl space, that portion of the vent connector shall be listed Type B, Type L, or listed vent material having equivalent insulation qualities.
Exception: Single-wall metal pipe located within the exterior walls of the building and located in an unconditioned area space other than an attic or a crawl space having a local 99 percent winter design temperature of 5°F (-15°C) or higher (NFPA 54:12.11.2.2).

802.10.1.2 Residential-Type Appliances. Vent connectors for residential-type appliances shall comply with the following:
(1) Vent connectors for listed appliances having draft hoods, appliances having draft hoods and equipped with listed conversion burners, and Category I appliances that are not installed in attics, crawl spaces, or other unconditioned areas spaces shall be one of the following:
(a) through (f) (remaining text unchanged)
(2) (remaining text unchanged)
Exception: Listed insulated vent connectors shall be installed in accordance with the manufacturer’s installation instructions. (NFPA 54:12.11.2.3).

Conditioned Space. An area, room, or space normally occupied and being heated or cooled for human comfort by any equipment.

SUBSTANTIATION:
This proposal adds a definition for “unconditioned space." Furthermore, the proposal modifies the term “unconditioned area” to “unconditioned space” as the term “unconditioned space” is consistent with the definition of "conditioned space" that already exists in the code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 048

UMC 2024  Section: 224.0

SUBMITTER: Adam Segura
Self

RECOMMENDATION:
Add new text

224.0  – V –
Vacuum Relief Valve. A device that automatically allows air to enter the piping system to prevent conditions that could siphon water from the system and prevent excessive vacuum in a pressure vessel.

(below shown for reference only)

1005.5 Vacuum Relief Valve. Hot-water heating systems that are subjected to a vacuum while in operation or during shutdown shall be protected with a vacuum relief valve. Where the piping configuration, equipment location, and valve outlets are located below the boiler elevation, the system shall be equipped with a vacuum relief valve at the highest point.

SUBSTANTIATION:
The proposed language adds the definition of a vacuum relief valve as used in a plumbing or mechanical system. The valve is not only protecting the pressure vessel from excessive vacuum, but also preventing conditions that could siphon the water from system and possibly cause damage to water heater and equipment. See Section 1005.5 (Vacuum Relief Valve).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The language is poorly written and subjective. The term "automatically" may create confusion regarding the term. The phrase "that could" is vague and subject to interpretation.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 049
UMC 2024  Section: 224.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

224.0 – V –
Valve, Isolation. A valve that isolates one piece of equipment from another.

SUBSTANTIATION:
A new definition for “Isolation Valve” is being added as it is currently used in the code but not defined. The definition correlates with the existing definition in the UPC.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The definition is incomplete and incorrect regarding isolation valves isolating one piece of equipment from another. The language is vague and subject to misinterpretation.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 050
UMC 2024 Section: 224.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

224.0 – V –
Valve, Zone. A valve that controls the gas or vacuum to a particular area.

SUBSTANTIATION:
A new definition for “Zone Valve” is being added as it is currently used in the code but not defined. See Section 1214.5. The definition correlates with the existing definition in the UPC.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The definition is incomplete and incorrect regarding zone valves controlling gas or vacuum.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 051
UMC 2024  Section: 222.0, 224.0

SUBMITTER: Randy Young  
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:  
Revise text

222.0 – T –  
**Type B Gas Vent.** A factory-made gas vent listed by a nationally recognized testing agency for venting listed or approved appliances equipped to burn only gas.  
**Type B-W Gas Vent.** A factory-made gas vent listed by a nationally recognized testing agency for venting listed or approved gas-fired vented wall furnaces.  
**Type L Gas Vent.** A venting system consisting of listed vent piping and fittings for use with oil-burning appliances listed for use with Type L or with listed gas appliances.

224.0 – V –  
**Vent.** A pipe or other conduit composed of factory-made components, containing a passageway for conveying combustion products and air to the atmosphere, listed and labeled for use with a specific type or class of appliance.

[The terms below are being relocated only]

**Vent, Type B Gas.** A factory-made gas vent listed by a nationally recognized testing agency for venting listed or approved appliances equipped to burn only gas.  
**Vent, Type B-W Gas.** A factory-made gas vent listed by a nationally recognized testing agency for venting listed or approved gas-fired vented wall furnaces.  
**Vent, Type L Gas.** A venting system consisting of listed vent piping and fittings for use with oil-burning appliances listed for use with Type L or with listed gas appliances.

SUBSTANTIATION:  
The code change adds a definition for “Vent” to improve the code as well as relocates and combines the existing vent types for ease of locating the terms.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:  
An editorial revision has been made to reflect “Vent,” in front of the defined terms, which is consistent with editorial modifications made to other items.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  
AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 052
UMC 2024 Section: 224.0

SUBMITTER: Bob Adler
Self

RECOMMENDATION:
Revise text

224.0 – V – Vent Connector, Gas. That portion of a gas-venting system that connects a listed gas appliance beginning at the draft hood or flue collar to a gas vent and is installed within the space or area in which the appliance is located.

SUBSTANTIATION:
A simple definition of a vent connector is elusive. You will know it when you see it, but accurately defining it is difficult. However, we can state specifically where it begins and that it remains in the space where it begins.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 052 and UPC Item # 027 resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

224.0 – V – Vent Connector, Gas. That portion of a gas-venting system that connects a listed gas appliance beginning at the draft hood or flue collar to a gas vent and is installed entirely within the space or area in which the appliance is located.

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT:
The definition for “Vent Connector, Gas” in UMC Item # 052 is being revised to correlate with the action taken by the UPC TC for Item # 027 by adding the term “entirely.”

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for the definition for “Vent Connector, Gas” by adding the term “entirely.”
Proposals

Item #: 053
UMC 2024  Section: 224.0

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

224.0  – V –
**Vertical.** A material that is installed in a vertical position or that makes an angle of not more than 45 degrees (0.79 rad) with the vertical.

SUBSTANTIATION:
A definition is being added for the term “Vertical” as there has been confusion regarding the term. The new definition is being added as the term is currently used in the code but not defined. The definition correlates with the existing definition of “Vertical Pipe” in the UPC.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed definition is being rejected as it may not be applicable to all materials within the code and does not have the same meaning as the definition in the UPC for "Vertical Pipe."

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Item #: 054
UMC 2024  Section: 225.0

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Add new text

225.0        – W –
Water Hammer. A hydraulic shock that occurs within a pressurized piping system when the fluid flow within the system is suddenly stopped and the fluid momentum is broken.

SUBSTANTIATION:
A definition for the term “water hammer” is being added. The term is used in Chapter 12 (See Section 1201.3) and Appendix F (See Section F 101.9). The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The definition is incorrect regarding "fluid flow within the system is suddenly stopped." Water hammer refers to the sudden change in velocity, but the flow or momentum does not suddenly stop.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 055
UMC 2024 Section: 225.0

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Add new text

225.0 – W –
Whole House Fan. A fan used for ventilating a building or space primarily to exhaust air from the conditioned space typically through an attic.

(below shown for reference only)

E 502.11 Whole House Fans. Whole house exhaust fans shall have insulated louvers or covers which close where the fan is off. Covers or louvers shall have an insulation value of not less than R-4.2, and shall be installed in accordance with the manufacturer’s installation instructions. The attic openings shall be sufficient to accommodate the ventilation capacity of the whole house fan. The operation of the whole house fan shall be considered in determining the adequacy of providing combustion air in accordance with this code.

SUBSTANTIATION:
A definition is being added for “whole house fans.” The term is used in the code and clarity is needed as to what these systems are. Section E 502.11 (Whole House Fans) addresses whole house fans. These fans pull air in from open windows and exhausts it through the attic and roof. These systems provide good attic ventilation in addition to whole house cooling.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

225.0 – W –
Whole House Fan. A fan used for ventilating a building or space primarily to exhaust air from the conditioned space typically through an attic.

E 201.0 Definitions.
Whole House Fan. A fan used for ventilating a building or space primarily to exhaust air from the conditioned space typically through an attic.

COMMITTEE STATEMENT:
The modification relocates the definition for "Whole House Fan" from Chapter 2 to the definitions section of Appendix E, Section E 201.0, as the term is used and better suited in Appendix E.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
303.0 Installation.

**303.5 Movement Restraining Device.** Movement of appliances with casters shall be limited by a restraining device installed in accordance with the connector and appliance manufacturer’s installation instructions. [NFPA 54:9.6.1.4]

**303.8.5 Electrical Power.** All appliances requiring an external source of electrical power for its operation shall be installed in accordance with NFPA 70, provided with the following:

1. A readily accessible electrical disconnecting means within sight of the appliance that completely de-energizes the appliance.
2. A 120 V ac grounding-type receptacle outlet on the roof adjacent to the appliance on the supply side of the disconnect switch. [NFPA 54:9.4.2.3]

**303.9 Avoiding Strain on Gas Piping.** Appliances shall be supported and connected to the piping so as not to exert undue strain on the connections. [NFPA 54:9.1.16]

**303.10 Clearances to Combustible Materials.** Appliances and their vent connectors shall be installed with clearances from combustible material so their operation does not create a hazard to persons or property. Minimum clearances between combustible walls and the back and sides of various conventional types of appliances and their vent connectors are specified in Chapter 8 and Chapter 9, or NFPA 211. [NFPA 54:9.2.2] Where not provided in this code, listed and unlisted equipment or appliances shall be installed to maintain the required clearances for servicing and to combustible construction in accordance with the listing and the manufacturer’s installation instructions.

**303.11 Installation in Commercial Garages.** Appliances installed in commercial garages shall be in accordance with Section 303.11.1 through Section 303.11.2.

**303.11.1 Parking Structures.** Appliances installed in enclosed, basement, and underground parking structures shall be installed in accordance with NFPA 88A. [NFPA 54:9.1.11.1]

**303.11.2 Repair Garages.** Appliances installed in repair garages shall be installed in accordance with NFPA 30A. [NFPA 54:9.1.11.2]

**304.0 Accessibility for Service.**

**304.3.1 Access from the Inside.** Buildings of more than 15 feet (4572 mm) in height shall have an inside means of access to the roof unless other means acceptable to the Authority Having Jurisdiction are used. [NFPA 54:9.4.3.2]

**304.4 Appliances in Attics and Under-Floor Spaces.** An attic or under-floor space in which an appliance is installed shall be accessible through an opening and passageway not less than the largest component of the appliance, and not less than 22 inches by 30 inches (559 mm by 762 mm). [NFPA 54:9.5.1]

**304.4.4 Lighting and Convenience Outlet.** A permanent 120 V receptacle outlet and a luminaire shall be installed near the appliance. The switch controlling the luminaire shall be located at the entrance to the passageway. [NFPA 54:9.5.3]
TABLE 303.10.1
REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
[NFPA 54: TABLE 402.3 10.2.4]
(portion of table not shown remains unchanged)

For SI units: 1 inch = 25.4 mm, °C = (°F - 32)/1.8

Notes:
1. Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.
2. All clearances shall be measured from the outer surface of the combustible material to the nearest point on the surface of the appliance, disregarding any intervening protection applied to the combustible material.
3. Spacers and ties shall be of noncombustible material. No spacer or tie shall be used directly opposite the appliance or connector.
4. Where all clearance reduction systems use a ventilated air space, adequate provision for air circulation shall be provided as described. [See Figure 303.10.1(2) and Figure 303.10.1(3)]
5. At least 1 inch (25.4 mm) shall be between clearance reduction systems and combustible walls and ceilings for reduction systems using a ventilated air space.
6. Where a wall protector is mounted on a single flat wall away from corners, it shall have a minimum 1 inch (25.4 mm) air gap. To provide adequate air circulation, the bottom and top edges, or only the side and top edges, or all edges shall be left open.
7. Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot (lb/ft³) (128 kg/m³) and a minimum melting point of 1500°F (816°C).
8. Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1.0 British thermal unit inch per hour square foot degree Fahrenheit [Btu•in/(h•ft²•°F)] [0.1W/(m•K)] or less.
9. At least 1 inch (25.4 mm) shall be between the appliance and the protector. In no case shall the clearance between the appliance and the combustible surface be reduced below that allowed in Table 303.10.1.
10. All clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.
11. Listed single-wall connectors shall be installed in accordance with the manufacturer’s installation instructions.
Notes:
(1) Masonry walls can be attached to combustible walls using wall ties.
(2) Spacers should not be used directly behind appliance or connector.

FIGURE 303.10.1(2)
WALL PROTECTOR CLEARANCE REDUCTION SYSTEM
[NFPA 54: FIGURE 40.3.2.3(b) 10.3.3.3(b)]
FIGURE 303.10.1(3)
MASONRY CLEARANCE REDUCTION SYSTEM
[NFPA 54: FIGURE 10.3.2.3(e) 10.3.3.3(e)]

Note: NFPA 70 and NFPA 211 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 3 is being revised to the latest edition of NFPA 54-2021.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UPC Item # 101, Section 508.4 (Appliances in Attics and Under-Floor Spaces) and UMC Item # 056, Section 304.4 (Appliances in Attics and Under-Floor Spaces) resulted in conflicting language within the code. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

304.4 Appliances in Attics and Under-Floor Spaces. An attic or under-floor space in which an appliance is installed shall be accessible through an opening and passageway not less larger than the largest component of the appliance, and not less than 22 inches by 30 inches (559 mm by 762 mm). {NFPA 54:9.5.1}

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT:
The language in UMC Item # 056 is being modified to change the phrase "not less than" to "larger than" as the TCC felt such revision of text was necessary to correct an error in the original text as sufficient accessibility through an opening is required.

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 304.4 regarding the change from the phrase “not less than” to “larger than.”
Proposals

Item #: 057

UMC 2024  Section: 302.2

SUBMITTER: Phillip H Ribbs
    PHR Consultants

RECOMMENDATION:
    Revise text

302.0 Materials – Standards and Alternates.

302.2 Alternate Materials and Methods of Construction Equivalency. Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code. Technical documentation shall be submitted to the Authority Having Jurisdiction to demonstrate equivalency. The Authority Having Jurisdiction shall have the authority to approve or disapprove the system, method, or device for the intended purpose.

    However, the exercise of this discretionary approval by the Authority Having Jurisdiction shall have no effect beyond the jurisdictional boundaries of said Authority Having Jurisdiction. An alternate material or method of construction so approved shall not be considered as in accordance with the requirements, intent, or both of this code for a purpose other than that granted by the Authority Having Jurisdiction where the submitted data does not prove equivalency.

SUBSTANTIATION:
    Section 302.2 grants authority to AHJ’s to approve materials or products at their discretion. However, Section 302.2 places an obligation on the AHJ to approve only those alternate materials or products which comply "with the intent of this code," which are "at least the equivalent of that prescribed in this code," and are not specifically prohibited elsewhere in the code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 17  NEGATIVE: 11  ABSTAIN: 1  NOT RETURNED: 1  Heine

Note: Item # 057 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.

EXPLANATION OF NEGATIVE:

ARYAN: The statement is too broad and may lead to difficulty in the AHJ’s ability to reject certain items/designs.

BALLANCO: This proposal would result in a violation of the Federal Trade Laws of the United States. The FTC website states, "The Sherman Act outlaws "every contract, combination, or conspiracy in restraint of trade," and any "monopolization, attempted monopolization, or conspiracy or combination to monopolize."" In accordance with Federal Law, an alternative approval is permitted even when the code specifically prohibits the material or method.

CUDAHY: This seems legally problematic to the code and IAPMO. "Nothing in this code" is deliberate, boilerplate language. Codes are not intended to prevent the use of designs or materials not prescribed.

FEEHAN: "Unless specifically prohibited" means everything which is not forbidden is allowed. It is going to cause confusion and require jurisdictions to list prohibited products, methods, materials, and so on.
GUNZNER: This change would at least cause confusion, if not also what is stated in the other comments.
KOERBER: This change would lead to confusion and potential legal issues.
MACNEVIN: The proposed change adds confusion to the code and is not necessary.
TRAFTON, A: I agree with Michael Cudahy that this may be legally problematic.
TRAFTON, P: I think this statement is overly broad and is not the intent of the Code.
WHITE: The change is not necessary, is confusing, and contrary to the intent of Section 302.2.
WISEMAN: This seems legally problematic.

EXPLANATION OF ABSTAIN:
TERZIGNI: Seems like wordplay to me. While I agree with standards and codes I also believe that the AHJ or even a licensed designer should be able to provide exceptions or exemptions as justified by their knowledge and experience.
Proposals

Item #: 058

UMC 2024 Section: 304.1

SUBMITTER: Bruce A Pfeiffer
Retired - City of Topeka

RECOMMENDATION:
Revise text

304.0 Accessibility for Service.
304.1 General. All appliances shall be located with respect to building construction and other equipment so as to permit access to the appliance. Sufficient clearance shall be maintained to permit removal of the appliance; cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls, and vent connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and the proper functioning of explosion vents, if provided. For attic installation, the passageway and servicing area adjacent to the appliance shall be floored. ([NFPA 54:9.2.1])

Unless otherwise specified, not less than 30 inches (762 mm) in depth, width, and height of working space shall be provided.

Exception: A platform shall not be required for unit heaters or room heaters.

SUBSTANTIATION:
The Code requires access for the repair of appliances in Section 304.1, but does not require access for the removal of appliances without the need to remove building construction or other appliances.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the changes pertaining to access for the removal of appliances in this proposal are already being addressed in Item # 059.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 059
UMC 2024  Section: 304.1

SUBMITTER: Phillip H Ribbs  
PHR Consultants

RECOMMENDATION:
Revise text

304.0 Accessibility for Service.
304.1 General. All appliances shall be located with respect to building construction and other equipment so as to permit access to the appliance. Sufficient A clearance shall be maintained to permit cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls, and vent connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and the proper functioning of explosion vents, if provided. For attic installation, the passageway and servicing area adjacent to the appliance shall be floored in accordance with Section 304.4. [NFPA 54:9.2.1]

Unless otherwise specified, a clearance of not less than 30 inches (762 mm) in depth, width, and height of working space shall be provided maintained.

Exception: A platform shall not be required for unit heaters or room heaters.

(below shown for reference only)

304.0 Accessibility for Service.

304.4 Appliances in Attics and Under-Floor Spaces. An attic or under-floor space in which an appliance is installed shall be accessible through an opening and passageway not less than the largest component of the appliance, and not less than 22 inches by 30 inches (559 mm by 762 mm).

304.4.1 Length of Passageway. Where the height of the passageway is less than 6 feet (1829 mm), the distance from the passageway access to the appliance shall not exceed 20 feet (6096 mm) measured along the centerline of the passageway. [NFPA 54:9.5.1.1]

304.4.2 Width of Passageway. The passageway shall be unobstructed and shall have solid flooring not less than 24 inches (610 mm) wide from the entrance opening to the appliance. [NFPA 54:9.5.1.2]

304.4.3 Work Platform. A level working platform not less than 30 inches by 30 inches (762 mm by 762 mm) shall be provided in front of the service side of the appliance. [NFPA 54:9.5.2]

Exception: A working platform need not be provided where the furnace is capable of being serviced from the required access opening. The furnace service side shall not exceed 12 inches (305 mm) from the access opening.

304.4.4 Lighting and Convenience Outlet. A permanent 120 V receptacle outlet and a luminaire shall be installed near the appliance. The switch controlling the luminaire shall be located at the entrance to the passageway. (NFPA 54:9.5.3)

SUBSTANTIATION:
The change is a cleanup of the language to improve Section 304.1. The term “sufficient” is being removed as it is poor code language.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

304.0 Accessibility for Service.

304.1 General. All appliances shall be located with respect to building construction and other equipment so as to permit access to for repair or replacement of the appliance. A clearance shall be maintained to permit removal of the appliance; cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls, and vent
connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and the proper functioning of explosion vents, if provided. For attic installation, the passageway and servicing area adjacent to the appliance shall be in accordance with Section 304.4. {NFPA 54:9.2.1}

Unless otherwise specified, a clearance of not less than 30 inches (762 mm) in depth, width, and height of working space shall be maintained.

**Exception:** A platform shall not be required for unit heaters or room heaters.

**COMMITTEE STATEMENT:**
The Code requires access for the repair of appliances in Section 304.1, but does not require access for the removal of appliances without the need to remove building construction or other appliances.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**  
**AFFIRMATIVE:** 28  
**NEGATIVE:** 1  
**NOT RETURNED:** 1  
Heine

**EXPLANATION OF NEGATIVE:**

**WHITE:** Clearance should be allowed for various reasons. Engaging in list making for it may not include all the reasons and should be avoided. Further, requiring clearance for removal, while sounding good for a furnace or smaller appliance, is a much different consideration for a chiller or boiler. Many times these are installed early in construction and are effectively built-in. This will require every mechanical room to have overhead doors or some form of access to remove a device that may not be touched for 50 years. This presents architectural issues as well.
Proposals

Item #: 060

UMC 2024  Section: 304.4.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

304.0 Accessibility for Service.

304.4 Appliances in Attics and Under-Floor Spaces. (remaining text unchanged)

304.4.1 Length of Passageway. Where the height of the passageway is less than 6 feet (1829 mm), the distance from the passageway access to the appliance shall not exceed 20 feet (6096 mm) measured along the centerline of the passageway. [NFPA 54:9.5.1.1] Where the height of the passageway is 6 feet (1829 mm) or more, the distance from the passageway access to the appliance shall not exceed 50 feet (15 240 mm) measured along the centerline of the passageway.

SUBSTANTIATION:
This code change would limit the length of a passageway that is 6 feet high or more to a maximum length of 50 feet to remove the conflict between the building/residential code. There is currently no limit or provisions for a distance for a passageway greater than 6 feet in height.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 28   NEGATIVE: 1   NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:

WHITE: This limits hallways and passageways to 50 feet for no reason. Passageways greater than 6 feet tall provide ample space to access equipment. This is not necessary.
Proposals

Item #: 061
UMC 2024  Section: 305.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

305.0 Location.
305.1 Installation in Residential Garages. Appliances in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit shall be installed so that all burners and burner-ignition devices are located not less than 18 inches (457 mm) above the floor unless listed as flammable vapor ignition resistant. {{NFPA 54:9.1.10.1}}

Exception: Flammable vapor ignition resistant (FVIR) appliances.

SUBSTANTIATION:
Several years ago, this language was added at the end of the sentence. As more of these appliances are now equipped with Flammable Vapor Ignition Resistant (FVIR) technology it seems that moving it to an exception makes sense to make sure it is not overlooked.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

305.0 Location.
305.1 Installation in Residential Garages. Appliances in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit shall be installed so that all heating elements, switches, burners, and burner-ignition devices are located not less than 18 inches (457 mm) above the floor. {{NFPA 54:9.1.10.1}}

Exception: Listed Flammable vapor ignition resistant (FVIR) appliances.

COMMITTEE STATEMENT:
Requirements for electric water heaters have been missing since the 2003 UPC. The reasons for this may no longer exist and are perhaps unimportant. The fact is that electric water heaters are still installed by plumbers and still need inspections. What document do plumbers and inspectors seek for these installation requirements?

Elements and switches (thermostats) are just as dangerous as burners and burner ignition devices, perhaps more so with the advent of FVIR for gas burning water heaters.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 062
UMC 2024  Section: 305.1

SUBMITTER: Arnie Rodio
Self

RECOMMENDATION:
Revise text

305.0 Location.
305.1 Installation in Residential Garages. Appliances in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit shall be installed so that all heating elements, switches, burners, and burner-ignition devices are located not less than 18 inches (457 mm) above the floor unless listed as flammable vapor ignition resistant. [(NFPA 54:9.1.10.1)]

SUBSTANTIATION:
Requirements for electric water heaters have been missing since the 2003 UPC. The reasons for this may no longer exist and are perhaps unimportant. The fact is that electric water heaters are still installed by plumbers and still need inspections. What document do plumbers and inspectors seek for these installation requirements?

Elements and switches (thermostats) are just as dangerous as burners and burner ignition devices, perhaps more so with the advent of FVIR for gas burning water heaters.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the changes pertaining to heating elements and switches in this proposal are already being addressed in Item # 061.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 063

UMC 2024 Section: 305.1.1, 305.1.4 - 305.1.4.3

SUBMITTER: Mark Rodriguez
Sunrun

RECOMMENDATION:
Revise text

305.0 Location.

305.1 Installation in Residential Garages. Appliances in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit shall be installed so that all burners and burner-ignition devices are located not less than 18 inches (457 mm) above the floor unless listed as flammable vapor ignition resistant. [NFPA 54:9.1.10.1]

305.1.1 Physical Damage. Appliances and energy storage systems (ESS) installed in garages, warehouses, or other areas subject to mechanical damage shall be guarded against such damage by being installed behind protective barriers designed to resist, deflect, or visually deter vehicle impact in accordance with Section 305.1.4 or by being elevated or located out of the normal path of vehicles, defined as a line perpendicular to the garage vehicle opening to the back wall extending 36 inches (914 mm) to either side along the back wall and to a height of 48 inches (1219 mm). (See Figure 305.1.4)

Exception: Where the clear height of the vehicle garage opening is equal to or less than 90 inches (2286 mm), ESS installed at least 36 inches (914 mm) above the finished floor shall not be subject to vehicle impact protection requirements.

305.1.4 Protective Barriers. Where appliances and ESS are in the normal driving path of vehicle travel, a protective barrier shall be provided in accordance with Section 305.1.4.1, Section 305.1.4.2, or Section 305.1.4.3. (See Figure 305.1.4)

305.1.4.1 Bollards. Where installed, construction of bollards shall be in accordance with one of the following:
(1) 48 inches in length by 3 inches in diameter (1219 mm x 76 mm). Schedule 80 steel pipe embedded in a concrete pier 12 inches (305 mm) deep and 6 inches (152 mm) in diameter, with 36 inches (914 mm) of pipe exposed, filled with concrete, and spaced at intervals not exceeding 60 inches (1524 mm). Each bollard shall be located not less than 6 inches (152 mm) from an ESS.
(2) 36 inches in height by 3 inches in diameter (914 mm x 76 mm). Schedule 80 steel pipe fully welded to an 8 inch by 8 inch by ½ inch (203 mm x 203 mm x 6.4 mm) thick steel plate and bolted to a concrete floor by means of four ½ inch (12.7 mm) concrete anchors with not less than 3 inches (76 mm) of embedment. Spacing shall not exceed 60 inches (1524 mm), and each bollard shall be located not less than 6 inches (152 mm) from the ESS.
(3) Pre-manufactured steel pipe bollards shall be filled with concrete and anchored in accordance with the manufacturer's installation instructions. Spacing between bollards shall not exceed 60 inches (1524 mm). Each bollard shall be located not less than 6 inches (152 mm) from the ESS.

305.1.4.2 Wheel Barriers. Where installed, construction of wheel barriers shall be in accordance with one of the following:
(1) 6 inches in height by 6 inches in width (152 mm x 152 mm). Wheel stop made of concrete or polymer, anchored to the concrete floor at intervals of not less than 36 inches (914 mm) and located not less than 54 inches (1372 mm) from the ESS. Not less than two ½ inch (12.7 mm) diameter concrete anchors with 3 inches (76 mm) of embedment per wheel stop shall be used. Spacing between wheel stops shall not exceed 36 inches (914 mm).
(2) Pre-manufactured wheel stops shall be anchored in accordance with the manufacturer’s installation instructions.

305.1.4.3 Other Approved Methods. Protective barriers installed 24 inches (610 mm) above grade and designed to resist a 2000 pound-force (8896 N) impact in the direction of vehicle travel shall be permitted.
FIGURE 305.1.4
PROTECTIVE BARRIERS FOR ESS

SUBSTANTIATION:
This change addresses the need for a clearly defined area in which a residential garage ESS installation would be within the normal path of vehicles. The existing language has led to widely varying interpretations and enforcement of impact protection. The proposed language has been added to define this area and set the expectation that the barriers are intended to deflect, resist, or visually deter an impact.

Figure 3.5.1.4 is being added to illustrate the zones in which a typical residential garage ESS installation would trigger the need for impact protection. The prescriptive barrier and post designs proposed represent protection from the assumed impact scenarios expected in a private residential garage where the building and fire codes speak more towards commercial installations.

The current UMC language leaves AHJs and installers with no guidelines for retrofit bollards designed to deter vehicle operators from carelessly striking the ESS units. The proposed language now allows for possible retrofitting where a floor mounted bollard may serve as a viable option for ESS protection. With this new language, designers, installers, and code officials will benefit from more explicit guidance within Section 305.1.1.

The limitation with bollard installation is mostly in the concrete to base plate connection. The average garage concrete slab will fall within these specifications: 2500 - 4000 psi concrete with 5" min thickness. Using 1/2" epoxy anchors, this equates to roughly a 2 mph impact that could be sustained without significant damage to the bollard.
This is aligned with a standard 4.5" bollard with 1/8" wall thickness and an 8" x 8" x 3/8" base plate. More strength requires a larger base plate, as the limitation is the connection to the concrete. The bolt down bollard specified in this proposal will take a 2000 lb impact, 24" off the ground with no damage, given 3000 psi concrete. More than 6" of permanent deflection would require a very significant force, and then only touching the face of the ESS. This seems to be a reasonable level of protection and clearance distance.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed language regarding protective barriers is outside of the scope of the UMC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine

EXPLANATION OF AFFIRMATIVE:

BALLANCO: There is actually some good information in this proposal, however, as written, it is overly restrictive.
Proposals

Item #: 064

UMC 2024  Section: 305.5

SUBMITTER: David Mann
CA State Pipe Trades Council

RECOMMENDATION:
Revise text

305.0 Location.

305.5 Drainage Pan. Where a water heater is located in an attic, in or on an attic ceiling assembly, floor-ceiling assembly, or floor-subfloor assembly or where damage results from a leaking water heater, a watertight pan of corrosion-resistant materials shall be installed beneath the water heater with not less than 3/4 of an inch (20 mm) diameter drain to an approved location. The terminating end of the drainpipe shall be readily visible. Such pan shall be not less than 1 1/2 inches (38 mm) in depth.

SUBSTANTIATION:
The proposed change will clarify that Section 305.5 is applicable to all water heaters, regardless of the type of water heater. The intent of the section is to prevent damage from occurring in the surrounding vicinity of the water heater should a leak occur.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

WHITE: Language is not consistent with the UPC where they must be readily observable [Section 608.5(8)].

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 064, Section 305.5 (Drainage Pan) and UPC Item # 104, Section 507.5 (Drainage Pan) resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

305.0 Location.

305.5 Drainage Pan. Where a water heater is located in an attic, in or on an attic ceiling assembly, floor-ceiling assembly, floor-subfloor assembly or where damage results from a leaking water heater, a watertight pan of corrosion-resistant materials shall be installed beneath the water heater in accordance with the following:

(1) The drainage pan shall be provided with not less than 3/4 of an inch (20 mm) diameter drain to an approved location. The terminating end of the drainpipe shall be readily visible.

(2) The drainage pan shall be not less than 1 1/2 inches (38 mm) in depth.
(3) Where a drainage pan pipe is installed, the material of the piping shall be rated for the temperature rating of the water heater and shall be approved for use with the liquid being discharged.

(4) Discharge from a relief valve into a drainage pan shall be prohibited.

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT:
The language in UMC Item # 064, Section 305.5 (Drainage Pan) is being revised to correlate with the action taken by the UPC TC for Item # 104, Section 507.5 (Drainage Pan) to separate drainage pan requirements into a numbered list format and add items (3) and (4) for temperature rating and discharge from a relief valve.

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 305.5 regarding separating drainage pan requirements into a numbered list format and adding items (3) and (4) for temperature rating and discharge from a relief valve.
Proposals

Item #: 065
UMC 2024  Section: 305.5

SUBMITTER: Bob Adler
Self

RECOMMENDATION: Revise text

305.0 Location.

305.5 Drainage Pan. Where an water heater appliance or equipment is located in an attic, in or on an attic ceiling assembly, floor-ceiling assembly, or floor-subfloor assembly where damage results from a leaking water heater appliance or equipment, a watertight pan of corrosion-resistant materials shall be installed beneath the water heater appliance or equipment in accordance with the following:

1. The drainage pan shall be provided with not less than 3/4 of an inch (20 mm) diameter drain to an approved location.
2. Such The drainage pan shall be not less than 1 1/2 inches (38 mm) in depth.
3. Where a drain pan pipe is installed, the material of the piping shall be rated for the temperature rating of the appliance or equipment and shall be approved for use with the liquid being discharged.

SUBSTANTIATION:
The new text will add provisions which clarify that piping used on hot water applications shall be rated for such temperatures as there are drain lines to be used for cold water applications only.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed language is overly restrictive and would require drainage pans on all appliances or equipment whether they condensate or not.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 066
UMC 2024  Section: 305.6

SUBMITTER: David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Add new text

305.0 Location.

305.6 Outdoor Locations. Appliances installed in outdoor locations shall be in accordance with the following:
(1) Listed for outdoor installation.
(2) Provided with approved protection from the outdoor environmental factors that can affect the operation, durability, or safety of such appliances and in accordance with the manufacturer’s installation instructions.
(3) Outdoor cooking appliances shall comply with Section 923.0.

(below shown for reference only)

923.0 Outdoor Cooking Appliances.
923.1 Listed Units. Listed outdoor cooking appliances shall be installed in accordance with their listing and the manufacturer’s installation instructions.
923.2 Unlisted Units. Unlisted outdoor cooking appliances shall be installed outdoors with clearances to combustible material of not less than 36 inches (914 mm) at the sides and back and not less than 48 inches (1219 mm) at the front. In no case shall the appliance be located under overhead combustible construction. [NFPA 54:10.19.2]

SUBSTANTIATION:
Additional provisions for protection of appliances located outdoors are being added for public health and safety. Outdoor appliances are commonly used and additional code language is needed to improve the code.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

305.0 Location.

305.6 Outdoor Locations. Appliances installed in outdoor locations shall be in accordance with the following:
(1) Listed for outdoor installation.
(2) Provided with approved protection from the outdoor elements that can affect the operation, durability, or safety of such appliances and in accordance with the manufacturer’s installation instructions.
(3) Outdoor cooking appliances shall comply with Section 923.0.

COMMITTEE STATEMENT:
The definition is being modified as "elements" is a better understood term than "environmental factors."

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 26   NEGATIVE: 3   NOT RETURNED: 1   Heine

EXPLANATION OF AFFIRMATIVE:

BALLANCO: While the concept of this change is fine, the wording needs to be corrected by a comment.
| **KOERBER:** | In general, the proposal is fine, but the wording should be revised to improve enforceability. |
| **EXPLANATION OF NEGATIVE:** | |
| **VAN RITE:** | I agree that the wording is too vague. |
| **WHITE:** | Item (2) should just require compliance with the manufacturer's instructions, not add an additional requirement to add protection from elements. This is a judgement call as to what additional protection is needed. |
| **WISEMAN:** | While we support the idea behind this proposal, "approved protection" is vague and unenforceable. |
Proposals

Item #: 067
UMC 2024 Section: 308.0, 308.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

305.0 Location.

305.6 Improper Prohibited Locations.

305.6.1 General. Piping, appliances, or equipment shall not be so located as to interfere with the normal use thereof or with the normal operation and use of windows, doors, or other required facilities. Unless permitted elsewhere in this code, fuel-burning appliances shall not be installed in, or in a space that communicates with, the following:

(1) Bedrooms
(2) Bathrooms
(3) Toilet rooms
(4) Storage rooms
(5) Surgical rooms

Exception: Central heating boilers and furnaces in accordance with Section 904.0.

(below shown for reference only)

303.2 Closet or Alcove Installations. Central heating furnaces and boilers installed in closets or alcoves shall be listed for such installation. Central heating furnaces not listed for closet or alcove installation shall be installed in a room or space having a volume not less than 12 times the total volume of the furnace. Central heating boilers not listed for closet or alcove installation shall be installed in a room or space having a volume 16 times the volume of the boiler. Where the ceiling height of the room or space exceeds 8 feet (2438 mm), the volume shall be calculated on the basis of an 8 foot (2438 mm) height.

The installation clearances shall be in accordance with the appliance listing, shall not be reduced, and shall be installed in accordance with Section 904.1.

904.0 Central Heating Boilers and Furnaces.

904.1 Location. Central heating furnace and low-pressure boiler installations in bedrooms or bathrooms shall comply with one of the following:

(1) Central heating furnaces and low-pressure boilers shall be permitted to be installed in a closet located in the bedroom or bathroom, provided the closet is equipped with a listed, gasketed door assembly, and a listed self-closing device. The self-closing door assembly shall comply with the requirements of Section 904.1.1. The door assembly shall be installed with a threshold and bottom door seal and shall comply with the requirements of Section 904.1.2. Combustion air for such installations shall be obtained from the outdoors. The closet shall be for the exclusive use of the central heating furnace or low-pressure boiler.

(2) Central heating furnaces and low-pressure boilers shall be of the direct vent type.

904.1.1 Self-Closing Doors. Self-closing doors shall swing easily and freely, and shall be equipped with a self-closing device to cause the door to close and latch each time it is opened. The closing mechanism shall not have a hold-open feature.

904.1.2 Gasketing. Gasketing on gasketed doors or frames shall be furnished in accordance with the published listings of the door, frame, or gasketing material manufacturer.

Exception: Where acceptable to the Authority Having Jurisdiction, gasketing of noncombustible or limited-combustible
material shall be permitted to be applied to the frame, provided closing and latching of the door are not inhibited.

904.2 Clearance. Central heating furnaces and low-pressure boilers shall be provided with clearances in accordance with Section 904.2.1 through Section 904.2.7.

904.2.1 Listed Units. Listed central heating furnaces and low-pressure boilers shall be installed with clearances in accordance with the terms of their listings and the manufacturer's installation instructions.

904.2.2 Unlisted Units. Unlisted central heating furnaces and low-pressure boilers shall be installed with clearances from combustible material not less than those specified in Table 904.2.2. [NFPA 54:10.3.2.2]

904.2.3 Listed and Unlisted Units. Listed and unlisted central heating furnaces and low-pressure boilers shall be permitted to be installed with reduced clearances to combustible material, provided that the combustible material or appliance is protected as described in Table 303.10.1 and Figure 303.10.1(1) through Figure 303.10.1(3), and such reduction is allowed by the manufacturer's installation instructions. [NFPA 54:10.3.2.3]

904.2.4 Front Clearance. Front clearance shall be sufficient for servicing the burner and the furnace or boiler. [NFPA 54:10.3.2.4]

904.2.5 Adjacent to Plaster or Noncombustible Materials. Where the furnace plenum is adjacent to plaster on metal lath or noncombustible material attached to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish where the clearance specified is 2 inches (51 mm) or less. [NFPA 54:10.3.2.5]

904.2.6 Interference. The clearances to these appliances shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. [NFPA 54:10.3.2.6]

904.2.7 Central Heating Furnaces. Central heating furnaces other than those listed in Section 603.13.2 or Section 603.13.3 shall have clearances from the supply ducts of not less than 18 inches (457 mm) from the furnace plenum for the first 3 feet (914 mm), then 6 inches (152 mm) for the next 3 feet (914 mm) and 1 inch (25.4 mm) beyond 6 feet (1829 mm). [NFPA 54:10.3.2.9]

904.3 Assembly and Installation. A central heating boiler or furnace shall be installed in accordance with the manufacturer's instructions in one of the following manners:

(1) On a floor of noncombustible construction with noncombustible flooring and surface finish and with no combustible material against the underside thereof.

(2) On fire-resistive slabs or arches having no combustible material against the underside thereof.

Exceptions:

(1) Appliances listed for installation on a combustible floor.

(2) Installation on a floor protected in an approved manner. [NFPA 54:10.3.3]

904.3.1 Under-Floor Installation. Furnaces installed in an under-floor area of the building shall be in accordance with the Section 904.3.1.1 through Section 904.3.1.3.

904.3.1.1 Supported by Ground. Where a furnace is supported by the ground, it shall be installed on a concrete slab not less than 3 inches (76 mm) above the adjoining ground level.

904.3.1.2 Supported from Above. Where a furnace is supported from above, a clearance of not less than 6 inches (152 mm) shall be provided from finished grade.

904.3.1.3 Excavation. Where excavation is necessary to install a furnace, it shall be installed in accordance with Section 303.11.

904.4 Temperature or Pressure Limiting Devices. Steam and hot water boilers, respectively, shall be provided with approved automatic limiting devices for shutting down the burner(s) to prevent boiler steam pressure or boiler water temperature from exceeding the maximum allowable working pressure or temperature. Safety limit controls shall not be used as operating controls. [NFPA 54:10.3.4]

904.5 Low-Water Cutoff. All water boilers and steam boilers shall be equipped, respectively, with listed or approved steam safety or pressure relief valves of appropriate discharge capacity and conforming with ASME requirements. A shutoff valve shall not be placed between the relief valve and the boiler or on discharge pipes between such valves and the atmosphere. [NFPA 54:10.3.6]

904.6.1 Discharge. Relief valves shall be piped to discharge near the floor. [NFPA 54:10.3.6.1]

904.6.2 Size. The entire discharged piping shall be at least the same size as the relief valve discharge piping. [NFPA 54:10.3.6.2]

904.6.3 End Connections. Discharge piping shall not contain threaded end connection at its termination point. [NFPA 54:10.3.6.3]

904.7 Refrigeration Coils. The installation of refrigeration coils shall comply with the following requirements:

(1) A refrigeration coil shall not be installed in conjunction with a forced air furnace where circulation of cooled air is provided by the furnace blower, unless the blower has sufficient capacity to overcome the external static pressure resistance imposed by the duct system and refrigeration coil at the air flow rate for heating or cooling, whichever is greater.

(2) Furnaces shall not be located upstream from refrigeration coils, unless the refrigeration coil is designed or equipped so as not to develop excessive temperature or pressure.
(3) Refrigeration coils shall be installed in parallel with or on the downstream side of central furnaces to avoid condensation in the heating element, unless the furnace has been specifically listed for downstream installation. With a parallel flow arrangement, the dampers or other means used to control flow of air shall be sufficiently tight to prevent any circulation of cooled air through the furnace.

(4) Means shall be provided for disposal of condensate and to prevent dripping of condensate on the heating element. [NFPA 54:10.3.8]

904.8 Cooling Units Used with Heating Boilers. Boilers, where used in conjunction with refrigeration systems, shall be installed so that the chilled medium is piped in parallel with the heating boiler with appropriate valves to prevent the chilled medium from entering the heating boiler. [NFPA 54:10.3.9.1]

904.8.1 Exposed to Refrigerated Air Circulation. Where hot water heating boilers are connected to heating coils located in air-handling units where they can be exposed to refrigerated air circulation, such boiler piping systems shall be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle. [NFPA 54:10.3.9.2]

904.9 Furnace (Upright and Horizontal). Upright furnaces shall be permitted to be installed in an attic, furred, or under-floor space exceeding 5 feet (1524 mm) in height, provided the required listings and furnace and duct clearances are observed. Horizontal furnaces shall be permitted to be installed in an attic, furred, or under-floor space, provided the required listings and furnace and duct clearances are observed.

904.10 Solid-Fuel-Fired Furnaces. Factory-built solid fuel-fired furnaces shall comply with UL 391 and shall be installed in accordance with the manufacturer’s installation instructions.

904.11 Oil-Fired Central Furnaces. Oil-fired central furnaces shall comply with UL 727 and shall be installed in accordance with the manufacturer’s installation instructions.

904.12 Commercial or Industrial Gas Heaters. Commercial or industrial gas-fired heaters shall comply with UL 795 and shall be installed in accordance with the manufacturer’s installation instructions.

904.13 Electric Central Furnaces. Electric central heating furnaces shall comply with UL 1995 or UL 60335-2-40 and shall be installed in accordance with the manufacturer’s installation instructions.

SUBSTANTIATION:
The code change provides a list of spaces where fuel burning appliances shall not be installed for public health and safety. For example, Section 303.2 allows central heating furnaces and boilers installed in closets or alcoves shall be listed for such installation.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal needs additional revisions and is currently vague and poorly written.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 068

UMC 2024  Section: 310.0, 310.1, 310.7

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

310.0 Condensate Wastes and Control.

310.1 Condensate Disposal. Condensate from air washers, air-cooling coils, condensing appliances, and the overflow from evaporative coolers and similar water-supplied equipment or similar air-conditioning equipment shall be collected and discharged to an approved plumbing fixture or disposal area. Where discharged into the drainage system, equipment shall drain by means of using an indirect waste pipe. The waste pipe shall have a slope of not less than 1/8 inch per foot (10.4 mm/m) or 1 percent slope and shall be of approved corrosion-resistant material not smaller than the outlet size in accordance with Section 310.3 or Section 310.4 for air-cooling coils or condensing appliances, respectively. Condensate or wastewater shall not drain over a public way.

310.7 Plastic Fittings. Female plastic screwed fittings shall be used with male plastic male fittings and plastic male threads.

SUBSTANTIATION:
The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There was insufficient technical justification provided to warrant such change.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 069
UMC 2024 Section: 310.1.1, Table 1701.1

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

310.0 Condensate Wastes and Control.
310.1 Condensate Disposal. (remaining text unchanged)
310.1.1 Condensate Pumps. Where approved by the Authority Having Jurisdiction, condensate pumps shall be installed in accordance with the manufacturer’s installation instructions. Pump discharge shall rise vertically to a point where it is possible to connect to a gravity condensate drain and discharged to an approved disposal point. Each condensing unit shall be provided with a separate sump and interlocked with the equipment to prevent the equipment from operating during a failure. Separate pumps shall be permitted to connect to a single gravity indirect waste where equipped with check valves and approved by the Authority Having Jurisdiction. Motor operated condensate pumps rated 600 volts or less shall be listed and labeled in accordance with CSA C22.2 No. 108 or UL 778.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
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<tr>
<td>CSA C22.2 No. 108 –2014 (R2019)</td>
<td>Liquid Pumps</td>
<td>Pumps</td>
<td>310.1.1</td>
</tr>
</tbody>
</table>

Note: CSA C22.2 No. 108 and UL 778 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
Section 310.1.1 is being modified to include CSA C22.2 No. 108 and UL 778 as the standards apply to liquid pumps and is consistent with the language in Section 1208.1. Various manufacturers are currently making condensate pumps which are being listed to these standards. The standards cover construction, markings, testing, bonding, and enclosures for liquid pumps including condensate pumps. Including these listings further enhances the code.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the proposed standards apply to all liquid pumps and are not specific to condensate pumps. Furthermore, UL 778 is already located in Table 1701.1 and Chapter 12 for hydronic pumps. These requirements belong in Chapter 12, not in Chapter 3.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 26   NEGATIVE: 3   NOT RETURNED: 1   Heine

EXPLANATION OF NEGATIVE:

MACNEVIN: This change would add an appropriate standard for these pumps into the code and make it mandatory that these pumps meet one of two listed standards.

WHITE: The standard is acceptable. Condensate pumps are liquid pumps and as such is applicable. This offers additional product opportunity in the market.

WISEMAN: This standard is appropriate and should be included in code.
Proposals

Item #: 070
UMC 2024 Section: 310.2

SUBMITTER: Arnie Rodio
Self

RECOMMENDATION:
Revise text

310.0 Condensate Wastes and Control.

310.2 Condensate Control. Where any equipment or appliance is installed in a space where damage is capable of resulting from condensate overflow, a drain line shall be provided and shall be drained in accordance with Section 310.1. An additional protection method for condensate overflow shall be provided in accordance with one of the following:

(1) A water level detecting device that will shut off the equipment or appliance in the event the primary drain is blocked.
(2) An additional watertight pan of corrosion-resistant material, with a separate drain line, installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain.
(3) An additional separate drain line at a level that is higher than the primary drain line connection of the drain pan.
(4) An additional watertight pan of corrosion-resistant material with a water level detection device installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain and to shut off the equipment.

The additional pan or the additional drain line connection shall be provided with a drain pipe of not less than 3/4 of an inch (20 mm) nominal pipe size, discharging at a point that is readily observed.

SUBSTANTIATION:
The recommended change will assist in identifying whether the condensate waste is coming from the primary or secondary drain. If there is condensate coming from the secondary line, it must be investigated.

The addition of "separate" is to ensure that the primary and secondary are not tied together.

It used to have proposed language to make sure it was visible and marked, but it was removed.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 070, Section 310.2(1) (Condensate Control), UPC Item # 207, Section 814.2(1) (Condensate Control), and UPC Item # 206, Section 814.2(1) (Condensate Control) resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:
310.0 Condensate Wastes and Control.

310.2 Condensate Control. Where any equipment or appliance is installed in a space where damage is capable of resulting from condensate overflow, a drain line shall be provided and shall be drained in accordance with Section 310.1. An additional protection method for condensate overflow shall be provided in accordance with one of the following:

(1) A water level detecting device that will shut off the equipment or appliance in the event the primary drain is blocked. Such detecting device shall be in accordance with the manufacturer’s installation instructions.

(2) An additional watertight pan of corrosion-resistant material, with a separate drain line, installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain.

(3) An additional separate drain line at a level that is higher than the primary drain line connection of the drain pan.

(4) An additional watertight pan of corrosion-resistant material with a water level detection device installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain and to shut off the equipment.

The additional pan or the additional drain line connection shall be provided with a drain pipe of not less than 3/4 of an inch (20 mm) nominal pipe size, discharging at a point that is readily observed.

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT:
The language in UMC Item # 070, Section 310.2(1) (Condensate Control) is being revised to correlate with the action taken by the UPC TC for Item # 206, Section 814.2(1) (Condensate Control) to add the sentence “Such detecting device shall be in accordance with the manufacturer’s installation instructions.”

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 310.2 regarding the addition of the sentence “Such detecting device shall be in accordance with the manufacturer’s installation instructions.”
Proposals

Item #: 071

UMC 2024  Section: 310.2, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

310.0 Condensate Wastes and Control.

310.2 Condensate Control. Where any equipment or appliance is installed in a space where damage is capable of resulting from condensate overflow, a drain line shall be provided and shall be drained in accordance with Section 310.1. An additional protection method for condensate overflow shall be provided in accordance with one of the following:

(1) A water level detecting device listed and labeled to UL 508 that will shut off the equipment or appliance in the event the primary drain is blocked.

(2) An additional watertight pan of corrosion-resistant material, with a separate drain line, installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain.

(3) An additional drain line at a level that is higher than the primary drain line connection of the drain pan.

(4) An additional watertight pan of corrosion-resistant material with a water level detection device listed and labeled to UL 508 installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain and to shut off the equipment.

The additional pan or the additional drain line connection shall be provided with a drain pipe of not less than 3/4 of an inch (20 mm) nominal pipe size, discharging at a point that is readily observed.

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<tr>
<td>UL 508-2018</td>
<td>Industrial Control Equipment</td>
<td>Control Equipment</td>
<td>310.2</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 508 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
Water level detecting devices need to properly function where used as part of the protection method for condensate overflow. UL 508 is the standard used for listing and labeling of these types of devices.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is overly restrictive regarding listing requirements for water level detection devices. Additionally, the term "comply" is preferred over "listed and labeled" for consistency throughout the codes. Section 301.2 already requires all products to be listed by a listing agency and Section 301.2.1 requires markings as required by the applicable reference standard and listing agency.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

WHITE: Adding product safety standards is a good idea. The proponent may choose to reword to “comply” with the preferred style of writing, but I find style to be a poor reason to accept safety.
Proposals

Item #: 072

UMC 2024  Section: 310.3.2

SUBMITTER:  Arnie Rodio  
Self

RECOMMENDATION:  
Add new text

310.0 Condensate Wastes and Control.

310.3 Condensate Waste Pipe Material and Sizing. (remaining text unchanged)

310.3.2 Material. Condensate waste pipes shall be constructed of DWV materials in accordance with the plumbing code.

SUBSTANTIATION:  
There is currently no direction for acceptable piping material for condensate waste pipe in the code. This code change adds provisions for condensate waste pipe materials to assist the installer and AHJ with installation of condensate waste pipe. The UPC, Table 701.2, lists the acceptable materials for condensate lines.

COMMITTEE ACTION:  REJECT

COMMITTEE STATEMENT:  
The proposed change directs the end user to DWV materials in the plumbing code, which may not contain all applicable materials and sizes for condensate waste pipe. Many condensate drains are smaller than 1¼ inch. The language needs to be rewritten as it is overly restrictive.

TOTAL ELIGIBLE TO VOTE:  30

VOTING RESULTS:  AFFIRMATIVE:  29  NOT RETURNED:  1  Heine
Proposals

Item #: 073

UMC 2024  Section: 310.5

SUBMITTER: Arnie Rodio
Self

RECOMMENDATION:
Revise text

310.0 Condensate Wastes and Control.

310.5 Point of Discharge. Air-conditioning condensate waste pipes shall connect indirectly, except where permitted in Section 310.6, to the drainage system through an air gap or air break to trapped and vented receptors, dry wells, mop sinks, leach pits, or the tailpiece of plumbing fixtures. A condensate drain shall be trapped in accordance with the appliance manufacturer's instructions or as approved.

SUBSTANTIATION:
The change clarifies that mop sinks are an option for indirect connections for condensate waste pipes. Condensate drainage through mop sinks is common and will assist the end user in installing indirect waste piping.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the changes pertaining to mop sinks in this proposal are already being addressed in Item # 074.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 074
UMC 2024 Section: 310.5

SUBMITTER: Arnie Rodio
Self

RECOMMENDATION:
Revise text

310.0 Condensate Wastes and Control.

310.5 Point of Discharge. Air-conditioning condensate waste pipes shall connect indirectly—except where permitted in Section 310.6—to the drainage system through an air gap or air break to trapped and vented receptors, dry wells, or leach pits, or the tailpiece of plumbing fixtures. A condensate drain shall be trapped in accordance with the appliance manufacturer’s instructions or as approved.

Exception: Direct connections in accordance with Section 310.6.

(below shown for reference only)

310.6 Condensate Waste From Air-Conditioning Coils. Where the condensate waste from air-conditioning coils discharges by direct connection to a lavatory tailpiece or to an approved accessible inlet on a bathtub overflow, the connection shall be located in the area controlled by the same person controlling the air-conditioned space.

SUBSTANTIATION:
The first sentence of Section 310.5 starts with indirect connection and then gives the exception. The change relocates language in Section 310.5 to an exception for clarity and to ensure it is not overlooked. Such "direct" connection to the tailpiece is covered in Section 310.6. Additionally, the term “tailpiece of plumbing fixtures” is grouped with the list of locations allowed for “air gap” or “air breaks.” A connection to a tailpiece of a plumbing fixture is neither through an air break or air gap.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

310.5 Point of Discharge. Air-conditioning condensate waste pipes shall connect indirectly to the drainage system through an air gap or air break to trapped and vented receptors, dry wells, mop sinks, or leach pits. A condensate drain shall be trapped in accordance with the appliance manufacturer’s instructions or as approved.

Exception: Direct connections in accordance with Section 310.6.

COMMITTEE STATEMENT:
The change clarifies that mop sinks are an option for indirect connections for condensate waste discharge. Condensate drainage through mop sinks is common and the modification will assist the end user in installing indirect condensate waste piping.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 27  NEGATIVE: 2  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:
WHITE: The removal of connections to tailpieces of plumbing fixtures is wrong. Once that is deleted, Section 310.6 is rendered useless, the tailpiece is no longer an acceptable point of disposal. The proponent states that a tailpiece is not...
an air break, but that is not a correct statement. Provided the tailpiece is above the trap weir, it is an air break. This will eliminate a very common method of disposal in multifamily construction.

WISEMAN: It makes no sense to remove lavatory tailpiece from Section 310.5. If you remove it from the current list of specific points-of-discharge, then it becomes an unacceptable discharge point. The industry uses this point-of-discharge all the time without problem.
Proposals

Item #: 075
UMC 2024  Section: 310.5

SUBMITTER: Bruce A Pfeiffer
Retired - City of Topeka

RECOMMENDATION:
Revise text

310.0 Condensate Wastes and Control.

310.5 Point of Discharge. Air-conditioning condensate waste pipes shall connect indirectly, except where permitted in Section 310.6, to the drainage system through an air gap or air break to trapped and vented receptors, dry wells, leach pits, or the tailpiece of plumbing fixtures. Condensate from rooftop air conditioning units shall be permitted to drain indirectly into a roof drain. A condensate drain shall be trapped in accordance with the appliance manufacturer’s instructions or as approved.

SUBSTANTIATION:
Condensate is essentially distilled water, low in mineral content and when pure is neutral (pH7). Condensate in contact with air is slightly acidic (approximately pH 5.6) due to dissolved carbon dioxide (CO2)(COX2). The same applies to rainwater.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as allowing condensate waste from rooftop air conditioning units to drain indirectly into a roof drain is prohibited by federal law.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine

EXPLANATION OF AFFIRMATIVE:
WHITE: It would be good to cite the CFR section that prohibits this practice.
Proposals

Item #: 076
UMC 2024  Section: 310.7

SUBMITTER: Arnie Rodio
Self

RECOMMENDATION:
Revise text

310.0 Condensate Wastes and Control.

310.7 **Female Plastic Fittings Connections**, Female plastic screwed fittings shall be used with plastic male fittings and plastic male threads. **Female plastic threaded connections shall not be allowed to be used when threaded onto a male metallic connection.**

SUBSTANTIATION:
It is common practice for installers to use female plastic fittings in installations where a male metal outlet is. This is common on condensate pans and HVAC units. It is often use at water services where a metal nipple is used. This issue is that this type of installation often cracks and then leaks or floods. When the female fitting is over tightened (which is hard not to do as there is no way to really torque it) it creates a stress on the fitting. Plastic products relieve stress by cracking. It is also important that this be in the general regulations as a clearly prohibited practice.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 077
UMC 2024  Section: 310.7.1

SUBMITTER:  Arnie Rodio
Self

RECOMMENDATION:
Add new text

310.0 Condensate Wastes and Control.

310.7.1 ABS/PVC Transition Connections. Except as provided in the plumbing code, PVC and ABS pipe and fittings shall not be solvent welded to any other unlike material.

SUBSTANTIATION:
The current language allows for a single transition from ABS to PVC or PVC to ABS exterior of the structure. Transition glue is not being represented to be allowable to make transition joints between ABS and PVC anywhere in the building. This code change clarifies that this practice is not approved. I have seen residences where the below slab plumbing was PVC and then the above slab plumbing all PVC with the joints being made with transition glue. This is an improper use of the product. It is important that this be in the general regulations as a prohibited practice.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
ABS and PVC should not be used interchangeably. Listing these materials would exclude other materials and may cause confusion when applying provisions.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:   AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

KOERBER: I agree with the intent, but the wording could cause further confusion.
Proposals

Item #: 078
UMC 2024 Section: 311.2 - 311.4

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

311.0 Heating or Cooling Air System.

311.2 Air Filters. Air filters shall be installed in a heating, cooling, or makeup air system. Media-type air filters shall comply with UL 900. Electrostatic and high efficiency particulate filters shall comply with Section 936.0.

Exceptions:
(1) Air filters used in systems serving single guest rooms or dwelling units shall not be required to be a listed filter.
(2) Air filters used in listed appliances and in accordance with the manufacturer’s instructions.

311.3 Prohibited Sources. Outside or return air for a heating or cooling air system shall not be taken from the following locations:
(1) Less than 10 feet (3048 mm) in distance from an appliance vent outlet, a vent opening of a plumbing drainage system, or the discharge outlet of an exhaust fan, unless the outlet is 3 feet (914 mm) above the outside-air inlet.
(2) Less than 10 feet (3048 mm) above the surface of an abutting public way, sidewalk, street, alley, or driveway.
(3) A hazardous or insanitary location, or a refrigeration machinery room as defined in this code.
(4) An area, the volume of which is less than 25 percent of the entire volume served by such system, unless there is a permanent opening to an area the volume of which is equal to 25 percent of the entire volume served.

Exception: Such openings where used for a heating or cooling air system in a dwelling unit shall be permitted to be reduced to not less than 50 percent of the required area, provided the balance of the required return air is taken from a room or hall having not less than three doors leading to other rooms served by the furnace.
(5) A closet, bathroom, toilet room, kitchen, garage, boiler room, furnace room, or unconditioned attic.
(6) Rooms or spaces containing a fuel-burning appliance therein. Where such room or space serves as source of return-air.

Exceptions:
(1) This shall not apply to fireplaces, fireplace appliances, residential cooking appliances, direct vent appliances, enclosed furnaces, and domestic-type clothes dryers installed within the room or space.
(2) This shall not apply to a gravity-type or listed vented wall heating or cooling air system.
(3) This shall not apply to a blower-type heating or cooling air system installed in accordance with the following requirements:
(a) Where the return air is taken from a room or space having a volume exceeding 1 cubic foot (0.03 m³) for each 10 Btu/h (0.003 kW) fuel input rating of fuel-burning appliances therein.
(b) Not less than 75 percent of the supply air is discharged back into the same room or space.
(c) Return-air inlets shall not be located within 10 feet (3048 mm) from an appliance firebox or draft diverter in the same enclosed room or confined space.
(7) Return air shall not be taken from indoor swimming pool enclosures and associated deck areas.

Exceptions:
(a) Where the air from such spaces is dehumidified.
(b) Dedicated HVAC systems serving only such spaces.
(8) Return air from one dwelling unit shall not discharge into another dwelling unit through the heating or cooling air system.

311.4 Return-Air Limitations. Return air from one dwelling unit shall not discharge into another dwelling unit through the heating or cooling air system.
SUBSTANTIATION:
The current wording in Section 311.2 is incorrect and misleading as it can be interpreted that air filters are not required to be installed in dwelling units. The exception is being corrected to clarify that air filters are indeed required in dwelling units, but they do not need to be listed.

Additional return air limitations are also being added to Section 311.3 to address missing return air prohibited sources, such as swimming pool enclosures, garages, boiler rooms, furnace rooms, and unconditioned attics. Section 311.4 is also being combined with Section 311.3 since they cover the same topic.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the language is unenforceable, overly restrictive, and lacks technical justification. The reference to boilers in basements and return air is not an issue. There is no provided reason for prohibiting this. Furthermore, chlorine latent vapors are being let into the building and the humidity can cause structural damage.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 079
UMC 2024  Section: 311.2.1

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Add new text

311.2 Air Filters. Air filters shall be installed in a heating, cooling, or makeup air system. Media-type air filters shall comply with UL 900. Electrostatic and high efficiency particulate filters shall comply with Section 936.0.

Exceptions:
(1) Systems serving single guest rooms or dwelling units shall not require a listed filter.
(2) Air filters used in listed appliances and in accordance with the manufacturer's instructions.

311.2.1 Minimum Filtration. In mechanically ventilated buildings, occupied areas of the building shall be provided with air filtration media for outside and return air that provides not less than a Minimum Efficiency Reporting Value (MERV) of 13 or as required by the Authority Having Jurisdiction. Installed filters shall be clearly labeled by the manufacturer indicating the MERV rating.

SUBSTANTIATION:
This code change would make air filters with a MERV of 13 or higher the requirement based on the ASHRAE measurement scale test method. MERV 13 air filters or better are already required by many jurisdictions. Since 2019, California Title 24, Part 6 has had the MERV 13 requirement for air filters. Many jurisdictions require MERV 14 rating in central ventilation systems. MERV 13 filters are beneficial because they are able to remove particles of lower-rated filters, plus smoke, bacteria, droplet nuclei (from a sneeze), smog, and aerosols. Indoor air pollution can cause health problems and one of the best ways to lower the risk of airborne contaminants in occupied spaces is to comply with the MERV 13 requirement. The AHJ can still require other minimum MERV ratings as necessary on a case-by-case basis.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
This item is being rejected as requiring MERV 13 filters is overly stringent and may lower the performance of existing HVAC systems and affect air pressure. MERV 13 filters are already required by energy codes. There may be residential occupancies that will not be able to comply with these requirements. Furthermore, nothing in this code restricts the use of MERV 13 filters.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 12  NEGATIVE: 17  NOT RETURNED: 1  Heine

Note: Item # 079 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.

EXPLANATION OF AFFIRMATIVE:

BALLANCO: While I believe MERV 13 filters should be considered for commercial construction, they are not feasible for many residential and light commercial units. This should not be a universal requirement for all systems. Furthermore, it is inappropriate to state, "or as required by the Authority Having Jurisdiction." This statement leaves the requirements wide open without proper guidelines to the AHJ.
KOERBER: I do not believe that MERV 13 requirements for filtration should be mandated by the code. Certainly they may be considered as a beneficial option to occupants, but mandating their use within the code is not a good idea.

MACNEVIN: I agree with the initial Committee Action to Reject this proposal. Mandating a specific filter type in the code is not enforceable because filters are frequently changed.

WHITE: This is a design consideration, not a code decision. Certainly, filters reduce particles in the air and improve IAQ, some better than others. There are design considerations to properly size filters such that the pressure drop is acceptable to the system, those are not free. In residential equipment, simply changing a 1 inch fiberglass filter with a 1 inch MERV 13 will not give the same performance at both the initial clean filter condition, but will degrade performance faster as the MERV 13 loads up with contaminants sooner.

WISEMAN: There are considerable problems implementing residential MERV 13 filters in the field without replacing the duct system. As the static pressure rises with higher efficiency filters, there is often not enough airflow over the coil to allow for proper operation. Thus, many California contractors are either avoiding permits, or returning after the job is completed to remove the MERV 13 filter so the system will operate properly. MERV 13 works wonderfully if the entire system is newly installed and properly designed. It does NOT work if installed on an older restrictive duct system. The decision for what filter is installed should be left to the building/homeowner and the design engineer/contractor.

EXPLANATION OF NEGATIVE:

ADLER: I agree with the statements of Dave Mann and Randy Young.

AGUILAR: Mechanical filters have been shown to reduce significantly indoor concentrations of airborne particles. Modest empirical evidence shows that their use will have positive effects on health. Numerous Committee members indicated this was already happening in their jurisdictions and have no real issues.

ARYAN: MERV 13 filters are already required by the California energy code and the LA City mechanical and green codes. There have not been any issues to enforcing this requirement and it is very feasible to require this as well as beneficial to ensure better air quality.

BENKOWSKI: The filter for a mechanical system should not be selected by the AHJ. The design engineer should select filter to benefit the intended operation of the building.

BERGER; EGG, J: I agree with the comments made by Randy Young and other TC members.

DIAS: One of the concerns was that if MERV 13 filters are required that the air handler would not be able to handle the increased pressure drop. But if it is already a requirement in certain jurisdictions without any issues then I do not think its a legitimate concern.

HAMILTON: MERV 13 can be added to systems with no, as in zero, increase in fan energy or increase in size of the fan.

KREITENBERG: This change is overly restrictive.

MANN: One of the concerns was to residential systems and I believe this is not addressing those systems. I also agree with the comment submitted by Randy Young.

RIBBS: I agree with April Trafton that in new construction, this is important. For remodel of existing systems, this needs to be designed to provide appropriate filtration without damaging existing equipment.

TAYLOR: I feel the minimum filtration rate is important to be in the code.

TERZIGNI: I think this is the right direction and existing buildings can be given an exemption per Section 302.1.3.

TRAFTON, A: In new construction, this is important. For remodel of existing systems, this needs to be designed to provide appropriate filtration without damaging existing equipment.

TRAFTON, P: As California is already requiring MERV 13 filters in residential applications and in some commercial applications and it has been found that it can be accomplished appropriately, this should be accepted. Though I do agree it should be up to the design professional to properly select and size filters, not the AHJ.

VAN RITE: I do not agree with the MERV 13 requirement.

YOUNG: Mechanical filters have been shown to reduce significantly indoor concentrations of airborne particles. Modest empirical evidence shows that their use will have positive effects on health. Numerous Committee members indicated this was already happening in their jurisdictions and have no real issues.
Proposals

Item #: 080

UMC 2024  Section: 313.0 - 313.2

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

313.0 Hangers, and Supports, and Anchors.
313.1 General. Piping, tubing, appliances, and appurtenances shall be supported in accordance with this code, the manufacturer's installation instructions, and in accordance with the Authority Having Jurisdiction. Seismic restraints shall be as required by the building code.
313.2 Material. Hangers, supports, and anchors shall be of sufficient strength to support the weight of the pipe or tubing and its contents. Piping or tubing shall be isolated from incompatible materials.

SUBSTANTIATION:
The proposed text is adding seismic restraints to ensure these provisions are not overlooked when designing in areas prone to seismic conditions. Additionally, Section 313.0 and Section 313.2 are being modified as the sections address hangers, supports, and anchors.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UPC Item # 041, Section 313.1 (General) and Section 313.2 (Material) and UMC Item # 080, Section 313.1 (General) and Section 313.2 (Material) resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

313.0 Hangers, Supports, and Anchors.
313.1 General. Piping, tubing, appliances, and appurtenances shall be supported in accordance with this code, the manufacturer's installation instructions, and in accordance with the Authority Having Jurisdiction. Seismic restraints shall be as required by in accordance with the building code.
313.2 Material. Hangers, supports, and anchors shall be of sufficient strength to support the weight of the pipe or tubing and its contents. Piping or tubing shall be isolated from incompatible materials.

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT:
The language in UMC Item # 080, Section 313.1 (General) is being revised to correlate with the action taken by the UPC TC for Item # 041, Section 313.1 (General) to change the phrase “as required by” to “in accordance with” for consistency throughout the code.
The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 313.1 regarding changing the phrase from “as required by” to “in accordance with.”
Proposals

Item #: 081

UMC 2024  Section: 313.1, Table 1701.1

SUBMITTER:  David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Revise text

313.0 Hangers and Supports.

313.1 General. Piping, tubing, appliances, and appurtenances shall be supported in accordance with this code, the manufacturer’s installation instructions, and in accordance with the Authority Having Jurisdiction. Pipe hangers, supports, and anchors used for fuel gas shall be in accordance with Section 1310.3.5. Pipe support hangers and hooks shall comply with IAPMO PS 95.

(below shown for reference only)

1310.3.5 Hangers, Supports, and Anchors. Piping shall be supported with metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers, or building structural components, suitable for the size of piping, of adequate strength and quality, and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected appliances and equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58. [NFPA 54:7.2.6.1]

Table 1701.1

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAPMO PS 95-2018e3</td>
<td>Pipe Support Hangers and Hooks</td>
<td>Hangers and Supports</td>
<td>313.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: IAPMO PS 95 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
Pipe hangers and supports must meet the requirements of Section 1310.3.5 for fuel gas piping, which references MSS SP-58, or IAPMO PS 95 for support handers and hooks. Therefore, a reference to Section 1310.3.5 and the IAPMO PS 95 standard are being added for completeness.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the changes pertaining to hangers and supports in this proposal are already addressed in Section 1310.3.5.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 082

UMC 2024  Section: 314.1, Table 1701.1

SUBMITTER: Benjamin Lipscomb
National Comfort Institute

RECOMMENDATION:
Revise text

314.0 Balancing.
314.1 General. Heating, ventilating, and air-conditioning systems (including hydronic systems) shall be balanced in accordance with one of the following methods:
(1) AABC National Standards for Total System Balance
(2) ACCA Manual B
(3) ASHRAE 111
(4) NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems
(5) SMACNA HVAC Systems Testing, Adjusting, and Balancing
(6) National Balancing Council Procedural Standards
(7) National Comfort Institute Air Balancing Procedures (air balancing for systems up to 20 tons capacity)
(8) National Comfort Institute Residential Air Balance Procedural Standards (air balancing for residential systems)

TABLE 1701.1
REFERENCED STANDARDS

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<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
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<tr>
<td>NCI-2015</td>
<td>National Comfort Institute Air Balancing Procedures</td>
</tr>
<tr>
<td>NCI-2020</td>
<td>National Comfort Institute Residential Air Balance Procedural Standards</td>
</tr>
</tbody>
</table>

APPLICATION | REFERENCED SECTIONS
--- | ---
Balancing | 314.1(6)
Balancing | 314.1(7)
Balancing | 314.1(8)

Note: The NCI standards do not meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

Note: The NBC standard was not developed via an open process having a published development procedure in accordance with Section 3-3.7.1.2 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
National Comfort Institute has certified thousands of test and balance professionals nationwide and has over 1,600 individuals with currently active TAB certifications. The omission of NCI and NBC standards in IAPMO UMC 2021 puts these professionals at a disadvantage when their credentials are questioned due to the absence of NCI/NBC in the mechanical code. We understand that the UMC does not designate required TAB certifications, but rather acceptable methods. Therefore, we are submitting our TAB procedures for inclusion in the list of acceptable methods. The attached NCI-NBC IAPMO UMC Code Inclusion Letter provides additional background and context for our proposal. Please start with this attachment when reviewing our proposal.

[Supporting documentation is provided in KAVI for TC review]

COMMITTEE ACTION: REJECT
COMMITTEE STATEMENT:
The proposed standards do not meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 083

UMC 2024  Section: 314.2

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Add new text

314.0 Balancing.
314.1 General. Heating, ventilating, and air-conditioning systems (including hydronic systems) shall be balanced in accordance with one of the following methods:
(1) AABC National Standards for Total System Balance
(2) ACCA Manual B
(3) ASHRAE 111
(4) NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems
(5) SMACNA HVAC Systems Testing, Adjusting, and Balancing

314.2 Air System Balancing. Each supply air outlet and zone terminal device shall be equipped with means for air balancing. Discharge dampers used for air system balancing shall not be used on constant air volume (CAV) fans and variable air volume (VAV) fans with motors 10 hp (7.5 kW) or more. Air systems shall be balanced in a manner to minimize throttling losses. For fans with system power exceeding 1 hp (0.74 kW), the fan speed shall be adjusted to meet design flow conditions.

Exceptions: Damper throttling shall be permitted for air system balancing with fan motors of 1 hp (0.74 kW) or less.

SUBSTANTIATION:
Additional air balancing conditions are being added to expand on the UMC section for balancing (Section 314.0). Air balancing is common across the country and is enforced on new HVAC installations due to code and utility program changes. In some areas, air balancing requirements are stretched to meet minimum compliance while others are strictly followed. In some mechanical designs, you will find a Variable Air Volume (VAV) system. This is the opposite of a Constant Air Volume (CAV) system. A VAV system will condition (heat or cool) a space by varying the airflow and using a constant temperature, while a CAV system conditions a space with a constant air flow and varying temperature. VAV and CAV boxes will have different balance procedures and the additional requirements will assist in calibrating boxes to meet design CFM requirements.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the requirements for air balancing would significantly affect fan sizing. The additional language is unenforceable, unnecessary, and no technical justification was provided to warrant such change.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 084
UMC 2024  Section: 314.2, Table 1701.1

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Add new text

314.0 Balancing.
314.1 General. Heating, ventilating, and air-conditioning systems (including hydronic systems) shall be balanced in accordance with one of the following methods:
(1) AABC National Standards for Total System Balance
(2) ACCA Manual B
(3) ASHRAE 111
(4) NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems
(5) SMACNA HVAC Systems Testing, Adjusting, and Balancing
314.2 Hydronic System Balancing. Hydronic systems shall be equipped with means for balancing and flow control in accordance with Chapter 12 of this code or the Uniform Solar, Hydronics and Geothermal Code (USHGC).

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<tr>
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</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

Note: IAPMO/ANSI USHGC 1 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
Section 314.1 states that hydronic systems shall be balanced, however, there is no direction for locating such requirements. Chapter 12 of the UMC and Chapters 3 and 4 of the Uniform Solar, Hydronics and Geothermal Code (USHGC) contain hydronic system balancing requirements. Therefore, it is recommended that the UMC send users of the code to UMC Chapter 12 or the USHGC for balancing requirements for hydronic systems.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the language pertaining to hydronic system balancing in this proposal is already addressed in Chapter 12.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 085
UMC 2024  Section: 315.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

315.0 Louvers in Hurricane Prone Regions.
315.1 General. Louvers located in areas within hurricane-prone regions that are within 1 mile (2 km) of the coastal mean high water line where the basic wind speed is 110 miles per hour (mi/h) (49.2 m/s) or more; or portions of hurricane-prone regions where the basic wind speed is 120 mi/h (53.6 m/s) or more; or Hawaii, as described in ASCE-7 shall be tested in accordance with Section 315.1.1 and Section 315.1.2.

SUBSTANTIATION:
The above ASCE standard is being deleted as the promulgator will not provide IAPMO with a copy of their standard as required in accordance with Section 5.0 of the IAPMO Guidelines for Referencing Mandatory Standards. The ASCE standard should be deleted as it cannot be reviewed for applicability. For informational purposes, Section 5.0 of the Guidelines for Referencing Mandatory Standards is shown as follows: “5.0 Procedure for Updating Mandatory Standards. Standards shall be kept current with that of the source document by administratively sending requests for updates to the standard promulgator. Updates shall be accomplished via a proposal or a comment during the regular revision process of the document.”

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 086

UMC 2024 Section: 316.6, Table 1701.1

SUBMITTER: Bruce A Pfeiffer  
Retired - City of Topeka

RECOMMENDATION:
Revise text

316.0 Protection of Piping, Tubing, Materials, and Structures.

316.6 Steel Nail Plates. Plastic piping or tubing, copper or copper alloy piping or tubing, and ducts penetrating framing members to within 1 inch (25.4 mm) of the exposed framing shall be protected by steel nail plates not less than No. 18 gauge (0.0478 inches) (1.2141 mm) in thickness. The steel nail plate shall extend along the framing member not less than 1 1/2 inches (38 mm) beyond the outside diameter of the pipe or tubing. Steel nail plates shall be in accordance with IAPMO IGC 193. Fuel gas piping shall be protected in accordance with Exception; See Section 1310.4.3.

<table>
<thead>
<tr>
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<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAPMO IGC 193-2019</td>
<td>Safety Plates, Plate Straps, Notched Plates and Safety Collars</td>
<td>Safety Plates</td>
<td>316.6</td>
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</table>

(portions of table not shown remain unchanged)

Note: IAPMO IGC 193 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The section is being revised to add the existing standard for safety plates for the protection of concealed pipes running through the framing of a building. These plates are used in the industry on a daily basis and the standard will ensure such plates meet minimum safety requirements. Additionally, fuel gas tubing is required to be protected by specific requirements in Section 1310.4.3 which may include steel plates. Therefore, not an exception.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The reference to IAPMO IGC 193 is overly restrictive since there are field-fabricated steel nail plates that can meet the thickness requirements in Section 316.6.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.
Actions taken on UPC Item # 039, Section 312.9 (Steel Nail Plates) and UMC Item # 086, Section 316.6 (Steel Nail Plates) resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

**316.0 Protection of Piping, Tubing, Materials, and Structures.**

**316.6 Steel Nail Plates.** Plastic piping or tubing, copper or copper alloy piping or tubing, and ducts penetrating framing members to within 1 inch (25.4 mm) of the exposed framing shall be protected by steel nail plates not less than No. 18 gauge (0.0478 inches) (1.2141 mm) in thickness. The steel nail plate shall extend along the framing member not less than 1 1/2 inches (38 mm) beyond the outside diameter of the pipe or tubing. **Exception:** See Fuel gas piping shall be protected in accordance with Section 1310.4.3.

**TCC ACTION:** ACCEPT AS SUBMITTED

**TCC STATEMENT:**
The language in UMC Item # 086, Section 316.6 (Steel Nail Plates) is being revised to correlate with the action taken by the UPC TC for Item # 039, Section 312.9 (Steel Nail Plates) for referencing Section 1310.4.3 for fuel gas piping protection.

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 316.6 regarding the reference to Section 1310.4.3 for fuel gas piping protection.
Proposals

Item #: 087
UMC 2024  Section: 317.2, 317.2.1

SUBMITTER: Armando Barragan
Self

RECOMMENDATION:
Revise text

317.0 Trenching, Excavation, and Backfill.

317.2 Tunneling and Driving. Tunneling and driving shall be permitted to be done in yards, courts, or driveways of a building site. Where sufficient depth is available to permit, tunnels shall be permitted to be used between open-cut trenches. The length of the tunneling shall be the distance required to clear the obstacle above.

Tunnels shall have a clear height of 2 feet (610 mm) above the pipe and shall be limited in length to one-half the depth of the trench, with a maximum length of 8 feet (2438 mm). Where pipes are driven, the drive pipe shall be not less than one size larger than the pipe to be laid.

317.2.1 Tunnels. Pipe installed in tunnels via tunneling or jacking shall be protected from uneven loading. Supporting structures, walls, and ceilings shall be designed to withstand the earth loads and account for earth movement and settling.

SUBSTANTIATION: Where pipe is to be installed by jacketing or tunneling to clear a slab, driveway, or other paved area, such tunnels should not be longer than necessary, as it is difficult to refill with the appropriate backfill in longer tunnels. Furthermore, a new section is being added to address the earth loads that must be taken into account for any tunneling and to account for any earth settlement in order to protect the piping within.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

317.0 Trenching, Excavation, and Backfill.

317.2 Tunneling and Driving. Tunneling and driving shall be permitted to be done in yards, courts, or driveways of a building site. Where sufficient depth is available to permit, tunnels shall be permitted to be used between open-cut trenches. The length of the tunneling shall be the distance required to clear the obstacle above.

Tunnels shall have a clear height of 2 feet (610 mm) above the pipe and shall be limited in length to one-half the depth of the trench, with a maximum length of 8 feet (2438 mm). Where pipes are driven, the drive pipe shall be not less than one size larger than the pipe to be laid.

317.2.1 Tunnels. Pipe installed in tunnels via tunneling or jacking shall be protected from uneven loading. Supporting structures, walls, and ceilings shall be designed to withstand the earth loads and account for earth movement and settling.

COMMITTEE STATEMENT: Section 317.2.1 is being stricken as it is overly restrictive and unenforceable. Walls, structures, and ceilings are outside of the scope of the mechanical code and are better suited in a building code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 087, Section 317.2 (Tunneling and Driving) and UPC Item # 043, Section 314.2 (Tunneling and Driving) resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

317.0 Trenching, Excavation, and Backfill.

317.2 Tunneling and Driving. Tunneling and driving shall be permitted to be done in yards, courts, or driveways of a building site. Where sufficient depth is available to permit, tunnels shall be permitted to be used between open-cut trenches. The length of the tunneling shall be the distance required to clear the obstacle above.

Tunnels shall have a clear height of 2 feet (610 mm) above the pipe and shall be limited in length to one-half the depth of the trench, with a maximum length of 8 feet (2438 mm). Where pipes are driven, the drive pipe shall be not less than one size larger than the pipe to be laid.

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT:
The language in UMC Item # 087, Section 317.2 (Tunneling and Driving) is being revised to correlate with the action taken by the UPC TC for Item # 043, Section 314.2 (Tunneling and Driving) by striking the sentence “The length of the tunneling shall be the distance required to clear the obstacle above.”

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 317.2 regarding the striking of the sentence “The length of the tunneling shall be the distance required to clear the obstacle above.”
Proposals

Item #: 088

UMC 2024  Section: Chapter 4, Table 1701.1

SUBMITTER: IAPMO Staff - Update Extracts
ASHRAE 62.1 Extract Update

RECOMMENDATION:
Revise text

402.2 Natural Ventilation Procedure. Natural ventilation systems shall be comply with the requirements of either Section 402.2.1 through Section 402.2.1.6(A) or Section 402.2.2. Designers shall provide interior air barriers, insulation, or other means that separate naturally ventilated spaces from mechanically cooled spaces to prevent high-dew-point outdoor air from coming into contact with mechanically cooled surfaces. [ASHRAE 62.1:6.4]

402.2.1 Prescriptive Compliance Path. Any zone designed in accordance with this section and for natural ventilation shall include a mechanical ventilation system designed in accordance with Section 403.0, Section 404.0, or both.

Exceptions:
(1) An engineered natural ventilation system where approved by the Authority Having Jurisdiction need not comply with Section 402.2.
(2) The mechanical ventilation systems shall not be required where:
   (1) Zones in buildings that have all of the following:
      (a) ≥N Natural ventilation openings that comply with the requirements of Section 402.2.1.1 through Section 402.2.1.6(A) and are permanently open or have controls
      (b) Controls that prevent the natural ventilation openings from being closed during periods of expected occupancy, or natural ventilation openings that are permanently open.
   (b) The zone is
(2) Zones that are not served by heating or cooling equipment. [ASHRAE 62.1:6.4.1]

402.2.1.1 Ceiling Height. The ceiling height, $H$, to be used in Section 402.2.1.1 through Section 402.2.1.3 shall be the minimum ceiling height in the space.

Exception:
For ceilings that are parallel to the floor, the ceiling height ($H$) to be used in Section 402.2.3 through Section 402.2.5 shall be the minimum ceiling height in the zone.

For zones where ceilings that are height increases increasing in height as distance from the openings is increased, the ceiling height shall be determined as the average height of the ceiling within 20 feet (6096 mm) from the operable openings. [ASHRAE 62.1:6.4.1.4]

402.2.1.2 Floor Area to be Ventilated. Spaces, or portions of spaces, to be The naturally ventilated area in zones or portions of zones shall be located within extend from the openings to a distance based on the ceiling height, as determined in accordance with Section 402.2.1.1, Section 402.2.2, or Section 402.2.1.3. From operable wall openings shall be in accordance with the requirements of Section 402.2.5. For spaces with where ceilings that are not parallel to the floor, the ceiling height shall be determined in accordance with Section 402.2.1.1.

402.2.1.3 Single Side Opening. For spaces zones with operable openings on only one side of the space zone, the naturally ventilated area shall extend to a distance not greater than 2 times the height of the ceiling from the operable openings shall be not more than 2$H$, where $H$ is the ceiling height. [ASHRAE 62.1:6.4.1.4]

402.2.1.4 Double Side Opening. For spaces zones with operable openings on two opposite sides of the space zone, the naturally ventilated area shall extend between distance from the operable openings shall be not more than 5$H$, where $H$ is the ceiling height separated by a distance not greater than 5 times the height of the ceiling. [ASHRAE 62.1:6.4.1.4]

402.2.1.5 Corner Openings. For spaces zones with operable openings on two adjacent sides of a space zone, the distance from the operable openings shall be not more than 5$H$ along a line drawn between the two openings.
that are farthest apart. Floor area outside that line shall comply with Section 402.2.1.1. [ASHRAE 62.1:6.4.1.3 6.4.1.5]

402.2.2 402.2.1.6 Location and Size of Openings. Spaces Zones or portions of spaces zones to be naturally ventilated shall have a permanently open to operable wall airflow path to openings directly connected to the outdoors. The minimum flow rate to the zone shall be determined in accordance with Section 403.2.1. The operable area shall be not less than 4 percent of the net occupiable floor area. Where openings are covered with louvers or otherwise obstructed, operable area shall be based on the net free unobstructed area through the opening. Where interior rooms, or portions of rooms, without direct openings to the outdoors are ventilated through adjoining rooms, the opening between rooms shall be permanently unobstructed and have a free area of not less than 8 percent of the area of the interior room or less than 25 square feet (2.3 m²). This flow rate shall be used to determine the required operable area of openings, accounting only for buoyancy-driven flow. Wind-driven flow shall be used only where it can be demonstrated that the minimum flow rate is provided during all occupied hours. Openings shall be sized in accordance with Section 402.2.1.6(A). Permanently open airflow path shall include, but not be limited to, pathways that would allow airflow unimpeded by partitions, walls, and furnishings. {ASHRAE 62.1:6.4.2 6.4.1.6}

402.2.1.6(A) Sizing Openings. Where the zone is ventilated using a single opening or multiple single openings located at the same elevation, the operable area as a percent of the net occupiable floor area shall be greater than or equal to the value indicated in Table 402.2.1.6(A)(1). Where the zone is ventilated using two openings located at different elevations or multiple pairs of such openings, the operable area as a percent of the net occupiable floor area shall be greater than or equal to the value indicated in Table 402.2.1.6(A)(2).

Where openings are obstructed by louvers or screens, the operable area shall be based on the net free area of the opening. Where interior zones, or portions of zones, without direct openings to the outdoors are ventilated through adjoining zones, the opening between zones shall be permanently unobstructed and have a free area of not less than twice the percent of occupiable floor area used to determine the opening size of adjacent exterior zones, or 25 square feet (2.3 m²), whichever is greater. Table 402.2.1.6(A)(1) and Table 402.2.1.6(A)(2) are based on buoyancy-driven flow and shall not address thermal comfort. [ASHRAE 62.1:6.4.1.6.1]

402.2.2 Engineered System Compliance Path. For an engineered natural ventilation system, the following shall be included:

(1) Determine hourly environmental conditions, including outdoor air dry-bulb temperature; dew-point temperature; outdoor concentration of contaminants, including PM2.5, PM10, and ozone where data are available; wind speed and direction; and internal heat gains during expected hours of natural ventilation operation.

(2) Determine the effect of pressure losses along natural ventilation airflow paths on the resulting flow rates, including inlet openings, air transfer grills, ventilation stacks, and outlet openings during representative conditions of expected natural ventilation system use.

(3) Quantify natural ventilation airflow rates of identified airflow paths accounting for wind induced and thermally induced driving pressures during representative conditions of expected natural ventilation system use.

(4) Design to provide outdoor air in quantities sufficient to result in acceptable IAQ as established under Section 403.2.1 or ASHRAE 62.1 during representative conditions of expected natural ventilation system use. [ASHRAE 62.1:6.4.1.6.1]

402.2.3 402.2.7 Control and Accessibility. The means to open required operable openings shall be readily accessible to building occupants where whenever the space is occupied. Controls shall be designed to coordinate operation of the natural and mechanical ventilation systems. [ASHRAE 62.1:6.4.3]

403.2 Zone Calculations. Ventilation zone parameters shall be determined in accordance with Section 403.2.1 through Section 403.2.2 for each ventilation zone served by the ventilation system, except that the ventilation rates from ASHRAE/ASHE 170 shall be used for the occupancy categories, as applicable. [ASHRAE 62.1:6.2.2 6.2.1.1]

403.2.1 Breathing Zone Outdoor Airflow. The outdoor airflow required in the breathing zone (Vbz) of the occupable space or spaces in a ventilation zone shall be not less than the value determined in accordance with Equation 403.2.1.

\[
Vbz = Rp \cdot Pz + Ra \cdot Az \quad \text{(Equation 403.2.1)}
\]

Where:

\( Az \) = zone floor area, the net occupiable floor area of the ventilation zone, square feet (m²).

\( Pz \) = population number of people in the ventilation zone during typical usage.

\( Rp \) = outdoor airflow rate required per person as determined from Table 402.1.

\( Ra \) = outdoor airflow rate required per unit area as determined from Table 402.1. [ASHRAE 62.1:6.2.2.1 6.2.1.1]

403.2.2 Zone Air Distribution Effectiveness. The zone air distribution effectiveness (Ez) shall be not greater than the default value determined in accordance with Table 403.2.2. [ASHRAE 62.1:6.2.2.2 6.2.1.2]

403.2.2.1 Stratified Air Distribution Systems. A stratified air distribution system shall be designed in accordance with Section 403.2.2.1.1 through Section 403.2.2.2.2, or the zone air distribution effectiveness (Ez) shall be determined in accordance with ASHRAE 62.1. [ASHRAE 62.1:6.2.1.2.1]

403.2.2.1.1 Supply Air. Cool air shall be at least 4°F (2°C) less than the average room air temperature. [ASHRAE 62.1:6.2.1.2.1.1]

403.2.2.1.2 Return Air. The return air openings or pathways shall be located not less than 9 feet (2.8 m) above the floor. [ASHRAE 62.1:6.2.1.2.1.2]
403.2.2.1 Stratification. The zone shall not contain any devices that mechanically mix the air, and shall be protected from impinging airstreams from adjacent ventilation zones. [ASHRAE 62.1:6.2.1.2.1.3]

403.2.2.2 Personalized Ventilation Systems. A personalized ventilation system shall be designed in accordance with the following subsections, or the zone air distribution effectiveness (Ez) shall be determined in accordance with ASHRAE 62.1. [ASHRAE 62.1:6.2.1.2.2]

403.2.2.2.1 Personalized Air. The personalized air shall be distributed in the breathing zone and designed such that the velocity is equal to or less than 50 feet per minute (0.25 m/s) at the head/facial region of the occupant. [ASHRAE 62.1:6.2.1.2.2.1]

403.2.2.2.2 Return Air. The return air openings or pathways shall be located more than 9 feet (2.8 m) above the floor. [ASHRAE 62.1:6.2.1.2.2.2]

403.2.3 Zone Outdoor Airflow. The zone outdoor airflow (Voz) provided to the ventilation zone by the supply air distribution system shall be determined in accordance with Equation 403.2.3. [ASHRAE 62.1:6.2.2.3 6.2.1.3]

\[
Voz = \frac{Vbz}{Ez} \quad \text{(Equation 403.2.3)}
\]

403.3 Single-Zone Systems. For ventilation systems where one or more air handlers supply a mixture of outdoor air and recirculated air to only one ventilation zone, the outdoor air intake flow (Vot) shall be determined in accordance with Equation 403.3. [ASHRAE 62.1:6.2.3 6.2.2]

\[
Vot = Voz \quad \text{(Equation 403.3)}
\]

403.4 One Hundred Percent Outdoor Air Systems. For ventilation systems where one or more air handlers supply only outdoor air to one or more ventilation zones, the outdoor air intake flow (Vot) shall be determined in accordance with Equation 403.4. [ASHRAE 62.1:6.2.4 6.2.3]

\[
Vot = S\text{ all zones} Voz \quad \text{(Equation 403.4)}
\]

403.5 Multiple-Zone Recirculating Systems. For ventilation systems where one or more air handlers supply a mixture of outdoor air and recirculated air to more than one ventilation zone, the outdoor air intake flow (Vot) shall be determined in accordance with Section 403.5.1 through Section 403.5.2. [ASHRAE 62.1:6.2.5 6.2.4]

403.5.1 Uncorrected Outdoor Air Intake. The uncorrected outdoor air intake (Vou) flow shall be determined in accordance with Equation 403.5.1. [ASHRAE 62.1:6.2.5.1 6.2.4.1]

\[
Vou = D S\text{ all zones} (Rp\cdot Pz) + S\text{ all zones} (Ra\cdot Az) \quad \text{(Equation 403.5.1)}
\]

403.5.1.1 Occupant Diversity. The occupant diversity ratio (D) shall be determined in accordance with Equation 403.5.1.1 to account for variations in population within the ventilation zones served by the system.

\[
D = \frac{Ps}{S\text{ all zones} Pz} \quad \text{(Equation 403.5.1.1)}
\]

Where the system population (Ps) is the total population in the area served by the system.

**Exception:** Alternative methods to account for occupant diversity shall be permitted, provided that the resulting (Vou) value is not less than that determined in accordance with Equation 403.5.1. [ASHRAE 62.1:6.2.5.1.1 6.2.4.1.1]

403.5.1.2 System Ventilation Efficiency. The system ventilation efficiency (Ev) shall be determined in accordance with Section 403.5.1.3 for the simplified procedure or Section 404.0 for the alternate procedure. These procedures also establish zone minimum primary airflow rates for VAV systems. [ASHRAE 62.1:6.2.5.2 6.2.4.2]

403.5.1.3 Simplified Procedure for System Ventilation Efficiency. System ventilation efficiency (Ev) shall be determined in accordance with Equation 403.5.1.3(1) or Equation 403.5.1.3(2). [ASHRAE 62.1:6.2.5.3 6.2.5.3.1 6.2.4.3 6.2.4.3.1]

\[
Ev = 0.88 + D + 0.22 \text{ for } D < 0.60 \quad \text{[Equation 403.5.1.3(1)]}
\]

\[
Ev = 0.75 \text{ for } D \geq 0.60 \quad \text{[Equation 403.5.1.3(2)]}
\]

403.5.1.4 Zone Minimum Primary Airflow. For each zone, the minimum primary airflow (Vpz-min) shall be determined in accordance with Equation 403.5.1.4. [ASHRAE 62.1:6.2.5.3.2 6.2.4.3.2]

\[
Vpz-min = Voz \times 1.5 \quad \text{(Equation 403.5.1.4)}
\]
403.5.2 Outdoor Air Intake. The design outdoor air intake flow (Vot) shall be determined in accordance with Equation 403.5.2. [ASHRAE 62.1:6.2.5.4 6.2.4.4]

\[ Vot = \frac{Vou}{Ev} \] \hspace{1cm} (Equation 403.5.2)

403.6 Design for Varying Operating Conditions. Ventilation systems shall be designed to be capable of providing not less than the minimum ventilation rates required in the breathing zone where the zones served by the system are occupied, including all full- and part-load conditions. The minimum outdoor air intake flow shall be permitted to be less than the design value at part-load conditions. [ASHRAE 62.1:6.2.6.4 6.2.5 – 6.2.5.1]

403.6.1 Short-Term Conditions. Where it is known that peak occupancy will be of short duration, ventilation will be varied or interrupted for a short period of time, or both, the design shall be permitted to be based on the average conditions over a time period (T) determined by Equation 403.6.1.

\[ T = \frac{3v}{Vbz} \] \hspace{1cm} (Equation 403.6.1)

Where:
- \( T \) = averaging time period, minutes.
- \( v \) = the volume of the ventilation zone where averaging is being applied, cubic foot (m³).
- \( Vbz \) = the breathing zone outdoor airflow calculated in accordance with Equation 403.2.1 and design value of the zone population (Pz), cubic foot per minute (CFM) (m³/min).

Acceptable design adjustments based on this optional provision including the following:
1. Zones with fluctuating occupancy: The zone population (Pz) shall be permitted to be averaged over time (T).
2. Zones with intermittent interruption of supply air: The average outdoor airflow supplied to the breathing zone over time (T) shall be not less than the breathing zone outdoor airflow (Vbz) calculated using Equation 403.2.1.
3. Systems with intermittent closure of the outdoor air intake: The average outdoor air intake over time (T) shall be not less than the minimum outdoor air intake (Vot) calculated using Equation 403.3, Equation 403.4, or Equation 403.5 as applicable. [ASHRAE 62.1:6.2.6.2 6.2.5.2]

403.8 Dynamic Reset. The system shall be permitted to be designed to reset the outdoor air intake flow (Vot), the space or ventilation zone airflow (Voz) as operating conditions change, or both. [ASHRAE 62.1:6.2.7 6.2.6]

403.9 Air Classification and Recirculation. Air shall be classified, and its recirculation shall be limited in accordance with Section 403.9.1 through Section 403.9.4. [ASHRAE 62.1:5.165.18] Recirculated air shall not be taken from prohibited locations in accordance with Section 311.3.

Air (return, transfer, or exhaust air) leaving each space or location shall be designated at an expected air-quality classification not less than that shown in Table 402.1, Table 403.7, or Table 403.9 or as approved by the Authority Having Jurisdiction. Air leaving spaces or locations that are not listed in Table 402.1, Table 403.7, or Table 403.9 shall be designated with the same classification as air from the most similar space or location listed in terms of occupant activities and building construction.

Exception: Air from spaces where environmental tobacco smoke (ETS) is present. (Classification of air from spaces where ETS is present is not addressed. Spaces that are expected to include ETS do not have a classification listed in Table 402.1.) [ASHRAE 62.1:5.18.1]

403.9.1 Class 1 Air. Recirculation or transfer of Class 1 air to other spaces any space shall be permitted. [ASHRAE 62.1:5.165.3.4 5.18.3.1]

403.9.2 Class 2 Air. Recirculation of Class 2 air within the space of origin shall be permitted. Recirculation or transfer of Class 2 air to other Class 2 or Class 3 spaces shall be permitted, provided that the other spaces are used for the same or similar purpose or task and involve the same or similar pollutant sources as the Class 2 space. Transfer of Class 2 air to toilet rooms shall be permitted. Recirculation or transfer of Class 2 air to Class 4 spaces shall be permitted. Class 2 air shall not be recirculated or transferred to Class 1 spaces. Where When using an energy recover device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device shall be permitted but shall not be counted as outdoor air, and the recirculated Exhaust air transfer ratio of Class 2 air shall not exceed 10 percent of the outdoor air intake flow at the design static pressure differential as defined in AHRI 1060. [ASHRAE 62.1:5.165.3.2 5.18.3.2 – 5.18.3.2.5]

403.9.3 Class 3 Air. Recirculation of Class 3 air within the space of origin shall be permitted. Class 3 air shall not be recirculated or transferred to any other spaces. Where When using an energy recover device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device shall be permitted but shall not be counted as outdoor air, and the recirculated Exhaust air transfer ratio of Class 3 air shall not exceed 5 percent of the outdoor air intake flow at the design static pressure differential as defined in AHRI 1060. [ASHRAE 62.1:5.165.3.3 5.18.3.3 – 5.18.3.3.2]
403.9.4 Class 4 Air. Class 4 air shall not be recirculated or transferred to any other space or be recirculated within the space of origin. [ASHRAE 62.1:5.16.3.4, 5.18.3.4]

404.1 **General System Ventilation Efficiency.** This section presents an alternative procedure for calculating the system ventilation efficiency (Ev) for multiple zone recirculating systems that shall be used when Section 403.5.1.3 is not used. The system ventilation efficiency shall equal the lowest zone ventilation efficiency among the ventilation zones served by the air handler in accordance with Equation 404.1. [ASHRAE 62.1:A1.3] This section presents an alternative procedure for calculating the system ventilation efficiency (Ev) for multiple zone recirculating systems that shall be used when Section 403.5.1.3 is not used.

\[ Ev = \text{minimum (Ev)} \text{z} \quad (\text{Equation 404.1}) \]

404.2 **Average Outdoor Air Fraction.** The average outdoor air fraction (Xs) for the ventilation system shall be determined in accordance with Equation 404.2.

\[ Xs = \frac{Vou}{Vps} \quad (\text{Equation 404.2}) \]

The Where the uncorrected outdoor air intake (Vou) shall be is determined in accordance with Section 403.5.1, and the system primary airflow (Vps) shall be determined at the condition analyzed. [ASHRAE 62.1:A1.1]

404.3 **Zone Ventilation Efficiency.** The zone ventilation efficiency (Evz) shall be determined in accordance with Section 404.3.1 or Section 404.3.2. [ASHRAE 62.1:A1.2]

404.3.1 **Single Supply Systems.** For single supply systems, where all of the air supplied to each a ventilation zone is a mixture of outdoor air and system-level recirculated air, zone ventilation efficiency (Evz) shall be determined in accordance with Equation 404.3.1. Examples of single supply systems include constant-volume reheat, single-duct VAV, single-fan dual-duct, and multizone systems.

\[ Evz = 1 + Xs - Zpz \quad (\text{Equation 404.3.1}) \]

The Where the average outdoor air fraction for the system (Xs) shall be determined in accordance with Equation 404.2, and the primary outdoor air fraction for the zone (Zpz) shall be determined in accordance with Equation 404.3.1. [ASHRAE 62.1:A1.2.1]

\[ Zpz = \frac{Voz}{Vpz} \quad (\text{Equation 404.3.1}) \]

For VAV systems, Vpz is the lowest zone primary airflow value expected at the design condition analyzed.

404.3.2 **Secondary-Recirculation Systems.** For secondary-recirculation systems where the supply air or a portion thereof to each ventilation zone is recirculated air (air that has not been directly mixed with outdoor air) from other zones, zone ventilation efficiency (Evz) shall be determined in accordance with Equation 404.3.2(1). Examples of secondary-recirculation systems include dual-fan dual-duct and fan-powered mixing-box systems, and systems that include transfer fans for conference rooms.

[Equation 404.3.2(1)]

\[ Evz = \left( Fa + Xs \cdot Fb - Zpz \cdot Ep \cdot Fc \right) / Fa \]

The Where system air fractions Fa, Fb, and Fc shall be are determined in accordance with Equation 404.3.2(2), Equation 404.3.2(3), and Equation 404.3.2(4), as applicable.

\[ Fa = Ep + (1 - Ep) \cdot Er \quad [\text{Equation 404.3.2(2)}] \]

\[ Fb = Ep \quad [\text{Equation 404.3.2(3)}] \]

\[ Fc = 1 - (1 - Ez) \cdot (1 - Er) \cdot (1 - Ep) \quad [\text{Equation 404.3.2(4)}] \]

The Where the zone primary air fraction (Ep) shall be determined in accordance with Equation 404.3.2(5), For single-zone and single-supply systems Ep shall equal to 1.0. The zone secondary recirculation fraction (Er) shall be determined by the designer based on system configuration. The and zone air distribution effectiveness (Ez) shall be determined in accordance with Section 403.2.2. [ASHRAE 62.1:A1.2.2]

\[ Fe = Ep + (1 - Ep) \cdot Er \quad [\text{Equation 404.3.2(2)}] \]
\[ F_b = E_p \text{ [Equation 404.3.2(3)]} \]
\[ F_c = 1 - (1 - E_z)(1 - E_r)(1 - E_p) \text{ [Equation 404.3.2(4)]} \]
\[ E_p = \frac{V_{pz}}{V_{dz}} \text{ [Equation 404.3.2(5)]} \]

Where:
- \( A_z \): Zone floor area: The net occupiable floor area of the ventilation zone, \( \text{ft}^2 \) (\( \text{m}^2 \)).
- \( D \): Occupant diversity: The ratio of the system population to the sum of the zone populations.
- \( E_p \): Primary air fraction: The fraction of primary air in the discharge air to the ventilation zone.
- \( E_r \): Secondary recirculation fraction: In systems with secondary recirculation of return air, the fraction of secondary recirculated air to the zone that is representative of average system return air rather than air directly recirculated from the zone.
- \( E_v \): System ventilation efficiency: the efficiency with which the system distributes air from the outdoor air intake to the breathing zone in the ventilation-critical zone, which requires the largest fraction of outdoor air in the primary airstream.
- \( E_{vz} \): Zone ventilation efficiency: The efficiency with which the system distributes air from the outdoor air intake to the breathing zone in any particular ventilation zone.
- \( E_z \): Zone air distribution effectiveness: A measure of the effectiveness of supply air distribution to the breathing zone. \( E_z \) is determined in accordance with Section 403.2.2.
- \( F_a \): Supply air fraction: The fraction of supply air to the ventilation zone from sources or air outside the zone.
- \( F_b \): Mixed air fraction: The fraction of supply air to the ventilation zone from fully mixed primary air.
- \( F_c \): Outdoor air fraction: The fraction of outdoor air to the ventilation zone from sources of air outside the zone.
- \( P_s \): System population: the simultaneous number of occupants in the area served by the ventilation system.
- \( P_{pz} \): Zone population: see Section 403.2.1.
- \( R_a \): Area outdoor air rate: see Section 403.2.1.
- \( R_{p} \): People outdoor air rate: see Section 403.2.1.
- \( V_{bz} \): Breathing zone outdoor airflow: see Section 403.2.1.
- \( V_{dz} \): Zone discharge airflow: The expected discharge (supply) airflow to the zone that includes primary airflow and secondary recirculated airflow, CFM (m³/min).
- \( V_{ot} \): Outdoor air intake flow: see Section 403.3, Section 403.4, and Section 403.5.2.
- \( V_{ou} \): Uncorrected outdoor air intake: see Section 403.5.1.
- \( V_{oz} \): Zone outdoor airflow: see Section 403.2.3.
- \( V_{ps} \): System primary airflow: The total primary airflow supplied to all zones served by the system from the air-handling unit at which the outdoor air intake is located.
- \( V_{pz} \): Zone primary airflow: The zone primary airflow to the ventilation zone, including outdoor air and recirculated air.
- \( X_s \): Average outdoor air fraction: At the primary air handler, the fraction of outdoor air intake flow in the system primary airflow.
- \( Z_{pz} \): Primary outdoor air fraction: The outdoor air fraction required in the primary air supplied to the ventilation zone prior to the introduction of any secondary recirculation air. [ASHRAE 62.1:A3]

### TABLE 402.1

**MINIMUM VENTILATION RATES IN BREATHING ZONE**

<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY</th>
<th>PEOPLE OUTDOOR Air Rate ( R_p ) (CFM/person)</th>
<th>AREA OUTDOOR Air Rate ( R_a ) (CFM/ft²)</th>
<th>DEFAULT OCCUPANT DENSITY ( \text{people}/1000 \text{ ft}^2 )</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANIMAL FACILITIES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal exam room (veterinary office)</td>
<td>10</td>
<td>0.12</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Animal imaging (MRI/CT/PET)</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Animal operating rooms</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Animal postoperative recovery room</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Animal preparation rooms</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Animal procedure room</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Animal surgery scrub</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Large-animal holding room</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Necropsy</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Small-animal-cage room (static cages)</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Small-animal-cage room (ventilated cages)</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>CORRECTIONAL FACILITIES</td>
<td></td>
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<tr>
<td>----------------------------------</td>
<td>-----</td>
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</tr>
<tr>
<td>Booking/waiting</td>
<td>7.5</td>
<td>0.06</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>Cell</td>
<td>5</td>
<td>0.12</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Day-room</td>
<td>5</td>
<td>0.06</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Guard stations</td>
<td>5</td>
<td>0.06</td>
<td>15</td>
<td>1</td>
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</table>

<table>
<thead>
<tr>
<th>EDUCATIONAL FACILITIES</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Art classroom</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Classrooms (ages 5- to 8)</td>
<td>10</td>
<td>0.12</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>Classrooms (age 9 plus)</td>
<td>10</td>
<td>0.12</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>Computer lab</td>
<td>10</td>
<td>0.12</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>Daycare (through age 4)</td>
<td>10</td>
<td>0.18</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Daycare sickroom</td>
<td>10</td>
<td>0.18</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Lecture classroom&lt;sup&gt;h&lt;/sup&gt;</td>
<td>7.5</td>
<td>0.06</td>
<td>65</td>
<td>1</td>
</tr>
<tr>
<td>Lecture hall (fixed seats)&lt;sup&gt;h&lt;/sup&gt;</td>
<td>7.5</td>
<td>0.06</td>
<td>150</td>
<td>1</td>
</tr>
<tr>
<td>Libraries</td>
<td>5</td>
<td>0.12</td>
<td>10</td>
<td>=</td>
</tr>
<tr>
<td>Media center&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10</td>
<td>0.12</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>Multi-use assembly&lt;sup&gt;h&lt;/sup&gt;</td>
<td>7.5</td>
<td>0.06</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Music/theater/dance&lt;sup&gt;h&lt;/sup&gt;</td>
<td>10</td>
<td>0.06</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>Science laboratories</td>
<td>10</td>
<td>0.18</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>University/college laboratories</td>
<td>10</td>
<td>0.18</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Wood/metal shop</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>2</td>
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<table>
<thead>
<tr>
<th>FOOD AND BEVERAGE SERVICE</th>
<th></th>
<th></th>
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</tr>
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<tbody>
<tr>
<td>Bars, cocktail lounges</td>
<td>7.5</td>
<td>0.18</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Cafeteria/fast-food dining</td>
<td>7.5</td>
<td>0.18</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Kitchen (cooking)</td>
<td>7.5</td>
<td>0.12</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Restaurant dining rooms</td>
<td>7.5</td>
<td>0.18</td>
<td>70</td>
<td>2</td>
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</table>

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<th>GENERAL</th>
<th></th>
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<tr>
<td>Break rooms&lt;sup&gt;h&lt;/sup&gt;</td>
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<td>Coffee stations&lt;sup&gt;h&lt;/sup&gt;</td>
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<tr>
<td>Barracks sleeping areas&lt;sup&gt;h&lt;/sup&gt;</td>
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<td>Occupiable storage rooms for dry materials&lt;sup&gt;h&lt;/sup&gt;</td>
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<td>Office space&lt;sup&gt;h&lt;/sup&gt;</td>
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<td>Reception areas&lt;sup&gt;h&lt;/sup&gt;</td>
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<td>Telephone/data-entry&lt;sup&gt;h&lt;/sup&gt;</td>
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<td>----------------------</td>
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<td>Main entry lobbies</td>
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<td>Reception areas</td>
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<tr>
<td>Telephone/data entry</td>
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<tr>
<td>Other dental treatment areas</td>
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<td>Psychiatric seclusion room</td>
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<td>Speech therapy room</td>
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<td>Urgent care treatment room</td>
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<td>0.18</td>
<td>20</td>
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<td>Urgent care triage room</td>
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<td>PUBLIC ASSEMBLY SPACES</td>
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<td>Courtrooms</td>
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<td>70</td>
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<td>Legislative chambers</td>
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<td>1</td>
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<tr>
<td>Lobbies</td>
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<td>0.06</td>
<td>150</td>
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<td>Museums (children’s)</td>
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<td>0.12</td>
<td>40</td>
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<tr>
<td>Museums/galleries</td>
<td>7.5</td>
<td>0.06</td>
<td>40</td>
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<td>Places of religious worship</td>
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<td>0.06</td>
<td>120</td>
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</table>

**RESIDENTIAL**

| Common corridors | – | 0.06 | – | 4 |
| Dwelling unit | 5 | 0.06 | See footnote | 4 |

**RETAIL**

| Sales (except as below) | 7.5 | 0.12 | 15 | 2 |
| Barber shop | 7.5 | 0.06 | 25 | 2 |
| Beauty and nail salons | 20 | 0.12 | 25 | 2 |
| Coin-operated laundries | 7.5 | 0.12 | 20 | 2 |
| Mall common areas | 7.5 | 0.06 | 40 | 1 |
| Pet shops (animal areas) | 7.5 | 0.18 | 10 | 2 |
| Supermarket | 7.5 | 0.06 | 8 | 1 |

**SPORTS AND ENTERTAINMENT**

| Bowling alley (seating) | 10 | 0.12 | 40 | 1 |
| Disco/dance floors | 20 | 0.06 | 100 | 2 |
| Gambling casinos | 7.5 | 0.18 | 120 | 1 |
| Game arcades | 7.5 | 0.18 | 20 | 1 |
| Gym, sports arena (play area) | 20 | 0.18 | 7 | 2 |
| Health club/aerobics room | 20 | 0.06 | 40 | 2 |
| Health club/weight rooms | 20 | 0.06 | 10 | 2 |
| Spectator areas | 7.5 | 0.06 | 150 | 1 |
| Stages, studios | 10 | 0.06 | 70 | 1 |
| Swimming (pool & and deck) | – | 0.48 | – | 2 |

**TRANSIENT RESIDENTIAL**

| Common corridors | – | 0.06 | – | 1 |
| Dwelling unit | 5 | 0.06 | – | 1 |

For SI units: 1 cubic foot per minute = 0.0283 m³/min, 1 square foot = 0.0929 m²

**Notes:**

1. This table applies to no-smoking areas. Rates for smoking-permitted spaces shall be determined using other methods.
2. Volumetric airflow rates are based on dry air density of 0.075 pounds of dry air per cubic foot (lbda/ft³) (1.201 kgda/m³) at a barometric pressure of 1 atm (101 kPa) and an air temperature of 70°F (21°C). Rates shall be permitted to be adjusted for actual density.
3. The default occupant density shall be used where actual occupant density is not known.
4. Where the occupancy category for a proposed space or zone is not listed, the requirements for the listed occupancy category that is most similar in terms of occupant density, activities, and building construction shall be used.

**ITEM-SPECIFIC NOTES FOR TABLE 402.1**

a. For high school and college libraries, the values shown for “Public Assembly Spaces – Libraries” shall be used.

b. Rate may not be sufficient where stored materials include those having potentially harmful emissions.

c. Rate does not allow for humidity control. “Deck area” refers to the area surrounding the pool that is capable of being wetted during pool use or when the pool is occupied. Deck area that is not expected to be wetted shall be designated as an occupancy category.

d. Rate does not include special exhaust for stage effects such as dry ice vapors and smoke.

e. Where combustion equipment is intended to be used on the playing surface or in the space, additional dilution ventilation, source control, or both shall be provided.

f. Default occupancy for dwelling units shall be two persons for studio and one-bedroom units, with one additional person for each additional bedroom.

g. Air from one residential dwelling shall not be recirculated or transferred to other spaces outside of that dwelling.
Ventilation air for this occupancy category shall be permitted to be reduced to zero where the space is in occupied-standby mode.

1 Outpatient facilities to which the rates apply are freestanding birth centers, urgent care centers, neighborhood clinics and physicians offices, Class 1 imaging facilities, outpatient psychiatric facilities, outpatient rehabilitation facilities, and outpatient dental facilities.

2 The requirements of this table provide for acceptable IAQ. The requirements of this table do not address the airborne transmission of airborne viruses, bacteria, and other infectious contagions.

3 These rates are intended only for outpatient dental clinics where the amount of nitrous oxide is limited. They are not intended for dental operatories in institutional buildings where nitrous oxide is piped.

<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY</th>
<th>EXHAUST RATE (CFM/unit)</th>
<th>EXHAUST RATE (CFM/ft²)</th>
<th>AIR CLASS</th>
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<tr>
<td>Animal imaging (MRI/CT/PET)</td>
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<tr>
<td>Animal operating rooms</td>
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<tr>
<td>Animal postoperative recovery room</td>
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<tr>
<td>Animal preparation rooms</td>
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<tr>
<td>Animal procedure room</td>
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<tr>
<td>Animal surgery scrub</td>
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<tr>
<td>Large-animal holding room</td>
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<tr>
<td>Necropsy</td>
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<td>Small-animal-cage room (ventilated cages)</td>
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<td>Arenas</td>
<td>= 0.50</td>
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<td>Auto repair rooms¹</td>
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<td>Beauty and nail salons</td>
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<td>Copy, printing rooms</td>
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<td>Darkrooms</td>
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<td>Educational science laboratories</td>
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<td>Residential—kitchens⁷</td>
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<td>Soiled laundry storage rooms⁶</td>
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<td>Storage rooms, chemical⁶</td>
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</tbody>
</table>
For SI units: 1 cubic foot per minute = 0.0283 m³/min, 1 square foot = 0.0929 m²

Notes:
1. Stands where engines are run shall have exhaust systems that directly connect to the engine exhaust and prevent escape of fumes.
2. Where combustion equipment is intended to be used on the playing surface, additional dilution ventilation, source control, or both shall be provided.
3. Exhaust shall not be required where two or more sides of walls that are at least 50 percent open to the outside.
4. Rate is per water closet, urinal, or both. Provide the higher rate where periods of heavy use are expected to occur. The lower rate shall be permitted to be used otherwise. The otherwise the higher rate shall be used.
5. Rate is for a toilet room intended to be occupied by one person at a time. For continuous system operation during normal hours of use, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.
6. See other applicable standards for exhaust rate.
7. For refrigeration machinery rooms, the exhaust rate shall comply with Chapter 11.
8. For continuous system operation, the lower rates shall be permitted to be used. Otherwise the higher rate shall be used.
9. For unlisted occupancies for a proposed space not listed in the table, the requirements for the listed occupancy that is most similar in terms of occupant density and occupancy type shall be used.
10. Exhaust air that has been cleaned in accordance with the criteria of to meet Class 1 criteria from Section 403.9 shall be permitted to be recirculated.

<table>
<thead>
<tr>
<th>TABLE 403.9</th>
<th>AIRSTREAMS OR SOURCES DESCRIPTION AIR CLASS</th>
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<tr>
<td>DESCRIPTION</td>
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<td>Commercial kitchen grease hoods</td>
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<tr>
<td>Diazo printing equipment discharge</td>
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<tr>
<td>Hydraulic elevator machine room</td>
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<td>Laboratory hoods</td>
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<td>Paint spray booths</td>
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<td>Refrigerating machinery rooms</td>
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<tr>
<td>Residential kitchen hoods in transient occupancy</td>
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<table>
<thead>
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<th>TABLE 403.2.2</th>
<th>ZONE AIR DISTRIBUTION EFFECTIVENESS1, 2, 3, 4, 5</th>
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<tr>
<td>AIR DISTRIBUTION CONFIGURATION</td>
<td>Ez</td>
</tr>
<tr>
<td>Well-Mixed Air Distribution Systems</td>
<td>1.0</td>
</tr>
<tr>
<td>Ceiling supply of cool air.</td>
<td>1.0</td>
</tr>
<tr>
<td>Ceiling supply of warm air and floor return.</td>
<td>0.8</td>
</tr>
<tr>
<td>Ceiling supply of warm air 15°F or more above space temperature and ceiling return.</td>
<td>1.06-0.8</td>
</tr>
</tbody>
</table>

1. Ez values are for continuous system operation during normal hours of use. If the system is operated during periods of heavy use, only the higher rate need be calculated. If the system is operated at all times, the lower rate need be calculated. Ez values for continuous system operation during normal hours of use shall be used as the basis for determining the applicable exhaust rate.

2. Ez values in Chapter 62.1: Table 6-2.2.2 shall be used as the basis for determining the applicable exhaust rate.

3. For refrigeration machinery rooms, the exhaust rate shall comply with Chapter 11.

4. For continuous system operation, the lower rates shall be permitted to be used. Otherwise the higher rate shall be used.

5. For unlisted occupancies for a proposed space not listed in the table, the requirements for the listed occupancy that is most similar in terms of occupant density and occupancy type shall be used.

6. Exhaust air that has been cleaned in accordance with the criteria of to meet Class 1 criteria from Section 403.9 shall be permitted to be recirculated.
is more than 50 fpm at a height of 4.5 feet or more above the floor. Ceiling supply of warm air less than 15°F above average space temperature where the supply air-jet velocity is equal to or greater than 150 feet per minute (fpm) within 4.5 feet of the floor and ceiling return.

Floor supply of cool air and ceiling return, provided low-velocity displacement ventilation achieves unidirectional flow and thermal stratification, or underfloor air distribution systems where the vertical throw is 50 fpm or less at a height of 4.5 feet above the floor.

Floor supply of warm air and floor return. 1.0
Floor supply of warm air and ceiling return. 0.7
Makeup supply drawn in on the opposite side of the room outlet located more than half the length of the space from the exhaust, return, or both. 0.8
Makeup supply drawn in near to the outlet located less than half the length of the space from the exhaust, return, or both locations. 0.5

**Stratified Air Distribution Systems (Section 403.2.2.1)**

Floor supply of cool air where the vertical throw is greater than or equal to 60 feet per minute (fpm) at a height of 4.5 feet above the floor and ceiling return at a height less than or equal to 18 feet above the floor. 1.05

Floor supply of cool air where the vertical throw is less than or equal to 60 feet per minute (fpm) at a height of 4.5 feet above the floor and ceiling return at a height less than or equal to 18 feet above the floor. 1.2

Floor supply of cool air where the vertical throw is less than or equal to 60 feet per minute (fpm) at a height of 4.5 feet above the floor and ceiling return at a height greater than 18 feet above the floor. 1.5

**Personalized Ventilation Systems (Section 403.2.2.2)**

Personalized air at a height of 4.5 feet above the floor combined with ceiling supply of cool air and ceiling return. 1.40

Personalized air at a height of 4.5 feet above the floor combined with ceiling supply of warm air and ceiling return. 1.40

Personalized air at a height of 4.5 feet above the floor combined with a stratified air distribution system with nonaspirating floor supply devices and ceiling return. 1.20

Personalized air at a height of 4.5 feet above the floor combined with a stratified air distribution system with aspirating floor supply devices and ceiling return. 1.50

For SI units: °C = (°F-32)/1.8, 1 foot per minute = 0.005 m/s, 1 foot = 304.8 mm

**Notes:**

1. “Cool air” is air cooler than space temperature.
2. “Warm air” is air warmer than space temperature.
3. “Ceiling supply” includes any point above the breathing zone.
4. “Floor supply” includes any point below the breathing zone.
5. As an alternative to using the above values, Ez shall be permitted to be regarded as equal to air change effectiveness determined in accordance with ASHRAE 129 for air distribution configurations except unidirectional flow.
6. For lower velocity supply air, Ez = 0.8

**TABLE 402.2.1.6(A)(1)**

**MINIMUM OPENABLE AREAS: SINGLE OPENINGS**

**[ASHRAE 62.1: TABLE 6-5]**

<table>
<thead>
<tr>
<th>$\frac{V_{bz}}{A_z}$ (L/s/m²)</th>
<th>$\frac{V_{bz}}{A_z}$ (cfm/ft²)</th>
<th>TOTAL OPENABLE AREAS IN ZONE AS A PERCENTAGE OF $A_z$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$HS/WS \leq 0.1$</td>
</tr>
<tr>
<td>1.0</td>
<td>0.2</td>
<td>4.0</td>
</tr>
<tr>
<td>2.0</td>
<td>0.4</td>
<td>6.9</td>
</tr>
<tr>
<td>3.0</td>
<td>0.6</td>
<td>9.5</td>
</tr>
<tr>
<td>4.0</td>
<td>0.8</td>
<td>12.0</td>
</tr>
<tr>
<td>5.5</td>
<td>1.1</td>
<td>15.5</td>
</tr>
</tbody>
</table>
For SI units: 1 cubic foot per minute = 0.0283 m$^3$/min, 1 square foot = 0.0929 m$^2$

Where:
- $V_{bz}$ = breathing zone outdoor airflow, per Table 402.1.
- $Az$ = zone floor area, the net occupiable floor area of the ventilation zone.
- $WS$ = aggregated width of all single outdoor openings located at the same elevation.
- $HS$ = vertical dimension of the single opening or the least vertical dimension of the openings where there are multiple openings.

* Volumetric airflow rates used to estimate required operable area are based on the following:
  • Dry-air density of 0.075 lbda/ft$^3$ (1.2 kgda/m$^3$) at a barometric pressure of 1 atm (101.3 kPa) and an air temperature of 70°F (21°C)
  • Temperature difference between indoors and outdoors of 1.8°F (1°C)
  • Gravity constant of 32.2 ft/s$^2$ (9.81 m/s$^2$)
  • Window discharge coefficient of 0.6

### TABLE 402.2.1.6(A)(2) MINIMUM OPENABLE AREAS: TWO VERTICALLY SPACED OPENINGS*

<table>
<thead>
<tr>
<th>$V_{bz}/Az$ (L/s/m$^2$)</th>
<th>$V_{bz}/Az$ (cfm/ft$^2$)</th>
<th>TOTAL OPENABLE AREAS IN ZONE AS A PERCENTAGE OF $Az$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$H_{vs} &lt;= 8.2$ ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$As/Al &lt;= 0.5$</td>
</tr>
<tr>
<td>1.0</td>
<td>0.2</td>
<td>2.0</td>
</tr>
<tr>
<td>2.0</td>
<td>0.4</td>
<td>4.0</td>
</tr>
<tr>
<td>3.0</td>
<td>0.6</td>
<td>6.0</td>
</tr>
<tr>
<td>4.0</td>
<td>0.8</td>
<td>8.0</td>
</tr>
<tr>
<td>5.5</td>
<td>1.1</td>
<td>11.0</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.0283 m$^3$/min, 1 square foot = 0.0929 m$^2$

Where:
- $V_{bz}$ = breathing zone outdoor airflow, per Table 402.1.
- $Az$ = zone floor area, the net occupiable floor area of the ventilation zone.
- $H_{vs}$ = vertical separation between the center of the top and bottom openings’ free operable area; in case of multiple horizontally spaced pairs of openings, use shortest distance encountered.
- $As$ = openable area of smallest opening (top or bottom); in case of multiple horizontally spaced pairs of top-and-bottom openings, use aggregated areas.
- $Al$ = openable area of largest opening (top or bottom); in case of multiple horizontally spaced pairs of top-and-bottom openings, use aggregated areas.

* Volumetric airflow rates used to estimate required operable area are based on the following:
  • Dry-air density of 0.075 lbda/ft$^3$ (1.2 kgda/m$^3$) at a barometric pressure of 1 atm (101.3 kPa) and an air temperature of 70°F (21°C)
  • Temperature difference between indoors and outdoors of 1.8°F (1°C)
  • Gravity constant of 32.2 ft/s$^2$ (9.81 m/s$^2$)
  • Window discharge coefficient of 0.6

### Air, Class 1
Air with low contaminant concentration, low sensory-irritation intensity, and inoffensive odor. [ASHRAE 62.1:5.16.1 5.18.1]

### Air, Class 2
Air with moderate contaminant concentration, mild sensory-irritation intensity, or mildly offensive odors. Class 2 air also includes air that is not necessarily harmful or objectionable, but that is inappropriate for transfer or recirculation to spaces used for different purposes. [ASHRAE 62.1:5.16.4 5.18.1]

### Air, Class 3
Air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor. [ASHRAE 62.1:5.16.4 5.18.1]

### Air, Class 4
Air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols, or gases, at concentrations high enough to be considered as harmful. [ASHRAE 62.1:5.16.4 5.18.1]
TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

Note: The AHRI and ASHRAE standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 4 is being revised to the latest edition of ASHRAE 62.1-2019, addendum p as published on February 11, 2020.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

402.2 Natural Ventilation Procedure. Natural ventilation systems shall comply with the requirements of either Section 402.2.1 through Section 402.2.1.6(A) or Section 402.2.2. Designers shall provide interior air barriers, insulation, or other means that separate naturally ventilated spaces from mechanically cooled spaces to prevent high-dew-point outdoor air from coming into contact with mechanically cooled surfaces. [ASHRAE 62.1:6.4]

402.2.1 Prescriptive Compliance Path. Any zone designed for natural ventilation shall include a mechanical ventilation system designed in accordance with Section 403.0.

Exceptions:
(1) Zones in buildings that have all of the following:
(a) Natural ventilation openings that comply with the requirements of Section 402.2.1.
(b) Controls that prevent the natural ventilation openings from being closed during periods of expected occupancy, or natural ventilation openings that are permanently open.
(2) Zones that are not served by heating or cooling equipment. {ASHRAE 62.1:6.4.1}

402.2.1.1 Ceiling Height. For ceilings that are parallel to the floor, the ceiling height \((H)\) to be used in Section 402.2.3 through Section 402.2.5 shall be the minimum ceiling height in the zone.

For zones where ceiling height increases as distance from the openings is increased, the ceiling height shall be determined as the average height of the ceiling within 20 feet (6096 mm) from the operable openings. [ASHRAE 62.1:6.4.1.1]

402.2.1.2 Floor Area to be Ventilated. The naturally ventilated area in zones or portions of zones shall extend from the openings to a distance determined in accordance with Section 402.2.3, Section 402.2.4, or Section 402.2.5. Openings shall be in accordance with the requirements of Section 402.2.6. For spaces where ceilings are not parallel to the floor, the ceiling height shall be determined in accordance with Section 402.2.1.1. [ASHRAE 62.1:6.4.1.2]

402.2.1.3 Single Side Opening. For zones with openings on only one side of the zone, the naturally ventilated area shall extend to a distance not greater than 2 times the height of the ceiling from the openings. [ASHRAE 62.1:6.4.1.3]

402.2.1.4 Double Side Opening. For zones with openings on two opposite sides of the zone, the naturally ventilated area shall extend between the openings separated by a distance not greater than 5 times the height of the ceiling. [ASHRAE 62.1:6.4.1.4]

402.2.1.5 Corner Openings. For zones with operable openings on two adjacent sides of a zone, the distance from the operable openings shall be not more than 5\(H\) along a line drawn between the two openings that are farthest apart. Floor area outside that line shall comply with Section 402.2.1.1. [ASHRAE 62.1:6.4.1.5]

402.2.1.6 Location and Size of Openings. Zones or portions of zones to be naturally ventilated shall have a permanently open airflow path to openings directly connected to the outdoors. The minimum flow rate to the zone shall be determined in accordance with Section 403.2.1. This flow rate shall be used to determine the required openable area of openings, accounting only for buoyancy-driven flow. Wind-driven flow shall be used only where it can be demonstrated that the minimum flow rate is provided during all occupied hours. Openings shall be sized in accordance with Section 402.2.1.6(A). Permanently open airflow path shall include, but not be limited to, pathways that would allow airflow unimpeded by partitions, walls, and furnishings. {ASHRAE 62.1:6.4.1.6}

402.2.1.6(A) Sizing Openings. Where the zone is ventilated using a single opening or multiple single openings located at the same elevation, the openable area as a percent of the net occupiable floor area shall be greater than or equal to the value indicated in Table 402.2.1.6(A)(1). Where the zone is ventilated using two openings located at different elevations or multiple pairs of such openings, the openable area as a percent of the net occupiable floor area shall be greater than or equal to the value indicated in Table 402.2.1.6(A)(2).
Where openings are obstructed by louvers or screens, the openable area shall be based on the net free area of the opening. Where interior zones, or portions of zones, without direct openings to the outdoors are ventilated through adjoining zones, the opening between zones shall be permanently unobstructed and have a free area of not less than twice the percent of occupiable floor area used to determine the opening size of adjacent exterior zones, or 25 square feet (2.3 m²), whichever is greater. Table 402.2.1.6(A)(1) and Table 402.2.1.6(A)(2) are based on buoyancy-driven flow and shall not address thermal comfort. [ASHRAE 62.1:6.4.1.6.1]

402.2.2 Engineered System Compliance Path. For an engineered natural ventilation system, the following shall be included:

1. Determine hourly environmental conditions, including outdoor air dry-bulb temperature; dew-point temperature; outdoor concentration of contaminants, including PM2.5, PM10, and ozone where data are available; wind speed and direction; and internal heat gains during expected hours of natural ventilation operation.
2. Determine the effect of pressure losses along natural ventilation airflow paths on the resulting flow rates, including inlet openings, air transfer grills, ventilation stacks, and outlet openings during representative conditions of expected natural ventilation system use.
3. Quantify natural ventilation airflow rates of identified airflow paths accounting for wind induced and thermally induced driving pressures during representative conditions of expected natural ventilation system use.
4. Design to provide outdoor air in quantities sufficient to result in acceptable IAQ as established under Section 403.2.1 or ASHRAE 62.1 during representative conditions of expected natural ventilation system use. [ASHRAE 62.1:6.4.2]

402.2.7 Control and Accessibility. The means to open required operable openings shall be readily accessible to building occupants whenever the space is occupied. Controls shall be designed to coordinate operation of the natural and mechanical ventilation systems. [ASHRAE 62.1:6.4.3]

403.2 Zone Calculations. Ventilation zone parameters shall be determined in accordance with Section 403.2.1 through Section 403.2.3 for ventilation zones served by the ventilation system, except that the ventilation rates from ASHRAE/ASHE 170 shall be used for the occupancy categories, as applicable. [ASHRAE 62.1:6.2.1]

403.2.1 Breathing Zone Outdoor Airflow. The outdoor airflow required in the breathing zone (Vbz) of the occupiable space or spaces in a ventilation zone shall be not less than the value determined in accordance with Equation 403.2.1.

\[ Vbz = Rp \cdot Pz + Ra \cdot Az \] (Equation 403.2.1)

Where:
- \( Az \) = zone floor area, the net occupiable floor area of the ventilation zone, square feet (m²).
- \( Pz \) = zone population, the number of people in the ventilation zone during usage.
- \( Rp \) = outdoor airflow rate required per person as determined from Table 402.1.
- \( Ra \) = outdoor airflow rate required per unit area as determined from Table 402.1. [ASHRAE 62.1:6.2.1.1]

403.2.2 Zone Air Distribution Effectiveness. The zone air distribution effectiveness (Ez) shall be determined in accordance with Table 403.2.2. [ASHRAE 62.1:6.2.1.2]

403.2.2.1 Stratified Air Distribution Systems. A stratified air distribution system shall be designed in accordance with Section 403.2.2.1.1 through Section 403.2.2.2.2, or the zone air distribution effectiveness (Ez) shall be determined in accordance with ASHRAE 62.1. [ASHRAE 62.1:6.2.1.2.1]

403.2.2.1.1 Supply Air. Cool air shall be at least 4°F (2°C) less than the average room air temperature. [ASHRAE 62.1:6.2.1.2.1.1]

403.2.2.1.2 Return Air. The return air openings or pathways shall be located not less than 9 feet (2.8 m) above the floor. [ASHRAE 62.1:6.2.1.2.1.2]

403.2.2.1.3 Stratification. The zone shall not contain any devices that mechanically mix the air, and shall be protected from impinging airstreams from adjacent ventilation zones. [ASHRAE 62.1:6.2.1.2.1.3]

403.2.2.2 Personalized Ventilation Systems. A personalized ventilation system shall be designed in accordance with the following subsections, or the zone air distribution effectiveness (Ez) shall be determined in accordance with ASHRAE 62.1. [ASHRAE 62.1:6.2.1.2.2]

403.2.2.2.1 Personalized Air. The personalized air shall be distributed in the breathing zone and designed such that the velocity is equal to or less than 50 feet per minute (0.25 m/s) at the head/facial region of the occupant. [ASHRAE 62.1:6.2.1.2.2.1]

403.2.2.2.2 Return Air. The return air openings or pathways shall be located more than 9 feet (2.8 m) above the floor. [ASHRAE 62.1:6.2.1.2.2.2]

403.2.3 Zone Outdoor Airflow. The zone outdoor airflow (Voz) provided to the ventilation zone by the supply air distribution system shall be determined in accordance with Equation 403.2.3. [ASHRAE 62.1:6.2.1.3]

\[ Voz = Vbz/Ez \] (Equation 403.2.3)

403.3 Single-Zone Systems. For ventilation systems where one or more air handlers supply a mixture of outdoor air and recirculated air to only one ventilation zone, the outdoor air intake flow (Vot) shall be determined in accordance with Equation 403.3. [ASHRAE 62.1:6.2.2]
Vot = Voz (Equation 403.3)

403.4 One Hundred Percent Outdoor Air Systems. For ventilation systems where one or more air handlers supply only outdoor air to one or more ventilation zones, the outdoor air intake flow (Vot) shall be determined in accordance with Equation 403.4. [ASHRAE 62.1:6.2.3]

\[ Vot = \text{Sall zones Voz} \] (Equation 403.4)

403.5 Multiple-Zone Recirculating Systems. For ventilation systems where one or more air handlers supply a mixture of outdoor air and recirculated air to more than one ventilation zone, the outdoor air intake flow (Vot) shall be determined in accordance with Section 403.5.1 through Section 403.5.2. [ASHRAE 62.1:6.2.4]

403.5.1 Uncorrected Outdoor Air Intake. The uncorrected outdoor air intake (Vou) flow shall be determined in accordance with Equation 403.5.1. [ASHRAE 62.1:6.2.4.1]

(Equation 403.5.1)

\[ Vou = D S \text{ all zones} (R_p P_z) + S \text{ all zones} (R_a A_z) \]

403.5.1.1 Occupant Diversity. The occupant diversity ratio (D) shall be determined in accordance with Equation 403.5.1.1 to account for variations in population within the ventilation zones served by the system.

(Equation 403.5.1.1)

\[ D = \frac{P_s}{S \text{ all zones} P_z} \]

Where the system population (Ps) is the total population in the area served by the system.

**Exception:** Alternative methods to account for occupant diversity shall be permitted, provided that the resulting (Vou) value is not less than that determined in accordance with Equation 403.5.1. [ASHRAE 62.1:6.2.4.1.1]

403.5.1.2 System Ventilation Efficiency. The system ventilation efficiency (Ev) shall be determined in accordance with Section 403.5.1.3 for the simplified procedure or Section 404.0 for the alternate procedure. These procedures also establish zone minimum primary airflow rates for VAV systems. [ASHRAE 62.1:6.2.4.2]

403.5.1.3 Simplified Procedure for System Ventilation Efficiency. System ventilation efficiency (Ev) shall be determined in accordance with Equation 403.5.1.3(1) or Equation 403.5.1.3(2). [ASHRAE 62.1:6.2.4.3 – 6.2.4.3.1]

\[ Ev = 0.88D + 0.22 \text{ for } D < 0.60 \quad \text{[Equation 403.5.1.3(1)]} \]

\[ Ev = 0.75 \text{ for } D \geq 0.60 \quad \text{[Equation 403.5.1.3(2)]} \]

403.5.1.4 Zone Minimum Primary Airflow. For each zone, the minimum primary airflow (Vpz-min) shall be determined in accordance with Equation 403.5.1.4. [ASHRAE 62.1:6.2.4.3.2]

\[ Vpz-min = Voz \times 1.5 \quad \text{(Equation 403.5.1.4)} \]

403.5.2 Outdoor Air Intake. The design outdoor air intake flow (Vot) shall be determined in accordance with Equation 403.5.2. [ASHRAE 62.1:6.2.4.4]

\[ Vot = \frac{Vou}{Ev} \quad \text{(Equation 403.5.2)} \]

403.6 Design for Varying Operating Conditions. Ventilation systems shall be designed to be capable of providing not less than the minimum ventilation rates required in the breathing zone where the zones served by the system are occupied, including all full- and part-load conditions. The minimum outdoor air intake flow shall be permitted to be less than the design value at part-load conditions. [ASHRAE 62.1:6.2.5 – 6.2.5.1]

403.6.1 Short-Term Conditions. Where it is known that peak occupancy will be of short duration, ventilation will be varied or interrupted for a short period of time, or both, the design shall be permitted to be based on the average conditions over a time period (T) determined by Equation 403.6.1.

\[ T = \frac{3v}{Vbz} \quad \text{(Equation 403.6.1)} \]

Where:
\[ T = \text{averaging time period, minutes.} \]
\[ v = \text{the volume of the ventilation zone where averaging is being applied, cubic foot (m}^3\text{).} \]
\[ Vbz = \text{the breathing zone outdoor airflow calculated in accordance with Equation 403.2.1 and design value of the zone population (Pz), cubic foot per minute (CFM) (m}^3\text{/min).} \]
Acceptable design adjustments based on this optional provision including the following:

(1) Zones with fluctuating occupancy: The zone population \( P_z \) shall be permitted to be averaged over time \( T \).

(2) Zones with intermittent interruption of supply air: The average outdoor airflow supplied to the breathing zone over time \( T \) shall not be less than the breathing zone outdoor airflow \( V_{bz} \) calculated using Equation 403.2.1.

(3) Systems with intermittent closure of the outdoor air intake: The average outdoor air intake over time \( T \) shall be not less than the minimum outdoor air intake \( V_{ot} \) calculated using Equation 403.3, Equation 403.4, or Equation 403.5.1 as applicable. [ASHRAE 62.1:6.2.5.2]

### 403.8 Dynamic Reset

The system shall be permitted to be designed to reset the outdoor air intake flow \( V_{ot} \), the space or ventilation zone airflow \( V_{oz} \) as operating conditions change, or both. [ASHRAE 62.1:6.2.6]

### 403.9 Air Classification and Recirculation

Air shall be classified, and its recirculation shall be limited in accordance with Section 403.9.1 through Section 403.9.4. [ASHRAE 62.1:5.18] Recirculated air shall not be taken from prohibited locations in accordance with Section 311.3.

Air (return, transfer, or exhaust air) leaving each space or location shall be designated at an expected air-quality classification not less than that shown in Table 402.1, Table 403.7, or Table 403.9 or as approved by the Authority Having Jurisdiction. Air leaving spaces or locations that are not listed in Table 402.1, Table 403.7, or Table 403.9 shall be designated with the same classification as air from the most similar space or location listed in terms of occupant activities and building construction.

#### Exception: Air from spaces where environmental tobacco smoke (ETS) is present. (Classification of air from spaces where ETS is present is not addressed. Spaces that are expected to include ETS do not have a classification listed in Table 402.1.) [ASHRAE 62.1:5.18.1]

### 403.9.1 Class 1 Air

Recirculation or transfer of Class 1 air to any space shall be permitted. [ASHRAE 62.1:5.18.3.1]

### 403.9.2 Class 2 Air

Recirculation of Class 2 air within the space of origin shall be permitted. Recirculation or transfer of Class 2 air to other Class 2 or Class 3 spaces shall be provided, provided that the other spaces are used for the same or similar purpose or task and involve the same or similar pollutant sources as the Class 2 space. Transfer of Class 2 air to toilet rooms shall be permitted. Recirculation or transfer of Class 2 air to Class 4 spaces shall be permitted. Class 2 air shall not be recirculated or transferred to Class 1 spaces. When using any energy recover device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device shall be permitted but shall not be counted as outdoor air. Exhaust air transfer ratio of Class 2 air shall not exceed 10 percent of the outdoor air intake flow at the design static pressure differential as defined in AHRI 1060. ([ASHRAE 62.1:5.18.3.2 – 5.18.3.2.5])

### 403.9.3 Class 3 Air

Recirculation of Class 3 air within the space of origin shall be permitted. Class 3 air shall not be recirculated or transferred to any other spaces. When using an energy recover device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device shall be permitted but shall not be counted as outdoor air. Exhaust air transfer ratio of Class 3 air shall not exceed 5 percent of the outdoor air intake flow at the design static pressure differential as defined in AHRI 1060. ([ASHRAE 62.1:5.18.3.3 – 5.18.3.3.2])

### 403.9.4 Class 4 Air

Class 4 air shall not be recirculated or transferred to any space or recirculated within the space of origin. [ASHRAE 62.1:5.18.3.4]

### 404.1 System Ventilation Efficiency

The system ventilation efficiency shall equal the lowest zone ventilation efficiency among the ventilation zones served by the air handler in accordance with Equation 404.1. [ASHRAE 62.1:A1.3] This section presents an alternative procedure for calculating the system ventilation efficiency \( Ev \) for multiple zone recirculating systems that shall be used when Section 403.5.1.3 is not used.

\[
Ev = \text{minimum } (Ev_z) \text{ (Equation 404.1)}
\]

### 404.2 Average Outdoor Air Fraction

The average outdoor air fraction \( X_s \) for the ventilation system shall be determined in accordance with Equation 404.2.

\[
X_s = \frac{V_{ou}}{V_{ps}} \text{ (Equation 404.2)}
\]

Where the uncorrected outdoor air intake \( V_{ou} \) is determined in accordance with Section 403.5.1, and the system primary airflow \( V_{ps} \) shall be determined at the condition analyzed. [ASHRAE 62.1:A1.1]

### 404.3 Zone Ventilation Efficiency

The zone ventilation efficiency \( Ev_z \) shall be determined in accordance with Section 404.3.1 or Section 404.3.2. [ASHRAE 62.1:A1.2]

#### 404.3.1 Single Supply Systems

For single supply systems, where all of the air supplied to each ventilation zone is a mixture of outdoor air and system-level recirculated air, zone ventilation efficiency \( Ev_z \) shall be determined in accordance with Equation 404.3.1. Examples of single supply systems include constant-volume reheat, single-duct VAV, single-fan dual-duct, and multizone-systems.

\[
Ev_z = 1 + X_s - Z_{pz} \text{ (Equation 404.3.1)}
\]
Where the average outdoor air fraction for the system \((X_s)\) shall be determined in accordance with Equation 404.2, and the primary outdoor air fraction for the zone \((Z_{pz})\) shall be determined in accordance with Equation 404.3.1. [ASHRAE 62.1:A1.2.1]

\[
Z_{pz} = \frac{V_{oz}}{V_{pz}} \quad \text{(Equation 404.3.1)}
\]

For VAV systems, \(V_{pz}\) is the lowest zone primary airflow value expected at the design condition analyzed.

**404.3.2 Secondary-Recirculation Systems.** For secondary-recirculation systems where the supply air or a portion thereof to each ventilation zone is recirculated air (air that has not been directly mixed with outdoor air) from other zones, zone ventilation efficiency \((E_{vz})\) shall be determined in accordance with Equation 404.3.2(1). Examples of secondary-recirculation systems include dual-fan dual-duct and fan-powered mixing-box systems, and systems that include transfer fans for conference rooms.

\[
E_{vz} = \frac{(F_a + X_s \cdot F_b - Z_{pz} \cdot E_p \cdot F_c)}{F_a} \quad \text{(Equation 404.3.2(1))}
\]

Where system air fractions \(F_a\), \(F_b\), and \(F_c\) are determined in accordance with Equation 404.3.2(2), Equation 404.3.2(3), and Equation 404.3.2(4), as applicable.

\[
F_a = E_p \cdot (1-E_p) \cdot E_r \quad \text{(Equation 404.3.2(2))}
\]

\[
F_b = E_p \quad \text{(Equation 404.3.2(3))}
\]

\[
F_c = 1-(1-E_z) \cdot (1-E_r) \cdot (1-E_p) \quad \text{(Equation 404.3.2(4))}
\]

Where the zone primary air fraction \((E_p)\) shall be determined in accordance with Equation 404.3.2(5), zone secondary recirculation fraction \((E_r)\) shall be determined by the designer based on system configuration. The zone air distribution effectiveness \((E_z)\) shall be determined in accordance with Section 403.2.2. [ASHRAE 62.1:A1.2.2]

\[
E_p = \frac{V_{pz}}{V_{dz}} \quad \text{(Equation 404.3.2(5))}
\]

Where:

- \(A_z\) = Zone floor area: The net occupiable floor area of the ventilation zone, ft\(^2\) (m\(^2\)).
- \(D\) = Occupant diversity: The ratio of the system population to the sum of the zone populations.
- \(E_p\) = Primary air fraction: The fraction of primary air in the discharge air to the ventilation zone.
- \(E_r\) = Secondary recirculation fraction: In systems with secondary recirculation of return air, the fraction of secondary recirculated air to the zone that is representative of average system return air rather than air directly recirculated from the zone.
- \(E_v\) = System ventilation efficiency: the efficiency with which the system distributes air from the outdoor air intake to the breathing zone in the ventilation-critical zone, which requires the largest fraction of outdoor air in the primary airstream.
- \(E_{vz}\) = Zone ventilation efficiency: The efficiency with which the system distributes air from the outdoor air intake to the breathing zone in any particular ventilation zone.
- \(E_z\) = Zone air distribution effectiveness: A measure of the effectiveness of supply air distribution to the breathing zone. \(E_z\) is determined in accordance with Section 403.2.2.
- \(F_a\) = Supply air fraction: The fraction of supply air to the ventilation zone from sources or air outside the zone.
- \(F_b\) = Mixed air fraction: The fraction of supply air to the ventilation zone from fully mixed primary air.
- \(F_c\) = Outdoor air fraction: The fraction of outdoor air to the ventilation zone from sources of air outside the zone.
- \(P_s\) = System population: the simultaneous number of occupants in the area served by the ventilation system.
- \(P_z\) = Zone population: see Section 403.2.1.
- \(R_a\) = Area outdoor air rate: see Section 403.2.1.
- \(R_p\) = People outdoor air rate: see Section 403.2.1.
- \(V_{bz}\) = Breathing zone outdoor airflow: see Section 403.2.1.
- \(V_{dz}\) = Zone discharge airflow: The expected discharge (supply) airflow to the zone that includes primary airflow and secondary recirculated airflow, CFM (m\(^3\)/min).
- \(V_{ot}\) = Outdoor air intake flow: see Section 403.3, Section 403.4, and Section 403.5.2.
- \(V_{ou}\) = Uncorrected outdoor air intake: see Section 403.5.1.
- \(V_{oz}\) = Zone outdoor airflow: see Section 403.2.3.
- \(V_{ps}\) = System primary airflow: The total primary airflow supplied to all zones served by the system from the air-handling unit at which the outdoor air intake is located.
- \(V_{pz}\) = Zone primary airflow: The zone primary airflow to the ventilation zone, including outdoor air and recirculated air.
Xs = Average outdoor air fraction: At the primary air handler, the fraction of outdoor air intake flow in the system primary airflow.
Zpz = Primary outdoor air fraction: The outdoor air fraction required in the primary air supplied to the ventilation zone prior to the introduction of any secondary recirculation air. [ASHRAE 62.1:A3]

<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY</th>
<th>PEOPLE OUTDOOR AIR RATE (CFM/PERSON)</th>
<th>AREA OUTDOOR AIR RATE (CFM/FT²)</th>
<th>DEFAULT OCCUPANT DENSITY (PEOPLE/1000 FT²)</th>
<th>AIR CLASS</th>
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<td>ANIMAL FACILITIES</td>
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<td>are used (excludes heavy industrial and</td>
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<td>0.12</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Barber shop</td>
<td>7.5</td>
<td>0.06</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Beauty and nail salons</td>
<td>20</td>
<td>0.12</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Coin-operated laundries</td>
<td>7.5</td>
<td>0.12</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Mall common areas</td>
<td>7.5</td>
<td>0.06</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Pet shops (animal areas)</td>
<td>7.5</td>
<td>0.18</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Supermarket</td>
<td>7.5</td>
<td>0.06</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td><strong>SPORTS AND ENTERTAINMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bowling alley (seating)</td>
<td>10</td>
<td>0.12</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Disco/dance floors</td>
<td>20</td>
<td>0.06</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Gambling casinos</td>
<td>7.5</td>
<td>0.18</td>
<td>120</td>
<td>1</td>
</tr>
<tr>
<td>Game arcades</td>
<td>7.5</td>
<td>0.18</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Gym, sports arena (play area)</td>
<td>20</td>
<td>0.18</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Health club/aerobics room</td>
<td>20</td>
<td>0.06</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Health club/weight rooms</td>
<td>20</td>
<td>0.06</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Spectator areas</td>
<td>7.5</td>
<td>0.06</td>
<td>150</td>
<td>1</td>
</tr>
<tr>
<td>Stages, studios</td>
<td>10</td>
<td>0.06</td>
<td>70</td>
<td>1</td>
</tr>
<tr>
<td>Swimming (pool and deck)</td>
<td>–</td>
<td>0.48</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td><strong>TRANSIENT RESIDENTIAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common corridors</td>
<td>–</td>
<td>0.06</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Dwelling unit</td>
<td>5</td>
<td>0.06</td>
<td>–</td>
<td>1</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.0283 m³/min, 1 square foot = 0.0929 m²

**Notes:**

1. Outpatient facilities to which the rates apply are freestanding birth centers, urgent care centers, neighborhood clinics and physicians offices, Class 1 imaging facilities, outpatient psychiatric facilities, outpatient rehabilitation facilities, and outpatient dental facilities.

2. The requirements of this table provide for acceptable IAQ. The requirements of this table do not address the airborne transmission of airborne viruses, bacteria, and other infectious contagions.

3. These rates are intended only for outpatient dental clinics where the amount of nitrous oxide is limited. They are not intended for dental operatories in institutional buildings where nitrous oxide is piped.
## OCCUPANCY CATEGORY

<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY</th>
<th>EXHAUST RATE (CFM/unit)</th>
<th>EXHAUST RATE (CFM/ft²)</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal imaging (MRI/CT/PET)</td>
<td>–</td>
<td>0.90</td>
<td>3</td>
</tr>
<tr>
<td>Animal operating rooms</td>
<td>–</td>
<td>3.00</td>
<td>3</td>
</tr>
<tr>
<td>Animal postoperative recovery room</td>
<td>–</td>
<td>1.50</td>
<td>3</td>
</tr>
<tr>
<td>Animal preparation rooms</td>
<td>–</td>
<td>1.50</td>
<td>3</td>
</tr>
<tr>
<td>Animal procedure room</td>
<td>–</td>
<td>2.25</td>
<td>3</td>
</tr>
<tr>
<td>Animal surgery scrub</td>
<td>–</td>
<td>1.50</td>
<td>3</td>
</tr>
<tr>
<td>Large-animal holding room</td>
<td>–</td>
<td>2.25</td>
<td>3</td>
</tr>
<tr>
<td>Necropsy</td>
<td>–</td>
<td>2.25</td>
<td>3</td>
</tr>
<tr>
<td>Small-animal-cage room (static cages)</td>
<td>–</td>
<td>2.25</td>
<td>3</td>
</tr>
<tr>
<td>Small-animal-cage room (ventilated cages)</td>
<td>–</td>
<td>1.50</td>
<td>3</td>
</tr>
<tr>
<td>Arenas</td>
<td>–</td>
<td>0.50</td>
<td>1</td>
</tr>
<tr>
<td>Art classrooms</td>
<td>–</td>
<td>0.70</td>
<td>2</td>
</tr>
<tr>
<td>Auto repair rooms¹</td>
<td>–</td>
<td>1.50</td>
<td>2</td>
</tr>
<tr>
<td>Barber shops</td>
<td>–</td>
<td>0.50</td>
<td>2</td>
</tr>
<tr>
<td>Beauty and nail salons</td>
<td>–</td>
<td>0.60</td>
<td>2</td>
</tr>
<tr>
<td>Cells with toilet</td>
<td>–</td>
<td>1.00</td>
<td>2</td>
</tr>
<tr>
<td>Copy, printing rooms</td>
<td>–</td>
<td>0.50</td>
<td>2</td>
</tr>
<tr>
<td>Darkrooms</td>
<td>–</td>
<td>1.00</td>
<td>2</td>
</tr>
<tr>
<td>Educational science laboratories</td>
<td>–</td>
<td>1.00</td>
<td>2</td>
</tr>
<tr>
<td>Janitor closets, trash rooms, recycling</td>
<td>–</td>
<td>1.00</td>
<td>3</td>
</tr>
<tr>
<td>Kitchenettes</td>
<td>–</td>
<td>0.30</td>
<td>2</td>
</tr>
<tr>
<td>Kitchens – commercial</td>
<td>–</td>
<td>0.70</td>
<td>2</td>
</tr>
<tr>
<td>Locker rooms for athletic, industrial, and health care facilities</td>
<td>–</td>
<td>0.50</td>
<td>2</td>
</tr>
<tr>
<td>All other locker rooms</td>
<td>–</td>
<td>0.25</td>
<td>2</td>
</tr>
<tr>
<td>Shower rooms</td>
<td>–</td>
<td>20/50</td>
<td>2</td>
</tr>
<tr>
<td>Paint spray booths</td>
<td>–</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td>Parking garages</td>
<td>–</td>
<td>0.75</td>
<td>2</td>
</tr>
<tr>
<td>Pet shops (animal areas)</td>
<td>–</td>
<td>0.90</td>
<td>2</td>
</tr>
<tr>
<td>Refrigerating machinery rooms</td>
<td>–</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td>Residential – kitchens</td>
<td>–</td>
<td>50/100</td>
<td>2</td>
</tr>
<tr>
<td>Soiled laundry storage rooms</td>
<td>–</td>
<td>1.00</td>
<td>3</td>
</tr>
<tr>
<td>Storage rooms, chemical</td>
<td>–</td>
<td>1.50</td>
<td>4</td>
</tr>
<tr>
<td>Toilets – private</td>
<td>25/50</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Toilets – public</td>
<td>50/70</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Woodwork shop/classrooms</td>
<td>–</td>
<td>0.50</td>
<td>2</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.0283 m³/min, 1 square foot = 0.0929 m²

**Notes:**

1. Stands where engines are run shall have exhaust systems that directly connect to the engine exhaust and prevent escape of fumes.
2. Where combustion equipment is intended to be used on the playing surface, additional dilution ventilation, source control, or both shall be provided.
3. Exhaust shall not be required where two or more sides compose walls that are at least 50 percent open to the outside.
4. Rate is per water closet, urinal, or both. Provide the higher rate where periods of heavy use are expected to occur. The lower rate shall be permitted to be used otherwise.
Rate is for a toilet room intended to be occupied by one person at a time. For continuous system operation during hours of use, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.

See other applicable standards for exhaust rate.

For continuous system operation, the lower rates shall be permitted to be used. Otherwise the higher rate shall be used.

Exhaust air that has been cleaned to meet Class 1 criteria from Section 403.9 shall be permitted to be recirculated.

Rate is per showerhead.

**TABLE 403.9**

**AIRSTREAMS OR SOURCES DESCRIPTION AIR CLASS**

[ASHRAE 62.1: TABLE 6-3]

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial kitchen grease hoods</td>
<td>4</td>
</tr>
<tr>
<td>Commercial kitchen hoods other than grease</td>
<td>3</td>
</tr>
<tr>
<td>Diazo printing equipment discharge</td>
<td>4</td>
</tr>
<tr>
<td>Hydraulic elevator machine room</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory hoods</td>
<td>4</td>
</tr>
<tr>
<td>Paint spray booths</td>
<td>4</td>
</tr>
<tr>
<td>Refrigerating machinery rooms</td>
<td>3</td>
</tr>
<tr>
<td>Residential kitchen hoods in transient occupancy</td>
<td>3</td>
</tr>
</tbody>
</table>

**TABLE 403.2.2**

**ZONE AIR DISTRIBUTION EFFECTIVENESS1, 2, 3, 4, 5**

[ASHRAE 62.1: TABLE 6-4]

<table>
<thead>
<tr>
<th>AIR DISTRIBUTION CONFIGURATION</th>
<th>Ez</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Well-Mixed Air Distribution Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Ceiling supply of cool air.</td>
<td>1.0</td>
</tr>
<tr>
<td>Ceiling supply of warm air and floor return.</td>
<td>1.0</td>
</tr>
<tr>
<td>Ceiling supply of warm air 15°F or more above space temperature and ceiling return.</td>
<td>0.8</td>
</tr>
<tr>
<td>Ceiling supply of warm air less than 15°F above space temperature where the supply air-jet velocity is less than 150 feet per minute (fpm) within 4.5 feet of the floor and ceiling return.</td>
<td>0.8</td>
</tr>
<tr>
<td>Ceiling supply of warm air less than 15°F above average space temperature where the supply air-jet velocity is equal to or greater than 150 feet per minute (fpm) within 4.5 feet of the floor and ceiling return.</td>
<td>1.0</td>
</tr>
<tr>
<td>Floor supply of warm air and floor return.</td>
<td>1.0</td>
</tr>
<tr>
<td>Floor supply of warm air and ceiling return.</td>
<td>0.7</td>
</tr>
<tr>
<td>Makeup supply outlet located more than half the length of the space from the exhaust, return, or both.</td>
<td>0.8</td>
</tr>
<tr>
<td>Makeup supply outlet located less than half the length of the space from the exhaust, return, or both.</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**Stratified Air Distribution Systems (Section 403.2.2.1)**

Floor supply of cool air where the vertical throw is greater than or equal to 60 feet per minute (fpm) at a height of 4.5 feet above the floor and ceiling return at a height less than or equal to 18 feet above the floor. | 1.05      |

Floor supply of cool air where the vertical throw is less than or equal to 60 feet per minute (fpm) at a height of 4.5 feet above the floor and ceiling return at a height less than or equal to 18 feet above the floor. | 1.2       |

Floor supply of cool air where the vertical throw is less than or equal to 60 feet per minute (fpm) at a height of 4.5 feet above the floor and ceiling return at a height greater than 18 feet above the floor. | 1.5       |

**Personalized Ventilation Systems (Section 403.2.2.2)**
Personalized air at a height of 4.5 feet above the floor combined with ceiling supply of cool air and ceiling return. 1.40

Personalized air at a height of 4.5 feet above the floor combined with ceiling supply of warm air and ceiling return. 1.40

Personalized air at a height of 4.5 feet above the floor combined with a stratified air distribution system with nonaspirating floor supply devices and ceiling return. 1.20

Personalized air at a height of 4.5 feet above the floor combined with a stratified air distribution system with aspirating floor supply devices and ceiling return. 1.50

For SI units: °C = (°F-32)/1.8, 1 foot per minute = 0.005 m/s, 1 foot = 304.8 mm

Notes:
1 “Cool air” is air cooler than space temperature.
2 “Warm air” is air warmer than space temperature.
3 “Ceiling supply” includes any point above the breathing zone.
4 “Floor supply” includes any point below the breathing zone.
5 As an alternative to using the above values, \( E_z \) shall be permitted to be regarded as equal to air change effectiveness determined in accordance with ASHRAE 129 for air distribution configurations except unidirectional flow.
6 For lower velocity supply air, \( E_z = 0.8 \)

### TABLE 402.2.1.6(A)(1)

**MINIMUM OPENABLE AREAS: SINGLE OPENINGS**

**[ASHRAE 62.1: TABLE 6-5]**

<table>
<thead>
<tr>
<th>( V_{bz}/A_z )</th>
<th>( V_{bz}/A_z )</th>
<th>TOTAL OPENABLE AREAS IN ZONE AS A PERCENTAGE OF ( A_z )</th>
</tr>
</thead>
<tbody>
<tr>
<td>((L/s)/m^2)</td>
<td>((cfm/ft^2))</td>
<td>( HS/WS = 0.1 )</td>
</tr>
<tr>
<td>1.0</td>
<td>0.2</td>
<td>4.0</td>
</tr>
<tr>
<td>2.0</td>
<td>0.4</td>
<td>6.9</td>
</tr>
<tr>
<td>3.0</td>
<td>0.6</td>
<td>9.5</td>
</tr>
<tr>
<td>4.0</td>
<td>0.8</td>
<td>12.0</td>
</tr>
<tr>
<td>5.5</td>
<td>1.1</td>
<td>15.5</td>
</tr>
</tbody>
</table>

Where:

\( V_{bz} \) = breathing zone outdoor airflow, per Table 402.1.

\( A_z \) = zone floor area, the net occupiable floor area of the ventilation zone.

\( WS \) = aggregated width of all single outdoor openings located at the same elevation.

\( HS \) = vertical dimension of the single opening or the least vertical dimension of the openings where there are multiple openings.

* Volumetric airflow rates used to estimate required openable area are based on the following:
  • Dry-air density of 0.075 lbda/ft³ (1.2 kgda/m³) at a barometric pressure of 1 atm (101.3 kPa) and an air temperature of 70°F (21°C)
  • Temperature difference between indoors and outdoors of 1.8°F (1°C)
  • Gravity constant of 32.2 ft/s² (9.81 m/s²)
  • Window discharge coefficient of 0.6

### TABLE 402.2.1.6(A)(2)

**MINIMUM OPENABLE AREAS: TWO VERTICALLY SPACED OPENINGS**

**[ASHRAE 62.1: TABLE 6-6]**

<table>
<thead>
<tr>
<th>( V_{bz}/A_z )</th>
<th>( V_{bz}/A_z )</th>
<th>TOTAL OPENABLE AREAS IN ZONE AS A PERCENTAGE OF ( A_z )</th>
</tr>
</thead>
<tbody>
<tr>
<td>((L/s/m^2))</td>
<td>((cfm/ft^2))</td>
<td>( H_v s = 8.2 \text{ ft (2.5 m)} )</td>
</tr>
<tr>
<td>1.0</td>
<td>0.2</td>
<td>2.0</td>
</tr>
<tr>
<td>2.0</td>
<td>0.4</td>
<td>4.0</td>
</tr>
<tr>
<td>3.0</td>
<td>0.6</td>
<td>6.0</td>
</tr>
<tr>
<td>4.0</td>
<td>0.8</td>
<td>8.0</td>
</tr>
</tbody>
</table>
Where:

$V_{bz} =$ breathing zone outdoor airflow, per Table 402.1.

$A_z =$ zone floor area, the net occupiable floor area of the ventilation zone.

$H_v =$ vertical separation between the center of the top and bottom openings’ free operable area; in case of multiple horizontally spaced pairs of openings, use shortest distance encountered.

$A_s =$ openable area of smallest opening (top or bottom); in case of multiple horizontally spaced pairs of top-and-bottom openings, use aggregated areas.

$A_l =$ openable area of largest opening (top or bottom); in case of multiple horizontally spaced pairs of top-and-bottom openings, use aggregated areas.

* Volumetric airflow rates used to estimate required operable area are based on the following:
  * Dry-air density of 0.075 lb/ft$^3$ (1.2 kg/m$^3$) at a barometric pressure of 1 atm (101.3 kPa) and an air temperature of 70°F (21°C)
  * Temperature difference between indoors and outdoors of 1.8°F (1°C)
  * Gravity constant of 32.2 ft/s$^2$ (9.81 m/s$^2$)
  * Window discharge coefficient of 0.6

203.0 – A –

**Air, Class 1.** Air with low contaminant concentration, low sensory-irritation intensity, and inoffensive odor. [ASHRAE 62.1:5.18.1]

**Air, Class 2.** Air with moderate contaminant concentration, mild sensory-irritation intensity, or mildly offensive odors. Class 2 air also includes air that is not necessarily harmful or objectionable, but that is inappropriate for transfer or recirculation to spaces used for different purposes. [ASHRAE 62.1:5.18.1]

**Air, Class 3.** Air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor. [ASHRAE 62.1:5.18.1]

**Air, Class 4.** Air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols, or gases, at concentrations high enough to be considered as harmful. [ASHRAE 62.1:5.18.1]

### TABLE 1701.1

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

**COMMITTEE STATEMENT:**

In Section 403.9.2 and Section 403.9.3, the language “at the design static pressure differential as defined in AHRI 1060” should be removed as adding the AHRI standard does not add any requirements or improve the code sections since they refer to definitions. Table 1701.1 is also being modified to remove AHRI 1060.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**

**AFFIRMATIVE:** 28  **NEGATIVE:** 1  **NOT RETURNED:** 1  Heine

**EXPLANATION OF NEGATIVE:**

**WHITE:** I disagree with the amended language and believe the proposal should be accepted as submitted. The reference language will keep people from gaming the system.
Proposals

Item #: 089
UMC 2024 Section: 401.1, Table 1701.1, Table 1701.2

SUBMITTER: David Dias  
Sheet Metal Workers Local 104

RECOMMENDATION:  
Revise text

401.0 General.
401.1 Applicability. This chapter contains requirements for ventilation air supply, exhaust, and makeup air requirements for occupiable spaces within a building. Spaces within buildings, except those within a dwelling unit in residential occupancies where occupants are nontransient, shall comply with Section 402.0 through Section 404.0. Requirements for ventilation air rate for dwelling units in residential occupancies, where the occupants are nontransient, shall be in accordance with Section 405.0 or ASHRAE 62.2.

TABLE 1701.1  
REFERRED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 62.2-2019</td>
<td>Ventilation and Acceptable Indoor Air Quality in Residential Buildings</td>
<td>Ventilation</td>
<td>401.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: ASHRAE 62.2 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

TABLE 1701.2  
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 62.2-2019</td>
<td>Ventilation and Acceptable Indoor Air Quality in Residential Buildings</td>
<td>Ventilation</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

SUBSTANTIATION:  
The requirements for ventilation air rate for dwelling units in residential occupancies can either be in accordance with Section 405.0 of the UMC or ASHRAE 62.2, “Ventilation and Acceptable Indoor Air Quality in Residential Buildings,” as the ASHRAE standard contains provisions for dwelling units in residential occupancies similar to the UMC. This change clarifies the intent of Section 401.1.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:  
The current language in the UMC already contains ventilation requirements for residential occupancies, therefore, reference to ASHRAE 62.2 is not necessary.
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

WHITE: ASHRAE 62.2 is an acceptable standard and should be allowed in the code. It could in fact replace the current related UMC language.
Proposals

Item #: 090

UMC 2024  Section: 401.2, Table 1701.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

401.0 General.
401.1 Applicability. (remaining text unchanged)

401.2 Indoor Swimming Pools. The design of ventilation systems serving an indoor aquatic facility (natatorium) shall comply with the Uniform Swimming Pool, Spa and Hot Tub Code (USPSHTC).

<table>
<thead>
<tr>
<th>TABLE 1701.1 REFERENCED STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD NUMBER</td>
</tr>
<tr>
<td>IAPMO/ANSI USPSHTC 1-2021</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: IAPMO/ANSI USPSHTC 1 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Chapter 4 (Ventilation) addresses ventilation for several types of spaces, however, swimming pool ventilation is specifically addressed in the Uniform Swimming Pool, Spa and Hot Tub Code (USPSHTC). Therefore, a section is being added to the beginning of Chapter 4 to reference the USPSHTC, which is an ANSI standard, to provide installation requirements.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
TABLE 402.1
MINIMUM VENTILATION RATES IN BREATHING ZONE\textsuperscript{1, 2}  
\{ASHRAE 62.1: TABLE 6.2.2.1\}

<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY\textsuperscript{4}</th>
<th>PEOPLE OUTDOOR Air Rate $R_p$ (CFM/person)</th>
<th>AREA OUTDOOR Air Rate $R_a$ (CFM/ft\textsuperscript{2})</th>
<th>DEFAULT OCCUPANT DENSITY\textsuperscript{3} (people/1000 ft\textsuperscript{2})</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warehouses\textsuperscript{b, i}</td>
<td>10</td>
<td>0.06</td>
<td>–</td>
<td>2</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

For SI units: 1 cubic foot per minute = 0.0283 m\textsuperscript{3}/min, 1 square foot = 0.0929 m\textsuperscript{2}

**Notes:**
1. This table applies to no-smoking areas. Rates for smoking-permitted spaces shall be determined using other methods.
2. Volumetric airflow rates are based on dry air density of 0.075 pounds of dry air per cubic foot (lbda/ft\textsuperscript{3}) (1.201 kgda/m\textsuperscript{3}) at a barometric pressure of 1 atm (101 kPa) and an air temperature of 70°F (21°C). Rates shall be permitted to be adjusted for actual density.
3. The default occupant density shall be used where actual occupant density is not known.
4. Where the occupancy category for a proposed space or zone is not listed, the requirements for the listed occupancy category that is most similar in terms of occupant density, activities, and building construction shall be used.

**ITEM-SPECIFIC NOTES FOR TABLE 402.1**

a. For high school and college libraries, the values shown for “Public Assembly Spaces – Libraries” shall be used.
b. Rate may not be sufficient where stored materials include those having potentially harmful emissions.
c. Rate does not allow for humidity control. “Deck area” refers to the area surrounding the pool that is capable of being wetted during pool use or when the pool is occupied. Deck area that is not expected to be wetted shall be designated as an occupancy category.
d. Rate does not include special exhaust for stage effects such as dry ice vapors and smoke.
e. Where combustion equipment is intended to be used on the playing surface or in the space, additional dilution ventilation, source control, or both shall be provided.
f. Default occupancy for dwelling units shall be two persons for studio and one-bedroom units, with one additional person for each additional bedroom.
g. Air from one residential dwelling shall not be recirculated or transferred to other spaces outside of that dwelling.
h. Ventilation air for this occupancy category shall be permitted to be reduced to zero where the space is in occupied-stay mode.
i. The occupiable floor area in warehouses does not include the floor area of self-storage units, floor areas under rack storage, or designated palletized storage floor areas.
SUBSTANTIATION:
This proposal clarifies the application of Section 402.1, regarding required minimum outdoor ventilation airflow rates, in storage occupancies. The code is clear that storage rooms do not require ventilation, however, the code language is inconsistently applied when there are storage areas that are not separated from other areas by a solid partition. This code change intends to clarify that fixed storage areas that cannot change without a permit are no different in their fresh air requirements than a closed off storage room. Examples of such floor areas may include those dedicated to high-piled rack storage, self-storage facility units that are not fully partitioned off from interior corridors, and other floor areas that are designated solely for storage. By not considering the volume taken up by storage and the thermal mass it provides in helping with temperature regulation, HVAC equipment is oversized, increasing energy use and limiting the effectiveness of humidity control that properly-sized systems provide. By adding this footnote, the minimum outdoor airflow rates for occupiable space in storage occupancies can be properly calculated and consistently enforced.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as warehouses and storage rooms require ventilation and the floor area below storage spaces should be included in the area calculation.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 092
UMC 2024 Section: 402.1.2, Table 1701.1

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Revise text

402.0 Ventilation Air.
402.1 Occupiable Spaces.
402.1.2 Ventilation in Health Care Facilities. Mechanical ventilation for health care facilities shall be designed and installed in accordance with this code, and ASHRAE 170, and NFPA 99.

TABLE 1701.1
REFERENCE STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFPA 99-2021</td>
<td>Health Care Facilities Code</td>
<td>Miscellaneous</td>
<td>402.1.2</td>
</tr>
</tbody>
</table>

(ports of table not shown remain unchanged)

Note: NFPA 99 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
It is often difficult to get to the bottom of code-related issues in health care. One root problem is that there is a lot of overlap in the subjects governed by different codes. These codes are continually being updated, but by different individuals with varying interests, and on different update cycles. When it comes to health care facilities, in addition to keeping up-to-date with ASHRAE 170, it is important to understand the latest changes to NFPA 99 (Health Care Facilities Code).

Criteria for both ASHRAE 170 and NFPA 99 focuses on HVAC requirements for medical environments. Ventilation criteria addressed in ASHRAE 170 includes the need for an emergency power supply for continual ventilation, parameters for temperature and humidity ranges, air filtration, and air dispersal/removal locations. HVAC requirements designated by NFPA 99 mostly deal with the necessity to exhaust air from anesthetizing areas continually, while ASHRAE 170 addresses building pressure, air filtration, and infection control. Imaging rooms that house anesthetic gases must also meet the same stringent air change rate requirements as operating rooms.

Building pressure directly affects temperature, humidity, and airflow. HVAC systems must be designed and implemented in such a way as to ensure compliance with both NFPA 99 and ASHRAE 170 requirements. This requires deep level thought during the earliest design stages to arrive at viable solutions.

The design of medical spaces and facilities can offer many design challenges for both HVAC designers and facility owners. Ideally, health care facilities will exceed minimum requirements as laid out by NFPA 99, ASHRAE 170, and associated codes and manuals. By complying with both NFPA 99 and ASHRAE 170 requirements, HVAC system designers, engineers, installers, and maintenance personnel will support the integrity of such systems to maintain ongoing compliance.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
<table>
<thead>
<tr>
<th>TOTAL ELIGIBLE TO VOTE: 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOTING RESULTS:</td>
</tr>
<tr>
<td>AFFIRMATIVE: 29</td>
</tr>
<tr>
<td>NOT RETURNED: 1</td>
</tr>
<tr>
<td>Heine</td>
</tr>
</tbody>
</table>
402.1.3 Demand Control Ventilation (DCV). Each occupiable space shall be equipped with a carbon dioxide sensor in accordance with the requirements in Section 402.1.3.1 and Section 402.1.3.3. Mechanical equipment serving each zone(s) shall be equipped with controls in accordance with the requirements in Section 402.1.3.2.

402.1.3.1 Carbon Dioxide Sensor Performance Specifications. Carbon dioxide sensors installed in accordance with Section 402.1.3 shall comply with the following carbon dioxide measurement specifications as certified by the equipment manufacturer:

1. Range lower bound less than or equal to 400 parts per million.
2. Range upper bound greater than or equal to 2000 parts per million.
3. Accuracy within ±75 parts per million at a reading of 1000 parts per million.
4. Output resolution of 5 parts per million or less.

402.1.3.2 Mechanical System Controls. Controls installed in accordance with Section 402.1.3 shall comply with the following:

1. Receive data from the carbon dioxide sensor in the occupiable zone(s) at least once per 5 minutes.
2. Be calibrated to provide pre-established outdoor airflow rates, or be equipped with the necessary instrumentation to measure outdoor airflow.
3. Be capable of adjusting the outdoor airflow in response to an adjustable outdoor airflow setpoint.
4. Increase the amount of outdoor air provided to each occupiable zone until the carbon dioxide level in each occupiable zone falls below a maximum threshold as defined by the user.

402.1.3.3 Ventilation Rate Alarming. When carbon dioxide levels are above a maximum level as defined by the user, sensors installed in accordance with Section 402.1.3 shall alert the occupants with a visual and audible indication in the zone or through a building monitoring system.

402.1.3.3.1 Default Carbon Dioxide Threshold Level. The threshold level for carbon dioxide measurement above which triggers an alert in accordance with Section 402.1.3.3 shall be set to 1100 parts per million by default.

SUBSTANTIATION:
Several recently published studies (see [1] and [2] below) have demonstrated that a large portion of indoor occupied spaces to not meet minimum requirements for ventilation as set in ASHRAE Standard 62.1, and have documented the impacts on occupant health, comfort, and productivity. Additionally, providing adequate ventilation is the most effective first step in mitigating the transmission of viruses carried by airborne particulates, an issue that has been highlighted during the COVID-19 pandemic.

This proposal seeks to ensure building occupants have access to adequate ventilation by bringing Demand Control Ventilation (DCV) to each occupiable zone and managing carbon dioxide levels – the best proxy we have for determining inadequate ventilation and/or above-normal occupancy. The proposal requires that every occupiable zone have a basic CO2 sensor, that the CO2 sensor communicate with the building mechanical system, and that the mechanical system be capable of adjusting airflow rates to keep CO2 levels (and therefore ventilation adequacy) within acceptable levels. It also requires that the CO2 sensor notify either the occupants, or the building...
manager, when ventilation is inadequate. This can be especially helpful first step in helping building occupants understand when indoor may be at unhealthy levels and take mitigating action.

If successfully deployed, this proposal would go a long way toward maintaining adequate ventilation, as well as assist in saving energy by preventing over-ventilation of spaces.


COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed language needs additional work. The applicability for residential occupancies is unclear. Additional clarity to specify such distinctions is needed. For this reason, the proposed sections are being rejected. The TC suggests rework by the submitter and reintroducing as a public comment.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:
WISEMAN: We support DCV, but this proposal as written should not be a part of the minimum code.
Proposals

Item #: 094
UMC 2024 Section: 402.3, 402.3.1

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

402.0 Ventilation Air.

402.3 Mechanical Ventilation. Where natural ventilation is not permitted by this section or the building code, mechanical ventilation systems shall be designed, constructed, and installed to provide a method of supply air and either return air or exhaust air, or both, as required. Mechanical ventilation systems shall include controls, manual or automatic, that enable the fan system to operate wherever the spaces served are occupied. The system shall be designed to maintain minimum outdoor airflow as required by Section 403.0 under any load conditions.

402.3.1 Air Balancing. Air balancing shall be performed on mechanical ventilation systems in accordance with Section 314.0 to meet the ventilation airflow rates of this chapter.

(definitions shown for reference only)

314.0 Balancing.
314.1 General. Heating, ventilating, and air-conditioning systems (including hydronic systems) shall be balanced in accordance with one of the following methods:
(1) AABC National Standards for Total System Balance
(2) ACCA Manual B
(3) ASHRAE 111
(4) NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems
(5) SMACNA HVAC Systems Testing, Adjusting, and Balancing

SUBSTANTIATION:
An added reference for air balancing in Chapter 4 (Ventilation Air) is recommended to assist in enforcing the air balancing requirements found in Chapter 3 (General Regulations). The reference is a simple change that improves the code. Additionally, in a mechanical ventilation system, supply air is required, and either return air or exhaust air depending on the requirements for the space.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed language requires rework as the structuring is confusing and difficult to interpret. The additional language creates confusion and may be misinterpreted by the end user.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 095
UMC 2024  Section: 402.3.1 - 402.3.1.2

SUBMITTER: Mark Lessans
Johnson Controls

RECOMMENDATION:
Add new text

402.0 Ventilation Air.

402.3 Mechanical Ventilation. (remaining text unchanged)
402.3.1 Clean Air Delivery Capability. Each mechanical system shall comply with the requirements in Section 402.3.1.1. Each occupiable space shall comply with the requirements in Section 402.3.1.2.
Exception: Occupiable spaces where 100 percent of the supply air meets High-Efficiency Particulate Air (HEPA) filtration.

402.3.1.1 Airflow for Increased Filtration. Mechanical systems shall be sized to accommodate a design airflow at a total static pressure drop which assumes the utilization of a supply air filter with a Minimum Efficiency Reporting Value (MERV) of not less than 13.

402.3.1.2 Zonal Filtration or Disinfection Capability. Each occupiable space shall have 120-volt receptacles which provide at least 0.2 watts per square foot of occupiable space above the requirements of NFPA 70 to support supplemental air cleaning devices.
Exception: Rooms with less than 500 square feet (46.45 m²) of occupiable space shall not be required to comply with Section 402.3.1.2.

Note: NFPA 70 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
This proposal seeks to “ready” buildings for retrofits and other changes if indoor clean air delivery needs to be increased – such as in response to mitigating an airborne contaminant – per ASHRAE and CDC guidance on reopening buildings during the COVID-19 pandemic. If the mechanical system is not designed with a MERV 13 filter, it would at least be sized to accommodate the use of one later on without having to redesign or replace the system. This is important, as MERV 13 filters are often at the balance point between filtration effectiveness and energy efficiency. However, these filters are thicker and have a larger airflow resistance when compared to conventional filters, and often existing systems cannot accommodate them. This proposal also requires that occupiable spaces be equipped with the electrical infrastructure needed to increase clean air delivery at the zonal level, such as using a HEPA room air cleaning machine.

Taken together, these requirements will result in a modest increase in construction costs, but this cost pales in comparison to the burden of adding them post-construction.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is overly restrictive and lacks technical justification. The code is not based on future assumptions or costs. There was no substantiation provided for the exception of rooms with less than 500 square feet of occupiable space.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

WISEMAN: As written, this should not be part of the minimum code.
Proposals

Item #: 096
UMC 2024  Section: 402.4, 402.4.1, 502.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

402.0 Ventilation Air.

402.4 Outdoor Air Intake Protection. Required outdoor air intakes shall be covered with a corrosion-resistant screen or louver having not less than ¼ of an inch (6.4 mm) openings, and shall have not more than ½ of an inch (12.7 mm) openings.

402.4.1 Weather Protections. Outdoor air intakes that are part of the mechanical ventilation system shall be designed to manage rain entrainment, to prevent rain intrusion, and manage water from snow in accordance with ASHRAE 62.1.

502.0 Termination.
502.1 Exhaust Opening Protection. Exhaust openings terminating to the outdoors shall be covered with a corrosion-resistant screen or louver having not less than 1/4 of an inch (6.4 mm) openings, and shall have not more than 1/2 of an inch (12.7 mm) openings.

Exception: Clothes dryers.

SUBSTANTIATION:
This code change clarifies that either a screen or louver shall be used to cover exhaust openings to the outdoors. Additionally, the language in Section 402.4 (Outdoor Air Intake Protection) is being revised to correlate with Section 502.1 (Exhaust Opening Protection). Simple clean up.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

402.0 Ventilation Air.

402.4 Outdoor Air Intake Protection. Required outdoor air intakes shall be covered with a corrosion-resistant screen or louver having not less than ¼ of an inch (6.4 mm) openings, and shall have not more than ½ of an inch (12.7 mm) openings.

402.4.1 Weather Protection. Outdoor air intakes that are part of the mechanical ventilation system shall be designed to manage rain entrainment, to prevent rain intrusion, and manage water from snow in accordance with ASHRAE 62.1.

502.0 Termination.
502.1 Exhaust Opening Protection. Exhaust openings terminating to the outdoors shall be covered with a corrosion-resistant screen or louver having not less than 1/4 of an inch (6.4 mm) openings, and shall have not more than 1/2 of an inch (12.7 mm) openings.

Exception: Clothes dryers.

COMMITTEE STATEMENT:
The term "louver" is not necessary as a corrosion-resistant screen having not less than ¼ of an inch opening is sufficient. The modification will clarify the screen will need to be of the specified size and corrosion resistance.
<table>
<thead>
<tr>
<th>TOTAL ELIGIBLE TO VOTE: 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine</td>
</tr>
</tbody>
</table>
**403.10 Air Balance.** All mechanical ventilation systems shall be tested, balanced, and operated to demonstrate that the installation and performance of the systems are in accordance with the design intent. All testing and balancing shall be performed by a technician certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB). **Exception:** For single family residential, compliance with Section 403.10 shall not be required.

(below shown for reference only)

**E 802.1 Commissioning Requirements.** HVAC commissioning shall be included in the design and construction processes of the project to verify that the HVAC systems and components meet the owner’s project requirements and in accordance with this appendix. Commissioning shall be performed in accordance with this appendix by personnel trained and certified in commissioning by a nationally recognized organization. Commissioning requirements shall include the following:

1. Owner’s project requirements
2. Basis of design
3. Commissioning measures shown in the construction documents
4. Commissioning plan
5. Functional performance
6. Testing
7. Post construction documentation and training
8. Commissioning report
   
HVAC systems and components covered by this appendix as well as process equipment and controls, and renewable energy systems shall be included in the scope of the commissioning requirements.

**SUBSTANTIATION:**

Concerns over airborne transmission of pathogens and the benefits of proper ventilation have highlighted the need for verified adequate ventilation. Inadequate ventilation is a recognized and documented concern (See Supporting Material: CEC-500-2020-049). If the ventilation system is not tested, adjusted, and balanced by a skilled, trained, and certified technician the public has little assurance that the ventilation system conforms to design intent. The listed organizations have significant certification programs which ensure the certified technician, and associated contractors, have the knowledgebase and skillset to accurately perform the Air Balance. (See Supporting Material: TAB-Technical-Report-051220) Section E 802.1 (Commissioning Requirements) of the Uniform Mechanical Code set a precedent for similar requirements where an accurate verification of design intent is required.

[Supporting documentation provided in KAVI for TC review]

**COMMITTEE ACTION:** ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

**403.10 Air Balance.** All mechanical ventilation systems shall be tested, balanced, and operated to demonstrate that the installation and performance of the systems are in accordance with the design intent. All testing and balancing shall be
performed by a technician certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB), or other ANSI-accredited agencies. **Exception:** For single family residential, compliance with Section 403.10 shall not be required.

**COMMITTEE STATEMENT:**
Modifications have been made by the Technical Committee to add the language “or other ANSI-accredited agencies” to prevent overly restrictive language.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 26  NEGATIVE: 3  NOT RETURNED: 1  Heine

**EXPLANATION OF NEGATIVE:**
KOERBER: No data was provided to support this change.
WHITE: The proposal is an onerous requirement that is not necessary on ALL jobs. The proponent does hold out single family residential, but there are many similar forms of construction that do not have complex installations requiring this level of certification.
WISEMAN: This is overly restrictive. No proof was submitted that would justify such an onerous requirement.

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 097, Section 403.10 (Air Balance), UMC Item # 110, Section 504.3 (Domestic Range Hoods), and UMC Item # 161, Section 603.9.2 (Duct Leakage Tests) resulted in conflicting language within the code. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

**403.0 Ventilation Rates.**

**403.10 Air Balance.** All mechanical ventilation systems shall be tested, balanced, and operated to demonstrate that the installation and performance of the systems are in accordance with the design intent. All testing and balancing shall be performed by a technician certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), the Testing, Adjusting and Balancing Bureau (TABB), or other ANSI-accredited equivalent approved agencies. **Exception:** For single family residential, compliance with Section 403.10 shall not be required.

**TCC ACTION:** ACCEPT AS SUBMITTED

**TCC STATEMENT:**
The language in UMC Item # 097, Section 403.10 (Air Balance) modifies the phrase “or other ANSI accredited agencies” to “or other equivalent approved agencies” to comply with the ANSI Essential Requirements for referencing products or services. Additionally, UMC Item # 110, Section 504.3 (Domestic Range Hoods) and UMC Item # 161, Section 603.9.2 (Duct Leakage Tests) were modified to correlate with the updated UMC Item # 097 by adding the phrase "or other equivalent approved agencies."

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 403.10 by modifying the phrase "or other ANSI accredited agencies" to "or other equivalent approved agencies."
Proposals

Item #: 098

UMC 2024 Section: 403.7.2, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

403.0 Ventilation Rates.

403.7 Exhaust Ventilation. Exhaust airflow shall be provided in accordance with the requirements in Table 403.7. Exhaust makeup air shall be permitted to be a combination of outdoor air, recirculated air, and transfer air.

403.7.1 Parking Garages. Exhaust rate for parking garages shall be in accordance with Table 403.7. Exhaust rate shall not be required for enclosed parking garages having a floor area of 1000 square feet (92.9 m$^2$) or less and used for the storage of 5 or less vehicles.

403.7.2 Enclosed Parking Garages. Mechanical ventilation systems for enclosed parking garages shall operate continuously.

Exceptions:
(1) Mechanical ventilation systems shall be permitted to operate intermittently where the system is designed to operate automatically upon detection of vehicle operation or the presence of occupants by approved automatic detection devices.
(2) Approved automatic carbon monoxide sensing devices, and nitrogen dioxide detectors shall be permitted to modulate the ventilation system to not exceed a maximum average of 50 parts per million of carbon monoxide, or 1 part per million nitrogen dioxide during an eight-hour period with a concentration of not more than 200 parts per million for carbon monoxide, or 5 parts per million nitrogen dioxide, for a period not exceeding 15 minutes. Automatic sensing devices installed in modulated parking garage ventilation systems shall be approved in accordance with Section 301.2. Such sensing devices shall be listed and labeled in accordance with UL 2075 and shall be installed in accordance with the manufacturer’s installation instructions.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 2075-2013</td>
<td>Gas and Vapor Detectors and Sensors (with revisions through December 21, 2017)</td>
<td>Detectors, sensors</td>
<td>403.7.2</td>
</tr>
</tbody>
</table>

Note: UL 2075 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
UL 2075 is being added to this section as the standard provides requirements that apply to gas and vapor detectors and sensors.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There was nothing in the standard that specified nitrogen dioxide. There is also concern with the phrase “listed and labeled” in this section as it is not needed since the code already requires third party certification.
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 24  NEGATIVE: 5  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

BALLANCO: This change should have been accepted as submitted. The justification provided supports the change.

FEEHAN: The language and standards are necessary for safety.

MACNEVIN: I do not agree with the rationale for rejection of this item. UL 2075 appears to be an appropriate standard for this purpose. This should be accepted during Public Comment with the removal of "listed and labeled."

WHITE: The Committee action is wrong. The standard is acceptable. Disqualifying the proposal based on the "style" use of language is a poor excuse as well. Style can be easily amended or considered editorial to correct.

WISEMAN: UL 2075 is appropriate for this application. It should be accepted as written.
Proposals

Item #: 099

UMC 2024  Section: 403.7.3 - 403.7.3.3, 502.0, 502.3 - 502.3.3

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

403.7 Exhaust Ventilation.

403.7.3 Storage Rooms, Chemical. Mechanical exhaust ventilation for chemical storage rooms containing hazardous substances, including, but not limited to, chlorine, chloramines, and chlorine dioxide shall be in accordance with Section 403.7.3.1 through Section 403.7.3.3.

403.7.3.1 Exhaust Inlet Locations. Inlets to exhaust ducts shall be within 1 foot (305 mm) of the lowest point of the room for chemicals that are heavier than air and shall be within 1 foot (305 mm) of the highest point for chemicals that are lighter than air.

403.7.3.2 Discharge. The discharge of the exhaust air shall be to the outdoors.

403.7.3.3 Power to Exhaust Fans. Mechanical exhaust air fans shall be supplied with emergency backup power.

502.0 Exhaust Termination and Inlet Requirements.

502.3 Exhaust Inlet Locations. The inlet to an exhaust system shall be located in the area of heaviest concentration of contaminants and in accordance with Section 502.3.1 through Section 502.3.3.

502.3.1 Fuel-Dispensing Areas. The bottom of an air inlet or exhaust opening in fuel-dispensing areas shall be located not more than 18 inches (457 mm) above the floor.

502.3.2 Refrigeration Machinery Rooms. Inlet locations for refrigeration machinery rooms shall be in accordance with Section 1106.2.4.

502.3.3 Storage Rooms, Chemical. Inlet locations for chemical storage rooms shall be in accordance with Section 403.7.3.

(below shown for reference only)

1106.2.4 Ventilation. Mechanical ventilation referred to in Section 1106.2.3 shall be by one or more power-driven fans capable of exhausting air from the machinery room at not less than the amount shown in accordance with Section 1106.2.5.

To obtain a reduced airflow for normal ventilation, multiple fans or multispeed fans shall be used. Provision shall be made to supply makeup air to replace that being exhausted. Ducts for supply and exhaust to the machinery room shall serve no other area. The makeup air supply locations shall be positioned relative to the exhaust air locations to avoid short-circuiting. Inlets to the exhaust ducts shall be located in an area where refrigerant from a leak will concentrate, in consideration of the location of the replacement supply air paths, refrigerating machines, and the density of the refrigerant relative to air.

Inlets to exhaust ducts shall be within 1 foot (305 mm) of the lowest point of the machinery room for refrigerants that are heavier than air, and shall be within 1 foot (305 mm) of the highest point for refrigerants that are lighter than air. The discharge of the exhaust air shall be to the outdoors in such a manner as not to cause a nuisance or danger.

SUBSTANTIATION:
A new section for chemical storage rooms is being added to Chapter 4 (Ventilation Air) as the code is currently lacking in ventilation requirements for chemical storage rooms. Section 502.0 is also being revised with exhaust inlet location requirements.
COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There is no definition for "hazardous material" and the proposed requirements for chemical storage rooms may conflict with the fire code. The language should be rewritten to clarify the intent and resubmit as a public comment.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 100
UMC 2024 Section: 405.3.1, 405.4, 405.4.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

405.0 Indoor Air Quality for Residential Occupancies.

405.3 Bathroom Exhaust. A mechanical exhaust directly to the outdoors shall be provided in each room containing a bathtub, shower, or tub/shower combination. The fan shall run intermittently (on demand) or continuously. A readily accessible manual control designed to be operated as needed or an automatic control shall be provided for intermittent operations.

405.3.1 Exhaust Rate. The exhaust rate shall be not less than 50 ft\(^3\)/min (0.02 m\(^3\)/s) for intermittent operation and 20 to 25 ft\(^3\)/min (0.009 m\(^3\)/s) for continuous operation.

405.4 Kitchen Exhaust. A mechanical exhaust system that discharges directly to the outdoors shall be provided in each kitchen. The fan shall run intermittently (on demand) or continuously. A readily accessible manual control designed to be operated as needed or an automatic control shall be provided for intermittent operations.

Exception: Recirculating systems installed in accordance with Section 516.0 and the manufacturer's installation instructions.

405.4.1 Exhaust Rate. For intermittent-controlled operations, the exhaust rate shall be not less than 100 ft\(^3\)/min (0.047 m\(^3\)/s) for range hoods or 300 ft\(^3\)/min (0.141 m\(^3\)/s) for mechanical exhaust fans including downdraft appliances. For continuous operated ventilation, the exhaust rate shall be not less than 5 air changes per hour based on kitchen volume for enclosed kitchens 50 ft\(^3\)/min (0.02 m\(^3\)/s).

(below shown for reference only)

| TABLE 403.7 |
| MINIMUM EXHAUST RATES |
| [ASHRAE 62.1: TABLE 6.5] |

<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY(^8)</th>
<th>EXHAUST RATE (CFM/unit)</th>
<th>EXHAUST RATE (CFM/ft(^2))</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential – kitchens(^7)</td>
<td>50/100</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Toilets – private(^5, 9)</td>
<td>25/50</td>
<td>–</td>
<td>2</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

516.0 Recirculating Systems.

516.1 General Requirements. Recirculating systems containing or for use with appliances used in processes producing smoke or grease-laden vapors shall be equipped with components complying with the following:

1. The clearance requirements of Section 507.4 through Section 507.4.3.3.
2. A hood complying with the requirements of Section 508.0.
3. Grease removal devices complying with Section 509.0.
4. The air movement requirements of Section 511.2.1 and Section 511.2.2.
5. Auxiliary equipment (such as particulate and odor removal devices) complying with Section 512.0.
6. Fire-extinguishing equipment complying with the requirements of Section 513.0.
Exception: Fire-extinguishing equipment in accordance with Section 513.1 and Section 513.5.
(7) The use and maintenance requirements of Section 514.0.
(8) The minimum safety requirements of Section 515.0.
(9) All the requirements of Section 516.0. [NFPA 96:13.1]

SUBSTANTIATION:
The code currently allows recirculation systems to be used for kitchen exhaust in Section 516.0 (Recirculating Systems). This change adds an exception to Section 405.4 to clarify that a mechanical exhaust system that discharges directly to the outdoors is not required where a recirculation system in accordance with Section 516.0 is used.

Additionally, there are conflicting exhaust rates for residential kitchens and bathrooms between Table 403.7 and Sections 405.3.1 and 405.4.1. These sections need to be updated to correspond with Table 403.7 to remove the conflicting exhaust rates.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 101
UMC 2024  Section: 406.0, 406.1, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Add new text

406.0 Minimizing Transmission of Diseases and Viruses from Airborne Particles.
406.1 Ultraviolet Light (Lamp) Air Sterilization or Purification Systems. UV-C germicidal lamp systems installed in ductwork shall be listed and labeled in accordance with UL 1995 or UL 60335-2-40, and shall be installed in accordance with the manufacturer’s installation instructions. Germicidal equipment and systems installed in rooms or spaces shall be listed and labeled in accordance with UL 8802 and shall be installed in accordance with the manufacturer’s installation instructions.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 8802-2020</td>
<td>Outline of Investigation for Germicidal Systems</td>
<td>Air purification</td>
<td>406.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 1995 and UL 60335-2-40 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

Note: UL 8802 was not developed via an open process having a published development procedure in accordance with Section 3-3.7.1.2 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The need for requirements for air sterilization or purification systems to follow before, during, and after a pandemic has become increasingly apparent. The proposed code change provides requirements for UV light air sterilization or purification systems that can be applied to a building’s mechanical system to minimize transmission of diseases and viruses from airborne particles during a pandemic. UL 8802 has been specifically developed to address the associated risks and hazards for installation within rooms or spaces. Following manufacturer’s installation instructions are critical.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as UL 1995 does not mention air cleaning capabilities. There must be additional research conducted to determine which methods and standards are the most effective at promoting health and safety.

Furthermore, the title of both sections should be revised to prevent misuse of the provisional language. It is recommended by the Technical Committee that these provisions be reworked and brought back as public comment.
since the provided standards do aid in preventing the incorrect systems from being installed. There is also concern that these are not the only UV sterilization devices to be used within ducts.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  
AFFIRMATIVE: 27  
NEGATIVE: 2  
NOT RETURNED: 1  

Heine

EXPLANATION OF NEGATIVE:

KOERBER: Proposal should be accepted and the standards added to the code.

WHITE: These standards would be good additions to the code.
Proposals

Item #: 102

UMC 2024  Section: 406.0 - 406.2

SUBMITTER: Jay Egg
Egg Geothermal

RECOMMENDATION:
Add new text

406.0 Engineering Infection Controls.
406.1 General. The provisions of this section establish a means of reducing and minimizing transmission of diseases and viruses from airborne particles associated with building mechanical systems.

406.2 Heating, Ventilating, and Air-Conditioning Systems. The following engineering infection controls shall be accomplished for the heating, ventilation, and air-conditioning systems and equipment:

(1) Increase ventilation and exhaust rates to greater than the rates found in this chapter.
(2) Maintain continuous operated ventilation to increase air exchanges in the conditioned space to not less than 6 air changes per hour (ACH).
(3) Verify ventilation systems operation and acceptable indoor air quality meets criteria for the current occupancy level for each space.
(4) Disable demand-controlled ventilation (DCV) a minimum of 6 air changes per hour (ACH) and controlled by CO2 concentration controls where available.
(5) Open outdoor air dampers beyond minimum settings to reduce air recirculation - open enough to confirm at least 6 air changes per hour (ACH).
(6) Increase central air filtration to Minimum Efficiency Rating Value (MERV) of 13 or better.
(7) Inspect air filters to ensure they are within service life and appropriately installed.
(8) Install portable high-efficiency particulate air (HEPA) fan/filtration systems in higher risk areas.
(9) Install ultraviolet germicidal irradiation (UVGI) systems.

SUBSTANTIATION:
Protective ventilation practices can reduce the airborne concentration of viral particles, which reduces the overall viral dose to occupants. The proposed section is a list of ventilation practices based on CDC recommendations that can help reduce the concentration of virus particles in the air. While the list is intended to be universally applicable across indoor environments, applying them to different building types, occupancies, and activities under environmental and seasonal changes can be challenging. The specific combination of tools chosen for use at any point in time can change. It will be up to the building owner/operator to identify which tools are appropriate for each building throughout the year.

(4) and (5) According to both the W.H.O and the CDC as quoted in an article by Shelly Miller at the University of Colorado, Boulder.

(6) and (7) Trying to fit the more effective filters into old racks causes gaps and leaks that enable unfiltered air to recirculate.

(9) Although the science is sound, there are some health related concerns if the occupants are exposed to high-energy light, known as UV germicidal irradiation. In the 207- to 222-nm range has been demonstrated to be effective at inactivating airborne aerosolized viruses, while not causing harm to in vivo rodent and in vitro 3-D human skin models. More tests are being done.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
In Section 406.2, the phrase “shall be accomplished” is not clear in its intent. There is concern with requiring MERV 13 filters as they may not be applicable for smaller commercial applications. It is not clear as to what the specific application is. It may be misunderstood to be applicable to all HVAC units. There is not enough information on the
installation of UVGI systems. Some of the other provided language relates more to maintenance than installation of the listed systems.

The language is not clear as to what the intent is and needs clarification. As written, this may apply to residential occupancies which is overly stringent. The language should be revised for clarity and enforceability.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
507.2.6 **Used in Other Applications.** Cooking equipment used in fixed, mobile, or temporary concessions, such as trucks, buses, trailers, pavilions, tents, or any form of roofed enclosure, shall comply with this chapter. ([NFPA 96:4.1.9 1.1.3])

507.4.4 **Factory Built.** Factory-built grease duct enclosures shall be protected with a through-penetration firestop system classified in accordance with ASTM E814 or UL 1479 having an “F” and a “T” rating equal to the fire resistance rating of the assembly being penetrated from the point at which the duct penetrates a ceiling, wall, or floor to the outlet terminal. ([NFPA 96:4.3.3.4 4.3.4])

507.4.4.1 **Listing.** The factory-built grease duct protection system shall be listed in accordance with UL 2221. ([NFPA 96:4.3.3.1 4.3.4.1])

507.4.4.2 **Single Wall.** Listed single wall factory-built grease ducts shall be permitted to be enclosed with field-applied grease duct enclosure material where the material and the assembly of duct and material are listed for that application and installed in accordance with the grease duct manufacturer’s listing and their installation instructions. ([NFPA 96:4.3.3.2 4.3.4.2])

507.4.4.3 **Installation.** The factory-built grease duct protection system shall be installed in accordance with the manufacturer’s instructions and the listing requirements. ([NFPA 96:4.3.3.3 4.3.4.3])

507.4.5 **Field Applied.** Field-applied grease duct enclosures shall be protected with a through penetration firestop system classified in accordance with ASTM E814 or UL 1479 having an “F” and a “T” rating equal to the fire resistance rating of the assembly being penetrated. The surface of the field fabricated grease duct shall be continuously covered on all sides from the point at which the duct enclosure penetrates a ceiling, wall, or floor to the outlet terminal. The field-applied grease duct shall be listed in accordance with ASTM E2336 and installed in accordance with the manufacturer’s instructions and the listing requirements. ([NFPA 96:4.3.1–4.3.1.2 4.3.2-4.3.2.2])

507.4.6 **Both Field-Applied and Factory Built.** Field-applied grease duct enclosures and factory-built grease duct enclosures shall demonstrate that they provide mechanical and structural integrity, resiliency, and stability when subjected to expected building environmental conditions, duct movement under general operating conditions, and duct movement due to fire conditions. ([NFPA 96:4.3.4 4.3.5])

507.4.6.2 **Specification.** The specifications of material, gauge, and construction of the duct used in the testing and listing of field-applied grease duct enclosures and factory-built grease duct enclosures shall be included as minimum requirements in their listing and installation documentation. ([NFPA 96:4.3.5 4.3.6])

507.4.6.3 **Clearance Options.** The following clearance options for which field-applied grease duct enclosures and factory-built grease duct enclosures have been successfully evaluated shall be clearly identified in their listing and installation documentation and on their labels:

(1) Open combustible construction clearance at manufacturer’s requested dimensions.

(2) Closed combustible construction clearance at manufacturer’s requested dimensions, with or without specified ventilation.

(3) Rated shaft clearance at manufacturer’s requested dimensions, with or without specified ventilation. ([NFPA 96:4.3.6 4.3.7])

507.5 **Drawings.** For cooking operations in buildings, aA drawing(s) of the exhaust system installation along with copies of operating instructions for subassemblies and components used in the exhaust system, including electrical
schematics, shall be kept on the premises and made available on request to the Authority Having Jurisdiction and maintenance persons. [NFPA 96:4.6.4]

508.2 Listed Type I Hood Assemblies. Listed hood assemblies shall be installed in accordance with the terms of their listing and the manufacturer’s instructions. Listed hood assemblies shall be tested in accordance with UL 710, CAN/ULC-S646 for Canada, or equivalent. [NFPA 96:5.4.1, 5.4.2]

508.2.1 Listed Ultraviolet Hoods. Listed ultraviolet hoods shall be installed and maintained in accordance with the terms of their listing and the manufacturer’s instructions. Duct systems connected to ultraviolet hoods shall comply with Section 510.0. Ultraviolet hoods shall be tested and listed in accordance with UL 710 and UL-749G CAN/ULC-S646 for Canada. [NFPA 96:5.5 – 5.5.2]

509.1 Grease Removal Devices. Listed grease filters or other listed grease removal devices intended for use with commercial cooking operations shall be provided. Listed grease filters and grease removal devices that are removable but not an integral component of a specific listed exhaust hood shall be listed in accordance with UL 1046 or CAN/ULC-S649 for Canada and shall be designated on the filter. [NFPA 96:6.1.1, 6.1.2]

509.1.1 Grease Filters, Mesh-Type. Mesh filters shall not be used unless evaluated as an integral part of a listed exhaust hood or listed in conjunction with a primary filter in accordance with UL 1046 or CAN/ULC-S649 for Canada. [NFPA 96:6.1.3]

510.1.3 Duct Installation. All ducts shall be installed with a minimum 2 percent slope of ¼ inch per linear foot on horizontal runs up to 75 feet (22 860 mm) and a minimum 8 percent slope of 1 inch per linear foot on horizontal runs greater than 75 feet (22 860 mm). Factory-built grease ducts shall be permitted to be installed at a lesser slope in accordance with the listing and the manufacturer’s instructions. All horizontal ducts shall be provided with access in accordance with Section 510.3.3.

Drains shall be provided at low points in horizontal ducts. Where provided, drains shall be continuously welded to the exhaust duct or in accordance with the terms of the listing and the manufacturer’s installation manual.

All ducts shall be installed without forming dips or traps. In manifold (common duct) systems, the lowest end of the main duct shall be connected flush on the bottom with the branch duct. [NFPA 96:7.1.4 – 7.1.4.5, 7.1.5, 7.1.5.5]

510.1.4 Accessibility. Openings required for accessibility shall comply with Section 510.3 through Section 510.3.2. [NFPA 96:7.1.6]

510.1.5 Sign. A sign stating the following shall be placed on all access panels: ACCESS PANEL – DO NOT OBSTRUCT [NFPA 96:7.4.6, 7.1.7]

510.1.7 Type I Exhaust Duct Systems. Listed grease ducts shall be installed in accordance with the terms of their listing and the manufacturer’s instructions. [NFPA 96:7.1.7.1.8]

510.3.2 Access for Cleaning and Inspection. Exhaust fans with ductwork connected to both sides shall have access for cleaning and inspection within 3 feet (914 mm) of each side of the fan. Wall-mounted exhaust fans shall have access for cleaning and inspection within 3 feet (914 mm) of the exhaust fan. [NFPA 96:7.3.7, 7.3.8, 7.3.9]

510.4 Listed Grease Ducts. Listed grease ducts shall be installed in accordance with the terms of the listing and the manufacturer’s instructions. [NFPA 96:7.4.7, 7.1.8]

510.5.2 Factory-Built Grease Ducts. Factory-built grease ducts listed in accordance with UL 1978 or CAN/ULC-S662 for Canada shall be permitted to use materials in accordance with their listing. [NFPA 96:7.5.1.2]

510.5.3 Installation. All seams, joints, penetrations, and duct-to-hood collar connections shall have a liquid-tight continuous external weld. [NFPA 96:7.5.2.1]

Exceptions:
1. Factory-built grease ducts listed in accordance with UL 1978 or CAN/ULC-S662 for Canada shall be permitted to incorporate nonwelded joint construction in accordance with their listings. [NFPA 96:7.5.2.1.1]
2. Duct-to-hood collar connections as shown in Figure 510.5.3 shall not require a liquid-tight continuous external weld. [NFPA 96:7.5.2.2]

510.5.3.2 Welded Duct Connection. Acceptable duct-to-duct connection shall be as follows:
1. Telescoping joint, as shown in Figure 510.5.3.2(1).
2. Bell-type joint, as shown in Figure 510.5.3.2(2).
3. Flange with edge weld, as shown in Figure 510.5.3.2(3).
4. Flange with filled lap joint weld, as shown in Figure 510.5.3.2(4). [NFPA 96:7.5.5.1]

510.6 Exterior Installations. For cooking operations in buildings, the exterior portion of the ductwork shall be vertical wherever possible and shall be installed and supported on the exterior of a building. Bolts, screws, rivets, and other mechanical fasteners shall not penetrate duct walls. Clearance of ducts shall comply with Section 507.4 through Section 507.4.3.3. [NFPA 96:7.6.4 – 7.6.3, 7.6.1, 7.6.3, 7.6.4]
510.6.1 Weather Protection. All ducts shall be protected on the exterior by paint or other suitable weather-protective coating. Ducts constructed of stainless steel shall not be required to have additional paint or weather-protective coatings. Ductwork subject to corrosion shall have minimal contact with the building surface. [NFPA 96:7.6.4–7.6.6 7.6.5–7.6.7]

**FIGURE 510.5.3.2(4)**

**FLANGE WITH FILLED LAP JOINT WELD DUCT CONNECTION**

[NFPA 96: FIGURE 7.5.5.1(d)]

510.1 Rooftop Terminations. Rooftop terminations shall be arranged with or provided with the following:

1. A minimum of 10 feet (3048 mm) of horizontal clearance from the outlet to adjacent buildings, property lines, and air intakes.
2. A minimum of 5 feet (1524 mm) of horizontal clearance from the outlet (fan housing) to any combustible structure.
3. A vertical separation of 3 feet (914 mm) above any air intakes within 10 feet (3048 mm) of the exhaust outlet.
4. The ability to drain grease out of any traps or low points formed in the fan or duct near the termination of the system into a collection container that is noncombustible, closed, rainproof, and structurally sound for the service to which it is applied and that will not sustain combustion.
5. A grease collection device that is applied to exhaust systems that does not inhibit the performance of any fan.
6. Listed grease collection systems that are listed in accordance with UL 710A and meet the requirements of Section 510.9.1(4) and Section 510.9.1(5).
7. A listed grease duct complying with Section 507.4.7 or ductwork complying with Section 507.4.8.
8. A hinged upblast fan supplied with flexible weatherproof electrical cable and service hold-open retainer to permit inspection and cleaning that is listed for commercial cooking equipment with the following conditions:
   a. Where the fan attaches to the ductwork, the ductwork is a minimum of 18 inches (457 mm) away from any roof surface, as shown in Figure 510.9.1.
   b. The fan discharges a minimum of 40 inches (1016 mm) away from any roof surface, as shown in Figure 510.9.1.
9. Other approved fan, provided it meets all of the following criteria:
   a. The fan meets the requirements of Section 510.9.1(3) and Section 511.1.3.
   b. Its discharge or its extended duct discharge meets the requirements of Section 510.9.1(2). (See Section 511.1.3)
   c. Exhaust fan discharge is directed up and away from the roof surface. [NFPA 96:7.8.2.1]

511.1.3.2 Within the Building. Fans installed within the building shall be in accordance with the following:

1. Located in an accessible area of adequate size to allow for service or removal. [NFPA 96:8.1.4.2]
2. Flexible connectors shall not be used. [NFPA 96:8.1.4.5 8.1.4.6]
3. (a) The fan attaches to the ductwork, the ductwork is a minimum of 18 inches (457 mm) away from any roof surface, as shown in Figure 510.9.1.
   (b) The fan discharges a minimum of 40 inches (1016 mm) away from any roof surface, as shown in Figure 510.9.1.
9. Other approved fan, provided it meets all of the following criteria:
   a. The fan meets the requirements of Section 510.9.1(3) and Section 511.1.3.
   b. Its discharge or its extended duct discharge meets the requirements of Section 510.9.1(2). (See Section 511.1.3)
   c. Exhaust fan discharge is directed up and away from the roof surface. [NFPA 96:7.8.2.1]

511.1.3.3 Duct Systems. Where the duct system connected to the fan is in an enclosure, the space or room in which the exhaust fan is located shall have the same fire resistance rating as the enclosure. The fan shall be connected to the exhaust duct by flanges securely bolted as shown in Figure 511.1.2(1) through Figure 511.1.2(4) or by a system specifically listed for such use. [NFPA 96:8.1.4.3, 8.1.4.4 8.1.4.5]

511.2.3 Exhaust Fan Operation. A hood exhaust fan(s) shall continue to operate after the extinguishing system has been activated unless fan shutdown is required by a listed component of the ventilation system or by the design of the extinguishing system. The hood exhaust fan shall start upon activation of the extinguishing system if the exhaust fan and all cooking equipment served by the fan have been shut down, unless fan shutdown is required by a listed component of the ventilation system or by the listing of the extinguishing system. The exhaust fan shall be provided with a means so that the fan is activated when any heat-producing cooking appliance under the hood is turned on. [NFPA 96:8.2.3.1 – 8.2.3.3]

513.2.5.4 Activation. Where a separate fire-extinguishing system is used for protection of cooking equipment only, a water-wash fire-extinguishing system listed for protection of the grease removal device(s), hood exhaust plenum(s), exhaust duct(s), or combination thereof shall be provided with instructions and appropriate means for electrical interface for simultaneous activation. [NFPA 96:10.2.8.5]

513.2.5.5 Water-Wash System. A water-wash system approved to be used for protection of the grease removal device(s), hood exhaust plenum(s), exhaust duct(s), or combination thereof shall include instructions and appropriate electrical interface for simultaneous activation of the water-wash system from an automatic fire-extinguishing system, where the automatic fire-extinguishing system is used for cooking equipment protection only. [NFPA 96:10.2.8.6]

513.2.5.6 Exception. Where the automatic fire-extinguishing system in accordance with NFPA 17A provides protection for the hood and duct in a fixed baffle hood containing a water-wash system, the water-wash system shall be made inoperable or delayed for a minimum of 60 seconds upon operation of the automatic fire-extinguishing system. [NFPA 96:10.2.8.7]

513.4 Fuel and Electric Power Shutoff. Upon activation of any fire-extinguishing system for a cooking operation, all sources of fuel and electrical power that produce heat to all equipment requiring protection are listed in accordance with UL 710A and meet the requirements of Section 510.9.1(4) and Section 510.9.1(5).
513.4.2 Protection Not Required. Any gas appliances not requiring protection but located under the same ventilation equipment where protected appliances are located, shall also be automatically shut off upon activation of the extinguishing system. [NFPA 96:10.4.3]

513.4.3 Manual Reset. Shutoff devices shall require manual reset resetting prior to fuel or power being restored. [NFPA 96:10.4.4]

513.5 Manual Activation. All systems shall have both automatic and manual methods of actuation. At least one manual actuation device shall be located in a means of egress or at a location acceptable to the Authority Having Jurisdiction.

The manual actuation device shall clearly identify the hazard protected and be provided with instructions for its use. An automatic sprinkler system shall not require a method of manual actuation. [NFPA 96:10.5.1, 10.5.1.1, 10.5.1.2, 10.5.2]

513.6 System Annunciation. Upon activation of an automatic fire-extinguishing system, an audible alarm or visual indicator shall be provided to show that the system has been activated. [NFPA 96:10.6.1]

513.6.1 Signaling. Where a fire alarm signaling system is serving the occupancy where the extinguishing system is located, the activation of the automatic fire-extinguishing system shall activate the fire alarm signaling system in accordance with the requirements of NFPA 72. [NFPA 96:10.6.2]

514 Operating Procedures. Exhaust systems shall be operated whenever cooking equipment is turned on. [NFPA 96:4.4.4 12.1.1]

514.1 Filters. Filter-equipped exhaust systems shall not be operated with filters removed. [NFPA 96:4.4.4 12.1.2]

514.1.2 Openings. Openings provided for replacing air exhausted through ventilating equipment shall not be restricted by covers, dampers, or any other means that would reduce the operating efficiency of the exhaust system. [NFPA 96:4.4.4 12.1.3]

514.1.3 Posting of Instructions. Instructions for manually operating the fire-extinguishing system shall be posted conspicuously in the kitchen and shall be reviewed with employees by the management. [NFPA 96:4.4.4.3 12.1.4.3]

514.1.4 Listing and Manufacturer’s Instructions. Listed exhaust hoods shall be operated in accordance with the terms of their listings and the manufacturer’s instructions. [NFPA 96:4.4.5 12.1.5]

514.1.5 Nonoperational. Cooking equipment shall not be operated while its fire-extinguishing system or exhaust system is nonoperational or impaired. [NFPA 96:4.4.6 12.1.6]

514.1.6 Secondary Control Equipment. Secondary filtration and pollution control equipment shall be operated in accordance with the terms of its listing and the manufacturer’s recommendations. [NFPA 96:4.4.7 12.1.7]

514.1.7 Inspection Frequency. Inspection and maintenance of “other equipment” as allowed in Section 512.3 shall be conducted by properly trained and qualified persons at a frequency determined by the manufacturer’s instructions or the equipment listing. [NFPA 96:4.4.8 12.1.8]

514.2 Inspection, Testing, and Maintenance. Maintenance of the fire-extinguishing systems and listed exhaust hoods containing a constant or fire-activated water system that is listed to extinguish a fire in the grease removal devices, hood exhaust plenums, and exhaust ducts shall be made by properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction at least every 6 months. [NFPA 96:4.4.2 12.2.1]

514.2.1 Requirements. All actuation and control components, including remote manual pull stations, mechanical and electrical devices, detectors, and actuators, shall be tested for proper operation during the inspection in accordance with the manufacturer’s procedures. The specific inspection and maintenance requirements of the extinguishing system standards as well as the applicable installation and maintenance manuals for the listed system and service bulletins shall be followed. [NFPA 96:4.4.2.2, 4.4.2.3 12.2.2, 12.2.3]

514.2.2 Fusible Links and Sprinklers. Fusible links of the metal alloy type and automatic sprinklers of the metal alloy type shall be replaced at least semiannually. [NFPA 96:4.4.2.4 12.2.4]

514.2.3 Inspection Tag. The year of manufacture and the date of installation of the fusible links shall be marked on the system inspection tag. The tag shall be signed or initialed by the installer.

514.2.4 Temperature-Sensing Elements. Fixed temperature-sensing elements other than the fusible metal alloy type shall be permitted to remain continuously in service, provided they are inspected and cleaned, or replaced if necessary in accordance with the manufacturer’s instructions, every 12 months or more frequently to ensure proper operation of the system. [NFPA 96:4.4.2.7 12.2.7]

514.2.5 Certification. Where required, certificates of inspection and maintenance shall be forwarded to the Authority Having Jurisdiction. [NFPA 96:4.4.2.8 12.2.8]

514.3 Inspection for Grease Buildup. The entire exhaust system shall be inspected for grease buildup by a properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction and in accordance with Table 514.3. [NFPA 96:4.4.4 12.4]

514.3.1 Cleaning of Exhaust Systems. If, upon inspection, the exhaust system is found to be contaminated with deposits from grease-laden vapors, the contaminated portions of the exhaust system shall be cleaned by a properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction. [NFPA 96:4.6.4 12.6.1]

514.4 Measurement System. A measurement system of deposition shall be established to trigger a need to clean when the exhaust system is inspected at the frequencies in Table 514.3. [NFPA 96:4.6.4.4 12.6.1.1]
514.4.1.1 **Combustible Contaminants.** Hoods, grease removal devices, fans, ducts, and other appurtenances shall be cleaned to remove combustible contaminants to a minimum of 0.002 of an inch (50 µm). [NFPA 96:41.6.4.1.4 12.6.1.1.1]

514.4.1.2 **Gauge Comb.** A grease depth gauge comb as shown in Figure 514.4.1.2 shall be placed upon the surface to measure grease depth. [NFPA 96:41.6.1.2 12.6.1.1.2]

**FIGURE 514.4.1.2**
[NFPA 96: FIGURE 41.6.4.1.2 12.6.1.1.2]

514.4.1.3 **Cleaning Method.** Where a measured depth of 0.078 of an inch (2000 µm) is observed, the surfaces shall be cleaned in accordance with Section 514.4. [NFPA 96:41.6.1.4.3 12.6.1.1.3]

514.4.1.4 **Combustible Contaminants.** Where a measured depth of 0.125 of an inch (3175 µm) is observed in a fan housing, the surfaces shall be cleaned in accordance with Section 514.4. [NFPA 96:41.6.4.1.4 12.6.1.1.4]

514.4.2 **Removal of Contaminants.** Hoods, grease removal devices, fans, ducts, and other appurtenances shall be cleaned to remove combustible contaminants prior to surfaces becoming heavily contaminated with grease or oily sludge. [NFPA 96:41.6.2 12.6.2]

514.4.3 **Electrical Switches.** At the start of the cleaning process, electrical switches that could be activated accidentally shall be locked out. [NFPA 96:41.6.3 12.6.3]

514.4.4 **Fire Suppression System.** Components of the fire suppression system shall not be rendered inoperable during the cleaning process. [NFPA 96:41.6.4 12.6.4]

514.4.5 **Inoperable.** Fire-extinguishing systems shall be permitted to be rendered inoperable during the cleaning process where serviced by properly trained and qualified persons. [NFPA 96:41.6.5 12.6.5]

514.4.6 **Solvents/Cleaning Aids.** Flammable solvents or other flammable cleaning aids shall not be used. [NFPA 96:41.6.6 12.6.6]

514.4.7 **Cleaning Chemicals.** Cleaning chemicals shall not be applied on fusible links or other detection devices of the automatic extinguishing system. [NFPA 96:41.6.7 12.6.7]

514.4.8 **Coating.** After the exhaust system is cleaned, it shall not be coated with powder or other substance. [NFPA 96:41.6.8 12.6.8]

514.4.9 **Access Panels and Cover Plates.** When cleaning procedures are completed, all access panels (doors) and cover plates shall be restored to their normal operational condition. [NFPA 96:41.6.9 12.6.9]

514.4.10 **Date of Inspection.** When an access panel is removed, a service company label or tag preprinted with the name of the company and giving the date of inspection or cleaning shall be affixed near the affected access panels. [NFPA 96:41.6.10 12.6.10]

514.4.11 **Airflow.** Dampers and diffusers shall be positioned for proper airflow. [NFPA 96:41.6.11 12.6.11]

514.4.12 **Operable State.** When cleaning procedures are completed, all electrical switches and system components shall be returned to an operable state. [NFPA 96:41.6.12 12.6.12]

514.4.13 **Certification of Service.** When an exhaust system is inspected or cleaned, a certificate showing the name of the servicing company, the name of the person performing the work, and the date of inspection or cleaning shall be maintained on the premises. [NFPA 96:41.6.13 12.6.13]

514.4.14 **Report Provided.** After cleaning or inspection is completed, the exhaust cleaning company and the person performing the work at the location shall provide the owner of the system with a written report that also specifies areas that were inaccessible or not cleaned. [NFPA 96:41.6.14 12.6.14]

514.4.15 **Unclean Area.** Where required, certificates of inspection and cleaning and reports of areas not cleaned shall be submitted to the Authority Having Jurisdiction. [NFPA 96:41.6.15 12.6.15]

514.4.16 **Metal Containers.** Metal containers used to collect grease drippings shall be inspected or emptied at least weekly. [NFPA 96:41.6.16 12.6.16]

514.5 **Cooking Equipment Maintenance.** Inspection and servicing of the cooking equipment shall be made at least annually by properly trained and qualified persons. [NFPA 96:41.7.4 12.7.1]

514.5.1 **Cleaning.** Cooking equipment that collects grease below the surface, behind the equipment, or in cooking equipment flue gas exhaust, such as griddles, deep-fat fryers, or charbroilers, shall be inspected and, if found with grease accumulation, cleaned by a properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction. [NFPA 96:41.7.2 12.7.2]

515.1 **Cooking Equipment.** Cooking equipment shall be approved based on one of the following criteria:
(1) Listings by a testing laboratory.
(2) Test data acceptable to the Authority Having Jurisdiction. [NFPA 96:41.1.1 13.1.1]

515.1.1 **Installation.** All listed appliances shall be installed in accordance with the terms of their listings and the manufacturer’s instructions. Solid fuel used for flavoring within a gas-operated appliance shall be in a solid fuel holder (smoker box) that is listed with the equipment. [NFPA 96:41.2.1.4 13.1.2.1.1]

515.1.1.1 **Re-evaluation.** Cooking appliances requiring protection shall not be moved, modified, or rearranged without prior re-evaluation of the fire-extinguishing system by the system installer or servicing agent, unless otherwise allowed by the design of the fire-extinguishing system. A solid fuel holder shall not be added to an existing appliance until the fire-extinguishing system has been evaluated by the fire-extinguishing system service provider. [NFPA 96:41.2.2.2 13.1.2.2.1]
515.1.1.2 Prior Location. The fire-extinguishing system shall not require re-evaluation where the cooking appliances are moved for the purposes of maintenance and cleaning, provided the appliances are returned to approved design location prior to cooking operations, and any disconnected fire-extinguishing system nozzles attached to the appliances are reconnected in accordance with the manufacturer’s listed design manual. [NFPA 96:4.2.2-3 13.1.2.3]

515.1.1.3 Minimum Space. All deep-fat fryers shall be installed with at least a 16 inch (406 mm) space between the fryer and surface flames from adjacent cooking equipment. [NFPA 96:4.2.2-4 13.1.2.4]

515.1.1.4 Space Not Required. Where a steel or tempered glass baffle plate is installed at a minimum 8 inches (203 mm) in height between the fryer and surface flames of the adjacent appliance, the requirement for a 16 inch (406 mm) space shall not apply. [NFPA 96:4.2.2-5 13.1.2.5]

515.1.1.5 Minimum Height. If the fryer and the surface flames are at different horizontal planes, the minimum height of 8 inches (203 mm) shall be measured from the higher of the two. [NFPA 96:4.2.2-5.4 13.1.2.5.1]

515.2 Operating Controls. Deep-fat fryers shall be equipped with a separate high-limit control in addition to the adjustable operating control (thermostat) to shut off fuel or energy when the fat temperature reaches 475°F (246°C) at 1 inch (25.4 mm) below the surface. [NFPA 96:4.2.13.2]

516.1 General Requirements. Recirculating systems containing or for use with appliances used in processes producing smoke or grease-laden vapors shall be equipped with components complying with the following:

(1) The clearance requirements of Section 507.4 through Section 507.4.3.3.
(2) A hood complying with the requirements of Section 508.0.
(3) Grease removal devices complying with Section 509.0.
(4) The air movement requirements of Section 511.2.1 and Section 511.2.2.
(5) Auxiliary equipment (such as particulate and odor removal devices) complying with Section 512.0.
(6) Fire-extinguishing equipment complying with the requirements of Section 513.0.

Exception: Fire-extinguishing equipment in accordance with Section 513.1 and Section 513.5.

(7) The use and maintenance requirements of Section 514.0.
(8) The minimum safety requirements of Section 515.0.
(9) All the requirements of Section 516.0. [NFPA 96:14.1]

516.2 Design Restrictions. All recirculating systems shall comply with the requirements of Section 516.2.1 through Section 516.2.9. [NFPA 96:14.2]

516.2.1 Gas/Electrically Fueled Cooking Appliances. Only gas-fueled or electrically fueled cooking appliances shall be used. Listed gas-fueled equipment designed for use with specific recirculating systems shall have the flue outlets connected in the intended manner. Gas-fueled appliances shall have a minimum 18 inches (457 mm) clearance from the flue outlet to the filter inlet in accordance with Section 509.2.2 through Section 509.2.2.3 and shall meet the installation requirements of this code, NFPA 54 or NFPA 58. (NFPA 96:13.2.1-13.2.3 13.1.2.5.1)

516.2.2 Recirculation. Recirculating systems shall be listed with a testing laboratory in accordance with UL 710B or equivalent. [NFPA 96:13.2.4]

516.2.3 Protection. Cooking appliances that require protection and that are under a recirculating hood shall be protected by either the integral fire protection system in accordance with UL 710B or a system in accordance with Section 513.0. [NFPA 96:13.2.4.2]

516.2.4 Maximum Limits. A recirculating system shall not use cooking equipment that exceeds that recirculating system’s labeled maximum limits for that type of equipment, stated in maximum energy input, maximum cooking temperature, and maximum square area of cooking surface or cubic volume of cooking cavity. [NFPA 96:13.2.6]

516.2.5 Label. The listing label shall show the type(s) of cooking equipment tested and the maximum limits specified in Section 516.2.4. [NFPA 96:13.2.7]

516.2.6 Fire Damper. A fire-actuated damper shall be installed at the exhaust outlet of the system. [NFPA 96:13.2.8]

516.2.8 Power Supply. The power supply of any electrostatic precipitator (ESP) shall be of the “cold spark,” ferroresonant type in which the voltage falls off as the current draw of a short increases. [NFPA 96:13.2.11]

516.2.9 Listing Evaluation. Listing evaluation shall include the following:

(1) Capture and containment of vapors at published and labeled airflow.
(2) Grease discharge at the exhaust outlet of the system not to exceed an average of 2.9 E-09 (oz/in$^3$) (5.0 E-06 kg/m$^3$) of exhausted air sampled from that equipment at maximum amount of product that is capable of being processed over a continuous 8 hour test with the system operating at its minimum listed airflow.
(3) Listing and labeling of clearance to combustibles from all sides, top, and bottom.
(4) Electrical connection in the field in accordance with NFPA 70.
(5) Interlocks on all removable components that lie in the path of airflow within the unit to ensure that they are in place during operation of the cooking appliance. (NFPA 96:13.2.12)

516.3 Interlocks. The recirculating system shall be provided with interlocks of all critical components and operations as indicated in Section 516.3.1 through Section 516.3.3.1 such that, if any of these interlocks are interrupted, the cooking appliance will not be able to operate. [NFPA 96:13.3.1]
516.3.1 Airflow Sections. All closure panels encompassing airflow sections shall have interlocks to ensure that the panels are in place and fully sealed. [NFPA 96:43.3.2 14.3.2]

516.3.2 Filter Component. Each filter component (grease and odor) shall have an interlock to prove the component is in place. [NFPA 96:43.3.3 14.3.3]

516.3.3 ESP Interlocks. Each ESP shall have a sensor to prove its performance is as designed, with no interruption of the power to exceed 2 minutes. [NFPA 96:43.3.4.1 14.3.4.1]

516.3.3.1 Manual Reset. The sensor shall be a manual reset device or circuit. [NFPA 96:43.3.4.2 14.3.4.2]

516.3.4 Airflow Switch or Transducer. An airflow switch or transducer shall be provided after the last filter component to ensure that a minimum airflow is maintained. The airflow switch or transducer shall open the interlock circuit when the airflow falls 25 percent below the system’s normal operating flow or 10 percent below its listed minimum rating, whichever is lower. The airflow switch or transducer shall be a manual reset device or circuit. [NFPA 96:43.3.5.1–14.3.5.3 14.3.5.1–14.3.5.3]

516.4 Location and Application Restrictions. The location of recirculating systems shall be approved by the Authority Having Jurisdiction. Items to be reviewed in the fire risk assessment shall include, but not be limited to, life safety, combustibility of surroundings, proximity to air vents, and total fuel load. [NFPA 96:43.4.1–43.4.2 14.4.1–14.4.2]

516.5 Additional Fire Safety Requirements. In addition to the appliance nozzle(s), a recirculating system shall be listed with the appropriate fire protection for grease filters, grease filtration, odor filtration units, and ductwork, where applicable. [NFPA 96:43.5 14.5.1]

516.5.1 Installation Downstream. In addition to any other fire-extinguishing system activation device, there shall be a fire-extinguishing system activation device installed downstream of any ESP. [NFPA 96:14.5.2 14.5.2]

516.5.2 Locations. The requirements of Section 513.6 shall also apply to recirculating system locations. [NFPA 96:14.5.3 14.5.3]

516.6 Use and Maintenance. Automatic or manual covers on cooking appliances, especially fryers, shall not interfere with the application of the fire suppression system. [NFPA 96:14.6.1]

516.6.1 Manufacturer’s Instructions. All filters shall be cleaned or replaced in accordance with the manufacturer’s instructions. [NFPA 96:14.6.2 14.6.2]

516.6.2 Cleaning Schedule. All ESPs shall be cleaned a minimum of once per week and according to the manufacturer’s cleaning instructions. [NFPA 96:14.6.3 14.6.3]

516.6.3 Hood Plenum and Blower Section Cleaning Schedule. The entire hood plenum and the blower section shall be cleaned a minimum of once every 3 months. [NFPA 96:14.6.4 14.6.4]

516.6.4 Inspection of Safety Interlocks. Inspection and testing of the total operation and all safety interlocks in accordance with the manufacturer’s instructions shall be performed by qualified service personnel a minimum of once every 6 months or more frequently if required. [NFPA 96:14.6.5 14.6.5]

516.6.5 Inspection. Fire-extinguishing equipment shall be inspected in accordance with Section 514.2. [NFPA 96:14.6.6 14.6.6]

516.6.6 Maintenance Log. A signed and dated log of maintenance as performed in accordance with Section 516.6.3 and Section 516.6.4 shall be available on the premises for use by the Authority Having Jurisdiction. [NFPA 96:14.6.7 14.6.7]

517.1 Venting Application. Venting requirements of solid-fuel cooking operations shall be determined in accordance with Section 517.1 through Section 517.1.6. [NFPA 96:14.4 15.1]

517.1.2 System Compliance. Where the solid-fuel cooking equipment has a self-contained top, is the appliance to be vented in an isolated space (except for a single water heater with its own separate vent), has a separate makeup air system, and is provided with supply and return air (not supplied or returned from other spaces), the system shall comply with Section 517.4 and Section 517.6. [NFPA 96:14.4.2 15.1.2]

517.1.3 Makeup Air System. Where the solid-fuel cooking equipment is located in a space with other vented equipment, all vented equipment shall have an exhaust system interlocked with a makeup air system for the space per Section 517.6. [NFPA 96:14.4.3 15.1.4]

517.1.4 Natural Draft Ventilation Systems. Natural draft ventilation systems and power-exhausted ventilation systems shall comply with Section 517.3, Section 517.4, and Section 517.6. [NFPA 96:14.4.1 15.1.5]

517.1.5 Opening Requirements. Where a solid-fuel cooking appliance allows effluent to escape from the appliance opening, this opening shall be covered by a hood and an exhaust system that meets the requirements of Section 517.3, Section 517.4, and Section 517.6. [NFPA 96:14.4.5 15.1.6]

517.1.6 Spark Arresters. Solid-fuel cooking operations shall have spark arresters to minimize the passage of airborne sparks and embers into plenums and ducts. Where the solid-fuel cooking operation is not located under a hood, a spark arrester shall be provided to minimize the passage of sparks and embers into flues and chimneys. [NFPA 96:14.4.6, 14.4.7, 15.1.7, 15.1.8]

517.2 Location of Appliances. For cooking operations in buildings, every appliance shall be located with respect to building construction and other equipment so as to permit access to the appliance. [NFPA 96:14.2.1 15.2.1]

517.2.1 Prohibited Location. Solid-fuel cooking appliances shall not be installed in confined spaces. [NFPA 96:14.2.2 15.2.2]
517.2.2 Flammable Vapors. Solid-fuel cooking appliances shall not be installed in any location where gasoline or any other flammable vapors or gases are present. [NFPA 96:4.2.2 15.2.4]

517.3 Hoods for Solid-Fuel Cooking. Hoods shall be sized and located in a manner capable of capturing and containing all the effluent discharging from the appliances. The hood and its exhaust system shall comply with the requirements of Section 508.0 through Section 513.0. [NFPA 96:4.3.1–4.3.2, 15.3.1, 15.3.2]

517.3.1 Separation. Except as permitted in Section 517.3.1.1, exhaust systems serving solid-fuel cooking equipment in buildings, including gas or electrically operated equipment, shall be separate from all other exhaust systems. [NFPA 96:4.3.3–15.3.3] Exception: Cooking equipment not requiring automatic fire-extinguishing equipment (per Section 513.0) shall be permitted to be installed under a common hood with solid-fuel cooking equipment that is served by a duct system separate from all other exhaust systems. [NFPA 96:4.3.6–15.3.5]

517.3.1.1 Equipment with Solid Fuel for Flavoring. Gas-operated equipment utilizing solid fuel for flavoring that meets all the following conditions shall not be required to have a separate exhaust system:

1. The solid fuel holder (smoker box) shall be listed with the gas-operated equipment.
2. The solid fuel holder shall be located underneath the gas burners.
3. Spark arresters conforming with Section 517.1.6 shall be provided.
4. The maximum quantity of solid fuel consumed shall not exceed 1 pound (0.45 kg) per hour per 100 000 Btu/h (29 kW) of gas burner capacity.
5. The gas-operated equipment shall be protected by a fire suppression system listed for the equipment, including the solid fuel holder.
6. Gas-operated equipment with integral solid fuel holder(s) intended for flavoring, such as radiant charbroiler(s), shall comply simultaneously with the requirements of UL 300 that address the gas radiant charbroiler(s) and mesquite wood charbroiler(s).
7. A fire suppression system nozzle(s) shall be installed to protect the solid fuel holder.
8. The fire suppression system shall be designed and installed to protect the entire cooking operation.
9. Each solid fuel holder shall be limited to a size of 150 cubic inches (2.5 L), with no dimension to exceed 20 inches (508 mm).
10. A maximum of one solid fuel holder for each 100 000 Btu/h (29 kW), or portion thereof, of burner capacity shall be permitted.
11. Solid fuel shall be immersed in water for a continuous period of at least 24 hours immediately prior to being placed in the cooking equipment.
12. The inspection frequency shall be the same as for solid fuel cooking operations in Table 514.3. [NFPA 96:14.3.4 15.3.4]

517.4 Exhaust Systems for Solid-Fuel Cooking. Where a hood is not required, in buildings where the duct system is three stories or less in height, a duct complying with Section 510.0 shall be provided. [NFPA 96:4.4 15.4]

517.4.1 Hood. If a hood is used in buildings where the duct system is three stories or less in height, the duct system shall comply with Section 510.0. [NFPA 96:4.4.1 15.4.1]

517.4.2 Building Exceeding Four Stories. A listed or approved grease duct system that is four stories in height or greater shall be provided for solid-fuel cooking exhaust systems. [NFPA 96:4.4.2 15.4.2]

517.4.3 Prohibited. Wall terminations of solid-fuel exhaust systems shall be prohibited. [NFPA 96:4.4.4 15.4.4]

517.5 Grease Removal Devices for Solid-Fuel Cooking. Grease removal devices shall be constructed of steel or stainless steel or be approved for solid-fuel cooking. [NFPA 96:4.5.1 15.5.1]

517.5.1 Spark Arrester Devices. If airborne sparks and embers can be generated by the solid fuel cooking operation, spark arrester devices shall be used prior to using the grease removal device, to minimize the entrance of these sparks and embers into the grease removal device and into the hood and the duct system. [NFPA 96:4.5.2 15.5.2]

517.5.2 Filters. Filters shall be a minimum of 4 feet (1219 mm) above the appliance cooking surface. [NFPA 96:4.5.3 15.5.3]

517.6 Air Movement for Solid-Fuel Cooking. Exhaust system requirements shall comply with Section 511.0 for hooded operation or shall be installed in accordance with the manufacturer’s recommendations for unhooded applications. [NFPA 96:4.6.1 15.6.1]

517.6.1 Replacement Air. A replacement or makeup air system shall be provided to ensure a positive supply of replacement air at all times during cooking operations. [NFPA 96:4.6.2 15.6.2]

517.6.2 Operation. Makeup air systems serving solid-fuel cooking operations shall be interlocked with the exhaust air system and powered, if necessary, to prevent the space from attaining a negative pressure while the solid-fuel appliance is in operation. [NFPA 96:4.6.3 15.6.3]

517.7 Fire-Extinguishing Equipment for Solid-Fuel Cooking. Solid-fuel cooking appliances that produce grease-laden vapors shall be protected by listed fire-extinguishing equipment.
517.7.1 Grease Removal Devices, Hoods, and Duct Systems. Listed fire-extinguishing equipment shall be provided for the protection of grease removal devices, hoods, and duct systems. [NFPA 96:14.7.2 15.7.1, 15.7.2]

Exception: Where acceptable to the Authority Having Jurisdiction, solid-fuel cooking appliances constructed of solid masonry or reinforced Portland or refractory cement concrete and vented in accordance with NFPA 211 shall not require fixed automatic fire-extinguishing equipment. [NFPA 96:14.7.1, 14.7.2 15.7.1, 15.7.2]

517.7.2 Listed Fire-Extinguishing Equipment. Listed fire-extinguishing equipment for solid-fuel-burning cooking appliances, where required, shall comply with Section 513.0 and shall use water-based agents. [NFPA 96:14.7.6 15.7.5]

517.7.3 Rating and Design. Fire-extinguishing equipment shall be rated and designed to extinguish solid-fuel cooking fires. The fire-extinguishing equipment shall be of sufficient size to totally extinguish fire in the entire hazard area and prevent reignition of the fuel. [NFPA 96:14.7.6–14.7.7 15.7.6–15.7.7]

517.7.4 Listing/Class. All solid fuel appliances (whether under a hood or not) with fireboxes of 5 cubic feet (0.14 m³) volume or less shall have at least a listed 2-A rated water-spray fire extinguisher or a 1.6 gallon (6.1 L) wet chemical fire extinguisher listed for Class K fires in accordance with NFPA 10 with a maximum travel distance of 20 feet (6096 mm) to the appliance. [NFPA 96:14.7.4–14.7.7 15.7.4]

517.7.5 Fixed-Water Pipe System. Solid fuel appliances with fireboxes exceeding 5 cubic feet (0.14 m³) shall be provided with a fixed-water pipe system with a hose in the kitchen capable of reaching the firebox. The hose shall be equipped with an adjustable nozzle capable of producing a fine to medium spray or mist. The nozzle shall be of the type that cannot produce a straight stream. The system shall have a minimum operating pressure of 40 psi (276 kPa) and shall provide a minimum of 5 gallons per minute (gpm) (0.3 L/s). [NFPA 96:14.7.9.1–14.7.9.2 15.7.9.1–15.7.9.2]

517.7.6 Fuel Storage. All fuel storage areas for cooking operations in buildings shall be provided with a sprinkler system meeting the requirements of NFPA 13 except as permitted in accordance with the following:

1. Where acceptable to the Authority Having Jurisdiction, fuel storage areas shall be permitted to be protected with a fixed water pipe system with a hose capable of reaching all parts of the area.
2. In lieu of the sprinkler system outlined in Section 517.7.6, a listed 2-A rated water spray fire extinguisher or a 1.6 gallon (6.1 L) wet chemical fire extinguisher listed for Class K fires with a maximum travel distance of 20 feet (6096 mm) to the solid fuel piles shall be permitted to be used for a solid fuel pile, provided that the fuel pile does not exceed 5 cubic feet (0.14 m³) volume. [NFPA 96:14.9.2.6–14.9.2.8.2 15.9.2.6, 15.9.2.8.2, 15.9.2.8.3]

517.7.7 Auxiliary Fuel. In addition to the requirements of Section 517.7.4 through Section 517.8.3, where any solid-fuel cooking appliance is also served by any portion of a fire-extinguishing system complying with Section 513.0, such auxiliary fuel shall be shut off on actuation of the fire-extinguishing system. [NFPA 96:14.7.4–14.7.7 15.7.11]

517.8 Other Safety Requirements. Metal-fabricated solid-fuel cooking appliances shall be listed for the application where produced in practical quantities or shall be approved by the Authority Having Jurisdiction. Where listed, metal-fabricated solid fuel cooking appliances shall be installed in accordance with the terms of their listings and with the applicable requirements of this chapter. [NFPA 96:14.9.4.1, 14.9.4.2 15.9.4.1, 15.9.4.2]

517.8.1 Site-Built Solid Fuel Cooling Appliances. Site-built solid-fuel cooking appliances shall be submitted for approval to the Authority Having Jurisdiction before being considered for installation. All units submitted to the Authority Having Jurisdiction shall be installed, operated, and maintained in accordance with the approved terms of the manufacturer's instructions and any additional requirements set forth by the Authority Having Jurisdiction. [NFPA 96:14.9.4.3.1–14.9.4.3.2 15.9.4.3.1–15.9.4.3.2]

517.8.2 Additional Devices. Except for the spark arresters required in Section 517.1.6, there shall be no additional devices of any type in any portion of the appliance, flue pipe, and chimney of a natural draft solid-fuel operation. [NFPA 96:14.9.4.4 15.9.4.4]

517.8.3 Prohibited. No solid fuel cooking device of any type shall be permitted for deep fat frying involving more than 1 quart (qt) (1 L) of liquid shortening, nor shall any solid fuel cooking device be permitted within 3 feet (914 mm) of any deep fat frying unit. [NFPA 96:14.9.4.5–15.9.4.5]

518.1 General. Downdraft appliance ventilation system containing or for use with appliances used in processes producing smoke or grease-laden vapors shall be equipped with components complying with the following:

1. The clearance requirements of Section 507.4 through Section 507.4.3.3.
2. The primary collection means designed for collecting cooking vapors and residues complying with the requirements of Section 508.0.
3. Grease removal devices complying with Section 509.0.
4. Special-purpose filters as listed in accordance with UL 1046 or CAN/ULC-S649 for Canada.
5. Exhaust ducts complying with Section 510.0.
6. The air movement requirements of Section 511.2.1 and Section 511.2.2.
7. Auxiliary equipment (such as particulate and odor removal devices) complying with Section 512.0.
518.2 Ventilation System. The downdraft appliance ventilation system shall be capable of capturing and containing all the effluent discharge from the appliance(s) it is serving. [NFPA 96:16.1.2]

518.3 Fire-Extinguishing Equipment. For fire-extinguishing equipment on downdraft appliance ventilation systems, the following shall apply:

1. Cooking surface, duct, and plenum protection shall be provided.
2. At least one fusible link or heat detector shall be installed within each exhaust duct opening in accordance with the manufacturer’s listing.
3. A fusible link or heat detector shall be provided for each protected cooking appliance located in the plenum area of that appliance or in accordance with the extinguishing system manufacturer’s listing.
4. A manual activation device shall be provided as part of each appliance at a height acceptable to the Authority Having Jurisdiction.
5. Portable fire extinguishers shall be provided in accordance with Section 513.10 through Section 513.11. [NFPA 96:16.2]

518.3.1 Integral Fire-Extinguishing System. A listed downdraft appliance ventilation system employing an integral fire-extinguishing system including detection systems that has been evaluated for grease and smoke capture, fire extinguishing, and detection shall be considered as complying with Section 518.3. [NFPA 96:16.2.1]

518.3.2 Interlocks. The downdraft appliance ventilation system shall be provided with interlocks such that the cooking fuel supply will not be activated unless the exhaust and supply air systems have been activated. [NFPA 96:16.2.2]

518.4 Airflow Switch or Transducer. An airflow switch or transducer shall be provided after the last filter component to ensure that a minimum airflow is maintained. [NFPA 96:16.3.1]

518.4.1 Interlocks. The airflow switch or transducer shall open the interlock circuit when the airflow falls 25 percent below the system’s normal operating flow or less than 10 percent its listed minimum rating, whichever is lower. [NFPA 96:16.3.2]

518.4.2 Manual Reset. The airflow switch or transducer shall be a manual reset device or circuit. [NFPA 96:16.3.3]

518.5 Surface Materials. Any surface located directly above the cooking appliance shall be of noncombustible or limited-combustible materials. [NFPA 96:16.4]

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Note: The NFPA and UL standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
In accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines), Chapter 5 is being revised to the latest edition of NFPA 96-2021.

[Digital View for UL Standards: https://www.shopulstandards.com/Catalog.aspx]

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
507.2.6 Used in Other Applications. Cooking equipment used in fixed, mobile, or temporary concessions, such as trucks, buses, trailers, pavilions, tents, or any form of roofed enclosure, shall comply with this chapter. {NFPA 96:1.1.3}

507.4.4 Factory Built. Factory-built grease duct enclosures shall be protected with a through-penetration firestop system classified in accordance with ASTM E814 or UL 1479 having an “F” and a “T” rating equal to the fire resistance rating of the assembly being penetrated from the point at which the duct penetrates a ceiling, wall, or floor to the outlet terminal. {NFPA 96:4.3.4.4}

507.4.4.1 Listing. The factory-built grease duct protection system shall be listed in accordance with UL 2221. {NFPA 96:4.3.4.1}

507.4.4.2 Single Wall. Listed single wall factory-built grease ducts shall be permitted to be enclosed with field-applied grease duct enclosure material where the material and the assembly of duct and material are listed for that application and installed in accordance with the grease duct manufacturer’s listing and their installation instructions. {NFPA 96:4.3.4.2}

507.4.4.3 Installation. The factory-built grease duct protection system shall be installed in accordance with the manufacturer’s instructions and the listing requirements. {NFPA 96:4.3.4.3}

507.4.5 Field Applied. Field-applied grease duct enclosures shall be protected with a through penetration firestop system classified in accordance with ASTM E814 or UL 1479 having an “F” and a “T” rating equal to the fire resistance rating of the assembly being penetrated. The surface of the field fabricated grease duct shall be continuously covered on all sides from the point at which the duct enclosure penetrates a ceiling, wall, or floor to the outlet terminal. The field-applied grease duct shall be listed in accordance with ASTM E2336 and installed in accordance with the manufacturer’s instructions and the listing requirements. {NFPA 96:4.3.2-4.3.2.2}

507.4.6 Both Field-Applied and Factory Built. Field-applied grease duct enclosures and factory-built grease duct enclosures shall demonstrate that they provide mechanical and structural integrity, resiliency, and stability when subjected to expected building environmental conditions, duct movement under general operating conditions, and duct movement due to fire conditions. {NFPA 96:4.3.5}

507.4.6.2 Specification. The specifications of material, gauge, and construction of the duct used in the testing and listing of field-applied grease duct enclosures and factory-built grease duct enclosures shall be included as minimum requirements in their listing and installation documentation. {NFPA 96:4.3.6}

507.4.6.3 Clearance Options. The following clearance options for which field-applied grease duct enclosures and factory-built grease duct enclosures have been successfully evaluated shall be clearly identified in their listing and installation documentation and on their labels:

(1) Open combustible construction clearance at manufacturer’s requested dimensions.

(2) Closed combustible construction clearance at manufacturer’s requested dimensions, with or without specified ventilation.

(3) Rated shaft clearance at manufacturer’s requested dimensions, with or without specified ventilation. {NFPA 96:4.3.7}

507.5 Drawings. For cooking operations in buildings, a drawing(s) of the exhaust system installation along with copies of operating instructions for subassemblies and components used in the exhaust system, including electrical schematics, shall be kept on the premises and made available on request to the Authority Having Jurisdiction and maintenance persons. {NFPA 96:4.6.4}

508.2 Listed Type I Hood Assemblies. Listed hood assemblies shall be installed in accordance with the terms of their listing and the manufacturer’s instructions. Listed hood assemblies shall be tested in accordance with UL 710, CAN/ULC-S646 for Canada, or equivalent. {NFPA 96:5.4.1, 5.4.2}

508.2.1 Listed Ultraviolet Hoods. Listed ultraviolet hoods shall be installed and maintained in accordance with the terms of their listing and the manufacturer’s instructions. Duct systems connected to ultraviolet hoods shall comply with Section 510.0. Ultraviolet hoods shall be tested and listed in accordance with UL 710 and CAN/ULC-S646 for Canada. {NFPA 96:5.5 – 5.5.2}

509.1 Grease Removal Devices. Listed grease filters or other listed grease removal devices intended for use with commercial cooking operations shall be provided. Listed grease filters and grease removal devices that are removable but not an integral component of a specific listed exhaust hood shall be listed in accordance with UL 1046 and CAN/ULC-S649 for Canada and shall be designated on the filter. {NFPA 96:6.1.1, 6.1.2}

509.1.1 Grease Filters, Mesh-Type. Mesh filters shall not be used unless evaluated as an integral part of a listed exhaust hood or listed in conjunction with a primary filter in accordance with UL 1046 and CAN/ULC-S649 for Canada. {NFPA 96:6.1.3}

510.1.3 Duct Installation. All ducts shall be installed with a minimum slope of ¼ inch per linear foot on horizontal runs up to 75 feet (22 860 mm) and a minimum slope of 1 inch per linear foot on horizontal runs greater than 75 feet (22 860 mm). Factory-built grease ducts shall be permitted to be installed at a lesser slope in accordance with the listing and the manufacturer’s instructions. All horizontal ducts shall be provided with access in accordance with Section 510.3.3.
Drains shall be provided at low points in horizontal ducts. Where provided, drains shall be continuously welded to the exhaust duct or in accordance with the terms of the listing and the manufacturer’s installation manual.

All ducts shall be installed without forming dips or traps. In manifold (common duct) systems, the lowest end of the main duct shall be connected flush on the bottom with the branch duct. [NFPA 96:7.1.5-7.1.5.5]

510.1.4 Accessibility. Openings required for accessibility shall comply with Section 510.3 through Section 510.3.2. [NFPA 96:7.1.6]

510.1.5 Sign. A sign stating the following shall be placed on all access panels: ACCESS PANEL – DO NOT OBSTRUCT [NFPA 96:7.1.7]

510.1.7 Type I Exhaust Duct Systems. Listed grease ducts shall be installed in accordance with the terms of their listing and the manufacturer’s instructions. [NFPA 96:7.1.8]

510.3.2 Access for Cleaning and Inspection. Exhaust fans with ductwork connected to both sides shall have access for cleaning and inspection within 3 feet (914 mm) of each side of the fan. Wall-mounted exhaust fans shall have access for cleaning and inspection within 3 feet (914 mm) of the exhaust fan. [NFPA 96:7.3.8, 7.3.9]

510.4 Listed Grease Ducts. Listed grease ducts shall be installed in accordance with the terms of the listing and the manufacturer’s instructions. [NFPA 96:7.1.8]

510.5.2 Factory-Built Grease Ducts. Factory-built grease ducts listed in accordance with UL 1978 or CAN/ULC-S662 for Canada shall be permitted to use materials in accordance with their listing. [NFPA 96:7.5.1.2]

510.5.3 Installation. All seams, joints, penetrations, and duct-to-hood collar connections shall have a liquid-tight continuous external weld. [NFPA 96:7.5.2.1]

Exceptions:
(1) Factory-built grease ducts listed in accordance with UL 1978 or CAN/ULC-S662 for Canada shall be permitted to incorporate nonwelded joint construction in accordance with their listings. [NFPA 96:7.5.2.1.1]
(2) Duct-to-hood collar connections as shown in Figure 510.5.3 shall not require a liquidtight continuous external weld. [NFPA 96:7.5.2.2]

510.5.3.2 Welded Duct Connection. Acceptable duct-to-duct connection shall be as follows:
(1) Telescoping joint, as shown in Figure 510.5.3.2(1).
(2) Bell-type joint, as shown in Figure 510.5.3.2(2).
(3) Flange with edge weld, as shown in Figure 510.5.3.2(3).
(4) Flange with lap joint weld, as shown in Figure 510.5.3.2(4). [NFPA 96:7.5.5.1]

510.6 Exterior Installations. For cooking operations in buildings, the exterior portion of the ductwork shall be vertical wherever possible and shall be installed and supported on the exterior of a building. Bolts, screws, rivets, and other mechanical fasteners shall not penetrate duct walls. Clearance of ducts shall comply with Section 507.4 through Section 507.4.3.3. [NFPA 96:7.6.1, 7.6.3, 7.6.4]

510.6.1 Weather Protection. All ducts shall be protected on the exterior by paint or other suitable weather-protective coating. Ducts constructed of stainless steel shall not be required to have additional paint or weather-protective coatings. Ductwork subject to corrosion shall have minimal contact with the building surface. [NFPA 96:7.6.5-7.6.7]

FIGURE 510.5.3.2(4)
FLANGE WITH LAP JOINT WELD DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(d)]

510.9.1 Rooftop Terminations. Rooftop terminations shall be arranged with or provided with the following:
(1) A minimum of 10 feet (3048 mm) of horizontal clearance from the outlet to adjacent buildings, property lines, and air intakes.
(2) A minimum of 5 feet (1524 mm) of horizontal clearance from the outlet (fan housing) to any combustible structure.
(3) A vertical separation of 3 feet (914 mm) above any air intakes within 10 feet (3048 mm) of the exhaust outlet.
(4) The ability to drain grease out of any traps or low points formed in the fan or duct near the termination of the system into a collection container that is noncombustible, closed, rainproof, and structurally sound for the service to which it is applied and that will not sustain combustion.
(5) A grease collection device that is applied to exhaust systems that does not inhibit the performance of any fan.
(6) Grease collection systems that are listed in accordance with UL 710A and meet the requirements of Section 510.9.1(4) and Section 510.9.1(5).
(7) A listed grease duct complying with Section 507.4.7 or ductwork complying with Section 507.4.8.
(8) A hinged upblast fan supplied with flexible weatherproof electrical cable and service hold-open retainer to permit inspection and cleaning that is listed for commercial cooking equipment with the following conditions:
(a) Where the fan attaches to the ductwork, the ductwork is a minimum of 18 inches (457 mm) away from any roof surface, as shown in Figure 510.9.1.
(b) The fan discharges a minimum of 40 inches (1016 mm) away from any roof surface, as shown in Figure 510.9.1.
(9) Other approved fan, provided it meets all of the following criteria:
(a) The fan meets the requirements of Section 510.9.1(3) and Section 511.1.3.
(b) Its discharge or its extended duct discharge meets the requirements of Section 510.9.1(2). (See Section 511.1.3)
(c) Exhaust fan discharge is directed up and away from the roof surface. [NFPA 96:7.8.2.1]

511.1.3.2 Within the Building. Fans installed within the building shall be in accordance with the following:
(1) Located in an accessible area of adequate size to allow for service or removal. [NFPA 96:8.1.4.2]
(2) Flexible connectors shall not be used. [NFPA 96:8.1.4.6]
(3) Exhaust fans shall have a drain directed to a readily accessible and visible grease receptacle not to exceed 1 gallon (4 L). [NFPA 96:8.1.4.7]

511.1.3.3 Duct Systems. Where the duct system connected to the fan is in an enclosure, the space or room in which the exhaust fan is located shall have the same fire resistance rating as the enclosure. The fan shall be connected to the exhaust duct by flanges securely bolted as shown in Figure 511.1.2(1) through Figure 511.1.2(4) or by a system specifically listed for such use. [NFPA 96:8.1.4.3, 8.1.4.5]

511.2.3 Exhaust Fan Operation. A hood exhaust fan(s) shall continue to operate after the extinguishing system has been activated unless fan shutdown is required by a listed component of the ventilation system or by the design of the extinguishing system. The hood exhaust fan shall start upon actuation of the extinguishing system if the exhaust fan and all cooking equipment served by the fan have been shut down, unless fan shutdown is required by a listed component of the ventilation system or by the listing of the extinguishing system. The exhaust fan shall be provided with a means so that the fan is activated when any heat-producing cooking appliance under the hood is turned on. [NFPA 96:8.2.3.1 – 8.2.3.3]

513.2.5.4 Activation. Where a separate fire-extinguishing system is used for protection of cooking equipment only, a water-wash fire-extinguishing system listed for protection of the grease removal device(s), hood exhaust plenum(s), exhaust duct(s), or combination thereof shall be provided with instructions and appropriate means for electrical interface for simultaneous actuation. [NFPA 96:10.2.8.5]

513.2.5.5 Water-Wash System. A water-wash system approved to be used for protection of the grease removal device(s), hood exhaust plenum(s), exhaust duct(s), or combination thereof shall include instructions and appropriate electrical interface for simultaneous actuation of the water-wash system from an automatic fire-extinguishing system, where the automatic fire-extinguishing system is used for cooking equipment protection only. [NFPA 96:10.2.8.6]

513.2.5.6 Exception. Where the automatic fire-extinguishing system in accordance with NFPA 17A provides protection for the hood and duct in a hood containing a water-wash system, the water-wash system shall be made inoperable or delayed for a minimum of 60 seconds upon operation of the automatic fire-extinguishing system. [NFPA 96:10.2.8.7]

513.4 Fuel and Electric Power Shutoff. Upon actuation of any fire-extinguishing system for a cooking operation, all sources of fuel and electric power that produce heat to all equipment protected by the system shall automatically shut off. [NFPA 96:10.4.1]

513.4.2 Protection Not Required. Gas appliances not requiring protection but located under the same ventilation equipment where protected appliances are located, shall also be automatically shut off upon actuation of the extinguishing system. [NFPA 96:10.4.3]

513.4.3 Manual Reset. Shutoff devices shall require manual resetting prior to fuel or power being restored. [NFPA 96:10.4.4]

513.5 Manual Activation. All systems shall have both automatic and manual methods of actuation. At least one manual actuation device shall be located in a means of egress or at a location acceptable to the Authority Having Jurisdiction. The manual actuation device shall clearly identify the hazard protected and be provided with instructions for its use. An automatic sprinkler system shall not require a method of manual actuation. [NFPA 96:10.5.1, 10.5.1.1, 10.5.1.2, 10.5.2]

513.6 System Annunciation. Upon actuation of an automatic fire-extinguishing system, an audible alarm or visual indicator shall be provided to show that the system has actuated. [NFPA 96:10.6.1]

513.6.1 Signaling. Where a fire alarm signaling system is serving the occupancy where the extinguishing system is located, the actuation of the automatic fire-extinguishing system shall actuate the fire alarm signaling system in accordance with the requirements of NFPA 72. [NFPA 96:10.6.2]

514.1 Operating Procedures. Exhaust systems shall be operated whenever cooking equipment is turned on. [NFPA 96:12.1.1]

514.1.1 Filters. Filter-equipped exhaust systems shall not be operated with filters removed. [NFPA 96:12.1.2]

514.1.2 Openings. Openings provided for replacing air exhausted through ventilating equipment shall not be restricted by covers, dampers, or any other means that would reduce the operating efficiency of the exhaust system. [NFPA 96:12.1.3]

514.1.3 Posting of Instructions. Instructions for manually operating the fire-extinguishing system shall be posted conspicuously in the kitchen and shall be reviewed with employees by the management. [NFPA 96:12.1.4.3]

514.1.4 Listing and Manufacturer's Instructions. Listed exhaust hoods shall be operated in accordance with the terms of their listings and the manufacturer's instructions. [NFPA 96:12.1.5]
514.1.5 Nonoperational. Cooking equipment shall not be operated while its fire-extinguishing system or exhaust system is nonoperational or impaired. [NFPA 96:12.1.6]

514.1.6 Secondary Control Equipment. Secondary filtration and pollution control equipment shall be operated in accordance with the terms of its listing and the manufacturer's recommendations. [NFPA 96:12.1.7]

514.1.7 Inspection Frequency. Inspection and maintenance of "other equipment" as allowed in Section 512.3 shall be conducted by properly trained and qualified persons at a frequency determined by the manufacturer's instructions or the equipment listing. [NFPA 96:12.1.8]

514.2 Inspection, Testing, and Maintenance. Maintenance of the fire-extinguishing systems and listed exhaust hoods containing a constant or fire-activated water system that is listed to extinguish a fire in the grease removal devices, hood exhaust plenums, and exhaust ducts shall be made by properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction at least every 6 months. [NFPA 96:12.2.1]

514.2.1 Requirements. All actuation and control components, including remote manual pull stations, mechanical and electrical devices, detectors, and actuators, shall be tested for proper operation during the inspection in accordance with the manufacturer's procedures. The specific inspection and maintenance requirements of the extinguishing system standards as well as the applicable installation and maintenance manuals for the listed system and service bulletins shall be followed. [NFPA 96:12.2.2, 12.2.3]

514.2.2 Fusible Links and Sprinklers. Fusible links of the metal alloy type and automatic sprinklers of the metal alloy type shall be replaced at least semiannually. [NFPA 96:12.2.4]

514.2.3 Inspection Tag. The year of manufacture and the date of installation of the fusible links shall be marked on the system inspection tag. The tag shall be signed or initialed by the installer.

514.2.4 Temperature-Sensing Elements. Fixed temperature-sensing elements other than the fusible metal alloy type shall be permitted to remain continuously in service, provided they are inspected and cleaned, or replaced if necessary in accordance with the manufacturer's instructions, every 12 months or more frequently to ensure proper operation of the system. [NFPA 96:12.2.7]

514.2.5 Certification. Where required, certificates of inspection and maintenance shall be forwarded to the Authority Having Jurisdiction. [NFPA 96:12.2.8]

514.3 Inspection for Grease Buildup. The entire exhaust system shall be inspected for grease buildup by a properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction and in accordance with Table 514.3. [NFPA 96:12.4]

514.4 Cleaning of Exhaust Systems. If, upon inspection, the exhaust system is found to be contaminated with deposits from grease-laden vapors, the contaminated portions of the exhaust system shall be cleaned by a properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction. [NFPA 96:12.6.1]

514.4.1 Measurement System. A measurement system of deposition shall be established to trigger a need to clean when the exhaust system is inspected at the frequencies in Table 514.3. [NFPA 96:12.6.1.1]

514.4.1.1 Combustible Contaminants. Hoods, grease removal devices, fans, ducts, and other appurtenances shall be cleaned to remove combustible contaminants to a minimum of 0.002 of an inch (50 µm). [NFPA 96:12.6.1.1.1]

514.4.1.2 Gauge Comb. A grease depth gauge comb as shown in Figure 514.4.1.2 shall be placed upon the surface to measure grease depth. [NFPA 96:12.6.1.1.2]

FIGURE 514.4.1.2

514.4.1.3 Cleaning Method. Where a measured depth of 0.078 of an inch (2000 µm) is observed, the surfaces shall be cleaned in accordance with Section 514.4. [NFPA 96:12.6.1.1.3]

514.4.1.4 Combustible Contaminants. Where a measured depth of 0.125 of an inch (3175 µm) is observed in a fan housing, the surfaces shall be cleaned in accordance with Section 514.4. [NFPA 96:12.6.1.1.4]

514.4.2 Removal of Contaminants. Hoods, grease removal devices, fans, ducts, and other appurtenances shall be cleaned to remove combustible contaminants prior to surfaces becoming heavily contaminated with grease or oily sludge. [NFPA 96:12.6.2]

514.4.3 Electrical Switches. At the start of the cleaning process, electrical switches that could be activated accidentally shall be locked out. [NFPA 96:12.6.3]

514.4.4 Fire Suppression System. Components of the fire suppression system shall not be rendered inoperable during the cleaning process. [NFPA 96:12.6.4]

514.4.5 Inoperable. Fire-extinguishing systems shall be permitted to be rendered inoperable during the cleaning process where serviced by properly trained and qualified persons. [NFPA 96:12.6.5]

514.4.6 Solvents/Cleaning Aids. Flammable solvents or other flammable cleaning aids shall not be used. [NFPA 96:12.6.6]

514.4.7 Cleaning Chemicals. Cleaning chemicals shall not be applied on fusible links or other detection devices of the automatic extinguishing system. [NFPA 96:12.6.7]
514.4.8 Coating. After the exhaust system is cleaned, it shall not be coated with powder or other substance. [NFPA 96:12.6.8]

514.4.9 Access Panels and Cover Plates. When cleaning procedures are completed, all access panels (doors) and cover plates shall be restored to their normal operational condition. [NFPA 96:12.6.9]

514.4.10 Date of Inspection. When an access panel is removed, a service company label or tag preprinted with the name of the company and giving the date of inspection or cleaning shall be affixed near the affected access panels. [NFPA 96:12.6.10]

514.4.11 Airflow. Dampers and diffusers shall be positioned for proper airflow. [NFPA 96:12.6.11]

514.4.12 Operable State. When cleaning procedures are completed, all electrical switches and system components shall be returned to an operable state. [NFPA 96:12.6.12]

514.4.13 Certification of Service. When an exhaust system is inspected or cleaned, a certificate showing the name of the servicing company, the name of the person performing the work, and the date of inspection or cleaning shall be maintained on the premises. [NFPA 96:12.6.13]

514.4.14 Report Provided. After cleaning or inspection is completed, the exhaust cleaning company and the person performing the work at the location shall provide the owner of the system with a written report that also specifies areas that were inaccessible or not cleaned. [NFPA 96:12.6.14]

514.4.15 Unclean Area. Where required, certificates of inspection and cleaning and reports of areas not cleaned shall be submitted to the Authority Having Jurisdiction. [NFPA 96:12.6.15]

514.4.16 Metal Containers. Metal containers used to collect grease drippings shall be inspected or emptied at least weekly. [NFPA 96:12.6.16]

514.5 Cooking Equipment Maintenance. Inspection and servicing of the cooking equipment shall be made at least annually by properly trained and qualified persons. [NFPA 96:12.7.1]

514.5.1 Cleaning. Cooking equipment that collects grease below the surface, behind the equipment, or in cooking equipment flue gas exhaust, such as griddles, deep-fat fryers, or charbroilers, shall be inspected and, if found with grease accumulation, cleaned by a properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction. [NFPA 96:12.7.2]

515.1 Cooking Equipment. Cooking equipment shall be approved based on one of the following criteria:
(1) Listings by a testing laboratory. [NFPA 96:13.1.1]
(2) Test data acceptable to the Authority Having Jurisdiction. [NFPA 96:13.1.1]

515.1.1 Installation. All listed appliances shall be installed in accordance with the terms of their listings and the manufacturer's instructions. Solid fuel used for flavoring within a gas-operated appliance shall be in a solid fuel holder (smoker box) that is listed with the equipment. [NFPA 96:13.1.2.1, 13.1.2.1.1]

515.1.1.1 Re-evaluation. Cooking appliances requiring protection shall not be moved, modified, or rearranged without prior re-evaluation of the fire-extinguishing system by the system installer or servicing agent, unless otherwise allowed by the design of the fire-extinguishing system. A solid fuel holder shall not be added to an existing appliance until the fire-extinguishing system has been evaluated by the fire-extinguishing system service provider. [NFPA 96:13.1.2.2, 13.1.2.2.1]

515.1.1.2 Prior Location. The fire-extinguishing system shall not require re-evaluation where the cooking appliances are moved for the purposes of maintenance and cleaning, provided the appliances are returned to approved design location prior to cooking operations, and any disconnected fire-extinguishing system nozzles attached to the appliances are reconnected in accordance with the manufacturer's listed design manual. [NFPA 96:13.1.2.3]

515.1.1.3 Minimum Space. All deep-fat fryers shall be installed with at least a 16 inch (406 mm) space between the fryer and surface flames from adjacent cooking equipment. [NFPA 96:13.1.2.4]

515.1.1.4 Space Not Required. Where a steel or tempered glass baffle plate is installed at a minimum 8 inches (203 mm) in height between the fryer and surface flames of the adjacent appliance, the requirement for a 16 inch (406 mm) space shall not apply. [NFPA 96:13.1.2.5]

515.1.1.5 Minimum Height. If the fryer and the surface flames are at different horizontal planes, the minimum height of 8 inches (203 mm) shall be measured from the higher of the two. [NFPA 96:13.1.2.5.1]

515.2 Operating Controls. Deep-fat fryers shall be equipped with a separate high-limit control in addition to the adjustable operating control (thermostat) to shut off fuel or energy when the fat temperature reaches 475°F (246°C) at 1 inch (25.4 mm) below the surface. [NFPA 96:13.2]

516.1 General Requirements. Recirculating systems containing or for use with appliances used in processes producing smoke or grease-laden vapors shall be equipped with components complying with the following:
(1) The clearance requirements of Section 507.4 through Section 507.4.3.3.
(2) A hood complying with the requirements of Section 508.0.
(3) Grease removal devices complying with Section 509.0.
(4) The air movement requirements of Section 511.2.1 and Section 511.2.2.
(5) Auxiliary equipment (such as particulate and odor removal devices) complying with Section 512.0.
(6) Fire-extinguishing equipment complying with the requirements of Section 513.0.

Exception: Fire-extinguishing equipment in accordance with Section 513.1 and Section 513.5.
516.2 Design Restrictions. All recirculating systems shall comply with the requirements of Section 516.2.1 through Section 516.2.9. [NFPA 96:14.1]

516.2.1 Gas/Electrically Fueled Cooking Appliances. Only gas-fueled or electrically fueled cooking appliances shall be used. Listed gas-fueled equipment designed for use with specific recirculating systems shall have the flue outlets connected in the intended manner. Gas-fueled appliances shall have a minimum 18 inches (457 mm) clearance from the flue outlet to the filter inlet in accordance with Section 509.2.2 through Section 509.2.2.3 and shall meet the installation requirements of this code, NFPA 54 or NFPA 58. [NFPA 96:14.2.1-14.2.3]

516.2.2 Recirculation. Recirculating systems shall be listed with a testing laboratory in accordance with UL 710B or equivalent. [NFPA 96:14.2.4]

516.2.3 Protection. Cooking appliances that require protection and that are under a recirculating hood shall be protected by either the integral fire protection system in accordance with UL 710B or a system in accordance with Section 513.0. [NFPA 96:14.2.4.2]

516.2.4 Maximum Limits. A recirculating system shall not use cooking equipment that exceeds that recirculating system’s labeled maximum limits for that type of equipment, stated in maximum energy input, maximum cooking temperature, and maximum square area of cooking surface or cubic volume of cooking cavity. [NFPA 96:14.2.6]

516.2.5 Label. The listing label shall show the type(s) of cooking equipment tested and the maximum limits specified in Section 516.2.4. [NFPA 96:14.2.7]

516.2.6 Fire Damper. A fire-actuated damper shall be installed at the exhaust outlet of the system. [NFPA 96:14.2.8]

516.2.8 Power Supply. The power supply of any electrostatic precipitator (ESP) shall be of the “cold spark,” ferroresonant type in which the voltage falls off as the current draw of a short increases. [NFPA 96:14.2.11]

516.2.9 Listing Evaluation. Listing evaluation shall include the following:

(1) Capture and containment of vapors at published and labeled airflows.

(2) Grease discharge at the exhaust outlet of the system not to exceed an average of 2.9 E-09 (oz/in³) (5.0 E-06 kg/m³) of exhausted air sampled from that equipment at maximum amount of product that is capable of being processed over a continuous 8 hour test with the system operating at its minimum listed airflow.

(3) Listing and labeling of clearance to combustibles from all sides, top, and bottom.

(4) Electrical connection in the field in accordance with NFPA 70.

(5) Interlocks on all removable components that lie in the path of airflow within the unit to ensure that they are in place during operation of the cooking appliance. [NFPA 96:14.2.12]

516.3 Interlocks. The recirculating system shall be provided with interlocks of all critical components and operations as indicated in Section 516.3.1 through Section 516.3.3.1 such that, if any of these interlocks are interrupted, the cooking appliance will not be able to operate. [NFPA 96:14.3.1]

516.3.1 Airflow Sections. All closure panels encompassing airflow sections shall have interlocks to ensure that the panels are in place and fully sealed. [NFPA 96:14.3.2]

516.3.2 Filter Component. Each filter component (grease and odor) shall have an interlock to prove the component is in place. [NFPA 96:14.3.3]

516.3.3 ESP Interlocks. Each ESP shall have a sensor to prove its performance is as designed, with no interruption of the power to exceed 2 minutes. [NFPA 96:14.3.4.1]

516.3.4 Airflow Switch or Transducer. An airflow switch or transducer shall be provided after the last filter component to ensure that a minimum airflow is maintained. The airflow switch or transducer shall open the interlock circuit when the airflow falls 25 percent below the system’s normal operating flow or 10 percent below its listed minimum rating, whichever is lower. The airflow switch or transducer shall be a manual reset device or circuit. [NFPA 96:14.3.5.1-14.3.5.3]

516.4 Location and Application Restrictions. The location of recirculating systems shall be approved by the Authority Having Jurisdiction. Items to be reviewed in the fire risk assessment shall include, but not be limited to, life safety, combustibility of surroundings, proximity to air vents, and total fuel load. [NFPA 96:14.4.1-14.4.2]

516.5 Additional Fire Safety Requirements. In addition to the appliance nozzle(s), a recirculating system shall be listed with the appropriate fire protection for grease filters, grease filtration, odor filtration units, and ductwork, where applicable. [NFPA 96:14.5.1]

516.6 Installation Downstream. In addition to any other fire-extinguishing system actuation device, there shall be a fire-extinguishing system actuation device installed downstream of any ESP. [NFPA 96:14.5.2]

516.6.1 Manufacturer’s Instructions. All filters shall be cleaned or replaced in accordance with the manufacturer’s instructions. [NFPA 96:14.6.2]
516.6.2 Cleaning Schedule. All ESPs shall be cleaned a minimum of once per week and according to the manufacturer’s cleaning instructions. [NFPA 96:14.6.3]

516.6.3 Hood Plenum and Blower Section Cleaning Schedule. The entire hood plenum and the blower section shall be cleaned a minimum of once every 3 months. [NFPA 96:14.6.4]

516.6.4 Inspection of Safety Interlocks. Inspection and testing of the total operation and all safety interlocks in accordance with the manufacturer’s instructions shall be performed by qualified service personnel a minimum of once every 6 months or more frequently if required. [NFPA 96:14.6.5]

516.6.5 Inspection. Fire-extinguishing equipment shall be inspected in accordance with Section 514.2. [NFPA 96:14.6.6]

516.6.6 Maintenance Log. A signed and dated log of maintenance as performed in accordance with Section 516.6.3 and Section 516.6.4 shall be available on the premises for use by the Authority Having Jurisdiction. [NFPA 96:14.6.7]

517.1 Venting Application. Venting requirements of solid-fuel cooking operations shall be determined in accordance with Section 517.1.1 through Section 517.1.6. [NFPA 96:15.1]

517.1.2 System Compliance. Where the solid-fuel cooking equipment has a self-contained top, is the appliance to be vented in an isolated space (except for a single water heater with its own separate vent), has a separate makeup air system, and is provided with supply and return air (not supplied or returned from other spaces), the system shall comply with Section 517.4 and Section 517.6. [NFPA 96:15.1.2]

517.1.3 Makeup Air System. Where the solid-fuel cooking equipment is located in a space with other vented equipment, all vented equipment shall have an exhaust system interlocked with a makeup air system for the space per Section 517.6. [NFPA 96:15.1.4]

517.1.4 Natural Draft Ventilation Systems. Natural draft ventilation systems and power-exhausted ventilation systems shall comply with Section 517.3, Section 517.4, and Section 517.6. [NFPA 96:15.1.5]

517.1.5 Opening Requirements. Where a solid-fuel cooking appliance allows effluent to escape from the appliance opening, this opening shall be covered by a hood and an exhaust system that meets the requirements of Section 517.3, Section 517.4, and Section 517.6. [NFPA 96:15.1.6]

517.1.6 Spark Arresters. Solid-fuel cooking operations shall have spark arresters to minimize the passage of airborne sparks and embers into plenums and ducts. Where the solid-fuel cooking operation is not located under a hood, a spark arrester shall be provided to minimize the passage of sparks and embers into flues and chimneys. [NFPA 96:15.1.7, 15.1.8]

517.2 Location of Appliances. For cooking operations in buildings, every appliance shall be located with respect to building construction and other equipment so as to permit access to the appliance. [NFPA 96:15.2.1]

517.2.1 Prohibited Location. Solid-fuel cooking appliances shall not be installed in confined spaces. [NFPA 96:15.2.2]

Exception: Solid-fuel cooking appliances listed for installation in confined spaces such as alcoves shall be installed in accordance with the terms of the listing and the manufacturer’s instructions. [NFPA 96:15.2.3]

517.2.2 Flammable Vapors. Solid-fuel cooking appliances shall not be installed in any location where gasoline or any other flammable vapors or gases are present. [NFPA 96:15.2.4]

517.3 Hoods for Solid-Fuel Cooking. Hoods shall be sized and located in a manner capable of capturing and containing all the effluent discharging from the appliances. The hood and its exhaust system shall comply with the requirements of Section 508.0 through Section 513.0. [NFPA 96:15.3.1, 15.3.2]

517.3.1 Separation. Except as permitted in Section 517.3.1.1, exhaust systems serving solid-fuel cooking equipment in buildings, including gas or electrically operated equipment, shall be separate from all other exhaust systems. [NFPA 96:15.3.3]

Exception: Cooking equipment not requiring automatic fire-extinguishing equipment (per Section 513.0) shall be permitted to be installed under a common hood with solid-fuel cooking equipment that is served by a duct system separate from all other exhaust systems. [NFPA 96:15.3.5]

517.3.1.1 Equipment with Solid Fuel for Flavoring. Gas-operated equipment utilizing solid fuel for flavoring that meets all the following conditions shall not be required to have a separate exhaust system:

1. The solid fuel holder (smoker box) shall be listed with the gas-operated equipment.
2. The solid fuel holder shall be located underneath the gas burners.
3. Spark arresters conforming with Section 517.1.6 shall be provided.
4. The maximum quantity of solid fuel consumed shall not exceed 1 pound (0.45 kg) per hour per 100 000 Btu/h (29 kW) of gas burner capacity.
5. The gas-operated equipment shall be protected by a fire suppression system listed for the equipment, including the solid fuel holder.
6. Gas-operated equipment with integral solid fuel holder(s) intended for flavoring, such as radiant charbroiler(s), shall comply simultaneously with the requirements of UL 300 that address the gas radiant charbroiler(s) and mesquite wood charbroiler(s).
7. A fire suppression system nozzle(s) shall be installed to protect the solid fuel holder.
8. The fire suppression system shall be designed and installed to protect the entire cooking operation.
9. Each solid fuel holder shall be limited to a size of 150 cubic inches (2.5 L), with no dimension to exceed 20 inches (508 mm).

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(10) A maximum of one solid fuel holder for each 100,000 Btu/h (29 kW), or portion thereof, of burner capacity shall be permitted.

(11) Solid fuel shall be immersed in water for a continuous period of at least 24 hours immediately prior to being placed in the cooking equipment.

(12) The inspection frequency shall be the same as for solid fuel cooking operations in Table 514.3. [NFPA 96:15.3.4]

517.4 Exhaust Systems for Solid-Fuel Cooking. Where a hood is not required, in buildings where the duct system is three stories or less in height, a duct complying with Section 510.0 shall be provided. [NFPA 96:15.4]

517.4.1 Hood. If a hood is used in buildings where the duct system is three stories or less in height, the duct system shall comply with Section 510.0. [NFPA 96:15.4.1]

517.4.2 Building Exceeding Four Stories. A listed or approved grease duct system that is four stories in height or greater shall be provided for solid-fuel cooking exhaust systems. [NFPA 96:15.4.2]

517.4.3 Prohibited. Wall terminations of solid-fuel exhaust systems shall be prohibited. [NFPA 96:15.4.4]

517.5 Grease Removal Devices for Solid-Fuel Cooking. Grease removal devices shall be constructed of steel or stainless steel or be approved for solid-fuel cooking. [NFPA 96:15.5.1]

517.5.1 Spark Arrester Devices. If airborne sparks and embers can be generated by the solid fuel cooking operation, spark arrester devices shall be used prior to using the grease removal device, to minimize the entrance of these sparks and embers into the grease removal device and into the hood and the duct system. [NFPA 96:15.5.2]

517.5.2 Filters. Filters shall be a minimum of 4 feet (1219 mm) above the appliance cooking surface. [NFPA 96:15.5.3]

517.6 Air Movement for Solid-Fuel Cooking. Exhaust system requirements shall comply with Section 511.0 for hooded operation or shall be installed in accordance with the manufacturer’s recommendations for unhooded applications. [NFPA 96:15.6.1]

517.6.1 Replacement Air. A replacement or makeup air system shall be provided to ensure a positive supply of replacement air at all times during cooking operations. [NFPA 96:15.6.2]

517.6.2 Operation. Makeup air systems serving solid-fuel cooking operations shall be interlocked with the exhaust air system and powered, if necessary, to prevent the space from attaining a negative pressure while the solid-fuel appliance is in operation. [NFPA 96:15.6.3]

517.7 Fire-Extinguishing Equipment for Solid-Fuel Cooking. Solid-fuel cooking appliances that produce grease-laden vapors shall be protected by listed fire-extinguishing equipment.

Exception: Where acceptable to the Authority Having Jurisdiction, solid-fuel cooking appliances constructed of solid masonry or reinforced Portland or refractory cement concrete and vented in accordance with NFPA 211 shall not require fixed automatic fire-extinguishing equipment. [NFPA 96:15.7.1, 15.7.2]

517.7.1 Grease Removal Devices, Hoods, and Duct Systems. Listed fire-extinguishing equipment shall be provided for the protection of grease removal devices, hoods, and duct systems. [NFPA 96:15.7.3]

Exception: Where acceptable to the Authority Having Jurisdiction, solid-fuel cooking appliances constructed of solid masonry or reinforced Portland or refractory cement concrete and vented in accordance with NFPA 211 shall not require automatic fire-extinguishing equipment for the protection of grease removal devices, hoods, and duct systems. [NFPA 96:15.7.4]

517.7.2 Listed Fire-Extinguishing Equipment. Listed fire-extinguishing equipment for solid-fuel-burning cooking appliances, where required, shall comply with Section 513.0 and shall use water-based agents. [NFPA 96:15.7.5]

517.7.3 Rating and Design. Fire-extinguishing equipment shall be rated and designed to extinguish solid-fuel cooking fires. The fire-extinguishing equipment shall be of sufficient size to totally extinguish fire in the entire hazard area and prevent reignition of the fuel. [NFPA 96:15.7.6, 15.7.7]

517.7.4 Listing/Class. All solid fuel appliances (whether under a hood or not) with fireboxes of 5 cubic feet (0.14 m³) volume or less shall have at least a listed 2-A rated water-spray fire extinguisher or a 1.6 gallon (6.1 L) wet chemical fire extinguisher listed for Class K fires in accordance with NFPA 10 with a maximum travel distance of 20 feet (6096 mm) to the appliance. [NFPA 96:15.7.8]

517.7.5 Fixed-Water Pipe System. Solid fuel appliances with fireboxes exceeding 5 cubic feet (0.14 m³) shall be provided with a fixed-water pipe system with a hose in the kitchen capable of reaching the firebox. The hose shall be equipped with an adjustable nozzle capable of producing a fine to medium spray or mist. The nozzle shall be of the type that cannot produce a straight stream. The system shall have a minimum operating pressure of 40 psi (276 kPa) and shall provide a minimum of 5 gallons per minute (gpm) (0.3 L/s). [NFPA 96:15.7.9.1 – 15.7.9.2]

517.7.6 Fuel Storage. All fuel storage areas for cooking operations in buildings shall be provided with a sprinkler system meeting the requirements of NFPA 13 except as permitted in accordance with the following:

(1) Where acceptable to the Authority Having Jurisdiction, fuel storage areas shall be permitted to be protected with a fixed water pipe system with a hose capable of reaching all parts of the area.

(2) In lieu of the sprinkler system outlined in Section 517.7.6, a listed 2-A rated water spray fire extinguisher or a 1.6 gallon (6.1 L) wet chemical fire extinguisher listed for Class K fires with a maximum travel distance of 20 feet (6096 mm) to the solid fuel piles shall be permitted to be used for a solid fuel pile, provided that the fuel pile does not exceed 5 cubic feet (0.14 m³) volume. [NFPA 96:15.9.2.8, 15.9.2.8.2, 15.9.2.8.3]
517.7.7 **Auxiliary Fuel.** In addition to the requirements of Section 517.7.4 through Section 517.8.3, where any solid-fuel cooking appliance is also provided with auxiliary electric, gas, oil, or other fuel for ignition or supplemental heat and the appliance is also served by any portion of a fire-extinguishing system complying with Section 513.0, such auxiliary fuel shall be shut off on actuation of the fire-extinguishing system. [NFPA 96:15.7.11]

517.8 **Other Safety Requirements.** Metal-fabricated solid-fuel cooking appliances shall be listed for the application where produced in practical quantities or shall be approved by the Authority Having Jurisdiction. Where listed, metal-fabricated solid fuel cooking appliances shall be installed in accordance with the terms of their listings and with the applicable requirements of this chapter. [NFPA 96:15.9.4.1, 15.9.4.2]

517.8.1 **Site-Built Solid Fuel Cooling Appliances.** Site-built solid-fuel cooking appliances shall be submitted for approval to the Authority Having Jurisdiction before being considered for installation. All units submitted to the Authority Having Jurisdiction shall be installed, operated, and maintained in accordance with the approved terms of the manufacturer's instructions and any additional requirements set forth by the Authority Having Jurisdiction. [NFPA 96:15.9.4.3.1 – 15.9.4.3.2]

517.8.2 **Additional Devices.** Except for the spark arresters required in Section 517.1.6, there shall be no additional devices of any type in any portion of the appliance, flue pipe, and chimney of a natural draft solid-fuel operation. [NFPA 96:15.9.4.4]

517.8.3 **Prohibited.** No solid fuel cooking device of any type shall be permitted for deep fat frying involving more than 1 quart (qt) (1 L) of liquid shortening, nor shall any solid fuel cooking device be permitted within 3 feet (914 mm) of any deep fat frying unit. [NFPA 96:15.9.4.5]

518.1 **General.** Downdraft appliance ventilation system containing or for use with appliances used in processes producing smoke or grease-laden vapors shall be equipped with components complying with the following:

1. The clearance requirements of Section 507.4 through Section 507.4.3.3.
2. The primary collection means designed for collecting cooking vapors and residues complying with the requirements of Section 508.0.
3. Grease removal devices complying with Section 509.0.
4. Special-purpose filters as listed in accordance with UL 1046 or CAN/ULC-S649 for Canada.
5. Exhaust ducts complying with Section 510.0.
6. The air movement requirements of Section 511.2.1 and Section 511.2.2.
7. Auxiliary equipment (such as particulate and odor removal devices) complying with Section 512.0.
8. Fire-extinguishing equipment complying with the requirements of Section 513.0, and as specified in Section 518.3.
9. The use and maintenance requirements of Section 514.0.
10. The minimum safety requirements of Section 515.0. 

518.2 **Ventilation System.** The downdraft appliance ventilation system shall be capable of capturing and containing all the effluent discharge from the appliance(s) it is serving. [NFPA 96:16.1.2]

518.3 **Fire-Extinguishing Equipment.** For fire-extinguishing equipment on downdraft appliance ventilation systems, the following shall apply:

1. Cooking surface, duct, and plenum protection shall be provided.
2. At least one fusible link or heat detector shall be installed within each exhaust duct opening in accordance with the manufacturer’s listing.
3. A fusible link or heat detector shall be provided for each protected cooking appliance located in the plenum area of that appliance or in accordance with the extinguishing system manufacturer’s listing.
4. A manual actuation device shall be provided as part of each appliance at a height acceptable to the Authority Having Jurisdiction.
5. Portable fire extinguishers shall be provided in accordance with Section 513.10 through Section 513.11. [NFPA 96:16.2]

518.3.1 **Integral Fire-Extinguishing System.** A listed downdraft appliance ventilation system employing an integral fire-extinguishing system including detection systems that has been evaluated for grease and smoke capture, fire extinguishing, and detection shall be considered as complying with Section 518.3. [NFPA 96:16.2.1]

518.3.2 **Interlocks.** The downdraft appliance ventilation system shall be provided with interlocks such that the cooking fuel supply will not be activated unless the exhaust and supply air systems have been activated. [NFPA 96:16.2.2]

518.4 **Airflow Switch or Transducer.** An airflow switch or transducer shall be provided after the last filter component to ensure that a minimum airflow is maintained. [NFPA 96:16.3.1]

518.4.1 **Interlocks.** The airflow switch or transducer shall open the interlock circuit when the airflow falls 25 percent below the system’s normal operating flow or less than 10 percent its listed minimum rating, whichever is lower. [NFPA 96:16.3.2]

518.4.2 **Manual Reset.** The airflow switch or transducer shall be a manual reset device or circuit. [NFPA 96:16.3.3]

518.5 **Surface Materials.** Any surface located directly above the cooking appliance shall be of noncombustible or limited-combustible materials. [NFPA 96:16.4]
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(portions of table not shown remain unchanged)

**COMMITTEE STATEMENT:**
The UL version of the Canadian standards are not needed in the code and are therefore being removed. Furthermore, the UL 710A standard was not readily available through the provided link.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Item #: 104
UMC 2024  Section: Chapter 5

SUBMITTER: IAPMO Staff - Update Extracts
NFPA 54 Extract Update

RECOMMENDATION:
Revise text

504.4.1 Provisions for Makeup Air. Makeup air shall be provided in accordance with the following:
(1) Makeup air shall be provided for Type 1 clothes dryers in accordance with the manufacturer’s installation instructions. [NFPA 54:10.4.3.1 10.4.4.1] Where a closet is designed for the installation of a clothes dryer, an opening of not less than 100 square inches (0.065 m²) for makeup air shall be provided in the door or by other approved means.
(2) Provision for makeup air shall be provided for Type 2 clothes dryers, with a minimum free area of 1 square inch (0.0006 m²) for each 1000 British thermal units per hour (Btu/h) (0.293 kW) total input rating of the dryer(s) installed. [NFPA 54:10.4.3.2 10.4.4.2]

504.4.3.1 Exhaust Ducts for Type 2 Clothes Dryers. Exhaust ducts for Type 2 clothes dryers shall comply with the following:
(1) Exhaust ducts for Type 2 clothes dryers shall comply with Section 504.4. [NFPA 54:10.4.5.1 10.4.6.1]
(2) Exhaust ducts for Type 2 clothes dryers shall be constructed of sheet metal or other noncombustible material. Such ducts shall be equivalent in strength and corrosion resistance to ducts made of galvanized sheet steel not less than 0.0195 of an inch (0.4953 mm) thick. [NFPA 54:10.4.5.2 10.4.6.2]
(3) Type 2 clothes dryers shall be equipped or installed with lint-controlling means. [NFPA 54:10.4.5.3 10.4.6.3]
(4) Exhaust ducts for unlisted Type 2 clothes dryers shall be installed with a minimum clearance of 6 inches (152 mm) from adjacent combustible material. Where exhaust ducts for Type 2 clothes dryers are installed with reduced clearances, the adjacent combustible material shall be protected in accordance with Table 303.10.1. [NFPA 54:10.4.5.4]
(5) Where ducts pass through walls, floors, or partitions, the space around the duct shall be sealed with noncombustible material. [NFPA 54:10.4.5.5 10.4.6.4]
(6) Multiple installations of Type 2 clothes dryers shall be made in a manner to prevent adverse operation due to back pressures that might be created in the exhaust systems. [NFPA 54:10.4.5.6 10.4.6.5] The exhaust fan shall operate continuously or shall be interlocked to exhaust air where a clothes dryer is in operation.

SUBSTANTIATION:
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 5 is being revised to the latest edition of NFPA 54-2021.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 105
UMC 2024  Section: 502.2.1

SUBMITTER: Arnie Rodio
Self

RECOMMENDATION:
Revise text

502.0 Termination.

502.2 Termination of Exhaust Ducts. Exhaust ducts shall terminate in accordance with Section 502.2.1 through Section 502.2.3.

502.2.1 Environmental Air Ducts. Environmental air duct exhaust shall terminate not less than 3 feet (914 mm) from a property line, 10 feet (3048 mm) from a forced air inlet, 10 feet (3048 mm) above a public walkway, and 3 feet (914 mm) from openings into the building. The discharge of environmental exhaust ducts shall not be directed onto a public walkway.

Exception: Whole house fans shall be permitted to discharge into the attic space of an individual dwelling unit.

SUBSTANTIATION:
An exception is being added to Section 502.2.1 as exhaust ducts typically must terminate to the outdoors, however, systems such as whole house fans are designed to exhaust into the attic space.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
While whole house fans usually exhaust into attics, there is concern that not all attics allow the air to escape, which may cause a pressure increase within the attic space. Some attics are not vented in certain parts of the country. Each jurisdiction is permitted to allow whole house fans to discharge into an attic. Discharging into the attic may not always be recommended as it may pressurize the attic and create an unhealthy situation for the homeowners. Whole house fans may need to discharge directly to the outdoors.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 28   NEGATIVE: 1   NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

TRAFTON, A: Although I agree with the Committee in part, it is true that many whole house fans do discharge to the attic. We should relook at this.

EXPLANATION OF NEGATIVE:

WHITE: This is very commonly done, in fact, the U.S. DOE encourages the use of these devices as energy savers.
Proposals

Item #: 106
UMC 2024  Section: 502.2.3

SUBMITTER: David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Revise text

502.0 Termination.

502.2 Termination of Exhaust Ducts.

502.2.3 Commercial Kitchen Ducts. Commercial kitchens exhaust ducts shall terminate in accordance with Section 510.9 for Type I exhaust systems or Section 519.5 for Type II exhaust systems.

(above shown for reference only)

510.9 Termination of Type I Hood Exhaust System. The exhaust system shall terminate as follows:
(1) Outside the building with a fan or duct.
(2) Through the roof or to the roof from outside, as in Section 510.9.1, or through a wall, as in Section 510.9.2. [NFPA 96:7.8.1]

519.5 Termination of Type II Hood Exhaust System. The exhaust system shall terminate as follows:
(1) Rooftop terminations shall terminate not less than 10 feet (3048 mm) from a property line, and the exhaust flow shall be directed away from the roof surface of the roof, not less than 40 inches (1016 mm).
(2) Horizontal terminations shall terminate not less than 10 feet (3048 mm) from adjacent buildings, property lines, operable openings, and from grade level.
(3) The discharge outlet shall not be directed onto a public walkway.

SUBSTANTIATION:
This code change clarifies that Section 510.9 applies to Type I exhaust terminations and Section 519.5 applies to Type II exhaust terminations. The code change improves the code by adding reference to the system each section applies to.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 107
UMC 2024  Section: 503.2.1, Table 1701.1

SUBMITTER:  Phil Pettit
  Control Air Conditioning Corporation
  Rep. Self

RECOMMENDATION:
Add new text

503.0 Motors, Fans, and Filters.

503.2 Fans. Parts of fans in contact with explosive or flammable vapors, fumes, or dusts shall be of nonferrous or nonsparking materials, or their casing shall be lined or constructed of such material. Where the size and hardness of materials passing through a fan are capable of producing a spark, both the fan, and the casing shall be of nonsparking materials. Where fans are required to be spark-resistant, their bearings shall not be within the airstream, and parts of the fan shall be grounded. Fans in systems handling materials that are likely to clog the blades, and fans in buffing or woodworking exhaust systems, shall be of the radial-blade or tube-axial type.

Equipment used to exhaust explosive or flammable vapors, fumes, or dusts shall bear an identification plate stating the ventilation rate for which the system was designed.

Fans located in systems conveying corrosives shall be of materials that are resistant to the corrosive or shall be coated with corrosion-resistant materials.

503.2.1 Testing. Fans providing exhaust or outdoor air shall be tested in accordance with ANSI/AMCA 210/ASHRAE 51. Induced flow fans shall be tested in accordance with AMCA 260.

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Note: ANSI/AMCA 210/ASHRAE 51 and AMCA 260 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
Testing requirements are being added for exhaust fans to clarify that such fans must be tested to AMCA 210/ASHRAE 51. This will assist the code official in approving such systems. To be assured that fan performance is factual for exhaust applications utilizing induced flow fans, be sure to specify fans and fan systems that have certified performance ratings. The ratings are based on testing in accordance with AMCA 210/ASHRAE 51 for standard fans and AMCA 260 for induced flow fans. AMCA certified ratings ensure that the product performs as tested and documented by the manufacturer. Caution must be taken when using performance data that is not verified by an independent third party.

COMMITTEE ACTION: REJECT
COMMITTEE STATEMENT:
The proposed standards are aerodynamic testing standards and are not applicable to this code. The change does not do anything to address health or safety. It only gives a design criteria for an end design.

There may be other performance standards available to test and rate exhaust fans. Furthermore, the standards are not used by the installer, but by the engineer. The proposed language is not necessary and does not improve the code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 27 NEGATIVE: 1 ABSTAIN: 1 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:
WHITE: These standards provide a factual basis for performance of products. This code is not just for installers, engineers design to the requirements and inspectors rely on the code for enforcement. Most standards referenced in the code are not directly used by installers, but they are there to provide quality installations.

EXPLANATION OF ABSTAIN:
GUNZNER: Though this proposal did not originate with AMCA, I am abstaining since it involves AMCA standards.
SUBMITTER: Keith Blazer  
Self

RECOMMENDATION:
Revise text

504.0 Environmental Air Ducts.

504.1 General. Where not specified in this chapter, exhaust ducts shall be constructed and installed in accordance with Chapter 6 and shall be airtight as approved by the Authority Having Jurisdiction. Environmental air ducts that have an alternate function as a part of an approved smoke-control system in accordance with Section 504.7 do not require design as Class 1 product-conveying ducts.

Exceptions:
(1) Ductless range hoods where installed in accordance with the manufacturer’s installation instructions.
(2) Condensing clothes dryers where installed in accordance with the manufacturer’s installation instructions.

504.7 Smoke Control Systems. Smoke control systems shall be designed in accordance with NFPA 92 and installed where required by the building code. Pressurized stairways, elevator shafts, and vestibules shall comply with this section and the building code. All components of the smoke control system shall be clearly identified and marked in field. Components include, but are not limited to, fire alarm initiating devices, junction boxes, panels, modules, relays, dampers, doors sensors and air movement sensors.

504.7.1 Fire Detection Systems. Fire detection systems providing control input or output signals to smoke control systems shall comply with the building code and shall be equipped with a control unit listed and labeled in accordance with UL 864. Activation of the smoke control system is required immediately upon detection.

221.0 Smoke Control System. A system that includes all methods for controlling smoke movement, intended to provide a means of egress for the evacuation or relocation of occupants.

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</table>

(portions of table not shown remain unchanged)

Note: NFPA 92 and UL 864 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
A smoke control system is a combination of fans, dampers, warning devices, and other equipment that work together to perform the containment function for any smoke event at any location in a building. Those who work in
the health care industry may be familiar with contamination control; smoke control systems are similar; however, such systems have additional applications. The term "smoke control" includes both the containment of smoke in a designated zone as well as the management of smoke within a large-volume space and adjacent connected spaces. The containment method is a smoke control method that uses mechanical equipment to produce pressure differences across smoke barriers. The management method is a smoke control method that utilizes natural or mechanical systems to maintain a tenable environment in the means of egress from a large-volume space or to control and reduce the migration of smoke between the fire area and communicating spaces.

Once it has been established that a smoke control system is required by the building code, the first step is to consult NFPA 92 and determine whether the system should be based on the smoke-containment concept or the smoke-management concept. NFPA 92 is arranged around smoke containment and smoke management, providing approaches and criteria for the implementation of each.

Smoke management generally is used for large multistory spaces, such as atriums. Smoke containment, achieved using pressurization, is used for elevators, stairways, and zoned smoke systems. Additionally, a building may include smoke management as well as a smoke containment; the two methodologies are not mutually exclusive systems and both are often found in the same building. After the design methodology and smoke control objectives are identified, the design approach(es) should be selected. For smoke-containment systems, the design approach includes one or more of the following: stairwell pressurization, zoned smoke control, elevator pressurization, vestibule pressurization, and smoke refuge area pressurization.

NFPA 92 applies to the design, installation, acceptance testing, operation, and ongoing periodic testing of smoke control systems, and covers both containment and management systems, including stairwell pressurization systems and testing requirements. NFPA 92A and NFPA 92B were withdrawn and the requirements were incorporated into NFPA 92. As the industry standard, it is important for designers, installers, and code officials to be familiar with the document.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed language provides life safety requirements. The language may conflict with the building code. Furthermore, there is no mention of passive smoke control systems nor fire sprinklers used as smoke control systems.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 109
UMC 2024  Section: 504.2

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

504.0 Environmental Air Ducts.

504.2 Independent Exhaust Systems. Single or combined mechanical exhaust systems for environmental air shall be independent of other exhaust systems. Combined exhaust systems shall be designed to operate at negative pressure and terminate in accordance with Section 502.2.1. Clothes dryer exhaust systems shall be independent of all other exhaust systems except where permitted in Section 504.4.4.

(below shown for reference only)

207.0 – E –
Environmental Air Duct. Ducting used for conveying air at temperatures not exceeding 250°F (121°C) to or from occupied areas of any occupancy through other than heating or air-conditioning systems, such as ventilation for human usage, domestic kitchen range exhaust, bathroom exhaust ducts, and domestic-type clothes dryer exhaust ducts.

502.2.1 Environmental Air Ducts. Environmental air duct exhaust shall terminate not less than 3 feet (914 mm) from a property line, 10 feet (3048 mm) from a forced air inlet, 10 feet (3048 mm) above a public walkway, and 3 feet (914 mm) from openings into the building. The discharge of environmental exhaust ducts shall not be directed onto a public walkway.

504.4.4 Common Exhaust. Where permitted by the clothes dryer manufacturer’s installation instructions, multiple clothes dryers shall be permitted to be installed with a common exhaust. The common exhaust duct shall be constructed of rigid metal and shall be installed in a fire-resistant rated enclosure in accordance with the building code. The duct material shall be of rigid metal with a thickness of not less than 0.020 of an inch (0.508 mm) (24 gauge). The duct enclosure shall be provided with a cleanout opening at the base of not less than 12 inches by 12 inches (305 mm by 305 mm). The exhaust fan shall be located downstream of branch connections and operated continuously and shall be monitored by an approved means.

SUBSTANTIATION:
The code change provides clarity to Section 504.2 regarding independent exhaust systems. The intention of the section is to prohibit combining of dissimilar exhaust systems. By mentioning “environmental air” the section is improved and clearly states which systems shall not be combined. Additionally, combined exhaust systems must only operate at negative pressure. Furthermore, clothes dryers shall not be combined with any other exhaust systems.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
While the original section needs clarification, the addition of this language does not add clarity. The change should be reworked to specify the intent.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 110

UMC 2024  Section: 504.3

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

504.0 Environmental Air Ducts.

504.3 Domestic Range Hoods. Ducts used for domestic kitchen range or cooktop ventilation shall be of metal and shall have smooth interior surfaces. All kitchen exhaust ducts used in domestic range hoods shall be constructed of metal and shall have a smooth surface, fastened and sealed with duct mastic or metal tapes that meet the requirements of UL 181. Range hoods shall discharge to the outdoors through a single wall duct and shall not terminate in an attic or crawl space.

A physical verification of air volume, operation, and design intent shall be performed by a certified Testing, Adjusting, and Balancing (TAB) technician. The TAB technician shall be certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB).

Exception: Ducts for domestic kitchen downdraft grill-range ventilation installed under a concrete slab floor shall be permitted to be of approved Schedule 40 PVC provided:
(1) The under-floor trench in which the duct is installed shall be completely backfilled with sand or gravel.
(2) Not more than 1 inch (25.4 mm) of 6 inch diameter (152 mm) PVC coupling shall be permitted to protrude above the concrete floor surface.
(3) PVC pipe joints shall be solvent cemented to provide an air and greasetight duct.
(4) The duct shall terminate above grade outside the building and shall be equipped with a backdraft damper.

Note: UL 181 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
There are currently no provisions to properly seal and test range hoods and ducts. This also clarifies that ducts shall terminate outside and be tested in accordance with the nationally recognized testing standards.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 20  NEGATIVE: 9  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

BALLANCO: The second paragraph of this proposal adds overly restrictive requirements. The amount of exhaust from some of these residential systems does not justify a test by a TAB professional. If the second paragraph was deleted, this would be an acceptable proposal.

FEEHAN: The second paragraph is overly restrictive.

KOERBER: I agree that small residential exhaust systems do not justify a physical verification of exhaust. This is overly restrictive.
MACNEVIN: The second paragraph of this proposal adds overly restrictive requirements, especially for residential systems.

TERZIGNI: Overly complicated for domestic applications.

TRAFTON, A: This code change is too restrictive.

TRAFTON, P: I agree with Julius Ballanco's comment, but, in addition, feel that any UL 181 duct is acceptable, not only smooth as flexible aluminum has been used successfully for years.

WHITE: Very restrictive. My home domestic range hood is built into my microwave that hangs on an exterior wall. The duct is about 4 1/2 inches in length. Why would I need to have a certified test and balance on that?

WISEMAN: Small residential exhaust systems do not justify a physical verification of exhaust. This is overly restrictive.

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 097, Section 403.10 (Air Balance), UMC Item # 110, Section 504.3 (Domestic Range Hoods), and UMC Item # 161, Section 603.9.2 (Duct Leakage Tests) resulted in conflicting language within the code. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

504.0 Environmental Air Ducts.

504.3 Domestic Range Hoods. All kitchen exhaust ducts used in domestic range hoods shall be constructed of metal and shall have a smooth surface, fastened and sealed with duct mastic or metal tapes that meet the requirements of UL 181. Range hoods shall discharge to the outdoors through a single wall duct and shall not terminate in an attic or crawl space.

A physical verification of air volume, operation, and design intent shall be performed by a certified Testing, Adjusting, and Balancing (TAB) technician. The TAB technician shall be certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB), or other equivalent approved agencies.

Exception: Ducts for domestic kitchen downdraft grill-range ventilation installed under a concrete slab floor shall be permitted to be of approved Schedule 40 PVC provided:

1. The under-floor trench in which the duct is installed shall be completely backfilled with sand or gravel.
2. Not more than 1 inch (25.4 mm) of 6 inch diameter (152 mm) PVC coupling shall be permitted to protrude above the concrete floor surface.
3. PVC pipe joints shall be solvent cemented to provide an air and greasetight duct.
4. The duct shall terminate above grade outside the building and shall be equipped with a backdraft damper.

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT: The language in UMC Item # 097, Section 403.10 (Air Balance) modifies the phrase "or other ANSI accredited agencies" to "or other equivalent approved agencies" to comply with the ANSI Essential Requirements for referencing products or services. Additionally, UMC Item # 110, Section 504.3 (Domestic Range Hoods) and UMC Item # 161, Section 603.9.2 (Duct Leakage Tests) were modified to correlate with the updated UMC Item # 097 by adding the phrase "or other equivalent approved agencies."

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 504.3 by adding the phrase "or other equivalent approved agencies."
Item #: 111

UMC 2024  Section: 504.4.2.1

SUBMITTER: Phil Pettit
  Control Air Conditioning Corporation
  Rep. Self

RECOMMENDATION:
  Revise text

504.0 Environmental Air Ducts.

504.4 Clothes Dryers. (remaining text unchanged)

504.4.2 Domestic Clothes Dryers. (remaining text unchanged)

504.4.2.1 Length Limitation. Unless otherwise permitted or required by the dryer manufacturer’s instructions and approved by the Authority Having Jurisdiction, domestic dryer moisture exhaust ducts shall not exceed a total combined horizontal and vertical length of 14 35 feet (4267 10 668 mm), including two 90 degree (1.57 rad) elbows. A length of 2 feet (610 mm) shall be deducted for each 90 degree (1.57 rad) elbow in excess of two.

Exception: Where an exhaust duct power ventilator, in accordance with Section 504.4.2.3, is used, the maximum length of the dryer exhaust duct shall be permitted to be in accordance with the dryer exhaust duct power ventilator manufacturer’s installation instructions.

SUBSTANTIATION:
The first sentence of Section 504.4.2.1 already requires that the total length of the exhaust duct must first be determined by the clothes dryer manufacturer's instructions. In the absence of manufacturer's instructions, the UMC states that the total combined length limitation shall not exceed 14 feet per Section 504.4.2.1. This requirement is overly stringent. This code change would allow up to 35 feet of total length of clothes dryer exhaust duct in the absence of manufacturer's instructions and when approved by the AHJ.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There was no technical justification provided to warrant the change for the maximum length of clothes dryer exhaust duct from 14 feet to 35 feet.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 27  NEGATIVE: 1  ABSTAIN: 1  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

TERZIGNI: The language in the code allows for longer lengths if the manufacturer's instruction permit it. This just sets a "default" maximum.

WHITE: I must agree that there is no technical substantiation provided with the proposal. It has been noted that the manufacturer's instructions would provide for longer lengths, but that is constrained by the AHJ (the code connects them with "and") so if the AHJ will not approve, it is 14 feet. Perhaps through public comment more substantiation can be provided.
EXPLANATION OF NEGATIVE:

BALLANCO: The 35-foot dimension has been substantiated by manufacturers of dryers. This change should have been accepted as submitted.

EXPLANATION OF ABSTAIN:

KOERBER: Abstaining as I would like to hear more information regarding either of the length limitations (14’ or 35’). Just as it can be said the 14’ length is too restrictive, what’s to say the 35 length is not too lenient? Looking for a true justification for either length or any length in between.
Proposals

Item #: 112
UMC 2024  Section: 504.4.2.2

SUBMITTER: Phil Pettit  
Control Air Conditioning Corporation  
Rep. Self

RECOMMENDATION: 
Revise text

504.0 Environmental Air Ducts.

504.4 Clothes Dryers. (remaining text unchanged)

504.4.2 Domestic Clothes Dryers. (remaining text unchanged)

504.4.2.2 Transition Ducts. Listed clothes dryer transition ducts not more than 6 8 feet (1829 2438 mm) in length shall be permitted to be used to connect the Type 1 dryer to the exhaust ducts. Transition ducts and flexible clothes dryer transition ducts shall not be concealed within construction, and shall be installed in accordance with the manufacturer’s installation instructions.

SUBSTANTIATION: 
The UMC currently limits the length of clothes dryer transition ducts to 6 feet per Section 504.4.2.2. This requirement is overly stringent. This change allows up to 8 feet total length in the absence of manufacturer’s instructions and when approved by the AHJ.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT: 
There was no technical justification provided to warrant the change for the maximum length of clothes dryer transition duct from 6 feet to 8 feet.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 26  NEGATIVE: 3  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

BALLANCO: This change should have been accepted as submitted. The 8-foot dimension is consistent with the listing of transition ducts.

KOERBER: Listed Clothes Dryer Transition Ducts are approved for use in lengths not to exceed 8 feet. The length should be changed to match the scope of the listing standard.

TRAFTON, A: Julius Ballanco is right, however, we should submit the transition information to the Committee for review.
Proposals

Item #: 113

UMC 2024  Section: 504.3, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

504.0 Environmental Air Ducts.

504.3 Domestic **Range Cooking Exhaust Equipment.** Where installed, domestic cooking exhaust equipment shall comply with the following, as applicable:

1. The fan for overhead range hoods and downdraft exhaust equipment not integral with the cooking appliance shall be listed and labeled in accordance with UL 507.
2. Overhead range hoods and downdraft exhaust equipment with integral fans shall be listed and labeled in accordance with UL 507.
3. Domestic cooking appliances with integral downdraft exhaust equipment shall be listed and labeled in accordance with UL 858 or ANSI Z21.1/CSA 1.1.
4. Microwave ovens with integral exhaust for installation over the cooking surface shall be listed and labeled in accordance with UL 923.
5. Ducts used for domestic kitchen range or cooktop ventilation shall be of metal and shall have smooth interior surfaces.

**Exception:** Ducts for domestic kitchen downdraft grill-range ventilation installed under a concrete slab floor shall be permitted to be of approved Schedule 40 PVC provided:

1. The under-floor trench in which the duct is installed shall be completely backfilled with sand or gravel.
2. Not more than 1 inch (25.4 mm) of 6 inch diameter (152 mm) PVC coupling shall be permitted to protrude above the concrete floor surface.
3. PVC pipe joints shall be solvent cemented to provide an air and greasetight duct.
4. The duct shall terminate above grade outside the building and shall be equipped with a backdraft damper.

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<td>Electric Fans</td>
<td>Fans</td>
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Note: The UL and CSA standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
This change adds requirements for domestic cooking exhaust equipment, including fans, overhead range hoods, integral downdraft equipment, and microwave ovens with integral exhaust.

[Digital View for UL Standards: https://www.shopulstandards.com/Catalog.aspx]

COMMITTEE ACTION: REJECT
COMMITTEE STATEMENT:
The proposed Section 504.3(4) is not needed as the UL 923 standard is already addressed in the code regarding microwave ovens and would, therefore, be redundant language and not needed. The phrase "listed and labeled" should be removed as the code already addresses this in Chapter 3.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  
   AFFIRMATIVE: 24   NEGATIVE: 5   NOT RETURNED: 1   Heine

EXPLANATION OF NEGATIVE:

BALLANCO: This change should have been accepted as submitted. The substantiation justifies the change.

FEEHAN: This language and these standards are necessary.

KOERBER: The substantiation justifies the change.

WHITE: The substantiation justifies the proposal and should have been accepted.

WISEMAN: These standards are appropriate and necessary. This should have been accepted.
Proposals

Item #: 114
UMC 2024  Section: 504.4.5

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

504.0 Environmental Air Ducts.

504.4 Clothes Dryers.

504.4.5 Duct Supports. Ducts shall be supported at intervals not to exceed 4 feet (1219 mm) and in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.

SUBSTANTIATION:
This code change adds duct support spacing requirements for clothes dryers at 4 foot intervals for clarity and ease of use of the code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 115
UMC 2024  Section: 504.4.6

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Add new text

504.0 Environmental Air Ducts.

504.4 Clothes Dryers.

504.4.6 Multistory Exhausting of Dryers. Each vertical riser shall be provided with a means for cleanout or access door located at the bottom of the main exhaust shaft for lint removal.

SUBSTANTIATION:
The code change adds provisions for clothes dryer cleanouts for vertical risers. The lint that dryer exhaust carries with it creates lint buildup that other exhaust systems do not create. Therefore, clothes dryer risers need cleanouts to manage lint buildup in the dryer exhaust ducts.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 116
UMC 2024  Section: 207.0, 210.0, 504.5

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

207.0  – E –
Energy Recovery Ventilation (ERV) System. A device intended to provide outdoor ventilation air, and in the process transfer energy between the intake and exhaust airstreams for the purpose of preheating, precooling, humidifying, or dehumidifying outdoor ventilation air prior to supplying such air to a conditioned space.

210.0  – H –
Heat (Energy) Recovery Ventilator Ventilation (HRV) System. A device intended to remove air from buildings, replace it with outside air, and in the process transfer heat from the warmer to the colder airstreams.

504.0 Environmental Air Ducts.

504.5 Heat (Energy) Recovery Ventilators Ventilation (HRV) and Energy Recovery Ventilation (ERV) Systems. Heat (energy) recovery ventilators (HRV) and energy recovery ventilators (ERV) shall be installed in accordance with their listings and comply with the appliance manufacturer’s installation instructions. Non-ducted heat recovery ventilators shall comply with UL 1815. Ducted heat recovery ventilators shall comply with UL 1812. Heat (energy) recovery ventilator and energy recovery ventilator ducts shall comply with Chapter 6.

SUBSTANTIATION:
After investigating various ventilation options, many HVAC designers conclude that they want either a heat-recovery ventilator (HRV) or an energy-recovery ventilator (ERV). They often remain confused, however, about which of the two devices to choose. There is quite a bit of debate out there as to where ERVs should be used and where HRVs should be used. HRVs, like ERVs, are ventilation systems that transfer heat. Like an HRV, an ERV contains a heat exchanger that transfers heat from one air stream to another. Unlike an HRV, an ERV also moves moisture between the two air streams. The two systems need to be differentiated to avoid confusion and clarify that Section 504.5 applies to both systems.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 117

UMC 2024  Section: 504.6

SUBMITTER: John R Hamilton  
International Certification Board  
Rep. DLS

RECOMMENDATION:  
Delete text without substitution

504.0 Environmental Air Ducts.

504.6 Gypsum Wallboard Ducts. Bathroom and laundry room exhaust ducts shall be permitted to be of gypsum wallboard subject to the limitations of Section 602.4.2.

SUBSTANTIATION:  
ASHRAE recommends all HVAC ducts are made to a standard. There is no standard for using building materials as ductwork. The Gypsum Association does not recommend or have a standard to make ducts out of gypsum. Gypsum has many specific limitations to exposure to humidity and mold growth. Using gypsum for these high humidity ducts is not recommended by the National Gypsum Association; in fact they say not to use gypsum as an HVAC ducting system.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  
AFFIRMATIVE: 27  
NEGATIVE: 2  
NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

BALLANCO: Gypsum has been used for many years without incident. If there was a problem with this section, failures should have been identified.

KOERBER: Gypsum should be allowed for use under the limitations already set forth in Chapter 6.
Proposals

Item #: 118
UMC 2024  Section: 203.0, 221.0, 505.12, Table 505.12, 603.11, Table 1701.1

SUBMITTER: Jane Malone
American Association of Radon Scientists and Technologists (AARST)

RECOMMENDATION:
Revise text

505.0 Product-Conveying Systems.

505.12 Subslab Exhaust Systems. Where soil gas mitigation is required, an active soil depressurization (ASD) system such as a subslab soil exhaust or depressurization system shall be installed in accordance with Table 505.12.

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<td>New Construction</td>
</tr>
<tr>
<td></td>
<td>Existing Buildings</td>
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</table>

603.0 Installation of Ducts.

603.11 Underground Installation. Ducts installed underground shall be approved for the installation and shall have a slope of not less than 1/8 inch per foot (10.4 mm/m) back to the main riser. Ducts, plenums, and fittings shall be permitted to be constructed of concrete, clay, or ceramics where installed in the ground or in a concrete slab, provided the joints are sealed and duct is secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Metal ducts where installed in or under a concrete slab shall be encased in not less than 2 inches (51 mm) of concrete, secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Subslab soil exhaust ducts shall be in accordance with Section 505.12.

203.0 – A – Active Soil Depressurization (ASD). A soil gas control system involving fan-powered soil depressurization, including but not limited to sub-slab depressurization and sub-membrane depressurization.

221.0 – S – Subslab Depressurization. A soil gas mitigation technique designed to maintain lower air pressure under a floor slab than above it by use of an active soil depressurization (ASD) fan installed in the radon system piping that draws air from below the floor slab.
### TABLE 1701.1
**REFERENCED STANDARDS**

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<td>Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings</td>
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</table>

(portions of table not shown remain unchanged)

**Note:** The ASTM and AARST standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

**SUBSTANTIATION:**
The purpose of this proposed change is to add the relevant consensus standards for soil gas exhaust systems, which includes additional specifications for materials, grade/slope, termination, and identification in the existing language as well as other essential components of soil gas control. The standards included in this proposal have been vetted and approved by EPA, multiple regulatory states, and HUD.

**COMMITTEE ACTION:** REJECT

**COMMITTEE STATEMENT:**
The proposal does not state when radon mitigation is required. The language is not found in the building code, where it may belong. Additionally, slab-on-grade radon protection may not always be feasible.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 119
UMC 2024  Section: 505.8

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

505.0 Product-Conveying Systems.

505.8 Product-Conveying Ducts Classification. Product-conveying ducts shall be classified according to their use, as follows:
Class 1 - Ducts conveying nonabrasives, such as smoke, spray, mists, fogs, noncorrosive fumes and gases, light fine dusts, or powders.
Class 2 - Ducts conveying moderately abrasive particulate in light concentrations, such as sawdust and grain dust, and buffing and polishing dust.
Class 3 - Ducts conveying Class 2 materials in high concentrations and highly abrasive materials in low concentrations, such as manganese, steel chips, and coke.
Class 4 - Ducts conveying Class 3 materials in high concentrations and highly abrasive material in high concentrations, such as alumina, bauxite, iron silicate, sand, and slag.
Class 5 - Ducts conveying corrosives, such as acid vapors.

SUBSTANTIATION:
Product conveying ducts are classified by the substances considered to be abrasive. Class 4 (highly abrasive material) is not defined and there are no substances indicated to be highly abrasive. The addition of the highly abrasive materials will assist the code official in classifying Class 4 product conveying ducts.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 120
UMC 2024 Section: 506.1

SUBMITTER: David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Revise text

506.0 Product-Conveying Ducts.
506.1 Materials. Materials used in product-conveying duct systems shall be suitable for the intended use and shall be of rigid sheet metal.

Exceptions:
1. Asbestos-cement, concrete, clay, or ceramic materials shall be permitted to be used where it is shown that these materials will be equivalent to metal ducts installed in accordance with this chapter.
2. Ducts serving a Class 5 system shall be permitted to be constructed of approved nonmetallic material where the corrosive characteristics of the material being conveyed make a metal system unsuitable and where the mixture being conveyed is nonflammable.
   - Approved nonmetallic material shall be either a listed product having a flame-spread index not exceeding 25 and a smoke-developed rating of 50 or less on both inside and outside surfaces without evidence of continued progressive combustion, or shall have a flame-spread index not exceeding 25 and shall be installed with an automatic fire-sprinkler protection system inside the duct.
3. Ducts used in central vacuum cleaning systems within a dwelling unit shall be constructed of materials in accordance with ASTM F2158 or the applicable standards referenced in Chapter 17. Penetrations of fire walls or floor-ceiling or roof-ceiling assemblies shall be in accordance with the building code.
   - Copper or ferrous pipes or conduits extending from within the separation between a garage and dwelling unit to the central vacuuming unit shall be permitted to be used.
   - Aluminum ducts shall not be used in systems conveying flammable vapors, fumes, or explosive dusts, nor in Class 2, 3, or 4 systems. Galvanized steel and aluminum ducts shall not be used where the temperature of the material being conveyed exceeds 400°F (204°C).
   - Metal ducts used in Class 5 systems that are not resistant to the corrosiveness of the product shall be protected with an approved corrosion-resistant material.

SUBSTANTIATION:
This code change clarifies that product conveying ducts shall be of “rigid sheet” metal as simply stating “metal” is vague and could be interpreted as metallic flexible or metal semi-rigid ducts.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 121
UMC 2024 Section: 505.11.1, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Add new text

505.0 Product-Conveying Systems.

505.11 Hoods and Enclosures. (remaining text unchanged)
505.11.1 Fume Hoods. Where installed, fume hoods used for exhausting flammable vapors shall be listed and labeled in accordance with UL 1805.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 1805-2002</td>
<td>Laboratory Hoods and Cabinets (with revisions through June 2, 2006)</td>
<td>Hoods</td>
<td>505.11.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 1805 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The applicable standard for fume hoods used for exhausting hazardous and flammable vapors is UL 1805, Standard for Laboratory Hoods and Cabinets.

[Digital View for UL Standards: https://www.shopulstandards.com/Catalog.aspx]

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
Although fume hoods are part of the ventilation and exhaust system, they are outside of the scope of the UMC, and therefore, should not be included in the code. Fume hoods are very specific to certain applications and use per facility.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 22 NEGATIVE: 7 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:
ARYAN: This information would be beneficial to the code because currently there is no standard acceptable for fume hoods listed in the code.

BALLANCO: This change should have been accepted as submitted. The substantiation justifies the proposal.

FEEHAN: This language and information is necessary in the code.
KOERBER: I agree with the proposal as the standard is appropriate. If "listed and labeled" does not match with the style of the UMC then the proposal should be modified to reflect "compliance with."

MACNEVIN: I disagree with the Committee statement for rejection, as this proposal is based on an appropriate UL standard for this purpose. Remove "listed and labeled" and it should be accepted in public comment.

WHITE: This information is necessary in the code and not beyond the scope of the UMC.

WISEMAN: This language is necessary for the code and should be included.
Proposals

Item #: 122
UMC 2024  Section: 506.6

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

506.0 Product-Conveying Ducts.

506.6 Explosion Venting. Ducts conveying explosive dusts shall have explosion vents, openings protected by anti-flashback swing valves, or rupture diaphragms. Openings to relieve explosive forces shall be located outside the building. Where relief devices cannot provide sufficient pressure relief, ductwork shall be designed to withstand an internal pressure of not less than 100 pounds-force per square inch (psi) (689 kPa).

Where a room or building contains a dust explosion hazard that is external to protected equipment, as defined in NFPA 654, such areas shall be provided with deflagration venting to a safe outside location.

Systems exhausting explosive mixtures shall be protected by an approved explosion relief or prevention system in accordance with NFPA 69.

Note: NFPA 69 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
NFPA 69, Explosion Prevention Systems, is being added as the industry standard for systems exhausting explosive mixtures.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

506.6 Explosion Venting. Ducts conveying explosive dusts shall have explosion vents, openings protected by anti-flashback swing valves, or rupture diaphragms. Openings to relieve explosive forces shall be located outside the building. Where relief devices cannot provide sufficient pressure relief, ductwork shall be designed to withstand an internal pressure of not less than 100 pounds-force per square inch (psi) (689 kPa).

Where a room or building contains a dust explosion hazard that is external to protected equipment, as defined in NFPA 654, such areas shall be provided with deflagration venting to a safe outside location.

Systems exhausting explosive mixtures shall be protected by an approved explosion relief or prevention system in accordance with NFPA 69.

COMMITTEE STATEMENT:
The proposal is being modified to remove "or prevention" as the explosion relief system is sufficient and clearly states the intent of the change.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 24  NEGATIVE: 5  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

BALLANCO: This proposal needs to be coordinated with the Fire Code. There are specific requirements in the Fire Code that will be in conflict with the direct reference as presented.
KOERBER: Recommend coordination with language in the Fire Code.

MACNEVIN: I agree with Julius Ballanco's recommendation for revision to coordinate with Fire Code.

TRAFTON, A: The proposal needs to be coordinated with the Fire Code.

TRAFTON, P: If this is covered in the Fire Code as Julius Ballanco indicates, then the reference to the Fire Code needs to be included.
Proposals

Item #: 123
UMC 2024  Section: 507.1, 507.2, 519.3, 519.3.1

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

507.0 General Requirements.
507.1 Type I Hood Exhaust Systems. Exhaust systems serving Type I hoods shall comply with Section 507.0 through Section 518.0. Exhaust systems serving Type II hoods shall comply with Section 519.0.
507.2 Type I Hood Exhaust System Requirements. (remaining text unchanged)

519.0 Type II Hood Exhaust System Requirements.

519.3 Type II Hood Exhaust System Net Airflow. The net airflow for Type II hoods shall be in accordance with Section 508.5.1.5 for light-duty cooking appliances. The net airflow for Type II hoods serving dishwashing appliances shall comply with Section 519.3.1.
519.3.1 Dishwashing Appliances. The net airflow for Type II hoods used for dishwashing equipment shall be not less than 200 cubic feet per minute (0.094 m$^3$/s) per linear foot (m) of hood length.

(below shown for reference only)

508.5.1.5 Light-Duty Cooking Appliances. The minimum net airflow for hoods used for cooking appliances such as gas and electric ovens (including standard, bake, roasting, revolving, retherm, convection, combination convection/steamer, rotisserie, countertop conveyorized baking/finishing, deck, and pastry), discrete element ranges (with or without oven), electric and gas steam-jacketed kettles less than 20 gallons (76 L), electric and gas pasta cookers, electric and gas compartment steamers (both pressure and atmospheric), electric and gas cheese melters, electric and gas tilting skillets (braising pans) electric and gas rotisseries, and electric and gas salamanders shall be in accordance with Table 508.5.1.5.

SUBSTANTIATION:
Section 507.1 is being revised to clarify that Type II hoods shall comply with Section 519.0. Furthermore, a new section is being added for Type II exhaust systems to specify the required net airflow for such systems.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 124
UMC 2024 Section: 508.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

508.0 Type I Hoods.
508.1 Where Required. Type I hoods shall be installed at or above commercial-type deep-fat fryers, broilers, grills, hot-top ranges, ovens, barbecues, rotisseries, and similar equipment that emits comparable amounts of smoke or grease in a food-processing establishment. For the purpose of this section, a food-processing establishment shall include a building or portion thereof used for the processing of food, but shall not include a dwelling unit.

Exceptions:
(1) Cooking appliances that are listed and labeled in accordance with UL 710B and 197 for reduced emissions where the grease discharge does not exceed 2.9 E-09 ounces per cubic inch (oz/in³) (5.0 E-06 kg/m³) where operated with a total airflow of 500 cubic feet per minute (CFM) (0.236 m³/s).
(2) Recirculating systems listed in accordance with UL 710B and installed in accordance with Section 516.0.
(3) Solid-fuel-fired ovens that are listed and labeled in accordance with UL 2162 and that are vented in accordance with the manufacturer’s instructions with venting systems complying with UL 103 and UL 1978.
(4) Listed and labeled cooking appliances with integral downdraft systems that comply with Section 518.0.

(below shown for reference only)

518.0 Downdraft Appliances.
518.1 General. Downdraft appliance ventilation system containing or for use with appliances used in processes producing smoke or grease-laden vapors shall be equipped with components complying with the following:
(1) The clearance requirements of Section 507.4 through Section 507.4.3.3.
(2) The primary collection means designed for collecting cooking vapors and residues complying with the requirements of Section 508.0.
(3) Grease removal devices complying with Section 509.0.
(4) Special-purpose filters as listed in accordance with UL 1046.
(5) Exhaust ducts complying with Section 510.0.
(6) The air movement requirements of Section 511.2.1 and Section 511.2.2.
(7) Auxiliary equipment (such as particulate and odor removal devices) complying with Section 512.0.
(8) Fire-extinguishing equipment complying with the requirements of Section 513.0, and as specified in Section 518.3.
(9) The use and maintenance requirements of Section 514.0.
(10) The minimum safety requirements of Section 515.0. [NFPA 96:15.1.1]

518.2 Ventilation System. The downdraft appliance ventilation system shall be capable of capturing and containing all the effluent discharge from the appliance(s) it is serving. [NFPA 96:15.1.2]

518.3 Fire-Extinguishing Equipment. For fire-extinguishing equipment on downdraft appliance ventilation systems, the following shall apply:
(1) Cooking surface, duct, and plenum protection shall be provided.
(2) At least one fusible link or heat detector shall be installed within each exhaust duct opening in accordance with the manufacturer’s listing.
(3) A fusible link or heat detector shall be provided for each protected cooking appliance located in the plenum area of that appliance or in accordance with the extinguishing system manufacturer’s listing.
(4) A manual activation device shall be provided as part of each appliance at a height acceptable to the Authority Having Jurisdiction.
Portable fire extinguishers shall be provided in accordance with Section 513.10 through Section 513.11. [NFPA 96:15.2]

518.3.1 Integral Fire-Extinguishing System. A listed downdraft appliance ventilation system employing an integral fire-extinguishing system including detection systems that has been evaluated for grease and smoke capture, fire extinguishing, and detection shall be considered as complying with Section 518.3. [NFPA 96:15.2.1]

518.3.2 Interlocks. The downdraft appliance ventilation system shall be provided with interlocks such that the cooking fuel supply will not be activated unless the exhaust and supply air systems have been activated. [NFPA 96:15.2.2]

518.4 Airflow Switch or Transducer. An airflow switch or transducer shall be provided after the last filter component to ensure that a minimum airflow is maintained. [NFPA 96:15.3.1]

518.4.1 Interlocks. The airflow switch or transducer shall open the interlock circuit when the airflow falls 25 percent below the system’s normal operating flow or less than 10 percent its listed minimum rating, whichever is lower. [NFPA 96:15.3.2]

518.4.2 Manual Reset. The airflow switch or transducer shall be a manual reset device or circuit. [NFPA 96:15.3.3]

518.5 Surface Materials. Any surface located directly above the cooking appliance shall be of noncombustible or limited-combustible materials. [NFPA 96:15.4]

Note: The UL standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The requirements for the reduced emissions testing for cooking appliances, as covered by Exception 1, have been incorporated into UL 197. NFPA 96 includes requirements for cooking appliances with integral downdraft exhaust systems which do not require a Type I hood above. Solid fuel fired ovens that are listed and labeled to UL 2162 that have been evaluated for connection with venting systems that comply with both UL 103 (chimneys) and UL 1978 (grease ducts) do not need to have a Type I hood above. The downdraft appliances covered in Section 518.0 of this code do not need a Type I hood above.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

508.0 Type I Hoods.

508.1 Where Required. Type I hoods shall be installed at or above commercial-type deep-fat fryers, broilers, grills, hot-top ranges, ovens, barbecues, rotisseries, and similar equipment that emits comparable amounts of smoke or grease in a food-processing establishment. For the purpose of this section, a food-processing establishment shall include a building or portion thereof used for the processing of food, but shall not include a dwelling unit.

Exceptions:
(1) Cooking appliances that are listed and labeled in accordance comply with UL 197 for reduced emissions where the grease discharge does not exceed 2.9 E-09 ounces per cubic inch (oz/in^3) (5.0 E-06 kg/m^3) where operated with a total airflow of 500 cubic feet per minute (CFM) (0.236 m^3/s).
(2) Recirculating systems listed in accordance with UL 710B and installed in accordance with Section 516.0.
(3) Solid-fuel-fired ovens that are listed and labeled in accordance comply with UL 2162 and that are vented in accordance with the manufacturer’s instructions with venting systems complying with UL 103 and UL 1978.
(4) Listed and labeled cooking appliances with integral downdraft systems that comply with Section 518.0.

COMMITTEE STATEMENT:
The proposal is being modified to change "listed and labeled" to "comply" since "comply" already implies that the product must be listed and labeled in accordance with the referenced standard. Also, Chapter 3 already has listing and marking requirements.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1  Heine
Proposals

Item #: 125
UMC 2024  Section: 508.1(1)

SUBMITTER: Maria Yepremian
County of Los Angeles Building and Safety

RECOMMENDATION:
Revise text

508.0 Type I Hoods.
508.1 Where Required. Type I hoods shall be installed at or above commercial-type deep-fat fryers, broilers, grills, hot-top ranges, ovens, barbecues, rotisseries, and similar equipment that emits comparable amounts of smoke or grease in a food processing establishment. For the purpose of this section, a food-processing establishment shall include a building or portion thereof used for the processing of food, but shall not include a dwelling unit.

Exceptions:
(1) A Type I hood shall not be required for a cooking appliance that is listed in accordance with UL 710B for reduced emissions where the grease discharge does not exceed 2.9 E-09 ounces per cubic inch (oz/in$^3$) (5.0 E-06 kg/m$^3$) where operated with a total airflow of 500 cubic feet per minute (cfm) (0.236 m$^3$/s).
(2) Recirculating systems listed in accordance with UL 710B and installed in accordance with Section 516.0.

SUBSTANTIATION:
Section 508.1 exception (1) is being revised as exception (1) is creating confusion during plan check and in the field for AHJs. Many in the field are interpreting this section as excepting hoods altogether. However, this section only exempts the use of Type I hoods, not the use of Type II hoods. Type II hoods shall be required when excessive heat and/or steam is being emitted. UL 710B only tests hoods to be exempt from grease applications but not for excessive heat or steam such as bread ovens. In addition, exception (1) does not have language specifying that the cooking appliance must be "listed" in accordance with UL 710B, which is causing issues for AHJs. The phrase "listed in accordance with" should be used in exception (1) the same way as exception (2).

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 124, Section 508.1 (Where Required) and UMC Item # 125, Section 508.1 (Where Required) resulted in conflicting language within the code. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

508.0 Type I Hoods.
508.1 Where Required. Type I hoods shall be installed at or above commercial-type deep-fat fryers, broilers, grills, hot-top ranges, ovens, barbecues, rotisseries, and similar equipment that emits comparable amounts of smoke or grease in a food processing establishment. For the purpose of this section, a food-processing establishment shall include a building or portion thereof used for the processing of food, but shall not include a dwelling unit.
Exceptions:
(1) A Type I hood shall not be required for a cooking appliance that is listed in accordance with UL 710B UL 197 for reduced emissions where the grease discharge does not exceed 2.9 E-09 ounces per cubic inch (oz/in$^3$) (5.0 E-06 kg/m$^3$) where operated with a total airflow of 500 cubic feet per minute (cfm) (0.236 m$^3$/s).
(2) Recirculating systems listed in accordance with UL 710B and installed in accordance with Section 516.0.
(3) Solid-fuel-fired ovens that comply with UL 2162 and that are vented in accordance with the manufacturer's instructions with venting systems complying with UL 103 and UL 1978.
(4) Listed and labeled cooking appliances with integral downdraft systems that comply with Section 518.0.

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT:
The language in UMC Item # 125, Section 508.1 (Where Required) is being revised to correlate with the action taken by the UMC TC for Item # 124, Section 508.1 (Where Required) regarding the reference to UL 197, the term “comply,” and the addition of Exceptions (3) and (4).

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 508.1 regarding the reference to UL 197, the term “comply,” and the addition of Exceptions (3) and (4).
Proposals

Item #: 126
UMC 2024  Section: 506.9, 508.4

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Revise text

508.0 Type I Hoods.

508.4 Supports. Hoods shall be secured in place to resist lateral loads by noncombustible supports. The supports shall be capable of supporting the expected weight of the hood and plus 800 pounds (362.9 kg).

506.0 Product-Conveying Ducts.

506.9 Protection from Physical Damage. Ducts and exhaust equipment installed in locations where they are subject to physical damage shall be protected by guards.

SUBSTANTIATION:
Lateral loads are live loads that are applied parallel to the ground; that is, they are horizontal forces acting on a structure and equipment. They are different to gravity loads, for example, which are vertical, downward forces. Significant lateral loads can be imposed on a structure during earth pressure, such as settlement, wind loads, water pressure, and earthquakes. Buildings, especially in areas of seismic activity, need to be carefully designed to ensure they do not fail if lateral loads should occur. Bracing can be used to resist lateral loads. The beams and columns of a braced frame structure carry vertical loads, while the bracing carries the lateral loads.

Additionally, ducts as well as exhaust equipment, such as rooftop exhaust fans, must be protected from damage.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29   NOT RETURNED: 1 Heine
508.5 Hood Size. (remaining text unchanged)

508.5.1 Canopy Size and Location. (remaining text unchanged)

508.5.1.4 Medium-Duty Cooking Appliances. The minimum net airflow for hoods used for cooking appliances such as electric and gas hot-top ranges, gas open-burner ranges (with or without oven), electric and gas flat griddles, electric and gas double-sided griddles, electric and gas fryers (including open deep fat fryers, donut fryers, kettle fryers, tortilla chip fryers, and pressure fryers), electric and gas smokers, and electric and gas conveyor pizza ovens shall be in accordance with Table 508.5.1.4.

SUBSTANTIATION:
Inspectors have had difficulty classifying medium duty cooking appliances for Type I hood requirements. The code change adds language to assist the AHJ in requiring the correct Type I hood.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

508.5 Hood Size. (remaining text unchanged)

508.5.1 Canopy Size and Location. (remaining text unchanged)

508.5.1.4 Medium-Duty Cooking Appliances. The minimum net airflow for hoods used for cooking appliances such as electric and gas hot-top ranges, gas open-burner ranges (with or without oven), electric and gas flat griddles, electric and gas double-sided griddles, electric and gas fryers (including open deep fat fryers, donut fryers, kettle fryers, tortilla chip fryers, and pressure fryers), electric and gas smokers, and electric and gas conveyor pizza ovens shall be in accordance with Table 508.5.1.4.

COMMITTEE STATEMENT:
The modification adds "conveyor" back to the section as to not classify all pizza ovens as medium-duty cooking appliances, only conveyor-type pizza ovens.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Item #: 128
UMC 2024  Section: 510.1.8

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

510.0 Exhaust Duct Systems.
510.1 General. (remaining text unchanged)

510.1.8 Independent Grease Duct System. Single or combined Type I exhaust systems shall be independent of other exhaust systems.

SUBSTANTIATION:
It is industry standard that Type I hood duct systems are not to be combined unless they meet specific conditions. This code change addresses a requirement that is enforced in jurisdictions all over the country. Although independent exhaust ducts for environmental air exhaust systems are addressed in Section 504.2, those requirements are only applicable to environmental exhaust, which includes domestic kitchens, not commercial kitchens.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
510.0 Exhaust Duct Systems.

510.6 Exterior Installations. (remaining text unchanged)

510.6.1 Weather Protection. All ducts shall be protected on the exterior by paint or other suitable weather-protective coating. Ducts constructed of stainless steel shall not be required to have additional paint or weather-protective coatings. Ductwork subject to corrosion shall not have minimal contact with the building surface. [{NFPA 96:7.6.5 – 7.6.7}]

Exception: Ducts constructed of stainless steel shall not be required to have additional paint or weather-protective coatings.

SUBSTANTIATION:
This change to Section 510.6.1 relocates a portion of the language into an exception for clarity and removes the term “minimal” as it is unenforceable language.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 130
UMC 2024 Section: 510.9.1.1, 511.1.3.1

SUBMITTER: Maria Yepremian
County of Los Angeles Building and Safety

RECOMMENDATION:
Revise text

510.0 Exhaust Duct Systems.

510.9 Termination of Type I Hood Exhaust System. (remaining text unchanged)
510.9.1 Rooftop Terminations. (remaining text unchanged)
510.9.1.1 Listed Vibration Isolation Connectors. Listed vibration isolation connectors shall be permitted to be used on exterior roof locations where required for proper equipment vibration isolation.

(renumber remaining sections)

511.0 Air Movement.
511.1 Exhaust Fans for Commercial Cooking Operations. (remaining text unchanged)

511.1.3 Utility Set Exhaust Fans. (remaining text unchanged)
511.1.3.1 At the Rooftop. Fans installed at the rooftop termination point shall be in accordance with the following:
(1) Section 510.9.1 and Section 510.9.1.2.
(2) Vibration isolation Flexible connectors shall be permitted prohibited.
(3) A drain shall be directed to a readily accessible and visible grease receptacle not to exceed 1 gallon (4 L).

SUBSTANTIATION:
Section 510.9.1.1 (Listed Vibration Isolation Connectors) is being deleted as there currently is no listing for vibration isolation connectors applicable for grease duct applications. Section 510.9.1.1 is creating problems for the AHJ as there currently is no guidance in the UMC as to what the acceptable listing for such vibration isolation connector is. NFPA 96, which is the source document for the majority of provisions for commercial kitchen ventilation, prohibits the use of flexible connectors altogether per sections 8.1.3.3 and 8.1.4.5 of the 2017 edition. The UMC shall either provide the appropriate listing for flexible connectors or prohibit their use as they do in NFPA 96.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the language is needed for enforcement of the code. There has been discussion on the topic in the past and the decision was made to add the current language to the sections in question.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 26 NEGATIVE: 3 NOT RETURNED: 1 Heine

EXPLANATION OF AFFIRMATIVE:
YOUNG: As a Committee member, I would like to see if a small task group can be assembled. I would be willing to take this on prior to the next UMC TC meeting and would welcome manufacturers of this product to participate.
EXPLANATION OF NEGATIVE:

KOERBER: I believe this proposal is merited for allowance of these "vibration connectors." Language in referenced standards such as NFPA 90A indicate that vibration isolation connectors in duct systems shall be made of materials having a maximum flame spread index of 25 and a maximum smoke developed index of 50. There is an obvious need for these products.

WHITE: This section has been discussed in the past but the results of those discussions have been problematic. There seems to be a desire for vibration elimination without calling those connectors flexible. Both in-line fans and fans within the building are prohibited from having flexible connectors (Sections 511.1.2 & 511.1.3.2(2)), transmitted vibrations in these applications are tolerated but if the fan is on the roof, we should make an exception for that toleration. If there are no listed devices, what is being accomplished? Further, Section 510.9.1.1 covers listed products, it does not specifically limit this application to listed products (Section 510.0 overall discusses both listed and unlisted products) so it is indeed confusing as to whether vibration eliminators are acceptable. Some might make the case that it is not specifically prohibited and point to Section 511.1.3.2(2) to support that. This proposal should have been accepted to correct this confusion and put the code back to being in alignment with NFPA 96.

WISEMAN: This proposal would have been a very nice simplification of a confusing code issue. This needs further discussion.
511.0 Air Movement.
511.1 Exhaust Fans for Commercial Cooking Operations. Exhaust fans shall be installed in accordance with Section 511.1.1 through Section 511.1.6. Exhaust fans shall comply be listed and labeled in accordance with UL 762 UL 705 and shall be installed in accordance with the manufacturer’s installation instructions.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 705-2017</td>
<td>Power Ventilators (with revisions through October 8, 2018)</td>
<td>Power Ventilators</td>
<td>504.4.2.3, 511.1</td>
</tr>
<tr>
<td>UL762-2013</td>
<td>Power Roof Ventilators for Restaurant Exhaust Appliances</td>
<td>Ventilators</td>
<td>511.1</td>
</tr>
</tbody>
</table>

( порtions of table not shown remain unchanged)

Note: UL 705 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
All the requirements in UL 762 have been moved into UL 705.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

511.0 Air Movement.
511.1 Exhaust Fans for Commercial Cooking Operations. Exhaust fans shall be installed in accordance with Section 511.1.1 through Section 511.1.6. Exhaust fans shall comply be listed and labeled in accordance with UL 705 and shall be installed in accordance with the manufacturer’s installation instructions.

COMMITTEE STATEMENT:
The proposal is being modified to change "listed and labeled" to "comply" since "comply" already implies that the product must be listed and labeled. Additionally, the second instance of the term "shall" is not needed and being removed to be grammatically correct.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
512.3 Other Equipment. Fume incinerators, thermal recovery units, air pollution control devices, or other devices shall be permitted to be installed in ducts or hoods or to be located in the path of travel of exhaust products where specifically listed for such use. [NFPA 96:9.3.1] Where installed, pollution control units shall be listed and labeled in accordance with UL 8782 and shall be installed in accordance with the manufacturer’s installation instructions.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 8782-2017</td>
<td>Outline of Investigation for Pollution Control Units for Commercial Cooking Operations</td>
<td>Miscellaneous</td>
<td>512.3</td>
</tr>
</tbody>
</table>

Note: UL 8782 was not developed via an open process having a published development procedure in accordance with Section 3-3.7.1.2 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The appropriate standard for pollution control units is UL 8782, Pollution Control Units for Commercial Cooking. Section 512.3 (Other Equipment) is a proper location to include the standard for pollution control units.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as UL 8782 is an outline of investigation and such language is not needed as the extracted NFPA language already allows pollution control units that are listed for their use.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 133
UMC 2024  Section: 513.2.3, Table 1701.1

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Revise text

513.0 Fire-Extinguishing Equipment.

513.2 Types of Equipment. (remaining text unchanged)

513.2.3 Installation. Approved automatic fire-extinguishing systems shall be installed in accordance with the terms of their listing, the manufacturer’s installation instructions, and the following standards where applicable:

1. A carbon dioxide extinguishing system in accordance with NFPA 12.
2. An automatic water sprinkler system in accordance with NFPA 13.
3. A dry chemical extinguishing system in accordance with NFPA 17.
4. A wet chemical extinguishing system in accordance with NFPA 17A.
6. A fixed aerosol extinguishing system in accordance with NFPA 2010.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
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</thead>
<tbody>
<tr>
<td>NFPA 2001-2018</td>
<td>Clean Agent Fire Extinguishing Systems</td>
<td>Fire Extinguishing</td>
<td>513.2.3</td>
</tr>
<tr>
<td>NFPA 2010-2020</td>
<td>Fixed Aerosol Fire-Extinguishing Systems</td>
<td>Fire Extinguishing</td>
<td>513.2.3</td>
</tr>
</tbody>
</table>

Note: NFPA 2001 and NFPA 2010 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Section 513.2.3 is not complete with the applicable fire protection systems. The section is being completed with the additional applicable fire protection system standards as well as the application of each standard for easy reference. Item (5) adds Clean Agent systems which utilize gases that are safe for humans and the environment. These systems are ideal for all occupied spaces. The clean agent is discharged as a gas. The gas is an electrically non-conductive and is designed to interrupt the combustion process to extinguish the fire but not damage sensitive equipment.

Item (6) adds Aerosol fire suppressant which is a potassium-based aerosol that suppresses fire by chemically interfering with the free radicals of flame. These systems are great for protecting small enclosures. The AHJ can approve the fire protection method(s) based on the needs of the system.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed provisions should be dictated by the fire code. The term "approved" is not understood as to who will enforce such fire extinguishing systems, and is therefore unenforceable.
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

WHITE: This proposal would help users understand the existing code language without having to look up the specific unnamed standards. As far as "approved" goes, it is defined as to being the AHJ and is certainly not the first time a user would need to determine which code official serves that function.
Proposals

Item #: 134
UMC 2024  Section: 519.7

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

519.0 Type II Hood Exhaust System Requirements.

519.7 Independent Exhaust Duct System. Single or combined Type II exhaust systems shall be independent of all other exhaust systems.

SUBSTANTIATION:
Type II exhaust systems, like Type I systems, shall not be combined with dissimilar exhaust systems. Although independent exhaust ducts for environmental air exhaust systems are addressed in Section 504.2, these requirements are only applicable to environmental air. A section is needed for Type II exhaust ducts.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 135
UMC 2024  Section: Chapter 6

SUBMITTER: IAPMO Staff - Update Extracts
   NFPA 54 Extract Update

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.13.2 Supply Air Ducts to Listed Furnaces. Supply air ducts connecting to listed central heating furnaces shall have the same minimum clearance to combustibles as required for the furnace supply plenum for a distance of not less than 3 feet (914 mm) from the supply plenum. Clearance shall not be required beyond the 3 feet (914 mm) distance. [NFPA 54:10.3.3.7]

603.13.3 Supply Air Ducts to Unlisted Furnaces. Supply air ducts connecting to unlisted central heating furnaces equipped with temperature limit controls with a maximum setting of 250°F (121°C) shall have a minimum clearance to combustibles of 6 inches (152 mm) for a distance of not less than 6 feet (1829 mm) from the furnace supply plenum. Clearance shall not be required beyond the 6 feet (1829 mm) distance. [NFPA 54:10.3.3.8]

603.13.4 Furnace Plenums and Air Ducts. A furnace plenum supplied as a part of the air-conditioning appliance shall be installed in accordance with the manufacturer's instructions. Where a furnace plenum is not supplied with the appliance, any fabrication and installation instructions provided by the manufacturer shall be followed. The method of connecting supply and return ducts shall facilitate proper circulation of air. [NFPA 54:10.3.7.1]

604.0 Furnace Plenums and Air Ducts Used in Fuel-Gas Appliances.
   604.1 Furnace Plenums and Air Ducts. Furnace plenums and air ducts shall be installed in accordance with this Chapter, and NFPA 90A or NFPA 90B. [NFPA 54:10.3.7.1 10.3.8.1]
   604.2 Supplied as a Part of Furnace. A furnace plenum supplied as a part of a furnace shall be installed in accordance with the manufacturer’s instructions. [NFPA 54:10.3.7.2 10.3.8.2]
   604.3 Not Supplied with the Furnace. Where a furnace plenum is not supplied with the furnace, any fabrication and installation instructions provided by the manufacturer shall be followed. The method of connecting supply and return ducts shall facilitate proper circulation of air. [NFPA 54:10.3.7.3 10.3.8.3]
   604.4 Return Air. Where a furnace is installed so supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace. Return air shall not be taken from the mechanical room containing the furnace. [NFPA 54:10.3.7.4 10.3.8.4]

SUBSTANTIATION:
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 6 is being revised to the latest edition of NFPA 54-2021.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 136
UMC 2024 Section: 601.1

SUBMITTER: David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Revise text

601.1 Applicability. Ducts and plenums that are portions of a heating, cooling, ventilation, or exhaust system shall comply with the requirements of this chapter, and Chapter 5 for exhaust ducts, and Chapter 7 for combustion air ducts.

SUBSTANTIATION:
This code change clarifies that ducts shall comply with Chapters 5, 6, and 7, as applicable.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

WHITE: This is confusing and not helpful. Chapter 7 is about combustion air, its sources, amounts, and locations. Nothing in that chapter has anything to do with ducts for heating, cooling, ventilation, or exhaust systems. For that matter, the previous addition of attaching Chapter 5 to Chapter 6 is wrong as well. The information in chapter 5 is for things other than HVAC systems. Section 504.1 directs users to follow Chapter 6 when Chapter 5 does not give specific instructions not to follow Chapter 5 for Chapter 6 HVAC systems. This forces users to go back and forth between the chapters looking for conflicts that, hopefully, this committee has avoided.
Proposals

Item #: 137

UMC 2024 Section: 602.1

SUBMITTER: Christopher Ruch
National Energy Management Institute Committee (NEMIC)

RECOMMENDATION:
Revise text

602.0 Material.
602.1 General. Materials used for duct systems shall comply with Section 602.2 through Section 602.6 as applicable. Concealed building spaces or independent construction within buildings shall be permitted to be used as ducts or plenums. Gypsum board shall not be used for positive pressure ducts.

Exception: In healthcare facilities, medical office buildings, and buildings used for medical purposes, concealed spaces shall not be permitted to be used as ducts or plenums.

SUBSTANTIATION:
Per UMC 2021 – Concealed Spaces. That portion(s) of a building behind walls, over suspended ceilings, in pipe chases, attics, and elsewhere whose size might normally range from 1 ¾ inch (44 mm) stud spaces to 8 foot (2438 mm) interstitial truss spaces and that might contain combustible materials such as building structural members, thermal, electrical insulation, or both, and ducting. Such spaces have sometimes been used as HVAC plenum chambers.

A building engineers' ability to reduce pathogen transmission in existing buildings are limited by the original design of the mechanical systems, the original installation achieving design intent, and proper maintenance by a skilled, trained, and certified technician. Two of the approaches that a building engineer has at their disposal to reduce pathogen transmission are pressure barriers and airflow distribution.

Open ceiling plenum returns limit a building engineers' capabilities to reduce pathogen transmission by removing fundamental aspects of pressure barrier and airflow distribution strategies. In addition, ceiling plenum returns add additional safety concerns to daily maintenance tasks, infiltration, source control, introduction of additional airborne particulates that may compromise indoor air quality, and reduced ability to disinfect.

The COVID-19 pandemic has highlighted the need for all healthcare facilities, Medical Office Buildings, buildings used for medical purposes, or any building has high chance to be commandeered during a pandemic to act as a medical facility to be available to meet the needs of unforeseen public health care emergencies and reduce airborne pathogen transmission at the Engineering Control level.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as providing lists may result in the exclusion of other applicable items. In this case, this could exclude other types of healthcare facilities. The term "healthcare facilities" already includes "medical office buildings, and buildings used for medical purposes."

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 138
UMC 2024  Section: 602.1

SUBMITTER: John R Hamilton
   International Certification Board
   Rep. DLS

RECOMMENDATION:
   Revise text

602.0 Material.
602.1 General. Materials used for duct systems shall comply with Section 602.2 through Section 602.6 as applicable. Concealed building spaces or independent construction within buildings shall be permitted to be used as ducts or plenums. Gypsum board shall not be used for positive pressure ducts. Exception: In healthcare facilities, concealed spaces shall not be permitted to be used as ducts or plenums.

SUBSTANTIATION:
ASHRAE recommends all HVAC ducts are made to a standard. There is no standard for using building materials as ductwork. The Gypsum Association does not recommend or have a standard to make ducts out of gypsum.

COMMITTEE ACTION:
REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the last sentence and second sentence contradict each other regarding concealed spaces being used as ducts or plenums. In addition, there is confusion regarding the meaning of “concealed spaces.”

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 17  NEGATIVE: 12  NOT RETURNED: 1  Heine

Note: Item # 138 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.

EXPLANATION OF NEGATIVE:

ADLER, MANN: I am in agreement with the comment made by Dave Dias.

AGUILAR: This item should be reconsidered or brought back during public comment. Life and safety issues for the occupants of the buildings should always come before cost or ease of design.

BENKOWSKI: Qualifications for air movement through chases created by building materials will need to be defined for appropriate enforcement in the field.

BERGER: After reviewing the comments for this proposal, I agree it should be reconsidered for public comment.

DIAS: After further consideration of the health and safety of building occupants and workers, I am voting Negative because I really believe that concealed spaces and building materials should not be used as ducts or plenums. No standards exist for constructing ducts or plenums out of building materials.

FENTY: This item places the costs of building construction above the life and safety of the building occupants.

HAMILTON: Why allow materials for duct systems that are not required to meet adopted duct construction standards?
RIBBS: I am voting Negative because I really believe that concealed spaces and building materials in healthcare facilities should not be used as ducts or plenums. No standards exists for constructing ducts or plenums out of building materials.

SEWELL: This item should be reconsidered or brought back during public comment. Life and safety issues for the occupants of the buildings should always come before cost or ease of design.

VAN RITE: I agree that using building materials for ducts is unregulated and therefore should not be allowed. This proposal should be given another chance in public comments.

YOUNG: This item should be reconsidered or brought back during public comment. Life and safety issues for the occupants of the buildings should always come before cost or ease of design.
Proposals

Item #: 139
UMC 2024 Section: 602.1

SUBMITTER: John R Hamilton
International Certification Board
Rep. DLS

RECOMMENDATION:
Revise text

602.0 Material.
602.1 General. Materials used for duct systems shall comply with Section 602.2 through Section 602.6 as applicable. Concealed building spaces or independent construction within buildings shall be permitted to be used as ducts or plenums. Gypsum board shall not be permitted to be used as ducts or plenums used for positive pressure ducts. Exception: In healthcare facilities, concealed spaces shall not be permitted to be used as ducts or plenums.

SUBSTANTIATION:
ASHRAE recommends all HVAC ducts are made to a standard. There is no standard for using building materials as ductwork. The Gypsum Association does not recommend or have a standard to make ducts out of gypsum.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as it eliminates a widely used construction method. This would result in a significant change in future installed work. If gypsum board is not permitted for such installation, documentation from gypsum board manufacturers should have been submitted to support the proposed changes.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 140

UMC 2024 Section: 602.1.1

SUBMITTER: John R Hamilton
International Certification Board
Rep. DLS

RECOMMENDATION:
Add new text

602.0 Material.
602.1 General. (remaining text unchanged)

602.1.1 Duct Construction. All HVAC ducts and plenums conveying air shall be built to SMACNA standards recognized in the HVAC industry, ANSI, or organizational standards for construction and installation.

SUBSTANTIATION:
ASHRAE recommends all HVAC ducts are made to a standard. There is no standard for using building materials as ductwork. The Gypsum Association does not recommend or have a standard to make ducts out of gypsum.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 22 NEGATIVE: 6 ABSTAIN: 1 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:
BALLANCO: As written, this proposal has no specific requirement. Without reference to specific standards, the new text is meaningless.

FEEHAN: This language is not necessary.

KOERBER: Although the intent of the proposal appears to be centered on the use of gypsum material for duct construction, the proposal as written would create confusion and potentially limit other duct materials already accepted by current language within the code.

MACNEVIN: The proposed language is not appropriate code language as it would allow ducts and plenums to be built to any standard by any organization, but with no listed standards nor any requirements for certification. The approved new language will create confusion unless it is fixed in public comment.

WHITE: Poor language. How do we determine which SMACNA standards are recognized by the industry and which are not? Too vague and unenforceable.

WISEMAN: Vague and unenforceable.

EXPLANATION OF ABSTAIN:
TERZIGNI: The change could materially affect SMACNA so I will abstain unless required to break a tie.
Proposals

Item #: 141
UMC 2024 Section: 602.2, 602.2.5, Table 1701.1

SUBMITTER: Michael Cudahy
PPFA

RECOMMENDATION:
Revise text

602.0 Material.

602.2 Combustibles Within Ducts or Plenums. Materials exposed within ducts or plenums shall be noncombustible or shall have a flame spread index not to exceed 25 and a smoke-developed index not to exceed 50, where tested as a composite product in accordance with ASTM E84 or UL 723. Plastic piping installed in plenums shall be tested in accordance with all requirements of ASTM E84 or UL 723. Mounting methods, supports and sample sizes of materials for testing that are not specified in ASTM E84 or UL 723 shall be prohibited.

Exceptions:
(1) through (4) (remaining text unchanged)
(5) Products listed and labeled for installation within plenums in accordance with Section 602.2.1 through Section 602.2.3.5.
(6) through (8) (remaining text unchanged)

602.2.5 Water Distribution Piping. Nonmetallic water distribution piping in plenums shall be listed and labeled for use in plenums. Piping shall have a flame spread distance not exceeding 5 feet (1524 mm), an average optical density not exceeding 0.15 and, a peak optical density not exceeding 0.5, where tested in accordance with UL 2846, or shall have a flame spread index not to exceed 25 and a smoke developed index not to exceed 50, where tested as a composite product in accordance with ASTM E84 or UL 723.

### TABLE 1701.1
### REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 2846-2014</td>
<td>Fire Test of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics (with revisions through December 20, 2016)</td>
<td>Surface Burning Test, Plastic Pipe</td>
<td>602.2.5</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: ASTM E84, UL 723, and UL 2846 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Adds new section for inclusion of UL 2846, Fire Test of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics, as an alternative plenum test standard to ASTM E84 / UL 723. This is similar to other standards in the UMC which are product specific, such as; UL 1887 (602.2.2 Fire Sprinkler Piping) and UL 1820 (602.2.3 Pneumatic Tubing). The UL 2846 standard has been in the IMC since the 2014 version.

COMMITTEE ACTION: REJECT
COMMITTEE STATEMENT:
The proposal is being rejected as there is concern that the language may reduce the safety level of existing plenum requirements. Additionally, there are concerns with the method and size of the test specimen, mounting procedures, and the time of the test used in UL 2846 as compared to ASTM E84.

An explanation of the testing methods in question are necessary for approval. Upon review of the proposed standards, it was determined that ASTM E84 is meant for testing of sheets and not piping.

Additionally, the UL 2846 standard has an entirely different test method/protocol than ASTM E84 and provides differing results. For this reason, the existing language is being kept. Furthermore, the proposed language conflicts with Section 602.2.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: 
AFFIRMATIVE: 21 
NEGATIVE: 8 
NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:

BALLANCO: The substantiation justified this change. This should have been approved as submitted.

CUDAHY: The rejection should be overturned in ballot. UL 2846, Fire Test of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics, is an alternative plenum test standard to ASTM E84/UL 723 similar to other standards already in the UMC which are product specific to rod and tube like products, such as UL 1887 (Section 602.2.2 Fire Sprinkler Piping) and UL 1820 (Section 602.2.3 Pneumatic Tubing). The UL 2846 standard has been in the IMC since the 2014 version.

KOERBER: Proposal should be accepted. The substantiation is sound.

MACNEVIN: I agree that the committee rejection should be overturned. The committee statement is inaccurate, because UL 2846 is actually a safer and more consistent test method for plastic pipes, as compared with ASTM E84 which was intended for flat sheet products, and is therefore open to potential misuse or misinterpretation. UL 2846 is an ANSI-accredited standard that is no less stringent than ASTM E84 and in fact does a better job at standardizing the testing of plastic pipes without misuse or misinterpretation, allowing for safer construction. As mentioned, UL 2846 was accepted in the IMC several code cycles ago, so unless this vote is reversed, the UMC is out-of-date with regards to plenum safety with plastic pipes.

TRAFTON, A: This section is appropriate and should be in code.

TRAFTON, P: This should have been accepted as it clearly provides proper safety for piping within plenums.

WHITE: This should be approved based on its substantiation.

WISEMAN: The substantiation is adequate for this proposal. This should have been approved.
602.0 Material.

602.2 Combustibles Within Ducts or Plenums. Materials exposed within ducts or plenums shall be noncombustible or shall have a flame spread index not to exceed 25 and a smoke-developed index not to exceed 50, where tested as a composite product in accordance with ASTM E84 or UL 723. Plastic piping installed in plenums shall be tested in accordance with all requirements of ASTM E84 or UL 723. Mounting methods, supports and sample sizes of materials for testing that are not specified in ASTM E84 or UL 723 shall be prohibited.

Exceptions:
(1) Return-air and outside-air ducts, plenums, or concealed spaces that serve a dwelling unit.
(2) Air filters in accordance with the requirements of Section 311.2.
(3) Water evaporation media in an evaporative cooler.
(4) Charcoal filters where protected with an approved fire suppression system.
(5) Products listed and labeled for installation within plenums in accordance with Section 602.2.1 through Section 602.2.3.
(6) Smoke detectors in accordance with the requirements of Section 609.0.
(7) Duct insulation, coverings, and linings and other supplementary materials installed in accordance with Section 605.0.
(8) Materials in a hazardous fabrication area including the areas above and below the fabrication area sharing a common air recirculation path with the fabrication area.

609.0 Automatic Shutoffs.
609.1 Air-Moving Systems and Smoke Detectors. Air-moving systems supplying air in excess of 2000 cubic feet per minute (ft³/min) (0.9439 m³/s) to enclosed spaces within buildings shall be equipped with an automatic shutoff. Automatic shutoff shall be accomplished by interrupting the power source of the air-moving equipment upon detection of smoke in the main supply-air duct served by such equipment. Duct smoke detectors shall comply with UL 268A and shall be installed in accordance with the manufacturer's installation instructions. Such devices shall be compatible with the operating velocities, pressures, temperatures, and humidities of the system. Where fire-detection or alarm systems are provided for the building, the smoke detectors shall be supervised by such systems in an approved manner.

Exceptions:
(1) Where the space supplied by the air-moving equipment is served by a total coverage smoke-detection system in accordance with the fire code, interconnection to such system shall be permitted to be used to accomplish the required shutoff.
(2) Automatic shutoff is not required where occupied rooms served by the air-handling equipment have direct exit to the exterior, and the travel distance does not exceed 100 feet (30 480 mm).
(3) Automatic shutoff is not required for Group R, Division 3 and Group U Occupancies.
(4) Automatic shutoff is not required for approved smoke-control systems or where analysis demonstrates shutoff would create a greater hazard, such as shall be permitted to be encountered in air-moving equipment supplying specialized portions of Group H Occupancies. Such equipment shall be required to have smoke detection with remote indication and manual shutoff capability at an approved location.
(5) Smoke detectors that are factory installed in listed air-moving equipment shall be permitted to be used in lieu of smoke detectors installed in the main supply-air duct served by such equipment.

SUBSTANTIATION:
Early warning plays a key role in a facility’s ability to safely evacuate its residents during a fire emergency. As a result, a lot is riding on smoke detectors and the fire alarm system’s ability to operate and function properly. Smoke detectors are addressed in Section 609.0. A reference to Section 609.0 is being made in Section 602.2 as this provides ease of use for the end user and ensures that smoke detectors are installed correctly up-to-code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 143
UMC 2024  Section: 602.2

SUBMITTER: Michael Cudahy
Plastic Pipe & Fittings Association

RECOMMENDATION:
Revise text

602.0 Material.

602.2 Combustibles Within Ducts or Plenums. Materials exposed within ducts or plenums shall be noncombustible or shall have a flame spread index not to exceed 25 and a smoke-developed index not to exceed 50, where tested as a composite product in accordance with ASTM E84 or UL 723. Plastic piping Combustible materials installed in plenums shall be tested in accordance with all requirements of ASTM E84 or UL 723. Mounting methods, supports and sample sizes of materials for testing that are not specified in ASTM E84 or UL 723 shall be prohibited.

Exceptions:
(1) through (8) (remain unchanged)

SUBSTANTIATION:
The language, being specific to only plastic piping suggests other combustible materials may not be required to be tested in accordance with or to all requirements of ASTM E84 or UL 723. The last sentence is redundant to the previous.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
Removing the existing language would create conflicts with other sections of the code. If this language is removed, it will no longer align with the other sections of the code and may cause confusion. The language should stay for guidance for all users of the code. Additionally, the change would allow all combustible materials to be installed in plenums rather than only plastic piping. All combustible materials would need to be tested to ASTM E84 or UL 723.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 22  NEGATIVE:  6  ABSTAIN:  1  NOT RETURNED:  1  Heine

EXPLANATION OF AFFIRMATIVE:
BALLANCO: This section needs to be modified, however, the change results in the first and second sentences saying the same thing. The second and third sentences should be deleted.

EXPLANATION OF NEGATIVE:
CUDAHY: The Committee statement is really inaccurate and the existing language is broken. There are exceptions for many products to the section. The requirement should not apply to just one class of product.

MACNEVIN: This proposal should be accepted as it adds safety to and reduces confusion from the code. Expanding the requirement to all "combustible materials" improves safety. Removing the last sentence reduces confusion, since the ASTM E84 and UL 723 standards should dictate the specific testing and mounting requirements, not the code.

TRAFTON, A: I agree with Michael Cudahy.
TRAFTON, P: This section needs modification as it does not seem to match its heading, but the suggested change does not improve it. Time should be taken to get it right.

WHITE: The section could stop after the first sentence, the remaining text is redundant. As proposed, it does clean up the section.

WISEMAN: This should have been accepted. Michael Cudahy is correct. The Committee statement is really inaccurate and the existing language is broken. There are exceptions for many products to the section. The requirement should not apply to just one class of product.

EXPLANATION OF ABSTAIN:

KOERBER: It is my belief that the entire last 2 sentences, "Plastic piping installed in plenums shall be tested in accordance with all requirements of ASTM E84 or UL 723. Mounting methods, supports and sample sizes of materials for testing that are not specified in ASTM E84 or UL 723 shall be prohibited" should have been relocated as Section 602.2.5 in the same manner as electrical wiring in plenums, fire sprinkler piping in plenums, pneumatic tubing in plenums, and discrete products in plenums. Placing plastic piping in its present location was not the best choice from the start.
Item #: 144

UMC 2024 Section: 602.2.1, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

602.0 Material.

602.2 Combustibles Within Ducts or Plenums. (remaining text unchanged)

602.2.1 Electrical. Electrical wiring in plenums shall comply with NFPA 70. Electrical wires and cables and optical fiber cables exposed within the plenum shall be listed and labeled for use in plenums and shall have a flame spread distance not exceeding 5 feet (1524 mm), an average optical density not exceeding 0.15, and a peak optical density not exceeding 0.5, where tested in accordance with NFPA 262, or shall be installed in metal raceways or metal sheathed cable.

Combustible optical fiber and communication raceways exposed within a plenum shall be listed and labeled for use in plenums and shall have a flame spread distance not greater than 5 feet (1524 mm), an average optical density not greater than 0.15, and a peak optical density not exceeding 0.5, where tested in accordance with UL 2024. Only plenum-rated wires and cables shall be installed in plenum-rated raceways.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 2024-2014</td>
<td>Cable Routing Assemblies and Communications Raceways (with revisions through August 5, 2015)</td>
<td>Miscellaneous</td>
<td>602.2.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 2024 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
This code change differentiates the requirements for electrical wiring and optical fiber cables in plenums from the requirements for optical fiber cable and communication raceways in plenums. The appropriate standard for the raceways is UL 2024, “Cable Routing Assemblies and Communications Raceways.”

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed language is being rejected as the provisions are already covered in Section 602.2.1 and the NFPA 262 standard. These provisions should be addressed in the electrical code. The language is repetitive and should be rewritten to clarify the intent.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 21 NEGATIVE: 8 NOT RETURNED: 1 Heine
EXPLANATION OF NEGATIVE:

BALLANCO: This change should have been accepted as submitted. The substantiation justifies the proposed change.

FEEHAN: This language and information is necessary for enforcement.

KOERBER: The substantiation is correct and sound. This proposal should be accepted.

MACNEVIN: This proposal should be accepted as submitted as it adds safety to the code. It is appropriate that requirements for communications wiring within ductwork are listed in the UMC, just as requirements for plumbing pipes and other materials installed within ducts are listed in the UMC. UL 2024 is the correct standard for this application.

TRAFTON, A: The substantiation is appropriate for this code change.

TRAFTON, P: This change is properly written and appropriate for this section of the Code, plus its substantiation justifies the change. This method of installation is correct and necessary. It should not have been rejected.

WHITE: The proposal is appropriate, not redundant, and improves the code.

WISEMAN: This proposal is necessary and well written. It would be helpful addition.
Proposals

Item #: 145
UMC 2024  Section: 602.3

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

602.0 Material.

602.3 Tall Wood (Mass Timber) Buildings. Duct systems installed in Type IV-A, Type IV-B, or Type IV-C tall wood (mass timber) buildings shall comply with the following:
(1) Be designed by a registered design professional in accordance with this code and the building code.
(2) Duct systems shall have a flame-spread index and a smoke developed index in accordance with Section 602.2.
(3) Smoke dampers, fire dampers, and ceiling dampers shall be in accordance with Section 606.0.
(4) Be designed to accommodate expansion, contraction, and differential movement between parts of a mass timber building.

(below renumber sections)

(below shown for reference only)

602.2 Combustibles Within Ducts or Plenums. Materials exposed within ducts or plenums shall be noncombustible or shall have a flame spread index not to exceed 25 and a smoke-developed index not to exceed 50, where tested as a composite product in accordance with ASTM E84 or UL 723. Plastic piping installed in plenums shall be tested in accordance with all requirements of ASTM E84 or UL 723. Mounting methods, supports and sample sizes of materials for testing that are not specified in ASTM E84 or UL 723 shall be prohibited.

Exceptions:
(1) Return-air and outside-air ducts, plenums, or concealed spaces that serve a dwelling unit.
(2) Air filters in accordance with the requirements of Section 311.2.
(3) Water evaporation media in an evaporative cooler.
(4) Charcoal filters where protected with an approved fire suppression system.
(5) Products listed and labeled for installation within plenums in accordance with Section 602.2.1 through Section 602.2.3.
(6) Smoke detectors.
(7) Duct insulation, coverings, and linings and other supplementary materials installed in accordance with Section 605.0.
(8) Materials in a hazardous fabrication area including the areas above and below the fabrication area sharing a common air recirculation path with the fabrication area.

606.0 Smoke Dampers, Fire Dampers, and Ceiling Dampers.
606.1 Smoke Dampers. Smoke dampers shall comply with UL 555S, and shall be installed in accordance with the manufacturer’s installation instructions where required by the building code.
606.2 Fire Dampers. Fire dampers shall comply with UL 555, and shall be installed in accordance with the manufacturer’s installation instructions where required by the building code. Fire dampers shall have been tested for closure under airflow conditions and shall be labeled for both maximum airflow permitted and direction of flow. Where more than one damper is installed at a point in a single air path, the entire airflow shall be assumed to be passing through the smallest damper area.
Ductwork shall be connected to damper sleeves or assemblies in accordance with the fire damper manufacturer’s installation instructions.

606.3 Ceiling Radiation Dampers. Ceiling radiation dampers shall comply with UL 555C, and shall be installed in accordance with the manufacturer’s installation instructions in the fire-resistive ceiling membrane of floor-ceiling and roof-ceiling assemblies where required by the building code. Fire dampers not meeting the temperature limitation of ceiling radiation dampers shall not be used as a substitute.

606.4 Multiple Arrangements. Where size requires the use of multiple dampers, each damper shall be listed for use in multiple arrangements and installed in accordance with the manufacturer’s installation instructions.

606.5 Access and Identification. Fire and smoke dampers shall be provided with an approved means of access large enough to allow inspection and maintenance of the damper and its operating parts. The access shall not affect the integrity of the fire-resistance-rated assembly. The access openings shall not reduce the fire-resistance rating of the assembly.

Access shall not require the use of tools. Access doors in ducts shall be tight fitting and approved for the required duct construction. Access points shall be permanently identified on the exterior by a label with letters not less than 1/2 of an inch (12.7 mm) in height reading as one of the following:

(1) Smoke Damper
(2) Fire Damper
(3) Fire/Smoke Damper

606.6 Freedom from Interference. Dampers shall be installed in a manner to ensure positive closing or opening as required by function. Interior liners or insulation shall be held back from portions of a damper, its sleeve, or adjoining duct that would interfere with the damper’s proper operation. Exterior materials shall be installed so as not to interfere with the operation or maintenance of external operating devices needed for the function of the damper.

606.7 Temperature Classification of Operating Elements. Fusible links, thermal sensors, and pneumatic or electric operators shall have a temperature rating or classification as in accordance with the building code.

SUBSTANTIATION:
The building codes include Type IV tall wood buildings (also known as mass timber construction) which are constructed with fire resistive ratings of either three or two hours. Proposed Section 602.3 provides information and direction for fire resistive ratings associated with mass timber construction.

There are no prescriptive requirements for allowance of expansion and contraction of mass timber buildings either during or after completion of construction. Current studies that are monitoring the moisture performance of mass timber building during construction utilize monitors, and there is indication that the mass timber expands during construction and contracts over time. The proposed Section 602.3 provides guidance for the mechanical system design within wood buildings constructed of Type IV-A, Type IV-B, or Type IV-C.

[Supporting documentation provided in KAVI for TC review]

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

602.0 Material.

602.3 Tall Wood (Mass Timber) Buildings. Duct systems installed in Type IV-A, Type IV-B, or Type IV-C tall wood (mass timber) buildings shall comply with the following:

(1) Be designed by a registered design professional in accordance with this code and the building code.
(2) Duct systems shall have a flame-spread index and a smoke developed index in accordance with Section 602.2.
(3) Smoke dampers, fire dampers, and ceiling dampers shall be in accordance with Section 606.0.
(4) Be designed to accommodate expansion, contraction, and differential movement between parts of a mass timber building.

COMMITTEE STATEMENT:
The proposed modification is to remove the listed Types (4A, 4B or 4C). All such types are already found in the building code and are better suited in that location. Including the various types may cause confusion for users of the code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 19 NEGATIVE: 10 NOT RETURNED: 1 Heine

Note: Item # 145 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.
EXPLANATION OF NEGATIVE:

BALLANCO: This change is unnecessary. There are no special mechanical requirements for tall wood buildings.

CUDAHY: This is an unnecessary language for a subject that the building code would address, if needed.

FEEHAN: This language is unnecessary. A pointer to the building code would be better.

KOERBER: The language proposed is not needed.

MACNEVIN: This change is not appropriate, as there is no need to add duct requirements for each specific type of building construction, which is what this item begins to do. There are no special mechanical requirements for tall wood buildings, and the language is redundant.

TERZIGNI: The change does not provide any real benefit and it does not prescribe (directly or by reference to a standard) how to address the concerns presented.

Tрафton, A: This does not belong in UMC but as a building code item.

Tрафton, P: Tall wood buildings belong in the building code and there are no special mechanical details and requirements needed for this type of building.

WHITE: This not appropriate for the UMC, these requirements exist for many types of structures and need not be singled out for one specific type of construction.

WISEMAN: This is not appropriate for the UMC. A reference to the building code would be sufficient.
Proposals

Item #: 146
UMC 2024  Section: 602.3.1, Table 602.3.1

SUBMITTER: Rudy B. Utulo, PE; Martin Espinosa
M & P Consulting Engineers, Inc.

RECOMMENDATION:
Add new text

602.0 Material.

602.3 Metallic. Ducts, plenums, or fittings of metal shall comply with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Flexible metallic ducts shall comply with UL 181.

602.3.1 Minimum Duct Thickness. Metallic ducts, plenums, or fittings shall have a thickness not less than that specified in Table 602.3.1 or in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

### TABLE 602.3.1
MINIMUM DUCT AND PLENUM SHEET METAL THICKNESS FOR ROUND AND FLAT-OVAL DUCTS (LOW, MEDIUM, AND HIGH PRESSURE)

<table>
<thead>
<tr>
<th>DUCT DIAMETER MAX WIDTH (inches)</th>
<th>ALUMINUM B. &amp; S. GAUGE</th>
<th>STEEL-THICKNESS IN INCHES (STEEL-GALVANIZED SHEET GAUGE)</th>
<th>GIRTH JOINTS¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW PRESSURE</td>
<td>ROUND</td>
<td>ROUND FLAT-OVAL SEAM PRESSURE&lt;2&quot;</td>
<td>MEDIUM &amp; HIGH PRESSURE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPIRAL SEAM PRESSURE&lt;2&quot; &lt;10&quot; WC²</td>
<td>MEDIUM GIRTH REINFORCING, MAX. SPACING &amp; ANGLE SIZE</td>
</tr>
<tr>
<td>ROUND</td>
<td>FLAT-OVAL</td>
<td>LONGITUDINAL SEAM WELDING FITTINGS</td>
<td></td>
</tr>
<tr>
<td>Up to 9</td>
<td>0.019 (26)</td>
<td>0.024 (24)</td>
<td>0.024 (24)</td>
</tr>
<tr>
<td>9 to 14</td>
<td>0.019 (26)</td>
<td>0.024 (24)</td>
<td>0.024 (24)</td>
</tr>
<tr>
<td>14 to 23</td>
<td>0.024 (24)</td>
<td>0.030 (22)</td>
<td>0.024 (24)</td>
</tr>
<tr>
<td>23 to 37</td>
<td>0.030 (22)</td>
<td>0.036 (20)</td>
<td>0.030 (22)</td>
</tr>
<tr>
<td>37 to 51</td>
<td>0.036 (20)</td>
<td>0.047 (18)</td>
<td>0.036 (20)</td>
</tr>
<tr>
<td>51 to 61</td>
<td>0.047 (18)</td>
<td>0.058 (16)</td>
<td>- (18)</td>
</tr>
<tr>
<td>61 to 84</td>
<td>0.058 (16)</td>
<td>0.070 (14)</td>
<td>- (16)</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 inch water gauge = 0.249 kPa
(1) For low pressure system any of the following joints are acceptable: butt slip, roll slip, snap slip, plenum lock and companion flange.
(2) Acceptable longitudinal seams for low-pressure systems: acme (grooved), snap lock, standing and spiral.
Note: The SMACNA standard was not developed via an open process having a published development procedure in accordance with Section 3-3.7.1.2 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The minimum duct sheet metal thickness table was removed from the 2009 UMC. This proposal adds the minimum sheet metal thickness for ducts that are commonly used in the industry.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed duct thicknesses and gauges are already addressed in industry standards such as SMACNA HVAC standards.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28  ABSTAIN: 1  NOT RETURNED: 1  Heine

EXPLANATION OF ABSTAIN:
TERZIGNI: I abstain as the change could materially affect SMACNA. I do agree with the Committee’s response.
Proposals

Item #: 147
UMC 2024  Section: 602.4, 602.4.4, Table 1701.1, Table 1701.2

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

602.0 Material.

602.4 Nonmetallic Ducts. Nonmetallic ducts shall comply with Section 602.4.1, Section 602.4.2, Section 602.4.3 or Section 602.4.4 through Section 602.4.5.

602.4.4 Fibrous Glass Duct. Fibrous glass ducts, plenums, or fittings shall be constructed in accordance with SMACNA Fibrous Glass Duct Construction Standards or NAIMA Fibrous Glass Duct Construction Standards.

602.4.5 Other Materials. Flexible and rigid ducts, plenums, or fittings for use in heating, ventilation, and air conditioning systems of other nonmetallic materials listed and labeled to UL 181 shall be permitted.

Exception: Plastic ducts shall comply with Section 603.5.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMACNA-2003</td>
<td>Fibrous Glass Duct Construction Standards, Seventh Edition</td>
<td>Fiberglass Ducts</td>
<td>602.4.4</td>
</tr>
<tr>
<td>NAIMA-2002</td>
<td>Fibrous Glass Duct Construction Standards, Fifth Edition</td>
<td>Fiberglass Ducts</td>
<td>602.4.4</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
</table>

(ports of table not shown remain unchanged)

Note: The SMACNA and NAIMA standards were not developed via an open process having a published development procedure in accordance with Section 3-3.7.1.2 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
A section for fibrous glass duct is being added to Chapter 6 as the UMC is currently silent on provisions for fibrous glass duct. There are two industry standards used for fibrous glass duct: SMACNA Fibrous Glass Duct Construction
Standards and NAIMA Fibrous Glass Duct Construction Standards. The standards provide the performance characteristics for fibrous glass board as well as specifications for closures and illustrations of how to construct the full range of fittings. Also covered are details for connections to equipment and air terminals, hanger schedules, reinforcement requirements, fabrication of rectangular duct and fittings, closures of seams and joints, channel and tie rod reinforcements, and hangers and supports.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28 ABSTAIN: 1 NOT RETURNED: 1 Heine

EXPLANATION OF ABSTAIN:

TERZIGNI: I abstain because the proposal could materially affect SMACNA.
602.0 Material.

602.4 Nonmetallic Ducts. Nonmetallic ducts shall comply with Section 602.4.1, Section 602.4.2, Section 602.4.3 or Section 602.4.4 through Section 602.4.5.

602.4.4 Plastic Ducts. Plastic air ducts and fittings shall comply with ASTM D1784 and ASTM D2412 and shall be constructed of polyvinyl chloride (PVC). Plastic air ducts and fittings shall only be utilized in underground installations in accordance with Section 603.5 and Section 603.11. The maximum design temperature for systems utilizing plastic air duct and fittings shall be 150°F (66°C).

602.4.5 Other Materials. Flexible and rigid ducts, plenums, or fittings for use in heating, ventilation, and air conditioning systems of other nonmetallic materials listed and labeled to UL 181 shall be permitted.

Exception: Plastic ducts shall comply with Section 603.5.

603.0 Installation of Ducts.

603.5 Plastic Ducts. Plastic air ducts and fittings shall be permitted where installed underground and listed for such use.

603.11 Underground Installation. Ducts installed underground shall be approved for the installation and shall have a slope of not less than 1/8 inch per foot (10.4 mm/m) back to the main riser. Ducts, plenums, and fittings shall be permitted to be constructed of concrete, clay, or ceramics where installed in the ground or in a concrete slab, provided the joints are sealed and duct is secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Metal ducts where installed in or under a concrete slab shall be encased in not less than 2 inches (51 mm) of concrete, secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.

### TABLE 1701.1 REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D1784-2020</td>
<td>Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds</td>
<td>Plastic ducts</td>
<td>602.4.4</td>
</tr>
<tr>
<td>ASTM D2412-2021</td>
<td>Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading</td>
<td>Plastic ducts</td>
<td>602.4.4</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: ASTM D 1784 and ASTM D 2412 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.
SUBSTANTIATION:
Plastic air ducts and fittings are commonly used in underground applications. ASTM D1784 and ASTM D2412 are the appropriate standards for the testing of plastic ducts for tensile strength, modulus of elasticity, flexural yield strength, impact strength, deflection temperatures, flammability, and chemical resistance. Plastic duct fittings are manufactured with either high density polyethylene (HDPE) or polyvinyl chloride (PVC). Since plastic duct and fitting systems are installed below grade, they are not directly exposed to a fire within the building. Therefore, the fire characteristics of the duct and fittings would not be applicable to underground duct systems.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed standards are not applicable to plastic ducts found in Chapter 6 of the UMC and should therefore be rejected. Furthermore, the proposal would limit plastic ducts to PVC material only, which is overly restrictive.

In Section 602.4, the referenced sections are not to be grouped together. They each apply to different types of ducts and the sections should reflect this. The substantiation also does not address fire within the ducts. Flammability requirements in the standard are for materials and not specific to ducts. There are no actual performance requirements.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 149

UMC 2024  Section: 602.6

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

602.6 Material.

602.6 Corridors. Corridors shall not be used to convey air to or from rooms where the corridor is required to be of fire-resistive construction in accordance with the building code except where permitted by the building code. Corridors shall not serve as supply, return, exhaust, relief, or ventilation air ducts except where permitted by the building code.

SUBSTANTIATION:
As stated in this code change, the added sentence clarifies that corridors shall not serve as supply, return, exhaust, relief, or ventilation air ducts except where permitted by the building code.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

602.0 Material.

602.6 Corridors. Corridors shall not be used to convey air to or from rooms where the corridor is required to be of fire-resistive construction in accordance with the building code except where permitted by the building code. Corridors shall not serve as supply, return, exhaust, relief, or ventilation air ducts except where permitted by the building code.

COMMITTEE STATEMENT:
The modification removes the exception referencing the building code as such code does not permit corridors to serve as supply, return, exhaust, relief, or ventilation air ducts.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 27  NEGATIVE: 2  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

WHITE: This is a change in the intent of Section 602.6 which previously only applied to corridors of fire resistive construction. This removes that stipulation and now applies to all corridors. It would seem you could no longer have a return air grille in a corridor, that is a big change in non-rated construction.

WISEMAN: I understand and agree with the intent, however, the wording will cause confusion. This should be revisited.
Proposals

Item #: 150
UMC 2024 Section: 603.1.1

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.1.1 Pressure Classification. The pressure classification of ducts shall be not less than the design operating pressure of the air distribution in which the duct is utilized. All ducts regardless of pressure classification(s) shall be sealed to Seal Class A.

SUBSTANTIATION:
Leaky ducts are a symptomatic problem within the industry. By requiring all ducts to be sealed to Seal Class A per the requirements of SMACNA HVAC Duct Construction Standards will decrease the issue, making a more reliable outcome for the end users.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 21 NEGATIVE: 7 ABSTAIN: 1 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:
BALLANCO: This proposal is overly restrictive for residential return ducts located completely within the interior envelope of the building.

FEEHAN: Too restrictive.

KOERBER: The proposal is overly restrictive as it would apply to all ducts under all conditions. I don't think that is the best direction.

TRAFTON, A: The code requirements are too restrictive for residential construction.

TRAFTON, P: I agree with Julius Ballanco. In residential applications, the duct leakage is not an issue. The issue is assuring that the return air goes through the high-efficiency filter (in California, we are required to use MERV 13).

WHITE: First, it is mis-categorized; it is in the section for pressure classifications not sealing. Second, this is an onerous requirement for all ducts to have Class A sealing applied.

WISEMAN: Onerous and overly restrictive.

EXPLANATION OF ABSTAIN:
MACNEVIN: Insufficient expertise on this topic.
Proposals

Item #: 151
UMC 2024  Section: 603.10

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.10 Cross Contamination. Exhaust ducts that convey Class 4 air shall be negatively pressurized relative to ducts, plenums, or occupiable spaces through which the ducts pass. Exhaust ducts under positive pressure that convey Class 2 or Class 3 air shall not extend into or pass through ducts, plenums, or occupiable spaces other than the space from which the exhaust air is drawn.

Exception: Exhaust ducts conveying Class 2 air and exhaust ducts conveying air from residential kitchen hoods that are sealed in accordance with Seal Class A of the SMACNA HVAC Air Duct Leakage Test Manual. (ASHRAE 62.1:5.2.1, 5.2.2)

SUBSTANTIATION:
Leaky ducts are a symptomatic problem within the industry, by requiring all ducts to be sealed to Seal Class A per the requirements of SMACNA HVAC Duct Construction Standards will decrease the issue making a more reliable outcome for the end users. This exception will not be needed if other proposals for 603.9 and 603.1.1 are approved.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

WHITE: If this would be taken care of in other proposed changes, it should have been included with those, I cannot tell where this is accomplished. Regardless, this proposal removes the exception for these ducts that (if approved elsewhere) would now be mandated to be sealed. It appears that these ducts carrying Class 2 Air or exhaust must now leave the structure in the room where it is generated, this is onerous.
Proposals

Item #: 152
UMC 2024  Section: 603.11

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.11 Underground Installation. Ducts installed underground shall be approved for the installation and shall have a slope of not less than 1/8 inch per foot (10.4 mm/m) back to the main riser. Underground Ducts, plenums, and fittings shall be permitted to be constructed of approved concrete, clay, or ceramics, metal, or plastic where installed in the ground or in a concrete slab, provided the joints are sealed and duct is secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Metal ducts where installed in or under a concrete slab shall be encased in not less than 2 inches (51 mm) of concrete, secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.

(below shown for reference only)

603.0 Installation of Ducts.

603.5 Plastic Ducts. Plastic air ducts and fittings shall be permitted where installed underground and listed for such use.

SUBSTANTIATION:
Plastic ducts are permitted to be installed underground per Section 603.5 (Plastic Ducts). Metal ducts are also allowed to be installed underground per the last sentence of Section 603.11 (Underground Installation). Therefore, metal and plastic need to be added to Section 603.11 to make it clear that these materials are permitted to be installed underground as long as they meet the requirements of this section and other applicable sections of the UMC.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The term “approved concrete” is vague, may be misinterpreted, and may not be enforceable.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposal

Item #: 153

UMC 2024 Section: 203.0, 602.4.3, 603.12

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.12 Fabric Air Dispersion Systems. Where installed, fabric air dispersion systems shall be completely in exposed locations in duct systems under positive pressure, and not pass through or penetrate fire-resistant-rated construction. Fabric air dispersion systems shall be listed and labeled in accordance with UL 2518.

Exception: Installation of under-floor air dispersion systems shall be permitted where listed and labeled for such use.

602.4.3 Fabric Air Dispersion Systems. Fabric air dispersion systems shall be listed and labeled in accordance with UL 2518.

203.0 – A – Fabric Air Dispersion Systems. Materials such as fabrics or textiles intended for use in air handling systems in exposed locations operating under positive pressure. Also known as fabric duct, air socks, textile ventilation, or textile air dispersion systems.

SUBSTANTIATION:

Air dispersion systems that are listed and labeled for under-floor installation are used in the industry and allowed by jurisdictions. Under-floor air dispersion systems are designed to distribute and disperse air to perimeter and high-heat load locations in Under Floor Air Distribution (UFAD) Systems. Fabric duct for underfloor air dispersion is an ideal alternative to conventional metal ducting for more efficient cooling. Efficient and effective cooling is necessary to create a comfortable indoor environment. Fabric underfloor air dispersion systems are a unique method for delivering conditioned air in buildings or spaces. Ideal for high rise buildings, offices, hospitals, hotels, schools, airports, and other commercial buildings.

Fabric duct for underfloor cooling are based on displacement ventilation principles, requiring that the air stratifies from the floor to the ceiling, where it is either exhausted or recycled back into the conditioned space. Under-floor air dispersion systems reduce heat loss (temperature gain) or thermal decay over extended distances and to perimeter zones. Additionally, porous fabrics eliminate the risk of condensation to the ductwork.

This change clarifies that air dispersion systems are not always installed in completely exposed locations when they are under-floor systems. UL 2518 uses the term “fabric air dispersion system” throughout the standard. Additionally, the code change removes a requirement from the definition of “Air Dispersion Systems” to be installed “in exposed locations.” Section 603.12 already requires air dispersion systems to be installed “in exposed locations.”

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:

The proposal is being rejected as under-floor air dispersion systems should not be allowed under-floor even if listed and labeled for such use. The exception may lead to poor installations that may create safety concerns. Furthermore, the term "fabric" is being rejected as not all air dispersion systems are made of fabric material and conflicts with the specifications of UL 2518.
<table>
<thead>
<tr>
<th>TOTAL ELIGIBLE TO VOTE: 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine</td>
</tr>
</tbody>
</table>
Proposals

Item #: 154
UMC 2024  Section: 603.2, 608.9, 608.11

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.2 Under Floor or Crawl Space. Air ducts installed under a floor in a crawl space be installed in accordance with the following:
(1) Shall not prevent access to an area of the crawl space.
(2) Where it is required to move under ducts for access to areas of the crawl space, a vertical clearance of not less than 18 inches (457 mm) shall be provided.
(3) Diffusers, registers, or grilles shall not be installed in floors of toilet rooms, bathrooms, or high-humidity areas.

608.0 Use of Under-Floor Space as Supply Plenum for Dwelling Units.

608.9 Floor Registers. Floor registers shall be designed for easy removal in order to give access for cleaning the receptacles. Where installed, floor registers shall be located not less than 4 inches (102 mm) from the finished wall. Diffusers, registers, or grilles shall not be installed in floors of toilet rooms, bathrooms, or high-humidity areas.

608.11 Wall Registers. Each wall register shall be connected to the air chamber by a register box or boot. Diffusers, registers, or grilles in walls of toilet rooms, bathrooms, or high-humidity areas shall be installed not less than 6 inches (152 mm) above the finished floor.

SUBSTANTIATION:
There are currently no code requirements for floor registers installed in bathrooms, or high-humidity areas, such as laundry areas and kitchens. Although it is a poor design choice, there is no code language that I know of. Water (or other substances) from these areas can and will make it into the duct system, causing mold growth, rust, odors, and other issues. For example, a floor register located near a shower is subject to water entering the duct system; a floor register located near a toilet is subject to bodily fluids such as vomit or urine making it into the duct system, which can occur with children, elderly, infirm, or pets. This code requirement should be located in both the under floor duct installation section as well as the section for floor registers. An additional requirement for wall registers is being added to address the same issue.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as no technical substantiation was provided to justify the distances and clearances provided for wall and floor diffusers, registers, or grilles.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 155
UMC 2024  Section: 603.3.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.
603.1 General. (remaining text unchanged)

603.3.1 603.1.6 Earthquake Loads. Ducts located in structures that are installed in areas classified as seismic design category C, D, E, or F categories shall be restrained to resist displacement due to earthquake motion in accordance with the building code.

SUBSTANTIATION:
This proposal change removes the specific seismic design categories and addresses potential duct displacement, leaving the responsibility to the installer or designer. The section is also being relocated to apply to ducts in general rather than only metal ducts.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee has requested that the proponent come back with the revision to replace the word "earthquake" with "seismic." The title was modified editorially.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 22  NEGATIVE: 7  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

BALLANCO: The current requirement is specific with reference to seismic design categories with a further reference to the Building Code. By removing this text, there is no enforcement language remaining. The section becomes subjective.

FEEHAN: How is "restrained to resist displacement due to earthquake motion" enforced if the Building Code requirement is removed? Who decides it is correct?

MACNEVIN: The proposed language is confusing, difficult to enforce, and subject to misinterpretation. Existing language should be kept.

TERZIGNI: This could potentially require that all ducts regardless of size or application to be braced. This is considerably more aggressive than ever historically required. There has always been exceptions for certain size or weight duct and when the duct was secured close to the supporting structure.

TRAFTON, A: The current code language is better.

WHITE: A huge over-reach to make seismic protection across all categories. This should have been rejected.

WISEMAN: This is creating vague and unenforceable language. The existing code is better.
Proposals

Item #: 156

UMC 2024  Section: 603.4.1

SUBMITTER:  Phil Pettit
            Control Air Conditioning Corporation
            Rep. Self

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.4 Flexible Air Ducts. (remaining text unchanged)

603.4.1 Length Limitation. Flexible air ducts shall be not more than 5 feet (1524 mm) in length and shall not be used in lieu of rigid elbows or fittings. Flexible air ducts shall be permitted to be used as an elbow at a terminal device.

Exceptions:
(1) Residential occupancies.
(2) Length limitations for flexible air ducts used as transition ducts for clothes dryers shall be in accordance with Section 504.4.2.2.

(below shown for reference only)

504.4.2.2 Transition Ducts. Listed clothes dryer transition ducts not more than 6 feet (1829 mm) in length shall be permitted to be used to connect the Type 1 dryer to the exhaust ducts. Transition ducts and flexible clothes dryer transition ducts shall not be concealed within construction, and shall be installed in accordance with the manufacturer’s installation instructions.

SUBSTANTIATION:
Although clothes dryer transition ducts are flexible air ducts, they are not intended to be grouped in with the flexible air duct requirements of Section 603.4.1. There has been confusion in the field and with code officials as to whether semi-rigid ducts are limited to the 5-foot length limit in UMC Section 603.4.1. Therefore, an exception is needed to clarify that the length limitation in Section 603.4.1 does not apply to flexible clothes dryer transition ducts; such requirements are found in Section 504.4.2.2 (Transition Ducts).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as Chapter 6 only applies to HVAC ducts, not clothes dryer ducts, and the UMC states that the more specific requirement prevails in Section 102.1.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 157
UMC 2024  Section: 603.5

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.5 Plastic Ducts. Plastic air ducts and fittings shall be permitted where installed underground in accordance with Section 603.11 and listed for such use.

(below shown for reference only)

603.11 Underground Installation. Ducts installed underground shall be approved for the installation and shall have a slope of not less than 1/8 inch per foot (10.4 mm/m) back to the main riser. Ducts, plenums, and fittings shall be permitted to be constructed of concrete, clay, or ceramics where installed in the ground or in a concrete slab, provided the joints are sealed and duct is secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Metal ducts where installed in or under a concrete slab shall be encased in not less than 2 inches (51 mm) of concrete, secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.

SUBSTANTIATION:
Plastic ducts are only permitted to be installed underground as stated in Section 603.5 (Plastic Ducts). The installation of underground ducts is addressed in Section 603.11 (Underground Installation). A reference in Section 603.5 would make it clear that plastic ducts must be installed underground per Section 603.11.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The reference is not needed regarding plastic ducts. The current language is clear and has sufficient requirements for plastic ducts.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 158
UMC 2024 Section: 603.6.1

SUBMITTER: David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Add new text

603.0 Installation of Ducts.

603.6 Protection of Ducts. Ducts installed in locations where they are exposed to mechanical damage by vehicles or from other causes shall be protected by approved barriers.

603.6.1 Weather Protection. Ducts installed on the exterior of the building shall be protected against the elements in accordance with Section 510.6.1.

(below shown for reference only)

510.6.1 Weather Protection. All ducts shall be protected on the exterior by paint or other suitable weather-protective coating. Ducts constructed of stainless steel shall not be required to have additional paint or weather-protective coatings. Ductwork subject to corrosion shall have minimal contact with the building surface. [NFPA 96:7.6.4 – 7.6.6]

SUBSTANTIATION:
Chapter 6 (Duct Systems) provides most of the duct requirements found in the UMC, however, there are some additional requirements from other chapters that apply to ducts in Chapter 6. For example, Section 510.6.1 applies to all ducts, not only exhaust ducts. Therefore, a reference to Section 510.6.1 would strengthen the code regarding weather protection of ducts installed on the exterior of buildings.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

603.6.1 Weather Protection. Ducts installed on the exterior of the building shall be protected against the elements in accordance with Section 510.6.1.

COMMITTEE STATEMENT:
The proposal is being modified so as not to reference a grease duct section and apply the provisions to all ducts.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Item #: 159
UMC 2024 Section: 603.9

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.9 Joints and Seams of Ducts. Joints and seams for duct systems shall comply with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Joints of duct systems shall be made substantially airtight by means of tapes, mastics, gasketing, or other means. All ducts shall be sealed to Seal Class A. Crimp joints for round ducts shall have a contact lap of not less than 1 1/2 inches (38 mm) and shall be mechanically fastened by means of not less than three sheet-metal screws equally spaced around the joint, or an equivalent fastening method.

SUBSTANTIATION:
Leaky ducts are a symptomatic problem within the industry. By requiring all ducts to be sealed to Seal Class A per the requirements of SMACNA HVAC Duct Construction Standards will decrease the issue, making a more reliable outcome for the end users.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 22 NEGATIVE: 7 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:
BALLANCO: This requirement is overly restrictive to return ducts in residential buildings where the duct is completely within the building interior envelope.

FEEHAN: Too restrictive.

KOERBER: I believe the proposal is overly restrictive.

MACNEVIN: The proposed new requirement is too restrictive and it was not justified in the Substantiation why all ducts should be Class A. Then what is the purpose or place for Classes B and C?

TRAFTON, A: Too restrictive.

WHITE: This proposal is too restrictive and unwarranted.

WISEMAN: Overly restrictive.
Proposal

Item #: 160

UMC 2024  Section: 603.9, Table 1701.1

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.9 Joints and Seams of Ducts. Joints and seams for duct systems shall comply with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Joints of duct systems shall be made substantially airtight by means of tapes, mastics, gasketing, or other means. Crimp joints for round ducts shall have a contact lap of not less than 1 1/2 inches (38 mm) and shall be mechanically fastened by means of not less than three sheet-metal screws equally spaced around the joint, or an equivalent fastening method. Joints and seams for duct systems in accordance with SMACNA Round Industrial Duct Construction Standards and SMACNA Rectangular Industrial Duct Construction Standards shall be permitted.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
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<tbody>
<tr>
<td>SMACNA 002-2004</td>
<td>SMACNA Rectangular Industrial Duct Construction Standards</td>
<td>Ducts</td>
<td>603.9</td>
</tr>
<tr>
<td>SMACNA 005-2013</td>
<td>SMACNA Round Industrial Duct Construction Standards</td>
<td>Ducts</td>
<td>603.9</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: The SMACNA standards do not meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The “SMACNA HVAC Duct Construction Standards – Metal and Flexible” standard covers general ducts joints and seams; however industrial rectangular and round ducts can also have joints and seams in accordance with the SMACNA Industrial Standards. The SMACNA Industrial Standards are being added to the end of Section 603.9 (Joints and Seams of Ducts).

The SMACNA Round Industrial Duct Construction standard covers joints and seams for round industrial duct and provides a standardized, engineered basis for design and construction of industrial ducts of Classes 1 to 5 air. The standard includes a spiral duct chapter for Classes 1 and 2 air that covers design pressures ranging from 30 in. wg negative to 50 in. wg positive, plus carbon and galvanized steel tables and tables for stainless steel and aluminum, tables for duct sizes up to 96 in. diameter, and Duct Class 5 for systems handling corrosives and spiral lockseam pipe.

The SMACNA Rectangular Industrial Duct Construction standard covers joints and seams for rectangular industrial duct and provides tables for stainless steels and aluminum, plus materials, welding practices, and a guide...
specification. It covers the simple, low or moderate temperature and pressure (or vacuum) indoor systems as well as the more complex outdoor systems that operate at moderate to high temperature and pressure (or vacuum), and are subject to higher and more complex external loading.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The SMACNA standards do not meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28  ABSTAIN: 1  NOT RETURNED: 1  Heine

EXPLANATION OF ABSTAIN:

TERZIGNI: While I support the committee action, I will abstain as this proposal could materially affect SMACNA.
Proposals

Item #: 161
UMC 2024  Section: 603.9.2

SUBMITTER: Christopher Ruch
National Energy Management Institute Committee (NEMIC)

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.9 Joints and Seams of Ducts. (remaining text unchanged)

603.9.2 Duct Leakage Tests. Ductwork shall be leak-tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual. Duct leakage tests shall be performed by a technician certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB). Representative sections totaling not less than 10 percent of the total installed duct area shall be tested. Where the tested 10 percent fail to comply with the requirements of this section, then 40 percent of the total installed duct area shall be tested. Where the tested 40 percent fail to comply with the requirements of this section, then 100 percent of the total installed duct area shall be tested. Sections shall be selected by the building owner or designated representative of the building owner. Positive pressure leakage testing shall be permitted for negative pressure ductwork. The permitted duct leakage shall be not more than the following:

(remaining text unchanged)

SUBSTANTIATION:
Duct Air Leakage Testing should be limited to a certified Testing, Adjusting, and Balancing Technician (AABC, NEBB, or TABB). To provide accurate testing results, certified technicians must complete extensive training in the proper use of the SMACNA test methods, mechanical system understanding and the knowledge of the principles of air flow and pressure measurements. The listed certification organizations have proven methods for quality control. (See Supporting Material: TAB-Technical-Report-051220)

Section E 802.1, Commissioning Requirements, of the Uniform Mechanical Code set a precedent for similar requirements where an accurate verification of design intent is required.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee recommends adding the language “or other ANSI-accredited agencies” via public comment.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 23  NEGATIVE: 6  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:
CUDAHY: Do not forget, the Technical Committee recommended adding the language “or other ANSI-accredited agencies” via public comment.
EXPLANATION OF NEGATIVE:

BALLANCO: Not all groups are listed in this proposal.

FEEHAN: The list is not complete.

KOERBER: Too restrictive by limiting to only three organizations. Should at minimum include "or other ...." option.

TRAFTON, A: All groups should be represented.

WHITE: It is not the business of the UMC to dictate worker certifications no matter how many get included via public comment. This is an AHJ issue. This is not necessary.

WISEMAN: This decision is up to the AHJ. The UMC should not be specifying contractor certification criteria.

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 097, Section 403.10 (Air Balance), UMC Item # 110, Section 504.3 (Domestic Range Hoods), and UMC Item # 161, Section 603.9.2 (Duct Leakage Tests) resulted in conflicting language within the code. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

603.0 Installation of Ducts.

603.9 Joints and Seams of Ducts. (remaining text unchanged)

603.9.2 Duct Leakage Tests. Ductwork shall be leak-tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual. Duct leakage tests shall be performed by a technician certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB), or other equivalent approved agencies. Representative sections totaling not less than 10 percent of the total installed duct area shall be tested. Where the tested 10 percent fail to comply with the requirements of this section, then 40 percent of the total installed duct area shall be tested. Where the tested 40 percent fail to comply with the requirements of this section, then 100 percent of the total installed duct area shall be tested. Sections shall be selected by the building owner or designated representative of the building owner. Positive pressure leakage testing shall be permitted for negative pressure ductwork. The permitted duct leakage shall be not more than the following:

(remaining text unchanged)

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT: The language in UMC Item # 097, Section 403.10 (Air Balance) modifies the phrase ”or other ANSI accredited agencies“ to ”or other equivalent approved agencies“ to comply with the ANSI Essential Requirements for referencing products or services. Additionally, UMC Item # 110, Section 504.3 (Domestic Range Hoods) and UMC Item # 161, Section 603.9.2 (Duct Leakage Tests) were modified to correlate with the updated UMC Item # 097 by adding the phrase ”or other equivalent approved agencies.”

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 603.9.2 by adding the phrase ”or other equivalent approved agencies.”
Proposals

Item #: 162

UMC 2024  Section: 603.9.2, Table 1701.1, Table 1701.2

SUBMITTER: Mitch Pinsker
Affiliated Engineers Inc
Rep. ASHRAE Golden Gate Chapter Chair of Government Affairs Committee and Code Review Committee

RECOMMENDATION:
Revise text

603.0 Installation of Ducts.

603.9 Joints and Seams of Ducts.

603.9.2 Duct Leakage Tests. Ductwork shall be leak-tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual and Table 603.9.2. Duct Locations in Table 603.9.2 shall be as defined in ASHRAE 90.1. Test A shall include testing of representative sections totaling not less than the Test A 40 percentage of the total installed duct area for the designated Duct Application, Duct Location, and Pressure Class in Table 603.9.2 shall be tested. Where the tested 10 percent Test A duct sections fail to comply with the leakage requirements of this section, then 40 the Test B percentage of the total installed duct area in Table 603.9.2 shall be tested. Where the tested 40 percent Test B duct sections fail to comply with the requirements of this section, then 100 the Test C percentage of the total installed duct area in Table 603.9.2 shall be tested. Sections shall be selected by the building owner or designated representative of the building owner. Positive pressure leakage testing shall be permitted for negative pressure ductwork. The permitted duct leakage shall be not more than the following:

\[ L_{\text{max}} = C_L P \cdot 0.65 \] (Equation 603.9.2)

Where:

\[ L_{\text{max}} = \text{maximum permitted leakage, (ft}^3/\text{min)/100 square feet [0.0001 (m}^3/\text{s)/m}^2\text{] duct surface area.} \]

\[ C_L = \text{six, duct leakage class, (ft}^3/\text{min)/100 square feet [0.0001 (m}^3/\text{s)/m}^2\text{] duct surface area at 1 inch water column (0.2 kPa).} \]

\[ P = \text{test pressure, which shall be equal to the design duct pressure class rating, inch water column (kPa).} \]

Exception: Transfer air duct operating at less than 1 inch of water column (0.25 kPa). Testing is not required where the total duct surface area for a Duct Application, Duct Location, and Pressure Class row in Table 603.9.2 is less than 500 ft\(^2\) (46.45 m\(^2\)).

<table>
<thead>
<tr>
<th>TABLE 603.9.2</th>
<th>DUCT LEAKAGE TEST REQUIREMENTS</th>
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</thead>
<tbody>
<tr>
<td>DUCT APPLICATION</td>
<td>DUCT LOCATION</td>
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<tr>
<td>All</td>
<td>Outdoors</td>
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<td>Supply Return</td>
<td>Unconditioned spaces</td>
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### TABLE 1701.1
**REFERENCED STANDARDS**

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<th>STANDARD TITLE</th>
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<th>REFERENCED SECTION</th>
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(portions of table not shown remain unchanged)

**TABLE 1701.2
**STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES**

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
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</thead>
</table>

(portions of table not shown remain unchanged)

**Note:** ASHRAE/IES 90.1 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

**SUBSTANTIATION:**
Section 603.9.2 currently requires leakage testing of all ductwork regardless of location, application (e.g. supply vs. return vs. exhaust), and operating static pressure. This is at times onerous, e.g. simply installing a small tenant improvement with a handful of diffusers and small area of ductwork would require expensive testing. On the other hand, this section requires testing of only a small amount of ductwork outside of the building and high pressure ducts, yet leaks from these ducts have the largest impact on energy use. ASHRAE 90.1 requires testing of all exterior ductwork starting with 25% sampling as proposed here. The other testing requirements proposed in Table 603.9.2 are the same stringency as the current requirement for higher pressure classes. They are less stringent than the current requirement for lower pressure classes but still more stringent ASHRAE 90.1 which only requires testing of ductwork 3 inch pressure class and higher. Testing scope is broader for applications where leakage results in thermal heating and cooling impacts (e.g. supply air and return air ducts) as well as fan energy impacts.

An Exception is added for small projects with less than 500 square feet of duct area. This equates to a negligible 30 CFM of leakage for 1 inch pressure class.

Members of the Golden Gate ASHRAE chapter have submitted this recommendation to the ASHRAE 90.1 committee.

**COMMITTEE ACTION:** REJECT

**COMMITTEE STATEMENT:**
Nothing in the code prohibits the proposed requirements from being done. Additionally, the requirements are overly restrictive regarding duct leakage testing. The Technical Committee requests that the exception in Section 603.9.2 be resubmitted as a public comment.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** **AFFIRMATIVE:** 29  **NOT RETURNED:** 1  Heine
Proposals

Item #: 163

UMC 2024  Section: 605.1.2

SUBMITTER: Kartik Patel
Armacell, LLC

RECOMMENDATION:
Revise text

605.0 Insulation of Ducts.

605.1 General. (remaining text unchanged)

605.1.2 Duct Coverings and Linings. Insulation applied to the surface of ducts, including duct coverings, linings, tapes, and adhesives, located in buildings shall have a flame-spread index not to exceed 25 and a smoke-developed index not to exceed 50, where tested in accordance with ASTM E84 or UL 723. The specimen preparation and mounting procedures of ASTM E2231 shall be used. Air duct coverings and linings shall not flame, glow, smolder, or smoke where tested in accordance with ASTM C411 at the temperature to which they are exposed in service. In no case shall the test temperature be less than 250 F (121 C). Coverings shall not penetrate a fire-resistance-rate assembly. The duct coverings and linings shall be listed and labeled.

SUBSTANTIATION:
The proposed change will unify the listed and labeled requirements in the Uniform Mechanical Code and International Mechanical Code, Section 602.2.1.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
Duct coverings and linings are not required to be listed and labeled.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29    NOT RETURNED: 1    Heine
Proposals

Item #: 164

UMC 2024 Section: 605.1.2, 605.1.3, Table 1701.1

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

605.0 Insulation of Ducts.
605.1 General. (remaining text unchanged)
605.1.2 Duct Coverings and Linings. Insulation applied to the surface of ducts, including duct coverings, linings, tapes, and adhesives, located in buildings shall have a flame-spread index not to exceed 25 and a smoke-developed index not to exceed 50, where tested in accordance with ASTM E84 or UL 723. The specimen preparation and mounting procedures of ASTM E2231 shall be used. Air duct coverings and linings shall not flame, glow, smolder, or smoke where tested in accordance with ASTM C411 at the temperature to which they are exposed in service. In no case shall the test temperature be less than 250°F (121°C). Coverings shall not penetrate a fire-resistance-rated assembly.
Exception: Polyurethane foam insulation shall be in accordance with Section 605.1.3.

605.1.3 Polyurethane Foam Insulation. Polyurethane foam insulation that is spray applied to the exterior of metallic ducts in attics and crawl spaces shall be tested in accordance with IAPMO/ANSI ES1000 and shall have a flame-spread index not to exceed 25 and a smoke-developed index not to exceed 450, where tested in accordance with ASTM E84 or UL 723. The specimen preparation and mounting procedures of ASTM E2231 shall be used. The foam plastic insulation shall not flame, glow, smolder, or smoke where tested in accordance with ASTM C411 at the temperature to which they are exposed in service. In no case shall the test temperature be less than 250°F (121°C) nor shall such foam insulation be applied to flexible air ducts.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAPMO/ANSI ES1000-2020</td>
<td>Spray Applied Polyurethane Foam</td>
<td>Miscellaneous</td>
<td>605.1.3</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: ASTM C411, ASTM E84, ASTM E2231, IAPMO/ANSI ES1000, and UL 723 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
A new section for polyurethane foam insulation is being added to Chapter 6 under Insulation of Ducts as foam insulation requires a smoke-developed index not to exceed 450.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
IAPMO/ANSI ES1000 is being used in an inappropriate application of the standard. The standard applies to building materials, not duct materials. Furthermore, the IAPMO standard is outside of the scope of the section, and is therefore being rejected.
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 165
UMC 2024 Section: 605.2, Table 1701.1, Table 1701.2

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Add new text

605.0 Insulation of Ducts.

605.2 Duct Lining in Health Care Facilities. Duct lining materials shall not be installed within ducts, terminal boxes, sound traps, or other in-duct systems serving areas such as operating rooms, delivery rooms, post anesthesia care units, cystoscopy, cardiac catheterization labs, nurseries, intensive care units, newborn intensive care units, and airborne infection isolation rooms. Duct lining materials shall not be installed within ducts which are downstream of 99.97 percent High-Efficiency Particulate Air (HEPA) filters or filters with a Minimum Efficiency Rating Value (MERV) of 17.
Exception: Terminal filters with 90 percent average efficiency in accordance with ASHRAE 52.2 or a Minimum Efficiency Rating Value (MERV) of 14 installed downstream of the duct lining.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 52.2-2017</td>
<td>Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size</td>
<td>Cleaning Devices</td>
<td>605.2</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 52.2-2012</td>
<td>General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size</td>
<td>Cleaning Devices</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: ASHRAE 52.2 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Health care facilities can benefit from the use of duct liner as a sound attenuator, although its use in these environments has been largely restricted due to duct liners having been generally associated with fiberglass, which can trap dirt and moisture and potentially support mold growth. Fiberglass degrades over time and may infiltrate the air stream, clogging filters. Elastomeric foam may be a solution as these problems do not apply to elastomeric foam, which is fiber-free with near zero moisture permeability. Still, it has been prohibited along with all other duct liners in certain critical care areas of hospitals. Previous guidelines prohibited the use of duct liner in any duct serving operating rooms, delivery rooms, LDR rooms, nurseries, protective environmental rooms, and critical care units. Now the use of duct liner is limited more by its location within the duct rather than the space the duct is serving. This gives engineers other options for sound attenuation in health care facilities.
COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is poorly written and overly restrictive. Healthcare facilities have their own standards that they follow for duct lining and the proposed language may conflict with such standards.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 166

UMC 2024  Section: 606.10

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Add new text

606.0 Smoke Dampers, Fire Dampers, and Ceiling Dampers.

606.10 Where Required. Fire dampers, smoke dampers, combination fire/smoke dampers, ceiling radiation dampers, and corridor dampers shall be installed where required by the building code at locations including, but not limited to, the following:
(1) Fire walls
(2) Fire barriers
(3) Horizontal barriers
(4) Fire partitions
(5) Fire-rated corridors and smoke barriers
(6) Shaft enclosures
(7) Exterior walls
(8) Smoke partitions

SUBSTANTIATION:
The code currently sends the end user to the building code for where dampers are required. This code change assists the end user by listing where dampers are required without conflicting with the building code.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There is concern that the proposed list of required damper locations is misleading and not consistent with the building code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 167
UMC 2024  Section: 606.3, Table 1701.1

SUBMITTER: Randy Young
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Revise text

606.0 Smoke Dampers, Fire Dampers, and Ceiling Dampers.

606.3 Ceiling Radiation Dampers. Ceiling radiation dampers shall comply with UL 555C or shall be tested as part of a fire-resistance-rated floor-ceiling or roof-ceiling assembly in accordance with ASTM E119 or UL 263, and shall be installed in accordance with the manufacturer’s installation instructions in the fire-resistant ceiling membrane of floor-ceiling and roof-ceiling assemblies where required by the building code. Fire dampers not meeting the temperature limitation of ceiling radiation dampers shall not be used as a substitute.

<table>
<thead>
<tr>
<th>TABLE 1701.1 REFERENCED STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD NUMBER</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

Note: ASTM E119 and UL 263 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Section 606.3 is being modified to clarify that ceiling radiation dampers shall either comply with UL 555C or shall be tested as part of a fire-resistance-rated floor-ceiling or roof-ceiling assembly in accordance with ASTM E119 or UL 263.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 168

UMC 2024  Section: 206.0, 606.4, 606.5

SUBMITTER: Randy Young  
Northern CA Valley Sheet Metal Training JATC

RECOMMENDATION:
Add new text

606.0 Smoke Dampers, Fire Dampers, and Ceiling Dampers.  
606.1 Smoke Dampers. Smoke dampers shall comply with UL 555S, and shall be installed in accordance with the manufacturer’s installation instructions where required by the building code.
606.2 Fire Dampers. Fire dampers shall comply with UL 555, and shall be installed in accordance with the manufacturer’s installation instructions where required by the building code. Fire dampers shall have been tested for closure under airflow conditions and shall be labeled for both maximum airflow permitted and direction of flow. Where more than one damper is installed at a point in a single air path, the entire airflow shall be assumed to be passing through the smallest damper area. Ductwork shall be connected to damper sleeves or assemblies in accordance with the fire damper manufacturer’s installation instructions.

606.4 Combination Fire/Smoke Dampers. Combination fire/smoke dampers shall comply with UL 555 and UL 555S and the requirements in Section 606.1 and Section 606.2.
606.5 Corridor Dampers. Corridor dampers shall comply with the requirements of combination fire/smoke dampers in Section 606.4.  
(renumber remaining sections)

206.0  – D –  
Damper. A valve or plate for controlling draft or the flow of gases, including air. [NFPA 211:3.3.52]

Corridor Damper. An automatic closing metal assembly consisting of one or more louvers, blades, slats, or vanes that closes upon detection of heat or smoke as to restrict the passage of flame and smoke used where air ducts penetrate horizontal openings in fire-resistance-rated corridors.

Note: UL 555 and UL 555S meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Sections for combination fire/smoke dampers and corridor dampers are being added to Chapter 6 for clarity on the requirements for such dampers. A definition for “corridor damper” is also being added.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  
AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 169
UMC 2024  Section: 606.6, Table 1701.1, Table 1701.2

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Add new text

606.0 Smoke Dampers, Fire Dampers, and Ceiling Dampers.

606.6 Testing and Inspection. Testing and inspection of dampers shall be in accordance with the following:
1. Smoke dampers shall be tested in accordance with NFPA 105.
2. Fire dampers shall be tested in accordance with NFPA 80.
3. Combination fire/smoke dampers shall be tested in accordance with NFPA 80 and NFPA 105.
(renumber remaining sections)

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFPA 80-2019</td>
<td>Fire Doors and Other Opening Protectives</td>
<td>Fire Doors</td>
<td>510.7.7, 606.6</td>
</tr>
<tr>
<td>NFPA 105-2019</td>
<td>Smoke Door Assemblies and Other Opening Protectives</td>
<td>Miscellaneous</td>
<td>606.6</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: The NFPA standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
Regular testing and inspection of dampers is required to determine if a damper will function when needed to resist the spread of fire. The requirements of NFPA 80 or NFPA 105 shall apply for testing and inspections. Per these NFPA standards, the first inspection involves the function test or operational test, which must be completed after the damper is installed. Each damper must then be tested and inspected one year after installation. After the one-year inspection, fire dampers must be tested and inspected every four years for non-hospitals; every six years for hospitals.

NFPA 80 regulates the installation and maintenance of assemblies and devices used to protect openings in walls, floors, and ceilings against the spread of fire and smoke within, into, or out of buildings.

NFPA 105 prescribes the minimum requirements for smoke door assemblies and smoke dampers that are used to restrict the flow of smoke though openings to provide safety to life and protection of property.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:
606.0 Smoke Dampers, Fire Dampers, and Ceiling Dampers.

606.6 Periodic Testing and Inspection. Testing and inspection of dampers shall be in accordance with the following:

(1) Smoke dampers shall be tested in accordance with NFPA 105.
(2) Fire dampers shall be tested in accordance with NFPA 80.
(3) Combination fire/smoke dampers shall be tested in accordance with NFPA 80 and NFPA 105.

(renumber remaining sections)

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<td>510.7.7, 606.6</td>
</tr>
<tr>
<td>NFPA 105-2019</td>
<td>Smoke Door Assemblies and Other Opening Protectives</td>
<td>Miscellaneous</td>
<td>606.6</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

COMMITTEE STATEMENT:
The modification clarifies that the section applies to "periodic" testing and inspection, not testing of the product by the manufacturer.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 25  NEGATIVE: 4  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:
FEEHAN: Even though this is not enforceable, the language and information are helpful.

EXPLANATION OF NEGATIVE:
BALLANCO: The proposal needs to stipulate who is doing the periodic inspection and testing and at what intervals.
KOERBER: Proposal is vague and I am not sure how it could be enforced.
WHITE: I agree that devices need to be tested, but the code covers installation. Construction building officials will not go back after the fact to see that this is done on schedule. Fire officials may do this as a result of the recommended standards, but this is not a UMC issue.
WISEMAN: Vague and unenforceable. Slight modification could make this very helpful.
Proposals

Item #: 170
UMC 2024  Section: 607.1

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Revise text

607.0 Ventilating Ceilings.
607.1 General. Perforated ceilings shall be permitted to be used for air supply within the limitations of this section. Exit corridors, where required to be of fire-resistive construction by the building code, shall not have ventilating ceilings. Ventilating ceilings shall not be permitted in health care facilities.

SUBSTANTIATION:
A ventilating ceiling, sometimes called a perforated ceiling, creates a downward uniform flow similar to the downward unidirectional flow for clean rooms. In most cases, ventilating ceilings discharge conditioned air through the entire ceiling to form a downward uniform flow, except in the area occupied by light troffers. Unidirectional flow requires a 60 to 90 fpm (0.3 to 0.45 m/s) air velocity and ultraclean air in the working area, and ventilating ceilings usually have a mean air velocity of less than 15 fpm (0.075 m/s) of conditioned air. There is no mixing of supply and space air in unidirectional flow; whereas just below the perforated ceiling, supply air is mixed with the ambient air at a vertical distance of less than 1 ft (0.3 m) in downward uniform flow from the ventilating ceiling. Although beneficial in other applications, ventilating ceilings shall not be permitted in health care facilities.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 171
UMC 2024 Section: 609.1.1, Table 1701.1

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Add new text

609.0 Automatic Shutoffs.
609.1 Air-Moving Systems and Smoke Detectors. Air-moving systems supplying air in excess of 2000 cubic feet per minute (ft³/min) (0.9439 m³/s) to enclosed spaces within buildings shall be equipped with an automatic shutoff. Automatic shutoff shall be accomplished by interrupting the power source of the air-moving equipment upon detection of smoke in the main supply-air duct served by such equipment. Duct smoke detectors shall comply with UL 268A and shall be installed in accordance with the manufacturer’s installation instructions. Such devices shall be compatible with the operating velocities, pressures, temperatures, and humidities of the system. Where fire-detection or alarm systems are provided for the building, the smoke detectors shall be supervised by such systems in an approved manner.

Exceptions:
(1) Where the space supplied by the air-moving equipment is served by a total coverage smoke-detection system in accordance with the fire code, interconnection to such system shall be permitted to be used to accomplish the required shutoff.
(2) Automatic shutoff is not required where occupied rooms served by the air-handling equipment have direct exit to the exterior, and the travel distance does not exceed 100 feet (30 480 mm).
(3) Automatic shutoff is not required for Group R, Division 3 and Group U Occupancies.
(4) Automatic shutoff is not required for approved smoke-control systems or where analysis demonstrates shutoff would create a greater hazard, such as shall be permitted to be encountered in air-moving equipment supplying specialized portions of Group H Occupancies. Such equipment shall be required to have smoke detection with remote indication and manual shutoff capability at an approved location.
(5) Smoke detectors that are factory installed in listed air-moving equipment shall be permitted to be used in lieu of smoke detectors installed in the main supply-air duct served by such equipment.

609.1.1 Smoke Detector Installation. Smoke detectors shall be installed in accordance with NFPA 72. Access shall be provided to smoke detectors for inspection and maintenance.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFPA 72-2019</td>
<td>National Fire Alarm and Signaling Code</td>
<td>Fire Alarms</td>
<td>609.1.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: NFPA 72 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Smoke detectors are addressed in Section 609.0. A new section is being created for the installation of smoke detectors. Early warning plays a key role in a facility’s ability to safely evacuate its residents during a fire emergency. As a result, a lot is riding on the fire alarm system’s ability to operate and function properly. NFPA 72, National Fire Alarm and Signaling Code, applies to both residential and commercial buildings and is the model
standard used by electricians, architects, engineers, builders, and inspectors to determine what features and equipment must be included in a fire alarm system.

The NFPA 72 standard covers the application, installation, location, performance, and inspection, testing, and maintenance of fire alarm and emergency communications systems, including Mass Notification Systems (MNS). The standard also includes testing requirements for Energy Storage Systems (ESS) and requirements for HVLS fans and air-sampling smoke detectors which are important for designers, installers, and AHJs.

NFPA 72 also addresses nuisance alarms in several ways. First, all smoke alarms are required to be “listed” by a nationally recognized testing lab. The applicable standard for testing of smoke alarms is UL 217, which has some limited requirements for resistance to nuisances. Second, NFPA 72 has requirements for technology and spacing aimed to limit nuisance alarms.

Standards are constantly changing to adapt to new building technologies and development patterns. NFPA 72 is adopted and incorporated into local building codes by virtually every community in the U.S. in one form or another through their residential, fire, and building codes.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
All of the requirements for smoke detectors are already found in Section 609.1. The proposed language is repetitive and unnecessary.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 172
UMC 2024  Section: 311.2, 610.0, 610.1

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

311.0 Heating or Cooling Air System.

311.2 Air Filters. Air filters shall be installed in a heating, cooling, or makeup air system and shall comply with Section 610.0. Media-type air filters shall comply with UL 900. Electrostatic and high efficiency particulate filters shall comply with Section 936.0.

Exceptions:
(1) Systems serving single guest rooms or dwelling units shall not require a listed filter.
(2) Air filters used in listed appliances and in accordance with the manufacturer’s instructions.

610.0 Air Filters.
610.1 General. Air filters shall be installed in heating and air conditioning systems in accordance with Section 311.2. Ducts shall be constructed to allow an even distribution of airflow through the entire air filter. Air filters shall be installed so that all return air, outdoor air, and makeup air is filtered upstream from any heat exchanger or coil. Liquid adhesive coatings used on filters shall have a flash point of not less than 325°F (163°C).

SUBSTANTIATION:
The air filter requirements in Section 311.2 do not address the full scope of air filters. This proposal adds improvements to the current provisions for air filters such as how duct construction (Chapter 6) is related to air filter performance and the requirement that air must be filtered upstream from heat exchangers or coils. As several studies have shown, the role of filtration in maintaining clean heat exchanger coils and overall performance must not be overlooked.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the language is unenforceable, overly restrictive, and lacks technical justification.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 173
UMC 2024 Section: Chapter 7

SUBMITTER: IAPMO Staff - Update Extracts
NFPA 54 Extract Update

RECOMMENDATION:
Revise text

701.0 General.

701.4.2 Known Air Infiltration Rate Method. Where the air infiltration rate of a structure is known, the minimum required volume shall be determined as follows [NFPA 54:9.3.2.2]:

(1) For appliances other than fan-assisted, calculate using the following Equation 701.4.2(1). [NFPA 54:9.3.2.2(1)]

\[
\text{Required Volume}_{\text{other}} \geq \frac{21 \text{ft}^3}{\text{ACH}} \left( \frac{I_{\text{other}}}{1000 \text{ Btu/hr}} \right)
\]

[Equation 701.4.2(1)]

(2) For fan-assisted appliances, calculate using the following Equation 701.4.2(2). [NFPA 54: 9.3.2.2(2)]

\[
\text{Required Volume}_{\text{fan}} \geq \frac{15 \text{ft}^3}{\text{ACH}} \left( \frac{I_{\text{fan}}}{1000 \text{ Btu/hr}} \right)
\]

[Equation 701.4.2(2)]

Where:
- \( I_{\text{other}} \) = All appliances other than fan-assisted input (Btu/h)
- \( I_{\text{fan}} \) = Fan-assisted appliance input (Btu/h)
- \( \text{ACH} \) = Air change per hour (percent of volume of space exchanged per hour, expressed as a decimal)

For SI units: 1 cubic foot = 0.0283 m\(^3\), 1000 British thermal units per hour = 0.293 Kw

(3) For purposes of these calculations, an infiltration rate greater than 0.60 ACH shall not be used in the equations in Section Equation 701.4.2(1) and Section Equation 701.4.2(2). [NFPA 54:9.3.2.2(3)]

701.8 Engineered Installations. Engineered combustion air installations shall provide an adequate supply of combustion, ventilation, and dilution air and shall be approved by the Authority Having Jurisdiction determined using engineering methods. [NFPA 54:9.3.5]

701.11 Combustion Air Ducts. Combustion air ducts shall comply with the following [NFPA 54:9.3.8]:

(1) Ducts shall be constructed of galvanized steel or a material having equivalent corrosion resistance, strength, and rigidity.

Exception: Within dwellings units, unobstructed stud and joist spaces shall not be prohibited from conveying combustion air, provided that not more than one fireblock is removed. [NFPA 54:9.3.8.1]

(2) Ducts shall terminate in an unobstructed space, allowing free movement of combustion air to the appliances. [NFPA 54:9.3.8.2]

(3) Ducts shall serve a single space. [NFPA 54:9.3.8.3]
(4) Ducts shall not serve both upper and lower combustion air openings where both such openings are used. The separation between ducts serving upper and lower combustion air openings shall be maintained to the source of combustion air. [NFPA 54:9.3.8.4]

(5) Ducts shall not be screened where terminating in an attic space. [NFPA 54:9.3.8.5]

(6) Combustion air intake openings located on the exterior of the building shall have the lowest side of the combustion air intake openings located at least 12 inches (305 mm) vertically from the adjoining finished ground level. [NFPA 54:9.3.8.8]

(7) Horizontal upper combustion air ducts shall not slope downward toward the source of combustion air. [NFPA 54:9.3.8.6]

(8) The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry, metal, or factory built chimney shall not be used to supply combustion air.

Exception: Direct vent appliances designed for installation in a solid fuel-burning fireplace where installed in accordance with the manufacturer’s installation instructions. [NFPA 54:9.3.8.7]

(8) Combustion air intake openings located on the exterior of the building shall have the lowest side of the combustion air intake openings located at least 12 inches (305 mm) vertically from the adjoining finished ground level. [NFPA 54:9.3.8.8]

SUBSTANTIATION:
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 7 is being revised to the latest edition of NFPA 54-2021.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 174
UMC 2024 Section: Chapter 8

SUBMITTER: IAPMO Staff - Update Extracts
NFPA 54 Extract Update

RECOMMENDATION:
Revise text

801.0 General.

802.1.1 Installation. Listed chimneys and vents shall be installed in accordance with this chapter and the manufacturer’s installation instructions. [NFPA 54:12.2.1]

802.2.6 Direct Vent Appliances. Listed direct vent appliances shall be installed in accordance with the manufacturer’s installation instructions and Section 802.8. [NFPA 54:12.3.5.1]

802.2.6.1 Through-the-Wall Vent Terminations. Through-the-wall vent terminations for listed direct vent appliances shall be in accordance with Section 802.8. [NFPA 54:12.3.5.2]

802.2.7 Appliances with Integral Vents. Appliances incorporating integral venting means shall be installed in accordance with the manufacturer’s installation instructions and Section 802.8 and Section 802.8.1. [NFPA 54:12.3.6]

802.2.8 Incinerators, Commercial–Industrial. Commercial industrial-type incinerators shall be vented in accordance with NFPA 82. [NFPA 54:12.3.7]

802.3.3.5 Exit Terminals. The exit terminals of mechanical draft systems shall be not less than 7 feet (2134 mm) above finished ground level where located adjacent to public walkways and shall be located as specified in Section 802.8 and Section 802.8.1. [NFPA 54:12.4.3.6]

802.3.4 Ventilating Hoods and Exhaust Systems. Where automatically operated appliances, other than food service commercial cooking appliances, are vented through a venting hood or exhaust system equipped with a damper or with a power means of exhaust, provisions shall be made to allow the flow of gas to the main burners only when the damper is open to a position to properly vent the appliance and when the power means of exhaust is in operation. [NFPA 54:12.4.4.1]

802.5.1 Factory-Built Chimneys. Factory-built chimneys shall be listed in accordance with UL 103, UL 959, or UL 2561. Factory-built chimneys shall be installed in accordance with the manufacturer’s installation instructions. Factory-built chimneys used to vent appliances that operate at positive vent pressure shall be listed for such application. [NFPA 54:12.6.1.1]

802.5.4 Termination. A chimney for residential-type or low-heat appliances shall extend at least 3 feet (914 mm) above the highest point where it passes through a roof of a building and at least 2 feet (610 mm) higher than any portion of any building within a horizontal distance of 10 feet (3048 mm). [NFPA 54:12.6.2.1] (See Figure 802.5.4)

802.5.5 Size of Chimneys. The effective area of a chimney venting system serving listed appliances with draft hoods, Category I appliances, and other appliances listed for use with Type B vents shall be in accordance with one of the following methods:
(1) Those listed in Section 803.0.
(2) For sizing an individual chimney venting system for a single appliance with a draft hood, the effective areas of the vent connector and chimney flue of a venting system serving a single appliance with a draft hood shall be not less than the area of the appliance flue collar or draft hood outlet or greater than seven times the draft hood outlet area.
(3) For sizing The effective area of the chimney flue of a chimney venting system connected to two appliances with draft hoods, the effective area of the chimney flue shall be not less than the area of the larger draft hood outlet plus...
50 percent of the area of the smaller draft hood outlet or greater than seven times the smaller draft hood outlet area.
(4) Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods. [NFPA 54:12.6.3.1]

802.5.7.1 Standard. Chimneys shall be lined in accordance with NFPA 211. 
**Exception:** Existing chimneys shall be permitted to have their use continued when an appliance is replaced by an appliance of similar type, input rating, and efficiency, where the chimney complies with Section 802.5.7 through Section 802.5.7.3 and the sizing of the chimney is in accordance with Section 802.5.6. [NFPA 54:12.6.4.2]

802.5.8.1 Gas and Liquid Fuel-Burning Appliances. Where one chimney serves gas appliances and liquid fuel-burning appliances, the appliances shall be connected through separate openings or connected through a single opening where joined by a suitable fitting located as close as practical to the chimney. Where two or more openings are provided into one chimney flue, they shall be at different levels. Where the gas appliance is automatically controlled, it shall be equipped with a safety shutoff device. [NFPA 54:12.6.5.2]

| TABLE 802.6.1 |
| ROOF PITCH SLOPE HEIGHTS |
| [NFPA 54: TABLE 12.7.3] |
| (portion of table not show remains unchanged) |

802.6.2.1 Category I Appliances. The sizing of natural draft venting systems serving one or more listed appliances equipped with a draft hood or appliances listed for use with a Type B gas vent, installed in a single story of a building, shall be in accordance with one of the following:
(1) The provisions of Section 803.0.
(2) Vents serving fan-assisted combustion system appliances, or combinations of fan-assisted combustion system and draft hood-equipped appliances, shall be sized in accordance with Section 803.0 or other approved engineering methods.
(3) For sizing an individual gas vent for a single, draft hood-equipped appliance, the effective area of the vent connector and the gas vent shall be not less than the area of the appliance draft hood outlet or greater than seven times the draft hood outlet area.
(4) For sizing a gas vent connected to two appliances with draft hoods, the effective area of the vent shall be not less than the area of the larger draft hood outlet plus 50 percent of the area of the smaller draft hood outlet or greater than seven times the smaller draft hood outlet area.
(5) Other approved engineering practices Engineering methods. [NFPA 54:12.7.4.1]

802.6.2.3 Category II, Category III, and Category IV Appliances. The sizing of gas vents for Category II, Category III, and Category IV appliances shall be in accordance with the appliance manufacturer's instructions. The sizing of plastic pipe specified by the appliance manufacturer as a venting material for Category II, III, and IV appliances shall be in accordance with the appliance manufacturers' instructions. [NFPA 54:12.7.4.3]

802.6.2.4 Sizing. Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods. [NFPA 54:12.7.4.4]

802.6.3 Gas Vents Serving Appliances on More than One Floor. A Where a common vent shall be permitted is installed in a multistory installation to vent Category I appliances located on more than one floor level, provided the venting system is shall be designed and installed in accordance with approved engineering methods. For the purpose of this section, crawl spaces, basements, and attics shall be considered as floor levels. [NFPA 54:12.7.5.1]

802.7.3-5 802.7.3.4 Roof Thimble. Where a single-wall metal pipe passes through a roof constructed of combustible material, a noncombustible, nonventilating thimble shall be used at the point of passage. The thimble shall extend at least 18 inches (457 mm) above and 6 inches (152 mm) below the roof with the annular space open at the bottom and closed only at the top. The thimble shall be sized in accordance with Section 802.7.3.4 802.7.3.5. [NFPA 54:12.8.4.5]

802.7.3.4 Combustible Exterior Wall. Single-wall metal pipe shall not pass through a combustible exterior wall unless guarded at the point of passage by a ventilated metal thimble not smaller than the following:
(1) For listed appliances with draft hoods and appliances listed for use with Type B gas vents, the thimble shall be a minimum of 4 inches (102 mm) larger in diameter than the metal pipe. Where there is a run of not less than 6 feet (1829 mm) of metal pipe in the opening between the draft hood outlet and the thimble, the thimble shall be a minimum of 2 inches (51 mm) larger in diameter than the metal pipe.
(2) For unlisted appliances having draft hoods, the thimble shall be a minimum of 6 inches (152 mm) larger in diameter than the metal pipe.
(3) For residential and low-heat appliances, the thimble shall be a minimum of 12 inches (305 mm) larger in diameter than the metal pipe.
**Exception:** In lieu of thimble protection, all combustible material in the wall shall be removed a sufficient distance from the metal pipe to provide the specified clearance from such metal pipe to combustible material. Any material used to close up such opening shall be noncombustible. [NFPA 54:12.8.4.6]

802.7.4 Size of Single-Wall Metal Pipe. Single-wall metal piping shall comply with the following requirements:

1. A venting system of a single-wall metal pipe shall be sized in accordance with one of the following methods and the appliance manufacturer's instructions:
   a. For a draft hood-equipped appliance, in accordance with Section 803.0.
   b. For a venting system for a single appliance with a draft hood, the areas of the connector and the pipe each shall not be less than the area of the appliance flue collar or draft hood outlet, whichever is smaller. The vent area shall not be greater than seven times the draft hood outlet area.
   c. Other approved engineering methods.

2. Where a single-wall metal pipe is used and has a shape other than round, it shall have an equivalent effective area equal to the effective area of the round pipe for which it is substituted and the minimum internal dimension of the pipe shall be 2 inches (51 mm).

3. The vent cap or a roof assembly shall have a venting capacity not less than that of the pipe to which it is attached. [NFPA 54:12.8.5]

802.8 Through-the-Wall Vent Termination. Through-the-wall vent termination shall be in accordance with Section 802.8.1 through Section 802.8.3. A mechanical draft venting system shall terminate at least 3 feet (914 mm) above any forced air inlet located within 10 feet (3048 mm). (See Figure 802.8)

**Exceptions:**

1. This provision shall not apply to the combustion air intake of a direct vent appliance.
2. This provision shall not apply to the separation of the integral outdoor air inlet and flue gas discharge of listed outdoor appliances. [NFPA 54:12.9.1]

802.8.1 Mechanical Draft Venting System. A mechanical draft venting system of other than direct vent type shall terminate not less than 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from, or 1 foot (305 mm) above any door, operable window, or gravity air inlet into any building. The bottom of the vent terminal shall be located at least 12 inches (305 mm) above finished ground level. [NFPA 54:12.9.2]

802.8.2 802.8.1 Direct Vent Appliance Clearance for Through-the-Wall Vent Termination. The clearances for through-the-wall direct vent and non-direct vent terminals shall be in accordance with Table 802.8.2 802.8.1 and Figure 802.8.1. The bottom of the vent terminal and the air intake shall be located not less than 12 inches (305 mm) above finished ground level.

**Exception:** The clearances in Table 802.8.1 shall not apply to the combustion air intake of a direct vent appliance. [NFPA 54:12.9.3 12.9.1]

<table>
<thead>
<tr>
<th>DIRECT VENT APPLIANCE INPUT RATING</th>
<th>THROUGH THE WALL VENT TERMINAL CLEARANCE FROM ANY AIR OPENING INTO A BUILDING (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 000 Btu/h and less</td>
<td>6</td>
</tr>
<tr>
<td>Greater than 10 000 Btu/h and not exceeding 50 000 Btu/h</td>
<td>9</td>
</tr>
<tr>
<td>Greater than 50 000 Btu/h and not exceeding 150 000 Btu/h</td>
<td>12</td>
</tr>
<tr>
<td>&gt; 150 000 Btu/h</td>
<td>In accordance with the appliance manufacturer's instructions and in no case less than the clearances specified in Section 802.8.1.</td>
</tr>
</tbody>
</table>

**TABLE 802.8.2 802.8.1 THROUGH-THE-WALL DIRECT VENT TERMINATION CLEARANCES**

|[NFPA 54: TABLE 12.9.3 12.9.1]|

<table>
<thead>
<tr>
<th>FIGURE CLEARANCE</th>
<th>CLEARANCE LOCATION</th>
<th>MINIMUM CLEARANCES FOR DIRECT VENT TERMINALS</th>
<th>MINIMUM CLEARANCES FOR NON-DIRECT VENT TERMINALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Clearance above finished grade level, veranda, porch.</td>
<td>12 inches</td>
<td>12 inches</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Clearance Details</th>
</tr>
</thead>
</table>
| B | Clearance to window or door that is openable                                | 6 inches for Appliances $\leq 10\,000$ Btu/hr  
9 inches for Appliances $> 10\,000$ Btu/hr  
12 inches for Appliances $> 50\,000$ Btu/hr  
Appliances $> 150\,000$ Btu/hr, in accordance with the appliance manufacturer's instructions and not less than the clearances specified for non-direct vent terminals in row B  
4 feet below or to side of opening or 1 foot above opening |
| C | Clearance to non-openable window                                            | None unless otherwise specified by the appliance manufacturer                                                                                                                                                     |
| D | Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 feet from the center line of the terminal | None unless otherwise specified by the appliance manufacturer                                                                                                                                                     |
| E | Clearance to unventilated soffit                                            | None unless otherwise specified by the appliance manufacturer                                                                                                                                                     |
| F | Clearance to outside corner of building                                     | None unless otherwise specified by the appliance manufacturer                                                                                                                                                     |
| G | Clearance to inside corner of building                                      | None unless otherwise specified by the appliance manufacturer                                                                                                                                                     |
| H | Clearance to non-mechanical air supply inlet to building and the combustion air inlet to any other appliance | Same clearance as specified for row B                                                                                                                                                                             |
| I | Clearance to a mechanical air supply inlet                                  | 10 feet horizontally from inlet or 3 feet above inlet                                                                                                                                                              |
| J | Clearance above paved sidewalk or paved driveway located on public property or other areas where condensate or vapor can cause a nuisance or hazard | 7 feet and not located above public walkways or other areas where condensate or vapor can cause a nuisance or hazard                                                                                           |
| K | Clearance to underside of veranda, porch, deck, or balcony                 | 12 inches where the area beneath the veranda, porch, deck, or balcony is open on not less than two sides. The vent terminal is prohibited in this location where only one side is open. |

For SI Units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW
802.8.3 Category I through Category IV and Noncategorized Appliances. Through-the-wall vents for Category II and Category IV appliances and noncategorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment. Where local experience indicates that condensate is a problem with Category I and Category III appliances, this provision shall also apply. Drains for condensate shall be installed in accordance with the appliance and the vent manufacturer’s installation instructions. [NFPA 54:12.9.4]

802.8.4 802.8.2 Annular Spaces. Where vents, including those for direct vent appliances or combustion air intake pipes, penetrate outside walls of buildings, the annular spaces around such penetrations shall be permanently sealed using approved materials to prevent entry of combustion products into the building. [NFPA 54:12.9.5 12.9.2]

802.8.5 802.8.3 Vent Terminals. Vent systems for Category IV appliances that terminate through an outside wall of a building and discharge flue gases perpendicular to the adjacent wall shall be located not less than 10 feet (3048 mm) horizontally from an operable opening in an adjacent building. Exception: This shall not apply to vent terminals that are 2 feet (610 mm) or more above or 25 feet (7620 mm) or more
802.10.1.4 Medium-Heat Appliances. Vent connectors for medium-heat appliances shall be constructed of factory-built, medium-heat chimney sections or steel of a thickness not less than that specified in Table 802.10.1.4 and shall comply with the following:

1. A steel vent connector for an appliance with a vent gas temperature in excess of 1000°F (538°C) measured at the entrance to the connector shall be lined with medium-duty fire brick or the equivalent.

2. The lining shall be at least 2 1/2 inches (64 mm) thick for a vent connector having a diameter or greatest cross-sectional dimension of 18 inches (457 mm) or less.

3. The lining shall be at least 4 1/2 inches (114 mm) thick laid on the 4 1/2 inches (114 mm) bed for a vent connector having a diameter or greatest cross-sectional dimension greater than 18 inches (457 mm).

4. Factory-built where factory-built chimney sections, if employed, are installed, they shall be joined together in accordance with the chimney manufacturer’s instructions. [NFPA 54:12.10.2]

802.10.2 Size of Vent Connector. A vent connector for an appliance with a single draft hood or for a Category I fan-assisted combustion system appliance shall be sized and installed in accordance with Section 803.0 or other approved engineering methods. [NFPA 54:12.11.3.1]

802.10.2.1 Manifold. Where a single appliance having more than one draft hood outlet or flue collar is installed, the manifold shall be constructed according to the instructions of the appliance manufacturer. Where there are no instructions, the manifold shall be designed and constructed in accordance with approved engineering methods. As an alternative method, the effective area of the manifold shall equal the combined area of the flue collars or draft hood outlets, and the vent connectors shall have a minimum 1 foot (305 mm) rise. [NFPA 54:12.11.3.2]

802.10.2.2 Size. Where two or more appliances are connected to a common vent or chimney, each vent connector shall be sized in accordance with Section 803.0 or other approved engineering methods. [NFPA 54:12.11.3.3]

As an alternative method applicable only where all of the appliances are draft hood-equipped, each vent connector shall have an effective area not less than the area of the draft hood outlet of the appliance to which it is connected. [NFPA 54:12.11.3.4]

802.10.2.3 Height. Where two or more appliances are vented through a common vent connector or vent manifold, the common vent connector or vent manifold shall be located at the highest level consistent with available headroom and clearance to combustible material and sized in accordance with Section 803.0 or other approved engineering methods. [NFPA 54:12.11.3.5]

As an alternative method applicable only where there are two draft hood-equipped appliances, the effective area of the common vent connector or vent manifold and all junction fittings shall be not less than the area of the larger vent connector plus 50 percent of the area of the smaller flue collar outlet. [NFPA 54:12.11.3.6]

802.10.6 Connector Junctions. Where vent connectors are joined together, the connection shall be made with a manufactured tee or wye fitting. [NFPA 54:12.11.7]

802.10.6.1 Single Wall Connector. The maximum horizontal length of a single-wall connector shall be 75 percent of the height of the chimney or vent, except for engineered systems. [NFPA 54:12.11.9.1]

802.10.7.2 Type B Double Wall Connector. The maximum horizontal length of a Type B double-wall connector shall be 100 percent of the height of the chimney or vent, except for engineered systems. The maximum length of an individual connector for a chimney or vent system serving multiple appliances, from the appliance outlet to the junction with the common vent or another connector, shall be 100 percent of the height of the chimney or vent. [NFPA 54:12.11.9.2]

802.10.8 Support. A vent connector shall be supported for the design and weight of the material employed to maintain clearances and prevent physical damage and separation of joints. [NFPA 54:12.11.10]

802.10.9 Chimney Connection. Where entering a flue in a masonry or metal chimney, the vent connector shall be installed above the extreme bottom to avoid stoppage. [NFPA 54:12.11.11.1] Where a thimble or slip joint is used to
facilitate removal of the connector, the connector shall be firmly attached to or inserted into the thimble or slip joint to prevent the connector from falling out. [NFPA 54:12.11.11.2] Means shall be employed to prevent the connector from entering so far as to restrict the space between its end and the opposite wall of the chimney flue. [NFPA 54: 12.11.10 12.11.11.3]

802.10.10 Inspection. The entire length of a vent connector shall be readily accessible for inspection, cleaning, and replacement. [NFPA 54: 12.11.11.12]

802.10.11 Fireplaces. A vent connector shall not be connected to a chimney flue serving a fireplace unless the fireplace flue opening is permanently sealed. [NFPA 54: 12.11.13]

802.10.12.1 Medium-Heat Appliances. Vent connectors for medium-heat appliances shall not pass through walls or partitions constructed of combustible material. [NFPA 54: 12.11.14.2]

802.12 Appliances Requiring Draft Hoods and Draft Controls. Vented appliances shall be installed with draft hoods. Exception: Dual oven-type combination ranges; incinerators; direct vent appliances; fan-assisted combustion system appliances; appliances requiring chimney draft for operation; single-firebox boilers equipped with conversion burners with inputs greater than 400,000 Btu/h (117 kW); appliances equipped with blast, power, or pressure burners that are not listed for use with draft hoods; and appliances designed for forced venting. [NFPA 54: 12.13.1]

802.12.1 Installation. A draft hood supplied with or forming a part of a listed vented appliance shall be installed without alteration, exactly as furnished and specified by the appliance manufacturer. [NFPA 54: 12.13.2] If a draft hood is not supplied by the appliance manufacturer where one is required, a draft hood shall be installed, be of a listed or approved type, and, in the absence of other instructions, be of the same size as the appliance flue collar. Where a draft hood is required with a conversion burner, it shall be of a listed or approved type. [NFPA 54: 12.13.2.1] Where a draft hood of special design is needed or preferable, the installation shall be approved and in accordance with the recommendations of the appliance manufacturer. [NFPA 54: 12.13.2.2]


802.14 Obstructions. Devices that retard the flow of vent gases shall not be installed in a vent connector, chimney, or vent. The following shall not be considered as obstructions:
(1) Draft regulators and safety controls specifically listed for installation in venting systems and installed in accordance with the manufacturer's installation instructions.
(2) Approved draft regulators and safety controls designed and installed in accordance with approved engineering methods.
(3) Listed heat reclaimers and automatically operated vent dampers installed in accordance with the manufacturer's installation instructions.
(4) Vent dampers serving listed appliances installed in accordance with Section 803.1 or Section 803.2 or other approved engineering methods.
(5) Approved economizers, heat reclaimers, and recuperators installed in venting systems of appliances not required to be equipped with draft hoods, provided the appliance manufacturer's instructions cover the installation of such a device in the venting system and performance in accordance with Section 802.3 and Section 802.3.1 is obtained. [NFPA 54: 12.16]

803.1.5 Multiple Input Ratings Two-Stage/Modulating Appliances. For appliances with more than one input rate, the minimum vent capacity (FAN Min) determined from Table 803.1.2(1) through Table 803.2(9) shall be less than the lowest appliance input rating, and the maximum vent capacity (FAN Max/NAT Max) determined from the tables shall be greater than the highest appliance rating input. [NFPA 54: 13.1.6]

803.1.6 Corrugated Chimney Liner Reduction. Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table 803.1.2(1) or Table 803.1.2(2) for Type B vents, with the maximum capacity reduced by 20 percent (0.80 x maximum capacity) and the minimum capacity as shown in Table 803.1.2(1) or Table 803.1.2(2). Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Section 803.1.2. The 20 percent reduction for corrugated metallic chimney liner systems includes an allowance for one long radius 90 degree (1.57 rad) turn at the bottom of the liner. [NFPA 54: 13.1.7]

803.1.8 Vertical Vent Upsizing Using the 7 × Times Rule. Where the vertical vent has a larger diameter than the vent
connector, the vertical vent diameter shall be used to determine the minimum vent capacity, and the connector diameter shall be used to determine the maximum vent capacity. The flow area of the vertical vent shall not exceed seven times the flow area of the listed appliance categorized vent area, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54:13.1.9]

803.1.14 **Single Run of Vent Multiple Vertical Vent Sizes.** In a single run of vent or vent connector, more than one diameter and type shall be permitted to be used, provided that all the sizes and types are permitted by the tables. [NFPA 54:13.1.14]

803.1.17 **Engineering Methods.** For Where a vent heights is lower than 6 feet (1829 mm) and or higher than shown in Table 803.1.2(1) through Table 803.2(9), an engineering methods shall be used to calculate the vent capacities. [NFPA 54:13.1.17]

803.2 **Multiple Appliance Vent Table 803.2(1) through Table 803.2(9) Obstructions and Vent Dampers.** (remaining text unchanged) [NFPA 54:13.2.1]

803.2.12 **Vent Height.** For The available total height \( H \) for multiple appliances all located on the same floor, available total height \( H \) shall be measured from the highest draft hood outlet or flue collar up to the level of the outlet of the common vent. [NFPA 54:13.2.13]

803.2.13 **Multistory Vent Height Installations.** For multistory installations, Where appliances are located on more than one floor, the available total height \( H \) for each segment of the system shall be the vertical distance between the highest draft hood outlet or flue collar entering that segment and the centerline of the next higher interconnection tee. [NFPA 54:13.2.14]

803.2.15 **Vent Type Multistory Type B Vents Required Installation.** (remaining text unchanged) [NFPA 54:13.2.16]

803.2.16 **Offsets in Multistory Vent Offsets and Capacity Installations.** (remaining text unchanged) [NFPA 54:13.2.17]

803.2.17 **Vertical Vent Size Limitation.** Where two or more appliances are connected to a vertical vent or chimney, the flow area of the largest section of vertical vent or chimney shall not exceed seven times the smallest listed appliance categorized vent areas, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54:13.2.18]

803.2.18 **Multiple Input Ratings Two-Stage/Modulating Appliances.** For appliances with more than one input rate, the minimum vent connector capacity (FAN Min) of appliances with more than one input rate shall be determined from the tables and shall be less than the lowest appliance input rating, and the maximum vent connector capacity (FAN Max or NAT Max) shall be determined from the tables shall be greater than the highest appliance input rating. [NFPA 54:13.2.19]

803.2.22 **Combination of Pipe Types and Multiple Vent and Connector Sizes.** All combinations of pipe sizes, single-wall metal pipe, and double-wall metal pipe shall be allowed within any connector run(s) or within the common vent, provided ALL of the appropriate tables permit ALL of the desired sizes and types of pipe, as if they were used for the entire length of the subject connector or vent. Where single-wall and Type B double-wall metal pipes are used for vent connectors within the same venting system, the common vent shall be sized using Table 803.2(2) or Table 803.2(4) as appropriate. [NFPA 54:13.2.25]

803.2.26 **Engineering Methods Sizing Vents Not Covered by Tables.** For vent heights lower than 6 feet (1829 mm) and higher than shown in the tables, engineering methods shall be used to calculate vent capacities. [NFPA 54:13.2.29]

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Note: UL 378 was not developed via an open process having a published development procedure in accordance with Section 3-3.7.1.2 of IAPMO’s Regulations Governing Committee Projects.

**SUBSTANTIATION:**
In accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines), Chapter 8 is being revised to the latest edition of NFPA 54-2021.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in
accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 174, Section 802.10.5(1) (Joints) and UPC Item # 115, Section 509.10.5(1) (Joints) resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

802.0 Venting of Appliances.

802.10 Vent Connectors for Category I Appliances.

802.10.5 Joints. Joints between sections of connector piping and connections to flue collars or draft hood outlets shall be fastened in accordance with one of the following methods:

1. Mechanically fastened by means of not less than three sheet-metal screws equally spaced around the joint.
2. Vent connectors of listed vent material assembled and connected to flue collars or draft hood outlets in accordance with the manufacturer’s instructions.
3. Other approved means. {NFPA 54:12.11.6}.

TCC ACTION: ACCEPT AS SUBMITTED

TCC STATEMENT:
The language in UMC Item # 174, Section 802.10.5(1) (Joints) is being revised to correlate with the action taken by the UPC TC for Item # 115, Section 509.10.5(1) (Joints) by rephrasing the sentence to “Mechanically fastened by means of not less than three sheet-metal screws equally spaced around the joint.”

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 802.10.5(1) regarding the rephrasing of the sentence to “Mechanically fastened by means of not less than three sheet-metal screws equally spaced around the joint.”
Proposals

Item #: 175

UMC 2024  Section: 802.10.12

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

802.0 Venting of Appliances.

802.10.2 Size of Vent Connector. (remaining text unchanged)

802.10.12 Passage Through Ceilings, Floors, or Walls. A vent connector shall not pass through a ceiling, floor, or fire-resistance-rated wall. A single-wall metal pipe connector shall not pass through an interior wall.

Exceptions:
(1) Vent connectors made of listed Type B or Type L vent material and serving listed appliances with draft hoods and other appliances listed for use with Type B gas vents that pass through walls or partitions constructed of combustible material shall be installed with not less than the listed clearance to combustible material.
(2) Connectors shall be permitted to pass through ceilings, floors, or walls in accordance with Section 802.7.3.1 and Section 802.7.3.4.

(below shown for reference only)

802.7.3.1 Limitations. Single-wall metal pipe shall be used only for runs directly from the space in which the appliance is located through the roof or exterior wall to the outer air. A pipe passing through a roof shall extend without interruption through the roof flashing, roof jacket, or roof thimble. [NFPA 54:12.8.4.2]

802.7.3.4 Combustible Exterior Wall. Single-wall metal pipe shall not pass through a combustible exterior wall unless guarded at the point of passage by a ventilated metal thimble not smaller than the following:
(1) For listed appliances with draft hoods and appliances listed for use with Type B gas vents, the thimble shall be a minimum of 4 inches (102 mm) larger in diameter than the metal pipe. Where there is a run of not less than 6 feet (1829 mm) of metal pipe in the opening between the draft hood outlet and the thimble, the thimble shall be a minimum of 2 inches (51 mm) larger in diameter than the metal pipe.
(2) For unlisted appliances having draft hoods, the thimble shall be a minimum of 6 inches (152 mm) larger in diameter than the metal pipe.
(3) For residential and low-heat appliances, the thimble shall be a minimum of 12 inches (305 mm) larger in diameter than the metal pipe.

Exception: In lieu of thimble protection, all combustible material in the wall shall be removed a sufficient distance from the metal pipe to provide the specified clearance from such metal pipe to combustible material. Any material used to close up such opening shall be noncombustible. [NFPA 54:12.8.4.6]

SUBSTANTIATION:
The intent of the exception to Section 802.10.12 is further clarified by directing the end user to Section 802.7.3.1 and Section 802.7.3.4 which permit connectors to pass through ceilings, floors, or wall and are specified in the indicated sections. This change will clarify the intent of Section 802.10.12 and avoid any confusion between the sections.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  
AFFIRMATIVE: 23  
NEGATIVE: 6  
NOT RETURNED: 1  

Heine

EXPLANATION OF NEGATIVE:

BALLANCO: This proposal associates connectors with single-wall metal pipe vents. These are two separate issues that should not be confused. A connector is not a vent and a single-wall metal pipe vent is not a connector. Connectors are not permitted to pass through ceilings, floors, or walls. There are no exceptions to this requirement. This change should have been rejected.

FEEHAN: This proposal is confusing. The beginning says no and the exception says yes. Vent connectors should NOT pass through anything.

KOERBER: I agree the proposal is confusing and could lead to the wrong intent. Hopefully through comment it can be cleared up.

MACNEVIN: I support the comments of Julius Ballanco and Pennie Feehan.

WHITE: Not all single-wall pipes are vent connectors. Vent connectors do not leave the room that the appliance is located in. This should have been rejected.

WISEMAN: This is confusing.

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UPC Item # 116, Section 509.10.12 (Passage Through Ceilings, Floors, or Walls) and UMC Item # 175, Section 802.10.12 (Passage Through Ceilings, Floors, or Walls) resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

802.10.12 Passage Through Ceilings, Floors, or Walls. A vent connector shall not pass through a ceiling, floor, or fire-resistance-rated wall. A single-wall metal pipe connector shall not pass through an interior wall.

Exceptions:
(1) Vent connectors made of listed Type B or Type L vent material and serving listed appliances with draft hoods and other appliances listed for use with Type B gas vents that pass through walls or partitions constructed of combustible material shall be installed with not less than the listed clearance to combustible material.
(2) Vent connectors shall be permitted to pass through ceilings, floors, or walls in accordance with Section 802.7.3.1 and Section 802.7.3.4.

TCC ACTION:  ACCEPT AS SUBMITTED

TCC STATEMENT:  
The language in UMC Item # 175, Section 802.10.12 (Passage Through Ceilings, Floors, or Walls) is being revised to correlate with the action taken by the UPC TC for Item # 116, Section 509.10.12 (Passage Through Ceilings, Floors, or Walls) by adding the term “vent” to the beginning of Exception (2).

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 802.10.12 regarding the addition of the term “vent” to the beginning of Exception (2).
Proposals

Item #: 176
UMC 2024  Section: 802.5.1.1, 1002.5, 1202.2, 1203.2

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

802.0 Venting of Appliances.

802.5 Masonry, Metal, and Factory-Built Chimneys. (remaining text unchanged)
802.5.1 Factory-Built Chimneys. (remaining text unchanged)
802.5.1.1 Decorative Shrouds. Decorative shrouds addressed in Section 802.5.4.3 shall be listed or and labeled in accordance with UL 103 for factory-built residential chimneys, UL 127 for factory-built fireplaces, or UL 1482 for solid-fuel room heaters.

1002.0 Standards.

1002.5 Dual Purpose Water Heaters. Water heaters utilized for combined space- and water-heating applications shall be listed or and labeled in accordance with the standards referenced in Table 1203.2, and shall be installed in accordance with the manufacturer’s installation instructions.

1202.0 Protection of Potable Water Supply.

1202.2 Chemical Injection. Where systems include an additive, chemical injection or provisions for such injection, the potable water supply shall be protected by a reduced-pressure principle backflow prevention assembly listed or and labeled in accordance with ASSE 1013. Such additive or chemical shall be compatible with system components.

1203.0 Capacity of Heat Source.

1203.2 Dual Purpose Water Heaters. Water heaters utilized for combined space-heating and water-heating applications shall be listed or and labeled in accordance with the standards referenced in Table 1203.2, and shall be installed in accordance with the manufacturer’s installation instructions. The total heating capacity of a dual purpose water heater shall be based on the sum of the potable hot water requirements and the space heating design requirements corrected for hot water first-hour draw recovery.

SUBSTANTIATION:
This proposal changes “listed or labeled” to “listed and labeled” to clarify the intention of the language.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

802.0 Venting of Appliances.

802.5 Masonry, Metal, and Factory-Built Chimneys. (remaining text unchanged)
802.5.1 Factory-Built Chimneys. (remaining text unchanged)
802.5.1.1 Decorative Shrouds. Decorative shrouds addressed in Section 802.5.4.3 shall be listed and labeled in accordance with UL 103 for factory-built residential chimneys, UL 127 for factory-built fireplaces, or UL 1482 for solid-fuel room heaters.
1002.0 Standards.

1002.5 Dual Purpose Water Heaters. Water heaters utilized for combined space- and water-heating applications shall be listed and labeled in accordance with the standards referenced in Table 1203.2, and shall be installed in accordance with the manufacturer’s installation instructions.

1202.0 Protection of Potable Water Supply.

1202.2 Chemical Injection. Where systems include an additive, chemical injection or provisions for such injection, the potable water supply shall be protected by a reduced-pressure principle backflow prevention assembly shall be listed and labeled in accordance with ASSE 1013. Such additive or chemical shall be compatible with system components.

1203.0 Capacity of Heat Source.

1203.2 Dual Purpose Water Heaters. Water heaters utilized for combined space-heating and water-heating applications shall be listed and labeled in accordance with the standards referenced in Table 1203.2, and shall be installed in accordance with the manufacturer’s installation instructions. The total heating capacity of a dual purpose water heater shall be based on the sum of the potable hot water requirements and the space heating design requirements corrected for hot water first-hour draw recovery.

COMMITTEE STATEMENT:
The proposal is being modified to change "listed and labeled" to "comply" since "comply" already implies that the product must be listed and labeled.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 177
UMC 2024  Section: 802.6.1.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

802.6 Gas Vents. (remaining text unchanged)
802.6.1 Gas Vent Termination. (remaining text unchanged)
802.6.1.1 Insulation Protection Shield. Where a vent passes through an insulated assembly, an approved metal shield constructed of steel having a thickness of not less than 26 gauge shall be installed between the vent and insulation. The shield shall extend not less than 2 inches (51 mm) above the insulation and be secured to the structure in accordance with the manufacturer’s installation instructions.

SUBSTANTIATION:
The existing language does not contain guidance regarding the minimum gauge required for insulation shields passing through insulated areas such as attics. The proposed language will add the minimum shield thickness. The proposed 26 gauge minimum thickness is found in other manufacturer requirements.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 178
UMC 2024  Section: 803.2.11

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

803.0 Sizing of Category I Venting Systems.

803.2 Multiple Appliance Vent Table 803.2(1) through Table 803.2(9). (remaining text unchanged)

803.2.11 Vent Connector Rise. The vent connector rise \((R)\) for each appliance connector shall be measured from the draft hood outlet or flue collar to the centerline where the vent gas streams come together. [{NFPA 54:13.2.12}]

SUBSTANTIATION:
The language in Section 803.2.11 is being revised for clarity and ease of use.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 179

UMC 2024  Section: Chapter 9, Table 1701.1

SUBMITTER: IAPMO Staff - Update Extracts
   NFPA 54 Extract Update

RECOMMENDATION:
Revise text

902.4 Type of Gas(es). The appliance shall be connected to the fuel gas for which it was designed. No attempt shall be made to convert the appliance from the gas specified on the rating plate for use with a different gas without consulting the installation instructions, the serving gas supplier, or the appliance manufacturer for complete instructions. Listed appliances shall not be converted unless permitted by and in accordance with the manufacturer’s installation instructions. [NFPA 54:9.1.3]

902.8 Building Structural Members Appliance Support. Appliances and equipment shall be furnished either with load-distributing bases or with a sufficient number of supports to prevent damage to either the building structure or the appliance and the equipment. [NFPA 54:9.1.8.1]

902.11 Combination of Appliances and Equipment. Any combination of appliances, equipment, attachments, or devices used together in any manner shall comply with the standards that apply to the individual appliance and equipment. [NFPA 54:9.1.21 9.1.19]

902.14 Gas Appliance Pressure Regulators. Where the gas supply pressure is higher than that at which the appliance is designed to operate or varies beyond the design pressure limits of the appliance, a gas appliance pressure regulator listed in accordance with ANSI Z21.18/CSA 6.3 shall be installed. [NFPA 54:9.1.18 9.1.17]

902.15 Venting of Gas Appliance Pressure Regulators. Venting of gas appliance pressure regulators shall comply with the following requirements:
   (1) Appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, if the regulator vent is an integral part of the appliance, into the combustion chamber adjacent to a continuous pilot, unless constructed or equipped with a vent limiting means to limit the escape of gas from the vent opening in the event of diaphragm failure.
   (2) Vent limiting means shall be employed on listed appliance pressure regulators only.
   (3) In the case of vents leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter.
   (4) Under no circumstances shall a regulator be vented to the appliance flue or exhaust system.
   (5) In the case of vents entering the combustion chamber, the vent shall be located so the escaping gas is readily ignited by the pilot and the heat liberated thereby does not adversely affect the normal operation of the safety shutoff system. The terminus of the vent shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the vent piping shall be determined.
   (6) A vent line(s) from an appliance pressure regulator and a bleed line(s) from a diaphragm-type valve shall not be connected to a common manifold terminating in a combustion chamber. Vent lines shall not terminate in positive-pressure-type combustion chambers. [NFPA 54:9.1.19]

(renumber remaining sections)

902.16 Bleed Lines for Diaphragm-Type Valves. Bleed lines shall comply with the following requirements:
   (1) Diaphragm-type valves shall be equipped to convey bleed gas to the outdoors or into the combustion chamber adjacent to a continuous pilot.
(2) In the case of bleed lines leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter.

(3) Bleed lines shall not terminate in the appliance flue or exhaust system.

(4) In the case of bleed lines entering the combustion chamber, the bleed line shall be located so the bleed gas is readily ignited by the pilot and the heat liberated thereby does not adversely affect the normal operation of the safety shutoff system. The terminus of the bleed line shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the bleed line piping shall be determined.

(5) A bleed line(s) from a diaphragm-type valve and a vent line(s) from an appliance pressure regulator shall not be connected to a common manifold terminating in a combustion chamber. Bleed lines shall not terminate in positive-pressure-type combustion chambers. [NFPA 54:9.1.20 9.1.18]

903.0 Air-Conditioning Appliances.

903.2 Gas-Fired Air Conditioners and Heat Pumps. Gas-fired air conditioners shall comply with Section 903.2.1 through Section 903.2.6 903.2.7.

903.2.1 Application. Gas-fired air conditioners and heat pumps shall be listed in accordance with ANSI Z21.40.1/CSA 2.91 or ANSI Z21.40.2/CSA 2.92. [NFPA 54:10.2.1]

(renumber remaining sections)

903.2.2 Connection of Gas Engine-Powered Air Conditioners. To protect against the effects of normal vibrations in service, gas engines shall not be rigidly connected to the gas supply piping. [NFPA 54:10.2.2 10.2.2]

903.2.3 Clearances for Indoor Installation. The installation of air-conditioning appliances shall comply with the following requirements:

(1) Listed air-conditioning appliances shall be installed with clearances in accordance with the terms of their listing and the manufacturer’s installation instructions. [NFPA 54: 10.2.4(1)]

(2) Unlisted air-conditioning appliances shall be installed with clearances from combustible material of not less than 18 inches (457 mm) above the appliance and at the sides, front, and rear and in accordance with the manufacturer’s installation instructions. [NFPA 54:10.2.3(2)]

(3) Listed and unlisted air-conditioning appliances shall be permitted to be installed with reduced clearances to combustible material, provided that the combustible material or appliance is protected as described in Table 303.10.1 and such reduction is allowed by the manufacturer’s installation instructions. [NFPA 54:10.2.3(3) 10.2.4(2)]

(4) Where the furnace plenum is adjacent to plaster on metal lath or noncombustible material attached to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish where the clearance specified is 2 inches (51 mm) or less. [NFPA 54:10.2.3(4) 10.2.4(3)]

(5) Listed air-conditioning appliances shall have the clearance from supply ducts within 3 feet (914 mm) of the furnace plenum be not less than that specified from the furnace plenum. No clearance is necessary beyond this distance. [NFPA 54:10.2.3(6) 10.2.4(4)]

903.2.4 Assembly and Installation. Air conditioning appliances shall be installed in accordance with the manufacturer’s installation instructions. Unless the appliance is listed for installation on a combustible surface, such as a floor or roof, or unless the surface is protected in an approved manner, it shall be installed on a surface of noncombustible construction with noncombustible material and surface finish and with no combustible material against the underside thereof. [NFPA 54:10.2.4 10.2.5]

903.2.5 Refrigeration Coils. The installation of refrigeration coils shall be in accordance with Section 904.7 and Section 904.8. [NFPA 54:10.2.6 10.2.7]

903.2.6 Switches in Electrical Supply Line. Means for interrupting the electrical supply to the air-conditioning appliance and to its associated cooling tower (if supplied and installed in a location remote from the air conditioner) shall be provided within sight of and not over 50 feet (15 240 mm) from the air conditioner and the cooling tower shall be in accordance with NFPA 70. [NFPA 54:10.2.7 10.2.8]

904.0 Central Heating Boilers and Furnaces.

904.1 Application. Central heating furnaces and boilers shall be listed in accordance with the following:

(1) Central heating furnaces and boilers having input ratings up to and including 400 000 Btu/hr shall be listed in accordance with the following as applicable:

(a) Furnaces listed in accordance with ANSI Z21.47/CSA 2.3.

(b) Low-pressure boilers listed in accordance with ANSI Z21.13/CSA 4.9. [NFPA 54:10.3.1.1]

(2) Furnaces and boilers having input ratings greater than 400 000 Btu/hr shall be listed or in accordance with Section 904.1(2)(a) and Section 904.1(2)(b). [NFPA 54:10.3.1.2]

(a) Acceptance of unlisted appliances, equipment, and accessories shall be on the basis of engineering methods. [NFPA 54:9.1.1.2]

(b) The unlisted appliance, equipment, or accessory shall be safe and suitable for the proposed service and shall be recommended for the service by the manufacturer. [NFPA 54:9.1.1.3]
904.2.2 Unlisted Units. Unlisted central heating furnaces and low-pressure boilers shall be installed with clearances from combustible material not less than those specified in Table 904.2.2. [NFPA 54:493.2-2 10.3.3.2]

904.2.3 Listed and Unlisted Units. Listed and unlisted central heating furnaces and low-pressure boilers shall be permitted to be installed with reduced clearances to combustible material, provided that the combustible material or appliance is protected as described in Table 303.10.1 and Figure 303.10.1(1) through Figure 303.10.1(3), and such reduction is allowed by the manufacturer’s installation instructions. [NFPA 54:493.2-3 10.3.3.3]

904.2.4 Front Clearance. Front clearance shall be sufficient for servicing the burner and the furnace or boiler. [NFPA 54:493.2-4 10.3.3.4]

904.2.5 Adjacent to Plaster or Noncombustible Materials. Where the furnace plenum is adjacent to plaster on metal lath or noncombustible material attached to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish where the clearance specified is 2 inches (51 mm) or less. [NFPA 54:493.2-5 10.3.3.5]

904.2.6 Interference. The clearances to these appliances shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. [NFPA 54:493.2-6 10.3.3.6]

904.2.7 Central Heating Furnaces. Central heating furnaces other than those listed in Section 603.13.2 or Section 603.13.3 shall have clearances from the supply ducts of not less than 18 inches (457 mm) from the furnace plenum for the first 3 feet (914 mm), then 6 inches (152 mm) for the next 3 feet (914 mm) and 1 inch (25.4 mm) beyond 6 feet (1829 mm). [NFPA 54:493.2-9 10.3.3.9]

904.3 Assembly and Installation. A central heating boiler or furnace shall be installed in accordance with the manufacturer’s instructions in one of the following manners:

(1) On a floor of noncombustible construction with noncombustible flooring and surface finish and with no combustible material against the underside thereof.

(2) On fire-resistive slabs or arches having no combustible material against the underside thereof.

Exceptions:

(1) Appliances listed for installation on a combustible floor.

(2) Installation on a floor protected in an approved manner. [NFPA 54:493.3-9 10.3.4]

904.4 Temperature or Pressure Limiting Devices. Steam and hot water boilers, respectively, shall be provided with approved automatic limiting devices for shutting down the burner(s) to prevent boiler steam pressure or boiler water temperature from exceeding the maximum allowable working pressure or temperature. Safety limit controls shall not be used as operating controls. [NFPA 54:493.4 10.3.5]

904.5 Low-Water Cutoff. All water boilers and steam boilers shall be provided with an automatic means to shut off the fuel supply to the burner(s) if the boiler water level drops below the lowest safe water line. In lieu of the low-water cutoff, water tube or coil-type boilers that require forced circulation to prevent overheating and failure shall have an approved flow sensing device arranged to shut down the boiler when the flow rate is inadequate to protect the boiler against overheating. [NFPA 54:493.5 10.3.6]

904.6 Steam Safety and Pressure Relief Valves. Steam and hot water boilers shall be equipped, respectively, with listed or approved steam safety or pressure relief valves of appropriate discharge capacity and conforming with ASME requirements. A shutoff valve shall not be placed between the relief valve and the boiler or on discharge pipes between such valves and the atmosphere. [NFPA 54:493.6 10.3.7]

904.6.1 Discharge. Relief valves shall be piped to discharge near the floor. [NFPA 54:493.6.1 10.3.7.1]

904.6.2 Size. The entire discharged piping shall be at least the same size as the relief valve discharge piping. [NFPA 54:493.6.2 10.3.7.2]

904.6.3 End Connections. Discharge piping shall not contain threaded end connection at its termination point. [NFPA 54:493.6.3 10.3.7.3]

904.7 Refrigeration Coils. The installation of refrigeration coils shall comply with the following requirements:

(1) A refrigeration coil shall not be installed in conjunction with a forced air furnace where circulation of cooled air is provided by the furnace blower, unless the blower has sufficient capacity to overcome the external static pressure resistance imposed by the duct system and refrigeration coil at the air flow rate for heating or cooling, whichever is greater.

(2) Furnaces shall not be located upstream from refrigeration coils, unless the refrigeration coil is designed or equipped so as not to develop excessive temperature or pressure.

(3) Refrigeration coils shall be installed in parallel with or on the downstream side of central furnaces to avoid condensation in the heating element, unless the furnace has been specifically listed for downstream installation. With a parallel flow arrangement, the dampers or other means used to control flow of air shall be sufficiently tight to prevent any circulation of cooled air through the furnace.

(4) Means shall be provided for disposal of condensate and to prevent dripping of condensate on the heating element. [NFPA 54:493.8 10.3.9]

904.8 Cooling Units Used with Heating Boilers. Boilers, where used in conjunction with refrigeration systems, shall be installed so that the chilled medium is piped in parallel with the heating boiler with appropriate valves to prevent the chilled medium from entering the heating boiler. [NFPA 54:493.9.4 10.3.10.1]
904.8.1 Exposed to Refrigerated Air Circulation. Where hot water heating boilers are connected to heating coils located in air-handling units where they can be exposed to refrigerated air circulation, such boiler piping systems shall be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle. [NFPA 54:10.3.9.2 10.3.10.2]

TABLE 904.2.2
CLEARANCES TO COMBUSTIBLE MATERIAL FOR UNLISTED FURNACES AND BOILERS*
[NFPA 54: TABLE 40.3.2.2 10.3.3.2]
(portion of table not shown remain unchanged)

905.0 Duct Furnaces.

905.1 Application. Duct furnaces with inputs of 10 MBtu/hr or less shall be listed in accordance with ANSI Z83.8/CSA 2.6. [NFPA 54:10.9.1]

(renumber remaining sections)

905.2 Installation of Duct Furnaces. Duct furnaces shall be installed in accordance with the manufacturer’s instructions. [NFPA 54:40.40.2 10.9.3]

905.3 Access Panels. The ducts connected to duct furnaces shall have removable access panels on both the upstream and downstream sides of the furnace. [NFPA 54:40.40.3 10.9.4]

905.4 Location of Draft Hoods and Controls. The controls, combustion air inlet, and draft hoods for duct furnaces shall be located outside the ducts. The draft hood shall be located in the same enclosure from which combustion air is taken. [NFPA 54:40.40.4 10.9.5]

905.5 Circulating Air. Where a duct furnace is installed so that supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace. The duct furnace shall be installed on the positive-pressure side of the circulating air blower. [NFPA 54:40.40.5 10.9.6]

905.6 Duct Furnaces Used with Refrigeration Systems. A duct furnace shall not be installed in conjunction with a refrigeration coil where circulation of cooled air is provided by the blower.

Exception: Where the blower has sufficient capacity to overcome the external static resistance imposed by the duct system, the furnace, and the cooling coil and the air throughput necessary for heating or cooling, whichever is greater. [NFPA 54:40.40.6.1 10.9.7.1]

905.6.1 In Conjunction with Cooling Appliances. Duct furnaces used in conjunction with cooling appliances shall be installed in parallel with or on the upstream side of cooling coils to avoid condensation within heating elements. With a parallel flow arrangement, the dampers or other means used to control the flow of air shall be sufficiently tight to prevent any circulation of cooled air through the unit.

Exception: Where the duct furnace has been specifically listed for downstream installation. [NFPA 54:40.40.6.2 10.9.7.2]

905.6.2 Located Upstream from Cooling Coils. Where duct furnaces are to be located upstream from cooling units, the cooling unit shall be so designed or equipped as to not develop excessive temperatures or pressures. [NFPA 54:40.40.6.3]

(renumber remaining sections)

905.6.3 Heat Exchangers. Where a duct furnace is installed downstream of an evaporative cooler or air washer, the heat exchanger shall be constructed of corrosion-resistant materials. Stainless steel, ceramic-coated steel, and an aluminum-coated steel in which the bond between the steel and the aluminum is an iron-aluminum alloy are considered to be corrosion resistant. Air washers operating with chilled water that deliver air below the dew point of the ambient air at the duct furnace shall be considered as refrigeration systems. [NFPA 54:40.40.6.4 10.9.7.3]

905.7 Installation in Commercial Garages and Aircraft Hangars. Duct furnaces installed in garages for more than three motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with Section 303.11 and Section 303.12. [NFPA 54:40.40.7 10.9.8]

906.0 Floor Furnaces.

906.1 Application. Floor furnaces shall be listed in accordance with ANSI Z21.86/CSA 2.32. [NFPA 54:10.10.1]

(renumber remaining sections)

906.1 Installation. The installation of floor furnaces shall comply with the following requirements:

(1) Listed floor furnaces shall be installed in accordance with their listing and the manufacturer’s installation instructions.

(2) Unlisted floor furnaces shall not be installed on combustible floors.

(3) Thermostats controlling floor furnaces shall not be located in a room or space that is capable of being separated from the room or space in which the register of the floor furnace is located. [NFPA 54:10.10.1]

906.2 Temperature Limit Controls. Floor furnaces shall be provided with temperature limit controls in accordance with the following requirements:

(1) Listed automatically operated floor furnaces shall be equipped with temperature limit controls. [NFPA 54:40.41.2.4 10.10.3]
906.3 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.4.10]

906.4 Placement. The following provisions apply to furnaces that serve one story:
(1) Floors. Floor furnaces shall not be installed in the floor of any doorway, stairway landing, aisle, or passageway of any enclosure, public or private, or in an exitway from any such room or space.
(2) Walls and Corners. The register of a floor furnace with a horizontal warm air outlet shall not be placed closer than 6 inches (152 mm) from the nearest wall. A distance of at least 18 inches (457 mm) from two adjoining sides of the floor furnace register to walls shall be provided to eliminate the necessity of occupants walking over the warm air discharge. The remaining sides shall be a minimum of 6 inches (152 mm) from a wall. Wall register models shall not be placed closer than 6 inches (152 mm) to a corner.
(3) Draperies. The furnace shall be placed so that a door, drapery, or similar object cannot be nearer than 12 inches (305 mm) to any portion of the register of the furnace. [NFPA 54:10.4.10.5]

906.5 Bracing. The space provided for the furnace shall be framed with doubled joists and with headers not lighter than the joists. [NFPA 54:10.4.10.6]

906.6 Support. Means shall be provided to support the furnace when the floor register is removed. [NFPA 54:10.4.10.7]

906.7 Clearance. The lowest portion of the floor furnace shall have at least a 6 inch (152 mm) clearance from the general ground level. A reduced clearance to a minimum of 2 inches (51 mm) shall be permitted, provided the lower 6 inches (152 mm) portion of the floor furnace is sealed by the manufacturer to prevent entrance of water. Where these clearances are not present, the ground below and to the sides shall be excavated to form a "basin-like" pit under the furnace so that the required clearance is provided beneath the lowest portion of the furnace. A 12 inch (305 mm) clearance shall be provided on all sides except the control side, which shall have an 18 inch (457 mm) clearance. [NFPA 54:10.4.10.8]

906.8 Access. The space in which any floor furnace is installed shall be accessible by an opening in the foundation not less than 24 inches by 18 inches (610 mm by 457 mm) or by a trapdoor not less than 24 inches by 24 inches (610 mm by 610 mm) in any cross-section thereof, and a passageway not less than 24 inches by 18 inches (610 mm by 457 mm) in any cross-section thereof. [NFPA 54:10.4.10.9]

906.9 Seepage Pan. Where the excavation exceeds 12 inches (305 mm) in depth or water seepage is likely to collect, a watertight copper pan, concrete pit, or other suitable material shall be used, unless adequate drainage is provided or the appliance is sealed by the manufacturer to meet this condition. A copper pan shall be made of not less than 16 ounces per square foot (oz/ft²) (4.9 kg/m²) sheet copper. The pan shall be anchored in place so as to prevent floating, and the walls shall extend at least 4 inches (102 mm) above the ground level with at least a 6 inches (152 mm) clearance on all sides, except on the control side, which shall have at least an 18 inch (457 mm) clearance. [NFPA 54:10.4.10.10]

906.10 Wind Protection. Floor furnaces shall be protected, where necessary, against severe wind conditions. [NFPA 54:10.4.10.11]

906.11 Upper Floor Installations. Listed floor furnaces shall be permitted to be installed in an upper floor, provided the furnace assembly projects below into a utility room, closet, garage, or similar nonhabitable space. In such installations, the floor furnace shall be enclosed completely (entirely separated from the nonhabitable space) with means for air intake to meet the provisions of Section 701.0, with access for servicing, minimum furnace clearances of 6 inches (152 mm) to all sides and bottom, and with the enclosure constructed of Portland cement plaster or metal lath or other noncombustible material. [NFPA 54:10.4.10.12]

906.12 First Floor Installation. Listed floor furnaces installed in the first or ground floors of buildings shall not be required to be enclosed unless the basements of these buildings have been converted to apartments or sleeping quarters, in which case the floor furnace shall be enclosed as specified for upper floor installations and shall project into a nonhabitable space. [NFPA 54:10.4.10.13]

907.0 Wall Furnaces.
907.1 Application. Wall furnaces shall be listed in accordance with ANSI Z21.86/CSA 2.32. [NFPA 54:10.25.1]

907.1.1 Unlisted Wall Furnaces. Unlisted wall furnaces shall not be installed in or attached to combustible material. [NFPA 54:10.26.1.2]

907.1.2 Vented Wall Furnaces. Vented wall furnaces connected to a Type B-W gas vent system listed only for a single story shall be installed only in single-story buildings or the top story of multistory buildings. Vented wall furnaces connected to a Type B-W gas vent system listed for installation in multistory buildings shall be permitted to be installed in single-story or multistory buildings. Type B-W gas vents shall be attached directly to a solid header plate that serves as a firestop at that point and that shall be permitted to be an integral part of the vented wall furnace, as illustrated in

[313]
907.1.2. The stud space in which the vented wall furnace is installed shall be ventilated at the first ceiling level by installation of the ceiling plate spacers furnished with the gas vent. Firestop spacers shall be installed at each subsequent ceiling or floor level penetrated by the vent. [NFPA 54:10.26.1.3 10.25.2.2]

907.1.3 Direct Vent Wall Furnaces. Direct vent wall furnaces shall be installed with the vent combustion air intake terminal in the outdoors. The thickness of the walls on which the furnace is mounted shall be within the range of wall thickness marked on the furnace and covered in the manufacturer’s installation instructions. [NFPA 54:10.26.1.4 10.25.2.3]

907.1.4 Panels, Grilles, and Access Doors. Panels, grilles, and access doors that are required to be removed for normal servicing operations shall not be attached to the building. For additional information on the venting of wall furnaces, see Section 802.0. [NFPA 54:10.26.1.5 10.25.2.4]

907.2 Location. Wall furnaces shall be located so as not to cause a hazard to walls, floors, curtains, furniture, or doors. Wall furnaces installed between bathrooms and adjoining rooms shall not circulate air from bathrooms to other parts of the building. [NFPA 54:10.26.2 10.25.3]

907.3 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.26.3 10.25.4]

908.0 Clothes Dryers.

908.1 Application. Clothes dryers shall be listed in accordance with ANSI Z21.5.1/CSA 7.1 for Type I clothes dryers or ANSI Z21.5.2/CSA 7.2 for Type II clothes dryers. [NFPA 54:10.4.1]

908.2.1 Clearance. The installation of clothes dryers shall comply with the following requirements:
1. Listed Type 1 clothes dryers shall be installed with a clearance of not less than 6 inches (152 mm) from adjacent combustible material. Clothes dryers listed for installation at reduced clearances shall be installed in accordance with their listing and the manufacturer’s installation instructions. Type 1 clothes dryers installed in closets shall be listed for such installation.
2. Listed Type 2 clothes dryers shall be installed with clearances of not less than that those shown on the marking plate and in the manufacturer’s instructions. Type 2 clothes dryers designed and marked, “For use only in noncombustible locations,” shall not be installed elsewhere.
3. Unlisted clothes dryers shall be installed with clearances to combustible material of not less than 18 inches (457 mm). Combustible floors under unlisted clothes dryers shall be protected in an approved manner. [NFPA 54:10.4.2]

908.2.2 Exhausting to the Outdoors. Type 1 and Type 2 clothes dryers shall be exhausted to the outside air in accordance with Section 504.4. [NFPA 54:10.4.3]

908.2.3 Multiple-Family or Public Use. All clothes dryers installed for multiple-family or public use shall be equipped with approved safety shutoff devices and shall be installed as specified for a Type 2 clothes dryer under Section 504.4.3.1. [NFPA 54:10.4.6]

911.0 Decorative Appliances for Installation in Vented Fireplaces.

911.1 Application. Decorative appliances for installation in vented fireplaces shall be listed in accordance with ANSI Z21.60/CSA 2.26. [NFPA 54:10.6.1]

911.1 Prohibited Installations. Decorative appliances for installation in vented fireplaces shall not be installed in bathrooms or bedrooms unless the appliance is listed and the bedroom or bathroom has the required volume in accordance with Section 701.4. [NFPA 54:10.6.4 10.6.2]

911.2 Installation. A decorative appliance for installation in a vented fireplace shall be installed only in a vented fireplace having a working chimney flue and constructed of noncombustible materials. These appliances shall not be thermostatically controlled. [NFPA 54:10.6.2 10.6.3]

911.2.1 Listed Decorative Appliance. A listed decorative appliance for installation in a vented fireplace shall be installed in accordance with its listing and the manufacturer’s installation instructions. [NFPA 54:10.6.3.1]

911.2.2 In Manufactured Homes. A decorative appliance for installation in a vented fireplace, where installed in a manufactured home, shall be listed for installation in manufactured homes. [NFPA 54:10.6.2.2 10.6.3.2]

911.2.3 Unlisted Decorative Appliance. An unlisted decorative appliance for installation in a vented fireplace shall be installed in a fireplace having a permanent free opening, based on appliance input rating and chimney height, equal to or greater than that specified in Table 911.2. [NFPA 54:10.6.2.3]
TABLE 911.2
FREE OPENING AREA OF CHIMNEY DAMPER FOR VENTING FLUE GASES FROM UNLISTED
DECORATIVE APPLIANCES FOR INSTALLATION IN VENTED FIREPLACES
[NFPA 54: TABLE 10.6.2.3]

<table>
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<tr>
<th>CHIMNEY HEIGHT (feet)</th>
<th>8</th>
<th>13</th>
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<th>29</th>
<th>39</th>
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<td>95600</td>
<td>125600</td>
<td>168000</td>
</tr>
</tbody>
</table>

For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* The first six minimum permanent free openings [8 square inches (0.005 m²) to 51 square inches (0.03 m²)] correspond approximately to the cross-sectional areas of chimneys having diameters of 3 inches (76 mm) through 8 inches (203 mm), respectively. The 64 square inch (0.04 m²) opening corresponds to the cross-sectional area of a standard 8 inch (203 mm) by 8 inch (203 mm) chimney tile.

911.3 Fireplace Screens. A fireplace screen shall be installed with a decorative appliance for installation in a vented fireplace. [NFPA 54:10.6.3 10.6.4]

912.0 Gas Fireplaces, Vented.
912.1 Application. Vented gas fireplaces shall be listed in accordance with ANSI Z21.50/CSA 2.22. [NFPA 54:10.7.1 (renumber remaining sections)]

912.1 Prohibited Installations. Vented gas fireplaces shall not be installed in bathrooms or bedrooms unless the appliance is listed and the bedroom or bathroom has the required volume in accordance with Section 701.4.

Exception: Direct vent gas fireplaces. [NFPA 54:10.7.2 10.7.2]

912.2 Installation. The installation of vented gas fireplaces shall comply with the following requirements:
(1) Listed vented gas fireplaces shall be installed in accordance with their listing and the manufacturer’s installation instructions and where installed in or attached to combustible material shall be specifically listed for such installation.
(2) Unlisted vented gas fireplaces shall not be installed in or attached to combustible material. They shall have a clearance at the sides and rear of not less than 18 inches (457 mm). Combustible floors under unlisted vented gas fireplaces shall be protected in an approved manner. Unlisted appliances of other than the direct vent type shall be equipped with a draft hood and shall be vented in accordance with Section 802.0. Appliances that use metal, asbestos, or ceramic material to direct radiation to the front of the appliance shall have a clearance of 36 inches (914 mm) in front and, where constructed with a double back of metal or ceramic, shall be installed with a clearance of not less than 18 inches (457 mm) at the sides and 12 inches (305 mm) at the rear.
(3) Panels, grilles, and access doors that are required to be removed for normal servicing operations shall not be attached to the building.
(4) Direct vent gas fireplaces shall be installed with the vent-air intake terminal in the outdoors and in accordance with the manufacturer’s installation instructions. [NFPA 54:10.7.3 10.7.4]

912.3 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.7.3 10.7.4]

914.0 Non-Recirculating Direct Gas-Fired Industrial Air Heaters.
914.1 Application. Direct gas-fired heating and forced ventilation appliances for commercial and industrial air heaters of the non-recirculating type applications shall be listed in accordance with CSA the following standards as applicable:
(1) ANSI Z283.4/CSA 3.7.
(2) ANSI Z283.18. [NFPA 54:10.8.1]

914.2 Prohibited Installations. Non-recirculating direct gas-fired industrial air heaters heating and forced ventilation appliances shall not serve any area containing sleeping quarters. Non-recirculating direct gas-fired industrial air heaters heating and forced ventilation appliances shall not recirculate room air.

Recirculating direct gas-fired industrial air heaters shall not recirculate room air in buildings that contain flammable solids, liquids, or gases; explosive materials; or substances that can become toxic when exposed to flame or heat. [NFPA 54:10.8.2.1-10.8.2.2-10.8.2.3]
914.3 Installation. **Non-recirculating direct** Direct gas-fired industrial air heaters heating and forced ventilation appliances shall be installed in accordance with the manufacturer’s instructions. [NFPA 54:10.8.3.1]

914.3.1 Fresh Air Ventilation. **Non-recirculating direct** Direct gas-fired industrial air heaters heating and forced ventilation appliances shall be permitted to provide fresh air ventilation. [NFPA 54:10.8.3.2]

914.3.2 Access Required. **Non-recirculating direct** Direct gas-fired industrial air heaters heating and forced ventilation appliances shall be provided with access for removal of burners; for replacement of motors, controls, filters, and other working parts; and for adjustment and lubrication of parts requiring maintenance. [NFPA 54:10.8.3.3]

914.4 Clearance from Combustible Materials. **Non-recirculating direct** Direct gas-fired industrial air heaters heating and forced ventilation appliances shall be installed with a clearance from combustible materials of not less than that shown on the rating plate and the manufacturer’s instructions. [NFPA 54:10.8.4]

914.5 Air Supply. All The air supply to the non-recirculating direct gas-fired industrial air heater heating and forced ventilation appliances shall be ducted directly from outdoors. Where outdoor air dampers or closing louvers are used, they shall be verified to be in the open position prior to main burner operation in accordance with Section 914.5.1 through Section 914.5.3. [NFPA 54:10.8.5]

914.5.1 Non-Recirculating Systems. All air to the non-recirculating direct gas-fired heating and forced ventilation appliance shall be ducted directly from outdoors. [NFPA 54:10.8.5.1]

914.5.2 Recirculating Systems. Ventilation air to the recirculating direct gas-fired heating and forced ventilation appliance shall be ducted directly from outdoors. Air in excess of the minimum ventilation air specified on the heater’s rating plate shall be taken from the building, ducted directly from outdoors, or a combination of both. [NFPA 54:10.8.5.2]

914.5.3 Dampers or Louvers. Where outdoor air dampers or closing louvers are used, they shall be verified to be in the open position prior to main burner operation. [NFPA 54:10.8.5.3]

914.6 Atmospheric Vents, Gas Reliefs, or Bleeds. **Non-recirculating direct** Direct gas-fired industrial air heaters heating and forced ventilation appliances with valve train components equipped with atmospheric vents, gas reliefs, or bleeds shall have their vent lines, gas reliefs, or bleeds lead to a safe point outdoors. Means shall be employed on these lines to prevent water from entering and to prevent blockage from insects and foreign matter. An atmospheric vent line shall not be required to be provided on a valve train component equipped with a listed vent limiter. [NFPA 54:10.8.6]

914.7 Relief Openings. The design of the installation shall include adequate provisions to permit the non-recirculating direct gas-fired industrial air heater heating and forced ventilation appliances to operate at its their rated airflow without overpressurizing the space served by the heater into account the structure’s designed infiltration rate, properly designed relief openings, or an interlocked powered exhaust system, or a combination of these methods. [NFPA 54:10.8.7]

914.7.1 Infiltration Rate. The structure’s designed infiltration rate and the size of relief opening(s) shall be determined by approved engineering methods. [NFPA 54:10.8.7.1]

914.9 Recirculating-Direct Gas-Fired-Industrial-Air-Heaters:

914.9.1 Application. Direct gas-fired industrial air heaters of the recirculating type shall be listed in accordance with CSA Z83.10. [NFPA 54:10.9.1]

914.9.2 Prohibited Installations. Recirculating direct gas-fired industrial air heaters shall not serve any area containing sleeping quarters. Recirculating direct gas-fired industrial air heaters shall not recirculate room air in buildings that contain flammable solids, liquids, or gases; explosive materials; or substances that can become toxic when exposed to flame or heat. [NFPA 54:10.9.2.1, 10.9.2.2]

914.9.3 Installation. Recirculating direct gas-fired industrial air heaters shall be installed in accordance with the manufacturer’s instructions. [NFPA 54:10.9.3]

914.9.4 Clearance from Combustible Materials. Recirculating direct gas-fired industrial air heaters shall be installed with a clearance from combustible materials of not less than that shown on the rating plate and the manufacturer’s instructions. [NFPA 54:10.9.4]

914.9.5 Air Supply. Ventilation air to the recirculating direct gas-fired industrial air heater shall be ducted directly from outdoors. Air to the recirculating direct gas-fired industrial air heater in excess of the minimum ventilation air specified on the heater’s rating plate shall be taken from the building, ducted directly from outdoors, or a combination of both. Where outdoor air dampers or closing louvers are used, they shall be verified to be in the open position prior to main burner operation. [NFPA 54:10.9.5]

914.9.6 Atmospheric Vents, Gas Reliefs, or Bleeds. Recirculating direct gas-fired industrial air heaters with valve train components equipped with atmospheric vents, gas reliefs, or bleeds shall have their vent lines, gas reliefs, or bleeds lead to a safe point outdoors. Means shall be employed on these lines to prevent water from entering and to prevent blockage from insects and foreign matter. An atmospheric vent line shall not be required to be provided on a valve train component equipped with a listed vent limiter. [NFPA 54:10.9.6]

914.9.7 Relief Openings. The design of the installation shall include adequate provisions to permit the recirculating direct gas-fired industrial air heater to operate at its rated airflow without overpressurizing the space served by the heater by taking into account the structure’s designed infiltration rate, properly designed relief openings or an interlocked powered exhaust system, or a combination of these methods. [NFPA 54:10.9.7]

914.9.7.1 Infiltration Rate. The structure’s designed infiltration rate and the size of relief opening(s) shall be determined by approved engineering methods. [NFPA 54:10.9.7.1]

914.9.7.2 Louver or Gravity Dampers. Louver or counterbalanced gravity damper relief openings shall be permitted.
Where motorized dampers or closeable louvers are used, they shall be proved to be in their open position prior to main burner operation. [NFPA 54:10.9.7.2]

915.8 Purging. Inlet ducting, when used, shall be purged with at least four air changes prior to an ignition attempt. [NFPA 54:10.9.8]

(renumber remaining sections)

916.0 Room Heaters.

916.1 Application. Room heaters shall be listed in accordance with Section 916.1.1 or Section 916.1.2. [NFPA 54:10.21.1]

916.1.1 Vented Room Heaters. Vented room heaters shall be listed in accordance with ANSI Z21.86/CSA 2.32 or ANSI Z21.88/CSA 2.33. [NFPA 54:10.21.1.1]

916.1.2 Unvented Room Heaters. Unvented room heaters shall be listed in accordance with ANSI Z21.11.2. [NFPA 54:10.21.1.2]

(renumber remaining sections)

916.2.1.1 Unvented Room Heaters. Unvented room heaters shall not be installed in bathrooms or bedrooms.

Exceptions:
(1) Where approved by the Authority Having Jurisdiction, one listed wall-mounted, unvented room heater equipped with an oxygen depletion safety shutoff system shall be permitted to be installed in a bathroom, provided that the input rating does not exceed 6000 Btu/h (1.76 kW) and combustion and ventilation air is provided as specified in Section 902.2.
(2) Where approved by the Authority Having Jurisdiction, one listed wall-mounted unvented room heater equipped with an oxygen depletion safety shutoff system shall be permitted to be installed in a bedroom, provided that the input rating does not exceed 10 000 Btu/h (3 kW) and combustion and ventilation air is provided as specified in Section 902.2.

916.2.2 Installations in Institutions. Room heaters shall not be installed in the following occupancies:
(1) Residential board and care
(2) Health care [NFPA 54:10.21.3]

916.2.4 Wall-Type Mounted Room Heaters. Wall-type mounted room heaters shall not be installed in or attached to walls of combustible material unless listed for such installation. [NFPA 54:10.21.4]

917.0 Unit Heaters.

917.1 Application. Unit heaters shall be listed in accordance with ANSI Z83.8/CSA 2.6 and installed in accordance with the manufacturer’s installation instructions. [NFPA 54:10.24.1]

(renumber remaining sections)

917.1 Support. Suspended-type unit heaters shall be safely and adequately supported, with due consideration given to their weight and vibration characteristics. Hangers and brackets shall be of noncombustible material. [NFPA 54:10.24.2]

917.2 Clearance for Suspended-Type Unit Heaters. Suspended-type unit heaters shall comply with the following requirements:
(1) Listed Unit heaters shall be installed with clearances from combustible material of not less than 18 inches (457 mm) at the sides, 12 inches (305 mm) at the bottom, and 6 inches (152 mm) above the top where the unit heater has an internal draft hood, or 1 inch (25.4 mm) above the top of the sloping side of a vertical draft hood. A unit heater listed for reduced clearances shall be installed in accordance with its listing and the manufacturer’s installation instructions.
(2) Unlisted unit heaters shall be installed with clearances to combustible material of not less than 18 inches (457 mm).
(3) Clearances for servicing shall be in accordance with the manufacturer’s installation instructions. [NFPA 54:10.24.3]

917.3 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.24.4]

917.4 Ductwork. A unit heater shall not be attached to a warm air duct system unless listed and marked for such installation. [NFPA 54:10.24.5]

917.5 Installation in Commercial Garages and Aircraft Hangars. Unit heaters installed in garages for more than three motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with Section 303.11 and Section 303.12. [NFPA 54:10.24.6]

918.0 Food Service Appliance, Floor-Mounted.

918.1 Application. Floor-mounted food service appliances shall be listed in accordance with CSA Z83.11. [NFPA 54:10.11.1]

918.2 Clearance for Listed Appliances. Listed floor mounted food service appliances, such as ranges for hotels and restaurants, deep fat fryers, unit broilers, kettles, steam cookers, steam generators, and baking and roasting ovens, shall be installed not less than 6 inches (152 mm) from combustible material except that at least a 2 inch (51 mm) clearance shall be maintained between a draft hood and combustible material. Floor-mounted food service
appliances listed for installation at lesser clearances shall be installed in accordance with its listing and the manufacturer’s installation instructions. Appliances designed and marked, “For use only in noncombustible locations,” shall not be installed elsewhere. [NFPA 54:10.11.2]

918.2 Clearance for Unlisted Appliances. Unlisted floor mounted food service appliances shall be installed to provide a clearance to combustible material of not less than 18 inches (457 mm) from the sides and rear of the appliance and from the vent connector and not less than 48 inches (1219 mm) above cooking tops and at the front of the appliance.

Clearances for unlisted appliances installed in partially enclosed areas such as alcoves shall not be reduced. Reduced clearances for unlisted appliances installed in rooms that are not partially enclosed shall be in accordance with Table 303.10.1. [NFPA 54:10.12.2]

(renumber remaining sections)

918.3 Mounting on Combustible Floors. Listed floor mounted food service appliances that are listed specifically for installation on floors constructed of combustible material shall be permitted to be installed on combustible floors in accordance with its listing and the manufacturer’s installation instructions. [NFPA 54:10.11.3.1]

918.3.1 Not Listed for Mounting on Combustible Floors. Floor-mounted food service appliances that are not listed for mounting installation on a combustible floor shall be mounted installed in accordance with Section 918.4 or be mounted installed in accordance with one of the following:

(1) Where the appliance is set on legs that provide not less than 18 inches (457 mm) open space under the base of the appliance or where it has no burners and no portion of any oven or broiler within 18 inches (457 mm) of the floor, it shall be permitted to be mounted installed on a combustible floor without special floor protection, provided at least one sheet metal baffle is between the burner and the floor.

(2) Where the appliance is set on legs that provide not less than 8 inches (203 mm) open space under the base of the appliance, it shall be permitted to be mounted installed on combustible floors, provided the floor under the appliance is protected with not less than 5/8 of an inch (9.5 mm) insulating millboard covered with sheet metal not less than 0.0195 of an inch (0.4953 mm) thick. The preceding specified floor protection shall extend not less than 6 inches (152 mm) beyond the appliance on all sides.

(3) Where the appliance is set on legs that provide not less than 4 inches (102 mm) under the base of the appliance, it shall be permitted to be mounted installed on combustible floors, provided the floor under the appliance is protected with hollow masonry not less than 4 inches (102 mm) in thickness covered with sheet metal not less than 0.0195 of an inch (0.4953 mm) thick. Such masonry courses shall be laid with ends unshealed and joints matched in such a way as to provide for free circulation of air through the masonry.

(4) Where the appliance does not have legs at least 4 inches (102 mm) high, it shall be permitted to be mounted installed on combustible floors, provided the floor under the appliance is protected by two courses of 4 inch (102 mm) hollow clay tile, or equivalent, with courses laid at right angles and with ends unshealed and joints matched in such a way as to provide for free circulation of air through such masonry courses, and covered with steel plate not less than 3/16 of an inch (4.8 mm) in thickness. [NFPA 54:10.12.3.2 10.11.3.2]

918.4 Installation on Noncombustible Floors. Listed floor mounted food service appliances that are designed and marked “For use only in noncombustible locations” shall be installed on floors of noncombustible construction with noncombustible flooring and surface finish and with no combustible material against the underside thereof, or on noncombustible slabs or arches having no combustible material against the underside thereof. Such construction shall in all cases extend not less than 12 inches (305 mm) beyond the appliance on all sides. [NFPA 54:10.12.4.1, 10.12.4.2 10.11.4.1, 10.11.4.2]

918.5 Combustible Material Adjacent to Cooking Top. Listed and unlisted food service ranges shall be installed to provide clearance to combustible material of not less than 18 inches (457 mm) horizontally for a distance of up to 2 feet (610 mm) above the surface of the cooking top where the combustible material is not completely shielded by high shelving, a warming closet, or other system. Reduced combustible material clearances are permitted where protected in accordance with Table 303.10.1. [NFPA 54:10.12.6 10.11.5]

918.6 Use with Casters. Floor-mounted appliances with casters shall be listed for such construction and shall be installed in accordance with the manufacturer’s installation instructions for limiting the movement of the appliance to prevent strain on the connection. [NFPA 54:10.12.6 10.11.6]

918.7 Level Installation. Floor-mounted food service appliances shall be installed level on a firm foundation. [NFPA 54:10.12.7 10.11.7]

918.8 Ventilation. Means shall be provided to properly ventilate the space in which a food service appliance is installed to permit proper combustion of the gas. [NFPA 54:10.12.8 10.11.8]

919.0 Food Service Appliances, Counter Appliances.

919.1 Application. Food service counter appliances shall be listed in accordance with ANSI Z83.11/CSA 1.8. [NFPA 54:10.12.1]

(renumber remaining sections)

919.1 Vertical Clearance. A vertical distance of not less than 48 inches (1219 mm) shall be provided between the top of all food service hot plates and griddles and combustible material. [NFPA 54:10.12.4 10.12.2]

919.3 Clearance for Unlisted Appliances. Unlisted food service hot plates and griddles shall be installed with a horizontal clearance from combustible material of not less than 18 inches (457 mm). Unlisted gas food service counter appliances, including coffee brewers and urns, waffle bakers, and hot water immersion sterilizers where
installed on combustible surfaces, shall be installed with a minimum horizontal clearance of 6 inches (152 mm) from combustible material of not less than 12 inches (305 mm) except that at least a 2 inches (51 mm). Reduced clearances for gas food clearance shall be maintained between a draft hood and combustible material. Food service counter appliances listed for installation at lesser clearances shall be installed in accordance with Table 303.10.1. Unlisted food and dish warmers shall be installed with a horizontal clearance from combustible material of not less than 6 inches (152 mm) the manufacturer’s installation instructions. [NFPA 54:10.13.3 10.12.3]

919.4 Mounting of Unlisted Appliances. Unlisted food service counter appliances shall not be set on combustible material unless they have legs that provide not less than 4 inches (102 mm) of open space below the burners and the combustible surface is protected with insulating millboard at least 1/4 of an inch (6.4 mm) thick covered with sheet metal not less than 0.0122 of an inch (0.3099 mm) thick, or with equivalent protection. [NFPA 54:10.13.4]

920.0 Household Cooking Appliances.

920.1 Application. Household cooking appliances shall be listed in accordance with ANSI Z21.1/CSA 1.1. [NFPA 54:10.13.1]

920.3.1 Clearances from Combustible Material. The clearances specified as follows: Floor-mounted household cooking appliances, where installed on combustible floors, shall be set on their own bases or legs and shall not interfere with combustion air, accessibility for operation, and servicing:

1. Listed floor mounted household cooking appliances, where installed on combustible floors, shall be set on their own bases or legs and shall be in accordance with their listing and the manufacturer’s installation instructions.
2. Listed household cooking appliances with listed gas room heater sections shall be installed so that the warm-air discharge side shall have a clearance of not less than 18 inches (467 mm) from adjacent combustible material. A clearance of not less than 36 inches (914 mm) shall be provided between the top of the heater section and the bottom of cabinets.
3. Listed household cooking appliances that include a solid or liquid fuel burning section shall be spaced from combustible material and otherwise installed in accordance with their listing and the manufacturer’s installation instructions for the supplementary fuel section of the appliance.
4. Unlisted floor mounted household cooking appliances shall be installed with not less than 6 inches (152 mm) clearance at the back and sides to combustible material. Combustible floors under unlisted appliances shall be protected in an approved manner. [NFPA 54:10.13.3]

920.3.2 Vertical Clearance Above Cooking Top. Household cooking appliances shall have a vertical clearance above the cooking top of not less than 30 inches (762 mm) to combustible material or metal cabinets. A minimum clearance of 24 inches (610 mm) is shall be permitted where one of the following is installed:

1. The underside of the combustible material or metal cabinet above the cooking top is protected with not less than 1/4 of an inch (6.4 mm) insulating millboard covered with sheet metal not less than 0.0122 of an inch (0.3099 mm) thick.
2. A metal ventilating hood of sheet metal not less than 0.0122 of an inch (0.3099 mm) thick is installed above the cooking top with a clearance of not less than 1/4 of an inch (6.4 mm) between the hood and the underside of the combustible material or metal cabinet, and the hood is not less than the width of as wide as the appliance and is centered over the appliance.
3. A listed cooking appliance or microwave oven installed over a listed cooking appliance shall be in accordance with the terms of the upper appliance’s listing and the manufacturer’s installation instructions. [NFPA 54:10.13.3.1]

920.4.3 Level Installation. Cooking appliances shall be installed so that the cooking top, broiler pan, or oven racks are level. [NFPA 54:10.14.3]

922.0 Open-Top Broiler Units.

922.1 Listed Units Application. Listed open-top broiler units shall be listed in accordance with ANSI Z83.11/CSA 1.8 or ANSI Z21.1/CSA 1.1 and installed in accordance with the manufacturer’s installation instructions. [NFPA 54:10.18.1 10.17.1]

922.2 Unlisted Units. Unlisted open-top broiler units shall be installed in accordance with the manufacturer’s instructions but shall not be installed in combustible material. [NFPA 54:10.18.2]

922.3 Protection Above Domestic Units. Domestic open-top broiler units shall be provided with a metal ventilating hood not less than 0.0122 of an inch (0.3099 mm) thick with a clearance of not less than 1/4 of an inch (6.4 mm) between the hood and the underside of combustible material or metal cabinets. A clearance of at least 24 inches (610 mm) shall be maintained between the cooking top and the combustible material or metal cabinet, and the hood shall be at least as wide as the open-top broiler unit and centered over the unit. Listed domestic Domestic open-top broiler units incorporating an integral exhaust system and listed for use without a ventilating hood shall not be required to be provided with a ventilating hood if installed in accordance with Section 920.3.2(1). [NFPA 54:10.18.3 10.17.2]

922.4 Commercial Units. Commercial open-top broiler units shall be provided with ventilation in accordance with Chapter 5, Part II. [NFPA 54:10.18.4 10.17.3]
923.0 Outdoor Cooking Appliances.

923.1 Listed Units Application. Listed outdoor cooking appliances shall be installed in accordance with their listing and the manufacturer’s installation instructions. Outdoor cooking appliances shall be listed in accordance with ANSI Z83.11/CSA 1.8, ANSI Z21.58/CSA 1.6, or ANSI Z21.89/CSA 1.18, and installed in accordance with the manufacturer’s installation instructions. [NFPA 54:10.18]

923.2 Unlisted Units. Unlisted outdoor cooking appliances shall be installed outdoors with clearances to combustible material of not less than 36 inches (914 mm) at the sides and back and not less than 48 inches (1219 mm) at the front. In no case shall the appliance be located under overhead combustible construction. [NFPA 54:10.19.2]

924.0 Illuminating Appliances.
924.1 Clearances for Listed Appliances. Listed illuminating appliances shall be installed in accordance with their listing and the manufacturer’s installation instructions. [NFPA 54:10.14.1]
924.2 Clearances for Unlisted Appliances. Clearances for unlisted illuminating appliances shall comply with the following:

(1) Unlisted enclosed illuminating appliances installed outdoors shall be installed with clearances in any direction from combustible material of not less than 12 inches (305 mm). [NFPA 54:10.15.2.1(1) 10.14.2.1(1)]

(2) Unlisted enclosed illuminating appliances installed indoors shall be installed with clearances in any direction from combustible material of not less than 18 inches (457 mm). [NFPA 54:10.15.2.1(2) 10.14.2.1(2)]

924.2.1 Open-Flame Type. Clearances shall comply with the following:

(1) Unlisted open-flame illuminating appliances installed outdoors shall have clearances from combustible material not less than that specified in Table 924.2.1. The distance from ground level to the base of the burner shall be a minimum of 7 feet (2134 mm) where installed within 2 feet (610 mm) of walkways. Lesser clearances shall be permitted to be used where acceptable to the Authority Having Jurisdiction.

(2) Unlisted open-flame illuminating appliances installed outdoors shall be equipped with a limiting orifice or other limiting devices that maintain a flame height consistent with the clearance from combustible material, as given in Table 924.2.1.

(3) Appliances designed for flame heights in excess of 30 inches (762 mm) shall be permitted to be installed if acceptable to the Authority Having Jurisdiction approved. Such appliances shall be equipped with a safety shutoff device or automatic ignition.

(4) Unlisted open-flame illuminating appliances installed indoors shall have clearances from combustible material acceptable to the Authority Having Jurisdiction shall be approved. [NFPA 54:10.15.2.2 10.14.2.2]

<table>
<thead>
<tr>
<th>TABLE 924.2.1</th>
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<tbody>
<tr>
<td>CLEARANCES FOR UNLISTED OUTDOOR OPEN-FLAME ILLUMINATING APPLIANCES</td>
</tr>
<tr>
<td>[NFPA 54:TABLE 10.15.2.2 10.14.2.2]</td>
</tr>
<tr>
<td>(portion of table not shown remains unchanged)</td>
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</tbody>
</table>

924.3 Mounting on Buildings. Illuminating appliances designed for installation on a wall or ceiling mounting shall be securely attached to substantial structures in such a manner that they are not dependent on the gas piping for support. [NFPA 54:10.16.3 10.14.3]

924.4 Mounting on Posts. Illuminating appliances designed for installation on a post mounting shall be securely and rigidly attached to a post. Posts shall be rigidly mounted installed. The strength and rigidity of posts greater than 3 feet (914 mm) in height shall be at least equivalent to that of a 2 1/2 inch (64 mm) diameter post constructed of 0.064 of an inch (1.626 mm) thick steel or a 1 inch (25.4 mm) Schedule 40 steel pipe. Posts 3 feet (914 mm) or less in height shall not be smaller than a 3/4 of an inch (19.1 mm) Schedule 40 steel pipe. Drain openings shall be provided near the base of posts where water collecting inside the posts is possible. [NFPA 54:10.16.4 10.14.4]

924.5 Appliance Pressure Regulators. Where an appliance pressure regulator is not supplied with an illuminating appliance and the service line is not equipped with a service pressure regulator, an appliance pressure regulator shall be installed in the line serving one or more illuminating appliances. [NFPA 54:10.16.5 10.14.5]

926.0 Infrared Heaters.
926.1 Application. Infrared heaters having an input rating of 400,000 Btu/hr or less shall be listed in accordance with ANSI Z83.19/CSA 2.35 or ANSI Z83.20/CSA 2.34. [NFPA 54:10.16.1] (renumber remaining sections)

926.1 Support. Suspended-type infrared heaters shall be fixed in position independent of gas and electric supply lines. Hangers and brackets shall be of noncombustible material. Heaters subject to vibration shall be provided with vibration-isolating hangers. [NFPA 54:10.17.4 10.16.2]
926.2 Clearance. The installation of infrared heaters shall comply with the following clearance requirements:

1. Listed heaters shall be installed with clearances from combustible material in accordance with their listing and the manufacturer’s installation instructions.
2. Unlisted heaters shall be installed in accordance with clearances from combustible material acceptable to the Authority Having Jurisdiction.
3. In locations used for the storage of combustible materials, signs shall be posted to specify the maximum permissible stacking height to maintain required clearances from the heater to the combustibles. [NFPA 54:10.16.3]

926.3 Combustion and Ventilation Air. Where unvented infrared heaters are used, natural or mechanical means shall be provided to supply and exhaust air at least 4 ft\(^3/\)min/1000 Btu/h (0.38 m\(^3/\)min/kW) input of installed heaters. [NFPA 54:10.17.3.1 10.16.4.1]

926.3.1 Exhaust Openings. Exhaust openings for removing flue products shall be above the level of the heated air intake. [NFPA 54:10.17.3.2 10.16.4.2]

926.4 Installation in Commercial Garages and Aircraft Hangars. Overhead heaters installed in garages for more than three motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with Section 303.11 and Section 303.12. [NFPA 54:10.17.4 10.16.5]

927.0 Pool Heaters.

927.1 Application. Pool heaters shall be listed in accordance with ANSI Z21.56/CSA 4.7. [NFPA 54:10.19.1]

927.2 Clearance. The installation of pool heaters shall comply with the following requirements:

1. In no case shall the clearances shall not be such as to interfere with combustion air, draft hood, or vent terminal clearance and relief, and accessibility for servicing.
2. A listed pool heater shall be installed in accordance with its listing and the manufacturer’s installation instructions. [NFPA 54:10.19.3]
3. An unlisted pool heater shall be installed with a clearance of not less than 12 inches (305 mm) on the sides and the rear. A combustible floor under an unlisted pool heater shall be protected in an approved manner.

927.3 Temperature or Pressure-Limiting Devices. An unlisted pool heater shall be provided with overtemperature protection or overtemperature and overpressure protection by means of an approved device(s). Where a pool heater is provided with overtemperature protection only and is installed with any device in the discharge line of the heater that can restrict the flow of water from the heater to the pool (such as a check valve, shutoff valve, therapeutic pool valve, or flow nozzles), a pressure relief valve shall be installed either in the heater or between the heater and the restrictive device. [NFPA 54:10.19.4]

927.3.1 Pressure Relief Valve. Where a pool heater is provided with over-temperature protection only and is installed with any device in the discharge line of the heater that can restrict the flow of water from the heater to the pool (such as a check valve, shutoff valve, therapeutic pool valve, or flow nozzles), a pressure relief valve shall be installed either in the heater or between the heater and the restrictive device. [NFPA 54:10.20.3.2]

927.4 Bypass Valves. Where an integral bypass system is not provided as a part of the pool heater, a bypass line and valve shall be installed between the inlet and outlet piping for use in adjusting the flow of water through the heater. [NFPA 54:10.20.4 10.19.5]

927.5 Venting. A pool heater listed for outdoor installation shall be installed with the venting means supplied by the manufacturer and in accordance with the manufacturer’s installation instructions. [NFPA 54:10.20.5 10.19.6]

928.0 Refrigerators.

928.1 Application. Refrigerators shall be listed in accordance with ANSI Z21.19/CSA 1.4. [NFPA 54:10.20.1]

928.1 Clearance. Refrigerators shall be provided with clearances for ventilation at the top and back in accordance with the manufacturer’s instructions. Where such instructions are not available, at least 2 inches (51 mm) shall be provided between the back of the refrigerator and the wall at least 12 inches (305 mm) above the top. [NFPA 54:10.21.1 10.20.2]

928.2 Venting or Ventilating Kits Approved for Use with a Refrigerator. Where an accessory kit is used for conveying air for burner combustion or unit cooling to the refrigerator from areas outside the room in which it is located, or for conveying combustion products diluted with air containing waste heat from the refrigerator to areas outside the room in which it is located, the kit shall be installed in accordance with the refrigerator manufacturer’s instructions. [NFPA 54:10.24.2 10.20.3]

929.0 Gas-Fired Toilets.

929.1 Clearance. A listed gas-fired toilet shall be installed in accordance with its listing and the manufacturer’s installation instructions, provided that the clearance shall be such to afford ready accessibility for use, cleanout, and necessary servicing. [NFPA 54:10.23.1]

929.2 Installation on Combustible Floors. Listed gas-fired toilets installed on combustible floors shall be listed for such installation. [NFPA 54:10.24.2 10.23.2]
929.3 Vents. Vents or vent connectors that are capable of being contacted during casual use of the room in which the toilet is installed shall be protected or shielded to prevent such contact. [NFPA 54:10.24.3 10.23.3]

930.0 Appliances for Installation in Manufactured Housing.
930.1 General. Appliances installed in manufactured housing after the initial sale shall be listed for installation in manufactured housing, or approved, and shall be installed in accordance with the requirements of this code and the manufacturer's installation instructions. Appliances installed in the living space of manufactured housing shall be in accordance with the requirements of Section 701.0. [NFPA 54:10.29 10.28]

932.0 Outdoor Open Flame Decorative Appliances.
932.1 General. Permanently fixed in place outdoor open flame decorative appliances shall be installed in accordance with Section 932.1.1 through Section 932.1.3. [NFPA 54:10.31 10.30]
932.1.1 Listed Units Application. Listed outdoor Outdoor open flame decorative appliances shall be listed in accordance with ANSI Z21.97/CSA 2.41 and shall be installed in accordance with the manufacturer's installation instructions. [NFPA 54:10.31.1 10.30.1]
932.1.2 Unlisted Units. Unlisted outdoor open flame decorative appliances shall be installed outdoors in accordance with the manufacturer's installation instructions and with clearances to combustible material of not less than 36 inches (914 mm) from the sides. In no case shall the appliance be located under overhead combustible construction. [NFPA 54:10.31.2]
932.1.3 Connection to the Piping System. The connection to the gas piping system shall be in accordance with Section 1312.1(1), Section 1312.1(2), Section 1312.1(4), or Section 1312.1(5). [NFPA 54:10.31.3 10.30.2]

938.0 Compressed Natural Gas (CNG) Vehicular Fuel Systems.
938.1 General. The installation of compressed natural gas (CNG) fueling (dispensing) systems shall conform to be in accordance with NFPA 52. Residential CNG fueling appliances shall be listed in accordance with ANSI/CSA NGV 5.1 and installed in accordance to the appliance manufacturer's installation instructions. Non-residential CNG fueling appliances shall be listed in accordance with ANSI/CSA NGV 5.2 and installed in accordance with the appliance manufacturer's installation instructions. [NFPA 54:10.28 10.27]

**TABLE 1701.1**
**REFERENCED STANDARDS**

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
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<tr>
<td>ANSI Z21.89/CSA 1.18-2017</td>
<td>Outdoor Cooking Specialty Gas Appliances</td>
<td>Gas Appliances</td>
<td>923.1</td>
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<td>ANSI Z21.97/CSA 2.41-2017</td>
<td>Outdoor Decorative Gas Appliances</td>
<td>Gas Appliances</td>
<td>932.1.1</td>
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<tr>
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<td>Vehicle Fueling Appliances (VFA)</td>
<td>Appliances</td>
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</table>

(portions of table not shown remain unchanged)

**Note:** The CSA standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

**SUBSTANTIATION:**
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 9 is being revised to the latest edition of NFPA 54-2021.

[Instructions for accessing the CSA standards is provided in KAVI]

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 180

UMC 2024  Section: 902.10.1, Table 1701.1

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Add new text

902.0 General.

902.10 Solid-Fuel Burning Appliances. Unless otherwise specified, solid-fuel burning appliances shall be installed in accordance with NFPA 211 and the manufacturer’s installation instructions.

902.10.1 Pellet Fuel-Burning Appliances. Pellet fuel-burning appliances shall be listed and labeled in accordance with ASTM E1509.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
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<tr>
<td>ASTM E1509-2012 (R2017)</td>
<td>Room Heaters, Pellet Fuel-Burning Type</td>
<td>Room Heaters</td>
<td>902.10.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: ASTM E1509 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
Pellet burning appliances such as fireplaces and stoves have risen in popularity thanks to their green credentials of burning renewable or otherwise waste products instead of nonrenewable sources of energy such as gas. Pellet burning fireplaces or stoves differ to wood burning stoves or wood burning fireplaces because they use compressed pellets as the fuel rather than pieces of wood. The pellets themselves are highly compressed pieces of material that burn with a hot flame thanks to their density. The ASTM E1509 standard covers performance requirements, test methods, and marking requirements for automatic feed, pellet fuel-burning room heaters that are intended to burn pellets.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
Pellet fuel-burning appliances are outside of the scope of the UMC. The section would only be relevant in new construction that includes a pellet fuel-burning appliance.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 181
UMC 2024  Section: 903.2.7

SUBMITTER: Brad Ketner
KBE, INC

RECOMMENDATION:
Add new text

903.0 Air-Conditioning Appliances.

903.2 Gas-Fired Air Conditioners and Heat Pumps.

903.2.7 Air-Conditioning Coil Freeze Protection. A sensor shall be attached to the air-conditioning coils that will shut off the equipment if it detects a temperature of 29°F (-2°C) to prevent icing of the coils. A manual reset button that is on the sensor shall be pushed to return the system to normal operation.

SUBSTANTIATION:
When any part of the air conditioning unit fails, i.e., the blower motor, low refrigerant, poor air flow, etc., the coils will begin to freeze. This leads to potential flood damage for the homeowner, mold, mildew, and additional equipment failure due running while frozen (txv fails, compressor slugs...), not to mention it is wasted time for the technicians that are waiting for the system to thaw before they can fix the problem, and the homeowner is financially burdened as well. With this safety sensor in place, hundreds of millions of dollars in property damage and equipment breakage can be alleviated.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The language does not provide direction as to where to find the sensor, and there is no standard for the sensor. The language is vague and ambiguous regarding this sensor. There is concern that not every coil needs freeze protection. As written, this requirement would apply to every single unit even if freeze protection is unnecessary. There is also concern regarding the manual reset button to return the system to normal operation. The section would only apply to gas-fired air conditioners based on the proposed location within the code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 182

UMC 2024  Section: 903.3, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Add new text

903.0 Air-Conditioning Appliances.

903.3 Packaged Terminal Air Conditioners. Packaged terminal air conditioners and heat pumps shall be listed and labeled in accordance with UL 484 or UL 60335-2-40, and shall be installed in accordance with the manufacturer’s installation instructions.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
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<tr>
<td>UL 484-2014</td>
<td>Room Air Conditioners (with revisions through May 15, 2019)</td>
<td>Room Air Conditioners</td>
<td>903.3</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 484 and UL 60335-2-40 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
A new section is being added to Chapter 9 (Installation of Specific Appliances) to address the safety standards for packaged terminal air conditioners and heat pumps to aid the code official in verifying safe installation for such systems.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

903.0 Air-Conditioning Appliances.

903.3 Packaged Terminal Air Conditioners. Packaged terminal air conditioners and heat pumps shall be listed and labeled in accordance with UL 484 or UL 60335-2-40, and shall be installed in accordance with the manufacturer’s installation instructions.
<table>
<thead>
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<td>UL 484-2014</td>
<td>Room Air Conditioners (with revisions through May 15, 2019)</td>
<td>Room Air Conditioners</td>
<td>903.3</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**COMMITTEE STATEMENT:**
The proposal is being modified to change "listed and labeled" to "comply" since "comply" already implies that the product must be listed and labeled.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 183
UMC 2024 Section: 911.0 - 911.2.2, Table 1701.1

SUBMITTER: Maria Yepremian
County of Los Angeles Building and Safety

RECOMMENDATION:
Revise text

911.0 Decorative Appliances for Installation in Vented Fireplaces.
911.1 Prohibited Installations in Vented Fireplaces. Decorative appliances for installation in vented fireplaces shall not be installed in bathrooms or bedrooms unless the appliance is listed and the bedroom or bathroom has the required volume in accordance with Section 701.4. [NFPA 54:10.6.1]

911.2 911.1.1 Installation. A decorative appliance for installation in a vented fireplace shall be installed only in a vented fireplace having a working chimney flue and constructed of noncombustible materials. These appliances shall not be thermostatically controlled. [NFPA 54:10.6.2]

911.2.1leral Decorative Appliance. A listed decorative appliance for installation in a vented fireplace shall be installed in accordance with its listing and the manufacturer's installation instructions.

911.2.2 911.1.2 Listed Decorative Appliance. A listed decorative appliance for installation in a vented fireplace shall be installed in accordance with its listing and the manufacturer's installation instructions.

911.2.3 911.1.3 In Manufactured Homes. A decorative appliance for installation in a vented fireplace, where installed in a manufactured home, shall be listed for installation in manufactured homes. [NFPA 54:10.6.2.2]

911.2.4 911.1.4 Unlisted Decorative Appliance. An unlisted decorative appliance for installation in a vented fireplace shall be installed in a fireplace having a permanent free opening, based on appliance input rating and chimney height, equal to or greater than that specified in Table 911.2. [NFPA 54:10.6.2.3]

911.3 911.1.5 Fireplace Screens. A fireplace screen shall be installed with a decorative appliance for installation in a vented fireplace. [NFPA 54:10.6.3]

911.2 Unvented Decorative Appliances. Unvented factory-built decorative appliances shall be installed in accordance with the manufacturer's installation instructions and its listing.

911.2.1 Alcohol Fuel Burning. Factory-built unvented liquid or gelled alcohol based intended to be fixed shall comply with UL 1370. No combustible material shall be within 18 inches (457 mm) of the appliance.

911.2.2 Prohibited Use. Factory-built unvented decorative appliances shall be used for decorative purposes and shall not be used as a primary heat source, a cooking appliance, or in conjunction with a blower assembly.

Unvented decorative appliances shall not be installed in spaces in which flammable vapors or gases may be present.

Unvented decorative appliances shall not be installed in bathrooms or bedrooms unless the appliance is listed for such purpose, and the bedroom or bathroom has the required volume of indoor air in accordance with Section 701.4.

(Shown for reference only)

701.4 Indoor Combustion Air. The required volume of indoor air shall be determined in accordance with the method in Section 701.4.1 or Section 701.4.2, except that where the air infiltration rate is known to be less than 0.40 ACH (air change per hour), the method in Section 701.4.2 shall be used. The total required volume shall be the sum of the required volume calculated for appliances located within the space. Rooms communicating directly with the space in which the appliances are installed through openings not furnished with doors, and through combustion air openings sized and located in accordance with Section 701.5, are considered a part of the required volume. [NFPA 54:9.3.2]
### TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
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<tr>
<td>UL 1370-2011</td>
<td>Unvented Alcohol Fuel Burning Decorative Appliances (with revisions through March 25, 2016)</td>
<td>Unvented Alcohol Fuel Burning Decorative Appliances</td>
<td>911.2.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**Note:** UL 1370 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

**SUBSTANTIATION:**
The existing code does not provide any information for unvented decorative appliances such as alcohol based space heaters. These systems are being installed more and more every day and the UMC does not provide guidance as to what are the appropriate requirements for the safe installation of such systems. UL 1370 is the appropriate standard for such application. Section 911.2 will clarify that such systems shall be installed in accordance with the manufacturer's installation instructions and its listing. This is necessary because there have been instances where the manufacture's installation instructions conflict with the listing. In such case, where the installation instructions conflict the listing, the more stringent provisions shall prevail in accordance with Section 102.1 of the UMC.

**COMMITTEE ACTION:** REJECT

**COMMITTEE STATEMENT:**
Section 911.2 raises safety concerns as to public health and safety. The proposal also goes beyond the minimum requirements of the code. Furthermore, such unvented decorative appliances can be installed without being inspected.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 184

UMC 2024  Section: 911.1

SUBMITTER: Keith Blazer  
Self

RECOMMENDATION:  
Revise text

911.0 Decorative Appliances for Installation in Vented Fireplaces.  
911.1 Prohibited Installations. Decorative appliances for installation in vented fireplaces shall not be installed in bathrooms or bedrooms unless the appliance is listed and the bedroom or bathroom has the required volume in accordance with Section 701.4. [NFPA 54:10.6.1] Decorative appliances for installation in vented fireplaces shall not be installed in health care facilities.

SUBSTANTIATION:  
Decorative appliances and portable heating devices are unsafe in health care facilities. Although heating devices must always be installed to prevent ignition of combustible materials, due to health and safety concerns, installation of such decorative appliances in health care facilities must not be permitted.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:  
Unvented decorative appliances can be installed without being inspected. Such appliances are out of the scope of the UMC and these appliances are meant to be decorative only and not used as a primary heat source.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  
AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 185

UMC 2024  Section: 913.0 - 913.4, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

913.0 Factory-Built Fireplaces and Fireplace Stoves.
913.1 Factory-Built Fireplaces. Factory-built fireplaces shall be listed and labeled in accordance with UL 127 and shall be installed in accordance with the manufacturer’s installation instructions.
913.2 Factory-Built Fireplace Stoves. Fireplace stoves shall be listed and labeled in accordance with UL 737 and shall be installed in accordance with the manufacturer’s installation instructions.
913.3 Masonry Fireplace Inserts. Solid-fuel-type fireplace inserts intended for installation in masonry fireplaces shall be listed and labeled in accordance with UL 1482 and shall be installed in accordance with the manufacturer’s installation instructions.
913.4 Fireplace Accessories. Fireplace accessories for use with masonry fireplaces, including heat exchangers, glass door assemblies, combustion air vents, and termination caps, shall be listed and labeled in accordance with UL 907 and shall be installed in accordance with the manufacturer’s installation instructions.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 1482-2011</td>
<td>Solid-Fuel Type Room Heaters (with revisions through February 25, 2020)</td>
<td>Room Heaters</td>
<td>913.3</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 1482 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
A new section is being added to Chapter 9 (Specific Appliances) to address solid-fuel-fired fireplace inserts. UL 907 applies to fireplace accessories that are intended only for field installation into or attachment to existing masonry fireplaces. Fireplace accessories include items such as heat exchangers, glass door assemblies, and the like. For the purpose of these requirements, fireplace accessories do not include fireplace inserts or devices that incorporate a closed fire chamber. UL 1482 is used to evaluate and certify fireplace inserts in masonry fireplaces. Any accessory or addition to a factory built fireplace needs to be evaluated and certified in accordance with UL 127. Determining compliance with a standard is done as “listed and labeled”, which are code-defined terms.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The current language is concise and clearly states the intent of the section. The proposal is overly restrictive. It adds only one standard for masonry fireplace inserts but there may be other standards that apply. Furthermore, the phrase "listed and labeled" should state "comply" as "comply" already implies that the product must be listed and labeled.
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 24  NEGATIVE: 5  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

BALLANCO: This change should have been accepted. The standard is the proper standard to reference.

FEEHAN: This language and standard are necessary in the code.

KOERBER: Standard is correct. This should be accepted.

WHITE: This is a good change, is well substantiated and should have been accepted.

WISEMAN: This should have been accepted. It would be a helpful addition to code.
Proposals

Item #: 186

UMC 2024  Section: 913.1 - 913.1.2, Table 1701.1, Table 1701.2

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

913.0 Factory-Built Fireplaces and Fireplace Stoves.
913.1 Factory-Built Fireplaces. Factory-built fireplaces shall comply with Section 913.1.1 and Section 913.1.2.

913.1.1 Solid-Fuel Fireplaces. Solid wood or coal fuel factory-built fireplaces shall comply with UL 127 and installed in accordance with the manufacturer’s installation instructions.

913.1.2 Gas-Fired Fireplaces. Natural gas and propane factory-built fireplaces shall comply with CSA Z21.50 and CSA Z21.88 and installed in accordance with the manufacturer’s installation instructions.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA Z21.50-2019</td>
<td>Vented Decorative Gas Appliances (same as CSA 2.22)</td>
<td>Decorative Gas Appliances</td>
<td>913.1.2</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA Z21.88-2017</td>
<td>Vented Gas Fireplace Heaters (same as CSA 2.33)</td>
<td>Fireplace Heaters</td>
</tr>
<tr>
<td>CSA Z21.50-2016</td>
<td>Vented Decorative Gas Appliances (same as CSA 2.22)</td>
<td>Appliances, Decorative Appliances</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

SUBSTANTIATION:
Section 913.1 for factory-built fireplaces is being split into 2 sections: solid-fuel and gas-fired. The appropriate standard for factory-built fireplaces depends on the type of fuel it uses:
• For solid-fuel fireplaces, UL 127, Standard for Factory-Built Fireplaces, applies.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed language is outside the scope of the mechanical code. In addition, such devices are decorative only and not meant to serve as a primary heat source.
TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
913.4 Gas Log Sets. Gas log sets installed into solid-fuel factory-built fireplaces shall be in accordance with Section 913.4.1 through Section 913.4.4 and installed in accordance with the manufacturer’s installation instructions.

913.4.1 Vented Decorative Gas Log Sets. Vented decorative gas log sets with automatic ignition systems shall be in accordance with CSA Z21.60.

913.4.2 Vented Decorative Gas Log Sets with Manual Ignition. Vented decorative natural gas log sets with manual ignition shall be in accordance with CSA Z21.84.

Exception: This requirement shall not apply to appliances using liquid propane.

913.4.3 Unvented Gas Log Sets. Unvented gas log sets shall be in accordance with CSA Z21.11.2.

913.4.4 Gas Log Sets as Heaters. Gas log sets that are intended to be used as heaters shall be in accordance with CSA Z21.86. Unvented heating gas log sets shall be in accordance with CSA Z21.11.2 and CSA Z21.86.

### TABLE 1701.1

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA Z21.11.2-2019</td>
<td>Gas Fired Room Heaters, Volume II, Unvented Room Heaters</td>
<td>Gas Appliances</td>
<td>913.4.3, 913.4.4</td>
</tr>
<tr>
<td>CSA Z21.60-2017</td>
<td>Decorative Gas Appliances for Installation into Solid-Fuel Burning Fireplaces (Same as CSA 2.26)</td>
<td>Gas Appliances</td>
<td>913.4.1</td>
</tr>
<tr>
<td>CSA Z21.84-2017</td>
<td>Manually Lighted, Natural Gas, Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces</td>
<td>Gas Appliances</td>
<td>913.4.2</td>
</tr>
<tr>
<td>CSA Z21.86-2016</td>
<td>Vented Gas-Fired Space Heating Appliances (Same as CSA 2.32)</td>
<td>Gas Appliances</td>
<td>913.4.4</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**Note:** The CSA standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

**SUBSTANTIATION:**
Gas log sets that are installed in solid-fuel factory-built fireplaces are tested to different standards depending on their intended function and operation. The standards are divided into vented or unvented, decorative or heater, and automatic or manually ignited:

• ANSI/CSA Z21.60, Standard for Decorative Gas Appliances for Installation into Solid-Fuel Burning Fireplaces, applies to decorative gas log sets (vented) with automatic ignition systems.
• ANSI/CSA Z21.84, Manually Lighted, Natural Gas, Decorative Gas Appliances for Installation In Solid-Fuel Burning Fireplaces, applies to decorative gas log sets (vented) with manual ignition. Note: this is for natural gas units only, not for appliances using liquid propane.
• ANSI/CSA Z21.86, Vented Gas-Fired Space Heating Appliances, applies to gas log sets that are intended as heaters. It should be noted that for vent-free heating gas log sets, a combination of the appropriate tests from both ANSI/CSA Z21.11.2 and ANSI/CSA Z21.86 are applicable.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
Section 913.4.3 raises concerns regarding unvented gas log sets. These type of fireplace inserts and applications create health and safety concerns. The burner is not a part of the log set which makes the provisions confusing. There already exists standards for compliance, and the proposed language can be overly restrictive for manufacturers.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Subsection 917.7 Prohibited Uses. In health care facilities, suspended-type unit heaters shall be prohibited in corridors, access or exit stairways and ramps, and patient sleeping areas.

Substantiation:
Portable heating devices are unsafe in patient-occupied portions of health care facilities. All heating devices should be designed and installed to prevent ignition of combustible materials. Approved suspended unit heaters may be used, except in means of egress and patient sleeping areas, as long as they are high enough to be out of the reach of persons using the area.

Committee Action: REJECT

Committee Statement:
The proposal is unnecessary as these types of installation of suspended-type unit heaters in healthcare facilities are not common and may not be feasible.

Total Eligible to Vote: 30

Voting Results:  Affirmative: 29  Not Returned: 1  Heine
Proposals

Item #: 189
UMC 2024  Section: 920.4.3

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION: Revise text

920.0 Household Cooking Appliances.

920.4 Built-In Units. Built-in units shall be installed in accordance with Section 920.4.1 through Section 920.4.3.

920.4.1 Installation. Listed built-in household cooking appliances shall be installed in accordance with their listing and the manufacturer’s installation instructions. The installation shall not interfere with combustion air, accessibility for operation, and servicing. Unlisted built-in household cooking appliances shall not be installed in or adjacent to combustible material.

920.4.2 Vertical Clearance. Built-in top (or surface) cooking appliances shall have a vertical clearance above the cooking top of not less than 30 inches (762 mm) to combustible material or metal cabinets. A clearance of not less than 24 inches (610 mm) is permitted where one of the following is installed:

1. The underside of the combustible material or metal cabinet above the cooking top is protected with not less than 1/4 of an inch (6.4 mm) insulating millboard covered with sheet metal not less than 0.0122 of an inch (0.3099 mm) thick.
2. A metal ventilating hood of sheet metal not less than 0.0122 of an inch (0.3099 mm) thick is installed above the cooking top with a clearance of not less than 1/4 of an inch (6.4 mm) between the hood and the underside of the combustible material or metal cabinet, and the hood not less than the width of the appliance and is centered over the appliance.
3. A listed cooking appliance or microwave oven installed over a listed cooking appliance shall be in accordance with the terms of the upper appliance listing and the manufacturer’s installation instructions. Microwave ovens shall comply with UL 923.

920.4.3 920.5 Level Installation. Cooking appliances shall be installed so that the cooking top, broiler pan, or oven racks are level. [NFPA 54:2018:10.14.3]

SUBSTANTIATION: This code change relocates Section 920.4.3 (Level Installation) so that household cooking appliances other than only built-in units require level installation.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 190

UMC 2024  Section: 923.3, Table 1701.1, Table 1701.2

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Add new text

923.0 Outdoor Cooking Appliances.

923.1 Listed Units. Listed outdoor cooking appliances shall be installed in accordance with their listing and the manufacturer’s installation instructions.

923.2 Unlisted Units. Unlisted outdoor cooking appliances shall be installed outdoors with clearances to combustible material of not less than 36 inches (914 mm) at the sides and back and not less than 48 inches (1219 mm) at the front. In no case shall the appliance be located under overhead combustible construction. [NFPA 54:10.19.2]

923.3 Outdoor Gas Cooking Appliances. Outdoor gas cooking appliances shall be in accordance with CSA Z21.58.

Outdoor cooking appliances connected to a fixed gas piping system shall comply with NFPA 54. Outdoor cooking appliances fueled by propane cylinders shall comply with NFPA 58.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA Z21.58-2018</td>
<td>Outdoor Cooking Gas Appliances (same as CSA 1.6)</td>
<td>Cooking Appliances</td>
<td>923.3</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: CSA Z21.58, NFPA 54/Z223.1, and NFPA 58 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA Z21.58-2018</td>
<td>Outdoor Cooking Gas Appliances (same as CSA 1.6)</td>
<td>Cooking Appliances</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

SUBSTANTIATION:
Outdoor cooking appliances such as built-in barbecue grills and outdoor kitchens are extremely common. The UMC contains listed and unlisted outdoor cooking appliances. To improve Section 923.0 (Outdoor Cooking Appliances), additional information for outdoor gas cooking appliances is added to cover fixed gas piping system and propane fueled appliances to ensure safe installation.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed change is already addressed in Section 923.1 and is therefore repetitive and not necessary to include.
TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1  Heine
Proposals

Item #: 191
UMC 2024  Section: 926.5

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Add new text

926.0 Infrared Heaters.

926.5 Electric Infrared Radiant Heaters. Electric infrared radiant heaters shall be listed and labeled in accordance with UL 2021 and installed in accordance with the manufacturer’s installation instructions.

Note: UL 2021 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
A new section for electric infrared radiant heaters is being added to Chapter 9 in order to reference the applicable safety standard, UL 2021.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

926.0 Infrared Heaters.

926.5 Electric Infrared Radiant Heaters. Electric infrared radiant heaters shall be listed and labeled in accordance comply with UL 2021 and installed in accordance with the manufacturer’s installation instructions.

COMMITTEE STATEMENT:
The proposal is being modified to remove the term "infrared" as such appliances are called "electric radiant heaters." Additionally, the phrase "listed and labeled" is being changed to "comply" since "comply" already implies that the product must be listed and labeled.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29 NOT RETURNED: 1  Heine
Proposals

Item #: 192

UMC 2024  Section: 931.4, 1108.2, 1124.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

931.0 Small Ceramic Kilns.

931.4 Electrical Equipment. All electrical equipment used as part of, or in connection with, the installation of a kiln shall be in accordance with the requirements in the electrical code NFPA 70. Electric kilns shall be listed and labeled in accordance with UL 499.

1108.0 Refrigeration Machinery Room Equipment and Controls.

1108.2 Electrical. Electrical equipment and installations shall comply with the electrical code NFPA 70. The refrigeration machinery room shall not be classified as a hazardous location except as provided in Section 1107.1.7 or Section 1107.1.8.

1124.0 Electrical.
1124.1 General. Electrical systems shall be in accordance with the electrical code NFPA 70. Equipment shall be provided with a vibration switch to shut off fans operating with excessive vibration. In climates commonly subject to electrical storms, lightning protection shall be provided on roof-mounted equipment.

Note: NFPA 70 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The reference to “the electrical code” is being replaced with “NFPA 70” for consistency within the code; there are only 3 references to “the electrical code” and 17 references to “NFPA 70” in the UMC. See Sections 301.4, 511.1.6, 512.2.5, 516.2.7, 516.2.9, 602.2.1, 905.8.2, 1104.4, 1107.1.7, 1107.1.8, 1217.8.1, 1310.14.5, 1311.2.4, 1311.7, and E 503.5.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 193
UMC 2024  Section: 933.5

SUBMITTER: Keith Blazer
Self

RECOMMENDATION:
Add new text

933.0 Evaporative Cooling Systems.

933.5 Evaporative Cooling Systems in Health Care Facilities. In health care facilities, direct evaporative cooling systems where the air directly contacts the wetted surface or spray shall be permitted in nonpatient areas, such as, but not limited to, laundry rooms, food preparation areas, and boiler or machinery rooms.

SUBSTANTIATION:
For health care facilities to maintain a comfortable indoor atmosphere with a consistent mid-range relative humidity and promote the recovery of patients and minimize the spread of airborne diseases, installing of evaporative cooling systems has been a way to efficiently regulate and minimize airborne dust particles, static, premature coagulation, and other threats to overall health. The energy efficiency of these systems allows for otherwise wasted energy to be utilized by vital lifesaving equipment that typically consumes more electricity. It should be stated that these systems must only be installed in nonpatient areas to promote the health and safety of health care facilities.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
Healthcare facilities can decide whether or not to allow direct evaporative cooling systems in non-patient areas. It is unnecessary to include such provisions within the code. The proposal is more of a design requirement. In addition, it is poorly written. It is unenforceable and outside the scope of the mechanical code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:
AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
934.0 Refrigeration Appliances.
934.1 Self-Contained Refrigerators and Freezers. Factory-built commercial refrigerators and freezers shall be listed and labeled in accordance with UL 471 or UL 60335-2-89 and shall be installed in accordance with the manufacturer’s installation instructions.
934.2 Unit Coolers. Factory-built unit coolers for use in refrigerators, freezers, refrigerated warehouses, and walk-in coolers shall be listed and labeled in accordance with UL 412 or UL 60335-2-89 and shall be installed in accordance with the manufacturer’s installation instructions.
934.3 Self-Contained Mechanical Refrigeration Systems. Self-contained mechanical refrigeration systems for use in walk-in coolers shall be listed and labeled in accordance with UL 427 or UL 60335-2-89 and shall be installed in accordance with the manufacturer’s installation instructions.
934.4 Refrigerant-Containing Components and Accessories. Nonelectrical refrigerant-containing components and accessories shall be listed and labeled in accordance with UL 207, and shall be installed in accordance with the manufacturer’s installation instructions.
934.5 Refrigeration Fittings. Refrigeration fittings, including press-connect, flared and threaded shall be listed and labeled in accordance with UL 109 and UL 207, and shall be installed in accordance with the manufacturer’s installation instructions.

**TABLE 1701.1**
**REFERENCED STANDARDS**

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 109-1997</td>
<td>Tube Fittings for Flammable and Combustible Fluids, Refrigeration Service, and Marine Use (with revisions through May 20, 2020)</td>
<td>Fittings</td>
<td>934.5</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 109 and UL 207 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

**SUBSTANTIATION:**
Sections are being added to Chapter 9 (Installation of Specific Appliances) to address the safety standards for refrigerant-containing components, accessories, and fittings to aid the code official in verifying safe installation for such systems.

**COMMITTEE ACTION:** REJECT

**COMMITTEE STATEMENT:**
The proposed change is being rejected as UL 207 has been updated to include provisions from UL 109. There is concern whether UL 207 covers these type of refrigerant fittings.

**TOTAL ELIGIBLE TO VOTE:** 30
VOTING RESULTS: AFFIRMATIVE: 21 NEGATIVE: 8 NOT RETURNED: 1 Heine

EXPLANATION OF AFFIRMATIVE:

MANN: I have the same concern the Committee has as to whether UL 207 covers these fittings. Furthermore, the Committee decided years ago to use "comply with" and not "be listed and labeled in accordance with."

EXPLANATION OF NEGATIVE:

BALLANCO: This change should have been either accepted as submitted or accepted as modified with the removal of UL 109 since this standard is incorporated into UL 207. The substantiation justifies the acceptance of this change.

FEEHAN: This language and standard are necessary in the code.

KOERBER: Should be accepted with modification to reference the appropriate standard.

MACNEVIN: This proposal should be accepted as UL 109 is appropriate for this purpose.

TRAFTON, A: This standard is necessary in the code.

VAN RITE: This proposal should be accepted as modified with removal of the UL 109 reference.

WHITE: Should be accepted based on substantiation.

WISEMAN: This is a necessary standard in the code.
Proposals

Item #: 195

UMC 2024 Section: 935.0 - 935.1.1

SUBMITTER: John Taecker
    UL LLC

RECOMMENDATION:
Revise text

935.0 Ductless Mini-Split Systems installation.
935.1 General. A ductless mini-split system's installation shall be installed in accordance with the manufacturer's installation instructions and Section 310.2 for condensate control.

935.1.1 Split System Air Conditioners. Split system air conditioners and heat pumps shall be listed and labeled in accordance with UL 1995 or UL 60335-2-40.

Note: UL 1995 and UL 60335-2-40 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
Referencing the appropriate product safety standard for ductless mini-split systems in the UMC will aid the code official in verifying safe installation for such systems.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the language is being added to the wrong section regarding split systems in the ductless mini-split system section. This change should be submitted on its own in a public comment.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 196
UMC 2024  Section: 936.1, 936.2, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

936.0 Air Filter Appliances.
936.1 Electrostatic Air Cleaners. Electrostatic air cleaners shall comply be listed and labeled in accordance with UL 867 and shall be installed in accordance with the manufacturer’s installation instructions.
936.2 High-Efficiency Particulate Air Filter Units. High-efficiency particulate air filter units for use in industrial and laboratory exhaust and ventilation systems shall be listed and labeled in accordance with UL 586 and shall be installed in accordance with the manufacturer’s installation instructions.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 586-2009</td>
<td>High-Efficiency, Particulate, Air Filter Units (with revisions through December 19, 2017)</td>
<td>Air Filters</td>
<td>936.2</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 586 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The appropriate standard for high-efficiency particulate air filter units is UL 586, “High-Efficiency, Particulate, Air Filter Units” and is being added to Section 936.2 “High-Efficiency Particulate Air Filter Units.”

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There may exist other applicable standards other than UL 586 for high efficiency particulate air filter units. In addition, the Technical Committee would like the submitter to come back with a public comment to modify the wording from “listed and labeled” to “comply with” for consistency throughout the code and to prevent overly restrictive language.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 22  NEGATIVE: 7  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:
ARYAN: This language would be beneficial to the code and the referenced standard is appropriate.
BALLANCO: This change should have been accepted. The substantiation justifies the proposal.
FEEHAN: This language and standard are necessary in the code.
KOERBER: The substantiation was appropriate and the proposal should be accepted.

MACNEVIN: This should be accepted as the UL 586 standard is appropriate for this application, and the proposal adds safety to the code.

WHITE: The change should have been accepted based on the substantiation.

WISEMAN: The substantiation was adequate to accept this proposal.
Proposals

Item #: 197

UMC 2024  Section: 939.0, 939.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Add new text

**939.0 Dehumidifiers.**

**939.1 General.** Dehumidifiers shall be listed and labeled in accordance with UL 60335-2-40, and shall be installed in accordance with the manufacturer’s installation instructions.

Note: UL 60335-2-40 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
A new section is being added to Chapter 9 (Installation of Specific Appliances) to address the safety standard for dehumidifiers to aid the code official in verifying safe installation for such systems.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

**939.0 Dehumidifiers.**

**939.1 General.** Dehumidifiers shall be listed and labeled in accordance with UL 60335-2-40, and shall be installed in accordance with the manufacturer’s installation instructions.

COMMITTEE STATEMENT:
The proposal is being modified to change "listed and labeled" to "comply" since "comply" already implies that the product must be listed and labeled. The term "shall" is also being deleted to removed repetitive wording.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 198

UMC 2024  Section: 221.0, 939.0, 939.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Add new text

939.0 Steam Bath Equipment.
939.1 General. Steam bath equipment shall be listed and labeled in accordance with UL 499 and shall be installed in
accordance with their listing and the manufacturer's installation instructions.

221.0 – S –

Steam Bath Equipment. Includes steam bath generators, combination room and steam generator systems, and steam
bath cabinets intended for personal bathing.

Note: UL 499 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s
Regulations Governing Committee Projects.

SUBSTANTIATION:
A new section is being added to Chapter 9 (Specific Appliances) to address steam bath equipment.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There is insufficient technical justification to warrant such change. There is also concern with requiring "listing and
labeling" to the standard. The language should only require compliance. The proposed language may also be
outside of the scope of the mechanical code. The language may be better suited in the plumbing code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 22  NEGATIVE: 7  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:
ARYAN: This change should be accepted in the code per the substantiation.
BALLANCO: This change should have been accepted. The substantiation justifies the proposal.
FEEHAN: This language and standard are necessary in the code.
KOERBER, WISEMAN: The substantiation was adequate to accept this proposal.
MACNEVIN: This proposal should be accepted as it improves the code with the UL 499 requirement, appropriate for this
purpose.
WHITE: This should be accepted based on the substantiation.
Proposals

Item #: 199

UMC 2024  Section: 223.0, 939.0 - 939.2, Table 1701.1

SUBMITTER: Bo Manalo
EcoSmart Inc

RECOMMENDATION:
Add new text

939.0 Unvented Alcohol Fuel-Burning Decorative Appliances.
939.1 General. Unvented alcohol fuel-burning decorative appliances shall be listed and labeled in accordance with UL 1370 and shall be installed in accordance with the conditions of the listing and manufacturer’s installation instructions.
939.2 Marking. Unvented alcohol fuel-burning decorative appliances shall have a permanent factory-applied marking showing the manufacturer’s name, model, thermal output (BTU/hr) (kW), approved fuel type, minimum room volume requirement for installation, and required clearances to combustibles.

223.0 – U – Unvented Alcohol Fuel Burning Decorative Appliance. An unvented, self-contained fire feature appliance fueled by alcohol whose only function is providing an aesthetic effect of flames; intended to be directly or indirectly secured to the wall or floor and not for duct connection.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 1370-2011</td>
<td>Unvented Alcohol Fuel Burning Decorative Appliances (with revisions through March 25, 2016)</td>
<td>Unvented Alcohol Fuel Burning Decorative Appliances</td>
<td>939.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 1370 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
This proposal adds a provision for a newer type of decorative appliance. It provides clear and specific requirements for the installation of unvented, self-contained alcohol fuel burning appliances. The requisite ANSI consensus Standard UL 1370 includes performance-based criteria that provide a consistent application of requirements and best practices to ensure safe installation and operation. The Standard includes combustion testing for carbon dioxide and carbon monoxide emission limits, oxygen depletion, materials and construction requirements. The Standard also tests for user abuse, stability, temperature, and wind tests. There is also a requirement for markings and instruction manual content.

These appliances are intended for decorative purposes and not intended to be utilized as a primary heat source. Denatured alcohol is formulated for the application and limited to a maximum input rate of 0.25 gallons of fuel per hour (0.95 liters per hour). They are not provided with means for duct connection nor is there electric/mechanical assist of heated air movement, such as a fan-blower assembly. The appliances are also labeled with minimum room
volume requirements for installation. The proposal improves the Code by providing installers and building officials with a clear path on the specifications that pertain to these products. Installation is intended to be in accordance with local codes, the manufacturer’s installation instructions and markings on the appliance.

The same proposal was submitted to ICC and approved and are not part of the 2021 ICC Mechanical Code.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed language raises safety concerns as to public health and safety. The proposal also goes beyond the minimum requirements of the code. Furthermore, such unvented decorative appliances can be installed without being inspected. These appliances are meant to be decorative only and not used as a primary heat source.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 200
UMC 2024  Section: 939.0, 939.1, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Add new text

939.0 Sauna Heaters.
939.1 General. Sauna heaters shall be listed and labeled in accordance with UL 875 and shall be installed in accordance with their listing and the manufacturer’s installation instructions.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 875-2009</td>
<td>Electric Dry-Bath Heaters (with revisions through January 4, 2021)</td>
<td>Sauna heaters</td>
<td>939.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 875 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
A new section is being added to Chapter 9 (Specific Appliances) to address sauna heaters.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There is insufficient technical justification to warrant such change. There is also concern with requiring "listing and labeling" to the standard. The language should only require compliance. The proposed language may be outside of the scope of the mechanical code. The language may be better suited in the plumbing code. The proposal should also clarify that it applies to "electric" sauna heaters only as there are other energy sources that may be used.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 23  NEGATIVE: 6  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

BALLANCO: The standard was submitted for review and is appropriate for the application in the proposed change.

FEEHAN: This language and standard are necessary in the code.

KOERBER: The standard is appropriate. The proposal should be accepted.

MACNEVIN: This proposal should be accepted as the UL 875 standard is appropriate for this application and the change adds safety to the code.

WHITE: This should be accepted based on the substantiation.

WISEMAN: The substantiation is adequate to accept the proposal.
Proposals

Item #: 201
UMC 2024  Section: 1001.1(9)

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

1001.0 General.
1001.1 Applicability. The requirements of this chapter shall apply in the construction, installation, operation, repair, and alteration of boilers and pressure vessels. Low-pressure boilers shall comply with this chapter and Section 904.0.

Exceptions:
(1) through (8) remain unchanged.
(9) Pressure vessels used in specific appliances shall comply with Chapter 9.

SUBSTANTIATION:
The product certification standards referenced in Chapter 9 provide specific requirements for pressure vessels and parts under pressure within those specific appliances. This proposal recognizes these requirements are already addressed in Chapter 9 (Installation of Specific Appliances).

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 202
UMC 2024  Section: 1002.2.3, Table 1701.1, Table 1701.2

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Add new text

1002.0 Standards.

1002.2 Oil-Burning Boilers. Oil-burning boilers shall comply with Section 1002.2.1 and Section 1002.2.2.
1002.2.1 Listing & Labeling. Oil-burning boilers shall be listed and labeled in accordance with UL 726.
1002.2.2 Installation. Tanks, piping, and valves for oil-burning boilers shall be installed in accordance with NFPA 31.
1002.2.3 Oil Gauging Devices. Liquid-level indicating gauges shall be listed and labeled in accordance with UL 180 and shall be installed in accordance with the manufacturer's installation instructions.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 180-2019</td>
<td>Combustible Liquid Tank Accessories (with revisions through May 8, 2020)</td>
<td>Gauges, Level Gauges</td>
<td>1002.2.3</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 180 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
UL 180 is being added to this section as the standard provides requirements that apply to liquid level gauges for oil burner fuels. By referencing this standard in the code, the reference to the standard needs to move from Table 1701.2 to Table 1701.1.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There is insufficient technical justification to warrant such change. There is also concern with requiring "listing and labeling" to the standard. The language should only require compliance. The language should be corrected to clarify the intent of the section.
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 23  NEGATIVE: 6  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

BALLANCO: The standard was submitted for review. The reference to the standard is applicable for the proposed new text. This change should have been accepted.

FEEHAN: This language and standard are necessary and belong in the code.

KOERBER: Proposal should be accepted as the standard is appropriate.

MACNEVIN: UL 180 is appropriate for this purpose and this item should be accepted. Remove "listed and labeled" in public comment.

WHITE: This should have been accepted based on the substantiation.

WISEMAN: The substantiation is adequate to accept this proposal.
Proposals

Item #: 203
UMC 2024 Section: 1003.4

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

1003.0 Detailed Requirements.

1003.4 Stack Dampers. Stack dampers on boilers fired with oil or solid fuel shall not close off more than 80 percent of the stack area where closed, except on automatic boilers with prepurge, automatic draft control, and interlock. Operative dampers shall not be placed within a stack, flue, or vent of a gas-fired boiler, except on an automatic boiler with prepurge, automatic draft control, and interlock.

Exception: Automatic boilers with prepurge, automatic draft control, and interlock.

SUBSTANTIATION:
This change to Section 1003.4 relocates language from the section into an exception for clarity and ease of use.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 204
UMC 2024  Section: 1004.4

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

1004.0 Expansion Tanks.

1004.4 Minimum Capacity of Closed-Type Tank. The minimum capacity for a gravity-type hot water system expansion tank shall be in accordance with Table 1004.4(1). The minimum capacity for a forced-type hot water system expansion tank shall be in accordance with Table 1004.4(2); or Equation 1004.4(1). Equation 1004.4 shall not be used for diaphragm-type expansion tanks. The minimum capacity for a diaphragm-type hot water system expansion tank shall be in accordance with Table 1004.4(2) or Equation 1004.4(2).

\[
V_t \text{ (forced-type)} = \frac{(0.00041t-0.0466) \cdot V_s}{Pa \left( \frac{P_f}{Pa} - \frac{Pa}{Po} \right)}
\]

\[
V_t \text{ (diaphragm-type)} = \frac{(0.00041t-0.0466) \cdot V_s}{\left( 1 - \frac{P_f}{Po} \right)}
\]

Where:
- \(V_t\) = Minimum volume of expansion tank, gallons (L).
- \(V_s\) = Volume of system, not including expansion tank, gallons (L).
- \(t\) = Average operating temperature, °F (°C).
- \(P_a\) = Atmospheric pressure, feet \(H_2O\) absolute pounds per square inch (kPa).
- \(P_f\) = Fill pressure, feet \(H_2O\) absolute pounds per square inch (kPa).
- \(P_o\) = Maximum operating pressure, feet \(H_2O\) absolute pounds per square inch (kPa).

For SI units: 1 gallon = 3.785 L, °C = (°F-32)/1.8, 1 foot of water = 2.99 kPa.
### TABLE 1004.4(1)
**EXPANSION TANK CAPACITIES FOR GRAVITY HOT WATER SYSTEMS**

<table>
<thead>
<tr>
<th>INSTALLED EQUIVALENT DIRECT RADIATION (square feet)</th>
<th>TANK CAPACITY (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 350</td>
<td>18</td>
</tr>
<tr>
<td>Up to 450</td>
<td>21</td>
</tr>
<tr>
<td>Up to 650</td>
<td>24</td>
</tr>
<tr>
<td>Up to 900</td>
<td>30</td>
</tr>
<tr>
<td>Up to 1100</td>
<td>35</td>
</tr>
<tr>
<td>Up to 1400</td>
<td>40</td>
</tr>
<tr>
<td>Up to 1600</td>
<td>2 to 30</td>
</tr>
<tr>
<td>Up to 1800</td>
<td>2 to 30</td>
</tr>
<tr>
<td>Up to 2000</td>
<td>2 to 35</td>
</tr>
<tr>
<td>Up to 2400</td>
<td>2 to 40</td>
</tr>
</tbody>
</table>

For SI units: 1 gallon = 3.785 L, 1 square foot = 0.0929 m²

**Notes:**

1. Based on a two-pipe system with an average operating water temperature of 170°F (77°C), using cast-iron column radiation with a heat emission rate of 150 British thermal units per square foot hour [Btu/(ft²·h)] (473 W/m²) equivalent direct radiation.

2. For systems that exceed 2400 square feet (222.9 m²) of installed equivalent direct water radiation, the required capacity of the cushion tank shall be increased on the basis of 1 gallon (4 L) tank capacity per 33 square feet (3.1 m²) of additional equivalent direct radiation.

### TABLE 1004.4(2)
**EXPANSION TANK CAPACITIES FOR FORCED HOT WATER SYSTEMS**

<table>
<thead>
<tr>
<th>SYSTEM VOLUME (gallons)</th>
<th>TANK CAPACITY DIAPHRAGM TYPE (gallons)</th>
<th>TANK CAPACITY NON-DIAPHRAGM TYPE (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>200</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>300</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>400</td>
<td>33</td>
<td>60</td>
</tr>
<tr>
<td>500</td>
<td>42</td>
<td>75</td>
</tr>
<tr>
<td>1000</td>
<td>83</td>
<td>150</td>
</tr>
<tr>
<td>2000</td>
<td>165</td>
<td>300</td>
</tr>
</tbody>
</table>

For SI units: 1 gallon = 3.785 L

**Notes:**

1. Based on an average operating water temperature of 195°F (91°C), a fill pressure of 12 psig (83 kPa), and an operating pressure of not more than 30 psig (207 kPa).

2. Includes volume of water in boiler, radiation, and piping, not including expansion tank.

**Substantiation:**

Diaphragm tanks are included in Table 1004.4(2), but Equation 1004.4(1) pertains to non-precharged tanks. Including the precharged tank equation is required to allow for more accurate tank sizing.

Sizing the tank is the primary thermal consideration when installing a tank into a system. For precharged tanks, including properly charged diaphragm and bladder tanks, the starting pressure when water first starts to enter the tank is equal to the initial precharge pressure. Hence, the equation reduces to Equation 1004.4(2). If Equation
1004.4(1) is used to calculate the volume of a diaphragm tank, the tank will be oversized for the system.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

A link for supporting documentation is as follows:

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 205
UMC 2024  Section: 1005.2(8)

SUBMITTER: Jim Erhardt
Watts Water Technologies

RECOMMENDATION:
Revise text

1005.0 Safety or Relief Valve Discharge.

**1005.2 Discharge Piping.** The discharge piping serving a temperature relief valve, pressure relief valve, or combination of both shall have no valves, obstructions, or means of isolation and provided with the following:

(1) Equal to the size of the valve outlet and shall discharge full size to the flood level of the area receiving the discharge and pointing down.

(2) Materials shall be rated at not less than the operating temperature of the system and approved for such use.

(3) Discharge pipe shall discharge independently by gravity through an air gap into the drainage system or outside of the building with the end of the pipe not exceeding 2 feet (610 mm) and not less than 6 inches (152 mm) above the ground and pointing downwards.

(4) Discharge in such a manner that does not cause personal injury or structural damage.

(5) No part of such discharge pipe shall be trapped or subject to freezing.

(6) The terminal end of the pipe shall not be threaded.

(7) Discharge from a relief valve into a water heater pan shall be prohibited.

(8) Discharge to a termination point that is readily observable by the building occupants. If the discharge termination point is not readily observable, discharge monitoring is required.

.SUBSTANTIATION:
Continuous low-level discharge ("dribble") of T&P valve due to over-pressure (failed expansion tank, lack of secondary pressure relief device for thermal expansion, etc.) with hard water conditions can cause build-up of scale in the relief valve discharge port. Such obstruction of discharge port can compromise the relieving capacity of the valve and pose a safety risk to building occupants. Remote monitoring of relief valve discharge will ensure that the condition is immediately known.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

1005.0 Safety or Relief Valve Discharge.

1005.2 Discharge Piping. The discharge piping serving a temperature relief valve, pressure relief valve, or combination of both shall have no valves, obstructions, or means of isolation and provided with the following:

(1) Equal to the size of the valve outlet and shall discharge full size to the flood level of the area receiving the discharge and pointing down.

(2) Materials shall be rated at not less than the operating temperature of the system and approved for such use.

(3) Discharge pipe shall discharge independently by gravity through an air gap into the drainage system or outside of the building with the end of the pipe not exceeding 2 feet (610 mm) and not less than 6 inches (152 mm) above the ground and pointing downwards.

(4) Discharge in such a manner that does not cause personal injury or structural damage.

(5) No part of such discharge pipe shall be trapped or subject to freezing.

(6) The terminal end of the pipe shall not be threaded.

(7) Discharge from a relief valve into a water heater pan shall be prohibited.
(8) Discharge to a termination point that is readily observable by the building occupants. If the discharge termination point is not readily observable, discharge monitoring is required.

COMMITTEE STATEMENT:
The modification is being made to clarify that the discharge to a termination point must be readily “visible.” The last sentence is also being removed as it is not necessary to enforce termination points for condensate waste discharge and may create confusion. It is not clear who will monitor the condensate discharge. Also, the discharge piping does not need to be visible to building occupants; it only needs to be visible to whomever is conducting maintenance.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

WHITE: As a note, the plumbing code language is "observable" not "visible" in UPC Section 608.5(8).
Proposals

Item #: 206

UMC 2024  Section: 1005.5, Table 1701.1, Table 1701.2

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

1005.0 Safety or Relief Valve Discharge.

1005.5 Vacuum Relief Valve. Hot-water heating systems that are subjected to a vacuum while in operation or during shutdown shall be protected with a vacuum relief valve that complies with CSA Z21.22. Where the piping configuration, equipment location, and valve outlets are located below the boiler elevation, the system shall be equipped with a vacuum relief valve at the highest point.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

Note: CSA Z21.22 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA Z21.22-2015</td>
<td>Relief Valves for Hot Water Supply Systems (same as CSA 4.4)</td>
<td>Valves</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

SUBSTANTIATION:
CSA Z21.22, Relief Valves for Hot Water Supply Systems, is being added to Section 1005.5 as it is the appropriate standard for vacuum relief valves. The change correlates with existing language in the UPC; the CSA standard is referenced in UPC Sections 607.5 and 608.7 regarding vacuum relief valves.

(below shown for reference only)

2021 UPC:
607.5 Valves. Pressurized tanks shall be provided with a listed pressure-relief valve installed in accordance with the manufacturer’s installation instructions. The relief valve shall be discharged in accordance with Section 608.5. Where a potable water supply tank is located above the fixtures, appliances, or system components it serves, it shall be equipped with a vacuum relief valve that complies with CSA Z21.22.

608.7 Vacuum Relief Valves. Where a hot-water storage tank or an indirect water heater is located at an elevation above the fixture outlets in the hot-water system, a vacuum relief valve that complies with CSA Z21.22 shall be installed on the storage tank or heater.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
1008.0 Low-Water Cutoff.  
1008.1 General. Hot water boilers and steam boilers shall be installed with a low-water cutoff. A coil-type boiler or a water-tube boiler that requires forced circulation to prevent overheating of the coils or tubes shall be installed with a flow-sensing device in the outlet piping in lieu of the low-water cutoff. The low-water cutoff or the flow sensing device shall be installed so as to prevent damage to the boiler and to permit testing of the fuel-supply cutoff without draining the heating system. The low-water cutoff shall shut off the combustion fuel-supply at a water level setpoint that is in accordance with the boiler manufacturer’s instructions.

SUBSTANTIATION:  
There has been confusion in the field by the requirement in Section 1008.1 to shut off the “combustion.” The intention of the low-water cutoff is to shut off the fuel-supply. The code change replaces “combustion” with “fuel-supply” for clarity.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:  
The term "combustion" is the correct term to be used in the section. Low-water level does not cutoff the fuel-supply, only combustion. A public comment is recommend to substitute the term "energy source."

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
1103.0 Classification.

1103.1 Classification of Refrigerants. Refrigerants shall be classified in accordance with Table 1102.3 or in accordance with ASHRAE 34 where approved by the Authority Having Jurisdiction.

1103.1.1 Safety Group. Table 1102.3 classifies refrigerants by toxicity and flammability, and assigns safety groups using combinations of toxicity class and flammability class. For the purposes of this chapter, the refrigerant Groups A1, A2L, A2, A3, B1, B2L, B2, and B3 shall be considered to be individual and distinct safety groups, as shown in Table 1103.1.1. Each refrigerant is assigned into not more than one group.

<table>
<thead>
<tr>
<th>Higher Flammability</th>
<th>A3</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable</td>
<td>A2</td>
<td>B2</td>
</tr>
<tr>
<td>Lower Flammability</td>
<td>A2L</td>
<td>B2L</td>
</tr>
<tr>
<td>No Flame Propagation</td>
<td>A1</td>
<td>B1</td>
</tr>
<tr>
<td>Lower Toxicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher Toxicity</td>
<td></td>
<td></td>
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</tbody>
</table>
Exception: For commercial, public assembly, and large mercantile occupancies, when the refrigerant charge of any independent circuit does not exceed 50 percent of the RCL, a detector shall not be required.

1104.6.2.4 Refrigerant Concentration Above Limit. When the refrigerant detector senses a refrigerant concentration at the maximum value specified in Section 1104.6.5(2), the following actions shall be taken:

1. The minimum airflow rate of the supply air fan shall be in accordance with the following equation.

\[ Q_{\text{min}} = 1000 \times \frac{M}{LFL} \]  

[Equation 1104.6.2.4]

Where:

- \( Q_{\text{min}} \) = minimum airflow rate, \( \text{ft}^3/\text{min} \)
- \( M \) = refrigerant charge of the largest independent refrigerating circuit of the system, \( \text{lb} \)
- \( LFL \) = lower flammability limit, \( \text{lb per 1000 ft}^3 \)

For SI units: \( Q = 60000 \times \frac{M}{LFL} \), where \( Q \) is the supply air flow rate (m³/h), \( M \) is the refrigerant charge (kg), \( LFL \) is the lower flammability limit (g/m³).

2. Turn off the compressor and all other electrical devices, excluding the control power transformers, control systems, and the supply air fan. The supply air fan shall continue to operate for at least five minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the value specified in Section 1104.6.5(2).

3. Any device that controls airflow located within the product or in ductwork that supplies air to the occupied space shall be fully open. Any device that controls airflow shall be listed.

4. Turn off any heaters and electrical devices located in the ductwork. The heaters and electrical devices shall remain off for at least five minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the value specified in Section 1104.6.5(2). [ASHRAE 15:7.6.2.4]

1104.6.3 Ignition Sources Located in Ductwork. Open-flame-producing devices shall not be permanently installed in the ductwork that serves the space. Unclassified electrical devices shall not be located within the ductwork that serves the space. Devices containing hot surfaces exceeding 1290°F (700°C) shall not be located in the ductwork that serves the space unless there is a minimum airflow of 200 ft/min (1.0 m/s) across the heating device(s) and there is proof of airflow before the heating device(s) is energized. [ASHRAE 15:7.6.3-7.6.3.3]

1104.6.4 Compressors and Pressure Vessel Located Indoors. For refrigeration compressors and pressure vessels located in an indoor space that is accessible only during service and maintenance, it shall be permissible to exceed the RCL if all of the following provisions are met:

1. The refrigerant charge of largest independent refrigerating circuit shall not exceed:
   (a) 6.6 lb (3 kg) for residential and institutional occupancies and
   (b) 22 lb (10 kg) for commercial and public/large mercantile occupancies.

2. The space where the equipment is located shall be provided with a mechanical ventilation system in accordance with Section 1104.6.4(3) and a refrigerant detector in accordance with Section 1104.6.5. The mechanical ventilation system shall be started when the refrigerant detector senses refrigerant in accordance with Section 1104.6.5. The mechanical ventilation system shall continue to operate for at least five minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the value specified in Section 1104.6.5(2).

3. A mechanical ventilation system shall be provided that will mix air with leaked refrigerant and remove it from the space where the equipment is located. The space shall be provided with an exhaust fan. The exhaust fan shall remove air from the space where the equipment is located in accordance with the following equation.

\[ Q_{\text{min}} = 1000 \times \frac{M}{LFL} \]  

Where:

- \( Q_{\text{min}} \) = minimum airflow rate, \( \text{ft}^3/\text{min} \)
- \( M \) = refrigerant charge of the largest independent refrigerating circuit of the system, \( \text{lb} \)
- \( LFL \) = lower flammability limit in \( \text{lb per 1000 ft}^3 \)

For SI units: \( Q = 60000 \times \frac{M}{LFL} \), where \( Q \) is the supply air flow rate (m³/h), \( M \) is the refrigerant charge (kg), \( LFL \) is the lower flammability limit (g/m³).

4. The exhaust air inlet shall be located where refrigerant from a leak is expected to accumulate. The bottom of the air inlet elevation shall be within 12 inches (30 cm) of the lowest elevation in the space where the compressor or pressure vessel is located. Provision shall be made for make-up air to replace that being exhausted. Openings for the make-up air shall be positioned such that air will mix with leaked refrigerant.

5. Air that is exhausted from the ventilation system shall be either:
   (a) discharged outside of the building envelope or
   (b) discharged to an indoor space, provided that the refrigerant concentration will not exceed the limit specified in Section 1104.6.1.
(6) In addition to the requirements of Section 1104.6.3, there shall be no open-flame-producing devices that do not contain a flame arrestor, or hot surfaces exceeding 1290°F (700 °C) that are installed within space where the equipment is located. [ASHRAE 15:7.6.4]

**1104.6.5 Refrigerant Detectors.** Refrigerant detectors required by Section 1104.6.2 shall meet the following requirements:

1. Refrigerant detectors that are part of the listing shall be evaluated by the testing laboratory as part of the equipment listing.
2. Refrigerant detectors, as installed, shall activate the functions required by Section 1104.6.2.4 within a time not to exceed 15 seconds when the refrigerant concentration reaches 25 percent of the lower flammability limit (LFL).
3. Refrigerant detectors shall be located such that refrigerant will be detected if the refrigerating system is operating or not operating. Use of more than one refrigerant detector shall be permitted.
   a. For refrigerating systems that are connected to the occupied space through ductwork, refrigerant detectors shall be located within the listed equipment.
   b. For refrigerating systems that are directly connected to the occupied space without ductwork, the refrigerant detector shall be located in the equipment, or shall be located in the occupied space at a height of not more than 12 inches (30 cm) above the floor and within a horizontal distance of not more 3.3 feet (1.0 m) with a direct line of sight of the unit.
4. Refrigerant detectors shall provide a means for an automatic operational self-test as provided in the product listing. Use of a refrigerant test gas is not required. If a failure is detected, a trouble alarm shall be activated, and the actions required by Section 1104.6.2.4 shall be initiated. [ASHRAE 15:7.6.5]

**1104.7 Applications for Human Comfort and for Nonindustrial Occupancies.** In nonindustrial occupancies, Group A2, A2L, A3, B1, B2L, B2, and B3 refrigerants shall not be used in high-probability systems for human comfort. Use of Group A2L refrigerants shall be in accordance with Section 1104.6.

(renumber remaining sections)

**SUBSTANTIATION:**
Task Group Recommendation 1 - Human Comfort: These are the extracted requirements from ASHRAE 15-2019 that regulate low GWP refrigerants used in direct systems that fall into the safety classification of Group A2L. The A2L Task Group modified various portions of the extracted language as needed to address enforceability and health and safety concerns. The requirements follow the extraction policy of IAPMO.

**COMMITTEE ACTION:** ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

**1103.0 Classification.**
**1103.1 Classification of Refrigerants.** Refrigerants shall be classified in accordance with Table 1102.3 or in accordance with ASHRAE 34 where approved by the Authority Having Jurisdiction.

**1103.1.1 Safety Group.** Table 1102.3 classifies refrigerants by toxicity and flammability, and assigns safety groups using combinations of toxicity class and flammability class. For the purposes of this chapter, the refrigerant Groups A1, A2L, A2, A3, B1, B2L, B2, and B3 shall be considered to be individual and distinct safety groups, as shown in Table 1103.1.1. Each refrigerant is assigned into not more than one group.

**TABLE 1103.1.1**

<table>
<thead>
<tr>
<th>Refrigerant Safety Group Classifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Flammability</td>
</tr>
<tr>
<td>Flammable</td>
</tr>
<tr>
<td>Lower Flammability</td>
</tr>
<tr>
<td>No Flame Propagation</td>
</tr>
</tbody>
</table>

| Lower Toxicity | Higher Toxicity |

**1104.0 Requirements for Refrigerant and Refrigeration System Use.**

**1104.6 Group A2L Refrigerants for Human Comfort.** High-probability systems using Group A2L refrigerants for human comfort applications shall comply with this section. [ASHRAE 15:7.6] All joints on refrigeration piping containing A2L refrigerant shall be brazed.

**Exception:** Male flared joint connections for system servicing.

**1104.6.1 Refrigerant Concentration Limits.** Occupied spaces shall comply with Section 1104.2. Unoccupied spaces with refrigerant containing equipment, including but not limited to piping or tubing, shall comply with Section 1104.6.4. (ASHRAE 15:7.6.1-7.6.1.2)
1104.6.2 Listing and Installation Requirements. Refrigeration systems shall be listed and shall be installed in accordance with listing, the manufacturer's instructions, and any markings on the equipment restricting the installation. [ASHRAE 15:7.6.2]

1104.6.2.1 Nameplate. The nameplate required by Section 1115.5 shall include a symbol indicating that a flammable refrigerant is used, as specified by the product listing. [ASHRAE 15:7.6.2.1]

1104.6.2.2 Labeling. A label indicating a flammable refrigerant is used shall be placed adjacent to service ports and other locations where service involving components containing refrigerant is performed, as specified by the product listing. [ASHRAE 15:7.6.2.2]

1104.6.2.3 Refrigerant Detectors. A refrigerant detector shall be provided in accordance with Section 1104.6.5 as a part of the listed equipment where any of the following apply:

1. The charge size of any independent circuit exceeds 4 lb (1.8 kg) \(0.212 \times \text{LFL (lb)}\), where LFL is in pounds per 1000 ft\(^3\) (6 \(\times \text{LFL \[kg\]}\) where LFL is in kg/m\(^3\)).
2. When the occupancy classification is institutional.
3. When using the provisions of Section 1104.6.4.

Exception: For commercial, public assembly, and large mercantile occupancies, when the refrigerant charge of any independent circuit does not exceed 50 percent of the RCL, a detector shall not be required.

1104.6.2.4 Refrigerant Concentration Above Limit. When the refrigerant detector senses a refrigerant concentration at the maximum value specified in Section 1104.6.5(2), the following actions shall be taken:

1. The minimum airflow rate of the supply air fan shall be in accordance with the following equation.

\[
Q_{\text{min}} = 1000 \times \frac{M}{\text{LFL}}
\]  \[\text{Equation 1104.6.2.4}\]

Where:

- \(Q_{\text{min}}\) = minimum airflow rate, ft\(^3\)/min
- \(M\) = refrigerant charge of the largest independent refrigerating circuit of the system, lb
- \(\text{LFL}\) = lower flammability limit, lb per 1000 ft\(^3\)

For SI units: \(Q = 60 \, 000 \times \frac{M}{\text{LFL}}\), where \(Q\) is the supply air flow rate (m\(^3\)/h), \(M\) is the refrigerant charge (kg), \(\text{LFL}\) is the lower flammability limit (g/m\(^3\)).

2. Turn off the compressor and all other electrical devices, excluding the control power transformers, control systems, and the supply air fan. The supply air fan shall continue to operate for at least five minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the value specified in Section 1104.6.5(2).
3. Any device that controls airflow located within the product or in ductwork that supplies air to the occupied space shall be fully open. Any device that controls airflow shall be listed.
4. Turn off any heaters and electrical devices located in the ductwork. The heaters and electrical devices shall remain off for at least five minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the value specified in Section 1104.6.5(2). \{ASHRAE 15:7.6.2.4\}

1104.6.3 Ignition Sources Located in Ductwork. Open-flame-producing devices shall not be permanently installed in the ductwork that serves the space. Unclassified electrical devices shall not be located within the ductwork that serves the space. Devices containing hot surfaces exceeding 1290°F (700°C) shall not be located in the ductwork that serves the space unless there is a minimum airflow of 200 ft/min (1.0 m/s) across the heating device(s) and there is proof of airflow before the heating device(s) is energized. [ASHRAE 15:7.6.3-7.6.3.3]

1104.6.4 Compressors and Pressure Vessel Located Indoors. For refrigeration compressors and pressure vessels located in an indoor space that is accessible only during service and maintenance, it shall be permissible to exceed the RCL if all of the following provisions are met:

1. The refrigerant charge of largest independent refrigerating circuit shall not exceed:
   (a) 6.6 lb (3 kg) for residential and institutional occupancies, applied products, and
   (b) 4 lb (1.8 kg) for unitary products.
   (bc) 22 lb (10 kg) for commercial and public/large mercantile occupancies.
2. The space where the equipment is located shall be provided with a mechanical ventilation system in accordance with Section 1104.6.4 (3) and a refrigerant detector in accordance with Section 1104.6.5. The mechanical ventilation system shall be started when the refrigerant detector senses refrigerant in accordance with Section 1104.6.5. The mechanical ventilation system shall continue to operate for at least five minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the value specified in Section 1104.6.5(2).
3. A mechanical ventilation system shall be provided that will mix air with leaked refrigerant and remove it from the space where the equipment is located. The space shall be provided with an exhaust fan. The exhaust fan shall remove air from the space where the equipment is located in accordance with the following equation.

\[
Q_{\text{min}} = 1000 \times \frac{M}{\text{LFL}}
\]
Where:

\[ Q_{\text{min}} = \text{minimum airflow rate, ft}^3 /\text{min} \]

\[ M = \text{refrigerant charge of the largest independent refrigerating circuit of the system, lb} \]

\[ LFL = \text{lower flammability limit in lb per 1000 ft}^3 \]

For SI units: \( Q = 60,000 \times \frac{M}{LFL} \), where \( Q \) is the supply air flow rate (m³/h), \( M \) is the refrigerant charge (kg), \( LFL \) is the lower flammability limit (g/m³).

(4) The exhaust air inlet shall be located where refrigerant from a leak is expected to accumulate. The bottom of the air inlet elevation shall be within 12 inches (30 cm) of the lowest elevation in the space where the compressor or pressure vessel is located. Provision shall be made for make-up air to replace that being exhausted. Openings for the make-up air shall be positioned such that air will mix with leaked refrigerant.

(5) Air that is exhausted from the ventilation system shall be either:

(a) discharged outside of the building envelope or

(b) discharged to an indoor space, provided that the refrigerant concentration will not exceed the limit specified in Section 1104.6.1.

(6) In addition to the requirements of Section 1104.6.3, there shall be no open-flame-producing devices that do not contain a flame arrester, or hot surfaces exceeding 1290°F (700 °C) that are installed within space where the equipment is located. {ASHRAE 15:7.6.4}

1104.6.5 Refrigerant Detectors. Refrigerant detectors required by Section 1104.6.2 shall meet the following requirements:

(1) Refrigerant detectors that are part of the listing shall be evaluated by the testing laboratory as part of the equipment listing.

(2) Refrigerant detectors, as installed, shall activate the functions required by Section 1104.6.2.4 within a time not to exceed 15 seconds when the refrigerant concentration reaches 25 percent of the lower flammability limit (LFL).

(3) Refrigerant detectors shall be located such that refrigerant will be detected if the refrigerating system is operating or not operating. Use of more than one refrigerant detector shall be permitted.

(a) For refrigerating systems that are connected to the occupied space through ductwork, refrigerant detectors shall be located within the listed equipment.

(b) For refrigerating systems that are directly connected to the occupied space without ductwork, the refrigerant detector shall be located in the equipment, or shall be located in the occupied space at a height of not more than 12 inches (30 cm) above the floor and within a horizontal distance of not more 3.3 feet (1.0 m) with a direct line of sight of the unit.

(4) Refrigerant detectors shall provide a means for an automatic operational self-test as provided in the product listing. Use of a refrigerant test gas is not required. If a failure is detected, a trouble alarm shall be activated, and the actions required by Section 1104.6.2.4 shall be initiated. {ASHRAE 15:7.6.5}

1104.7 Applications for Human Comfort and for Nonindustrial Occupancies. In nonindustrial occupancies, Group A2, A3, B1, B2L, B2, and B3 refrigerants shall not be used in high-probability systems for human comfort. Use of Group A2L refrigerants shall be in accordance with Section 1104.6.

(COMMITTEE STATEMENT:

For safety, all joints used on A2L refrigerant piping shall be brazed. Brazed joints are required to be made with brazing alloys having a liquidous temperature above 1000°F (538°C). Brazed joints have been proven to provide a zero percent leak free (no annual leak rate) system beyond the normal lifespan of the equipment for which the system serves. In the event of elevated system piping temperature, brazed joints provide the highest degree of safety and protection from catastrophic failures for high-probability installations. Additionally, the ASHRAE Standard 15-2019, Section 9.10.2, and IAPMO UMC 2021, Section 1106.9, requires that all joints, located in air ducts conveying conditioned air to and from an occupied space shall be constructed to withstand a temperature of 700°F (371°C) without leaking into the airstream. This ASHRAE 15 requirement is applicable to all refrigerants including Group A1 and A2L refrigerants. As most refrigerant piping installations for equipment would be considered in the airstream (i.e. above ceiling, equipment closets, mechanical rooms, etc.), this requirement would be applicable to the majority of refrigeration piping installations.

As the 2021 UMC, Section 1109.1 requires that all refrigeration piping shall be metallic, and as brazed joints are a proven all metallic joining system, all refrigerant piping, especially A2L refrigerant piping, should be required to be brazed.

An exception should be made to Section 1104.6 for the use of male flare joints of access fittings, as these systems will require an access connection for gauges and service equipment. If not already provided by the manufacturer on
the system equipment, male flare fittings may be required to be installed on the system piping. The male flare fitting will be required to be able to be isolated from the system by means of an inline valve or have a Schrader (core type) valve incorporated into its construction. Flare fittings are usually ¼” or 5/16” SAE flare and are usually equipped with a brass cap to protect the threads of the fitting and prevent debris from entering the port.

The proposed amount in Section 1104.6.2.3(1) of 4 pounds (1800 grams) promotes public safety and consumer confidence. As the UL 60335-2-40 and ASHRAE 15 standards already reference required refrigerant detection sensor levels (about 1.8 kg or 4 lbs), there is no need to add any language.

Section 1104.6.4 (1)(a) is being modified to differentiate between applied products and unitary products. Section 1104.6.4(1)(b) was added to be consistent with the modified language in Section 1104.6.2.3. According to AHRI (AHRI Industry Sectors (ahrinet.org) applied products range from Air-cooled water-chilling chillers to water-cooled water-chilling or heat pump water-heating chillers. Unitary products are self-contained equipment to split systems. Furthermore, Section 1104.6(5)(b) is being stricken and 1104.6(5)(a) is being modified to remove “or” to support the deletion of 1104.6(5)(b). Air should not be exhausted from the ventilation system into the building.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 18  NEGATIVE: 11  NOT RETURNED: 1  Heine

Note: Item # 208 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.

EXPLANATION OF AFFIRMATIVE:

BENKOWSKI: For consumer confidence in low GWP and low ODP, refrigerants joints should be brazed. This is not an issue to allow safety to be subverted by low cost.

BERGER: ASHRAE's research data (RP-1808) for the use of Press-Connect on refrigeration piping is flawed, as well as skewed in favor of an unproven application. RP-1808 did prove that brazed joints were the only joining method included in the report to have a zero percent annual leak rate. I cannot understand why Industry Professionals would be voting against the allowance of environmentally friendly somewhat flammable A2L into the UMC while supporting the misapplication of a technology with a documented annual leak rate, no matter how small, to remain in the code. Perhaps a letter writing campaign is the way to go when you want to override the decision of the Technical Committee.


DIAS: I agree with the changes to this proposal and I believe that only brazed joints should be allowed for A2L refrigerants.

MANN: We are finally accepting A2L refrigerants in direct systems. To require systems utilizing A2L refrigerants to be brazed is the proper installation requirement. There are letters being circulated that are asking for a negative vote on this item. One of the letters states that the singular aim of this item is to remove the use of copper press-connect fittings for refrigerant-containing systems from the UMC. This item is stating that A2L systems in direct systems shall be brazed; only these systems. This item was approved by the A2L sub-committee and amended by the Technical Committee. The amendments improve this section and the Committee statement sums up perfectly as to why the Committee accepted the item as amended.

TERZIGNI: Thanks to all who provided technical information. I also conducted an informal survey and for refrigerant the majority of contractors use brazed connections because they either do not trust the other types or have had significant failures regarding those types of connections. Some (fewer) contractors did use the press-connect as their primary connection. While no joint is perfect, according to the ASHRAE research sent to me, the press-fit connections all leaked under positive pressure to some degree whereas the brazed fittings did not. Since this change is limited to the flammable refrigerants, and although I am very reluctant to limit a "product," I think it is reasonable to limit the connection for now.

YOUNG: I agree with the other comments submitted in support. I for one am not a huge fan of the letter writing campaign that could be misinterpreted as threatening in nature. We all worked diligently on the A2L task force and did all the research on this topic. The simple fact that properly brazed fitting(s) have a zero percent leakage rate. This is very convincing as we place more volatile compounds in the HVAC systems with very little regard to occupant safety. I stand firmly behind the actions taken on this item. Let's consider there are 1 million of these press-connect fittings being used in refrigeration systems. Let's say the average leakage rate is .75 grams per year per fitting, an average based on ASHRAE 1808. This is 750,000 grams of refrigerant we willingly agree to let slip into the atmosphere. This would be about 1651 pounds of refrigerant annually. Is this really ok?
EXPLANATION OF NEGATIVE:

BALLANCO: This change should have been approved as submitted without the modifications. The modifications are inappropriate regarding the prohibition of press-connect fittings, the mandate of brazing for Group A2L refrigerants, the identification of applied and unitary equipment, and the prohibition of using indoor space for dilution. All of these items are inconsistent with ASHRAE 15 and the work by the A2L Task Group. There is no technical justification for mandating brazed joints for Group A2L refrigerants. It is interesting that brazing was mandated for only one group of refrigerant. Similar requirements do not apply to Group A2, A3, B1, B2L, B2, or B3 refrigerants. Furthermore, this change will make the code inconsistent with the listing requirements, thus violating the listing of the product. The use of applied and unitary to define equipment is inappropriate. What does this mean? The code does not have a definition of applied equipment nor unitary equipment. The ventilation air provisions are not technically justified. When dealing with refrigerant concentration level, the room volume is always measured for determining compliance. The change to ventilating to the outdoors is inconsistent with this long accepted concept. The change was made without technical justification.

CUDAHY: This change should be approved as submitted, without the modifications. The modifications are inappropriate regarding the prohibition of press-connect fittings, which seem to be a useful addition to joining.

FEEHAN: The proposal removes press-connect fittings without any technical justification.

GUNZNER: The changes made to this item do not fully take into account the information developed by ASHRAE 15 and the UMC A2L Task Group. AMCA supports the work of the UMC A2L Task Group. The ASHRAE 15 Committee spent several years updating and including data in the standard to safely install equipment that is listed to the UL standard.

KOERBER: Based on the exhaustive work by the A2L Task Group and ASHRAE, I must agree that the proposal should have been accepted without Committee modification. No technical justification was provided to override the language in the proposal.

MACNEVIN: This proposal by the A2L Task Group should be accepted as submitted, without the Committee amendments. There was no evidence submitted to prohibit press-connect fittings. In fact, a previous report submitted to this TC showed that press-connect fittings are the most reliable joining technology overall.

TRAFTON, A: This material should be allowed in the code. Has been used for years.

TRAFTON, P: While I agree with some of the comments regarding letter writing, which should have been done with the submittal of the Change in question, I also believe there has been sufficient research through ASHRAE to show that the press-fit joining methods are reliable. Further, I agree with Julius Ballanco in his descriptions.

VAN RITE: To require brazed joints when newer, better and faster technology exists is short sided. Crimp connectors are proven to be safe and there is no justification for blocking them in the UMC.

WHITE: The changes to the section lack technical justification. I do not see how a sub-committee's work can be disregarded by those who either did not participate in that work or were unsatisfied with the outcome. This besmirched technology is proven and is here to stay. Submission of additional documentation is appropriate during the public comment period. It seems to have been the practice of the Committee to not allow information to be considered that was not submitted by the cutoff date for proposed changes. It is inappropriate to consider additional information at this time.

WISEMAN: Press-connect fittings have been thoroughly tested and have proven reliable in the field. Nothing other than hearsay was given as proof of a problem. A brazed joint is only as good as the human making the weld. To pretend that a human can always provide a properly brazed joint is misleading. Humans make mistakes. There is not a perfect connection method, but without documentation of a problem, the code should stay as written.
Proposals

Item #: 209
UMC 2024  Section: 307.3, 307.4, 1115.5

SUBMITTER: Jay Egg
Egg Geothermal
Rep. Chair, A2L Task Group

RECOMMENDATION:
Revise text

1115.0 Labeling and Identification.

1115.5 Nameplate. Each self-contained system and each separate condensing unit, compressor, or compressor unit sold for field assembly in a refrigerating system shall carry a nameplate marked with the manufacturer’s name, nationally registered trademark or trade name, identification number, design pressures, and refrigerant for which it is designed. The refrigerant shall be designated by the refrigerant number (“R-” number) as shown in Table 1102.3. (ASHRAE 15:9.15)
Heat pumps and electric cooling appliances shall bear a factory-applied nameplate in accordance with Section 307.3.

307.0 Labeling.

307.3 Heat Pump and Electric Cooling Appliances. Heat pumps and electric cooling appliances shall bear a permanent and legible factory-applied nameplate on which shall appear:
(1) The name or trademark of the manufacturer.
(2) The model number or equivalent.
(3) The serial number.
(4) The amount of refrigerant, and type of refrigerant designation.
(5) The factory test pressures or pressures applied.
(6) The electrical rating in volts, amperes, and, for other than single phase, the number of phases.
(7) The output rating in Btu/h (kW).
(8) The type of fuel approved for use with the unit.
(9) Cooling capacity Btu/h (kW).
(10) Required clearances from combustible surfaces on which or adjacent to which it is permitted to be mounted.

An appliance shall be accompanied by clear and complete installation instructions, including required clearances from combustible other than mounting or adjacent surfaces, and temperature rating of field-installed wiring connections exceeding 140°F (60°C).

307.4 Absorption Units. Absorption units shall bear a permanent and legible factory-applied nameplate on which shall appear:
(1) The name or trademark of the manufacturer.
(2) The model number or equivalent.
(3) The serial number.
(4) The amount of refrigerant, and type of refrigerant designation.
(5) Hourly rating in Btu/h (kW).
(6) The type of fuel approved for use with the unit.
(7) Cooling capacity Btu/h (kW).
(8) Required clearances from combustible surfaces on which or adjacent to which it is permitted to be mounted.
(9) The symbol of an approved agency certifying compliance of the equipment with recognized standards.
SUBSTANTIATION:
Task Group Recommendation 4 - Labeling and Identification: The nameplate requirements in Section 307.3 are specifically for heat pumps and electric cooling appliances. These requirements include electrical ratings. The scope of Section 1115.5 is a broader scope, including products that do not have electrical ratings. Because the scope of Section 1115.5 is specific to products used in Chapter 11, this requirement belongs in Chapter 11 to provide a complete set of requirements for refrigeration installations.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
1104.0 Requirements for Refrigerant and Refrigeration System Use.

1104.5 Flammable Refrigerants. The total of Group A2, B2, A3, and B3 refrigerants, other than Group A2L and B2L refrigerants shall not exceed 1100 pounds (498.9 kg) without approval by the Authority Having Jurisdiction. Institutional Occupancies shall comply with Section 1104.3. Machinery rooms required in accordance with Section 1106.0 based on flammability shall be constructed and maintained in accordance with Section 1106.2.1 through Section 1106.2.6 and Section 1106.13 for Group A2L and B2L refrigerants.

1106.0 Refrigeration Machinery Rooms.

1106.1 Where Required. (remaining text unchanged)

1106.2 Refrigeration Machinery Room, General Requirements. Where a refrigeration system is located indoors and a machinery room is required in accordance with Section 1106.1, the machinery room shall be in accordance with Section 1106.2.1 through Section 1106.2.5.2.

1106.2.1 Access. Machinery rooms shall not be prohibited from housing other mechanical equipment unless specifically prohibited elsewhere in this chapter. A machinery room shall be so dimensioned that parts are accessible with space for service, maintenance, and operations. There shall be clear head room of not less than 7.25 feet (2210 mm) below equipment situated over passageways. [ASHRAE 15:8.11.1]

1106.2.2 Openings. Each refrigeration machinery room shall have a tight-fitting door or doors opening outward, self-closing where they open into the building and adequate in number to ensure freedom for persons to escape in an emergency. With the exception of access doors and panels in air ducts and air-handling units in accordance with Section 1106.6, there shall be no openings that will permit passage of escaping refrigerant to other parts of the building. [ASHRAE 15: 8.11.2]

1106.6 Airflow. There shall be no airflow to or from an occupied space through a machinery room unless the air is ducted and sealed in such a manner as to prevent a refrigerant leakage from entering the airstream. Access doors and panels in ductwork and air-handling units shall be gasketed and tight fitting. [ASHRAE 15: 8.11.3]

1106.13 Restricted Access. Access to the refrigeration machinery room shall be restricted to authorized personnel. Doors shall be clearly marked or permanent signs shall be posted at each entrance to indicate this restriction. [ASHRAE 15:8-11-88.11.4]

1106.2.4 Detectors and Alarms. Each refrigeration machinery room shall contain one or more refrigerant detectors in accordance with Section 1106.2.2.2 located in areas where refrigerant from a leak will concentrate, that actuate an alarm and mechanical ventilation in accordance with Section 4106.2.2.2 located at a set point not more than the corresponding Occupational Exposure Limit, OEL, in accordance with Table 1102.3, a set point determined in accordance with the OEL as defined in Chapter 2 shall be approved by the Authority Having Jurisdiction. The alarm shall annunciate visual and audible alarms inside the refrigeration machinery room and outside each entrance to the refrigeration machinery room. The alarms required in this section shall be of the manual reset type with the reset located inside the refrigeration machinery room. Alarms set at other levels, such as IDLH, and automatic reset alarms shall be permitted in addition to those required in accordance with this section. The meaning of each alarm shall be clearly marked by signage near the annunciator.

Exception: Refrigerant detectors are not required where only systems using R-718 (water) are located in the refrigeration machinery room. For Group A2L and B2L refrigerant detectors shall comply with Section 1106.13.
**1106.2.2 Refrigerant Detectors.** Refrigerant detectors required in accordance with Section 1106.2.2.1 or Section 1107.1.7 shall meet all of the following conditions:

1. The refrigerant detector shall perform automatic self-testing of sensors. Where a failure is detected, a trouble signal shall be activated.
2. The refrigerant detector shall have one or more set points to activate responses in accordance with Section 1106.2.2.1 or Section 1107.1.7.
3. The refrigerant detector as installed, including any sampling tubes, shall activate responses within a time not to exceed 30 seconds after exposure to refrigerant concentration exceeding the set point value specified in Section 1106.2.2.1 or Section 1107.1.7.

**1106.2.5 Emergency Ventilation-Required Airflow.** An emergency ventilation system shall be required to exhaust an accumulation of refrigerant due to leaks or a rupture of the system. The emergency ventilation required shall be capable of removing air from the machinery room in not less than the airflow quantity in Section 1106.2.5.1 or Section 1106.2.5.2. Where multiple refrigerants are present, then the highest airflow quantity shall apply.

**1106.2.5.1 Ventilation - A1, A2, A3, B1, B2L, B2 and B3 Refrigerants.** The emergency ventilation for A1, A2, A3, B1, B2L, B2 and B3 refrigerants shall have the capacity to provide mechanical exhaust at a rate as determined in accordance with Equation 1106.2.5.1:

\[
Q = 100 \times vG
\]  
(Equation 1106.2.5.1)

Where:

- \(Q\) = Air flow rate, cubic feet per minute.
- \(G\) = Refrigerant mass in largest system, pounds.

For SI units: 1 cubic foot per minute = 0.00047 m\(^3\)/s, 1 pound = 0.453 kg

**1106.2.5.2 Ventilation - Group A2L Refrigerants.** The emergency ventilation for A2L refrigerants shall have the capacity to provide mechanical exhaust at a rate determined in accordance with Table 1106.2.5.2:

<table>
<thead>
<tr>
<th>REFRIGERANT</th>
<th>MINIMUM AIR FLOW* (CFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-32</td>
<td>32,500</td>
</tr>
<tr>
<td>R-143a</td>
<td>28,600</td>
</tr>
<tr>
<td>R-444A</td>
<td>43,700</td>
</tr>
<tr>
<td>R-444B</td>
<td>22,400</td>
</tr>
<tr>
<td>R-445A</td>
<td>46,400</td>
</tr>
<tr>
<td>R-446A</td>
<td>60,500</td>
</tr>
<tr>
<td>R-447A</td>
<td>60,200</td>
</tr>
<tr>
<td>R-447B</td>
<td>29,600</td>
</tr>
<tr>
<td>R-451A</td>
<td>44,900</td>
</tr>
<tr>
<td>R-451B</td>
<td>44,900</td>
</tr>
<tr>
<td>R-452B</td>
<td>31,500</td>
</tr>
<tr>
<td>R-454A</td>
<td>4290</td>
</tr>
<tr>
<td>R-454B</td>
<td>6650</td>
</tr>
<tr>
<td>R-454C</td>
<td>32,900</td>
</tr>
<tr>
<td>R-455A</td>
<td>4770</td>
</tr>
<tr>
<td>R-457A</td>
<td>31,400</td>
</tr>
<tr>
<td>R-1234yf</td>
<td>46,500</td>
</tr>
<tr>
<td>R-1234zeE</td>
<td>42,600</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m\(^3\)/s

*The values were tabulated from the following equation:

\[
Q_{A2L} = \left(\frac{P \times V}{LFL \times 0.50}\right)
\]  
(Equation 1106.2.5.2)
Where:

- \( P \) = Refrigerant density, pounds per cubic feet (kg/m\(^3\)).
- \( V \) = Refrigerant velocity equal to the refrigerant acoustic velocity (speed of sound), feet per second (m/s).
- \( A \) = Cross-section flow area of refrigerant leak, square feet (m\(^2\)). \( A = 0.00136 \text{ ft}^2 \) (0.000126 m\(^2\)).
- \( LFL \) = Lower Flammability Limit, or ETFL\(_{60}\) where no LFL exist, published value in accordance with ASHRAE 34.
- \( Q_{A2L} \) = Minimum required air flow rate, conversion to other units of measures is permitted, cubic feet per second (m\(^3\)/s).

For exact ventilation rates and for refrigerants not listed, the ventilation rate shall be calculated using this equation.

1106.4 Natural Ventilation. Where When a refrigerating system is located outdoors more than 20 feet (6096 mm) from buildings openings and is enclosed by a penthouse, lean-to, or other open structure, natural or mechanical ventilation shall be provided. The requirements for such natural ventilation shall be in accordance with the following:

1. The free-aperture cross section for the ventilation of a machinery room shall be not less than as determined in accordance with Equation 1106.4.

\[ F = vG \]  

(Equation 1106.4)

Where:

- \( F \) = The free opening area, square feet.
- \( v \) = The mass of refrigerant in the largest system, any part of which is located in the machinery room, pounds.

For SI units: 1 cubic foot per minute = 0.00047 m\(^3\)/s, 1 pound = 0.453 kg

(2) The locations of the gravity ventilation openings shall be based on the relative density of the refrigerant to air. [ASHRAE 15:8.11.5(a), (b)]

1106.13 Machinery Room, A2L and B2L. When required by Section 1106.1, machinery rooms shall comply with Section 1106.13.1 through Section 1106.13.6. [ASHRAE 15:8.13]

1106.13.1 Flame-Producing Device. There shall be no flame-producing device or hot surface over 1290°F (700°C) in the room, other than that used for maintenance or repair, unless installed in accordance with Section 1106.5. [ASHRAE 15:8.13.1]

1106.13.2 Communicating Spaces. Doors communicating with the building shall be approved, self-closing, tight-fitting fire doors. [ASHRAE 15:8.13.2]

1106.13.3 Noncombustible Construction. Walls, floor, and ceiling shall be tight and of noncombustible construction. Walls, floor, and ceiling separating the refrigerating machinery room from other occupied spaces shall be of at least one-hour fire-resistive construction. [ASHRAE 15:8.13.3]

1106.13.4 Exterior Openings. Exterior openings, if present, shall not be under any fire escape or any open stairway. [ASHRAE 15:8.13.4]

1106.13.5 Pipe Penetrations. All pipes piercing the interior walls, ceiling, or floor of such rooms shall be tightly sealed to the walls, ceiling, or floor through which they pass. [ASHRAE 15:8.13.5]

1106.13.6 Machinery Room Designation. When any refrigerant of Groups A2, A3, B2, or B3 are used, the machinery room shall be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with NFPA 70. When the only flammable refrigerants used are from Group A2L or B2L, the machinery room shall comply with both Section 1106.13.6.1 for ventilation and Section 1106.13.6.2 for refrigerant detection, or shall be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with NFPA 70. [ASHRAE 15:8.13.6]

1106.13.6.1 Mechanical Ventilation. The machinery room shall have a mechanical ventilation system in accordance with Section 1106.13.11. The mechanical ventilation system shall:

1. Run continuously, and failure of the mechanical ventilation system actuates an alarm, or
2. Be activated by one or more refrigerant detectors, conforming to requirements of Section 1106.13.8. [ASHRAE 15:8.13.6.1]

1106.13.6.2 Detection System. Detection of refrigerant concentration that exceeds 25 percent of the LFL or the upper detection limit of the refrigerant detector, whichever is lower, shall automatically de-energize the following equipment in the machinery room:

1. Refrigerant compressors
2. Refrigerant pumps
3. Normally closed automatic refrigerant valves
4. Other unclassified electrical sources of ignition with apparent power rating greater than 1 kVA, where the apparent power is the product of the circuit voltage and current rating. [ASHRAE 15:8.13.6.2]

1106.13.7 Mechanical Equipment Control. Remote control of the mechanical equipment in the refrigerating machinery room shall be provided immediately outside the machinery room door solely for the purpose of shutting down the equipment in an emergency. Ventilation fans shall be on a separate electrical circuit and have a control switch located immediately outside the machinery room door. [ASHRAE 15:8.13.7]

1106.13.8 Refrigerant Detectors. Each refrigerating machinery room in accordance with Section 1106.13 shall contain one or more refrigerant detectors in accordance with Section 1106.13.9. The detector(s) sensing element shall be
located in areas where refrigerant from a leak will concentrate, with one or more set points that activate responses in accordance with Section 1106.13.10 for alarms and Section 1106.13.11 for mechanical ventilation. Multiport-type devices shall be prohibited. [ASHRAE 15:8.13.8]

1106.13.9 Refrigerant Detectors Requirements. Refrigerant detectors required by Section 1106.13 shall meet all of the following conditions:
1. A refrigerant detector shall be capable of detecting each of the specific refrigerant designations in the machinery room.
2. The refrigerant detector shall activate responses within a time not to exceed a limit specified in Section 1106.13.10 and Section 1106.13.11 after exposure to refrigerant concentration exceeding a limit value specified in Section 1106.13.10 and Section 1106.13.11.
3. The refrigerant detector shall have a set point not greater than the applicable Occupational Exposure Limit (OEL) value in accordance with Table 1102.3. The applicable OEL value shall be the lowest OEL value for any refrigerant designation in the machinery room. For refrigerants that do not have an OEL value in Table 1102.3, use a value determined in accordance with the OEL as defined by ASHRAE 34 where approved by the Authority Having Jurisdiction.
4. The refrigerant detector shall have a set point not more than the applicable Refrigerant Concentration Limit (RCL) value in accordance with Table 1102.3. The applicable RCL value shall be the lowest RCL value for any refrigerant designation in the machinery room. For refrigerants that do not have a RCL value in Table 1102.3, use a value determined in accordance with the RCL as defined by ASHRAE 34 where approved by the Authority Having Jurisdiction.
5. The refrigerant detector shall provide a means for automatic self-testing and shall be in accordance with Section 1106.13.10.4. The refrigerant detector shall be tested during installation and annually thereafter in accordance with the fire code, or at an interval not exceeding the manufacturer’s installation instructions, whichever is less. Testing shall verify compliance with the alarm set points and response times per Section 1106.13.10 and Section 1106.13.11.

[ASHRAE 15:8.13.9]

1106.13.10 Alarms. Alarms required by Section 1106.13.8 shall comply with Section 1106.13.10.1 through Section 1106.13.10.4.

1106.13.10.1 Visual and Audio. The alarm shall have visual and audible annunciation inside the refrigerating machinery room and outside each entrance to the refrigerating machinery room. [ASHRAE 15:8.13.10.1]

1106.13.10.2 Detector Activation. The refrigerant detector set points shall activate an alarm in accordance with the type of reset in Table 1106.13.10.2. Manual reset type alarms shall have the reset located inside the refrigerating machinery room. [ASHRAE 15:8.13.10.2]

**TABLE 1106.13.10.2**

<table>
<thead>
<tr>
<th>LIMIT VALUE</th>
<th>RESPONSE TIME (seconds)</th>
<th>ALARM TYPE</th>
<th>ALARM RESET TYPE</th>
<th>VENTILATION RATE</th>
<th>VENTILATION RESET TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set point &lt;= OEL</td>
<td>&lt;= 300</td>
<td>Trouble</td>
<td>Automatic</td>
<td>Level 1</td>
<td>Automatic</td>
</tr>
</tbody>
</table>

1106.13.10.3 Alarm Levels. Alarms set at levels other than Table 1106.13.10.2 (such as IDLH) and automatic reset alarms are permitted in addition to those required by Section 1106.13.10. The meaning of each alarm shall be clearly marked by signage near the annunciators. [ASHRAE 15:8.13.10.3]

1106.13.10.4 Emergency. In the event of a failure during a refrigerant detector self-test in accordance with Section 1106.13.9(5), a trouble alarm signal shall be transmitted to an approved monitored location. [ASHRAE 15:8.13.10.4]

1106.13.11 Mechanical Ventilation. Machinery rooms, in accordance with Section 1106.13, shall be vented to the outdoors, using mechanical ventilation in accordance with Section 1106.13.11.1, Section 1106.13.11.2, and Section 1106.13.11.3. [ASHRAE 15:8.13.11]

1106.13.11.1 Mechanical Ventilation Requirements. Mechanical ventilation referred to in Section 1106.13.11 shall be in accordance with all of the following:
1. Include one or more power-driven fans capable of exhausting air from the machinery room; multispeed fans shall be permitted.
2. Electric motors driving fans shall not be placed inside ducts; fan rotating elements shall be nonferrous or non-sparking, or the casing shall consist of or be lined with such material.
3. Include provision to supply make-up air to replace that being exhausted; ducts for supply to and exhaust from the machinery room shall serve no other area; the makeup air supply locations shall be positioned relative to the exhaust air locations to avoid short circuiting.
(4) Inlets to the exhaust ducts shall be located in an area where refrigerant from a leak will concentrate, in consideration of the location of the replacement supply air paths, refrigerating machines, and the density of the refrigerant relative to air.

(5) Inlets to exhaust ducts shall be within 1 foot (0.3 m) of the lowest point of the machinery room for refrigerants that are heavier than air and shall be within 1 foot (0.3 m) of the highest point for refrigerants that are lighter than air.

(6) The discharge of the exhaust air shall be to the outdoors in such a manner as not to cause a nuisance or danger. [ASHRAE 15:8.13.11.1]

<table>
<thead>
<tr>
<th>TABLE 1106.13.11.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL 1 VENTILATION RATE FOR CLASS 2L REFRIGERANTS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STATUS</th>
<th>AIRFLOW</th>
</tr>
</thead>
</table>
| Operated when occupied and operated when activated in accordance with Section 1106.13.10.2 and Table 1106.13.10.2 | The greater of the following:
|                                             | (1) 0.5 ft³/min ft³ (2.54 L/s per m³) of machinery room area, or |
|                                             | (2) 20 ft³/min (9.44 L/s) per person                                      |
| Operable when occupied                      | With or without mechanical cooling of the machinery room, the greater of: |
|                                             | (1) The airflow rate required to not exceed a temperature rise of 18°F (10°C) above inlet air temperature or |
|                                             | (2) The airflow rate required to not exceed a maximum air temperature of 122°F (50°C) in the machinery room. |

1106.13.11.2 Level 1 Ventilation Rate. The refrigerating machinery room mechanical ventilation in Section 1106.13.11.1 shall exhaust at an airflow rate not less than shown in Table 1106.13.11.2. [ASHRAE 15:8.13.11.2]

1106.13.11.3 Level 2 Ventilation. A part of the refrigerating machinery room mechanical ventilation referred to in Section 1106.13.11.1 shall exhaust an accumulation of refrigerant due to leaks or a rupture of a refrigerating system, or portion thereof, in the machinery room. The refrigerant detectors required in accordance with Section 1106.13.8 shall activate ventilation at a set point and response time in accordance with Table 1106.13.10.2, at an airflow rate not less than the value determined in accordance with Section 1106.13.11.4.

When multiple refrigerant designations are in the machinery room, evaluate the required airflow according to each refrigerating system, and the highest airflow quantity shall apply.

Ventilation reset shall be in accordance with the type of reset in Table 1106.13.10.2. Manual-type ventilation reset shall have the reset located inside the refrigerating machinery room. [ASHRAE 15:8.13.11.3]

1106.13.11.4 Level 2 Ventilation Rate. When required by Section 1106.13.11.3, the total airflow for Level 2 ventilation shall be not less than the airflow rate determined by Figure 1106.13.11.4. [ASHRAE 15:8.13.11.4]

1107.1.7 Group A2L and B2L Refrigerants. Where refrigerant of Groups A2L or B2L are used, the requirements of Class 1, Division 2, of NFPA 70, shall not apply to the machinery room provided that the conditions in Section 1107.1.7.1 through Section 1107.1.7.3 are met.

1107.1.7.1 Mechanical Ventilation. The mechanical ventilation system in the machinery room is run continuously in accordance with Section 4406.2.51106.13.6.1 and failure of the mechanical ventilation system actuates an alarm, or the mechanical ventilation system in the machinery room is activated by one or more refrigerant detectors, in accordance with the requirements of Section 4406.2.2.1 and Section 1106.13.11.

1107.1.7.2 Refrigeration Detectors. For the refrigerant detection required in Section 4406.2.2.1 1106.2.5, detection of refrigerant concentration that exceeds 25 percent of the LFL or the upper detection limit of the refrigerant detector, whichever is lower, shall automatically de-energize the following equipment in the machinery room:
(a) refrigerant compressors
(b) refrigerant pumps
(c) normally-closed automatic refrigerant valves

1107.1.7.3 Machinery Rooms. The machinery room shall comply with Section 4407.1.81106.13.

1112.11 Discharge from Pressure-Relief Devices. Pressure-relief systems designed for vapor shall comply with Section 1112.11.1 through Section 1112.11.4.1.

1112.11.1 Discharging Location Interior to Building. Pressure-relief devices, including fusible plugs, serving refrigeration systems shall be permitted to discharge to the interior of a building where in accordance with the following:
(1) The system contains less than 110 pounds (49.9 kg) of a Group A1 or A2L refrigerant.
(2) The system contains less than 6.6 pounds (2.99 kg) of a Group A2, B1, or B2 or B2L refrigerant.
(3) The system does not contain any quantity of a Group A3 or B3 refrigerant.
(4) The system is not required to be installed in a machinery room in accordance with Section 1106.0.
(5) The refrigerant concentration limits in Section 1104.0 are not exceeded. Refrigeration systems that do not comply with the above requirements shall comply with the requirements of Section 1112.11.2 through Section 1112.11.4. [ASHRAE 15:9.7.8.1]
220.0  —  R —  

**Refrigerant Concentration Limit (RCL).** The refrigerant concentration limit, in air, determined in accordance with this code and intended to reduce the risks of acute toxicity, asphyxiation, and flammability hazards in normally occupied, enclosed spaces. [ASHRAE 34:3.1]
<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 15-2016</td>
<td>Safety Standard for Refrigeration Systems</td>
<td>Refrigeration Systems</td>
<td>1102.1, 1106.1, Table 1113.5</td>
</tr>
<tr>
<td>ASHRAE 34-2016</td>
<td>Designation and Safety Classification of Refrigerants</td>
<td>Refrigeration Classifications</td>
<td>1102.3, 1103.1, Table 1102.3, Table 1106.2.5.2, 1106.13.9(3), 1106.13.9(4)</td>
</tr>
<tr>
<td>NFPA 70-2017</td>
<td>National Electrical Code</td>
<td>Miscellaneous</td>
<td>301.4(1), 301.4(3), 511.1.6, 512.2.5, 516.2.7, 516.2.9(4), 602.2.1, 905.8.2, 1104.4(5), 1106.13.6, 1107.1.7, 1107.1.8, 1217.8.1, 1310.14.5(2), 1311.2.4, 1311.7</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: The ASHRAE, NFPA, and UL standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
Task Group Recommendation 2 - Machinery Rooms: The proposed modification would bring the Uniform Mechanical Code in line with ASHRAE 15. The 3rd edition of UL/CSA 60335-2-40 has requirements for testing (and listing) of equipment using Group A2L refrigerants. The A2L Task Group modified various portions of the extracted language as needed to address enforceability and health and safety concerns. The requirements follow the extraction policy of IAPMO. Furthermore, a definition for Refrigerant Concentration Limit (RCL) is being added from ASHRAE 34 as the term is used but currently not defined in the code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
### TABLE 1104.1

**TABLE 1104.1 \(^1\)**

<table>
<thead>
<tr>
<th>OCCUPANCY GROUP(^3)</th>
<th>HIGH-PROBABILITY SYSTEM</th>
<th>LOW PROBABILITY SYSTEM</th>
<th>MACHINERY ROOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>Group A1 or A2L(^4) only</td>
<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>A-2</td>
<td>Group A1 or A2L(^4) only</td>
<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>A-3</td>
<td>Group A1 or A2L(^4) only</td>
<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>A-4</td>
<td>Group A1 or A2L(^4) only</td>
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</tr>
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<td>Group A1 or A2L(^4) only</td>
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<td>Any</td>
</tr>
<tr>
<td>F-2</td>
<td>Any(^2)</td>
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<td>Any</td>
</tr>
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<td>Any</td>
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</tr>
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<td>Any</td>
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<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>H-4</td>
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<td>Any</td>
</tr>
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<td>Any</td>
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<td>Any</td>
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<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>I-4</td>
<td>Group A1 or A2L(^4) only</td>
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<td>Any</td>
</tr>
<tr>
<td>M</td>
<td>Group A1 or A2L(^4) only</td>
<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>R-1</td>
<td>Group A1 or A2L(^4) only</td>
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<td>Any</td>
</tr>
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</tr>
<tr>
<td>R-3</td>
<td>Group A1 or A2L(^4) only</td>
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<tr>
<td>R-4</td>
<td>Group A1 or A2L(^4) only</td>
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<td>Any</td>
</tr>
<tr>
<td>S-1</td>
<td>Group A1 or A2L(^4) only</td>
<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>S-2</td>
<td>Any(^2)</td>
<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>U</td>
<td>Any</td>
<td>Any</td>
<td>Any</td>
</tr>
</tbody>
</table>
Notes:
1 See Section 1104.0.
2 A refrigerant shall be permitted to be used within a high-probability system where the room or space is in accordance with Section 1104.4.
3 Occupancy classifications are defined in the building code.
4 See Section 1104.6 for requirements applicable to A2L equipment.

SUBSTANTIATION:
Task Group Recommendation 3 - Table 1104.1: This change clarifies the acceptance of Group A2L refrigerants in high probability systems used for human comfort applications. Section 1104.6 already permits Group A2L refrigerants to be used for human comfort in direct systems provided the equipment is listed for A2L refrigerants. Footnote 4 identifies the requirements in Section 1104.6 for A2L refrigerants. This will assure that the equipment meets the listing and safety requirements of Section 1104.6.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
1103.2.1 High-Probability System. Systems in which the basic design, or the location of components, is such that a leakage of refrigerant from a failed connection, seal, or component will enter the occupied space shall be classified as high-probability systems. A typical high-probability system shall be one of the following:
(1) a direct system or
(2) an indirect open spray system in which the refrigerant is capable of producing pressure that is more than the secondary coolant. [ASHRAE 15:5.2.1]

1103.2.2 Low-Probability System. Systems in which the basic design, or the location of the components, is such that a leakage of refrigerant from a failed connection, seal, or component is not capable of entering the occupied space shall be classified as low-probability systems. A typical low-probability system shall be one of the following:
(1) an indirect closed system,
(2) double indirect system, or
(3) an indirect open spray system. In a low-probability indirect open spray system, the secondary coolant pressure remains more than the refrigerant pressure in operating and standby conditions. [ASHRAE 15:5.2.2]

1104.2.2 Nonconnecting Spaces. Where a refrigerating system, or a part thereof, is located in one or more enclosed occupied spaces that do not connect through permanent openings or HVAC ducts, the volume of the smallest occupied space shall be used to determine the refrigerant quantity limit in the system. Where different stories and floor levels connect through an open atrium or mezzanine arrangement, the volume to be used in calculating the refrigerant quantity limit shall be determined by multiplying the floor area of the lowest space by 8.2 feet (2499 mm). [ASHRAE 15:7.3.1]

1104.7.4 Mixing. Refrigerants, including refrigerant blends, with different refrigerant designations as in accordance with Table 1102.3 shall not only be mixed in a system in accordance with the following:

Exception:
(1) The addition of a second refrigerant shall be permitted where specified by the equipment manufacturer to improve oil return at low temperatures. The refrigerant and amount added shall be in accordance with the manufacturer’s instructions.
(2) The resulting mixture does not change the refrigerant safety group. [ASHRAE 15:7.5.1.7]

1104.8 Changing Refrigerants. A change in the type of refrigerant in a system shall not be made without notifying the Authority Having Jurisdiction, the user, and due observance of safety requirements. The refrigerant being considered shall be evaluated for suitability. Changes of refrigerant in an existing system to a refrigerant with a different refrigerant designation shall only be allowed where in accordance with Sections 1104.8.1 through Section 1104.8.4. [ASHRAE 15:5.3]

1104.8.1 Approval. The change of refrigerant shall be approved by the owner. [ASHRAE 15:5.3.1]

1104.8.2 Procedures. The change of refrigerant shall be in accordance with one of the following:
(1) Written instructions of the original equipment manufacturer.
(2) An evaluation of the system by a registered design professional or by an approved nationally recognized testing laboratory that validates safety and suitability of the replacement refrigerant.
(3) Approval of the Authority Having Jurisdiction. [ASHRAE 15:5.3.2]

1104.8.3 Replacement Refrigerant of Same Classification. Where the replacement refrigerant is classified into the same safety group, requirements that were applicable to the existing system shall continue to apply. [ASHRAE 15:5.3.3]
1104.8.4 Replacement Refrigerant of Different Classification. Where the replacement refrigerant is classified into a different safety group, the system shall comply with the requirements of this chapter for a new installation, and the change of refrigerant shall require Authority Having Jurisdiction approval. [ASHRAE 15:5.3.4]

1106.6 Airflow. There shall be no airflow to or from an occupied space through a machinery room unless the air is ducted and sealed in such a manner as to prevent any refrigerant leakage from entering the airstream. Access doors and panels in ductwork and air-handling units shall be gasketed and tight fitting. [ASHRAE 15:8.4.4.7 8.11.3]

1106.11 Restricted Access. Access to the refrigeration machinery room shall be restricted to authorized personnel. Doors shall be clearly marked, or permanent signs shall be posted at each entrance to indicate this restriction. [ASHRAE 15:8.11.4 8.11.4]

1109.1 Materials. Materials used in the construction and installation of refrigerating systems shall be suitable for conveying the refrigerant used. Materials shall not be used that will deteriorate because of the refrigerant, the lubricant, or their combination in the presence of air or moisture to a degree that poses a safety hazard. [ASHRAE 15:9.1.1] Refrigerant piping shall be metallic.

1109.1.4 Prohibited Contact. Aluminum, zinc, magnesium, or their alloys shall not be used in contact with any halogenated refrigerants. [ASHRAE 15:9.1.2]

1109.4 Location of Refrigeration Piping. Refrigerant piping crossing an open space that affords passageway in any building shall be not less than 7.25 feet (2210 mm) above the floor unless the piping is located against the ceiling of such space and is permitted by the Authority Having Jurisdiction. [ASHRAE 15:8.10.1]

1109.4.1 Protection from Mechanical Damage. Passages shall not be obstructed by refrigerant piping. Refrigerant piping shall not be located placed in any elevator, dumbwaiter, or other shaft containing a moving object, or in any shaft that has openings to living quarters; or to means of egress. Refrigerant piping shall not be installed in an enclosed public stairway, stair landing, or means of egress. [ASHRAE 15:8.10.2]

1109.5.1 Piping in Concrete Floors. Refrigerant piping installed in concrete floors shall be encased in a pipe duct. Refrigerant piping shall be isolated and supported to prevent damaging vibration, stress, or corrosion. [ASHRAE 15:8.10.4]

1110.1 More than 6.6 Pounds of Refrigerant. Systems containing more than 6.6 pounds (2.99 kg) of refrigerant shall have stop valves installed at the following locations:

1. The suction inlet of each compressor, compressor unit, or condensing unit.
2. The discharge of each compressor, compressor unit, or condensing unit.
3. The outlet of each liquid receiver.

Exceptions:

1. Systems that have a refrigerant pumpout function capable of storing the entire refrigerant charge.
2. Systems that are equipped with the provisions for pumpout of the refrigerant.

1110.2 More than 110 Pounds of Refrigerant. Systems containing more than 110 pounds (49.9 kg) of refrigerant shall have stop valves installed at the following locations:

1. The suction inlet of each compressor, compressor unit, or condensing unit.
2. The discharge of each compressor, compressor unit, or condensing unit.
3. The inlet of each liquid receiver, except for self-contained systems or where the receiver is an integral part of the condenser or condensing unit.
4. The outlet of each liquid receiver.
5. The inlets and outlets of condensers where more than one condenser is used in parallel in the systems.

Exceptions:

1. Systems that have a refrigerant pumpout function capable of storing the entire refrigerant charge.
2. Systems that are equipped with the provisions for pumpout of the refrigerant.

1112.2 Positive Displacement Compressor. A positive displacement compressor with a stop valve in the discharge connection shall be equipped with a pressure-relief device that is sized, and with a pressure setting, in accordance with the compressor manufacturer to prevent rupture of the compressor or to prevent the pressure from increasing to more than 10 percent above the maximum allowable working pressure of any other component located in the discharge line between the compressor and the stop valve or in accordance with Section 1113.5, whichever is larger. The pressure-relief device shall discharge into the low-pressure side of the system or in accordance with Section 1112.11.

Exception: Hermetic refrigerant motor-compressors that are listed and have a displacement not more than 50 cubic feet per minute (1.42 m³/min).

The relief device(s) shall be sized based on compressor flow at the following conditions:

1. For compressors in single-stage systems and high-stage compressors of other systems, the flow shall be calculated based on 50°F (10°C) saturated suction temperature at the compressor suction.
(2) For low-stage or booster compressors in compound refrigerating systems, the compressors that are capable of running only where discharging to the suction of a high-stage compressor, the flow shall be calculated based on the saturated suction temperature equal to the design operating intermediate temperature.

(3) For low-stage compressors in cascade systems, the compressors that are located in the lower-temperature stage(s) of cascade systems, the flow shall be calculated based on the suction pressure being equal to the pressure setpoint of the pressure-relieving devices that protect the lowside of the stage against overpressure.

Exceptions: For Section 1112.2(1), Section 1112.2(2), and Section 1112.2(3), the discharge capacity of the relief device shall be permitted to be the minimum regulated flow rate of the compressor where the following conditions are met:

(1) The compressor is equipped with capacity regulation.
(2) Capacity regulation actuates to a flow at not less than 90 percent of the pressure-relief device setting.
(3) A pressure-limiting device is installed and set in accordance with the requirements of Section 1111.0. [ASHRAE 15:9.8]

1112.11.1 Discharging Location Interior to Building. Pressure-relief devices, including fusible plugs, serving refrigeration systems shall be permitted to discharge to the interior of a building where in accordance with all of the following:

(1) The system contains less than 110 pounds (49.9 kg) of a Group A1 or A2L refrigerant.
(2) The system contains less than 6.6 pounds (2.99 kg) of a Group A2, B1, B2L, or B2 refrigerant.
(3) The system does not contain any quantity of a Group A3 or B3 refrigerant.
(4) The system is not required to be installed in a machinery room in accordance with Section 1106.0.
(5) The refrigerant concentration limits in Section 1104.2 are not exceeded. Refrigeration systems that do not comply with the above requirements shall comply with the requirements of Section 1112.11.2 through Section 1112.11.4. [ASHRAE 15:9.7.8.1]

1112.11.4 Discharge Location, Special Requirements. Additional requirements for pressure relief device discharge location and allowances shall apply for specific refrigerants in accordance with Section 1112.11.4.1. [ASHRAE 15:9.7.8.4]

1112.11.4.1 Water (R-718). Where water is the only refrigerant, discharge to a floor drain shall be permitted where all of the following conditions are met:

(1) The pressure-relief device set pressure shall not exceed 15 psig (103 kPa).
(2) The floor drain shall be sized to handle the flow rate from a single broken tube in any refrigerant containing heat exchanger.
(3) Either of the following:
   (a) The Authority Having Jurisdiction finds it acceptable that the working fluid, corrosion inhibitor, and other additives used in this type of refrigeration system are permitted to infrequently be discharged to the sewer system, or
   (b) A catch tank sized to handle the expected discharge shall be installed and equipped with a normally closed drain valve and an overflow line to drain. [ASHRAE 15:9.7.8.4.1]

1112.12.3 Maximum Length. The maximum length of the discharge piping installed on the outlet of pressure-relief devices and fusible plugs discharging to the atmosphere shall be determined in accordance with Section 1112.12.4 and Section 1112.12.5. See Table 1112.12.3 for the allowable flow capacity of various equivalent lengths of single discharge piping vents for conventional pressure-relief valves. [ASHRAE 15:9.7.9.3]

<table>
<thead>
<tr>
<th>Table 1112.12.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATMOSPHERIC PRESSURE AT NOMINAL INSTALLATION ELEVATION (Pa)</td>
</tr>
<tr>
<td>[ASHRAE 15: TABLE 9.7.9.3.2 9-2]</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

1112.12.4 Design Back Pressure. The design back pressure due to flow in the discharge piping at the outlet of pressure-relief devices and fusible plugs discharging to atmosphere, shall be limited by the allowable equivalent length of piping determined in accordance with Equation 1112.12.4(1).

\[
L = \frac{0.2146d^5}{f\cdot C_r} \left( \frac{P_0^2 - P_2^2}{P_2^2} \right) - \frac{d\cdot \ln \left( \frac{P_0}{P_2} \right)}{6\cdot f}
\]

[Equation 1112.12.4(1)]

Where:
- \( L \) = Equivalent length of discharge piping, feet.
- \( C_r \) = Rated capacity as stamped on the pressure relief device in pounds per minute (lb/min), or in standard cubic feet per minute (SCFM) multiplied by 0.0764, or as calculated in Section 1112.14 for a rupture member or fusible plug, or as adjusted for reduced capacity due to piping in accordance with the manufacturer of the device, or as adjusted for reduced capacity due to piping as estimated by an approved method.
f = Moody friction factor in fully turbulent flow.
d = Inside diameter of pipe or tube, inches.
ln = Natural logarithm.
P_2 = Absolute pressure at outlet of discharge piping, psia.
P_0 = Allowed back pressure (absolute) at the outlet of pressure relief device, (psia).
For SI units: 1 foot = 304.8 mm, 1 pound-force per square inch = 6.8947 kPa, 1 pound per minute = 0.00756 kg/s

Unless the maximum allowable back pressure (P_0) is specified by the relief valve manufacturer, the following maximum allowable back pressure values shall be used for P_0, where P is the set pressure and P_a is atmospheric pressure at the nominal elevation of the installation (see Table 1112.12.3):

1. For conventional relief valves: 15 percent of set pressure:
   
   \[ P_0 = (0.15 \cdot P) + P_a \]  
   [Equation 1112.12.4(2)]

2. For balanced relief valves: 25 percent of set pressure:
   
   \[ P_0 = (0.25 \cdot P) + P_a \]  
   [Equation 1112.12.4(3)]

3. For rupture disks alone; fusible plugs, and or pilot-operated relief devices: 50 percent of set pressure:
   
   \[ P_0 = (0.50 \cdot P) + P_a \]  
   [Equation 1112.12.4(4)]

For fusible plugs, P shall be the saturated absolute pressure for the stamped temperature melting point of the fusible plug or the critical pressure of the refrigerant used, whichever is smaller. [ASHRAE 15:9.7.9.3.1, 9.7.9.3.2]

### 1112.12.5 Simultaneous Operation

When outlets of two or more relief devices or fusible plugs, which are expected to operate simultaneously, connect to a common discharge pipe, the common pipe shall be sized large enough to prevent the back pressure at each pressure-relief device from exceeding the maximum allowable back pressure in accordance with Section 1112.12.4. [ASHRAE 15:9.7.9.3.3]

### 1112.14 Rating of Rupture Members and Fusible Plugs

The rated discharge capacity of a rupture member or fusible plug discharging to the atmosphere under critical flow conditions, in pounds of air per minute (kg/s), shall be determined in accordance with the following formulas:

\[ C = 0.64P_1 d^2 \]  
[Equation 1112.14(1)]

\[ d = 1.25 \sqrt{C/P_1} \]  
[Equation 1112.14(2)]

Where:
- \( C \) = Rated discharge capacity expressed as mass flow of air, pounds per minute.
- \( d \) = Smallest of the internal diameter of the inlet pipe, retaining flanges, fusible plug, or rupture member, inches.

For rupture members:

\[ P_1 = (\text{rated pressure in psig x 1.1}) + 14.7 \]

For fusible plugs:

\( P_1 \) = Absolute saturation pressure; corresponding to the stamped temperature melting point of the fusible plug or the critical pressure of the refrigerant used, whichever is smaller, pound-force per square inch atmosphere, psia. [ASHRAE 15:9.7.7]

For SI units: 1 inch = 25.4 mm, 1 pound-force per square inch = 6.8947 kPa, 1 pound per minute = 0.00756 kg/s

### 1113.5 Discharge Capacity

The minimum required discharge capacity of the pressure relief device or fusible plug for each pressure vessel shall be determined in accordance with Equation 1113.5: ASHRAE 15.

\[ C = fDL \]  
(Equation 1113.5)

Where:
- \( C \) = Minimum required discharge capacity of the relief device expressed as mass flow of air, pounds per minute (kg/s).
- \( D \) = Outside diameter of vessel, feet (m).
- \( L \) = Length of vessel, feet (m).
- \( f \) = Factor dependent upon type of refrigerant from Table 1113.5.
Where combustible materials are used within 20 ft (6096 mm) of a pressure vessel, the value of $f$ shall be multiplied by 2.5. Equation 1113.5 is based on fire conditions, other heat sources shall be calculated separately. Where one pressure-relief device or fusible plug is used to protect more than one pressure vessel, the required capacity shall be the sum of the capacity required for every pressure vessel. [ASHRAE 15:9.7.5]

### TABLE 1113.5
**RELIEF-DEVICES CAPACITY FACTOR**
[ASHRAE 15: TABLE 9.7.5]

<table>
<thead>
<tr>
<th>REFREGERANT</th>
<th>VALUE OF $f$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where used on the lowside of a limited-charge cascade system:</td>
<td></td>
</tr>
<tr>
<td>R-23, R-170, R-744, R-1150, R-508A, R-508B</td>
<td>4</td>
</tr>
<tr>
<td>R-13, R-13B1, R-503</td>
<td>2</td>
</tr>
<tr>
<td>R-14</td>
<td>2.5</td>
</tr>
<tr>
<td>Other applications:</td>
<td></td>
</tr>
<tr>
<td>R-718</td>
<td>-</td>
</tr>
<tr>
<td>R-717</td>
<td>0.2</td>
</tr>
<tr>
<td>R-11, R-32, R-113, R-123, R-142b, R-152a, R-200, R-600, R-600a, R-764</td>
<td>1</td>
</tr>
<tr>
<td>R-143a, R-402B, R-403A, R-407A, R-408A, R-413A</td>
<td>2</td>
</tr>
</tbody>
</table>

* In accordance with Section 1102.2, ammonia refrigeration systems are not regulated by this chapter. R-717 (ammonia) is included in this table because the table is extracted from ASHRAE 15 and is not capable of being modified.

1115.4 Marking of Pressure-Relief Devices. Pressure-relief valves for refrigerant containing components shall be set and sealed by the manufacturer or an assembler as defined in ASME BPVC Section VIII. Each pressure relief valve shall be marked by the manufacturer or assembler with the data required in ASME BPVC Section VIII.

**Exception:** Relief valves for systems with design pressures of 15 pounds-force per square inch gauge (psig) (103 kPa gauge) or less shall be marked by the manufacturer with the pressure setting capacity. [ASHRAE 15:9.6.1]

1116.1.1 Testing Procedure. Tests shall be performed with dry nitrogen or another nonflammable, nonreactive, dried gas. Oxygen, air, or mixtures containing them shall not be used. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gage on the outlet side. The pressure relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system’s components.

**Exceptions:**
(1) Mixtures of dry nitrogen, inert gases, and Class 1 nonflammable refrigerants shall be permitted for factory tests.
(2) Mixtures of dry nitrogen, inert gases, or a combination thereof with flammable Class 2L, Class 2, or Class 3 refrigerants in concentrations not exceeding the lesser of a refrigerant weight fraction (mass fraction) of 5 percent or 25 percent of the LFL shall be permitted for factory tests.
(3) Compressed air without added refrigerant shall be permitted for factory tests, provided the system is subsequently evacuated to less than 0.039 inch of mercury (0.132 kPa) before charging with refrigerant. The required evacuation level is atmospheric pressure for systems using R-718 (water) or R-744 (carbon dioxide) as the refrigerant. [ASHRAE 15:9.14.1.1]

1116.3 Test Gases. Tests shall be performed with dry nitrogen or either another nonflammable, nonreactive, dried gas. Oxygen, air, or mixtures containing them shall not be used. The means used to build up the test pressure shall have either a pressure-limiting device...
or a pressure-reducing device and a gauge on the outlet side. The pressure-relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system’s components.

**Exceptions:**

(1) Mixtures of dry nitrogen, inert gases, or a combination thereof such as Class 1 nonflammable refrigerant refrigerants in concentrations of a refrigerant weight fraction (mass fraction) not exceeding 5 percent shall be permitted for tests.

(2) Mixtures of dry nitrogen, inert gases, or a combination thereof such as flammable Class 2L, Class 2, and Class 3 refrigerants in concentrations not exceeding the lesser of a refrigerant weight fraction (mass fraction) of 5 percent or 25 percent of the LFL shall be permitted for tests.

(3) Compressed air without added refrigerants shall be permitted for tests, provided the system is subsequently evacuated to less than 1000 microns (0.1333 kPa) before charging with refrigerant. The required evacuation level is atmospheric pressure for systems using R-718 (water) or R-744 (carbon dioxide) as the refrigerant.

(4) Systems erected on the premises using Group A1 refrigerant and with copper tubing not exceeding 0.62 of an inch (15.7 mm) outside diameter shall be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at not less than 68°F (20°C). [ASHRAE 15:10.1.2]

### Subpart 220.0 – R –

**Recycled Refrigerants.** Refrigerants for which contaminants have been reduced by oil separation, removal of noncondensible gases, and single or multiple passes through filter driers or other devices that reduce moisture, acidity, and particulate matter. [ASHRAE 15:3]

**SUBSTANTIATION:**

In accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines), Chapter 11 is being revised to the latest edition of ASHRAE 15-2019 and Addendum J as published on October 30, 2020 to ASHRAE 15-2019.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 213
UMC 2024  Section: Table 1104.1, 1104.5 - 1104.7, 1106.2.2 - 1106.2.8.1, 1106.4, 1107.1.7.1 - 1107.1.7.3, 1112.11 - 1112.11.1, Table 1701.1

SUBMITTER: Emily Toto
ASHRAE

RECOMMENDATION:
Revise text

TABLE 1104.1
PERMISSIBLE REFRIGERATION SYSTEMS

<table>
<thead>
<tr>
<th>OCCUPANCY GROUP(^3)</th>
<th>HIGH-PROBABILITY SYSTEM</th>
<th>LOW PROBABILITY SYSTEM</th>
<th>MACHINERY ROOM</th>
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<tbody>
<tr>
<td>A-1</td>
<td>Group A1 or A2L only</td>
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<td>Any</td>
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</tr>
</tbody>
</table>

Notes:
\(^1\) See Section 1104.0.
A refrigerant shall be permitted to be used within a high-probability system where the room or space is in accordance with Section 1104.4.

Occupy classifications are defined in the building code.

### 1104.5 Flammable Refrigerants

The total of Group A2, B2, A3, and B3 refrigerants, other than Group A2L and B2L refrigerants shall not exceed 1100 pounds (498.9 kg) without approval by the Authority Having Jurisdiction. Institutional Occupancies shall comply with Section 1104.3. Machinery rooms required in accordance with Section 1106.0 based on flammability shall be constructed and maintained in accordance with Section 1106.2.1 through Section 1106.2.6.

### 1104.6 Group A2L Refrigerants for Human Comfort

High-probability systems using Group A2L refrigerants for human comfort applications shall comply with ASHRAE 15 requirements for ventilation, refrigerant detection systems, and machinery rooms. [ASHRAE 15:7.6; 8.13]

### 1104.6 Applications for Human Comfort and for Nonindustrial Occupancies

In nonindustrial occupancies, Group A2, A2L, A3, B1, B2L, B2, and B3 refrigerants shall not be used in high-probability systems for human comfort.

### 1106.2.2 Openings

Each refrigeration machinery room shall have a tight-fitting door or doors opening outward, self-closing where they open into the building and adequate in number to ensure freedom for persons to escape in an emergency. With the exception of access doors and panels in air ducts and air-handling units in accordance with Section 1106.6, there shall be no openings that will permit passage of escaping refrigerant to other parts of the building. [ASHRAE 15:8.11.2]

### 1106.2.3 Airflow

There shall be no airflow to or from an occupied space through a machinery room unless the air is ducted and sealed in such a manner as to prevent a refrigerant leakage from entering the airstream. Access doors and panels in ductwork and air-handling units shall be gasketed and tight fitting. [ASHRAE 15:8.11.7; 8.11.3]

### 1106.2.4 Restricted Access

Access to the refrigeration machinery room shall be restricted to authorized personnel. Doors shall be clearly marked or permanent signs shall be posted at each entrance to indicate this restriction. [ASHRAE 15:8.11.8]

### 1106.2.5 Detectors and Alarms

Each refrigeration machinery room shall contain one or more refrigerant detectors in accordance with Section 1106.2.6, located in areas where refrigerant from a leak will concentrate, that actuate an alarm and mechanical ventilation in accordance with Section 1106.2.2, at a set point not more than the corresponding Occupational Exposure Limit, OEL, in accordance with Table 1102.3, as a set point determined in accordance with the OEL as defined in Chapter 2 shall be approved by the Authority Having Jurisdiction. The alarm shall annunciate visual and audible alarms inside the refrigeration machinery room and outside each entrance to the refrigeration machinery room. The alarms required in this section shall be of the manual reset type with the reset located inside the refrigeration machinery room. Alarms set at other levels, such as IDLH, and automatic reset alarms shall be permitted in addition to those required in accordance with this section. The meaning of each alarm shall be clearly marked by signage near the annunciator.

**Exception:** Refrigerant detectors are not required where only systems using R-718 (water) are located in the refrigeration machinery room. For Group A2 and B2L, refrigerant detectors shall comply with Section 1107.1.7.2. [ASHRAE 15:8.11.3]

### 1106.2.6 Refrigerant Detectors

Refrigerant detectors required in accordance with Section 1106.2.4 or Section 1106.2.5 or Section 1107.1.7 shall meet all of the following conditions:

1. The refrigerant detector shall perform automatic self-testing of sensors. Where a failure is detected, a trouble signal shall be activated.
2. The refrigerant detector shall have one or more set points to activate responses in accordance with Section 1106.2.2 or Section 1107.1.7.
3. The refrigerant detector as installed, including any sampling tubes, shall activate responses within a time not to exceed 30 seconds after exposure to refrigerant concentration exceeding the set point value specified in Section 1106.2.2 or Section 1107.1.7.

### 1106.2.7 Ventilation

An emergency ventilation system shall be required to exhaust an accumulation of refrigerant due to leaks or a rupture of the system. The emergency ventilation system shall be capable of removing air from the machinery room in not less than the airflow quantity in Section 1106.2.6.1 for the specified refrigerants or Section 1106.2.6.2, A2L and B2L refrigerants shall comply with the ventilation requirements specified in ASHRAE 15. Where multiple refrigerants are present, then the highest airflow quantity shall apply. [ASHRAE 15:8.13]

### 1106.2.8 Emergency Ventilation-Required Airflow

The emergency ventilation for A1, A2, A3, B1, B2L, B2 and B3 refrigerants shall have the capacity to provide mechanical exhaust at a rate as determined in accordance with Equation 1106.2.8.1:

\[
Q = 100 \sqrt[3]{G}
\]  

(Equation 1106.2.5.1)

**Where:**

- \(Q\) = Air flow rate, cubic feet per minute.
- \(G\) = Refrigerant mass in largest system, pounds.
**1106.2.5.2 Ventilation - Group A2L Refrigerants.** The emergency ventilation for A2L refrigerants shall have the capacity to provide mechanical exhaust at a rate determined in accordance with Table 1106.2.5.2:

<table>
<thead>
<tr>
<th>REFRIGERANT</th>
<th>MINIMUM AIR FLOW* (GFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-32</td>
<td>32500</td>
</tr>
<tr>
<td>R-143a</td>
<td>28600</td>
</tr>
<tr>
<td>R-444A</td>
<td>43700</td>
</tr>
<tr>
<td>R-444B</td>
<td>22400</td>
</tr>
<tr>
<td>R-445A</td>
<td>46400</td>
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<td>R-446A</td>
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<tr>
<td>R-447A</td>
<td>50200</td>
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<tr>
<td>R-447B</td>
<td>29600</td>
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<tr>
<td>R-451A</td>
<td>44900</td>
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<tr>
<td>R-451B</td>
<td>44900</td>
</tr>
<tr>
<td>R-452B</td>
<td>31500</td>
</tr>
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<td>R-454A</td>
<td>4290</td>
</tr>
<tr>
<td>R-454B</td>
<td>6650</td>
</tr>
<tr>
<td>R-454C</td>
<td>32800</td>
</tr>
<tr>
<td>R-455A</td>
<td>4770</td>
</tr>
<tr>
<td>R-457A</td>
<td>31400</td>
</tr>
<tr>
<td>R-1234yf</td>
<td>16500</td>
</tr>
<tr>
<td>R-1234zeE</td>
<td>42600</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 pound = 0.453 kg

*The values were tabulated from the following equation:

\[ QA2L = \frac{P \cdot V \cdot A}{(LFL \cdot 0.50)} \] (Equation 1106.2.5.2)

Where:
- \( P \): Refrigerant density, pounds per cubic feet (kg/m³).
- \( V \): Refrigerant velocity equal to the refrigerant acoustic velocity (speed of sound), feet per second (m/s).
- \( A \): Cross-section flow area of refrigerant leak, square feet (m²); \( A = 0.00136 \text{ ft}^2 (0.000126 \text{ m}^2) \).
- \( LFL \): Lower Flammability Limit, or ETFL60 where no LFL exist, published value in accordance with ASHRAE 34.

\( QA2L \): Minimum required air flow rate, conversion to other units of measures is permitted, cubic feet per second (m³/s).

For exact ventilation rates and for refrigerants not listed, the ventilation rate shall be calculated using this equation.

**1106.4 Natural Ventilation.** Where a refrigerating system is located outdoors more than 20 feet (6096 mm) from buildings opening and is enclosed by a penthouse, lean-to, or other open structure, natural or mechanical ventilation shall be provided. The requirements for such natural ventilation shall be in accordance with the following:

1. The free-aperture cross section for the ventilation of a machinery room shall be not less than as determined in accordance with Equation 1106.4.

\[ F = \sqrt{G} \] (Equation 1106.4)

Where:
- \( F \): The free opening area, square feet.
- \( G \): The mass of refrigerant in the largest system, any part of which is located in the machinery room, pounds.

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 pound = 0.453 kg

2. The location of the gravity ventilation openings shall be based on the relative density of the refrigerant to air.

[ASHRAE 15:8.11.5(a),(b) 8.14]

**1107.1.7.1 Mechanical Ventilation.** The mechanical ventilation system in the machinery room is run continuously in accordance with Section 1106.2.5 1106.2.8 and failure of the mechanical ventilation system actuates an alarm, or the mechanical ventilation system in the machinery room is activated by one or more refrigerant detectors, in accordance...
with the requirements of Section 4106.2.2.4 1106.2.5 and Section 4106.2.2.2 1106.2.6.

1107.1.7.2 Refrigeration Detectors. For the refrigerant detection required in Section 4106.2.2.4 1106.2.5, detection of refrigerant concentration that exceeds 25 percent of the LFL or the upper detection limit of the refrigerant detector, whichever is lower, shall automatically de-energize the following equipment in the machinery room:
(a) refrigerant compressors
(b) refrigerant pumps
(c) normally-closed automatic refrigerant valves

1107.1.7.3 Machinery Rooms. The machinery room shall comply with Section 1107.1.8 [ASHRAE 15:8.13]

1112.11 Discharge from Pressure-Relief Devices. Pressure-relief systems designed for vapor shall comply with Section 1112.11.1 through Section 1112.11.4.1.

1112.11.1 Discharging Location Interior to Building. Pressure-relief devices, including fusible plugs, serving refrigeration systems shall be permitted to discharge to the interior of a building where in accordance with the following:
(1) The system contains less than 110 pounds (49.9 kg) of a Group A1 or A2L refrigerant.
(2) The system contains less than 6.6 pounds (2.99 kg) of a Group A2, B1, or B2 or B2L refrigerant.
(3) The system does not contain any quantity of a Group A3 or B3 refrigerant.
(4) The system is not required to be installed in a machinery room in accordance with Section 1106.0.
(5) The refrigerant concentration limits in Section 1104.0 are not exceeded. Refrigeration systems that do not comply with the above requirements shall comply with the requirements of Section 1112.11.2 through Section 1112.11.4. [ASHRAE 15:9.7.8.1]

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 15-2016-2019</td>
<td>Safety Standard for Refrigeration Systems</td>
<td>Refrigeration Systems</td>
<td>1102.1, 1106.1, Table 1113.5</td>
</tr>
<tr>
<td>ASHRAE 34-2016-2019</td>
<td>Designation and Safety Classification of Refrigerants</td>
<td>Refrigeration Classifications</td>
<td>1102.3, 1103.1, Table 1102.3, Table 1106.2.5.2</td>
</tr>
</tbody>
</table>

Note: The ASHRAE standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
This change is very important since it addresses the safety measure necessary for the use of Low GWP refrigerants that fall into the category of Group A2L refrigerants. It also updates the requirements for use of Group A2L refrigerants in machinery rooms.

Currently, all of the Low GWP refrigerants recommended for approval by EPA for high probability systems for human comfort fall into the category of Group A2L. The industry is transitioning to Low GWP refrigerants to help the environment and future generations.

Table 1104.1 needs to be updated to address all of the refrigerants in common use for high probability systems. A2L is added to the first column.

Section 1104.6 is a new section regarding the use of Group A2L refrigerants in high probability systems for human comfort. Section 1104.6 are the requirements that were added to the 2019 edition of ASHRAE 15. The section only allows the use of listed equipment when using Group A2L refrigerants in high probability systems.

The section identifies when a refrigerant detector is required for the equipment. This requirement is similar to the requirement found in UL/CSA 60335-2-40. ASHRAE 15 Committee thought it was important for the code to identify when a detector is required while the product standard should identify the installation and testing of the detector.

The activation of the detector signals the mitigation to activate. This results in the mixing of the refrigerant with the surrounding air and the shut down of the equipment.
The machinery room requirements are extracted from the 2019 edition of ASHRAE 15.

New ventilation requirements were added to ASHRAE 15 for machinery rooms using Group A2L refrigerants. The new charts are used for determining the amount of ventilation required based on the amount of refrigerant charge in a system.

There are two levels of annunciation in the event of a refrigerant leak in a machinery room. The first activation is a trouble alarm for a small leak. This requires a minimal amount of ventilation. The second level is an emergency alarm. This signals the activation of the full amount of ventilation for the room.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the changes pertaining to A2L refrigerants in this proposal are already being addressed in Item #s 208 and 211.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 214

UMC 2024  Section: 1104.5 - 1112.11.1

SUBMITTER: Automatic Proposal
2019 UMC ROC Item # 091 PC 1 (Previous "HOLD" item)

RECOMMENDATION:
Revise text

1104.0 Requirements for Refrigerant and Refrigeration System Use.

1104.5 Flammable Refrigerants. The total of Group A2, B2, A3, and B3 refrigerants, other than Group A2L and B2L refrigerants shall not exceed 1100 pounds (498.9 kg) without approval by the Authority Having Jurisdiction. Institutional Occupancies shall comply with Section 1104.3. Machinery rooms required in accordance with Section 1106.0 based on flammability shall be constructed and maintained in accordance with Section 1106.2.1 through Section 1106.2.6 and Section 1106.13 for Group A2L and B2L refrigerants other than R-717(ammonia).

1106.0 Refrigeration Machinery Rooms.

1106.1 Where Required. (remaining text unchanged)

1106.2 Refrigeration Machinery Room, General Requirements. Where a refrigeration system is located indoors and a machinery room is required in accordance with Section 1106.1, the machinery room shall be in accordance with Section 1106.2.1 through Section 1106.2.5.2.

1106.2.1 Access. Machinery rooms shall not be prohibited from housing other mechanical equipment unless specifically prohibited elsewhere in this chapter. A machinery room shall be so dimensioned that parts are accessible with space for service, maintenance, and operations. There shall be clear head room of not less than 7.25 feet (2210 mm) below equipment situated over passageways. [ASHRAE 15:8.11.1]

1106.2.2 Openings. Each refrigeration machinery room shall have a tight-fitting door or doors opening outward, self-closing where they open into the building and adequate in number to ensure freedom for persons to escape in an emergency. With the exception of access doors and panels in air ducts and air-handling units in accordance with Section 1106.6.1106.2.3, there shall be no openings that will permit passage of escaping refrigerant to other parts of the building. [ASHRAE 15: 8.11.2]

1106.6.1106.2.3 Airflow. There shall be no airflow to or from an occupied space through a machinery room unless the air is ducted and sealed in such a manner as to prevent a refrigerant leakage from entering the airstream. Access doors and panels in ductwork and air-handling units shall be gasketed and tight fitting. [ASHRAE 15:8.44.7 8.11.3]

1106.4 1106.2.4 Restricted Access. Access to the refrigeration machinery room shall be restricted to authorized personnel. Doors shall be clearly marked or permanent signs shall be posted at each entrance to indicate this restriction. [ASHRAE 15:8.44.8 8.11.4]

1106.2.2.1 1106.2.5 Detectors and Alarms. Each refrigeration machinery room shall contain one or more refrigerant detectors in accordance with Section 1106.2.6, located in areas where refrigerant from a leak will concentrate, that actuate an alarm and mechanical ventilation in accordance with Section 1106.2.2 1106.2.4 at a set point not more than the corresponding Occupational Exposure Limit, OEL, in accordance with Table 1102.3, a set point determined in accordance with the OEL as defined in Chapter 2 shall be approved by the Authority Having Jurisdiction. The alarm shall annunciate visual and audible alarms inside the refrigeration machinery room and outside each entrance to the refrigeration machinery room. The alarms required in this section shall be of the manual reset type with the reset located inside the refrigeration machinery room. Alarms set at other levels, such as IDLH, and automatic reset alarms shall be permitted in addition to those required in accordance with this section. The meaning of each alarm shall be clearly marked by signage near the annunciator.

Exception: Refrigerant detectors are not required where only systems using R-718 (water) are located in the refrigeration machinery room. For Group A2L and B2L, other than ammonia, refrigerant detectors shall comply with Section 1106.13.
Refrigerant Detectors. Refrigerant detectors required in accordance with Section 1106.2.2 or Section 1107.1.7 shall meet all of the following conditions:

1. The refrigerant detector shall perform automatic self-testing of sensors. Where a failure is detected, a trouble signal shall be activated.
2. The refrigerant detector shall have one or more set points to activate responses in accordance with Section 1106.2.2 or Section 1107.1.7.
3. The refrigerant detector as installed, including any sampling tubes, shall activate responses within a time not to exceed 30 seconds after exposure to refrigerant concentration exceeding the set point value specified in Section 1106.2.2 or Section 1107.1.7.

Emergency Ventilation-Required Airflow. An emergency ventilation system shall be required to exhaust an accumulation of refrigerant due to leaks or a rupture of the system. The emergency ventilation required shall be capable of removing air from the machinery room in not less than the airflow quantity in Section 1106.2.5.1 or Section 1106.2.5.2. Where multiple refrigerants are present, then the highest airflow quantity shall apply.

Ventilation - A1, A2, A3, B1, B2L, B2 and B3 refrigerants. The emergency ventilation for A1, A2, A3, B1, B2L, B2 and B3 refrigerants shall have the capacity to provide mechanical exhaust at a rate as determined in accordance with Equation 1106.2.5.1:

\[ Q = 100 \times v \times G \]  
(Equation 1106.2.5.1)

Where:

- \( Q \) = Air flow rate, cubic feet per minute.
- \( v \) = Refrigerant mass in largest system, pounds.
- For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 pound = 0.453 kg

Ventilation - Group A2L Refrigerants. The emergency ventilation for A2L refrigerants shall have the capacity to provide mechanical exhaust at a rate as determined in accordance with Table 1106.2.5.2:

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Minimum Air Flow* (CFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-32</td>
<td>32,500</td>
</tr>
<tr>
<td>R-143a</td>
<td>28,600</td>
</tr>
<tr>
<td>R-444A</td>
<td>43,700</td>
</tr>
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<td>R-444B</td>
<td>22,400</td>
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<td>R-445A</td>
<td>46,400</td>
</tr>
<tr>
<td>R-446A</td>
<td>60,500</td>
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<tr>
<td>R-447A</td>
<td>60,200</td>
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<td>R-447B</td>
<td>29,600</td>
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<tr>
<td>R-451A</td>
<td>44,900</td>
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<td>R-451B</td>
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<td>R-452B</td>
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<td>R-1234zeE</td>
<td>12,600</td>
</tr>
</tbody>
</table>

\[ Q_{A2L} = \frac{(P \times V \times A)}{(LFL \times 0.50)} \]  
(Equation 1106.2.5.2)

Where:

- \( P \) = Refrigerant density, pounds per cubic feet (kg/m³).
1106.4 Natural Ventilation. Where a refrigerating system is located outdoors more than 20 feet (6096 mm) from buildings opening and is enclosed by a penthouse, lean-to, or other open structure, natural or mechanical ventilation shall be provided. The requirements for such natural ventilation shall be in accordance with the following:

(1) The free-aperture cross section for the ventilation of a machinery room shall be not less than as determined in accordance with Equation 1106.4.

\[ F = vG \]  
(Equation 1106.4)

Where:

\( F \) = The free opening area, square feet.
\( G \) = The mass of refrigerant in the largest system, any part of which is located in the machinery room, pounds.

For SI units: 1 cubic foot per minute = 0.00047 m\(^3\)/s, 1 pound = 0.453 kg

(2) The location of the gravity ventilation openings shall be based on the relative density of the refrigerant to air. [ASHRAE 15:8.11.5(a), (b) 8.14]

1106.13 Machinery Room, A2L and B2L Other than R-717 (Ammonia). When required by Section 1106.1, machinery rooms shall comply with Sections 1106.13.1 through Section 1106.13.6. [ASHRAE 15:8.13]

1106.13.1 Flame-Producing Device. There shall be no flame-producing device or hot surface over 1290°F (700°C) in the room, other than that used for maintenance or repair, unless installed in accordance with Section 1106.5. [ASHRAE 15:8.13.1]

1106.13.2 Communicating Spaces. Doors communicating with the building shall be approved, self-closing, tight-fitting fire doors. [ASHRAE 15:8.13.2]

1106.13.3 Noncombustible Construction. Walls, floor, and ceiling shall be tight and of noncombustible construction. [ASHRAE 15:8.13.3]

1106.13.4 Exterior Openings. Exterior openings, if present, shall not be under any fire escape or any open stairway. [ASHRAE 15:8.13.4]

1106.13.5 Pipe Penetrations. All pipes piercing the interior walls, ceiling, or floor of such rooms shall be tightly sealed to the walls, ceiling, or floor through which they pass. [ASHRAE 15:8.13.5]

1106.13.6 Machinery Room Designation. When any refrigerant of Groups A2, A3, B2, or B3 are used, the machinery room shall be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with the NFPA 70. When the only flammable refrigerants used are from Group A2L or B2L other than R-717 (ammonia), the machinery room shall comply with both Section 1106.13.6.1 for ventilation and Section 1106.13.6.2 for refrigerant detection, or shall be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with the NFPA 70. [ASHRAE 15:8.13.6]

1106.13.6.1 Mechanical Ventilation. The machinery room shall have a mechanical ventilation system in accordance with Section 1106.13.11. The mechanical ventilation system shall:

(1) run continuously, and failure of the mechanical ventilation system actuates an alarm, or
(2) be activated by one or more refrigerant detectors, conforming to requirements of Section 1106.13.8. [ASHRAE 15:8.13.6.1]

1106.13.6.2 Detection System. Detection of refrigerant concentration that exceeds 25 percent of the LFL or the upper detection limit of the refrigerant detector, whichever is lower, shall automatically de-energize the following equipment in the machinery room:

(1) Refrigerant compressors
(2) Refrigerant pumps
(3) Normally closed automatic refrigerant valves
(4) Other unclassified electrical sources of ignition with apparent power rating greater than 1 kVA, where the apparent power is the product of the circuit voltage and current rating. [ASHRAE 15:8.13.6.2]

1106.13.7 Mechanical Equipment Control. Remote control of the mechanical equipment in the refrigerating machinery room shall be provided immediately outside the machinery room door solely for the purpose of shutting down the equipment in an emergency. Ventilation fans shall be on a separate electrical circuit and have a control switch located immediately outside the machinery room door. [ASHRAE 15:8.13.7]

1106.13.8 Refrigerant Detectors. Each refrigerating machinery room in accordance with Section 1106.13 shall contain one or more refrigerant detectors in accordance with Section 1106.13.9, with sensing element located in areas where refrigerant from a leak will concentrate, with one or more set points that activate responses in accordance with Section
1106.13.10 and Section 1106.13.11 after exposure to refrigerant concentration exceeding a limit value specified in Section 1106.13.10 and Section 1106.13.11. 

(3) The refrigerant detector shall have a set point not greater than the applicable Occupational Exposure Limit (OEL) value as published in Table 1102.3. The applicable OEL value shall be the lowest OEL value for any refrigerant designation in the machinery room. For refrigerants that do not have a published OEL value in Table 1102.3, use a value determined in accordance with the OEL as defined by Standard Table 1102.3 where approved by the Authority Having Jurisdiction.

(4) The refrigerant detector shall have a set point not more than the applicable Refrigerant Concentration Limit (RCL) value as published in Table 1102.3. The applicable RCL value shall be the lowest RCL value for any refrigerant designation in the machinery room. For refrigerants that do not have a published RCL value in Table 1102.3, use a value determined in accordance with the RCL as defined by Table 1102.3 where approved by the Authority Having Jurisdiction.

(5) The refrigerant detector shall provide a means for automatic self-testing and shall be in accordance with Section 1106.13.10.4. The refrigerant detector shall be tested during installation and annually thereafter, or at an interval not exceeding the manufacturer's installation instructions, whichever is less. Testing shall verify compliance with the alarm set points and response times per Sections 1106.13.10 and Section 1106.13.11. [ASHRAE 15:8.13.9]

1106.13.10 Alarms. Alarms required by Section 1106.13.8 shall comply with Section 1106.13.10.1 through Section 1106.13.10.4.

1106.13.10.1 Visual and Audio. The alarm shall have visual and audible annunciation inside the refrigerating machinery room and outside each entrance to the refrigerating machinery room. [ASHRAE 15:8.13.10.1]

1106.13.10.2 Detector Activation. The refrigerant detector set points shall activate an alarm in accordance with the type of reset in Table 1106.13.10.2. Manual reset type alarms shall have the reset located inside the refrigerating machinery room. [ASHRAE 15:8.13.10.2]

1106.13.10.3 Alarm Levels. Alarms set at levels other than Table 1106.13.10.2 (such as IDLH) and automatic reset alarms are permitted in addition to those required by Section 1106.13.10. The meaning of each alarm shall be clearly marked by signage near the annunciators. [ASHRAE 15:8.13.10.3]

1106.13.10.4 Emergency. In the event of a failure during a refrigerant detector self-test in accordance with Section 1106.13.9(5), a trouble alarm signal shall be transmitted to an approved monitored location. [ASHRAE 15:8.13.10.4]

1106.13.11 Mechanical Ventilation. Machinery rooms, in accordance with Section 1106.13.13, shall be vented to the outdoors, using mechanical ventilation in accordance with Section 1106.13.11.1, Section 1106.13.11.2, and Section 1106.13.11.3. [ASHRAE 15:8.13.11.3]

1106.13.11.1 Mechanical Ventilation Requirements. Mechanical ventilation referred to in Section 1106.13.11 shall be in accordance with all of the following:

(1) Include one or more power-driven fans capable of exhausting air from the machinery room; multispeed fans shall be permitted.

(2) Electric motors driving fans shall not be placed inside ducts; fan rotating elements shall be nonferrous or non-sparking, or the casing shall consist of or be lined with such material.

(3) Include provision to supply make-up air to replace that being exhausted; ducts for supply to and exhaust from the machinery room shall serve no other area; the makeup air supply locations shall be positioned relative to the exhaust air locations to avoid short circuiting.

(4) Inlets to the exhaust ducts shall be located in an area where refrigerant from a leak will concentrate, in consideration of the location of the replacement supply air paths, refrigerating machines, and the density of the refrigerant relative to air.

(5) Inlets to exhaust ducts shall be within 1 foot (0.3 m) of the lowest point of the machinery room for refrigerants that are heavier than air and shall be within 1 foot (0.3 m) of the highest point for refrigerants that are lighter than air. [ASHRAE 15:8.13.11.1]

(6) The discharge of the exhaust air shall be to the outdoors in such a manner as not to cause a nuisance or danger.

1106.13.11.2 Level 1 Ventilation. The refrigerating machinery room mechanical ventilation in Section 1106.13.11.1 shall exhaust at an airflow rate not less than shown in Table 1106.13.11.2. [ASHRAE 15:8.13.11.2]

1106.13.11.3 Level 2 Ventilation. A part of the refrigerating machinery room mechanical ventilation referred to in Section 1106.13.11.1 shall exhaust an accumulation of refrigerant due to leaks or a rupture of a refrigerating system or portion thereof in the machinery room. The refrigerant detectors required in accordance with Section 1106.13.8 shall activate ventilation at a set point and response time in accordance with Table 1106.13.10.2, at an airflow rate not less than the value determined in accordance with Section 1106.13.11.4. When multiple refrigerant designations are in the machinery room, evaluate the required airflow according to each refrigerating system, and the highest airflow quantity shall apply. Ventilation reset shall be in accordance with the type of reset in Table 1106.13.10.2. Manual-type ventilation reset shall have the reset located inside the refrigerating machinery room. [ASHRAE 15:8.13.11.3]
### TABLE 1106.13.10.2
SAFETY GROUPS: A2L, B2L OTHER THAN R-717 (AMMONIA)
[ASHRAE 15: TABLE 8.13.10.2]

<table>
<thead>
<tr>
<th>LIMIT VALUE</th>
<th>RESPONSE TIME (seconds)</th>
<th>ALARM TYPE</th>
<th>ALARM RESET TYPE</th>
<th>VENTILATION RATE</th>
<th>VENTILATION RESET TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set point (\leq) OEL</td>
<td>(\leq 300)</td>
<td>Troubled Alarm</td>
<td>Automatic</td>
<td>Level 1</td>
<td>Automatic</td>
</tr>
<tr>
<td>Set point (\leq) RCL</td>
<td>(\leq 15)</td>
<td>Emergency Alarm</td>
<td>Manual</td>
<td>Level 2</td>
<td>Manual</td>
</tr>
</tbody>
</table>

### TABLE 1106.13.11.2
LEVEL 1 VENTILATION RATE FOR CLASS 2L REFRIGERANTS
[ASHRAE 15: TABLE 8.13.11.2]

<table>
<thead>
<tr>
<th>STATUS</th>
<th>AIRFLOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operated when occupied and operated when activated in accordance with Section 1106.13.10.2 and Table 1106.13.10.2</td>
<td>The greater of the following: (1) (0.5 \text{ ft}^3/\text{min per ft}^3 (2.54 \text{ L/s per m}^3)) of machinery room area, or (2) (20 \text{ ft}^3/\text{min (9.44 L/s)}) per person</td>
</tr>
<tr>
<td>Operable when occupied</td>
<td>With or without mechanical cooling of the machinery room, the greater of: (1) The airflow rate required to not exceed a temperature rise of (18^\circ\text{F (10^\circ\text{C})}) above inlet air temperature or (2) The airflow rate required to not exceed a maximum air temperature of (122^\circ\text{F (50^\circ\text{C})}) in the machinery room.</td>
</tr>
</tbody>
</table>

1107.1.7 Group A2L and B2L Refrigerants. Where refrigerant of Groups A2L or B2L are used, the requirements of Class 1, Division 2, of NFPA 70, shall not apply to the machinery room provided that the conditions in Section 1107.1.7.1 through Section 1107.1.7.3 are met.

1107.1.7.1 Mechanical Ventilation. The mechanical ventilation system in the machinery room is run continuously in accordance with Section 1106.2.6 1106.13.6.1 and failure of the mechanical ventilation system actuates an alarm, or the mechanical ventilation system in the machinery room is activated by one or more refrigerant detectors, in accordance with the requirements of Section 1106.2.2.1 and Section 1106.2.2.2 1106.13.11.

1107.1.7.2 Refrigeration Detectors. For the refrigerant detection required in Section 1106.2.2.1, detection of refrigerant concentration that exceeds 25 percent of the LFL or the upper detection limit of the refrigerant detector, whichever is lower, shall automatically de-energize the following equipment in the machinery room:
(a) refrigerant compressors  
(b) refrigerant pumps  
(c) normally-closed automatic refrigerant valves

1107.1.7.3 Machinery Rooms. The machinery room shall comply with Section 1106.13.

1112.11 Discharge from Pressure-Relief Devices. Pressure-relief systems designed for vapor shall comply with Section 1112.11.1 through Section 1112.11.4.1.

1112.11.1 Discharging Location Interior to Building. Pressure-relief devices, including fusible plugs, serving refrigeration systems shall be permitted to discharge to the interior of a building where in accordance with the following:
(1) The system contains less than 110 pounds (49.9 kg) of a Group A1 or A2L refrigerant.  
(2) The system contains less than 6.6 pounds (2.99 kg) of a Group A2, B1, or B2 or B2L refrigerant.  
(3) The system does not contain any quantity of a Group A3 or B3 refrigerant.  
(4) The system is not required to be installed in a machinery room in accordance with Section 1106.0.  
(5) The refrigerant concentration limits in Section 1104.0 are not exceeded. Refrigeration systems that do not comply
with the above requirements shall comply with the requirements of Section 1112.11.2 through Section 1112.11.4. [ASHRAE 15:9.7.8.1]

**FIGURE 1106.13.11.4**
**LEVEL 2 VENTILATION RATE FOR CLASS 2L REFRIGERANTS**
[ASHRAE 15: FIGURE 8.13.11.4-1]

**SUBSTANTIATION:**

[This item was placed on “HOLD” by the Technical Committee in the 2019 Report on Comments in accordance with Section 4-4.6.2.2 as it was proposing new information that did not have public review. See 2019 Report on Comments Item # 091 (Public Comment 1)]

In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 11 has been revised to correlate with Addendum h of ASHRAE 15-2016 (published October 9, 2018). This public comment adds the requirements from Addendum h to the code so that the Uniform Mechanical Code remains consistent with ASHRAE 15. This public comment and Addendum h address the safe use of Group A2L refrigerants which fall into the category of lower global warming potential refrigerants.

These requirements are needed for advancing the use of environmentally friendly refrigerants. Many states,
including the State of California, are requiring a switch to lower global warming potential refrigerants. Without these requirements, states will not have the proper tools for the code enforcement community to regulate lower global warming potential refrigerants that fall within Group A2L.

Within the safety requirements of this public comment are limitations on the charge size of refrigerating systems based on their location, as well as, detector requirements. It should be noted that the requirements rely on the equipment being listed. The standard regulating refrigerant equipment is UL/CSA 60335-2-40 which is currently referenced in the UMC.

**COMMITTEE ACTION:** REJECT

**COMMITTEE STATEMENT:**
The proposal is being rejected as the changes pertaining to A2L refrigerants in this proposal are already being addressed in Item # 208.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
### Proposals

**Item #: 215**

UMC 2024  Section: 228.0, Table 1102.3

**SUBMITTER:** IAPMO Staff - Update Extracts  
ASHRAE 34 Extract Update

**RECOMMENDATION:**
Revise text

#### TABLE 1102.3
REFRIGERANT GROUPS, PROPERTIES, AND ALLOWABLE QUANTITIES
[ASHRAE 34: TABLE 4-1, TABLE 4-2]

<table>
<thead>
<tr>
<th>REFRIGERANT</th>
<th>CHEMICAL FORMULA</th>
<th>CHEMICAL NAME(^1) (COMPOSITION FOR BLENDS)</th>
<th>SAFETY GROUP(^7)</th>
<th>OEL(^2) (ppm)</th>
<th>RCL (POUNDS PER 1000 CUBIC FEET OF SPACE lb/Mcf)</th>
<th>LFL (lb/Mcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-11</td>
<td>CCl(_3)F</td>
<td>Trichlorofluoromethane</td>
<td>A1</td>
<td>€1000</td>
<td>0.39</td>
<td></td>
</tr>
<tr>
<td>R-12</td>
<td>CCl(_2)F(_2)</td>
<td>Dichlorodifluoromethane</td>
<td>A1</td>
<td>1000</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>R-12B1</td>
<td>CBrClF(_2)</td>
<td>Bromochlorodifluoromethane</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-13</td>
<td>CCl(_3)</td>
<td>Chlorotrifluoromethane</td>
<td>A1</td>
<td>1000</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-13B1</td>
<td>CBrF(_3)</td>
<td>Bromotrifluoromethane</td>
<td>A1</td>
<td>1000</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-13I1</td>
<td>CF(_3)I</td>
<td>Trifluoroiodomethane</td>
<td>A1</td>
<td>500</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>R-14</td>
<td>CF(_4)</td>
<td>Tetrafluoromethane (carbon tetrafluoride)</td>
<td>A1</td>
<td>1000</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>R-21</td>
<td>CHCl(_2)F</td>
<td>Dichlorofluoromethane</td>
<td>B1</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-22</td>
<td>CHClF(_2)</td>
<td>Chlorodifluoromethane</td>
<td>A1</td>
<td>1000</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>R-23</td>
<td>CHF(_3)</td>
<td>Trifluoromethane</td>
<td>A1</td>
<td>1000</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>R-30</td>
<td>CH(_2)Cl(_2)</td>
<td>Dichloromethane (methylene chloride)</td>
<td>B1</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-31</td>
<td>CH(_2)ClF</td>
<td>Chlorofluoromethane</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-32</td>
<td>CH(_2)F(_2)</td>
<td>Difluoromethane (methylene fluoride)</td>
<td>A2L</td>
<td>1000</td>
<td>4.8</td>
<td>19.1</td>
</tr>
<tr>
<td>R-40</td>
<td>CH(_3)Cl</td>
<td>Chloromethane (methyl chloride)</td>
<td>B2</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-41</td>
<td>CH(_3)F</td>
<td>Fluoromethane (methyl fluoride)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-50</td>
<td>CH(_4)</td>
<td>Methane</td>
<td>A3</td>
<td>1000</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-113</td>
<td>CCl(_2)FClF(_2)</td>
<td>1, 1, 2-trichloro-1, 2, 2(-) trifuoroethane</td>
<td>A1</td>
<td>1000</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>R-114</td>
<td>CClF(_2)ClF(_2)</td>
<td>1, 2-dichloro-1, 1, 2, 2(-) tetrafluoroethane</td>
<td>A1</td>
<td>1000</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>R-115</td>
<td>CClF(_2)CF(_3)</td>
<td>Chloropentafluoroethane</td>
<td>A1</td>
<td>1000</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>R-116</td>
<td>CF(_3)CF(_3)</td>
<td>Hexafluoroethane</td>
<td>A1</td>
<td>1000</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>R-123</td>
<td>CHCl(_2)CF(_3)</td>
<td>2, 2-dichloro-1, 1, 1(-) trifuoroethane</td>
<td>B1</td>
<td>50</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>R-124</td>
<td>CHCl(_2)CF(_2)</td>
<td>2-chloro-1, 1, 1, 2(-)</td>
<td>A1</td>
<td>1000</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>ISO Code</td>
<td>Chemical Formulation</td>
<td>Trade Name</td>
<td>Isobutane TCE</td>
<td>Refrigerant TCE</td>
<td>Flammability Rating</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>----------------------</td>
<td>------------</td>
<td>---------------</td>
<td>----------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>R-125</td>
<td>CHF₂CF₃</td>
<td>Pentafluoroethane</td>
<td>A1</td>
<td>1000</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>R-134a</td>
<td>CH₂FCF₂</td>
<td>R-125 CHF₂CF₃ 1, 1, 1, 2-tetrafluoroethane</td>
<td>A1</td>
<td>1000</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>R-141b</td>
<td>CH₃CCl₂F</td>
<td>1,1-dichloro-1-fluoroethane</td>
<td>—</td>
<td>500</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>R-142b</td>
<td>CH₃CCIF₂</td>
<td>1-chloro-1, 1-difluoroethane</td>
<td>A2</td>
<td>1000</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>R-143a</td>
<td>CH₃CF₃</td>
<td>1, 1, 1-trifluoroethane</td>
<td>A2L</td>
<td>1000</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>R-170</td>
<td>CH₃CH₂</td>
<td>Ethane</td>
<td>A3</td>
<td>1000</td>
<td>0.54</td>
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</tr>
<tr>
<td>R-E170</td>
<td>CH₃OCH₃</td>
<td>Methoxymethane (Dimethyl ether)</td>
<td>A3</td>
<td>1000</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>R-218</td>
<td>CF₃CF₂CF₃</td>
<td>Octafluoropropane</td>
<td>A1</td>
<td>1000</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>R-227ea</td>
<td>CF₃CHFCF₃</td>
<td>1, 1, 1, 2, 3, 3, 3-heptafluoropropene</td>
<td>A1</td>
<td>1000</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>R-236fa</td>
<td>CF₃CH₂CF₃</td>
<td>1, 1, 1, 3, 3, 3-hexafluoropropane</td>
<td>A1</td>
<td>1000</td>
<td>21</td>
<td></td>
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<tr>
<td>R-245fa</td>
<td>CF₃CH₂CF₃</td>
<td>1, 1, 1, 3, 3-pentafluoropropane</td>
<td>B1</td>
<td>300</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>R-290</td>
<td>CH₃CH₂CH₃</td>
<td>Propane</td>
<td>A3</td>
<td>1000</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>R-C318</td>
<td>-(CF₂)₄-</td>
<td>Octafluorocyclobutane</td>
<td>A1</td>
<td>1000</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>R-400</td>
<td>zeotrope R-12/114 (60.0/40.0)</td>
<td>A1</td>
<td>1000</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-401A</td>
<td>zeotrope R-22/152a/124 (53.0/13.0/34.0)</td>
<td>A1</td>
<td>1000</td>
<td>6.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-401B</td>
<td>zeotrope R-22/152a/124 (61.0/11.0/28.0)</td>
<td>A1</td>
<td>1000</td>
<td>7.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-401C</td>
<td>zeotrope R-22/152a/124 (33.0/15.0/52.0)</td>
<td>A1</td>
<td>1000</td>
<td>5.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-402A</td>
<td>zeotrope R-125/290/22 (60.0/2.0/38.0)</td>
<td>A1</td>
<td>1000</td>
<td>17</td>
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<td></td>
</tr>
<tr>
<td>R-402B</td>
<td>zeotrope R-125/290/22 (38.0/2.0/60.0)</td>
<td>A1</td>
<td>1000</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-403A</td>
<td>zeotrope R-290/22/218 (5.0/75.0/20.0)</td>
<td>A2</td>
<td>1000</td>
<td>7.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-403B</td>
<td>zeotrope R-290/22/218 (5.0/56.0/39.0)</td>
<td>A1</td>
<td>1000</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-404A</td>
<td>zeotrope R-125/143a/134a (44.0/52.0/4.0)</td>
<td>A1</td>
<td>1000</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-405A</td>
<td>zeotrope R-22/152a/142b/C318 (4.0/7.0/5.5/42.5)</td>
<td>—</td>
<td>1000</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-406A</td>
<td>zeotrope R-22/600a/142b (55.0/4.0/41.0)</td>
<td>A2</td>
<td>1000</td>
<td>4.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407A</td>
<td>zeotrope R-32/125/134a (20.0/40.0/40.0)</td>
<td>A1</td>
<td>1000</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407B</td>
<td>zeotrope R-32/125/134a (10.0/70.0/20.0)</td>
<td>A1</td>
<td>1000</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407C</td>
<td>zeotrope R-32/125/134a (23.0/25.0/52.0)</td>
<td>A1</td>
<td>1000</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407D</td>
<td>zeotrope R-32/125/134a (15.0/15.0/70.0)</td>
<td>A1</td>
<td>1000</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407E</td>
<td>zeotrope R-32/125/134a (25.0/15.0/60.0)</td>
<td>A1</td>
<td>1000</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407F</td>
<td>zeotrope R-32/125/134a (30.0/30.0/40.0)</td>
<td>A1</td>
<td>1000</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407G</td>
<td>zeotrope R-32/125/134a (2.5/2.5/95.0)</td>
<td>A1</td>
<td>1000</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407H</td>
<td>zeotrope R-32/125/134a (32.5/15.0/52.5)</td>
<td>A1</td>
<td>1000</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407I</td>
<td>zeotrope R-32/125/134a (19.5/8.5/72.0)</td>
<td>A1</td>
<td>1000</td>
<td>16.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-408A</td>
<td>zeotrope R-125/143a/22 (7.0/46.0/47.0)</td>
<td>A1</td>
<td>1000</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-409A</td>
<td>zeotrope R-22/124/142b (60.0/25.0/15.0)</td>
<td>A1</td>
<td>1000</td>
<td>7.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-409B</td>
<td>zeotrope R-22/124/142b (65.0/25.0/10.0)</td>
<td>A1</td>
<td>1000</td>
<td>7.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-410A</td>
<td>zeotrope R-32/125 (50.0/55.0)</td>
<td>A1</td>
<td>1000</td>
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<td>R-12/152a (73.8/26.2)</td>
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<td>R-31/114 (55.1/44.9)</td>
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<td>R-1234ze(E)/227ea (91.1/8.9)</td>
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<td>Butane</td>
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<td>R-620</td>
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<td>Methanamine (methyl amine)</td>
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<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-720</td>
<td>Ne</td>
<td>Neon</td>
<td>A1</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-728</td>
<td>N2</td>
<td>Nitrogen</td>
<td>A1</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-732</td>
<td>O2</td>
<td>Oxygen</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-740</td>
<td>Ar</td>
<td>Argon</td>
<td>A1</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-744</td>
<td>CO2</td>
<td>Carbon dioxide</td>
<td>A1</td>
<td>5000</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>R-744A</td>
<td>N2O</td>
<td>Nitrous oxide</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-764</td>
<td>SO2</td>
<td>Sulfur dioxide</td>
<td>B1</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-1130(E)</td>
<td>CHCl=CHCl</td>
<td>Trans-1,2-dichloroethene</td>
<td>B4</td>
<td>200</td>
<td>0.25</td>
<td></td>
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<tr>
<td>R-1132a</td>
<td>CF2 = CH2</td>
<td>1, 1-difluoroethylene</td>
<td>A2</td>
<td>500</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>R-1150</td>
<td>CH2=CH2</td>
<td>Ethene (ethylene)</td>
<td>A3</td>
<td>200</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-1224yd(Z)</td>
<td>CF3CF=CHCl</td>
<td>(Z)-1-chloro-2,3,3,3-tetrafluoropropane</td>
<td>A1</td>
<td>1000</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>R-1233zd(E)</td>
<td>CF3CH=CHCl</td>
<td>Trans-1-chloro-3,3,3-trifluoro-1-propene</td>
<td>A1</td>
<td>800</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
<td>R-1234yf</td>
<td>CF3CF=CH2</td>
<td>2, 3, 3, 3-tetrafluoro-1-propene</td>
<td>A2L</td>
<td>500</td>
<td>4.7</td>
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<tr>
<td>R-1270</td>
<td>CH3CH=CH2</td>
<td>Propene (propylene)</td>
<td>A3</td>
<td>500</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>R-1336mzz(E)</td>
<td>CF3CH=CHCF3</td>
<td>Trans-1,1,1,4,4,4-hexafluoro-2-butene</td>
<td>A1</td>
<td>400</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>R-1336mzz(Z)</td>
<td>CF3CHCHCF3</td>
<td>Cis-1,1,1,4,4,4-hexafluoro-2-butene</td>
<td>A1</td>
<td>500</td>
<td>5.4</td>
<td></td>
</tr>
</tbody>
</table>

406
For SI units: 1 pound = 0.453 kg, 1 cubic foot = 0.0283 m³

Notes:
1 The preferred chemical name is followed by the popular name in parenthesis.
2 The OELs are 8-hour TWAs; a “C” designation denotes a ceiling limit.
3 Azeotropic refrigerants exhibit some segregation of components at conditions of temperature and pressure other than those at which they were formulated. The extent of segregation depends on the particular azeotrope and hardware system configuration.
4 The exact composition of this azeotrope is in question and additional experimental studies are needed.
5 R-507, R-508, and R-509 are allowed alternative designations for R-507A, R-508A, and R-509A due to a change in designations after assignment of R-500 through R-509. Corresponding changes were not made for R-500 through R-506.
6 The RCL values for these refrigerant blends are approximated in the absence of adequate data for a component comprising less than 4 percent m/m of the blend and expected to have a small influence in an acute, accidental release.
7 Refrigerant flammability classification of Class 2L shall comply with the requirements for flammability classification of Class 2.
8 In accordance with Section 1102.2, ammonia refrigeration systems are not regulated by this chapter. R-717 (ammonia) is included in this table because the table is extracted from ASHRAE 34 and is not capable of being modified.

228.0 – Z –
Zeotropic. Blends comprising multiple components of different volatilities that, when used in refrigeration cycles, change volumetric composition and saturation temperatures as they evaporate (boil) or condense at constant pressure. [ASHRAE 34.3]

SUBSTANTIATION:
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Table 1102.3 is being revised to the latest edition of ASHRAE 34-2019 which includes addendums to ASHRAE 15-2019 (a through y), as applicable.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29, NOT RETURNED: 1, Heine
Proposals

Item #: 216
UMC 2024  Section: 1102.1, Table 1701.1

SUBMITTER: Emily Toto
ASHRAE

RECOMMENDATION:
Revise text

1102.0 Refrigeration Systems.
1102.1 General. Refrigeration systems using a refrigerant other than ammonia shall comply with this chapter and either ASHRAE 15 or ASHRAE 15.2, as applicable.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 15.2-2021</td>
<td>Refrigeration Systems in Residential</td>
<td>Residential Refrigeration Systems</td>
<td>1102.1</td>
</tr>
<tr>
<td>(Working Draft)</td>
<td>Applications</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: ASHRAE 15.2 is a working draft and is not completed at the time of this monograph.

SUBSTANTIATION:
ASHRAE 15.2 has been developed as the installation standard for individual dwelling units. The user of the code is directed to whichever standard is applicable.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
ASHRAE 15.2 is a working draft and is not completed at the time of this monograph and is therefore being rejected.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 217

UMC 2024  Section: 1102.1, 1102.2, Table 1701.1

SUBMITTER: Jeffrey Shapiro
International Code Consultants
Rep. IIAR

RECOMMENDATION:
Revise text

1102.0 Refrigeration Systems.
1102.1 General. Refrigeration systems using a refrigerant other than ammonia shall comply with this chapter and ASHRAE 15. Refrigeration systems containing carbon dioxide as the refrigerant shall also comply with BSR/IIAR CO2.

1102.2 Ammonia Refrigeration Systems. Refrigeration systems using ammonia as the refrigerant shall comply with IIAR 2, IIAR 3, IIAR 4, and IIAR 5, and IIAR 6 and shall not be required to comply with this chapter.

TABLE 1701.1 REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSR/IIAR CO2-2021 (Working Draft)</td>
<td>Safety Standard for Closed-Circuit Carbon Dioxide Refrigeration Systems</td>
<td>Carbon Dioxide Refrigeration Systems</td>
<td>1102.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: IIAR 6 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

Note: BSR/IIAR CO2 is a working draft and is not completed at the time of this monograph.

SUBSTANTIATION:
IIAR 6 is a new standard for maintenance and inspection of closed-circuit ammonia refrigeration systems that is part of the suite of IIAR standards regulating ammonia refrigeration systems. Because this standard addresses system maintenance, which is part of the UMC scope in Section 101.2 (Scope), it is important to have the standard referenced by the UMC to provide for proper compliance and enforcement of ammonia system regulations. Mandatory system maintenance regulations covering ammonia refrigeration systems in the UMC is important to safe operation of these systems in UMC jurisdictions.

BSR/IIAR CO2 is in the process of completion for issuance in 2021. It is a new standard governing refrigeration systems that use carbon dioxide as the refrigerant, and it is designed to be a companion to ASHRAE 15, providing additional design requirements that are unique to carbon dioxide systems to supplement ASHRAE 15 and going beyond the scope of ASHRAE 15 by regulating the complete life-cycle of carbon dioxide systems. Carbon dioxide has become increasingly popular as an industrial refrigerant because it is considered efficient and climate friendly. Including IIAR's new standard will assure that these systems are properly regulated.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

1102.0 Refrigeration Systems.
1102.1 General. Refrigeration systems using a refrigerant other than ammonia shall comply with this chapter and ASHRAE 15. Refrigeration systems containing carbon dioxide as the refrigerant shall also comply with BSR/IIAR CO2.
1102.2 Ammonia Refrigeration Systems. Refrigeration systems using ammonia as the refrigerant shall comply with IIAR 2, IIAR 3, IIAR 4, IIAR 5, and IIAR 6 and shall not be required to comply with this chapter.

<table>
<thead>
<tr>
<th>TABLE 1701.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>REFERENCED STANDARDS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSR/IIAR CO2-2021 (Working Draft)</td>
<td>Safety Standard for Closed-Circuit Carbon Dioxide Refrigeration Systems</td>
<td>Carbon Dioxide Refrigeration Systems</td>
<td>1102.4</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

COMMITTEE STATEMENT:
The modification removes BSR/IIAR CO2 as it was a working draft at the time of this Monograph.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine

EXPLANATION OF AFFIRMATIVE:

BALLANCO: While I am voting affirmative, the proponent indicated that the standard was complete. Hence, this should be accepted as submitted.
Item #: 218

UMC 2024  Section: 1108.1

SUBMITTER: Mitch Pinsker
Affiliated Engineers Inc
Rep. ASHRAE Golden Gate Chapter Chair of Government Affairs Committee and Code Review Committee

RECOMMENDATION:
Revise text

1108.0 Refrigeration Machinery Room Equipment and Controls.
1108.1 General. Equipment, piping, ducts, vents, or similar devices that are not essential for the refrigeration process, maintenance of the equipment, or for the illumination, ventilation, or fire protection of the room require access or maintenance by personnel not authorized to access the refrigeration machinery room in accordance with Section 1106.11 shall not be placed in or pass through a refrigeration machinery room.

(above shown for reference only)

1106.11 Restricted Access. Access to the refrigeration machinery room shall be restricted to authorized personnel. Doors shall be clearly marked or permanent signs shall be posted at each entrance to indicate this restriction. [ASHRAE 15:8.11.8]

SUBSTANTIATION:
The current wording of Section 1108.1 has been very inconsistently enforced and can be onerous. For instance, AHJs have at times disallowed the following from being inside refrigeration machinery (e.g. chiller) rooms:
1. Roof drain piping from a drain in the roof above the chiller room
2. Hot water piping passing through a corner of the chiller room from an adjacent boiler room
3. Electrical panels that include circuits serving equipment outside the chiller room in addition to equipment inside the room

Locating these elements in the chiller room poses no safety risk provided anyone accessing these elements, e.g. for maintenance, are authorized to access the room. Section 1106.11 says:

1106.11 Restricted Access. Access to the refrigeration machinery room shall be restricted to authorized personnel. Doors shall be clearly marked or permanent signs shall be posted at each entrance to indicate this restriction. [ASHRAE 15:8.11.8]

This proposal then disallows equipment and materials to be located inside the refrigeration room if the personnel required to maintain them are not authorized to access the room. For instance, this would disallow the following from being located in the chiller room:
1. Window washing equipment
2. Irrigation control panels and equipment
3. Cellular phone panels

Note that the blanket limitations in Section 1108.1 are unique to the UMC; neither ASHRAE Standard 15 (from which most of this chapter was extracted) nor the International Mechanical Code include a similar requirement. So even with the proposed revisions, the UMC would be more stringent than these other standards and codes.

COMMITTEE ACTION: REJECT
COMMITTEE STATEMENT:
The proposed change is not enforceable, poorly written, and the section already clearly states the intent of section. The proposal may also change the intent of the section.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 219
UMC 2024  Section: 1108.1

SUBMITTER: Vanessa O'Connor
Western Allied Mechanical Inc

RECOMMENDATION:
Revise text

1108.0 Refrigeration Machinery Room Equipment and Controls.
1108.1 General. Equipment, piping, ducts, vents, or similar devices that are not essential for the refrigeration process, maintenance of the equipment, or for the illumination, ventilation, or fire protection of the room shall not be placed in or pass through a refrigeration machinery room.

Exception: Piping that does not affect the operation of equipment in the refrigeration machinery room.

SUBSTANTIATION:
The additional text is to provide an exception for piping that does not interfere with the refrigeration machinery room equipment. Examples would include pipe for HHW, CHW, or drainage, which would not affect the equipment and do not necessarily need to be rerouted.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed change is not enforceable, poorly written, open-ended, and the section already clearly states the intent of section. The proposal may also change the intent of the section.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 220

UMC 2024  Section: 1108.1

SUBMITTER: Phillip H Ribbs  
PHR Consultants

RECOMMENDATION:
Revise text

1108.0 Refrigeration Machinery Room Equipment and Controls.
1108.1 General. Equipment, piping, ducts, vents, or similar devices that are not essential for the refrigeration process, maintenance of the equipment, or for the illumination, ventilation, or fire protection of the room shall not be placed in or pass through a refrigeration machinery room.

   Equipment essential to the refrigeration process permitted to be placed in or pass through a refrigeration machinery room shall include:

(1) Refrigeration compressors.
(2) Condensing units.
(3) Pumps, associated piping and automatic control valves for refrigerant, condenser water, and brine or chilled water.
(4) Refrigeration control devices and panels.
(5) Machinery room ventilation equipment.
(6) Refrigerant receivers and accumulators.
(7) Refrigerant vapor-detection and alarm systems.
(8) Machinery room fire sprinkler system.
(9) Machinery room lighting and service receptacles.
(10) Motor control centers and electrical panels for machinery room systems.

SUBSTANTIATION:
There is confusion in the field as to which equipment is “essential” for the refrigeration process and allowed in a refrigeration machinery room. The list of equipment being added to Section 1108.1 provides clarity as to which equipment is allowed in the refrigeration machinery room. The list was taken from past editions of the UMC.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed list may not be all-inclusive. The change does not provide clarity and the current language sufficiently addresses the intent of the section.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 221
UMC 2024 Section: 1109.1

SUBMITTER: William E Chapin
Professional Code Consulting, LLC

RECOMMENDATION:
Revise text

1109.0 Refrigeration Piping, Containers, and Valves.
1109.1 Materials. Materials used in the construction and installation of refrigerating systems shall be suitable for conveying the refrigerant used. Materials shall not be used that will deteriorate because of the refrigerant, lubricant, or their combination in presence of air or moisture to a degree that poses a safety hazard. [ASHRAE 15:9.1.1] Refrigerant piping shall be metallic.

SUBSTANTIATION:
The first two sentences of this section clearly states that materials must be safe and reliable for refrigerant systems. The last sentence of this section is overly restrictive by prohibiting current and future piping materials that are tested and listed for conveying refrigerant safely. Additional code change proposals are being introduced this cycle to allow materials have been used for refrigerant systems around the world for decades.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The substantiation refers to "future" piping materials. When such materials are available they will be reviewed by the TC before inclusion in the code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
1109.0 Refrigeration Piping, Containers, and Valves.
1109.1 Materials. Materials used in the construction and installation of refrigerating systems shall be suitable for conveying the refrigerant used. Materials shall not be used that will deteriorate because of the refrigerant, lubricant, or their combination in presence of air or moisture to a degree that poses a safety hazard. [ASHRAE 15:9.1.1] Refrigerant piping shall be metallic. Materials for refrigerant piping, tubing, and fittings shall be acceptable to the Authority Having Jurisdiction and shall comply with the applicable standards in Table 1109.1 or other approved standards.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>ASTM B210, ASTM B491</td>
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</tbody>
</table>

**TABLE 1109.1**
MATERIALS FOR REFRIGERANT PIPING, TUBING, AND FITTINGS

**TABLE 1701.1**
REFERENCED STANDARDS
A333/A333M-2018 Temperature Service and Other Applications with Required Notch Toughness

ASTM A334/A334M-2004a (R2016) Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service Piping Table 1109.1

ASTM A707/A707M-2019 Forged Carbon and Alloy Steel Flanges for Low-Temperature Service Fittings Table 1109.1

ASTM B68/B68M-2019 Seamless Copper Tube, Bright Annealed Piping Table 1109.1

ASTM B361-2016 Factory-made Wrought Aluminum and Aluminum-alloy Welding Fittings Fittings Table 1109.1

ASTM B491/ASTM B491M-2015 Aluminum and Aluminum-Alloy Extruded Round Tubes for General-Purpose Applications Piping Table 1109.1

ASTM B819-2019 Seamless Copper Tube for Medical Gas Systems Piping Table 1109.1

(portions of table not shown remain unchanged)

Note: The ASME and ASTM standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The first step in refrigerant piping design and installation is to gather product and jobsite information. Installing a new HVAC system requires skill and knowledge of appropriate procedures in electrical wiring, controls wiring, and pipework, including the refrigeration piping and fittings. Proper refrigeration piping installation practices requires the use of proper and rated materials for the installation. The new table provides an easy to reference list of acceptable standards for each application to assist the AHJ in approving refrigerant piping.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

1109.0 Refrigeration Piping, Containers, and Valves.

1109.1 Materials. Materials used in the construction and installation of refrigerating systems shall be suitable for conveying the refrigerant used. Materials shall not be used that will deteriorate because of the refrigerant, lubricant, or their combination in presence of air or moisture to a degree that poses a safety hazard. [ASHRAE 15:9.1.1] Refrigerant piping shall be metallic. Materials for refrigerant piping, tubing, and fittings shall be acceptable to the Authority Having Jurisdiction and shall comply with the applicable standards in Table 1109.1 or other approved standards.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PIPING/TUBING</strong></td>
<td><strong>FITTINGS</strong></td>
</tr>
<tr>
<td>Aluminum</td>
<td>ASTM B210, ASTM B491</td>
</tr>
<tr>
<td>Steel</td>
<td>ASTM A105, ASTM A181, ASTM A193, ASTM A234, ASTM A420, ASTM A707</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B16.50-2018</td>
<td>Wrought Copper and Copper Alloy Braze-joint Pressure Fittings</td>
<td>Piping</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>ASTM A105/A105M-2021</td>
<td>Carbon Steel Forgings for Piping Applications</td>
<td>Piping</td>
<td>Table 1109.1</td>
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<tr>
<td>ASTM</td>
<td>Carbon Steel Forgings, for General-Purpose Piping</td>
<td>Piping</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>Specification</td>
<td>Description</td>
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<tr>
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<tr>
<td>ASTM A181/A181M-2014 (R2020)</td>
<td>Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications</td>
<td>Fittings</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>ASTM A193/A193M-2020</td>
<td>Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service</td>
<td>Fittings</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>ASTM A234/A234M-2019</td>
<td>Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness</td>
<td>Piping</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>ASTM A334/A334M-2004a (R2016)</td>
<td>Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service</td>
<td>Piping</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>ASTM A707/A707M-2019</td>
<td>Forged Carbon and Alloy Steel Flanges for Low-Temperature Service</td>
<td>Fittings</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>ASTM B68/B68M-2019</td>
<td>Seamless Copper Tube, Bright Annealed</td>
<td>Piping</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>ASTM B361-2016</td>
<td>Factory-made Wrought Aluminum and Aluminum-alloy Welding Fittings</td>
<td>Fittings</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>ASTM B491/ASTM B491M-2015</td>
<td>Aluminum and Aluminum-Alloy Extruded Round Tubes for General-Purpose Applications</td>
<td>Piping</td>
<td>Table 1109.1</td>
</tr>
<tr>
<td>ASTM B819-2019</td>
<td>Seamless Copper Tube for Medical Gas Systems</td>
<td>Piping</td>
<td>Table 1109.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: The ASME and ASTM standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

COMMITTEE STATEMENT:
The modification removes redundant language regarding approved standards for refrigerant piping materials since the AHJ is already authorized to allow or reject refrigerant piping material.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 223
UMC 2024  Section: 1109.1.3, Table 1701.1

SUBMITTER: William E Chapin
Professional Code Consulting, LLC

RECOMMENDATION:
Add new text

1109.0 Refrigeration Piping, Containers, and Valves.
1109.1 Materials.

**1109.1.3 Polyethylene of Raised Temperature/Aluminum/Polyethylene of Raised Temperature (PERT/AL/PERT) Linesets.** PE-RT/AL/PE-RT piping shall be approved for the intended use and shall comply with ASTM F3346.

(renumber remaining sections)

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM F3346-2019</td>
<td>Standard Specification for Polyethylene of Raised Temperature/Aluminum/Polyethylene of Raised Temperature (PERT/AL/PE-RT) Composite Pressure Pipe</td>
<td>Piping</td>
<td>1109.1.3</td>
</tr>
</tbody>
</table>

NOTE: ASTM F3346 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
ASTM F3346 was published in 2019. The standard includes all of the design and testing requirements of other existing composite piping standards and includes requirements for testing in accordance with UL 207 for each refrigerant intended to be used.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The title of the section is misleading because it applies to all piping and not only linesets. After the discussion on the previous item, it is preferred to promote use of metal piping.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:
WHITE: The scope of the standard indicates that it is for air conditioning and refrigeration (plus additional uses). The proponent indicates that the section is for linesets and as such it should be allowable for the standard to apply to that use by the code. I do not believe the code "prefers" one material over another or is in the business of promoting products, especially when there is substantiation to support the use of the material.
Proposals

Item #: 224

UMC 2024  Section: 218.0, 1109.1.5, Table 1701.1

SUBMITTER: Brad Campbell
Gastite

RECOMMENDATION:
Add new text

1109.0 Refrigeration Piping, Containers, and Valves.
1109.1 Materials.

1109.1.5 Polyethylene of Raised Temperature-Aluminum-Polyethylene of Raised Temperature (PE-RT/AL/PE-RT) Linesets. PE-RT/AL/PE-RT linesets shall comply with ASTM FXXXX.

218.0  – P –
PE-RT/AL/PE-RT. Polyethylene of raised temperature-aluminum-polyethylene of raised temperature.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM FXXXX-2021</td>
<td>Polyethylene of Raised Temperature - Aluminum - Polyethylene of Raised Temperature (PERT/AL/PERT) Composite Pressure Pipe based on Inner Diameter (ID) for use in Air Conditioning and Refrigeration Line Set Systems</td>
<td>PE-RT/AL/PE-RT</td>
<td>1109.1.5</td>
</tr>
</tbody>
</table>

(Note: ASTM FXXXX is a working draft and is not completed at the time of this monograph.

SUBSTANTIATION: 
PERT-AL-PERT pipe material is not listed in the UMC Section 1109.1 Refrigeration Piping Materials section. This type of composite pipe has primarily been used for water conveyance applications but if the pipe is designed and tested to the new ASTM FXXXX Standard for “Polyethylene of Raised Temperature - Aluminum - Polyethylene of Raised Temperature (PERT/AL/PERT) Composite Pressure Pipe based on Inner Diameter (ID) for use in Air Conditioning and Refrigeration Line Set Systems” will be a comparable line set option. Given previous requests to add PERT/AL/PERT pipe to Sections 1109.1.5 and 1109.2 (for refrigeration pipe material and joints), the definition of PERT/AL/PERT should be defined in Section 218.0. This new ASTM FXXXX standard will be finalized and published in the next 30 days.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
ASTM FXXXX was a working draft and was not completed at the time of this monograph.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
1109.0 Refrigeration Piping, Containers, and Valves.

1109.2 Joints. Iron or steel pipe joints shall be of approved threaded, flanged, or welded types. Exposed threads shall be tinned or coated with an approved corrosion inhibitor. Copper or copper alloy pipe joints of iron pipe size shall be of approved threaded, flanged, press-connect or brazed types. Copper tubing joints and connections shall be connected by approved flared, lapped, swaged, or brazed joints, soldered joints, or mechanical joints that comply with UL 207 either individually or as part of an assembly or a system by an approved nationally recognized laboratory. Piping and tubing shall be installed so as to prevent vibration and strains at joints and connections.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
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<tbody>
<tr>
<td>UL-207-2009</td>
<td>Refrigerant-Containing Components and Accessories, Nonelectrical (with revisions through June 27, 2014)</td>
<td>Refrigeration Components</td>
<td>1109.2</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

SUBSTANTIATION:
Section 1109.2 of the UMC originally listed only those joint types for refrigeration piping which have been time tested for soundness. Fittings for each joining process were required to be manufactured in accordance with recognized ASME and ASTM Standards, with the intent of the code being a leak-free piping system installed to safely contain the refrigerant within it.

The use of press-connect technology on copper or copper alloy pipe joints of iron pipe size, as well as the use of press-connect technology on copper tubing joints and connections, was introduced into the 2018 UMC through ROP #154 and finally approved into the UMC as being tested per the industry standard, UL 207. It is my intention to substantiate that UL 207 was misapplied for the allowance of press-connect technology into this section of the 2021 UMC.

The Scope: Section 1.1 of the UL 207-2009 Refrigerant-Containing Components and Accessories, Nonelectrical (with revisions through June 27, 2014) clearly states which nonelectrical refrigerant-containing components and accessories are covered by the requirements of the UL 207. The subsequent paragraph of the Scope; Section 1.2 (a), clearly states “These requirements do not apply to: Electrical valves and electric refrigeration controllers, hermetic refrigerant motor compressors, tubing fittings such as flare or compression type fittings, and the like, which are covered in or as part of separate, individual requirements.”

There is an existing ASME B16.51 Copper and Copper Alloy Press-Connect Pressure Fittings Standard listed in the 2021 UMC, but that standard does not include ASTM B280 copper and copper alloy piping or the use of press-connect technology as a joining process for refrigeration piping.
As press-connect technology for fittings would be covered by other recognized standards, such as the ASME B31.5 Refrigeration Piping and Heat Transfer Components, it is my opinion that the UL 207 was incorrectly substantiated by the Submitter of the original proposal.

Additionally, Section 1109.1 Materials, of the 2021 UMC clearly states "Refrigerant piping shall be metallic." As press-connect fittings rely upon a non-metallic elastomeric seal to contain refrigerant, press-connect technology for refrigerant piping applications would be considered as non-compliant with the requirements of the 2021 UMC.

As the UMC Technical Committee did not recognize the error in the Submitter’s substantiation, I am requesting the UMC Technical Committee to consider my substantiation for this proposal.

UL 207-2009, Refrigerant Containing Components and Accessories, Nonelectrical (with revisions through June 27, 2014), was incorrectly referenced for this section of the 2021 UMC. As there are no additional sections of the 2021 UMC that reference this standard, there is no reason to retain it in the code. Therefore, UL 207 should be deleted from Table 1701.1.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 17 NEGATIVE: 11 ABSTAIN: 1 NOT RETURNED: 1 Heine

Note: Item # 225 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.

EXPLANATION OF AFFIRMATIVE:

BENKOWSKI: A "low leakage rate" is technical justification enough to choose a method other than press-connect to join the piping that conveys a mildly flammable refrigerant.

BERGER: Extensive substantiation was submitted with this proposal and was approved by the TC to proceed. Perhaps a letter writing campaign is the way to go when you want to override the decision of the Technical Committee.


RIBBS: I agree with Don Taylor. I am voting yes to remove press-connect for refrigeration usage for any refrigerant not listed in the standard. A2L's were not listed (and not tested) and until I see testing data showing press-connect passes for A2L refrigerants, I cannot support its usage.

TAYLOR: I am voting yes to remove press-connect for refrigeration usage for any refrigerant not listed in the standard. A2L's were not listed (and not tested) and until I see testing data showing press-connect passes for A2L refrigerants, I cannot support its usage.

EXPLANATION OF NEGATIVE:

BALLANCO: The technical justification for removing press-connect, solder, and mechanical joints complying to UL 207 is not correct. UL 207 addresses fittings, contrary to what is stated in the substantiation. Press-connect fittings are proven joints used in refrigeration systems. The claim that they leak is incorrect. The ASHRAE study on refrigerant joints and connections identified press-connect fittings as one of the highest quality joints regardless of the level of expertise of the installer. Solder joints have long been used on industrial refrigeration systems. There is no justification for removing solder joints when the refrigeration system falls within the temperature and pressures of the refrigeration system. All of these joints proposed for deletion are accepted by ASHRAE 15.

CUDAHY: Overly restrictive. Joints proposed for deletion are accepted by ASHRAE 15.

FEEHAN: The proposal removes press-connect fittings without any technical justification.

GUNZNER: Press-connect fittings are specifically permitted by ASHRAE 15. AMCA supports consistency between related codes and standards where applicable. These modifications would cause confusion and other disruptions. AMCA supports the work of the UMC A2L Task Group.

KOERBER: No technical justification was provided for the removal of these joining methods.
MACNEVIN: This item should be rejected, as there was no evidence submitted to prohibit press-connect fittings. In fact, a previous report submitted to this TC showed that press-connect fittings are the most reliable joining technology overall.

TRAFTON, A: This proposal removes a joining method approved within the industry.

TRAFTON, P: The research sponsored by ASHRAE indicates that the press-fittings function well for this purpose and, as such, seem to meet the application. There may be some limitations that might be imposed to limit this to certain sizes pending further research. Further, it should be remembered that no matter the joining method, if it is not done correctly, leaks will occur.


WHITE: There is no technical justification for this proposal and should be rejected. Additional substantiation is not appropriate at this time but may be submitted during the public comment period.

WISEMAN: There is no technical justification for this change. It is not possible for a human to always make a proper weld. The truth is, there is not a perfect way to guarantee a 100% seal. Humans are fallible, and make mistakes. Even the best technicians make mistakes. Without technical justification, the code should not change.

EXPLANATION OF ABSTAIN:

TERZIGNI: I am still doing research on the various claims before casting my vote.
Proposals

Item #: 226
UMC 2024 Section: 1109.2, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

1109.0 Refrigeration Piping, Containers, and Valves.

1109.2 Joints. Iron or steel pipe joints shall be of approved threaded, flanged, or welded types. Exposed threads shall be tinned or coated with an approved corrosion inhibitor. Copper or copper alloy pipe joints of iron pipe size shall be of approved threaded, flanged, press-connect or brazed types. Copper tubing joints and connections shall be connected by approved flared, lapped, swaged, or brazed joints, soldered joints, or mechanical joints that comply with UL 109 and UL 207 either individually or as part of an assembly or a system by an approved nationally recognized laboratory. Piping and tubing shall be installed so as to prevent vibration and strains at joints and connections.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 109-1997</td>
<td>Tube Fittings for Flammable and Combustible Fluids, Refrigeration Service, and Marine Use (with revisions through May 20, 2020)</td>
<td>Fittings</td>
<td>1109.2</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 109 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
UL 109, “Tube Fittings for Flammable and Combustible Fluids, Refrigeration Service, and Marine Use,” is being added to Section 1109.2 (Joints) as the standard provides requirements that apply to copper tubing joints.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed change is overly restrictive regarding adding the UL 109 standard. The substantiation lacks technical justification as it only provides a statement that UL 109 addresses copper tubing joints. The addition of UL 109 does not improve or strengthen the code.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 25 NEGATIVE: 4 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:
BALLANCO, KOERBER: The reference to UL 109 is acceptable, however, UL 109 is now incorporated into UL 207.

WHITE: UL 109 is a valid referenced standard and acceptable for materials used in the code. This should have been accepted.

WISEMAN: The substantiation is adequate to accept this proposal.
1109.2 Joints. Iron or steel pipe joints shall be of approved threaded, flanged, or welded types. Exposed threads shall be tinned or coated with an approved corrosion inhibitor. Copper or copper alloy pipe joints of iron pipe size shall be of approved threaded, flanged, press-connect or brazed types. Copper and PE-RT/AL/PE-RT tubing joints and connections shall be connected by approved flared, lapped, swaged, or brazed joints, soldered joints, or mechanical joints that comply with UL 207 either individually or as part of an assembly or a system by an approved nationally recognized laboratory. Piping and tubing shall be installed so as to prevent vibration and strains at joints and connections.

SUBSTANTIATION:
This proposal adds the requirement for PE-RT/AL/PE-RT joints to be made by approved means tested and listed by an approved nationally recognized laboratory.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The substantiation states "This proposal adds the requirement for PE-RT/AL/PE-RT joints to be made by approved means tested and listed by an approved nationally recognized laboratory." It is not clear who the "approved nationally recognized laboratory" is. The language is vague and ambiguous and is therefore being rejected.
Proposals

Item #: 228
UMC 2024 Section: 1109.2

SUBMITTER: Brad Campbell
Gastite

RECOMMENDATION:
Revise text

1109.0 Refrigeration Piping, Containers, and Valves.

1109.2 Joints. Iron or steel pipe joints shall be of approved threaded, flanged, or welded types. Exposed threads shall be tinned or coated with an approved corrosion inhibitor. Copper or copper alloy pipe joints of iron pipe size shall be of approved threaded, flanged, press-connect or brazed types. Copper tubing joints and connections shall be connected by approved flared, lapped, swaged, or brazed joints, soldered joints, or mechanical joints that comply with UL 207 either individually or as part of an assembly or a system by an approved nationally recognized laboratory. PE-RT/AL/PE-RT pipe joints and connections shall be of approved mechanical or press-connect types. Piping and tubing shall be installed so as to prevent vibration and strains at joints and connections.

SUBSTANTIATION:
PERT-AL-PERT pipe joints are not listed in the UMC Section 1109.2 Joints section. This type of composite pipe has primarily been used for water conveyance applications but if the pipe is designed and tested to the new ASTM FXXXX Standard for “Polyethylene of Raised Temperature - Aluminum - Polyethylene of Raised Temperature (PERT/AL/PERT) Composite Pressure Pipe based on Inner Diameter (ID) for use in Air Conditioning and Refrigeration Line Set Systems” it will be a comparable Line set option. PERT/AL/PERT pipe can be mechanical or press-connected. This new ASTM FXXXX standard will be finalized and published in the next 30 days.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The substantiation speaks to ASTM FXXXX, a standard that was a working draft and not yet published at the time of this Monograph. Therefore, the proposal is being rejected.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 229
UMC 2024  Section: 1109.1.5, 1109.1.6, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Add new text

1109.0 Refrigeration Piping, Containers, and Valves.
1109.1 Materials.

1109.1.5 Refrigerant-Containing Components and Accessories. Nonelectrical refrigerant-containing components and accessories shall be listed and labeled in accordance with UL 207, and shall be installed in accordance with the manufacturer’s installation instructions.

1109.1.6 Refrigeration Fittings. Refrigeration fittings, including press-connect, flared and threaded shall be listed and labeled in accordance with UL 109 and UL 207, and shall be installed in accordance with the manufacturer’s installation instructions.

<table>
<thead>
<tr>
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<td>Tube Fittings for Flammable and Combustible Fluids, Refrigeration Service, and Marine Use (with revisions through May 20, 2020)</td>
<td>Fittings</td>
<td>1109.1.6</td>
</tr>
<tr>
<td>UL 207-2009</td>
<td>Refrigerant-Containing Components and Accessories, Nonelectrical (with revisions through June 27, 2014 January 21, 2020)</td>
<td>Refrigeration Components</td>
<td>1109.1.5, 1109.1.6, 1109.2</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: The UL standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Sections are being added to Chapter 11 (Refrigeration) to address the safety standards for refrigerant-containing components, accessories, and fittings to aid the code official in verifying safe installation for such systems.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as it is poorly worded and UL 207 has been updated to include provisions from UL 109. There is concern whether UL 207 covers these type of refrigerant fittings. The Technical Committee would also like the submitter to come back with a public comment to modify the wording from “listed and labeled” to “comply with” for consistency throughout the code and to prevent overly restrictive language.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 21  NEGATIVE: 8  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:
BALLANCO: This change should have been accepted since it adds clarity to the code and is properly substantiated.

FEEHAN: This language and standard are necessary in the code.

KOERBER: The proposal and standards referenced are sound and should be accepted.

MACNEVIN: This proposal should be accepted as it adds safety to the code, and the UL standards are appropriate for this application.

TRAFTON, A: The language and standard are necessary.

VAN RITE: This proposal should be accepted and the reference to UL 207 is appropriate.

WHITE: The proposal should be accepted based on the substantiation.

WISEMAN: This language is necessary.
1109.7 Pipe Enclosure Protection of Piping. Refrigerant piping and tubing shall be installed so that it is not subject to damage from an external source. Soft annealed copper tubing shall not exceed 1 3/8 inches (35 mm) nominal size. Mechanical joints, other than approved press connect joints, shall not be made on tubing exceeding ¾ of an inch (20 mm) nominal size. Soft annealed copper tubing conveying refrigerant shall be enclosed in iron or steel piping and fittings, or in conduit, molding, or raceway that will protect the tubing against mechanical injury from an exterior source. Exceptions:

(1) Tubing entirely within or tubing within 5 feet (1524 mm) of a refrigerant compressor where so located that it is not subject to external injury.

(2) Copper tubing serving a dwelling unit, where such tubing contains Group A1 refrigerant and is placed in locations not subject to damage from an external source.

SUBSTANTIATION:

Somewhere in the timeline of code development, language for the use of soft annealed copper was added to this section UMC in error. As this section of the 2021 UMC is for the protection requirements of all refrigeration piping, the size limitations of and methods of joining annealed temper copper tube do not belong in this section of the UMC.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

1109.0 Refrigeration Piping, Containers, and Valves.

1109.7 Protection of Piping. Refrigerant piping and tubing shall be installed so that it is not subject to damage from an external source. Soft annealed copper tubing conveying refrigerant shall be enclosed in iron or steel piping and fittings, or in conduit, molding, or raceway that will protect the tubing against mechanical injury from an exterior source. Exceptions:

(1) Tubing entirely within or tubing within 5 feet (1524 mm) of a refrigerant compressor where so located that it is not subject to external injury.

(2) Copper tubing serving a dwelling unit, where such tubing contains Group A1 refrigerant and is placed in locations not subject to damage from an external source.

1109.1 Materials. Materials used in the construction and installation of refrigerating systems shall be suitable for conveying the refrigerant used. Materials shall not be used that will deteriorate because of the refrigerant, lubricant, or their combination in presence of air or moisture to a degree that poses a safety hazard. [ASHRAE 15:9.1.1] Refrigerant piping shall be metallic. Soft annealed copper tubing shall not exceed 1 3/8 inches (35 mm) nominal size.

1109.2 Joints. Iron or steel pipe joints shall be of approved threaded, flanged, or welded types. Exposed threads shall be tinned or coated with an approved corrosion inhibitor. Copper or copper alloy pipe joints of iron pipe size shall be of approved threaded, flanged, press-connect or brazed types. Copper tubing joints and connections shall be connected by approved flared, lapped, swaged, or brazed joints, soldered joints, or mechanical joints that comply with UL 207 either individually or as part of an assembly or a system by an approved nationally recognized laboratory. Piping and tubing shall be installed so as to prevent vibration and strains at joints and connections. Mechanical joints shall not be made on
tubing exceeding ¾ of an inch (20 mm) nominal size.

**TABLE 1701.1**

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
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</thead>
<tbody>
<tr>
<td>UL-207-2009</td>
<td>Refrigerant-Containing Components and Accessories, Nonelectrical (with revisions through June 27, 2014)</td>
<td>Refrigeration Components</td>
<td>1109.2</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

**COMMITTEE STATEMENT:**
The proposal is being amended by relocating the material portions to the correct section, Section 1109.1, and relocating the language pertaining to joints to Section 1109.2. The other revisions are to correlate with the action taken on Item # 225.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**

<table>
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<th>NEGATIVE: 11</th>
<th>ABSTAIN: 1</th>
<th>NOT RETURNED: 1</th>
</tr>
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</table>

**Note:** Item # 230 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.

**EXPLANATION OF AFFIRMATIVE:**

**BENKOWSKI:** A "low leakage rate" is technical justification enough to choose a method other than press-connect to join the piping that conveys a mildly flammable refrigerant.

**BERGER:** Extensive substantiation was provided on why this section of the UMC needs correction. This section describes requirements for the protection of piping and should have never had mention of diameters of annealed copper tubing or press-connect fittings in it. Relevant information being removed is being relocated to the correct sections of the chapter. However, this proposal was included in the letters recently sent to TC members. Perhaps a letter writing campaign is the way to go when you want to override the decision of the Technical Committee.


**EXPLANATION OF NEGATIVE:**

**BALLANCO:** This change should have been rejected. The substantiation does not justify the removal of press-connect fittings. The modification is completely inconsistent with the original change. Furthermore, the modification is not technically substantiated.

**CUDAHY:** Press-connect fittings seem a useful product for these applications.

**FEEHAN:** The proposal removes press-connect fittings without any technical justification.

**GUNZNER:** Press-connect fittings are specifically permitted by ASHRAE 15. AMCA supports consistency between related codes and standards where applicable. These modifications would cause confusion and other disruptions.

**KOERBER:** No valid substantiation was provided for this modification.

**MACNEVIN:** There was no evidence submitted to justify the removal of press-connect fittings or UL 207. In fact, a previous report submitted to this TC showed that press-connect fittings are the most reliable joining technology overall.

**TRAFTON, A:** Press-fit is a valid connector.

**TRAFTON, P:** Similar to Julius Ballanco's comment, this change is unjustified by removing press-connect fittings and should have been rejected.

**VAN RITE:** There is still no justification given for removing press-connect fittings.

**WHITE:** The changes to the proposal as amended change the intent of the proposal. Originally the proponent was trying to remove language that was not pertinent to the section title. This action expands the actions to interfere with other proposed changes. This should be rejected.

**WISEMAN:** Hearsay is not a reason to change the code. If there is a technical reason to make a change, then it needs to be submitted and properly reviewed. Human welds can fail also. There is not a way to 100% avoid leakage. Without a
technical justification, code should not change.

EXPLANATION OF ABSTAIN:

TERZIGNI: I am still collecting information on the claims made by those in support and those who oppose the proposal.
Proposals

Item #: 231

UMC 2024 Section: 1116.2, Table 1116.2

SUBMITTER: Arnie Rodio
Self

RECOMMENDATION:
Revise text

1116.0 Testing of Refrigeration Equipment.

1116.2 Field Tests. Refrigerant-containing parts of a system that is field-erected shall be tested and proved tight after complete installation and before the operation. The high and low sides of each system shall be tested and proved tight at not less than the lower of the design pressure in Table 1116.2 or the setting of the pressure-relief device.

Exceptions:
(1) Compressors, condensers, evaporators, coded pressure vessels, safety devices, pressure gauges, control mechanisms, and systems that are factory tested.
(2) Refrigeration systems containing Group R-22, not exceeding 5 tons of refrigeration capacity (18 kW), and field-piped using approved, factory-charged line sets shall be permitted to be proved tight by observing retention of pressure on a set of charging gauges and soaping connections while the system is operating.

![Table 1116.2](Image)

For SI units: 1 pound-force per square inch gauge = 6.8947 kPa
*Special design required; test pressures typically exceed 1000 psig (6895 kPa).

SUBSTANTIATION:
Table 1116.2 is being deleted as it is outdated as it does not include many of the refrigerants used today. Additionally, the field leak test pressures should be “not less than the lower of the design pressure or the setting of the pressure-relief device.” This change correlates with the language found in ASHRAE 15 Section 10.1 (Field Tests) regarding testing at “the lower of the design pressure or the setting of the pressure relief device.”

COMMITTEE ACTION: ACCEPT AS SUBMITTED
<table>
<thead>
<tr>
<th>Description</th>
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<tr>
<td>VOTING RESULTS</td>
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<td>AFFIRMATIVE</td>
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<tr>
<td>NOT RETURNED</td>
<td>1</td>
</tr>
<tr>
<td>Heine</td>
<td></td>
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</table>
Proposals

Item #: 232
UMC 2024 Section: 1119.1

SUBMITTER: Julius Ballanco, P.E.
JB Engineering and Code Consulting, P.C.
Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Revise text

1119.0 General.
1119.1 Applicability. Cooling towers, evaporative condensers, and fluid coolers, and associated remote sump tanks shall be readily accessible. Where located on roofs, such equipment having combustible exterior surfaces shall be protected with an approved automatic fire-extinguishing system.

SUBSTANTIATION:
This code change was submitted and discussed during the UMC Legionella Task Group and the decision was made by the Task Group to submit as a separate code change so as to focus on the scope of the Task Group in the new Appendix H (Impact of Water Temperature on The Potential for Legionella Growth).

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 233
UMC 2024 Section: 1121.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

1121.0 Drainage.
1121.1 General. Drains, overflows, and blow-down provisions shall have an indirect connection to an approved disposal location. Discharge of chemical waste shall be as approved by the regulatory authority Authority Having Jurisdiction.

SUBSTANTIATION:
The term “regulatory authority” is not defined in the code. The term “Authority Having Jurisdiction” should be used as it is defined in the code and consistent with other requirements within the code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 234
UMC 2024  Section: 1123.1

SUBMITTER: Julius Ballanco, P.E.
           JB Engineering and Code Consulting, P.C.
           Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Revise text

1123.0 Location.
1123.1 General. Cooling towers, evaporative condensers, and fluid coolers shall be located such that their plumes
cannot enter occupied spaces. Plume discharges shall be not less than 25 feet (7620 mm) away from a ventilation inlet
to a building. Location on the property shall be as required for buildings by the building code. Remote sump tanks
located in occupied spaces shall have exhaust directly to the outdoors.

SUBSTANTIATION:
This code change was submitted and discussed during the UMC Legionella Task Group and the decision was made
by the Task Group to submit as a separate code change so as to focus on the scope of the Task Group in the new
Appendix H (Impact of Water Temperature on The Potential for Legionella Growth).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as no technical substantiation was provided to justify the language.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 235
UMC 2024 Section: 218.0, 311.3, 402.4 - 402.4.5, 403.9, 502.2 - 502.2.3, 519.5, 1123.1, Table 1701.1

SUBMITTER: Mitch Pinsker
Affiliated Engineers Inc
Rep. ASHRAE Golden Gate Chapter Chair of Government Affairs Committee and Code Review Committee

RECOMMENDATION:
Revise text

218.0 Property Line. A line of record that divides one lot or parcel from another lot or parcel or from a public or private street or any other public space. For the purposes of separation distances for building openings and device terminations on walls abutting a public way, the effective property line shall be the centerline of the public way.

Public Way. A street (with or without a sidewalk), alley, or walkway not adjacent to a street, that is accessible to the general public.

311.0 Heating or Cooling Air System.

311.3 Prohibited Source. Outside or return air for a heating or cooling air system shall not be taken from the following locations:
(1) Less than 10 feet (3048 mm) in distance from an appliance vent outlet, a vent opening of a plumbing drainage system, or the discharge outlet of an exhaust fan, unless the outlet is 3 feet (914 mm) above the outside-air inlet the separation distances to vents required by Sections 802.6.1 and 802.8.
(2) Less than 10 feet (3048 mm) above the surface of an abutting public way, sidewalk, street, alley, or driveway the separation distances required by Section 402.4.
(3) through (6) (remaining text unchanged)

402.0 Ventilation Air.

402.4 Outdoor Air Intake Protection. Required outdoor air intakes shall be covered with a screen having not less than ¼ of an inch (6.4 mm) openings, and shall have not more than ½ of an inch (12.7 mm) openings.

402.4.1 Weather Protections. Outdoor air intakes that are part of the mechanical ventilation system shall be designed to manage rain entrainment, to prevent rain intrusion, and manage water from snow in accordance with ASHRAE 62.1.

402.4 Outdoor Air Intakes. Ventilation system outdoor air intakes shall be designed in accordance with Section 402.4.1 through Section 402.4.5. [ASHRAE 62.1:5.5]

402.4.1 Location. Outdoor air intakes (including openings that are required as part of a natural ventilation system) shall be located such that the shortest distance from the intake to any specific potential outdoor contaminant source listed in Table 402.4.1 shall be equal to or greater than the following:
(1) The separation distance in Table 402.4.1 or
(2) The calculation methods in ASHRAE 62.1 Normative Appendix B and shall comply with all other requirements of this section. [ASHRAE 62.1:5.5.1]

402.4.1.1 Exhaust/Relief Outlets. Separation criteria for Class 2 and Class 3 exhaust/relief outlets apply to the distance from the outdoor air intakes for one ventilation system to the exhaust and relief outlets for any other ventilation system. [ASHRAE 62.1:5.5.1.1]

402.4.1.2 Fuel-Burning Equipment. The minimum distances relative to fuel-fired appliances shall be as required by ANSI Z223.1/NFPA 54 for fuel-gas-burning appliances and equipment, NFPA 31 for oil burning appliances and equipment, and NFPA 211 for other combustion appliances and equipment. [ASHRAE 62.1:5.5.1.2]

402.4.1.3 Roof, Landscaped Grade, or Another Surface Directly Below Intake. Where snow accumulation is
expected, the surface of the snow at the expected average snow depth shall be considered to be a surface directly below an intake. [ASHRAE 62.1:5.5.1.3]

**Exception:** The minimum separation distance in Table 402.4.1 shall not apply where outdoor surfaces below the air intake are sloped more than 45 degrees from horizontal or where such surfaces are less than 1 inch (30 mm) in width.

**402.4.1.4 Laboratory Exhaust.** Separation criteria for fume hood exhaust shall be in compliance with ANSI/ASSP Z9.5. [ASHRAE 62.1:5.5.1.4]

**402.4.2 Rain Entrainment.** Outdoor air intakes that are part of the mechanical ventilation system shall be designed to manage rain entrainment in accordance with one or more of the following:

1. Limit water penetration through the intake to 0.07 oz/ft²·h (21.5 g/m²·h) of inlet area when tested using the rain test apparatus described in UL 1995.

2. Select louvers that limit water penetration to a maximum of 0.01 oz/ft² (3 g/m²) of louver free area at the maximum intake velocity. This water penetration rate shall be determined for a minimum 15 minute test duration when subjected to a water flow rate of 0.25 gal/min (16 mL/s) as described under the water penetration test in AMCA 500-L or equivalent. Manage the water that penetrates the louver by providing a drainage area or moisture removal devices.

3. Select louvers that restrict wind-driven rain penetration to less than 2.36 oz/ft²·h (721 g/m²·h) when subjected to a simulated rainfall of 3 inches (75 mm) per hour and a 29 mph (13 m/s) wind velocity at the design outdoor air intake rate with the air velocity calculated based on the louver face area. This performance corresponds to Class A (99 percent effectiveness) when rated according to AMCA 511 and tested per AMCA 500-L.

4. Use rain hoods sized for no more than 500 fpm (2.5 m/s) face velocity with a downward-facing intake such that all intake air passes upward through a horizontal plane that intersects the solid surfaces of the hood before entering the system. Manage the water that penetrates the intake opening by providing a drainage area or moisture removal devices. [ASHRAE 62.1:5.5.2]

**402.4.3 Rain Intrusion.** Air-handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in UL 1995. [ASHRAE 62.1:5.5.3]

**402.4.4 Snow Entrainment.** Where climate dictates, outdoor air intakes that are part of the mechanical ventilation system shall be designed as follows to manage water from snow that is blown or drawn into the system:

1. Access doors to permit cleaning of wetted surfaces shall be provided.

2. Outdoor air ductwork or plenums shall pitch to drains designed in accordance with the requirements of ASHRAE 62.1. [ASHRAE 62.1:5.5.4]

**402.4.5 Bird Screens.** Outdoor air intakes shall include a screening device designed to prevent penetration by a 0.5 inch (13 mm) diameter probe. The screening device material shall be corrosion resistant. The screening device shall be located, or other measures shall be taken, to prevent bird nesting within the outdoor air intake. [ASHRAE 62.1:5.5.5]

**TABLE 402.4.1**

**AIR INTAKE MINIMUM SEPARATION DISTANCE**

[ASHRAE 62.1:TABLE 5-1]

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>MINIMUM DISTANCE (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 2 air exhaust/relief outlet</td>
<td>10</td>
</tr>
<tr>
<td>Class 3 air exhaust/relief outlet</td>
<td>15</td>
</tr>
<tr>
<td>Class 4 air exhaust/relief outlet</td>
<td>30</td>
</tr>
<tr>
<td>Cooling tower exhaust</td>
<td>25</td>
</tr>
<tr>
<td>Cooling tower intake or basin</td>
<td>15</td>
</tr>
<tr>
<td>Driveway, street, or parking place</td>
<td>5</td>
</tr>
<tr>
<td>Garage entry, automobile loading area, or drive-in queue</td>
<td>15</td>
</tr>
<tr>
<td>Garbage storage/pick-up area, dumpsters</td>
<td>15</td>
</tr>
<tr>
<td>Plumbing vents terminating at least 3 ft (1000 mm) above the level of the outdoor air intake</td>
<td>3</td>
</tr>
<tr>
<td>Plumbing vents terminating less than 3 ft (1000 mm) above the level of the outdoor air intake</td>
<td>10</td>
</tr>
<tr>
<td>Roof, landscaped grade, or other surface directly below intake</td>
<td>1</td>
</tr>
<tr>
<td>Thoroughfare with high traffic volume</td>
<td>25</td>
</tr>
<tr>
<td>Truck loading area or dock, bus parking/idling area</td>
<td>25</td>
</tr>
<tr>
<td>Vents, chimneys, and flues from combustion appliances and equipment</td>
<td>15</td>
</tr>
</tbody>
</table>
403.0 Ventilation Rates.

403.9 Air Classification and Recirculation. Air shall be classified as shown in Table 402.1, Table 403.7, or Table 403.9, and its recirculation shall be limited in accordance with Section 403.9.1 through Section 403.9.4. Recirculated air shall not be taken from prohibited locations in accordance with Section 311.3.

### TABLE 403.9 AIRSTREAMS OR SOURCES

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial kitchen grease hoods</td>
<td>4</td>
</tr>
<tr>
<td>Commercial kitchen hoods other than grease</td>
<td>3</td>
</tr>
<tr>
<td>Diazo printing equipment discharge</td>
<td>4</td>
</tr>
<tr>
<td>Hydraulic elevator machine room</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory hoods</td>
<td>4</td>
</tr>
<tr>
<td>Paint spray booths</td>
<td>4</td>
</tr>
<tr>
<td>Refrigerating machinery rooms</td>
<td>3</td>
</tr>
<tr>
<td>Residential kitchen hoods in transient occupancy</td>
<td>3</td>
</tr>
</tbody>
</table>

502.0 Termination.

502.2 Termination of Exhaust Ducts. Exhaust ducts shall terminate in accordance with Section 502.2.1 through Section 502.2.3. Classes of air shall be as defined in Section 203.0 and classified in Section 403.9.

502.2.1 Environmental Class 1 and Class 2 Air Ducts. Environmental Class 1 and 2 air duct exhaust shall terminate not less than 3 feet (914 mm) from a property line, 10 feet (3048 mm) from a forced air inlet, 10 feet (3048 mm) above a public walkway, and 3 feet (914 mm) from openings into the building, and the minimum separation distance from ventilation system outdoor air intakes determined in accordance with Section 402.4.1. The discharge of environmental dryer exhaust ducts shall not be directed onto a public walkway or over an area where condensate or vapor could create a nuisance or hazard.

502.2.2 502.2.3 Product Conveying, Flammable, and Class 4 Air Ducts. Ducts conveying Class 4 air or explosive or flammable vapors, fumes, or dusts shall terminate not less than 30 feet (9144 mm) from a property line, 10 feet (3048 mm) from openings into the building, 6 feet (1829 mm) from exterior walls or roofs that are in the direction of the exhaust discharge, 30 feet (9144 mm) from combustible walls or openings into the building that are in the direction of the exhaust discharge, and 10 feet (3048 mm) above adjoining grade, and the minimum separation distance from ventilation system outdoor air intakes determined in accordance with Section 402.4.1.

Exception: Type I Hood exhaust termination shall be in accordance with Section 510.9.1.

Other product-conveying outlets 502.2.2 Class 3 Air Ducts. Class 3 air duct exhaust shall terminate not less than 10 feet (3048 mm) from a property line, 3 feet (914 mm) from exterior walls or roofs that are in the direction of the exhaust discharge, 10 feet (3048 mm) from openings into the building, and 10 feet (3048 mm) above adjoining grade, and the minimum separation distance from ventilation system outdoor air intakes determined in accordance with Section 402.4.1.

519.0 Type II Hood Exhaust System Requirements.

519.5 Termination of Type II Hood Exhaust System. The exhaust system shall terminate as follows: in accordance with Section 502.2.2.
(4) Rooftop terminations shall terminate not less than 10 feet (3048 mm) from a property line, and the exhaust flow shall be directed away from the roof surfaces of the roof, not less than within 40 inches (1016 mm).
(2) Horizontal terminations shall terminate not less than 10 feet (3048 mm) from adjacent buildings, property lines, operable openings, and from grade level.
(3) The discharge outlet of moisture conveying exhaust ducts, such as dishwasher exhaust ducts, shall not be directed onto terminate over a public walkway or over an area where condensate or vapor could create a nuisance or hazard.

1123.0 Location.
1123.1 General. Cooling towers, evaporative condensers, and fluid coolers shall be located such that their plumes cannot enter occupied spaces as required by Section 402.4.1. Plume discharges shall be not less than 25 feet (7620 mm) away from a ventilation inlet to a building. Location on the property shall be as required for buildings by the building code Section 502.2.3.

(below shown for reference only)

203.0 – A –
Air, Class 1. Air with low contaminant concentration, low sensory-irritation intensity, and inoffensive odor. [ASHRAE 62.1:5.16.1]

Air, Class 2. Air with moderate contaminant concentration, mild sensory-irritation intensity, or mildly offensive odors. Class 2 air also includes air that is not necessarily harmful or objectionable, but that is inappropriate for transfer or recirculation to spaces used for different purposes. [ASHRAE 62.1:5.16.1]

Air, Class 3. Air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor. [ASHRAE 62.1:5.16.1]

Air, Class 4. Air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols, or gases, at concentrations high enough to be considered harmful. [ASHRAE 62.1:5.16.1]

510.9.1 Rooftop Terminations. Rooftop terminations shall be arranged with or provided with the following:
(1) A minimum of 10 feet (3048 mm) of horizontal clearance from the outlet to adjacent buildings, property lines, and air intakes.
(2) A minimum of 5 feet (1524 mm) of horizontal clearance from the outlet (fan housing) to any combustible structure.
(3) A vertical separation of 3 feet (914 mm) above any air intakes within 10 feet (3048 mm) of the exhaust outlet.
(4) The ability to drain grease out of any traps or low points formed in the fan or duct near the termination of the system into a collection container that is noncombustible, closed, rainproof, and structurally sound for the service to which it is applied and that will not sustain combustion.
(5) A grease collection device that is applied to exhaust systems that does not inhibit the performance of any fan.
(6) Listed grease collection systems that meet the requirements of Section 510.9.1(4) and Section 510.9.1(5).
(7) A listed grease duct complying with Section 507.4.7 or ductwork complying with Section 507.4.8.
(8) A hinged upblast fan supplied with flexible weatherproof electrical cable and service hold-open retainer to permit inspection and cleaning that is listed for commercial cooking equipment with the following conditions:
(a) Where the fan attaches to the ductwork, the ductwork is a minimum of 18 inches (457 mm) away from any roof surface, as shown in Figure 510.9.1.
(b) The fan discharges a minimum of 40 inches (1016 mm) away from any roof surface, as shown in Figure 510.9.1.
(9) Other approved fan, provided it meets all of the following criteria:
(a) The fan meets the requirements of Section 510.9.1(3) and Section 511.1.3.
(b) Its discharge or its extended duct discharge meets the requirements of Section 510.9.1(2). (See Section 511.1.3)
(c) Exhaust fan discharge is directed up and away from the roof surface. [NFPA 96:7.8.2.1]

510.9.1.1 Listed Vibration Isolation Connectors. Listed vibration isolation connectors shall be permitted to be used on exterior roof locations where required for proper equipment vibration isolation.

510.9.1.2 Inspection and Cleaning. Fans shall be provided with safe access and a work surface for inspection and cleaning. [NFPA 96:7.8.2.2]

802.6.1 Gas Vent Termination. The termination of gas vents shall comply with the following requirements:
(1) A gas vent shall terminate in accordance with one of the following:
(a) Gas vents that are 12 inches (300 mm) or less in size and located not less than 8 feet (2438 mm) from a vertical wall or similar obstruction shall terminate above the roof in accordance with Figure 802.6.1 and Table 802.6.1.
(b) Gas vents that are over 12 inches (300 mm) in size or are located less than 8 feet (2438 mm) from a vertical wall or similar obstruction shall terminate not less than 2 feet (610 mm) above the highest point where they pass through the roof and not less than 2 feet (610 mm) above a portion of a building within 10 feet (3048 mm) horizontally.
(c) Industrial appliances as provided in Section 802.2.5.
(d) Direct vent systems as provided in Section 802.2.6.
(e) Appliances with integral vents as provided in Section 802.2.7.
(f) Mechanical draft systems as provided in Section 802.3.3 through Section 802.3.3.5.
(g) Ventilating hoods and exhaust systems as provided in Section 802.3.4.
(2) A Type B or a Type L gas vent shall terminate at least 5 feet (1524 mm) in vertical height above the highest connected appliance draft hood or flue collar.
(3) A Type B-W gas vent shall terminate at least 12 feet (3658 mm) in vertical height above the bottom of the wall furnace.
(4) A gas vent extending through an exterior wall shall not terminate adjacent to the wall or below eaves or parapets, except as provided in Section 802.2.6 and Section 802.3.3 through Section 802.3.3.5.
(5) Decorative shrouds shall not be installed at the termination of gas vents except where such shrouds are listed for use with the specific gas venting system and are installed in accordance with the manufacturer’s installation instructions.
(6) All gas vents shall extend through the roof flashing, roof jack, or roof thimble and terminate with a listed cap or listed roof assembly.
(7) A gas vent shall terminate at least 3 feet (914 mm) above a forced air inlet located within 10 feet (3048 mm). [NFPA 54:12.7.3]

802.8 Through-the-Wall Vent Termination. A mechanical draft venting system shall terminate at least 3 feet (914 mm) above any forced air inlet located within 10 feet (3048 mm). (See Figure 802.8)

Exceptions:
(1) This provision shall not apply to the combustion air intake of a direct vent appliance.
(2) This provision shall not apply to the separation of the integral outdoor air inlet and flue gas discharge of listed outdoor appliances. [NFPA 54:12.9.1]

802.8.1 Mechanical Draft Venting System. A mechanical draft venting system of other than direct vent type shall terminate not less than 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from, or 1 foot (305 mm) above any door, operable window, or gravity air inlet into any building. The bottom of the vent terminal shall be located at least 12 inches (305 mm) above finished ground level. [NFPA 54:12.9.2]

802.8.2 Direct Vent Appliance. The clearances for through-the-wall direct vent terminals shall be in accordance with Table 802.8.2. The bottom of the vent terminal and the air intake shall be located not less than 12 inches (305 mm) above finished ground level. [NFPA 54:12.9.3]

802.8.3 Category I through Category IV and Noncategorized Appliances. Through-the-wall vents for Category II and Category IV appliances and noncategorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment. Where local experience indicates that condensate is a problem with Category I and Category III appliances, this provision shall also apply.

Drains for condensate shall be installed in accordance with the appliance and the vent manufacturer’s installation instructions. [NFPA 54:12.9.4]

802.8.4 Annular Spaces. Where vents, including those for direct vent appliances or combustion air intake pipes, penetrate outside walls of buildings, the annular spaces around such penetrations shall be permanently sealed using approved materials to prevent entry of combustion products into the building. [NFPA 54:12.9.5]

802.8.5 Vent Terminals. Vent systems for Category IV appliances that terminate through an outside wall of a building and discharge flue gases perpendicular to the adjacent wall shall be located not less than 10 feet (3048 mm) horizontally from an operable opening in an adjacent building.

Exception: This shall not apply to vent terminals that are 2 feet (610 mm) or more above or 25 feet (7620 mm) or more below operable openings. [NFPA 54:12.9.6]

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMCA 511-2010 (R2016)</td>
<td>Certified Ratings Program Product Rating Manual for Air Control Devices</td>
<td>Air Control Devices</td>
<td>402.4.2 (3)</td>
</tr>
<tr>
<td>AMCA 500-L-2012 (R2015)</td>
<td>Laboratory Methods of Testing Louvers for Rating</td>
<td>Louvers</td>
<td>402.4.2(2), 402.4.2 (3)</td>
</tr>
<tr>
<td>ANSI/ASSP Z9.5-2012</td>
<td>Laboratory Ventilation</td>
<td>Ventilation</td>
<td>402.4.1.4</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)
Note: The AMCA, ASSP, ASHRAE, NFPA, and UL standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:

The purpose of this proposed revision is to:

1. Consolidate exhaust air termination and outdoor air intake requirements which are currently addressed in several sections and not always consistently. For instance, the separation distance to an appliance vent is Section 311.3 is not consistent with those in Sections 802.6.1 and 802.8 for the same application.

2. Update separation distance requirements to meet the those in ASHRAE 62.1-2019 Ventilation and Acceptable Air Quality. Some separation requirements listed in ASHRAE 62.1-2019 are not listed in the UMC. For example, there is no requirement in the UMC that an outdoor intake be located a minimum of 15 feet from dumpsters. The separation requirements listed in Section 502.2.1 also do not distinguish requirements based on Class of Air as is the case in ASHRAE 62.1 2019. For example, the separation requirement between an outdoor air intake and general building relief is the same as the separation requirement for outdoor air intake and janitor closets (10 feet). ASHRAE 62.1 lists more stringent separation requirements for each subsequent Class of Air, which accurately pairs mitigation measures through separation distance with the intensity of contamination. The requirements listed in ASHRAE 62.1 represent the current standard of care for ventilation system design and should be reflected in the UMC.

3. Fully incorporate Standard 62.1 Classes of Air and use them to more clearly define separation distances and exhaust termination. Classes of Air have been included in Table 402.1 (Minimum Ventilation Rates), Table 403.7 (Minimum Exhaust Rates) for several code cycles but they are used only to limit recirculation. Standard 62.1 also includes Table 6-3 Airstreams or Sources (which is incorporated in this proposal as Table 403.9), to fully address all Classes of Air, and uses these Classes to more clearly define separation distances and exhaust termination requirements. Currently Section 502.2 termination requirements are split into three ill-defined categories that are open to interpretation causing confusion: “environmental air ducts,” “product conveying ducts conveying explosive or flammable vapors, fumes, or dusts,” and “other product conveying outlets.” “Environmental air ducts” are defined in Section 207.0 as, “ducting used for conveying air at temperatures not exceeding 250°F (121°C)...such as ventilation for human usage, domestic kitchen range exhaust, bathroom exhaust ducts, and domestic-type clothes dryer exhaust ducts.” Exhaust air can be comprised from many more sources than those currently listed in this definition, leading to an uncertainty of exactly which type of air is categorized as “environmental exhaust”. The term “other product conveying” is not defined anywhere in the UMC and thus is open to interpretation as to what source of exhaust qualifies as “other product conveying.” Using the Class of Air more clearly defines what the requirements are for all types of exhaust discharge.

4. Define terms that currently not well defined and thus subject to interpretation.

To resolve these issues, we propose revisions to multiple sections. Below, we provide rationale by section for each revision.

Section 218.0:

Explanation for Section 218.0 Revision:

Figure 1 Section 218.0 Revision:
The term “property line” is used in multiple sections of the UMC, including Section 502.2.1, yet is undefined. Defining "property line" in Section 218.0 provides specificity and ensures consistent application of the term. The definition is adapted from multiple administrative codes found online. On significant inclusion is how to define property lines for the purpose of separation distance requirements in cities where the legal property line is at the building edge. A common interpretation is that separation distances are to the centerline of the street or public way. This definition solidifies that interpretation.

The term “public way” or “public walkway” is used multiple times in the UMC along with references to streets, alleys, and sidewalks. None of these terms are defined and they appear to reference the same basic application. So we propose creating a single term to cover all of them.

Section 311.3:

Explanation for Section 311.3(1) Revision:
Figure 2 Section 311.3(1) Revision:
Separation requirements between appliance vent outlets are already prescribed in Section 802.6.1 and 802.8. Therefore, we propose to delete the separation requirement of “10 feet (3048 mm) in distance from an appliance vent outlet” listed in Section 311.3(1) and instead refer to Sections 802.6.1 and 802.8 to eliminate redundant and conflicting requirements.

The separation requirements for “a vent opening of a plumbing drainage system, or the discharge outlet of an exhaust fan, unless the outlet is 3 feet (914 mm) above the outside air inlet” listed in Section 311.3(1) will be addressed in proposed Table 402.4.1 of Section 402.4.1. Therefore, these requirements are redundant and may be deleted.

Explanation for Section 311.3(2) Revision:

Figure 3 Section 311.3(2) Revision:
All separation requirements for outdoor air intakes will be prescribed in proposed Table 402.4.1 extracted from Standard 62.1. Therefore, we propose to delete the phrase, “10 feet (3048 mm) above the surface of an abutting public way, sidewalk, street, alley, or driveway” and instead refer to Section 402.4. Note that Standard 62.1 separation requirements vary from the blanket 10 feet required here; some are shorter and some are longer, as determined by the ASHRAE 62.1 committee.

Section 402.4:
We propose to replace Section 402.4 in its entirety with verbatim language from ASHRAE 62.1-2019 prescribing outdoor air intake requirements.

Explanation for Section 402.4 Deletion:

Figure 4 Section 402.4 Revision:
We propose to remove this section because outdoor air intake protection will be described in proposed Section 402.4.5 per ASHRAE 62.1 verbatim language.

Explanation for Section 402.4.1 Deletion:

Figure 5 Section 402.4.1 Revision:
We propose to remove existing Section 402.4.1 because rain intrusion and snow entrainment requirements will be described in proposed Sections 402.4.2 through 402.4.4. The proposed section copies the existing ASHRAE 62.1 requirements that the UMC refers to in the 2021 edition. This does not change the content of the code requirement and is purely a clerical change allowing the reader to view rain and snow entrainment requirements directly in the UMC instead of needing to refer to ASHRAE 62.1.

Explanation for Section 402.4.1 Addition:

The proposed section is taken directly from ASHRAE 62.1 and will add specific requirements for separation distances between potential pollution sources and outdoor air intakes. The separation distances listed in this section and in Table 402.4.1 will update the UMC requirements for outdoor air separation to the latest Standard 62.1 requirements. The addition of this section will also consolidate outdoor air intake separation requirements into one section of the code making it easier to reference.

Note that Standard 62.1-2019 includes an alternative approach to separation distances in Normative Appendix B. This is a long and complex procedure that is not as commonly used as using the prescriptive Table 402.4.1, so rather than extract that entire appendix, we propose just referencing it. There is precedence of references to other ASHRAE documents in lieu of extraction already in the UMC, e.g. 102.3.1, 314.1, 402.1.2, 402.4.1, 510.5.6, 1013.3, 1102, 1106.1, and 1106.2, in addition to references to documents by ACCA, UL, ASME, NFPA, etc.

Section 403.9:
Explanation for Section 403.9 Revision:

Figure 6 Section 403.9 Revision:
The added phase indicates the tables where Classes of Air are defined, which makes the code easier to interpret. The current UMC makes no direct reference to the Classes of Air in existing Tables 402.1 and 403.7.
Explanation for Table 403.9 Addition:

ASHRAE classifies sources of air in Table 6-1, 6-2, and 6-3 in Standard 62.1-2019. The UMC currently includes the first two tables in Tables 402.1 and 403.7, but does not currently include Table 6-3 which leaves gaps in air classification. Adding this table to Section 403.9 remedies the issue.

Section 502.2:

Explanation for Section 502.2 Revision:

Figure 7 Section 502.2 Revision:
The added sentence makes it clear where Classes of Air are defined in the UMC.

Explanation for Section 502.2.1 Revision:

Figure 8 Section 502.2.1 Revision:
We propose to revise the title of the section to be more precise and refer to “Class 1 and Class 2” air ducts which are already defined and classified in Section 203.0 and Section 403.9. An “environmental air duct” is too broad of a description, does not align with the method for classifying air located elsewhere in the UMC, and has led to confusion over what types of air fall under this category.

We propose removing the phrase of “10 feet (3048 mm) from a forced air inlet,” because this requirement is prescribed in proposed Table 402.4.1 of Section 402.4.

The term “public walkway” is revised to “public way” to match the proposed definition in Section 213.0. This will provide further clarity and consistency to the term.

The addition of the phrase, ”and the minimum separation distance from ventilation system outdoor air intakes determined in accordance with Section 402.4.1” refers to the ASHRAE 62.1 separation requirements that are proposed be added as part of this proposal.

The phrase, “the discharge of environmental exhaust ducts shall not be directed onto a public walkway” is proposed to be limited to only dryer exhaust, which is the only Class 1 or 2 exhaust composed of near-saturated air. This air can condense in cold weather and drip onto the public way and potentially freeze in cold climates, creating a hazard. The words “directed onto” are revised to “terminate over” since the hazard can exist even if the air is discharged horizontally, and the limitation was expanded to include any area where condensation may be a hazard using the wording from Section 8.2.8.3 for condensing appliance vents. Other Type 1 and 2 exhaust are addressed by the requirements earlier in the section requiring that discharge be at least “10 feet (3048 mm) above a public way”. This allows for dilution to occur before the exhaust odors, if any, are a nuisance. Note that Type I grease exhaust terminations have no limitations relative to public walkways and that exhaust is much more likely to be a nuisance due to odors and smoke.

Explanation for Section 502.2.2 Revision:

Figure 9 Section 502.2.2 Revision:
We propose to split Section 502.2.2 into two sections. One section pertaining to “Class 3 Air” which will replace “other product conveying” air, and one section pertaining to “Flammable and Class 4 Air” in addition to “product conveying” air. (Note that proposed Sections 502.2.2 and 502.2.3 are shown out of order simply to make the proposed changes from the current wording clear. Logically “Class 3” air should be addressed before “Class 4” air; hence the proposed numbering. This is just editorial.)

We propose to replace the term “other product conveying” airstreams to “Class 3 Air” to provide a clear and consistent definition for the type of air that requirements previously listed under “other product conveying” in Section 502.2.2 apply to. The term “other product conveying” is not defined in the UMC, which makes it difficult to understand what type of air is classified as “other product conveying.” The definition and classification of “Class 3 Air” per Section 203.0 and Section 403.9 is consistent with the intent of the meaning of “other product conveying,” is already defined in the UMC, and matches Standard 62.1.

The addition of the phrase, “that are in the direction of the exhaust discharge” will further qualify the requirements of
the location of “Class 3 Air” exhaust termination in relation to adjacent exterior walls and roofs. There is no known benefit to requiring a separation distance to a wall or roof if the exhaust stream is not discharging in the direction of that wall or roof. This will allow a side discharge of Class 3 air, which is very common.

The addition of the phrase, "and the minimum separation distance from ventilation system outdoor air intakes determined in accordance with Section 402.4.1" to Section 502.2.2 refers to the ASHRAE 62.1 separation requirements that will be added as part of this proposal.

We propose to add the term phrase “Flammable and Class 4 Air” to “product conveying” airstreams to improve clarity and consistency with the air classification references used in the rest of Section 502.2.

The addition of the phrase, “that are in the direction of the exhaust discharge” will further qualify the requirements of the location of “Class 4 Air” exhaust termination in relation to adjacent exterior walls and roofs. There is no known benefit to requiring a separation distance to a wall or roof if the exhaust stream is not discharging in the direction of that wall or roof.

The addition of the phrase, "and the minimum separation distance from ventilation system outdoor air intakes determined in accordance with Section 402.4.1" to proposed Section 502.2.3 refers to the ASHRAE 62.1 separation requirements that will be added as part of this proposal.

The exception to 502.2.3 for Type I grease exhaust termination is added to ensure there is only one section that applies. Section 510.9.1. is extract from NFPA which is the more definitive source.

Explanation for Section 519.5 Revision:

Figure 10 Section 519.5 Revision:
We propose that separation distances be those required of other Class 3 airstreams per Section 502.2.2. The 40-inch separation to the roof is retained but clarified. The limitation on moisture conveying ducts is the same as that proposed for dryer exhaust in Section 502.2.1. Other Type II hoods not conveying moisture, such as heat generating appliance vents, do not pose a nuisance risk for public ways because of the 10 foot separation above grade required by Section 502.2.2.

Explanation for Section 1123.1 Revision:

Figure 11 Section 1123.1 Revision:
Plume discharge separation requirements will be listed in Section 402.4.1 (Table 402.4.1); thus, we propose to replace the phrase, “Plume discharges shall be not less than 25 feet (7620 mm) away from a ventilation inlet to a building” with "as required by Section 402.4.1" for consistency.

Cooling tower discharge is considered “product conveying” air; thus, location on property is dictated by Section 502.2.3. We have therefore replaced “the building code” with “Section 502.2.3” to provide a more precise reference to location requirements.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The added language extracted from ASHRAE 62.1 that is being proposed in Section 402.4.2 regarding rain entrainment is not accurate. It is recommended to rework the section and submit a public comment.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 236

UMC 2024  Section: 1127.0, 1127.1

SUBMITTER: Julius Ballanco, P.E.
           JB Engineering and Code Consulting, P.C.
           Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Add new text

Part II – Cooling Towers.

1127.0 Water Supply.
1127.1 General. Cooling towers, evaporative coolers and fluid coolers shall be provided with an approved water supply, sized for peak demand. The quality of water shall be provided in accordance with the equipment manufacturer’s recommendations. The piping system and protection of the potable water supply system shall be installed in accordance with the plumbing code.

SUBSTANTIATION:
This code change was submitted and discussed during the UMC Legionella Task Group and the decision was made by the Task Group to submit as a separate code change so as to focus on the scope of the Task Group in the new Appendix H (Impact of Water Temperature on The Potential for Legionella Growth).

An additional section for water supply in the cooling towers sections should be added. The quality of the water supply has a major impact on the safety of the tower. The water supply must be approved by the AHJ and sized for peak demand. Additionally, the plumbing code must govern the piping system and protection of the potable water supply for safety.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29 NOT RETURNED: 1  Heine
Proposals

Item #: 237
UMC 2024  Section: 1201.1

SUBMITTER: Lance MacNevin, P.Eng.
Plastics Pipe Institute

RECOMMENDATION:
Revise text

1201.0 General.
1201.1 Applicability. This chapter shall apply to hydronic piping systems that are part of heating, cooling, ventilation, refrigeration, and air conditioning systems. Such piping systems include steam, hot water, radiant heating and cooling, chilled water, steam condensate, condenser water, and ground source heat pump systems, and snow and ice melting systems. The regulations of this chapter shall govern the construction, location, and installation of hydronic piping systems.

SUBSTANTIATION:
The hydronic applications known as radiant heating, radiant cooling, and snow and ice melting are currently listed within Chapter 12 in Sections 1217.0 and 1220.0 but are missing from the Applicability. Therefore, these types of hydronic systems should be listed within the Applicability.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 238

UMC 2024 Section: 1201.6 - 1201.9

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

1201.0 General.

1201.6 Heat Emitters. Heat emitters shall be installed in accordance with the manufacturer’s installation instructions.
1201.7 Mechanical Devices. Where listed mechanical devices are used, the manufacturer’s installation instructions as to the location and method of installation shall be followed.
1201.8 Flexible Connectors. Listed flexible connectors shall be installed in readily accessible locations, unless otherwise listed.
1201.9 Freeze Protection. Hydronic systems and components shall be designed, installed, and protected from freezing.

SUBSTANTIATION:
Additional sections are being added to Chapter 12 (Hydronics) to address heat emitters, mechanical devices, and flexible connectors for hydronic applications. Section 1215.3 (Freeze Protection) is being relocated to the general section for clarity. The change correlates with the USHGC. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

1201.0 General.

1201.6 Heat Emitters. Heat emitters shall be installed in accordance with the manufacturer’s installation instructions.
1201.7 Mechanical Devices. Where listed mechanical devices are used, the manufacturer’s installation instructions as to the location and method of installation shall be followed.
1201.8 Flexible Connectors. Listed flexible connectors shall be installed in readily accessible locations, unless otherwise listed.
1201.9 Freeze Protection. Hydronic systems and components shall be designed, installed, and protected from freezing.

COMMITTEE STATEMENT:
The modification removes "unless otherwise listed" as the phrase is not necessary for enforcing flexible connectors.

Additionally, the Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 239
UMC 2024  Section: 1201.6, Table 1701.1

SUBMITTER: Cary Smith  
Sound Geothermal Corporation

RECOMMENDATION:
Add new text

1201.0 General.

1201.6 Heat Transfer Fluid Quality. Heat transfer fluid used in hydronic systems shall be in accordance with IAPMO H1001.1.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

Note: IAPMO H1001.1 is a working draft and is not completed at the time of this monograph.

SUBSTANTIATION:
The new standard for water quality for hydronic systems is being added to the General section of Chapter 12 (Hydronics).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
IAPMO H1001.1 is a working draft and is not completed at the time of this monograph.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 239.01
UMC 2024  Section: 1221.6

SUBMITTER: UMC Technical Committee Proposal

RECOMMENDATION:
Add new text

1221.6 Hydronic Fluid Disposal. Hydronic system fluids that contain additives such as antifreeze, corrosion inhibitors, and cleaning solutions shall be recycled or disposed of in an approved manner in accordance with Department of Environmental Health or as required by the Authority Having Jurisdiction.

SUBSTANTIATION:
Currently, the code is silent as it pertains to disposal of used hydronic fluids. These fluids can be detrimental to the environment and to the health and safety of the public. The addition of this language will ensure that these used fluids are not poured down the drain and are properly disposed of. Additionally, these used fluids may be recycled.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The language is unenforceable since it would be difficult to enforce disposal of system fluids. Also, the approved manner of disposal is unclear. The disposal methods should be laid out and specified. The language needs additional work. There are environmental agencies that take care of such requirements, which makes the proposed language unnecessary. Each state has a unique name for the department which addresses such disposal of fluids.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29    NOT RETURNED: 1    Heine
SUBMITTER: UMC Technical Committee Proposal

RECOMMENDATION:
Revise text

1214.0 Pressure and Flow Controls.
1214.4 Automatic Makeup Fluid. Where a potable water automatic makeup fluid supply fill device is used to maintain the fluid content of the heat-source unit, or any closed-loop in the system, the potable water makeup supply shall be located at the expansion tank connection or other approved location. A potable water makeup supply shall not be provided for systems which use antifreeze as the heat transfer fluid.

On systems using only water as a heat transfer medium, and where pressurization is achieved using a potable water supply, a pressure-reducing valve shall be installed on a potable water makeup feed line. The pressure of the feed line shall be set in accordance with the design of the system, and connections to potable water shall be in accordance with Section 1202.0 to prevent contamination due to backflow.

Makeup fluid systems that are designed to add pre-mixed antifreeze solutions shall be permitted. Some examples of such systems shall include glycol feeders, limited-volume reservoir.

On systems using additives, such as glycol or corrosion inhibitors, the use of a system pressurization unit (also known as a glycol feeder) shall be required.

SUBSTANTIATION:
The use of system pressurization units, or glycol feeders, guarantees that there is no connection between the potable water line and system fluid. In an ordinary backflow prevention setup, protection of potable water is dependent only on mechanical components such as backflow preventers and pressure reducing valves. If these fail, then there is a direct connection between potable water and system fluid. The use of a glycol feeder ensures that there exists no connection between system fluid and the potable water line. The system pressurization unit regulates pressure in the system and automatically pumps in system fluid when necessary, directly from the feed tank, without any connection to the water line. System feeders also provide flood protection. If a leak occurs, only the contents of the tank can be pumped out, rather than unrestricted flow, as would occur with a potable water make-up supply that was not isolated. If the PRV is installed as per the manufacture’s recommendations (make-up water isolated) then it is not automatic. It becomes a manual operation. Also, using a system feeder allows you to ensure a compatible fluid is used for make-up requirements.

The use of system feeders has gained wide acceptance over the last 15 years and it is now common practice in the US and Canada. There exist several competing companies who make these sorts of products in all sizes required for hydronic systems.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the potable water supply is commonly used to mix antifreeze as the heat transfer fluid, therefore, the provision may be overly stringent. It is recommended that the submitter rewrite the proposed language and resubmit as a public comment. There is also no mention of backflow prevention for public health and safety.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 239.03
UMC 2024  Section: F 101.11, F 201.6.2.2

SUBMITTER: UMC Technical Committee Proposal

RECOMMENDATION:
Revise text

F 101.11 Transfer Fluid. The heat transfer fluid shall be compatible with the makeup water fluid supplied to the system.

F 201.6.2.2 Testing Procedure. The test section and the test liquid shall be at the same temperature. The test section shall be filled with liquid and purged of air. The test section shall be brought to the specified test pressure. Test pressure shall be maintained for 4 hours, with makeup additional fluid added as needed. The test pressure shall be reduced by 10 psi (69 kPa) and monitored for 1 hour with no addition of pressure or makeup additional fluid. A passing test is indicated where after a period of 1 hour no visual leakage is observed, and pressure remains equal to or greater than 95 percent of the original pressure.

SUBSTANTIATION:
The makeup fluid is not always water. Some examples of other fluids are glycol or alcohol-based antifreeze solutions. The term “makeup” is a specific term used in Hydronics indicating fluid that is added to maintain system pressure.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 240
UMC 2024  Section: 1202.1

SUBMITTER: Julius Ballanco, P.E.
JB Engineering and Code Consulting, P.C.
Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Revise text

1202.0 Protection of Potable Water Supply.
1202.1 Prohibited Sources. Hydronic systems or parts thereof shall be constructed in such a manner that polluted, contaminated water or substances shall not enter a portion of the potable water system either during normal use or where the system is subject to pressure that exceeds the operating pressure in the potable water system. Piping, components and devices in contact with the potable water shall be approved for such use and where an additive or item, such as carbon filter or sodium zeolite, is used it shall not affect the performance of the system, including the residual of municipal water disinfectant.

SUBSTANTIATION:
This code change was submitted and discussed during the UMC Legionella Task Group and the decision was made by the Task Group to submit as a separate code change so as to focus on the scope of the Task Group in the new Appendix H (Impact of Water Temperature on The Potential for Legionella Growth).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as no technical substantiation was provided to justify the language.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 241
UMC 2024  Section: 1202.2, Table 1701.1

SUBmitter: Jeff Matson
Viega LLC

RECOMMENDATION:
Revise text

1202.0 Protection of Potable Water Supply.

1202.2 Chemical Injection. Additives or chemicals shall be compatible with system components. Where systems include an additive, chemical injection or provisions for such injection, the potable water supply shall be protected by an air gap in accordance with ASME A112.1.2, an air gap fitting in accordance with ASME A112.1.3, or a reduced-pressure principle backflow prevention assembly listed or and labeled in accordance with ASSE 1013. Such additive or chemical shall be compatible with system components.

<table>
<thead>
<tr>
<th>TABLE 1701.1 REFERENCES STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD NUMBER</td>
</tr>
<tr>
<td>ASME A112.1.2–2012 (R2017)</td>
</tr>
</tbody>
</table>

Note: ASME A112.1.2 and ASME A112.1.3 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The above proposed standards are included to provide specifications for air gaps. This modification will ensure that the end user is required to comply with industry standards.

ASME A112.1.2 identifies methods of providing protection against backsiphonage through means of an air gap and establishes physical requirements and methods of testing air gaps for plumbing fixtures and water receptors.

ASME A112.1.3 provides physical requirements and methods of testing for air gap fittings for protection against back siphonage and back pressure backflow.

Furthermore, the last sentence of Section 1202.2 has been relocated to the beginning of the section as this is more appropriate for the provision. This change correlates with changes made to the 2021 USHGC.

COMMITTEE ACTION: REJECT
COMMITTEE STATEMENT:
The proposal is being rejected with regards to the ASME standards for air gaps as there may be other standards that apply. Such provisions for backflow prevention should remain in the plumbing code.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 242
UMC 2024   Section: 1202.4

SUBMITTER: Julius Ballanco, P.E.
            JB Engineering and Code Consulting, P.C.
            Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Add new text

1202.0 Protection of Potable Water Supply.

1202.4 Potable Water Treatment Equipment. Potable water treatment equipment, including, but not limited to, carbon filters, water softeners, and UV filters, that can, by design, reduce the level of disinfectant in potable water, shall be identified in drawings and building manuals as documented to increase risk for Legionella growth.

SUBSTANTIATION:
This code change was submitted and discussed during the UMC Legionella Task Group and the decision was made by the Task Group to submit as a separate code change so as to focus on the scope of the Task Group in the new Appendix H (Impact of Water Temperature on The Potential for Legionella Growth).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as no technical substantiation was provided to justify the language.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:   AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 243

UMC 2024  Section: 1202.5

SUBMITTER: Julius Ballanco, P.E.
          JB Engineering and Code Consulting, P.C.
          Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Add new text

1202.0 Protection of Potable Water Supply.

1202.5 Potable Water System Flow Reducers. Equipment that, by design, will reduce velocity at fixtures to levels lower than design plumbing system velocity of 2 feet per second (0.6 m/s) minimum shall be identified in drawings and manuals as documented to increase risk for Legionella growth.

SUBSTANTIATION:
This code change was submitted and discussed during the UMC Legionella Task Group and the decision was made by the Task Group to submit as a separate code change so as to focus on the scope of the Task Group in the new Appendix H (Impact of Water Temperature on The Potential for Legionella Growth).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as no technical substantiation was provided to justify the language.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1  Heine
Proposals

Item #: 244

UMC 2024  Section: 1202.6

SUBMITTER: Julius Ballanco, P.E.
JB Engineering and Code Consulting, P.C.
Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Add new text

1202.0 Protection of Potable Water Supply.

1202.6 Water Softeners. Water softeners for non-residential potable use applications shall be sized in accordance with the following:
(1) As small as possible for the application, and
(2) To regenerate, preferably every 24 hours, but no more than every 72 hours, and with a minimum of 10 percent bypass capacity to reduce salt use, water consumption, and corrosivity of water. Water softener installation with parallel units where one unit may be in standby for 24 hours or longer shall have the standby unit flushed to drain for a minimum of 10 minutes immediately prior to being placed in service. When using fixture count to determine peak water demand, the softener sizing shall be based on softener rated peak flow and not continuous flow. Designers shall review with the Authority Having Jurisdiction to determine if installing a softener on water intended for cold potable water consumption results in the building being required to register as a Public Water System.

SUBSTANTIATION:
This code change was submitted and discussed during the UMC Legionella Task Group and the decision was made by the Task Group to submit as a separate code change so as to focus on the scope of the Task Group in the new Appendix H (Impact of Water Temperature on The Potential for Legionella Growth).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as no technical substantiation was provided to justify the language.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 245
UMC 2024  Section: 1203.0, 1203.1, 1203.2

SUBMITTER: Julius Ballanco, P.E.
JB Engineering and Code Consulting, P.C.
Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Add new text

1203.0 Protection of Non-Potable Water Systems.
1203.1 Indoor Ornamental Fountains. Ornamental fountains shall not have submerged lights that add heat to the water (i.e., incandescent). Only LED or other types of low to no heat generation lights shall be used. If all parts and components of an indoor ornamental fountain system are not located in a conditioned space, then a biocide monitoring and feed control system shall be required to control risk associated with Legionella.
1203.2 Public Spas. Spas located in public spaces for general use including, but not limited to hotels, health clubs, etc., shall have an automatic biocide feeder, monitor, and controller with data logging ability.

(renumber remaining sections)

SUBSTANTIATION:
This code change was submitted and discussed during the UMC Legionella Task Group and the decision was made by the Task Group to submit as a separate code change so as to focus on the scope of the Task Group in the new Appendix H (Impact of Water Temperature on The Potential for Legionella Growth).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as no technical substantiation was provided to justify the language.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
1203.3 Tankless Water Heaters. Tankless water heaters used in space-heating applications shall be rated by the manufacturer for space-heating applications, and the output performance shall be determined by the temperature rise and flow rate of water through the unit. The ratings shall be expressed by the water temperature rise at a given flow rate. Manufacturer’s flow rates shall not be exceeded.

SUBSTANTIATION:
The proposed language adds further clarification on tankless water heaters. Tankless water heaters must only be rated by the manufacturer for space heating applications when they are used to provide space heat.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 247
UMC 2024  Section: 1204.7

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Add new text

1204.0 Identification of a Potable and Nonpotable Water Systems.

1204.7 Heat Transfer Fluid. Solar thermal piping shall be identified with an orange background with black uppercase lettering, with the words “CAUTION: HEAT TRANSFER FLUID, DO NOT DRINK.” Each solar thermal system shall be identified to designate the fluid being conveyed. The minimum size of the letters and length of the color field shall comply with Table 1204.3.

Each outlet on the solar thermal piping system shall be posted with black uppercase lettering as follows: “CAUTION: HEAT TRANSFER FLUID, DO NOT DRINK.”

SUBSTANTIATION:
A section for heat transfer fluid identification is being added to assist in the requirements for marking such piping.

The change correlates with the USHGC Section 404.7. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 248

UMC 2024  Section: 1205.2

SUBMITTER: Pennie L Feehan
Pennie L Feehan Consulting
Rep. Copper Development Association

RECOMMENDATION:
Revise text

1205.0 Installation, Testing, and Inspection.

1205.2 Pressure Testing. System piping and components shall be tested with a pressure of not less than one and one-half times the operating pressure but not less than 100 psi (689 kPa). Piping shall be tested with water or air except that plastic pipe shall not be tested with air. Test pressures shall be held for a period of not less than 30 minutes with no perceptible drop in pressure. These tests shall be made in the presence of the Authority Having Jurisdiction.

Exceptions:
(1) For PEX, PP-R, PP-RCT, PEX-AL-PEX, PE-RT, and PE-AL-PE piping systems, testing with air shall be permitted where authorized by the manufacturer’s instructions for the PEX, PP-R, PP-RCT, PEX-AL-PEX, PE-RT, and PE-AL-PE pipe and fittings products, and air testing is not prohibited by applicable codes, laws, or regulations outside this code.
(2) Copper tubing shall be permitted to be tested at not less than 80 psi (552 kPa).

SUBSTANTIATION:
The phrase “permitted to be” is being stricken as the phrase implies that a test pressure not less than 80 psi is optional and not a requirement. The change also correlates with the action taken by the USHGC Technical Committee.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but does not agree with the substantiation regarding the statement, "The change also correlates with the action taken by the USHGC Technical Committee."

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
1206.0 Pressure and Safety Devices.

1206.2 Discharge Piping. The discharge piping serving a temperature relief valve, pressure relief valve, or combination of both shall have no valves, obstructions, or means of isolation and be provided with the following:

1. Equal or Not less than to the size of the valve outlet and shall discharge full size to the flood level of the area receiving the discharge and pointing down.
2. Materials shall be rated at not less than the operating temperature of the system and approved for such use or shall comply with ASME A112.4.1.
3. Discharge pipe shall discharge independently by gravity through an air gap into the drainage system or outside of the building with the end of the pipe not exceeding 2 feet (610 mm) and not less than 6 inches (152 mm) above the ground and pointing downwards.
4. Discharge in such a manner that does not cause personal injury or structural damage.
5. No part of such discharge pipe shall be trapped or subject to freezing.
6. The terminal end of the pipe shall not be threaded.
7. Discharge from a relief valve into a water heater pan shall be prohibited.
8. The discharge termination point shall be readily observable.

<table>
<thead>
<tr>
<th>TABLE 1701.1</th>
<th>REFERENCED STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD NUMBER</td>
<td>STANDARD TITLE</td>
</tr>
<tr>
<td>ASME A112.4.1-2009 (R2019)</td>
<td>Water Heater Relief Valve Drain Tubes</td>
</tr>
</tbody>
</table>

Note: ASME A112.4.1 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The revision to Section 1206.2 item (1) is needed as there are cases where PEX and PE-RT tubing require insert fittings to reduce inner diameters. Requiring the piping to be greater than the valve outlet prevents the PEX tubing inner diameter from being smaller than the valve outlet. ASME A112.4.1 is being included as it is applicable to discharge piping provisions and provides performance requirements and test methods applicable to water heater relief valve drain (or runoff) tubes for use with relief valves having a steam rating of 105,000 Btu/hr or less.

The addition of item (8) makes it clear that the termination point of the drainage line must be visible in order to detect leaks or failed valves. The change correlates with the actions taken by the UPC and USHGC Technical Committees. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

1206.0 Pressure and Safety Devices.

1206.2 Discharge Piping. The discharge piping serving a temperature relief valve, pressure relief valve, or combination of both shall have no valves, obstructions, or means of isolation and be provided with the following:
(1) Not less than to the size of the valve outlet and shall discharge full size to the flood level of the area receiving the discharge and pointing down.
(2) Materials shall be rated at not less than the operating temperature of the system and approved for such use or shall comply with ASME A112.4.1.
(3) Discharge pipe shall discharge independently by gravity through an air gap into the drainage system or outside of the building with the end of the pipe not exceeding 2 feet (610 mm) and not less than 6 inches (152 mm) above the ground and pointing downwards.
(4) Discharge in such a manner that does not cause personal injury or structural damage.
(5) No part of such discharge pipe shall be trapped or subject to freezing.
(6) The terminal end of the pipe shall not be threaded.
(7) Discharge from a relief valve into a water heater pan shall be prohibited.
(8) The discharge termination point shall be readily observable.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME A112.4.1-2009 (R2019)</td>
<td>Water Heater Relief Valve Drain Tubes</td>
<td>Discharge Piping</td>
<td>1206.2(2)</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

COMMITTEE STATEMENT:
The modification clarifies that the discharge termination shall be readily "visible."

Additionally, the Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine

EXPLANATION OF AFFIRMATIVE:
WHITE: The UPC Section 608.5(8) uses the term "observable" not "visible."
Proposals

Item #: 250
UMC 2024 Section: 1207.2.2

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

1207.0 Heating Appliances and Equipment.

1207.2 Boilers.

1207.2.2 Noncondensing Boilers. Where the heat exchanger and venting system are not designed to operate with condensed flue gases, the boiler shall be permitted to connect directly to the panel heating system where protected from flue gas condensation. The operating temperature of the boiler shall be more than the fluid temperature in accordance with the manufacturer's instructions. The minimum return-water temperature to the heat source shall comply with Section 1201.5.

(below shown for reference only)

1201.5 Return-Water Low-Temperature Protection. Where a minimum return-water temperature to the heat source is specified by the manufacturer, the heating system shall be designed and installed to meet or exceed the minimum return-water temperature during the normal operation of the heat source.

SUBSTANTIATION:
A reference to Section 1201.5 (Return-Water Low-Temperature Protection) has been added to ensure that the heating system is installed and designed to at least meet the minimum return water temperature specified by the manufacturer. This is necessary to prevent condensation of moisture in the flue gases since noncondensing boilers are constructed of materials like carbon steel, cast iron or copper, and these materials are unable to withstand the corrosive condensate produced. This corrosive condensate will chemically eat away at the boiler’s heat exchanger as well as the inside of the vent connector. For these reasons, the additional proposed language is needed.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28 NEGATIVE: 1 NOT RETURNED: 1 Heine

EXPLANATION OF NEGATIVE:
WHITE: This is redundant, Section 1207.2.2 directs users to be in compliance with manufacturer's instructions and then points back to a section that says to be in compliance with manufacturer’s instructions. While well intended, this sets up the possibility of future conflict should the referenced (pointed to) section change, one would have to know to go change...
the pointer. Also, Section 1207.2.2 should be clarified. If the operating temperature must be more than the fluid temperature, the system would never shut off. This is clumsy language.
Proposals

Item #: 251

UMC 2024  Section: 1207.5, Table 1701.1, Table 1701.2

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Add new text

1207.0 Heating Appliances and Equipment.

1207.5 Heat Pumps. Water source heat pumps shall comply with AHRI/ASHRAE/ISO 13256-1 for water-to-air heat pumps and AHRI/ASHRAE/ISO 13256-2 for water-to-water heat pumps. Air source heat pumps shall comply with AHRI 210/240. Heat pumps shall be fitted with a means to indicate that the compressor is locked out.

<table>
<thead>
<tr>
<th>TABLE 1701.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>REFERENCED STANDARDS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

<table>
<thead>
<tr>
<th>TABLE 1701.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

Note: AHRI 210/240, AHRI/ASHRAE/ISO 13256-1, and AHRI/ASHRAE/ISO 13256-2 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Section 1207.5 is being added to provide standards to address both water- and air-source heat pumps. Both standards provide detailed test methods, performance requirements and marking provisions for water-source heat pumps.
pumps. AHRI/ASHRAE/ISO 13256-1 specifically addresses water-to-water and brine-to-water heat pumps while AHRI/ASHRAE/ISO 13256-2 addresses water-to-air and brine-to-air heat pumps. AHRI/ASHRAE/ISO 13256-1 and AHRI/ASHRAE/ISO 13256-2 have been used in the industry since 1998 and have been reaffirmed two times without substantive changes to the requirements. AHRI 210/240 covers air source heat pumps and their classifications, markings, as well as testing and rating requirements.

The inclusion of both water and air source heat pumps is applicable to Chapter 12 (Hydronics) as these heat pumps are used in hydronic space heating applications including radiant flooring and air heating.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed AHRI standards are performance standards, not safety standards. There is also concern that requiring a means to indicate that the compressor is locked out is overly stringent and is a service requirement; not related to safety. The proponent should come back with a public comment to reflect language as shown in Appendix F for heat pump specifications.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 252
UMC 2024  Section: 1208.1, Table 1701.1

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

1208.0 Circulators and Pumps.
1208.1 General. Circulators and pumps shall be selected for their intended use based on the heat transfer fluid, intended operating temperature range and pressure. Circulators and pumps shall be installed to allow for service and maintenance. The manufacturer’s installation instructions shall be followed for correct orientation and installation. Motor Operated pumps rated 600V or less shall be listed and labeled in accordance with CSA C22.2 No. 108 or UL 778.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA C22.2 No. 108 –2014 (R2019)</td>
<td>Liquid Pumps</td>
<td>Pumps</td>
<td>1208.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: CSA C22.2 No. 108 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Section 1208.1 is being modified to include CSA C22.2 No. 108 as the standard applies to liquid pumps. Various manufacturers are currently making condensate pumps which are being listed to this standard. The standard covers construction, markings, testing, bonding, and enclosures for liquid pumps including condensate pumps. Including this additional listing further enhances the code.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

1208.0 Circulators and Pumps.
1208.1 General. Circulators and pumps shall be selected for their intended use based on the heat transfer fluid, intended operating temperature range and pressure. Circulators and pumps shall be installed to allow for service and maintenance. The manufacturer’s installation instructions shall be followed for correct orientation and installation. Motor Operated pumps rated 600V or less shall be listed and labeled in accordance with CSA C22.2 No. 108 or UL 778.
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<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA C22.2 No. 108 –2014 (R2019)</td>
<td>Liquid Pumps</td>
<td>Pumps</td>
<td>1208.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

COMMITTEE STATEMENT:
The proposed modification is being submitted to change “listed and labeled” to “comply with.” This is consistent with the other changes made by the Technical Committee on other items.

Additionally, the Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 253
UMC 2024  Section: 1209.1, 1209.3

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Delete text without substitution

1209.0 Expansion Tanks.
1209.1 General. An expansion tank shall be installed in each closed hydronic system to control system pressure due to thermal expansion and contraction. Expansion tanks shall be of the closed or open type. Expansion tanks shall be rated for the pressure of the system.

1209.3 Open-Type Expansion Tanks. Open type expansion tanks shall be located not less than 3 feet (914 mm) above the highest point of the system. An overflow with a diameter of not less than one-half the size of the supply or not less than 1 inch (25 mm) in diameter shall be installed at the top of the tank. The overflow shall discharge through an air gap into the drainage system.

(remaining text unchanged)

SUBSTANTIATION:
Open type expansion tanks are no longer installed in any new or retrofit applications. These types of tanks are not capable of reaching high operating temperatures like that of closed expansion tanks. Open tanks allow for air to migrate into the system resulting in corrosion of components. Additionally, open expansion tanks must be located above the highest heating element, in general on the top of buildings, where they may be exposed to freezing conditions. For these reasons, open type expansion tanks and their listed provisions should be removed from the code.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:
WHITE: These are probably not going in on new systems and people do not understand them on retrofits, but I disagree with the substantiation. There are many of these types of systems in use for maybe 100 years without corrosion failures. They are typically installed on systems that do not have high temperatures but can sustain temperatures just below boiling. If a system needs repair sufficient enough to require a permit, it is not always necessary to force removal of these devices. Also, these systems are lower pressure, limited to the elevation of the tank. Typically, pressure is measured in feet, not psi. Installing closed tanks can lead to excessive pressures in these legacy systems. No one puts them in new, but there is no harm in keeping this in the code.
Proposals

Item #: 254

UMC 2024  Section: Table 1210.1, Table 1701.1

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

### TABLE 1210.1
MATERIALS FOR HYDRONIC SYSTEM PIPING, TUBING, AND FITTINGS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PIPING/TUBING</strong></td>
<td><strong>FITTINGS</strong></td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td><strong>ASTM F2165</strong>, ASTM F2389, CSA B137.11, NSF 358-2</td>
</tr>
<tr>
<td>Raised Temperature Polyethylene (PE-RT)</td>
<td><strong>ASTM F2165</strong>, ASTM F2623, ASTM F2769, CSA B137.18</td>
</tr>
<tr>
<td>Cross-Linked Polyethylene/Aluminum/Cross-Linked Polyethylene (PEX-AL-PE)</td>
<td>ASTM F1281, <strong>ASTM F2165</strong>, CSA B137.10</td>
</tr>
<tr>
<td>Polyethylene/Aluminum/Polyethylene (PE-AL-PE)</td>
<td>ASTM F1282, <strong>ASTM F2165</strong>, CSA B137.9</td>
</tr>
</tbody>
</table>

**Notes:**
1. Ductile and gray iron.
2. Only type K, L, or M tubing allowed to be installed.
TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM F2165-2019</td>
<td>Flexible Pre-Insulated Plastic Piping</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F3347-2020a</td>
<td>Metal Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F3348-2020b</td>
<td>Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: The ASTM standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Additional approved standards are being added to Table 1210.1 regarding materials for hydronic system piping, tubing, and fittings. The standards being added have been vetted for correct application. The change correlates with the actions taken by the USHGC Technical Committee.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
TABLE 1210.1
MATERIALS FOR HYDRONIC SYSTEM PIPING, TUBING, AND FITTINGS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARDS PIPING/TUBING</th>
<th>STANDARDS FITTINGS</th>
</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

**Note:** ASTM F3226 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

**SUBSTANTIATION:**
It was an oversight not to include ASTM F3226 Standard Specification for Metallic Press-Connect fittings for piping and tubing systems in the standards fittings column for Copper/Copper alloy fittings during the 2021 code development cycle as it is for stainless steel. The inclusion of ASTM F3226 will align this table with other codes including the 2021 IAPMO USHGC which references ASTM F3226 under fittings for copper and copper alloy materials as this standard was developed for this type of technology and should be referenced here.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**COMMITTEE STATEMENT:**
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**   **AFFIRMATIVE:** 29   **NOT RETURNED:** 1   Heine
Proposals

Item #: 256

UMC 2024  Section: Table 1210.1, Table 1701.1

SUBMITTER: Mark Fasel
Viega LLC

RECOMMENDATION:
Revise text

TABLE 1210.1
MATERIALS FOR HYDRONIC SYSTEM PIPING, TUBING, AND FITTINGS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARDS</th>
<th>FITTINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless Steel</td>
<td>ASTM A269, ASTM A312, ASTM A554, ASTM A778</td>
<td>ASTM F1476, ASTM F1548, ASTM F3226, IAPMO IGC 353, IAPMO PS 117</td>
</tr>
</tbody>
</table>

Note: Portions of the table not shown remain unchanged.

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAPMO IGC 353-2019</td>
<td>Branch Connectors</td>
<td>Branch Connectors</td>
<td>Table 1210.1</td>
</tr>
</tbody>
</table>

Note: IAPMO IGC 353 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The IAPMO IGC 353 Branch Connectors standard was developed for branch connectors NPS 1 1/2" - 6 inches. Branch connectors are defined within the standard as a permanent fitting or connection that allows a NPT threaded branch connection to be added to existing piping. Branch connectors covered by IAPMO IGC 353 shall include (a) Saddle like permanent connection mechanically fixed in place to the host pipe; and (b) leak tight seal realized through the compression of a sealing element between the outer surface of the pipe and body or flange of the branch connector. Note: One method of mechanically fixing the branch connection is via a swaging action which secures the fitting by mechanically deforming a flange of metal attached to the branch connector so that it matches the contour of the inside surface of a host pipe as indicated in Standard Section 1.1.2.

The body of branch connectors covered by this Standard shall be made of carbon steel, stainless steel, copper nickel or other materials with similar strength properties.

Branch connectors meet the current definition of Mechanical Joint as provided in the code: Joint, Mechanical. General form for gastight or liquid-tight joints obtained by the joining of parts through a positive holding mechanical construction.

The addition of this standard to the Materials for hydronic system piping, tubing and fittings table will provide a consensus standard listing requirement for these type of fittings that have been proven through the variety of testing that is mandatory to obtain the listing.
COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The standard is not applicable to potable water systems. Additionally, there is concern that fittings complying with the IAPMO IGC 353 standard will create turbulence within the system.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:

WHITE: The application for these is appropriate to hydronic piping, which is not potable, therefore the potable argument is moot. This should have been approved.
Proposals

Item #: 257
UMC 2024  Section: Table 1210.1

SUBMITTER: Mark Fasel
Viega LLC

RECOMMENDATION:
Revise text

TABLE 1210.1
MATERIALS FOR HYDRONIC SYSTEM PIPING, TUBING, AND FITTINGS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PIPE/TUBING</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: IAPMO PS 117 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The inclusion of IAPMO PS 117 to the steel material fittings column was an oversight during the 2021 code development cycle. It was added to stainless steel but not steel. This proposal is to include IAPMO PS 117 into the standard/fitting section of Steel material as Steel is a material covered by this standard and used often in hydronic piping systems.

IAPMO PS 117 is currently referenced in the standard fittings column for copper/copper alloy and stainless steel in this table. The inclusion of this referenced standard in Steel will cover match what has been completed in the 2021 IAPMO USHGC and will align the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 258
UMC 2024  Section: Table 1210.1

SUBMITTER: Mark Fasel
Viega LLC

RECOMMENDATION:
Revise text

TABLE 1210.1
MATERIALS FOR HYDRONIC SYSTEM PIPING, TUBING, AND FITTINGS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARDS</th>
</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

Note: ASTM F3226 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
It was an oversight not to include ASTM F3226 Standard Specification for Metallic Press-Connect fittings for piping and tubing systems in the standards fittings column for steel fittings during the 2021 code development cycle as it is for stainless steel. The inclusion of ASTM F3226 will align this table with other codes including the 2021 IAPMO USHGC which references ASTM F3226 under fittings for steel material as this standard was developed for this type of technology and should be referenced here.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There is no technical justification to warrant adding the ASTM standard to the fittings section for steel in the Hydronics table.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 28  NEGATIVE: 1  NOT RETURNED: 1  Heine

EXPLANATION OF NEGATIVE:
WHITE: The proposal should have been accepted based on the substantiation.
Proposals

Item #: 259
UMC 2024 Section: Table 1210.1, Table 1701.1

SUBMITTER: Mark Fasel
Viega LLC

RECOMMENDATION:
Revise text

**TABLE 1210.1**
MATERIALS FOR HYDRONIC SYSTEM PIPING, TUBING, AND FITTINGS

<table>
<thead>
<tr>
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<th>STANDARDS</th>
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</thead>
</table>

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**TABLE 1701.1**
REFERENCED STANDARDS

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(portions of table not shown remain unchanged)

Note: IAPMO IGC 353 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The IAPMO IGC 353 Branch Connectors standard was developed for branch connectors NPS 1 1/2" - 6 inches. Branch connectors are defined within the standard as a permanent fitting or connection that allows a NPT threaded branch connection to be added to existing piping. Branch connectors covered by IAPMO IGC 353 shall include:
(a) Saddle like permanent connection mechanically fixed in place to the host pipe; and
(b) leak tight seal realized through the compression of a sealing element between the outer surface of the pipe and body or flange of the branch connector.

Note: One method of mechanically fixing the branch connection is via a swaging action which secures the fitting by mechanically deforming a flange of metal attached to the branch connector so that it matches the contour of the inside surface of a host pipe as indicated in Standard section 1.1.2.

Branch connectors meet the current definition of Mechanical Joint as provided in the code: Joint, Mechanical. General form for gastight or liquid-tight joints obtained by the joining of parts through a positive holding mechanical construction.

The addition of this standard to the Materials for hydronic system piping, tubing and fittings table will provide a consensus standard listing requirement for these type of fittings that have been proven through the variety of testing that is mandatory to obtain the listing.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 260
UMC 2024  Section: Table 1210.1, Table 1701.1

SUBMITTER: Michael Cudahy
PPFA

RECOMMENDATION:
Revise text

**TABLE 1210.1**
MATERIALS FOR HYDRONIC SYSTEM PIPING, TUBING, AND FITTINGS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>PIPING/TUBING</th>
<th>FITTINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene of Raised Temperature Polyethylene (PE-RT)</td>
<td>ASTM F2623, ASTM F2769, CSA B137.18</td>
<td>ASSE 1061, ASTM F1807, ASTM F2159, ASTM F2735, ASTM F2769, ASTM D3261, ASTM F3347, ASTM F3348, ASTM F1055, CSA B137.18</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**TABLE 1701.1**
REFERENCES STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM F3347-2020a</td>
<td>Metal Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F3348-2020b</td>
<td>Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: The ASTM standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:

COMMITTEE ACTION: ACCEPT AS SUBMITTED
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 261
UMC 2024  Section: 1210.4

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

1210.0 Materials.

1210.4 Oxygen Diffusion Corrosion. PEX and PE-RT tubing in closed hydronic systems shall contain an oxygen barrier with an oxygen permeation rate not to exceed \(4.59 \times 10^{-4}\) grains per square foot per day \(0.32 \text{ mg/m}^2 \text{/day}\) at \(104^\circ\text{F} (40^\circ\text{C})\).

Exception: Closed hydronic systems without ferrous components in contact with the hydronic fluid.

SUBSTANTIATION:
PEX and PE-RT tubing used for hydronic applications requires an oxygen barrier to prevent diffusion of oxygen molecules into the water through the piping walls. An oxygen barrier also prevents corrosion of any cast iron components or parts such as circulator pumps, fill valves and boiler heating elements. The barrier allows for PEX and PE-RT use in hot water hydronic heating applications such as radiator heating, fan coils, and radiant floor heating. The revision of this section is necessary as it provides a maximum limit for oxygen permeation through the tubing.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed language is not enforceable and should reference the appropriate standard that provides the required oxygen permeation rate listed.

Additionally, the Technical Committee disagrees with the substantiation regarding the necessity for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 262
UMC 2024  Section: 1211.12, Table 1701.1

SUBMITTER: Michael Cudahy
PPFA

RECOMMENDATION:
Revise text

1211.0 Joints and Connections.

1211.12 Polyvinyl Chloride (PVC) Pipe. (remaining text unchanged)
(1) (remaining text unchanged)
(2) Solvent cement joints for PVC pipe and fittings shall be clean from dirt and moisture. Pipe shall be cut square and pipe shall be deburred. Where surfaces to be joined are cleaned and free of dirt, moisture, oil, and other foreign material, apply primer purple in color in accordance with ASTM F656. Primer shall be applied until the surface of the pipe and fitting is softened. Solvent cements in accordance with ASTM D2564 shall be applied to all joint surfaces. Joints shall be made while both the inside socket surface and outside surface of pipe are wet with solvent cement. Two-step joining methods shall be in accordance with ASTM D2855. Hold joint in place and undisturbed for 1 minute after assembly.
(3) (remaining text unchanged)

| TABLE 1701.1 |
| REFERENCED STANDARDS |
| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTION |
| ASTM D2855-2020 | The Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets | Miscellaneous | 1211.12(2) |

Note: ASTM D2855 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The standard for two step solvent cement joining is ASTM D2855, “Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.”

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the current code language provides the needed requirements for proper joining methods.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 22  NEGATIVE: 7  NOT RETURNED: 1  Heine
EXPLANATION OF NEGATIVE:
BALLANCO: This change should have been accepted. The substantiation justifies the addition of this standard.

CUDAHY: The standard contains significantly more information than the code.

KOERBER: I vote to accept the change. The substantiation is sound.

MACNEVIN: This proposal should be accepted as it adds an important joining method, ASTM D2855, into the code, improving clarity.

TRAFTON, A; WISEMAN: The change should be accepted.

WHITE: The proposal should be accepted based on the substantiation.
Proposals

Item #: 263
UMC 2024  Section: 1211.14.1

SUBMITTER: Pennie Feehan
Pennie L Feehan Consulting
Rep. Copper Development Association

RECOMMENDATION:
Revise text

1211.14.1 Copper or Copper Alloy Pipe or Tubing to Threaded Pipe Joints. Joints from copper or copper alloy pipe or tubing to threaded pipe that is not copper or copper alloy shall be made by the use of copper alloy adapter, copper alloy nipple [minimum 6 inches (152 mm)], dielectric fitting, or dielectric union in accordance with ASSE 1079. The joint between the copper or copper alloy pipe or tubing and the fitting shall be a soldered, brazed, flared, or pressed joint and the connection between the threaded pipe and the fitting shall be made with a standard pipe size threaded joint.

SUBSTANTIATION:
The original sentence is not clear and does not specify that the connection is from copper alloy pipe or tubing to threaded pipe of a different material. This proposal does not change the intent of the code section.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The language is not clear on its intent. It is requested that proponent come back with a public comment.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 264
UMC 2024 Section: 1211.14.2

SUBMITTER: Arnie Rodio
Self

RECOMMENDATION: Revise text

1211.0 Joints and Connections.

1211.14 Joints Between Various Materials. (remaining text unchanged)

1211.14.2 Plastic Pipe to Other Materials. Where connecting plastic pipe to other types of piping, approved types of adapter or transition fittings designed for the specific transition intended shall be used. Except as provided in the plumbing code, PVC and ABS pipe and fittings shall not be solvent welded to any other unlike material.

SUBSTANTIATION:
The current language allows for a single transition from ABS to PVC or PVC to ABS exterior of the structure. Transition glue is not being represented to be allowable to make transition joints between ABS and PVC anywhere in the building. This code change clarifies that this practice is not approved. I have seen residences where the below slab plumbing was PVC and then the above slab plumbing all PVC with the joints being made with transition glue. This is an improper use of the product. While there is a code change to place this change in Chapter 3 as a prohibited practice it is also important that this be in this section as a prohibited practice to aid the end user and AHJ.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 264, Section 1211.14.2 (Plastic Pipe to Other Materials) and UPC Item # 179, Section 705.10.3 (Plastic Pipe to Other Materials) resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

1211.14.2 Plastic Pipe to Other Materials. Where connecting plastic pipe to other types of piping approved listed adapter or transition fittings designed for and listed for the specific transition intended shall be used. Except as provided in the plumbing code, PVC and ABS pipe and fittings shall not be solvent welded to any other unlike material.

TCC ACTION: ACCEPT AS SUBMITTED
TCC STATEMENT:
The language in UMC Item # 264, Section 1211.14.2 (Plastic Pipe to Other Materials) is being revised to correlate with the action taken by the UPC TC for Item # 179, Section 705.10.3 (Plastic Pipe to Other Materials) with regards to adapters and transition fittings. Additionally, the TCC fixed an error by striking ABS as ABS is not listed as one of the approved materials in Table 1210.1 (Materials for Hydronic System Piping, Tubing, and Fittings).

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 1211.14.2 regarding with regards to adapters and transition fittings and the striking of ABS.
Proposals

Item #: 265
UMC 2024  Section: 1211.2(2)

SUBMITTER: Forest Hampton
Lubrizol, Inc.

RECOMMENDATION:
Revise text

1211.0 Joints and Connections.

1211.2 Chlorinated Polyvinyl Chloride (CPVC) Pipe. (remaining text unchanged)
(1) (remaining text unchanged)
(2) Solvent cement joints for CPVC pipe and fittings shall be clean from dirt and moisture. Solvent cements in accordance with ASTM F493, requiring the use of a primer shall be orange in color. The primer shall be colored and be in accordance with ASTM F656. Listed solvent cement in accordance with ASTM F493 that does not require the use of primers, yellow, green, or red in color, shall be permitted for pipe and fittings manufactured in accordance with ASTM D2846, 1/2 of an inch (15 mm) through 2 inches (50 mm) in diameter or ASTM F442, 1/2 of an inch (15 mm) through 3 inches (80 mm) in diameter. Apply primer where required inside the fitting and to the depth of the fitting on pipe. Apply liberal coat of cement to the outside surface of pipe to depth of fitting and inside of fitting. Place pipe inside fitting to forcefully bottom the pipe in the socket and hold together until joint is set.
(3) (remaining text unchanged)

SUBSTANTIATION:
Currently, it can be difficult to see the yellow solvent cement ring on a tan CTS CPVC joint during inspection. A high contrast cement has been asked for from the field to aid in the inspection of CPVC joints. The color green was chosen because of its high contrast against the tan pipe and fittings and green is not currently used to identify any other type of cement.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 266

UMC 2024  Section: 1211.5

SUBMITTER: Lance MacNevin, P.Eng.
Plastics Pipe Institute

RECOMMENDATION:
Revise text

1211.0 Joints and Connections.

1211.5 Cross-Linked Polyethylene (PEX) Pipe. Joints between cross-linked polyethylene (PEX) pipe and fittings shall be installed with fittings for PEX tubing that comply with the applicable standards referenced in Table 1210.1. PEX tubing labeled in accordance with ASTM F876 or ASTM F3253 shall be marked with the applicable standard designation for the fittings specified for use with the tubing. Mechanical joints shall be installed in accordance with the manufacturer’s installation instructions.

Note: ASTM F3253 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
ASTM F3253 “Standard Specification for Crosslinked Polyethylene (PEX) Tubing with Oxygen Barrier for Hot- and Cold-Water Hydronic Distribution Systems” was first published in 2017. ASTM Specification F3253 was added into the UMC Table 1210.1 “Materials for Hydronic System Piping, Tubing, and Fittings” in the 2021 edition. It was an oversight that PEX tubing produced in accordance with ASTM F3253 was not added into Section 1211.5 at that time.

This revision will clarify that PEX tubing made to ASTM Specification F3253 must comply with the labelling requirements stated within Section 1211.5.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Item #: 267
UMC 2024 Section: 1217.3, 1217.3.1, 1217.4

SUBMITTER: Lance MacNevin, P.Eng.,
Chair, UMC Radiant Cooling Working Group

RECOMMENDATION:
Revise text

1217.0 Radiant Heating and Cooling.

1217.3 Radiant Cooling Systems. Radiant cooling systems shall be designed to minimize the potential for condensation. To prevent condensation on any cooled radiant surface, the supply water temperature for a radiant cooling system shall be not less than 3°F (2°C) above the anticipated space dewpoint temperature, or in accordance with the manufacturer’s recommendation.

1217.3.1 Minimum Floor Temperatures. The minimum floor surface temperature shall not be less than 66°F (19°C) in general occupied applications.

1217.4 Chilled Water Supply/Distribution Piping. Chilled water piping, valves, and fittings, and manifolds shall be insulated and vapor sealed to prevent surface condensation.

(Substantiation)

The UMC Radiant Cooling Working Group was formed in January 2020 by members of ASHRAE TC 6.5, Radiant Heating and Cooling, to address concerns with existing UMC language in Section 1217.3. The working group met through a series of calls throughout 2020 to finalize the language submitted in this proposal.

Proposal 1:
The UMC Radiant Cooling Working Group has identified that the current supply water temperature limitation in Section 1217.3 is overly restrictive and represents design guidance rather than a proper code minimum for health and safety.

The new Section 1217.3.1 is required based on ASHRAE Standard 55, “Thermal Environmental Conditions for Human Occupancy,” which defines the minimum acceptable temperature for a radiant floor of 66°F (19°C), which is well accepted in North America and internationally. This proposal, agreed upon by the UMC Radiant Cooling Working Group, improves the code by clarifying that water temps must be above dewpoint for health & safety while adding a clarifying section for cooling comfort temperature which incorporates the ASHRAE minimum similar to existing Section 1217.2 for Radiant Heating.

The requirements of the proposed Section 1217.4 were previously grouped into Section 1217.3 but have been separated for clarity. Manifolds are being added as another part of the distribution system which are common to radiant systems.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

1217.0 Radiant Heating and Cooling.
1217.3 Radiant Cooling Systems. Radiant cooling systems shall be designed to minimize the potential for condensation. To prevent condensation on any cooled radiant surface, the supply water temperature for a radiant cooling system shall be above the space dewpoint temperature, or in accordance with the manufacturer’s recommendation.

1217.3.1 Minimum Floor Temperatures. The minimum floor surface temperature shall not be less than 66°F (19°C) in general occupied applications.

1217.4 Chilled Water Supply/Distribution Piping. Chilled water piping, valves, fittings, and manifolds shall be insulated and vapor sealed to prevent surface condensation.

Exception: Piping, valves, fittings, and manifolds used to supply radiant cooling systems and where the water temperature is above the space dewpoint temperature shall not require insulation.

COMMITTEE STATEMENT:
The proposal is being modified to include the exception pertaining to insulation of chilled water supply piping, valves, fittings, and manifolds in this proposal from Item # 268.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 268

UMC 2024  Section: 1217.3, 1217.4

SUBMITTER: Lance MacNevin, P.Eng.
Chair, UMC Radiant Cooling Working Group

RECOMMENDATION:
Revise text

1217.0 Radiant Heating and Cooling.

1217.3 Radiant Cooling Systems. Radiant cooling systems shall be designed to minimize the potential for condensation. To prevent condensation on any cooled radiant surface, the supply water temperature for a radiant cooling system shall be not less than 3°F (2°C) above the anticipated space dewpoint temperature, or in accordance with the manufacturer’s recommendation.

1217.4 Chilled Water Supply/Distribution Piping. Chilled water piping, valves, and fittings, and manifolds shall be insulated and vapor sealed to prevent surface condensation. Exception: Piping, valves, fittings, and manifolds used to supply radiant cooling systems and where the water temperature is above the space dewpoint temperature shall not require insulation.

(renumber remaining sections)

SUBSTANTIATION:
The UMC Radiant Cooling Working Group was formed in January 2020 by members of ASHRAE TC 6.5, Radiant Heating and Cooling, to address concerns with existing UMC language in Section 1217.3. The working group met through a series of calls throughout 2020 to finalize the language submitted in this proposal.

Proposal 2:
The requirements of the proposed Section 1217.4 were previously grouped into Section 1217.3 but have been separated for clarity. Manifolds are being added as another part of the distribution system which are common to radiant systems.

The UMC Radiant Cooling Working Group proposes that an exception to the 1217.4 insulation requirements be added to clarify that insulation is not required for radiant cooling systems where the piping system will always operate above the dewpoint. The insulation requirements have been amended such that only piping, valves, fittings, and manifolds subject to condensation (below dewpoint) requires vapor sealed insulation. For example, a high temperature cooling system (e.g., Radiant cooling) operating with a water temperature above the dewpoint supplied from a cooling tower.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the language pertaining to insulation of chilled water supply piping, valves, fittings, and manifolds in this proposal are already being addressed in Item # 267.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 269
UMC 2024  Section: 1217.3

SUBMITTER: Lance MacNevin, P.Eng.
Chair, UMC Radiant Cooling Working Group

RECOMMENDATION:
Revise text

1217.0 Radiant Heating and Cooling.

1217.3 Radiant Cooling Systems. Radiant cooling systems shall be designed to minimize the potential for condensation. To prevent condensation on any cooled radiant surface, the supply water temperature for a radiant cooling system shall be not less than 3°F (2°C) above the anticipated space dewpoint temperature, or in accordance with the manufacturer’s recommendation. Chilled water piping, valves, and fittings shall be insulated and vapor sealed to prevent surface condensation.

SUBSTANTIATION:
The UMC Radiant Cooling Working Group was formed in January 2020 by members of ASHRAE TC 6.5, Radiant Heating and Cooling, to address concerns with existing UMC language in Section 1217.3. The working group met through a series of calls throughout 2020 to finalize the language submitted in this proposal.

Proposal 3:
The UMC Radiant Cooling Working Group has identified that the current supply water temperature limitation in Section 1217.3 is overly restrictive and represents design guidance rather than a proper code minimum for health and safety.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the changes regarding "not less than 3 degrees Fahrenheit" and the deletion of the term "anticipated" in this proposal are already being addressed in Item # 267.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 270
UMC 2024 Section: 1217.4

SUBMITTER: Lance MacNevin, P.Eng.
Plastics Pipe Institute

RECOMMENDATION:
Revise text

1217.4 Tube Placement. Hydronic radiant system tubing shall be installed in accordance with the manufacturer’s installation instructions and with the tube layout and spacing in accordance with the system design. Except for distribution mains, tube spacing and the individual loop lengths shall be installed with a variance of not more than ±10 percent from the design. The maximum loop length of continuous tubing from a supply-and-return manifold shall not exceed the lengths specified by the manufacturer or, in the absence of manufacturer’s specifications, the lengths specified in Table 1217.4. Actual loop lengths shall be determined by spacing, flow rate, and pressure drop requirements as specified in the system design.

For the purpose of system balancing, each individual loop shall have a tag or label securely affixed to the manifold to indicate the length of the loop and the room(s) and area(s) served.

SUBSTANTIATION:
Requiring installation of all radiant tube spacing at ± 10% of design is sometimes too restrictive, so “tube spacing” should be removed from the list as shown. For example, a tubing layout intended to be installed at 8 inch on-center spacing would allow a ± of only 0.8 inches (3/4 inch) throughout an entire area. In rooms with irregular shapes or holes or obstructions in the floor, it may be necessary to adjust tube spacing to allow the tubing to pass around such hole or obstruction. These holes or obstructions may be unknown to the designer of the radiant tubing design and, therefore, the installer must deviate from the tubing design to meet as-built conditions. The majority of the tube spacing may be exactly per design, but a portion of the tube spacing must be allowed to deviate from the design. The proposed deletion provides this practical flexibility.

Also, it is important for radiant tubing loops (circuits) to be tagged or labelled to help identify which circuit, attached to a central manifold, is connected to which room. The addition of "or label" provides the installer with flexibility to achieve this objective.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 271
UMC 2024  Section: Table 1220.4.1

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

<table>
<thead>
<tr>
<th>NOMINAL TUBE SIZE (inches)</th>
<th>MAXIMUM ACTIVE LOOP LENGTH (feet)</th>
<th>TOTAL LOOP LENGTH (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE-RT and PEX Tubing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>115</td>
<td>130</td>
</tr>
<tr>
<td>5/8</td>
<td>225</td>
<td>250</td>
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<td>3/4</td>
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<td>325</td>
</tr>
<tr>
<td>1</td>
<td>450</td>
<td>475</td>
</tr>
<tr>
<td>Copper Tubing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>–</td>
<td>140</td>
</tr>
<tr>
<td>3/4</td>
<td>–</td>
<td>280</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

SUBSTANTIATION:
Proposed changes are being made to update Table 1220.4.1 as the original source (CSA B214) of the table has also been updated. The values within this table have been determined based on the head loss, heat outputs, and various nominal tube sizes listed. Each of these changes are harmonized with the newest edition of CSA B214.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the reference to necessity for correlation with the USHGC in the substantiation.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 272
UMC 2024  Section: 1221.2, 1221.2.3

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Revise text

1221.0 Piping Installation.

1221.2 Embedded Piping Materials and Joints. Piping embedded in concrete shall be steel pipe, Type L copper tubing or plastic pipe or tubing rated at not less than 80 psi at 180°F (552 kPa at 82°C). Joints of pipe or tubing that are embedded in a portion of the building, such as concrete or plaster shall be installed in accordance with the requirements of Section 1221.2.1 through Section 1221.2.3.

1221.2.3 Plastics. Plastic pipe and tubing shall be installed in continuous lengths or shall be joined by heat fusion methods or other approved fittings in accordance with Table 1210.1 and the manufacturer's installation instructions. Exception: Solvent cement joints shall not be used in embedded applications.

SUBSTANTIATION:
Section 1221.2.3 is being modified for clarification on the intent of the exception. The language is being revised to specify that solvent cement joints are not to be used in embedded applications.

The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

1221.0 Piping Installation.

1221.2 Embedded Piping Materials and Joints. Piping embedded in concrete shall be steel pipe, Type L copper tubing or plastic pipe or tubing rated at not less than 80 psi at 180°F (552 kPa at 82°C). Joints of pipe or tubing that are embedded in a portion of the building, such as concrete or plaster shall be installed in accordance with Section 1221.2.1 through Section 1221.2.3.

1221.2.3 Plastics. Plastic pipe and tubing shall be installed in continuous lengths or shall be joined by heat fusion methods or other approved fittings in accordance with Table 1210.1 and the manufacturer's installation instructions. Exception: Solvent cement joints shall not be used in embedded applications.

COMMITTEE STATEMENT:
The proposal is being modified to relocate language pertaining to solvent cements from the exception into the body of the section. There is concern that solvent cement fusion methods are not applicable for embedded applications and subject to failure.

Additionally, the Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30
EXPLANATION OF NEGATIVE:

BALLANCO: There is no justification provided as to why solvent cemented joints should be prohibited in embedded applications. If there have been failures of solvent cemented joints for these applications, such information should be submitted for review.

CUDAHY: There is concern that solvent cement fusion methods are not applicable for embedded applications, but never any proof. Solvent welding is the optimal joining method for certain materials.

MACNEVIN: There is no need to prohibit solvent cemented joints in embedded applications. They have been widely and successfully used in this installation type for many years, and are allowed in other codes. Solvent cement is not "glue," it actually welds pipes and fittings together in strong monolithic joints. This exception is not justified.

WISEMAN: There is no evidence that this is necessary. Without evidence, this proposal should be rejected.
Proposals

Item #: 273
UMC 2024 Section: 1221.2.3

SUBMITTER: Michael Cudahy
PPFA

RECOMMENDATION:
Revise text

1221.0 Piping Installation.

1221.2 Embedded Piping Materials and Joints. (remaining text unchanged)

1221.2.3 Plastics. Plastic pipe and tubing shall be installed in continuous lengths or shall be joined by heat fusion methods, solvent cement, or other approved fittings in accordance with Table 1210.1 and the manufacturer's installation instructions.

Exception: Solvent cement joints.

SUBSTANTIATION:
Like welding for steel and brazing for copper, solvent cementing is the optimal joining method for PVC and CPVC plastic piping systems. While use of those materials in hydronics is less frequent than other piping materials, it should not be specifically excepted.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There is concern that solvent cement fusion methods are not be applicable for embedded applications and are subject to failure.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 24 NEGATIVE: 5 NOT RETURNED: 1 Heine

EXPLANATION OF AFFIRMATIVE:
TRAFTON, P: I concur that there may be concern about this application in embedded locations.

EXPLANATION OF NEGATIVE:
BALLANCO: This change should have been accepted since there is no information provided that solvent cement joints do not perform properly (or fail) for embedded applications.

CUDAHY: There is concern that solvent cement fusion methods are not be applicable for embedded applications and are subject to failure, but never any proof. Solvent welding is the optimal joining method for several materials.

MACNEVIN: There is no need to prohibit solvent cemented joints in embedded applications. Solvent cement is not "glue," it actually welds pipes and fittings together in strong monolithic joints. They have been widely and successfully used in this installation type for many years, and are allowed in other codes. This exception is not justified.

WHITE: There is no reason to exclude solvent cement joints in this application. This should have been accepted.

WISEMAN: Further analysis is necessary.
Proposals

Item #: 274

UMC 2024  Section: Chapter 13, Table 1701.1, Table 1701.2

SUBMITTER: IAPMO Staff - Update Extracts
NFPA 54 Extract Update

RECOMMENDATION:
Revise text

1308.2 Provision for Location of Point of Delivery. The location of the point of delivery shall be acceptable to the serving gas supplier. [NFPA 54:5.2]

1308.3 Interconnections Between Gas Piping Systems Supplying Separate Users. Where two or more meters, or two or more service regulators where meters are not provided, are located on the same premises and supply separate users, the gas piping systems shall not be interconnected on the outlet side of the meters or service regulators. [NFPA 54:5.3.4.5.2.1]

1308.3.1 Interconnections for Standby Fuels. Where a supplementary gas for standby use is connected downstream from a meter or a service regulator where a meter is not provided, equipment to prevent backflow shall be installed. A three-way valve installed to admit the standby supply and at the same time shut off the regular supply shall be permitted to be used for this purpose. [NFPA 54:5.3.2.25.2.2.1 – 5.2.2.2]

1308.4 Sizing of Gas Piping Systems. Gas piping systems shall be of such size and so installed as to provide a supply of gas sufficient to meet the maximum demand and supply gas to each appliance inlet at not less than the minimum supply pressure required by the appliance. [NFPA 54:5.4.4 5.3.1]

1308.4.1 Maximum Gas Demand. The volumetric flow rate of gas to be supplied shall be the sum of the maximum input of the appliances served. The volumetric flow rate of gas to be provided shall be adjusted for altitude where the installation is above 2000 feet (610 m). [NFPA 54:5.4.2.1 – 5.4.2.2 5.3.2.1 – 5.3.2.2] Where the input rating is not indicated, the gas supplier, appliance manufacturer, or a qualified agency shall be contacted or the rating from Table 1308.4.1 shall be used for estimating the volumetric flow rate of gas to be supplied.

The total connected hourly load shall be used as the basis for piping sizing, assuming all appliances are operating at full capacity simultaneously.

Exception: Sizing shall be permitted to be based upon established load diversity factors. [NFPA 54:5.4.2.3 5.3.2.3]

1308.4.2 Sizing Methods. Gas piping shall be sized in accordance with one of the following:
(1) Pipe sizing tables or sizing equations in this chapter.
(2) Other approved engineering methods.
(3) Sizing tables included in a listed piping system manufacturer’s installation instructions.
(4) Engineering methods. [NFPA 54:5.4.3 5.3.3]

1308.4.3 Allowable Pressure Drop. The design pressure loss in any piping system under maximum probable flow conditions, from the point of delivery to the inlet connection of the appliance, all appliances served shall be such that the supply pressure at the each appliance inlet is greater than or equal to the minimum pressure required by the appliance. [NFPA 54:5.4.4 5.3.4]

1308.5 Acceptable Piping Materials and Joining Methods. Materials used for piping systems shall either comply with the requirements of this chapter or be acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.1.1 5.5.1.1]

1308.5.1 Used Materials. Pipe, fittings, valves, or other materials shall not be used again unless they are free of foreign materials and have been ascertained to be adequate for the service intended. [NFPA 54:5.6.1.2 5.5.1.2]

1308.5.1.1 Other Materials. Material not covered by the standards specifications listed herein shall meet the following criteria:
(1) Be investigated and tested to determine that it is safe and suitable for the proposed service.
(2) Be recommended for that service by the manufacturer.
(3) Be acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.1.3]

1308.5.2 Metallic Pipe. Metallic pipe shall be in accordance with Section 1308.5.2.1 through Section 1308.5.2.4.
Cast-iron pipe shall not be used. [NFPA 54: 5.6.2.4 5.5.2.1]

Steel, Stainless Steel, and Wrought-Iron. Steel, stainless steel, and wrought-iron pipe shall be at least Schedule 40 and shall comply with the dimensional standards of ASME B36.10M and one of the following:

(1) ASTM A53
(2) ASTM A106
(3) ASTM A312 [NFPA 54: 5.6.2.2 5.5.2.2]

Copper and Copper Alloy Pipe. Copper and copper alloy pipe shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet (scf) of gas (0.7 mg/100 L). [NFPA 54: 5.6.2.3 5.5.2.3]

Threaded copper, copper alloy, or aluminum alloy pipe shall not be used with gases corrosive to such material. [NFPA 54: 5.6.2.4 5.5.2.4]

Aluminum Alloy Pipe. Aluminum alloy pipe shall comply with ASTM B241 (except that the use of alloy 5456 is prohibited), and shall be marked at each end of each length indicating compliance. Aluminum alloy pipe shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergents, or sewage. [NFPA 54: 5.6.2.5 5.5.2.5]

Aluminum alloy pipe shall not be used in exterior locations or underground. [NFPA 54: 5.6.2.6 5.5.2.6]

Metallic Tubing. Tubing shall not be used with gases corrosive to the tubing material. [NFPA 54: 5.6.3.4 5.5.3.1]

Steel Tubing. Steel tubing shall comply with ASTM A254. [NFPA 54: 5.6.3.2 5.5.3.2]

Stainless Steel Tubing. Stainless steel tubing shall comply with one of the following:

(1) ASTM A268
(2) ASTM A269 [NFPA 54: 5.6.3.3 5.5.3.3]

Copper and Copper Alloy Tubing. Copper and copper alloy tubing shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 scf of gas (0.7 mg/100 L). Copper tubing shall comply with standard Type K or Type L of ASTM B88 or ASTM B280. [NFPA 54: 5.5.3.4]

Aluminum Alloy Tubing. Aluminum alloy tubing shall comply with ASTM B210 or ASTM B241. Aluminum alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergent, or sewage. Aluminum alloy tubing shall not be used in exterior locations or underground. [NFPA 54: 5.6.3.6 5.5.3.5]

Corrugated Stainless Steel Tubing. Corrugated stainless steel tubing shall be listed in accordance with CSA LC-1. [NFPA 54: 5.6.3.6 5.5.3.6]

Plastic Pipe, Tubing, and Fittings. Polyethylene plastic pipe, tubing, and fittings used to supply fuel gas shall conform to ASTM D2513. Pipe to be used shall be marked “gas” and “ASTM D2513.” [NFPA 54: 5.6.4.1.1 5.5.4.1.1]

Polyamide pipe, tubing, and fittings shall be identified in and conform to ASTM F2945. Pipe to be used shall be marked “gas” and “ASTM F2945.” [NFPA 54: 5.6.4.1.2 5.5.4.1.2]

Polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) plastic pipe, tubing, and fittings shall not be used to supply fuel gas. [NFPA 54: 5.6.4.1.3 5.5.4.1.3]

Anodeless Risers. Anodeless risers shall comply with Section 1308.5.4.2.1 through Section 1308.5.4.2.3. [NFPA 54: 5.6.4.2]

Factory-Assembled Anodeless Risers. Factory-assembled anodeless risers shall be recommended by the manufacturer for the gas used and shall be leak-tested by the manufacturer in accordance with written procedures. [NFPA 54: 5.6.4.3(4) 5.5.4.3(1)]

Service Head Adapters and Field-Assembled Anodeless Risers. Service head adapters and field-assembled anodeless risers incorporating service head adapters shall be recommended by the manufacturer for the gas used and shall be design-certified to meet the requirements of Category I of ASTM D2513 and 49 CFR 192.281(e). The manufacturer shall provide the user qualified installation instructions as prescribed by 49 CFR 192.283(b). [NFPA 54: 5.6.4.3(2) 5.5.4.3(2)]

Undiluted Liquefied Petroleum Gas Piping. The use of plastic pipe, tubing, and fittings in undiluted LP-Gas piping systems shall be in accordance with NFPA 58. [NFPA 54: 5.6.4.3(3) 5.5.4.3(3)]

Workmanship and Defects. Gas pipe, tubing, and fittings shall be clear and free from cutting burrs and defects in structure or threading; and shall be thoroughly brushed and chip and scale blown. Defects in pipe, tubing, and fittings shall not be repaired. Defective pipe, tubing, and fittings shall be replaced. [NFPA 54: 5.6.5 5.5.5]

Metallic Pipe Threads. Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ASME B1.20.1. [NFPA 54: 5.6.6.1 5.5.6.1]

Damaged Threads. Pipe with threads that are stripped, chipped, corroded, or otherwise damaged shall not be used. Where a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used. [NFPA 54: 5.6.6.2 5.5.6.2]

Number of Threads. Field threading of metallic pipe shall be in accordance with Table 1308.5.6.2. [NFPA 54: 5.6.6.3 5.5.6.3]

Thread Joint Compounds Sealing. Thread joint sealing materials shall be compatible with the pipe and fitting material on which the compounds are used. [NFPA 54: 5.5.6.4.1] Thread joint sealing materials shall be nonhardening and shall
be resistant to the action of LP-Gas or to any other chemical constituents of the gases to be conducted through the piping. [NFPA 5.5.6.4.3]

1308.5.7 Metallic Piping Joints and Fittings. The type of piping joint used shall be suitable for the pressure and temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, vibration, fatigue, or the weight of the pipe and its contents. [NFPA 5.5.6.7.5.7]

1308.5.7.1 Pipe Joints. Schedule 40 and heavier pipe joints shall be threaded, flanged, brazed, welded, or assembled with press-connect fittings listed to CSA LC 4.

1. Where nonferrous pipe is brazed, the brazing materials shall have a melting point in excess of 1000°F (538°C).
2. Brazing alloys shall not contain more than 0.05 percent phosphorus. (NFPA 5.5.7.1)

1308.5.7.2 Copper Tubing Joints. Copper tubing joints shall be assembled with approved gas tubing fittings, shall be brazed with a material having a melting point in excess of 1000°F (538°C), or shall be assembled with press-connect fittings listed to CSA LC 4. Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems. Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 5.5.7.2]

1308.5.7.3 Stainless Steel Tubing Joints. Stainless steel joints shall be welded, assembled with approved tubing fittings, brazed with a material having a melting point in excess of 1000°F (538°C), or assembled with press-connect fittings listed to CSA LC 4. Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems. Brazing alloys and fluxes shall be recommended by the manufacturer for use on stainless steel alloys. [NFPA 5.5.7.3]

1308.5.7.4 Flared Joints. Flared joints shall be used only in systems constructed from nonferrous pipe and tubing where experience or tests have demonstrated that the joint is suitable for the conditions and where provisions are made in the design to prevent separation of the joints. [NFPA 5.5.7.4]

1308.5.7.5 Metallic Pipe Fittings. Metallic fittings shall comply with the following:

1. Threaded fittings in sizes exceeding 4 inches (100 mm) shall not be used.
2. Fittings used with steel, stainless steel, or wrought-iron pipe shall be steel, stainless steel, copper alloy, malleable iron, or cast-iron.
3. Fittings used with copper or copper alloy pipe shall be copper or copper alloy.
4. Fittings used with aluminum alloy pipe shall be aluminum alloy.
5. Cast-iron fittings shall comply with the following:
   a. Flanges shall be permitted.
   b. Bushings shall not be used.
6. Fittings shall not be used in systems containing flammable gas-air mixtures.
7. Fittings in sizes 4 inches (100 mm) and larger shall not be used indoors unless approved by the Authority Having Jurisdiction.
8. Fittings in sizes 6 inches (150 mm) and larger shall not be used unless approved by the Authority Having Jurisdiction.
9. Aluminum alloy fitting threads shall not form the joint seal.
10. Zinc-aluminum alloy fittings shall not be used in systems containing flammable gas-air mixtures.
11. Special fittings such as couplings, proprietary-type joints, saddle tees, gland-type compression fittings, and flared, flareless, or compression-type tubing fittings shall be as follows:
   a. Used within the fitting manufacturer’s pressure-temperature recommendations.
   b. Used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion, or contraction.
   c. Acceptable to the Authority Having Jurisdiction.
12. When pipe fittings are drilled and tapped in the field, the operation shall be in accordance with the following:
   a. The operation shall be performed on systems having operating pressures of 5 psi (34 kPa) or less.
   b. The operation shall be performed by the gas supplier or their designated representative.
   c. The drilling and tapping operation shall be performed in accordance with written procedures prepared by the gas supplier.
13. The fittings shall be located outdoors.
14. The tapped fitting assembly shall be inspected and proven to be free of leaks. [NFPA 5.5.8(1)]

1308.5.8 Plastic Piping Joints and Fittings. Plastic pipe, tubing, and fittings shall be joined in accordance with the manufacturer’s instructions. Section 1308.5.8.1 through Section 1308.5.8.4 shall be observed when making such joints. [NFPA 5.5.8.8(1)]

1308.5.8.1 Joint Design. The joint shall be designed and installed so that the longitudinal pullout resistance of the joint will be at least equal to the tensile strength of the plastic piping material. [NFPA 5.5.8.1]

1308.5.8.2 Heat Fusion Joint. Heat fusion joints shall be made in accordance with qualified procedures that have been established and proven by test to produce gastight joints at least as strong as the pipe or tubing being joined. Joints shall be made with the joining method recommended by the pipe manufacturer. Heat Polyethylene heat fusion fittings shall be marked “ASTM D2513.” Polyamide heat fusion fittings shall be marked “ASTM F2945.” [NFPA 5.5.8.2]

1308.5.8.3 Compression-Type Mechanical Joints. Where compression-type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal
tubular rigid stiffener shall be used in conjunction with the fitting. The stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. Split tubular stiffeners shall not be used. [NFPA 54:5.6.8(3)]

1308.5.8.4 Liquefied Petroleum Gas Piping Systems. Plastic piping joints and fittings for use in LP-Gas piping systems shall be in accordance with NFPA 58. [NFPA 54:5.6.8(4)]

1308.5.9 Flange Specifications. Cast iron flanges shall be in accordance with ASME B16.1. [NFPA 54:5.6.9.1.1]

1308.5.9.1 Steel Flanges. Steel flanges shall be in accordance with the following:
   (1) ASME B16.5 or
   (2) ASME B16.47. [NFPA 54:5.6.9.1.2]

1308.5.9.2 Non-Ferrous Flanges. Non-ferrous flanges shall be in accordance with ASME B16.24. [NFPA 54:5.6.9.1.3]

1308.5.9.3 Ductile Iron Flanges. Ductile iron flanges shall be in accordance with ASME B16.42. [NFPA 54:5.6.9.1.4]

1308.5.9.4 Dissimilar Flange Connections. Raised-face flanges shall not be joined to flat-faced cast iron, ductile iron or nonferrous material flanges. [NFPA 54:5.6.9.2]

1308.5.9.5 Flange Facings. Standard facings shall be permitted for use under this code. Where 150 psi (1034 kPa) steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed. [NFPA 54:5.6.9.3]

1308.5.9.6 Lapped Flanges. Lapped flanges shall be used only aboveground or in exposed locations accessible for inspection. [NFPA 54:5.6.9.4]

1308.5.10 Flange Gaskets. The material for gaskets shall be capable of withstanding the design temperature and pressure of the piping system and the chemical constituents of the gas being conducted without change to its chemical and physical properties. The effects of fire exposure to the joint shall be considered in choosing the material. [NFPA 54:5.6.10]

1308.5.10.1 Flange Gasket Materials. Acceptable materials shall include the following:
   (a1) Metal (plain or corrugated)
   (b2) Composition
   (c3) Aluminum "O" rings
   (d4) Spiral-wound metal gaskets
   (e5) Rubber-faced phenolic
   (f6) Elastomeric [NFPA 54:5.6.10.1]

1308.5.10.2 Metallic Flange Gaskets. Metallic flange gaskets shall be in accordance with ASME B16.20. [NFPA 54:5.6.10.2.1]

1308.5.10.3 Non-Metallic Flange Gaskets. Non-metallic flange gaskets shall be in accordance with ASME B16.21. [NFPA 54:5.6.10.2.2]

1308.5.10.4 Full-Face Flange Gasket. Full-face flange gaskets shall be used with all non-steel flanges. [NFPA 54:5.6.10.3]

1308.5.10.5 Separated Flanges. When a flanged joint is separated, the gasket shall be replaced. [NFPA 54:5.6.10.4]

1308.6 Gas Meters. Gas meters shall be selected for the maximum expected pressure and permissible pressure drop. [NFPA 54:5.6.1]

1308.6.1 Location. Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement, or necessary maintenance. [NFPA 54:5.6.2.1]

1308.6.1.1 Subject to Protection from Damage. Gas meters shall not be placed where they will be subjected to damage, such as adjacent to a driveway, under a fire escape, in public passages, halls, or where they will be subject to excessive corrosion or vibration. [NFPA 54:5.6.2.2]

1308.6.1.2 Extreme Temperatures. Gas meters shall not be located where they will be subjected to extreme temperatures or sudden extreme changes in temperature or in areas where they are subjected to temperatures beyond those recommended by the manufacturer. [NFPA 54:5.6.2.3]

1308.6.2 Supports. Gas meters shall be supported or connected to rigid piping so as not to exert a strain on the meters. Where flexible connectors are used to connect a gas meter to downstream piping at mobile homes in mobile home parks, the meter shall be supported by a post or bracket placed in a firm footing or by other means providing equivalent support. [NFPA 54:5.6.3]

1308.6.3 Meter Protection. Meters shall be protected against overpressure, backpressure, and vacuum. [NFPA 54:5.6.4]

1308.6.4 Identification. Gas piping at multiple meter installations shall be marked by a metal tag or other permanent means designating the building or the part of the building being supplied and attached by the installing agency. [NFPA 54:5.6.5]

1308.7 Gas Pressure Regulators. A line pressure regulator shall be installed where the gas supply pressure exceeds the maximum allowable inlet pressure of the appliance served. [NFPA 54:5.6.7.1]

1308.7.1 Listing. Line pressure regulators shall be listed in accordance with CSA Z21.80 where the outlet pressure is 503
set to 2 psi (14 kPa) or less. [NFPA 54:5.8.25.7.2]

1308.7.2 Location. The gas pressure regulator shall be accessible for servicing. [NFPA 54:5.8.35.7.3]

1308.7.3 Regulator Protection. Pressure regulators shall be protected against physical damage. [NFPA 54:5.8.45.7.4]

1308.7.4 Regulator Vents. Venting of Line Pressure Regulators. Regulator vents shall be in accordance with Section 1308.15. Line pressure regulators shall comply with all of the following:

- An independent vent to the exterior of the building, sized in accordance with the regulator manufacturer’s instructions, shall be provided where the location of a regulator is such that a ruptured diaphragm will cause a hazard.
- Where more than one regulator is at a location, each regulator shall have a separate vent to the outdoors or, if approved by the Authority Having Jurisdiction, the vent lines shall be permitted to be manifolded in accordance with accepted engineering practices to minimize backpressure in the event of diaphragm failure.
- Materials for vent piping shall be in accordance with Section 1308.5 through Section 1308.5.10.5.

Exception: A regulator and vent limiting means combination listed as complying with CSA Z21.80 shall be permitted to be used without a vent to the outdoors.

1308.7.5 Bypass Piping. Valved and regulated bypasses shall be permitted to be placed around gas line pressure regulators where continuity of service is imperative. [NFPA 54:5.8.6]

1308.7.6 Bypass Piping. Valved and regulated bypasses shall be permitted to be placed around gas line pressure regulators where continuity of service is imperative. [NFPA 54:5.8.6]

1308.7.7 Identification. Line pressure regulators at multiple regulator installations shall be marked by a metal tag or other permanent means designating the building or the part of the building being supplied. [NFPA 54:5.8.7.7]

1308.8 Overpressure Protection. Where the serving gas supplier delivers gas at a pressure greater than 2 psi for piping systems serving appliances designed to operate at a gas pressure of 14 inches water column or less, overpressure protection devices shall be installed. Piping systems serving equipment designed to operate at inlet pressures greater than 14 inches water column (3.5 kPa) shall be equipped with overpressure protection devices as required by the appliance manufacturer’s installation instructions. [NFPA 54:5.9.1.1]

1308.9 Pressure Limitation Requirements. Where piping systems serving appliances designed to operate with a gas supply pressure of 14 inches water column (3.5 kPa) or less are required to be equipped with overpressure protection by Section 1308.8, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance to 2 psi (14 kPa) or less upon a failure of the line pressure regulator. [NFPA 54:5.9.2.1]

1308.9.1 Overpressure Protection Required. Where piping systems serving appliances designed to operate with a gas supply pressure greater than 14 inches water column (3.5 kPa) are required to be equipped with overpressure protection by Section 1308.8, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance as required by the appliance manufacturer’s installation instructions. [NFPA 54:5.9.2.25.8.2.2]

1308.9.2 Overpressure Protection Devices. Each overpressure protection device installed to meet the requirements of this section shall be capable of limiting the pressure to its connected appliance(s) as required by this section independently of any other pressure control equipment in the piping system. [NFPA 54:5.9.2.35.8.2.3]

1308.9.3 Detection of Failure. Each gas piping system for which an overpressure protection device is required by this section shall be designed and installed so that a failure of the primary pressure control device(s) is detectable. [NFPA 54:5.9.2.45.8.2.4]

1308.9.4 Flow Capacity. If a pressure relief valve is used to meet the requirements of this section, it shall have a flow capacity such that the pressure in the protected system is maintained at or below the limits specified in Section 1308.9 under the following conditions:

- The line pressure regulator for which the relief valve is providing overpressure protection has failed wide open.
- The gas pressure at the inlet of the line pressure regulator for which the relief valve is providing overpressure protection is not less than the regulator’s normal operating inlet pressure. [NFPA 54:6.9.2.65.8.2.5]

1308.10 Overpressure Protection Devices. Overpressure protection devices shall be one of the following:

- Pressure relief valve.
- Monitor regulator.
- Series regulator installed upstream from the line regulator and set to continuously limit the pressure on the inlet of the line regulator to the maximum values specified by Section 1308.9 or less.
- Automatic shutoff device installed in series with the line pressure regulator and set to shut off when the pressure on the downstream piping system reaches the maximum values specified by Section 1308.9 or less. This device shall be designed so that it will remain closed until manually reset. [NFPA 54:5.9.2.45.8.3.1]

1308.10.1 Separate Devices. The devices in Section 1308.10 shall be installed either as an integral part of the service or line pressure regulator or as separate devices. Where separate overpressure protection devices are installed, they shall comply with Section 1308.10.2 through Section 1308.10.7. [NFPA 54:5.9.3.25.8.3.2]

1308.10.2 Construction and Installation. All overpressure protection devices shall meet the following requirements:

- Be constructed of materials so that the operation of the device is not impaired by corrosion of external parts by the
5.9.8.2 or vent line shall be at least the same size as the outlet of the pressure relieving device. [NFPA 54:5.9.8.1, 5.9.8.2]

1308.10.4 Setting. Each pressure limiting or pressure relieving device shall be set so that the gas pressure supplied to the connected appliance(s) does not exceed the limits specified in Section 1308.9 and Section 1308.9.1. [NFPA 54:5.9.10.4]

1308.10.5 Unauthorized Operation. Where unauthorized operation of any shutoff valve could render a pressure relieving valve or pressure limiting device inoperative, one of the following shall be accomplished:

(1) The valve shall be locked in the open position. Instruct authorized personnel in the importance of leaving the shutoff valve open and of being present while the shutoff valve is closed so that it can be locked in the open position before leaving the premises.

(2) Duplicate relief valves shall be installed, each having adequate capacity to protect the system, and arrange the isolating valves or three-way valve so that only one relief valve can be rendered inoperative at a time. [NFPA 54:5.9.75.7, 5.9.8.1, 5.9.8.2]

1308.10.6 Discharge of Vents. The discharge stacks, vents, or outlet parts of all pressure relieving and pressure limiting devices shall be located so that gas is safely discharged to the outdoors. Discharge stacks or vents shall be designed to prevent the entry of water, insects, or other foreign material that could cause blockage. The discharge stack or vent line shall be at least the same size as the outlet of the pressure relieving device. [NFPA 54:5.9.8.4, 5.9.8.25.8.8.1, 5.8.8.2]

1308.10.7 Size of Fittings, Pipe, and Openings. The fittings, pipe, and openings located between the system to be protected and the pressure relieving device shall be sized to prevent hammering of the valve and to prevent impairment of relief capacity. [NFPA 54:5.9.8.5, 5.9.8.9]

1308.11 Backpressure Protection. Protective devices shall be installed as close to the equipment as practical where the design of equipment connected is such that air, oxygen, or standby gases could be forced into the gas supply system. Gas and air combustion mixers incorporating double diaphragm “zero” or “atmosphere” governors or regulators shall require no further protection unless connected directly to compressed air or oxygen at pressures of 5 psi (34 kPa) or more. [NFPA 54:5.40.11, 5.40.1.25.9.1.1, 5.9.1.2]

1308.11.1 Protective Devices. Protective devices shall include but not be limited to the following:

(1) Check valves.

(2) Reverse flow indicators controlling positive shutoff valves.

(3) Normally closed air-actuated positive shutoff pressure regulators. [NFPA 54:5.40.25.9.2]

1308.12 Low-Pressure Protection. A protective device shall be installed between the meter and the appliance or equipment if the operation of the appliance or equipment is such that it could produce a vacuum or a dangerous reduction in gas pressure at the meter. Such protective devices include, but are not limited to, mechanical, diaphragm-operated, or electrically operated low-pressure shutoff valves. [NFPA 54:5.445.10]

1308.13 Shutoff Valves. Shutoff valves shall be approved and shall be selected giving consideration to pressure drop, service involved, emergency use, and reliability of operation in accordance with Table 1308.13. Shutoff valves of size 1 inch (25 mm) National Pipe Thread and smaller shall be listed and labeled. Where used outdoors, such use shall be in accordance with the manufacturer’s recommendation. [NFPA 54:5.425.11]

1308.14 Expansion and Flexibility. Piping systems shall be designed to prevent failure from thermal expansion or contraction. [NFPA 54:5.444, 5.13.1]

1308.14.1 Special Local Conditions. Where local conditions include earthquake, tornado, unstable ground, or flood hazards, special consideration shall be given to increased strength and flexibility of piping supports and connections. [NFPA 54:5.444, 5.13.2]

1308.15 Pressure Regulator and Pressure Control Venting. The venting of the atmospheric side of diaphragms in line pressure regulators, gas appliance regulators, and gas pressure limit controls shall be in accordance with all of the following:

(1) An independent vent pipe to the outdoors, sized in accordance with the device manufacturer's instructions, shall be provided where the location of a device is such that a discharge of fuel gas will cause a hazard. For devices other than appliance regulators, vents are not required to be independent where the vents are connected to a common manifold designed in accordance with engineering methods to minimize backpressure in the event of diaphragm failure and such design is approved.

Exceptions:

(1) A regulator and vent limiting means combination listed as complying with ANSI Z21.80/CSA 6.22, shall not be required to be vented to the outdoors.

(2) A listed gas appliance regulator factory equipped with a vent limiting device is not required to be vented to the outdoors.

(2) Materials for vent piping shall be in accordance with Section 1308.5 through Section 1308.5.10.5.
(3) The vent terminus shall be designed to prevent the entry of water, insects, and other foreign matter that could cause blockage.
(4) Vent piping shall be installed to minimize static loads and bending moments placed on the regulators and gas pressure control devices.
(5) Vents shall terminate not less than 3 feet (914 mm) from a possible source of ignition.
(6) At locations where a vent termination could be submerged during floods or snow accumulations, an antiflood-type breather vent fitting shall be installed, or the vent terminal shall be located above the height of the expected flood waters or snow.
(7) Vent piping from pressure regulators and gas pressure controls shall not be connected to a common manifold that serves a bleed line from a diaphragm-type gas valve. [NFPA 54:5.14]

1309.0 Excess Flow Valve.
1309.1 General. Where automatic excess flow valves are installed, they shall be listed to CSA in accordance with ANSI Z21.93/CSA 6.30 and shall be sized and installed in accordance with the manufacturer’s instructions. [NFPA 54:5.4.35.12]

1310.0 Gas Piping Installation.
1310.1 Piping Underground. Underground gas piping shall be installed with sufficient clearance from any other underground structure to avoid contact therewith, to allow maintenance, and to protect against damage from proximity to other structures. In addition, underground plastic piping shall be installed with sufficient clearance or shall be insulated from any source of heat so as to prevent the heat from impairing the serviceability of the pipe. [NFPA 54:7.1.1.1, 7.1.1.2]

1310.1.1 Cover Requirements. Underground piping systems shall be installed with a minimum of 12 inches (305 mm) of cover. The minimum cover shall be increased to 18 inches (457 mm) if external damage to the pipe or tubing from external forces is likely to result. Where a minimum of 12 inches (305 mm) of cover cannot be provided, the pipe shall be installed in conduit or bridged ( shielded ). [NFPA 54:7.1.2.1 – 7.1.2.1(B)]

1310.1.5 Piping Through Foundation Wall. Piping through a foundation wall shall comply with all of the following:
(1) Underground piping, where installed through the outer foundation or basement wall of a building, shall be encased in a protective sleeve or protected by an approved device or method.
(2) The space between the gas piping and the sleeve and between the sleeve and the wall shall be sealed to prevent entry of gas and water.
(3) Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.1.5]

1310.1.7 Connections of Plastic Piping. Plastic piping shall be installed outdoors, underground only. Exceptions:
(1) Plastic piping shall be permitted to terminate aboveground where an anodeless riser is used.
(2) Plastic piping shall be permitted to terminate with a wall head adapter aboveground in buildings, including basements, where the plastic piping is inserted in a piping material permitted for use in buildings. [NFPA 54:7.1.7.1]

1310.3 Installation of Aboveground Piping. Piping installed aboveground shall comply with all of the following:
(1) Piping shall be securely supported and located where it will be protected from physical damage.
(2) Where passing through an exterior wall, the piping shall also be protected from corrosion by coating or wrapping with an inert material approved for such applications.
(3) The piping shall be sealed around its circumference at the point of the exterior penetration to prevent the entry of water, insects, and rodents.
(4) Where piping is encased in a protective pipe sleeve, the annular spaces between the gas piping and the sleeve and between the sleeve and the wall opening shall be sealed.
(5) Piping installed outdoors shall be elevated not less than 3\(\frac{1}{2}\) inches (89 mm) above the ground.
(6) Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.2.1]

1310.3.5.3 Piping on Roofs. Gas piping installed on the roof surfaces shall be elevated above the roof surface and shall be supported in accordance with Table 1310.3.5.1. Gas piping shall be elevated not less than 3\(\frac{1}{2}\) inches (89 mm) above the roof surface. [NFPA 54:7.2.6.4.1, 7.2.6.4.2]

1310.4.4 Piping in Floors Industrial Occupancies. In industrial occupancies, gas piping in solid floors such as concrete shall be laid in channels in the floor and covered to permit access to the piping with a minimum of damage to the building. Where piping in floor channels could be exposed to excessive moisture or corrosive substances, the piping shall be protected in an approved manner. [NFPA 54:7.3.5.1]

Exception: 1310.4.5 Other Occupancies. In other than industrial occupancies and where approved by the Authority Having Jurisdiction, gas piping embedded in concrete floor slabs constructed with Portland cement shall be surrounded with a minimum of 1\(\frac{1}{2}\) inches (38 mm) of concrete and shall not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. All piping, fittings, and risers shall be protected against corrosion in accordance with Section 1308.5.6. Piping shall not be embedded in concrete slabs containing quick-set additives or cinder aggregate. [NFPA 54:7.3.5.2]

1310.6 Maximum Operating Pressure in Buildings. The maximum operating pressure for any piping systems located inside buildings shall not exceed 5 psi (34 kPa) unless one or more of the following conditions are met:
The piping joints are welded or brazed.

The piping is joined by fittings listed to ANSI LC 4/CSA 6.32 and installed according to the manufacturer's installation instructions.

The piping joints are flanged and all pipe-to-flange connections are made by welding or brazing.

The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.

The piping is located inside buildings or separate areas of buildings used exclusively for one of the following:
(a) Industrial processing or heating
(b) Research
(c) Warehousing
(d) Boiler or mechanical rooms

The piping is a temporary installation for buildings under construction.

The piping serves appliances or equipment used for agricultural purposes.

The piping system is an LP-Gas piping system with an operating pressure greater than 20 psi (138 kPa) and complies with NFPA 58. [NFPA 54: 5.5.4 5.4.4]

**TABLE 1308.13**

**MANUAL GAS VALVE STANDARDS**

**[NFPA 54: TABLE 5.11]**

<table>
<thead>
<tr>
<th>SHUTOFF VALVE APPLICATION</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appliance shutoff valve up to 1/2 psi</td>
<td>ANSI Z21.15/CSA 9.1</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.44</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32</td>
</tr>
<tr>
<td>Valve up to 1/2 psi</td>
<td>ANSI/ASME B16.44</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32</td>
</tr>
<tr>
<td>Valve up to 2 psi</td>
<td>ANSI/ASME B16.44 labeled 2G</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32 with ANSI/ASME B16.44 labeled 2G or labeled 5G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32 with ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td>Valve up to 5 psi</td>
<td>ANSI/ASME B16.44 labeled 5G</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32 with ANSI/ASME B16.44 marked 5G</td>
</tr>
</tbody>
</table>
ANSI LC 4/CSA 6.32 with ANSI/ASME B16.33 marked 125 G
Valve up to 125 psi
ANSI/ASME B16.33 marked 125 G
ANSI LC 4/CSA 6.32 with ANSI/ASME B16.33 marked 125 G

SI Units: 1 pound-force per square inch = 6.8947 kPa

1310.14.5 Installation of Gas-Mixing Machines. Installation of gas-mixing machines shall comply with the following:

(1) **Location.** The gas-mixing machine shall be located in a well-ventilated area or in a detached building or cutoff room provided with room construction and explosion vents in accordance with sound engineering principles. Such rooms or below-grade installations shall have adequate positive ventilation. [NFPA 54:7.11.5.1]

(2) **Electrical Requirements.** Where gas-mixing machines are installed in well-ventilated areas, the type of electrical equipment shall be in accordance with NFPA 70 for general service conditions unless other hazards in the area prevail. Where gas-mixing machines are installed in small detached buildings or cutoff rooms, the electrical equipment and wiring shall be installed in accordance with NFPA 70 for hazardous locations (Articles 500 and 501, Class I, Division 2). [NFPA 54:7.11.5.2]

(3) **Air Intakes.** Air intakes for gas-mixing machines using compressors or blowers shall be taken from outdoors whenever practical. [NFPA 54:7.11.5.3]

(4) **Controls.** Controls for gas-mixing machines shall include interlocks and a safety shutoff valve of the manual reset type in the gas supply connection to each machine arranged to automatically shut off the gas supply in the event of high or low gas pressure. Except for open burner installations only, the controls shall be interlocked so that the blower or compressor stops operating following a gas supply failure. Where a system employs pressurized air, means shall be provided to shut off the gas supply in the event of air failure. [NFPA 54:7.11.5.4]

(5) **Installation in Parallel.** Centrifugal gas-mixing machines in parallel shall be reviewed by the user and equipment manufacturer before installation, and means or plans for minimizing the effects of downstream pulsation and equipment overload shall be prepared and utilized as needed. [NFPA 54:7.11.5.1—7.11.5.5]

1311.0 Electrical Bonding and Grounding.

1311.4 Prohibited Use. Gas piping shall not be used as a grounding conductor or electrode. [NFPA 54:7.42.4 7.12.4.1]

1312.0 Appliance and Equipment Connections to Building Piping.

1312.1 Connecting Appliances and Equipment. Appliances and equipment shall be connected to the building piping in compliance with Section 1312.6 through Section 1312.8 by one of the following:

(1) Rigid metallic pipe and fittings.

(2) Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.

(3) A listed connector for gas appliances listed in compliance with CSA Z21.24. The connector shall be used in accordance with the manufacturer’s installation instructions and shall be in the same room as the appliance. Only one connector shall be used per appliance.

(4) A listed connector for outdoor gas appliances and manufactured homes listed in compliance with CSA Z21.75. Only one connector shall be used per appliance.

(5) CSST where installed in accordance with the manufacturer’s installation instructions. CSST shall not be directly routed into a metallic appliance enclosure where the appliance is connected to a metallic vent that terminates above a roofline. CSST shall connect only to appliances that are fixed in place.

(6) Listed nonmetallic gas hose connectors in accordance with Section 1312.3.

(7) Unlisted gas hose connectors for use in laboratories and educational facilities in accordance with Section 1312.4. [NFPA 54:9.6.1.3]

1312.1.1 Commercial Cooking Appliances Food Service Appliance Connectors. Connectors used with commercial cooking food service appliances that are moved for cleaning and sanitation purposes shall be installed in accordance with CSA Z21.69. [NFPA 54:9.6.1.3]

1312.7 Quick-Disconnect Devices. Quick-disconnect devices used to connect appliances to the building piping shall be listed to in accordance with CSA Z21.41. Where installed indoors, an approved manual shutoff valve with a nondisplaceable valve member shall be installed upstream of the quick-disconnect device. [NFPA 54:9.6.6 – 9.6.6.2]

### TABLE 1308.4.1

| APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES |
| [NFPA 54: TABLE A.5.4.2.1 A.5.3.2.1] |

### TABLE 1308.5.6.2

| SPECIFICATIONS FOR THREADING METALLIC PIPE |
TABLE 1310.3.5.1
SUPPORT OF PIPING

<table>
<thead>
<tr>
<th>STEEL PIPE, NOMINAL SIZE OF PIPE (inches)</th>
<th>SPACING OF SUPPORTS (feet)</th>
<th>NOMINAL SIZE OF TUBING SMOOTH WALL SMOOTH WALL (inches O.D.)</th>
<th>SPACING OF SUPPORTS (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>6</td>
<td>1/2</td>
<td>4</td>
</tr>
<tr>
<td>3/4 or 1</td>
<td>8</td>
<td>5/8 or 3/4</td>
<td>6</td>
</tr>
<tr>
<td>1 1/4 or larger (horizontal)</td>
<td>10</td>
<td>7/8 or 1 (horizontal)</td>
<td>8</td>
</tr>
<tr>
<td>1 1/4 or larger (vertical)</td>
<td>Every floor level</td>
<td>1 or larger (vertical)</td>
<td>Every floor level</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

TABLE 1313.6.1
SIZE AND LENGTH OF PIPING

* CSST EHD size of 62 is equivalent to nominal 2 inches (50 mm) nominal size pipe or tubing size.

TABLE 1315.2(27)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3.1(d)]

<table>
<thead>
<tr>
<th>GAS: UNDILUTED PROPANE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INLET PRESSURE: 11.0 In. w.c.</td>
</tr>
<tr>
<td>PRESSURE DROP: 0.5 In. w.c.</td>
</tr>
<tr>
<td>SPECIFIC GRAVITY: 1.50</td>
</tr>
</tbody>
</table>

INTENDED USE: PIPE SIZING BETWEEN SINGLE- OR SECOND-STAGE (LOW-PRESSURE) REGULATOR AND APPLIANCE.

<table>
<thead>
<tr>
<th>PIPE SIZE (inch)</th>
<th>NOMINAL INSIDE 1/2</th>
<th>3/4</th>
<th>1</th>
<th>1 1/4</th>
<th>1 1/2</th>
<th>2</th>
<th>2 1/2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTUAL ID:</td>
<td>0.622</td>
<td>0.824</td>
<td>1.049</td>
<td>10.380</td>
<td>1.610</td>
<td>2.067</td>
<td>2.469</td>
<td>3.068</td>
<td>4.026</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LENGTH (feet)</th>
<th>CAPACITY IN THOUSANDS OF BTU PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>291 608 1150 2350 3520 6790 10 800 19 100 39 000</td>
</tr>
<tr>
<td>20</td>
<td>200 418 787 1620 2420 4660 7430 13 100 26 800</td>
</tr>
<tr>
<td>30</td>
<td>160 336 632 1300 1940 3750 5970 10 600 21 500</td>
</tr>
<tr>
<td>40</td>
<td>137 287 541 1110 1660 3210 5110 9030 18 400</td>
</tr>
<tr>
<td>50</td>
<td>122 255 480 985 1480 2840 4530 8000 16 300</td>
</tr>
<tr>
<td>60</td>
<td>110 231 434 892 1340 2570 4100 7250 14 800</td>
</tr>
<tr>
<td>8070</td>
<td>101 212 400 821 1230 2370 3770 6670 13 600</td>
</tr>
<tr>
<td>40080</td>
<td>94 197 372 763 1140 2200 3510 6210 12 700</td>
</tr>
<tr>
<td>42590</td>
<td>89 185 349 716 1070 2070 3290 5820 11 900</td>
</tr>
<tr>
<td>450100</td>
<td>84 175 330 677 1010 1950 3110 5500 11 200</td>
</tr>
<tr>
<td>476250</td>
<td>74 155 292 600 899 1730 2760 4880 9950</td>
</tr>
<tr>
<td>290150</td>
<td>67 140 265 543 814 1570 2500 4420 9010</td>
</tr>
<tr>
<td>260175</td>
<td>62 129 243 500 749 1440 2300 4060 8290</td>
</tr>
<tr>
<td>300200</td>
<td>58 120 227 465 697 1340 2140 3780 7710</td>
</tr>
<tr>
<td>360250</td>
<td>51 107 201 412 618 1190 1900 3350 6840</td>
</tr>
</tbody>
</table>
### TABLE 1701.1
**REFERENCED STANDARDS**

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B16.33-2012 (R2017)</td>
<td>Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 175 psi (Sizes NPS 1/2 through NPS 2)</td>
<td>Valves</td>
<td>Table 1308.13</td>
</tr>
<tr>
<td>ASME B16.44-2012 (R2017)</td>
<td>Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi</td>
<td>Valves</td>
<td>Table 1308.13</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**Note:** The ASME and CSA standards meet the requirements for mandatory reference standards in accordance with Section 3.3.7.1 of IAPMO’s Regulations Governing Committee Projects.

### TABLE 1701.2
**STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES**

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B16.33-2012 (R2017)</td>
<td>Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 175 psi (Sizes NPS 1/2 through NPS 2)</td>
<td>Valves</td>
</tr>
<tr>
<td>CSA Z21.15b-2013 (R2014)</td>
<td>Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves (same as CSA 9.1b)</td>
<td>Fuel Gas</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**SUBSTANTIATION:**
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 13 is being revised to the latest edition of NFPA 54-2021.

**COMMITTEE ACTION:** ACCEPT AS AMENDED BY THE TC
1308.3 Interconnections Supplying Separate Users. Where two or more meters, or two or more service regulators where meters are not provided, are located on the same premises and supply separate users, the gas piping systems shall not be interconnected on the outlet side of the meters or service regulators. [NFPA 54:5.2.1]

1308.3.1 Interconnections for Standby Fuels. Where a supplementary gas for standby use is connected downstream from a meter or a service regulator where a meter is not provided, equipment to prevent backflow shall be installed. A three-way valve installed to admit the standby supply and at the same time shut off the regular supply shall be permitted to be used for this purpose. [NFPA 54:5.2.2.1 – 5.2.2.2]

1308.4 Sizing of Gas Piping Systems. Gas piping systems shall be of such size and so installed as to provide a supply of gas sufficient to meet the maximum demand and supply gas to each appliance inlet at not less than the minimum supply pressure required by the appliance. [NFPA 54:5.3.1]

1308.4.1 Maximum Gas Demand. The volumetric flow rate of gas to be provided shall be the sum of the maximum input of the appliances served. The volumetric flow rate of gas to be provided shall be adjusted for altitude where the installation is above 2,000 feet (610 m). [NFPA 54:5.3.2.1 – 5.3.2.2] Where the input rating is not indicated, the gas supplier, appliance manufacturer, or a qualified agency shall be contacted or the rating from Table 1308.4.1 shall be used for estimating the volumetric flow rate of gas to be supplied.

The total connected hourly load shall be used as the basis for piping sizing, assuming all appliances are operating at full capacity simultaneously.

Exception: Sizing shall be permitted to be based upon established load diversity factors. [NFPA 54:5.3.2.3]

1308.4.2 Sizing Methods. Gas piping shall be sized in accordance with one of the following:

(1) Pipe sizing tables or sizing equations in this chapter.

(2) Sizing tables included in a listed piping system manufacturer’s installation instructions.

(3) Engineering methods. [NFPA 54:5.3.3]

1308.4.3 Allowable Pressure Drop. The design pressure loss in a piping system from the point of delivery to the inlet connection of all appliances served shall be such that the supply pressure at each appliance inlet is greater than or equal to the minimum pressure required by the appliance. [NFPA 54:5.3.4]

1308.5 Acceptable Piping Materials and Joining Methods. Materials used for piping systems shall either comply with the requirements of this chapter or be acceptable to the Authority Having Jurisdiction. [NFPA 54:5.5.1.1]

1308.5.1 Used Materials. Pipe, fittings, valves, or other materials shall not be used again unless they are free of foreign materials and have been ascertained to be adequate for the service intended. [NFPA 54:5.5.1.2]

1308.5.2 Metallic Pipe. Metallic pipe shall be in accordance with Section 1308.5.2.1 through Section 1308.5.2.4.

1308.5.2.1 Cast Iron. Cast-iron pipe shall not be used. [NFPA 54:5.5.2.1]

1308.5.2.2 Steel, Stainless Steel, and Wrought-Iron. Steel, stainless steel, and wrought-iron pipe shall be at least Schedule 40 and shall comply with the dimensional standards of ASME B36.10M and one of the following:

(1) ASTM A53

(2) ASTM A106

(3) ASTM A312 {NFPA 54:5.5.2.2}

1308.5.2.3 Copper and Copper Alloy Pipe. Copper and copper alloy pipe shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet (scf) of gas (0.7 mg/100 L). [NFPA 54:5.5.2.3]

Threaded copper, copper alloy, or aluminum alloy pipe shall not be used with gases corrosive to such material. [NFPA 54:5.5.2.4]

1308.5.2.4 Aluminum Alloy Pipe. Aluminum alloy pipe shall comply with ASTM B241 (except that the use of alloy 5456 is prohibited), and shall be marked at each end of each length indicating compliance. Aluminum alloy pipe shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergents, or sewage. [NFPA 54:5.5.2.5]

Aluminum alloy pipe shall not be used in exterior locations or underground. [NFPA 54:5.5.2.6]

1308.5.3 Metallic Tubing. Tubing shall not be used with gases corrosive to the tubing material. [NFPA 54:5.5.3.1]

1308.5.3.1 Steel Tubing. Steel tubing shall comply with ASTM A254. [NFPA 54:5.5.3.2]

1308.5.3.2 Stainless Steel Tubing. Stainless steel tubing shall comply with one of the following:

(1) ASTM A268

(2) ASTM A269 [NFPA 54:5.5.3.3]

1308.5.3.3 Copper and Copper Alloy Tubing. Copper and copper alloy tubing shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 scf of gas (0.7 mg/100 L). Copper tubing shall comply with standard Type K or Type L of ASTM B88 or ASTM B280. [NFPA 54:5.5.3.4]

1308.5.3.4 Aluminum Alloy Tubing. Aluminum alloy tubing shall comply with ASTM B210 or ASTM B241. Aluminum alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergent, or sewage. Aluminum alloy tubing shall not be used in exterior locations or underground. [NFPA 54:5.5.3.5]

1308.5.3.5 Corrugated Stainless Steel Tubing. Corrugated stainless steel tubing shall be listed in accordance with CSA LC-1. [NFPA 54:5.5.3.6]

1308.5.4 Plastic Pipe, Tubing, and Fittings. Polyethylene plastic pipe, tubing, and fittings used to supply fuel gas shall
conform to ASTM D2513. Pipe to be used shall be marked “gas” and “ASTM D2513.” [NFPA 54:5.5.4.1.1] Polyamide pipe, tubing, and fittings shall be identified in and conform to ASTM F2945. Pipe to be used shall be marked “gas” and “ASTM F2945.” [NFPA 54:5.5.4.1.2] Polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) plastic pipe, tubing, and fittings shall not be supplied to fuel gas. [NFPA 54:5.5.4.1.3]

1308.5.4.1 Regulator Vent Piping. Plastic pipe and fittings used to connect regulator vents to remote vent terminations shall be PVC conforming to UL 651. PVC vent piping shall not be installed indoors. [NFPA 54:5.5.4.2]

1308.5.4.2 Anodeless Risers. Anodeless risers shall comply with Section 1308.5.4.2.1 through Section 1308.5.4.2.3.

1308.5.4.2.1 Factory-Assembled Anodeless Risers. Factory-assembled anodeless risers shall be recommended by the manufacturer for the gas used and shall be leak-tested by the manufacturer in accordance with written procedures. [NFPA 54:5.5.4.3(1)]

1308.5.4.2.2 Service Head Adapters and Field-Assembled Anodeless Risers. Service head adapters and field-assembled anodeless risers incorporating service head adapters shall be recommended by the manufacturer for the gas used and shall be design-certified to meet the requirements of Category I of ASTM D2513 and 49 CFR 192.281(e). The manufacturer shall provide the user qualified installation instructions as prescribed by 49 CFR 192.283(b). [NFPA 54:5.5.4.3(2)]

1308.5.4.2.3 Undiluted Liquefied Petroleum Gas Piping. The use of plastic pipe, tubing, and fittings in undiluted LP-gas piping systems shall be in accordance with NFPA 58. [NFPA 54:5.5.4.3(3)]

1308.5.5 Workmanship and Defects. Gas pipe, tubing, and fittings shall be clear and free from cutting burrs and defects in structure or threading, and shall be thoroughly brushed and chip and scale blown. Defects in pipe, tubing, and fittings shall not be repaired. Defective pipe, tubing, and fittings shall be replaced. [NFPA 54:5.5.5]

1308.5.6 Metallic Pipe Threads. Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ASME B1.20.1. [NFPA 54:5.5.6.1]

1308.5.6.1 Damaged Threads. Pipe with threads that are stripped, chipped, corroded, or otherwise damaged shall not be used. Where a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used. [NFPA 54:5.5.6.2]

1308.5.6.2 Number of Threads. Field threading of metallic pipe shall be in accordance with Table 1308.5.6.2. [NFPA 54:5.5.6.3]

1308.5.6.3 Thread Joint Sealing. Threaded joints shall be made using a thread joint sealing material. [NFPA 54:5.5.6.4.1] Thread joint sealing materials shall be compatible with the pipe and fitting material on which the compounds are used. [NFPA 54:5.5.6.4.2] Thread joint sealing materials shall be nonhardening and shall be resistant to the chemical constituents of the gases to be conducted through the piping. [NFPA 54:5.5.6.4.3]

1308.5.7 Metallic Piping Joints and Fittings. The type of piping joint used shall be suitable for the pressure and temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, vibration, fatigue, or the weight of the pipe and its contents. [NFPA 54:5.5.7]

1308.5.7.1 Pipe Joints. Schedule 40 and heavier pipe joints shall be threaded, flanged, brazed, welded, or assembled with press-connect fittings listed to CSA LC 4.

(1) Where nonferrous pipe is brazed, the brazing materials shall have a melting point in excess of 1000°F (538°C).

(2) Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.5.7.1]

1308.5.7.2 Copper Tubing Joints. Copper tubing joints shall be assembled with approved gas tubing fittings, shall be brazed with a material having a melting point in excess of 1000°F (538°C), or shall be assembled with press-connect fittings listed to CSA LC 4. Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.5.7.2]

1308.5.7.3 Stainless Steel Tubing Joints. Stainless steel joints shall be welded, assembled with approved tubing fittings, brazed with a material having a melting point in excess of 1000°F (538°C), or assembled with press-connect fittings listed to CSA LC 4. Brazing alloys and fluxes shall be recommended by the manufacturer for use on stainless steel alloys. [NFPA 54:5.5.7.3]

1308.5.7.4 Flared Joints. Flared joints shall be used only in systems constructed from nonferrous pipe and tubing where experience or tests have demonstrated that the joint is suitable for the conditions and where provisions are made in the design to prevent separation of the joints. [NFPA 54:5.5.7.4]

1308.5.7.5 Metallic Pipe Fittings. Metallic fittings shall comply with the following:

(1) Threaded fittings in sizes exceeding 4 inches (100 mm) shall not be used.

(2) Fittings used with steel, stainless steel, or wrought-iron pipe shall be steel, stainless steel, copper alloy, malleable iron, or cast-iron.

(3) Fittings used with copper or copper alloy pipe shall be copper or copper alloy.

(4) Fittings used with aluminum alloy pipe shall be aluminum alloy.

(5) Cast-iron fittings shall comply with the following:

(a) Flanges shall be permitted.

(b) Bushings shall not be used.

(c) Fittings shall not be used in systems containing flammable gas-air mixtures.

(d) Fittings in sizes 4 inches (100 mm) and larger shall not be used indoors unless approved by the Authority Having Jurisdiction.
Fittings in sizes 6 inches (150 mm) and larger shall not be used unless approved by the Authority Having Jurisdiction.

(6) Aluminum alloy fitting threads shall not form the joint seal.

(7) Special fittings such as couplings, proprietary-type joints, saddle tees, gland-type compression fittings, and flared, flareless, or compression-type tubing fittings shall be as follows:

(a) Used within the fitting manufacturer’s pressure-temperature recommendations.

(b) Used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion, or contraction.

(c) Acceptable to the Authority Having Jurisdiction.

(9) When pipe fittings are drilled and tapped in the field, the operation shall be in accordance with the following:

(a) The operation shall be performed on systems having operating pressures of 5 psi (34 kPa) or less.

(b) The operation shall be performed by the gas supplier or their designated representative.

(c) The drilling and tapping operation shall be performed in accordance with written procedures prepared by the gas supplier.

(d) The fittings shall be located outdoors.

(e) The tapped fitting assembly shall be inspected and proven to be free of leaks. [NFPA 54:5.5.7.5]

1308.5.8 Plastic Piping Joints and Fittings. Plastic pipe, tubing, and fittings shall be joined in accordance with the manufacturers’ instructions. Section 1308.5.8.1 through Section 1308.5.8.4 shall be observed when making such joints. [NFPA 54:5.5.8]

1308.5.8.1 Joint Design. The joint shall be designed and installed so that the longitudinal pullout resistance of the joint will be at least equal to the tensile strength of the plastic piping material. [NFPA 54:5.5.8(1)]

1308.5.8.2 Heat Fusion Joint. Heat fusion joints shall be made in accordance with qualified procedures that have been established and proven by test to produce gastight joints at least as strong as the pipe or tubing being joined. Joints shall be made with the joining method recommended by the pipe manufacturer. Polyethylene heat fusion fittings shall be marked “ASTM D2513.” Polyamide heat fusion fittings shall be marked “ASTM F2945.” [NFPA 54:5.5.8(2)]

1308.5.8.3 Compression-Type Mechanical Joints. Where compression-type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting. The stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. Split tubular stiffeners shall not be used. [NFPA 54:5.5.8(3)]

1308.5.8.4 Liquefied Petroleum Gas Piping Systems. Plastic piping joints and fittings for use in LP-Gas piping systems shall be in accordance with NFPA 58. [NFPA 54:5.5.8(4)]

1308.5.9 Flange Specifications. Cast iron flanges shall be in accordance with ASME B16.1. [NFPA 54:5.5.9.1.1]

1308.5.9.1 Steel Flanges. Steel flanges shall be in accordance with the following:

(1) ASME B16.5 or ASME B16.47. [NFPA 54:5.5.9.1.2]

1308.5.9.2 Non-Ferrous Flanges. Non-ferrous flanges shall be in accordance with ASME B16.24. [NFPA 54:5.5.9.1.3]

1308.5.9.3 Ductile Iron Flanges. Ductile iron flanges shall be in accordance with ASME B16.42. [NFPA 54:5.5.9.1.4]

1308.5.9.4 Dissimilar Flange Connections. Raised-face flanges shall not be joined to flat-faced cast iron, ductile iron or nonferrous material flanges. [NFPA 54:5.5.9.2]

1308.5.9.5 Flange Facings. Standard facings shall be permitted for use under this code. Where 150 psi (1034 kPa) steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed. [NFPA 54:5.5.9.3]

1308.5.9.6 Lapped Flanges. Lapped flanges shall be used only aboveground or in exposed locations accessible for inspection. [NFPA 54:5.5.9.4]

1308.5.10 Flange Gaskets. The material for gaskets shall be capable of withstanding the design temperature and pressure of the piping system and the chemical constituents of the gas being conducted without change to its chemical and physical properties. The effects of fire exposure to the joint shall be considered in choosing the material. [NFPA 54:5.5.10]

1308.5.10.1 Flange Gasket Materials. Acceptable materials shall include the following:

(1) Metal (plain or corrugated)

(2) Composition

(3) Aluminum “O” rings

(4) Spiral-wound metal gaskets

(5) Rubber-faced phenolic

(6) Elastomeric [NFPA 54:5.5.10.1]

1308.5.10.2 Metallic Flange Gaskets. Metallic flange gaskets shall be in accordance with ASME B16.20. [NFPA 54:5.5.10.2.1]

1308.5.10.3 Non-Metallic Flange Gaskets. Non-metallic flange gaskets shall be in accordance with ASME B16.21. [NFPA 54:5.5.10.2.2]

1308.5.10.4 Full-Face Flange Gasket. Full-face flange gaskets shall be used with all non-steel flanges. [NFPA 54:5.5.10.3]
1308.5.10.5 Separated Flanges. When a flanged joint is separated, the gasket shall be replaced. [NFPA 54:5.5.10.4]

1308.6 Gas Meters. Gas meters shall be selected for the maximum expected pressure and permissible pressure drop. [NFPA 54:5.6.1]

1308.6.1 Location. Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement, or necessary maintenance. [NFPA 54:5.6.2.1]

1308.6.1.1 Protection from Damage. Gas meters shall not be placed where they will be subjected to damage, such as adjacent to a driveway, under a fire escape, in public passages, halls, or where they will be subject to excessive corrosion or vibration. [NFPA 54:5.6.2.2]

1308.6.1.2 Extreme Temperatures. Gas meters shall not be located where they will be subjected to extreme temperatures or sudden extreme changes in temperature or in areas where they are subjected to temperatures beyond those recommended by the manufacturer. [NFPA 54:5.6.2.3]

1308.6.2 Supports. Gas meters shall be supported or connected to rigid piping so as not to exert a strain on the meters. Where flexible connectors are used to connect a gas meter to downstream piping at mobile homes in mobile home parks, the meter shall be supported by a post or bracket placed in a firm footing or by other means providing equivalent support. [NFPA 54:5.6.3]

1308.6.3 Meter Protection. Meters shall be protected against overpressure, backpressure, and vacuum. [NFPA 54:5.6.4]

1308.6.4 Identification. Gas piping at multiple meter installations shall be marked by a metal tag or other permanent means designating the building or the part of the building being supplied and attached by the installing agency. [NFPA 54:5.6.5]

1308.6.7 Gas Pressure Regulators. A line pressure regulator shall be installed where the gas supply pressure exceeds the maximum allowable inlet pressure of the appliance served. [NFPA 54:5.7.1]

1308.7.1 Listing. Line pressure regulators shall be listed in accordance with CSA Z21.80 where the outlet pressure is set to 2 psi (14 kPa) or less. [NFPA 54:5.7.2]

1308.7.2 Location. The gas pressure regulator shall be accessible for servicing. [NFPA 54:5.7.3]

1308.7.3 Regulator Protection. Pressure regulators shall be protected against physical damage. [NFPA 54:5.7.4]

1308.7.4 Regulator Vents. Regulator vents shall be in accordance with Section 1308.15. [NFPA 54:5.7.5]

1308.7.5 Identification. Line pressure regulators at multiple regulator installations shall be marked by a metal tag or other permanent means designating the building or the part of the building being supplied. [NFPA 54:5.7.6]

1308.8 Overpressure Protection. Where the serving gas supplier delivers gas at a pressure greater than 2 psi for piping systems serving appliances designed to operate at a gas pressure of 14 inches water column or less, overpressure protection devices shall be installed. Piping systems serving equipment designed to operate at inlet pressures greater than 14 inches water column (3.5 kPa) shall be equipped with overpressure protection devices as required by the appliance manufacturer’s installation instructions. [NFPA 54:5.8.1]

1308.9 Pressure Limitation Requirements. Where piping systems serving appliances designed to operate with a gas supply pressure of 14 inches water column (3.5 kPa) or less are required to be equipped with overpressure protection by Section 1308.8, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance to 2 psi (14 kPa) or less upon a failure of the line pressure regulator. [NFPA 54:5.8.2.1]

1308.9.1 Overpressure Protection Required. Where piping systems serving appliances designed to operate with a gas supply pressure greater than 14 inches water column (3.5 kPa) are required to be equipped with overpressure protection by Section 1308.8, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance as required by the appliance manufacturer’s installation instructions. [NFPA 54:5.8.2.2]

1308.9.2 Overpressure Protection Devices. Each overpressure protection device installed to meet the requirements of this section shall be capable of limiting the pressure to its connected appliance(s) as required by this section independently of any other pressure control equipment in the piping system. [NFPA 54:5.8.2.3]

1308.9.3 Detection of Failure. Each gas piping system for which an overpressure protection device is required by this section shall be designed and installed so that a failure of the primary pressure control device(s) is detectable. [NFPA 54:5.8.2.4]

1308.9.4 Flow Capacity. If a pressure relief valve is used to meet the requirements of this section, it shall have a flow capacity such that the pressure in the protected system is maintained at or below the limits specified in Section 1308.9 under the following conditions:

(1) The line pressure regulator for which the relief valve is providing overpressure protection has failed wide open.

(2) The gas pressure at the inlet of the line pressure regulator for which the relief valve is providing overpressure protection is not less than the regulator’s normal operating inlet pressure. [NFPA 54:5.8.2.5]

1308.10 Overpressure Protection Devices. Overpressure protection devices shall be one of the following:

(1) Pressure relief valve.

(2) Monitor regulator.

(3) Series regulator installed upstream from the line regulator and set to continuously limit the pressure on the inlet of the line regulator to the maximum values specified by Section 1308.9 or less.

(4) Automatic shutoff device installed in series with the line pressure regulator and set to shut off when the pressure on the downstream piping system reaches the maximum values specified by Section 1308.9 or less. This device shall be designed so that it will remain closed until manually reset. [NFPA 54:5.8.3.1]

1308.10.1 Separate Devices. The devices in Section 1308.10 shall be installed either as an integral part of the service
or line pressure regulator or as separate units. Where separate overpressure protection devices are installed, they shall comply with Section 1308.10.2 through Section 1308.10.7. [NFPA 54:5.8.3.2]

1308.10.2 Construction and Installation. All overpressure protection devices shall meet the following requirements:

(1) Be constructed of materials so that the operation of the device is not impaired by corrosion of external parts by the atmosphere or of internal parts by the gas.

(2) Be designed and installed so they can be operated to determine whether the valve is free. The devices shall also be designed and installed so they can be tested to determine the pressure at which they operate and be examined for leakage when in the closed position. [NFPA 54:5.8.4]

1308.10.3 External Control Piping. External control piping shall be designed and installed so that damage to the control piping of one device does not render both the regulator and the overpressure protective device inoperative. [NFPA 54:5.8.5]

1308.10.4 Setting. Each pressure limiting or pressure relieving device shall be set so that the gas pressure supplied to the connected appliance(s) does not exceed the limits specified in Section 1308.9 and Section 1308.9.1. [NFPA 54:5.8.6]

1308.10.5 Unauthorized Operation. Where unauthorized operation of any shutoff valve could render a pressure relieving valve or pressure limiting device inoperative, one of the following shall be accomplished:

(1) The valve shall be locked in the open position. Instruct authorized personnel in the importance of leaving the shutoff valve open and of being present while the shutoff valve is closed so that it can be locked in the open position before leaving the premises.

(2) Duplicate relief valves shall be installed, each having adequate capacity to protect the system, and arrange the isolating valves or three-way valve so that only one relief valve can be rendered inoperative at a time. [NFPA 54:5.8.7]

1308.10.6 Discharge of Vents. The discharge stacks, vents, or outlet parts of all pressure relieving and pressure limiting devices shall be located so that gas is safely discharged to the outdoors. Discharge stacks or vents shall be designed to prevent the entry of water, insects, or other foreign material that could cause blockage. The discharge stack or vent line shall be at least the same size as the outlet of the pressure relieving device. [NFPA 54:5.8.8.1, 5.8.8.2]

1308.10.7 Size of Fittings, Pipe, and Openings. The fittings, pipe, and openings located between the system to be protected and the pressure relieving device shall be sized to prevent hammering of the valve and to prevent impairment of relief capacity. [NFPA 54:5.8.9]

1308.11 Backpressure Protection. Protective devices shall be installed as close to the equipment as practical where the design of equipment connected is such that air, oxygen, or standby gases could be forced into the gas supply system. Gas and air combustion mixers incorporating double diaphragm “zero” or “atmosphere” governors or regulators shall require no further protection unless connected directly to compressed air or oxygen at pressures of 5 psi (34 kPa) or more. [NFPA 54:5.9.1.1, 5.9.1.2]

1308.11.1 Protective Devices. Protective devices shall include but not be limited to the following:

(1) Check valves.

(2) Three-way valves (of the type that completely closes one side before starting to open the other side).

(3) Reverse flow indicators controlling positive shutoff valves.

(4) Normally closed air-actuated positive shutoff pressure regulators. [NFPA 54:5.9.2]

1308.12 Low-Pressure Protection. A protective device shall be installed between the meter and the appliance or equipment if the operation of the appliance or equipment is such that it could produce a vacuum or a dangerous reduction in gas pressure at the meter. Such protective devices include, but are not limited to, mechanical, diaphragm-operated, or electrically operated low-pressure shutoff valves. [NFPA 54:5.10]

1308.13 Shutoff Valves. Shutoff valves shall be selected in accordance with Table 1308.13. Shutoff valves of size 1 inch (25 mm) National Pipe Thread and smaller shall be listed and labeled. Where used outdoors, such use shall be in accordance with the manufacturer’s recommendation. [NFPA 54:5.11]

1308.14 Expansion and Flexibility. Piping systems shall be designed to prevent failure from thermal expansion or contraction. [NFPA 54:5.13.1]

1308.14.1 Special Local Conditions. Where local conditions include earthquake, tornado, unstable ground, or flood hazards, special consideration shall be given to increased strength and flexibility of piping supports and connections. [NFPA 54:5.13.2]

1308.15 Pressure Regulator and Pressure Control Venting. The venting of the atmospheric side of diaphragms in line pressure regulators, gas appliance regulators, and gas pressure limit controls shall be in accordance with all of the following:

(1) An independent vent pipe to the outdoors, sized in accordance with the device manufacturer's instructions, shall be provided where the location of a device is such that a discharge of fuel gas will cause a hazard. For devices other than appliance regulators, vents are not required to be independent where the vents are connected to a common manifold designed in accordance with engineering methods to minimize backpressure in the event of diaphragm failure and such design is approved.

Exceptions:

(1) A regulator and vent limiting means combination listed as complying with ANSI Z21.80/CSA 6.22, shall not be required to be vented to the outdoors.

(2) A listed gas appliance regulator factory equipped with a vent limiting device is not required to be vented to the outdoors.
(2) Materials for vent piping shall be in accordance with Section 1308.5 through Section 1308.5.10.5.
(3) The vent terminus shall be designed to prevent the entry of water, insects, and other foreign matter that could
cause blockage.
(4) Vent piping shall be installed to minimize static loads and bending moments placed on the regulators and gas
pressure control devices.
(5) Vents shall terminate not less than 3 feet (914 mm) from a possible source of ignition.
(6) At locations where a vent termination could be submerged during floods or snow accumulations, an antiflood-type
breather vent fitting shall be installed, or the vent terminal shall be located above the height of the expected flood
waters or snow.
(7) Vent piping from pressure regulators and gas pressure controls shall not be connected to a common manifold that
serves a bleed line from a diaphragm-type gas valve. [NFPA 54:5.14]

1309.0 Excess Flow Valve.
1309.1 General. Where automatic excess flow valves are installed, they shall be listed in accordance with
ANSI Z21.93/CSA 6.30 and shall be sized and installed in accordance with the manufacturers' instructions. [NFPA
54:5.12]

1310.0 Gas Piping Installation.
1310.1 Piping Underground. Underground gas piping shall be installed with sufficient clearance from any other
underground structure to avoid contact therewith, to allow maintenance, and to protect against damage from proximity to
other structures. Underground plastic piping shall be installed with sufficient clearance or shall be insulated from any
source of heat so as to prevent the heat from impairing the serviceability of the pipe. [NFPA 54:7.1.1.1, 7.1.1.2]
1310.1.1 Cover Requirements. Underground piping systems shall be installed with a minimum of 12 inches (305 mm)
of cover. The minimum cover shall be increased to 18 inches (457 mm) if external damage to the pipe or tubing from
external forces is likely to result. Where a minimum of 12 inches (305 mm) of cover cannot be provided, the piping shall
be installed in conduit. [NFPA 54:7.1.2.1 – 7.1.2.1(B)]
1310.1.5 Piping Through Foundation Wall. Piping through a foundation wall shall comply with all of the following:
(1) Underground piping, where installed through the outer foundation or basement wall of a building, shall be encased in
a protective sleeve or protected by an approved device or method.
(2) The spaces between the gas piping and the sleeve and between the sleeve and the wall shall be sealed to prevent
entry of gas and water.
(3) Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.1.5]
1310.1.7 Connections of Plastic Piping. Plastic piping shall be installed outdoors, underground only.
Exceptions:
(1) Plastic piping shall be permitted to terminate aboveground where an anodeless riser is used.
(2) Plastic piping shall be permitted to terminate with a wall head adapter aboveground in buildings, including
basements, where the plastic piping is inserted in a piping material permitted for use in buildings. [NFPA 54:7.1.7.1]
1310.3 Installation of Aboveground Piping. Piping installed aboveground shall comply with all of the following:
(1) Piping shall be securely supported and located where it will be protected from physical damage.
(2) Where passing through an exterior wall, the piping shall also be protected from corrosion by coating or wrapping
with an inert material approved for such applications.
(3) The piping shall be sealed around its circumference at the point of the exterior penetration to prevent the entry of
gas, water, insects, and rodents.
(4) Where piping is encased in a protective pipe sleeve, the annular spaces between the gas piping and the sleeve and
between the sleeve and the wall opening shall be sealed.
(5) Piping installed outdoors shall be elevated not less than $3\frac{1}{2}$ inches (89 mm) above the ground.
(6) Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.2.1]
1310.3.5.3 Piping on Roofs. Gas piping installed on the roof surfaces shall be elevated above the roof surface and
shall be supported in accordance with Table 1310.3.5.1. Gas piping shall be elevated not less than $3\frac{1}{2}$ inches (89 mm)
above the roof surface: [NFPA 54:7.2.6.4.1, 7.2.6.4.2]
1310.4.4 Industrial Occupancies. In industrial occupancies, gas piping in solid floors such as concrete shall be laid in
channels in the floor and covered to permit access to the piping with a minimum of damage to the building. Where piping
in floor channels could be exposed to excessive moisture or corrosive substances, the piping shall be protected in an
approved manner. [NFPA 54:7.3.5.1]
1310.4.5 Other Occupancies. In other than industrial occupancies and where approved by the Authority Having
Jurisdiction, gas piping embedded in concrete floor slabs constructed with Portland cement shall be surrounded with a
minimum of $1\frac{1}{2}$ inches (38 mm) of concrete and shall not be in physical contact with other metallic structures such as
reinforcing rods or electrically neutral conductors. All piping, fittings, and risers shall be protected against corrosion in
accordance with Section 1308.5.6. Piping shall not be embedded in concrete slabs containing quickset additives or
cinder aggregate. [NFPA 54:7.3.5.2]
1310.6 Maximum Operating Pressure in Buildings. The maximum operating pressure for any piping systems located
inside buildings shall not exceed 5 psi (34 kPa) unless one or more of the following conditions are met:
The piping joints are welded or brazed.
The piping is joined by fittings listed to ANSI LC 4/CSA 6.32 and installed according to the manufacturer's installation instructions.
The piping joints are flanged and all pipe-to-flange connections are made by welding or brazing.
The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
The piping is located inside buildings or separate areas of buildings used exclusively for one of the following:
(a) Industrial processing or heating
(b) Research
(c) Warehousing
(d) Boiler or mechanical rooms
The piping is a temporary installation for buildings under construction.
The piping serves appliances or equipment used for agricultural purposes.
The piping system is an LP-Gas piping system with an operating pressure greater than 20 psi (138 kPa) and complies with NFPA 58. [NFPA 54:5.4.4]

1310.6.1 LP-Gas Systems Operating Below -5°F (-21°C). LP-Gas systems designed to operate below -5°F (-21°C) or with butane or a propane-butane mix shall be designed to either accommodate liquid LP-Gas or to prevent LP-Gas vapor from condensing back into a liquid. [NFPA 54:5.4.5]

1310.11 Manual Gas Shutoff Valves. An accessible gas shutoff valve shall be provided upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve shall not be required at the second regulator. [NFPA 54:7.8.2]

1310.11.1 Accessibility of Gas Valves. System shutoff valves shall be readily accessible for operation and installed so as to be protected from physical damage. System shutoff valves shall be marked with a metal tag or other permanent means attached by the installing agency so that the gas piping systems supplied through them can be readily identified. [NFPA 54:7.8.1.1, 7.8.1.2]

1310.11.1.1 Shutoff Valves for Multiple House Lines. In multiple-tenant buildings supplied through a master meter, through one service regulator where a meter is not provided, or where meters or service regulators are not readily accessible from the appliance or equipment location, an individual shutoff valve for each apartment or tenant line shall be provided at a convenient point of general accessibility. In a common system serving a number of individual buildings, shutoff valves shall be installed at each building. [NFPA 54:7.8.3.1]

1310.11.2 Emergency Shutoff Valves. An exterior shutoff valve to permit turning off the gas supply to each building in an emergency shall be provided. The emergency shutoff valves shall be plainly marked as such and their locations posted as required by the Authority Having Jurisdiction. [NFPA 54:7.8.3.2]

1310.11.3 Shutoff Valve for Laboratories. Each laboratory space containing two or more gas outlets installed on tables, benches, or in hoods in educational, research, commercial, and industrial occupancies shall have a single shutoff valve through which all such gas outlets are supplied. The shutoff valve shall be accessible, located within the laboratory or adjacent to the laboratory’s egress door, and identified. [NFPA 54:7.8.3.3]

1310.11.4 System Shutoff Valves. Where a system shutoff valve is installed, the valve shall comply with Section 1308.13. [NFPA 54:7.8.4]

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<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32</td>
</tr>
<tr>
<td>Valve up to 1/2 psi</td>
<td>ANSI/ASME B16.44</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32</td>
</tr>
<tr>
<td>Valve up to 2 psi</td>
<td>ANSI/ASME B16.44 labeled 2G</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32 with ANSI/ASME B 16.44 labeled 2G or labeled 5G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32 with ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td>Valve up to 5 psi</td>
<td>ANSI/ASME B16.44 labeled 5G</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32 with ANSI/ASME B16.44 marked 5G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32 with ANSI/ASME B16.33 marked 125 G</td>
</tr>
</tbody>
</table>
1310.14.5 Installation of Gas-Mixing Machines. Installation of gas-mixing machines shall comply with Section 1310.14.5.1 through 1310.14.5.5.

1310.14.5.1 Location. The gas-mixing machine shall be located in a well-ventilated area or in a detached building or cutoff room provided with room construction and explosion vents in accordance with engineering methods. Such rooms or below-grade installations shall have adequate positive ventilation. [NFPA 54:7.11.5.1]

1310.14.5.2 Electrical Requirements. Where gas-mixing machines are installed in well-ventilated areas, the type of electrical equipment shall be in accordance with NFPA 70 for general service conditions unless other hazards in the area prevail. Where gas-mixing machines are installed in small detached buildings or cutoff rooms, the electrical equipment and wiring shall be installed in accordance with NFPA 70 for hazardous locations (Articles 500 and 501, Class I, Division 2). [NFPA 54:7.11.5.2]

1310.14.5.3 Air Intakes. Air intakes for gas-mixing machines using compressors or blowers shall be taken from outdoors whenever practical. [NFPA 54:7.11.5.3]

1310.14.5.4 Controls. Controls for gas-mixing machines shall include interlocks and a safety shutoff valve of the manual reset type in the gas supply connection to each machine arranged to automatically shut off the gas supply in the event of high or low gas pressure. Except for open burner installations only, the controls shall be interlocked so that the blower or compressor stops operating following a gas supply failure. Where a system employs pressurized air, means shall be provided to shut off the gas supply in the event of air failure. [NFPA 54:7.11.5.4]

1310.14.5.5 Installation in Parallel. Centrifugal gas-mixing machines in parallel shall be reviewed by the user and equipment manufacturer before installation, and means or plans for minimizing the effects of downstream pulsation and equipment overload shall be prepared and utilized as needed. [NFPA 54:7.11.5.5]

1311.0 Electrical Bonding and Grounding.
1311.4 Prohibited Use. Gas piping shall not be used as a grounding conductor or electrode. [NFPA 54:7.12.4.1]

1312.0 Appliance and Equipment Connections to Building Piping.
1312.1 Connecting Appliances and Equipment. Appliances and equipment shall be connected to the building piping in compliance with Section 1312.6 through Section 1312.8 by one of the following:

1. Rigid metallic pipe and fittings.
2. Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.
3. A connector for gas appliances listed in accordance with CSA Z21.24. The connector shall be used in accordance with the manufacturer's installation instructions and shall be in the same room as the appliance. Only one connector shall be used per appliance.
4. A connector for outdoor gas appliances and manufactured homes listed in accordance with CSA Z21.75. Only one connector shall be used per appliance.
5. CSST where installed in accordance with the manufacturer's installation instructions. CSST shall not be directly routed into a metallic appliance enclosure where the appliance is connected to a metallic vent that terminates above a roofline. CSST shall connect only to appliances that are fixed in place.
6. Listed nonmetallic gas hose connectors in accordance with Section 1312.3.
7. Unlisted gas hose connectors for use in laboratories and educational facilities in accordance with Section 1312.4. [NFPA 54:9.6.1]

1312.1.1 Food Service Appliance Connectors. Connectors used with food service appliances that are moved for cleaning and sanitation purposes shall be installed in accordance with the connector manufacturer's installation instructions. Such connectors shall be listed in accordance with CSA Z21.69. [NFPA 54:9.6.1.3]

1312.7 Quick-Disconnect Devices. Quick-disconnect devices used to connect appliances to the building piping shall be listed in accordance with CSA Z21.41. Where installed indoors, an approved manual shutoff valve with a nondisplaceable valve member shall be installed upstream of the quick-disconnect device. [NFPA 54:9.6.6 – 9.6.6.2]

TABLE 1308.4.1
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES
[NFPA 54: TABLE A.5.3.2.1]

TABLE 1308.5.6.2
SPECIFICATIONS FOR THREADING METALLIC PIPE
[NFPA 54: TABLE 5.5.6.3]
TABLE 1310.3.5.1
SUPPORT OF PIPING
[NFPA 54: TABLE 7.2.6.2]

<table>
<thead>
<tr>
<th>STEEL PIPE, NOMINAL SIZE OF PIPE (inches)</th>
<th>SPACING OF SUPPORTS (feet)</th>
<th>NOMINAL SIZE OF TUBING SMOOTH WALL (inches O.D.)</th>
<th>SPACING OF SUPPORTS (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>6</td>
<td>1/2</td>
<td>4</td>
</tr>
<tr>
<td>3/4 or 1</td>
<td>8</td>
<td>5/8 or 3/4</td>
<td>6</td>
</tr>
<tr>
<td>1 1/4 or larger (horizontal)</td>
<td>10</td>
<td>7/8 or 1 (horizontal)</td>
<td>8</td>
</tr>
<tr>
<td>1 1/4 or larger (vertical)</td>
<td>Every floor level</td>
<td>1 or larger (vertical)</td>
<td>Every floor level</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

TABLE 1313.6.1
SIZE AND LENGTH OF PIPING
[NFPA 54: TABLE 8.3.1]*
(portion of table not shown remains unchanged)

* CSST EHD size of 62 is equivalent to 2 inch (50 mm) nominal size pipe or tubing.

TABLE 1315.2(27)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3.1(d)]

<table>
<thead>
<tr>
<th>NOMINAL INSIDE</th>
<th>1/2</th>
<th>3/4</th>
<th>1</th>
<th>1 1/4</th>
<th>1 1/2</th>
<th>2</th>
<th>2 1/2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTUAL:</td>
<td>0.622</td>
<td>0.824</td>
<td>1.049</td>
<td>1.380</td>
<td>1.610</td>
<td>2.067</td>
<td>2.469</td>
<td>3.068</td>
<td>4.026</td>
</tr>
</tbody>
</table>

LENGTH (feet)

<table>
<thead>
<tr>
<th>PIPE SIZE (inch)</th>
<th>CAPACITY IN THOUSANDS OF BTU PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>291</td>
</tr>
<tr>
<td>20</td>
<td>418</td>
</tr>
<tr>
<td>30</td>
<td>632</td>
</tr>
<tr>
<td>40</td>
<td>854</td>
</tr>
<tr>
<td>50</td>
<td>1078</td>
</tr>
<tr>
<td>60</td>
<td>1298</td>
</tr>
<tr>
<td>70</td>
<td>1511</td>
</tr>
<tr>
<td>80</td>
<td>1724</td>
</tr>
<tr>
<td>90</td>
<td>1936</td>
</tr>
<tr>
<td>100</td>
<td>2148</td>
</tr>
<tr>
<td>125</td>
<td>2645</td>
</tr>
<tr>
<td>150</td>
<td>3142</td>
</tr>
<tr>
<td>175</td>
<td>3639</td>
</tr>
<tr>
<td>200</td>
<td>4136</td>
</tr>
<tr>
<td>250</td>
<td>4833</td>
</tr>
<tr>
<td>300</td>
<td>5530</td>
</tr>
<tr>
<td>350</td>
<td>6227</td>
</tr>
<tr>
<td>400</td>
<td>6924</td>
</tr>
<tr>
<td>450</td>
<td>7621</td>
</tr>
<tr>
<td>500</td>
<td>8318</td>
</tr>
</tbody>
</table>

GAS: UNDILUTED PROPANE

| INLET PRESSURE: 11.0 In. w.c. | PRESSURE DROP: 0.5 In. w.c. | SPECIFIC GRAVITY: 1.50 |

INTENDED USE: PIPE SIZING BETWEEN SINGLE- OR SECOND-STAGE (LOW-PRESSURE) REGULATOR AND APPLIANCE.
For SI units: 1 inch = 25 mm, 1 foot = 304.8, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.

### TABLE 1701.1
**REFERENCED STANDARDS**

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B16.33-2012 (R2017)</td>
<td>Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 175 psi (Sizes NPS 1/2 through NPS 2)</td>
<td>Valves</td>
<td>Table 1308.13</td>
</tr>
<tr>
<td>ASME B16.44-2012 (R2017)</td>
<td>Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi</td>
<td>Valves</td>
<td>Table 1308.13</td>
</tr>
<tr>
<td>ANSI Z21.15b/CSA 9.1b-2013 (R2019)</td>
<td>Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves (portions of table not shown remain unchanged)</td>
<td>Valves</td>
<td>Table 1308.13</td>
</tr>
</tbody>
</table>

**COMMITTEE STATEMENT:**
There is no technical justification provided for changing the gas piping elevation to 3-1/2 inches above the roof surface. For example, 2x4 lumber has been used for years to elevate gas piping on roofs and is considered acceptable by the industry.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** **AFFIRMATIVE:** 29  **NOT RETURNED:** 1  Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 274, Section 1308.5.4.1 (Regulator Vent Piping) and UPC Item # 246, Section 1208.6.6 (Regulator Vent Piping); UMC Item # 274, Section 1308.5.6.3 (Thread Joint Sealing) and UPC Item # 246, Section 1208.6.9.3 (Thread Joint Sealing); UMC Item # 274, Section 1310.3 (Installation of Aboveground Piping) and UPC Item # 246, Section 1210.3 (Installation of Aboveground Piping); UMC Item # 274, Section 1310.3.5.3 (Piping on Roofs) and UPC Item # 246, Section 1210.3.5.3 (Piping on Roofs); and UMC Item # 274, Section 1312.1 (Connecting Appliances and Equipment) and 1312.2 (Suspended Low-Intensity Infrared Tube Heaters) and UPC Section 1212.2 (Suspended Low-Intensity Infrared Tube Heaters) all resulted in conflicting language between the
codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

**1308.5.4.1 Regulator Vent Piping.** Plastic pipe and fittings used to connect regulator vents to remote vent terminations shall be PVC (Schedule 40 and 80) conforming to UL 651. PVC vent piping shall not be installed indoors. ([NFPA 54:5.5.4.2])

<table>
<thead>
<tr>
<th>TABLE 1701.1</th>
<th>REFERENCED STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STANDARD NUMBER</strong></td>
<td><strong>STANDARD TITLE</strong></td>
</tr>
<tr>
<td>UL 651-2011</td>
<td>Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings (with revisions through June 15, 2016)</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**1308.5.6.3 Thread Joint Sealing.** Threaded joints shall be made using a thread joint sealing material. ([NFPA 54: 5.5.6.4.1]) Thread joint sealing materials shall be compatible with the pipe and fitting material on which the compounds are used. ([NFPA 54: 5.5.6.4.2]) Thread joint sealing materials shall be nonhardening and shall be resistant to the chemical constituents of the gases to be conducted through the piping. ([NFPA 54:5.5.6.4.3])

**1310.3 Installation of Aboveground Piping.** Piping installed aboveground shall comply with all of the following:

1. Piping shall be securely supported and located where it will be protected from physical damage.
2. Where passing through an exterior wall, the piping shall also be protected from corrosion by coating or wrapping with an inert material approved for such applications.
3. The piping shall be sealed around its circumference at the point of the exterior penetration to prevent the entry of water, insects, and rodents.
4. Where piping is encased in a protective pipe sleeve, the annular spaces between the gas piping and the sleeve and between the sleeve and the wall opening shall be sealed.
5. **Piping installed outdoors shall be elevated not less than 3½ inches (89 mm) above the ground.**
6. Sealing materials shall be compatible with the piping and sleeve. ([NFPA 54:7.2.1])

**1310.3.5.3 Piping on Roofs.** Gas piping installed on the roof surfaces shall be elevated above the roof surface and shall be supported in accordance with Table 1310.3.5.1. Gas piping shall be elevated not less than 3½ inches (89 mm) above the roof surface. ([NFPA 54-2018:7.2.6.4.1, 7.2.6.4.2])

**1312.1 Connecting Appliances and Equipment.** Appliances and equipment shall be connected to the building piping in compliance with Section 1312.6 through Section 1312.8 by one of the following:

1. Rigid metallic pipe and fittings.
2. Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.
3. A connector for gas appliances listed in accordance with ANSI Z21.24/CSA 6.27 CSA-Z21.24. The connector shall be used in accordance with the manufacturer’s installation instructions and shall be in the same room as the appliance. Only one connector shall be used per appliance.
4. A connector for outdoor gas appliances and manufactured homes listed in accordance with ANSI Z21.75/CSA 6.27 CSA-Z21.75. Only one connector shall be used per appliance.
5. CSST where installed in accordance with the manufacturer’s installation instructions. CSST shall not be directly routed into a metallic appliance enclosure where the appliance is connected to a metallic vent that terminates above a roofline. CSST shall connect only to appliances that are fixed in place.
6. Listed nonmetallic gas hose connectors in accordance with Section 1312.3.
7. Unlisted gas hose connectors for use in laboratories and educational facilities in accordance with Section 1312.4. ([NFPA 54:9.6.1])

**1312.2 Suspended Low-Intensity Infrared Tube Heaters.** Suspended low-intensity infrared tube heaters shall be connected to the building piping system with a connector listed for the application in accordance with ANSI Z21.24/CSA 6.27 CSA-Z21.24 as follows:

1. The connector shall be installed in accordance with the tube heater installation instructions, and shall be in the same room as the appliance.
2. Only one connector shall be used per appliance. ([NFPA 54:9.6.1.5])
TCC ACTION:  ACCEPT AS SUBMITTED

TCC STATEMENT:
The language in UMC Item # 274, Section 1308.5.4.1 (Regulator Vent Piping) is being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1208.6.6 (Regulator Vent Piping) with regards to the addition of “Schedule 40 and 80” and striking the UL 651 standard. Additionally, the UL 651 standard is being stricken from Table 1701.1 (Referenced Standards) for both the UPC and UMC.

The language in UMC Item # 274, Section 1308.5.6.3 (Thread Joint Sealing) is being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1208.6.9.3 (Thread Joint Sealing) by striking the language pertaining to “nonhardening.”

The language in UMC Item # 274, Section 1310.3 (Installation of Aboveground Piping) is being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1210.3 (Installation of Aboveground Piping) with regards to elevating piping installed outdoors to not less than 3 ½ inches above the ground.

The language in UMC Item # 274, Section 1310.3.5.3 (Piping on Roofs) is being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1210.3.5.3 (Piping on Roofs) with regards to elevating gas piping installed on roofs to not less than 3 ½ inches above the roof surface.

Lastly, the language in UMC Item # 274, Section 1312.1 (Connecting Appliances and Equipment) and 1312.2 (Suspended Low-Intensity Infrared Tube Heaters) and UPC Section 1212.2 (Suspended Low-Intensity Infrared Tube Heaters) are being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1212.1 (Connecting Appliances and Equipment) regarding the designation of the CSA standards.

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section 1308.5.4.1 by adding “Schedule 40 and 80” and striking of the UL 651 standard; Section 1308.5.6.3 by striking the language pertaining to “nonhardening”; Section 1310.3 by modifying the text regarding elevating piping installed outdoors to not less than 3 ½ inches above the ground; Section 1310.3.5.3 by modifying the text regarding elevating gas piping installed on roofs to not less than 3 ½ inches above the roof surface; and Section 1312.1 and Section 1312.2 by updating the designation of the CSA standard.
Proposals

Item #: 275

UMC 2024 Section: 1301.1, Table 1701.1

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

1301.0 Scope of Gas Piping.
1301.1 Applicability. The regulations of this chapter shall govern the installation of fuel gas piping in or in connection with a building, structure or within the property lines of premises up to 5 pounds-force per square inch (psi) (34 kPa) for natural gas and 10 psi (69 kPa) for undiluted propane, other than service pipe. Fuel oil piping systems shall be installed in accordance with NFPA 31 and the manufacturer’s installation instructions. Above-ground piping systems shall be listed and labeled in accordance with UL 1369. Metallic underground piping systems shall be listed and labeled in accordance with UL 971A. Non-metallic underground piping systems shall be listed and labeled in accordance with UL 971.

TABLE 1701.1 REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 971-1995</td>
<td>Nonmetallic Underground Piping for Flammable Liquids (with revisions through March 2, 2006)</td>
<td>Gas Piping</td>
<td>1301.1</td>
</tr>
<tr>
<td>UL 971A-2006</td>
<td>Outline of Investigation for Metallic Underground Fuel Pipe</td>
<td>Gas Piping</td>
<td>1301.1</td>
</tr>
<tr>
<td>UL 1369-2018</td>
<td>Aboveground Piping for Flammable and Combustible Liquids (with revisions through August 25, 2020)</td>
<td>Gas Piping</td>
<td>1301.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: UL 1369 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

Note: UL 971 and UL 971A were not developed via an open process having a published development procedure in accordance with Section 3-3.7.1.2 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Applicable standards for above ground and below ground piping are being added to Section 1301.1 to clarify the requirements for such applications to aid the code official in verifying safe installation for such systems.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the proposed gas piping standards for above-ground and underground piping are not needed for the enforcement of such systems.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS:  AFFIRMATIVE: 22   NEGATIVE: 7   NOT RETURNED: 1   Heine

EXPLANATION OF NEGATIVE:

BALLANCO: This change should have been approved with a modification. The modification would be to clarify that the three standards apply to fuel oil piping.

FEEHAN: This language and standard are necessary in the code.

KOERBER: I agree with comment by Julius Ballanco.

MACNEVIN: I agree with other comments that the standards should be added with the noted clarification.

TRAFTON, A: The language and standard are needed.

WHITE: These standards are useful to installers and inspectors. I agree with the clarification that the added language is for fuel oil.

WISEMAN: This standard is needed.
Proposals

Item #: 276
UMC 2024  Section: 1302.3

SUBMITTER:  Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

1302.0 Coverage of Piping System.

1302.3 Applications. This chapter shall not apply to the following items:
(1) through (20) remain unchanged [NFLPA 54:1.1.1.2]

SUBSTANTIATION:
The code change clarifies that Chapter 13 shall not apply to the items listed in Section 1302.3 rather than "this code." Simple fix.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 277
UMC 2024  Section: 1308.5

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

1308.0 Gas Piping System Design, Materials, and Components.

1308.5 Acceptable Piping Materials and Joining Methods. Materials used for piping systems shall either comply with the requirements of this chapter Section 1308.5.1 through Section 1308.5.4.2.3 or be acceptable to the Authority Having Jurisdiction. ([NFPA 54:5.6.1.1 5.5.1.1])

SUBSTANTIATION:
The phrase “this chapter” is being changed to “Section 1308.5 through Section 1308.5.4.2.3” to clarify that the piping material requirements from those subsections of Section 1308.5 shall comply to aid the code official in approving piping materials. The last part of the sentence is being removed as the AHJ is already authorized by Chapters 1 and 3 to approve/accept materials.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 278
UMC 2024 Section: 1308.5, Table 1308.5, Table 1701.1

SUBMITTER: Phil Pettit
Control Air Conditioning Corporation
Rep. Self

RECOMMENDATION:
Revise text

1308.0 Gas Piping System Design, Materials, and Components.

1308.5 Acceptable Piping Materials and Joining Methods. Materials used for piping systems shall either comply with the requirements of this chapter or be acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.1.1 5.5.1.1] Materials for fuel gas piping, tubing, and fittings shall comply with the applicable standards in Table 1308.5 or other approved standards.

<table>
<thead>
<tr>
<th>TABLE 1308.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIAL</td>
</tr>
<tr>
<td>PIPING/TUBING</td>
</tr>
<tr>
<td>Aluminum alloy</td>
</tr>
<tr>
<td>Fiberglass</td>
</tr>
<tr>
<td>Plastic</td>
</tr>
</tbody>
</table>

Note: The ASME and ASTM standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

[527]

SUBSTANTIATION:
The new table provides an easy to reference list of acceptable fuel gas piping and fitting standards for each application to assist the AHJ in approving gas piping.
COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
This proposal is being rejected as Table 1308.5 is not needed. Section 1305.5.1 through Section 1308.5.4.2.3 already addresses the appropriate standards for fuel gas materials. Furthermore, the appropriate reference to the sections were already approved in Item #277. Some of the proposed standards may also be outside of the scope of fuel gas piping.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 279
UMC 2024  Section: 1308.5.3.5, Table 1701.1

SUBMITTER: Robert Torbin
OmegaFlex

RECOMMENDATION:
Revise text

1308.5.2 Metallic Pipe.

1308.5.3.5 Corrugated Stainless Steel Tubing. Corrugated stainless steel tubing shall be listed in accordance with CSA LC-1. [NFPA 54:5.6.3.6] Corrugated stainless steel tubing shall also comply with IAPMO IGC 201 when a listed encasement system is required.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAPMO IGC 201-2018</td>
<td>Polyethylene Sleeved-Corrugated Stainless-Steel Tubing for use in Fuel Gas Piping Systems</td>
<td>Gas Tubing</td>
<td>1308.5.3.5</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: IAPMO IGC 201 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The proposed standard covers polyethylene sleeved-corrugated stainless steel tubing (CSST) which is used in fuel gas systems. PE sleeved CSST have been tested and installed for over 10 years and continues to be installed today. Reference to the proper standard for this product will ensure public health and safety by clearly identifying products that are approved for this application assisting to the installers, inspectors, and other end users of the code.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the term "encasement" may be misinterpreted to be a conduit.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

BALLANCO: This change has merit, however, it needs to be better worded to clarify when the standard applies.
Item #: 280

UMC 2024  Section: 1310.1.3.2

SUBMITTER: Shane Peters  
  City of Santa Monica

RECOMMENDATION:  
Revise text

1310.0 Gas Piping Installation.  
1310.1 Piping Underground.  (remaining text unchanged)

1310.1.3 Protection Against Corrosion.  (remaining text unchanged)
1310.1.3.2 Underground Piping. Underground piping shall comply with one or more of the following unless approved  
technical justification is provided to demonstrate that protection is unnecessary:
(1) The piping shall be made of corrosion-resistant material that is suitable for the environment in which it will be  
installed.
(2) Pipe shall have a factory-applied, electrically insulating coating. Fittings and joints between sections of coated pipe  
shall be coated in accordance with the coating manufacturer’s instructions.
(3) The piping shall have a cathodic protection system installed, and the system shall be maintained in accordance with  
Section 1310.1.3.3 or Section 1310.1.3.6. [NFPA 54:7.1.3.2]
Underground metallic gas piping shall be protected from corrosion by approved coatings or wrapping materials. Gas  
pipe protective coatings shall be in accordance with the following:
(1) Approved types, factory-applied, and conform to approved standards.
(2) Field wrapping shall provide equivalent protection and is restricted to those sections and fittings that are necessarily  
stripped for threading or welding.
(3) Risers shall be coated or wrapped to a point at least 6 inches (152 mm) above ground.

SUBSTANTIATION:  
The above recommended language gives specific direction on how to protect underground gas piping. The current  
section is not clear as to what requirements are required.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:  
The existing extracted language sufficiently clarifies the intent of the section. The phrase "coatings or wrapping  
materials" is vague, open-ended, and may be misinterpreted. This change would also remove the cathodic  
protection out of the section, which is needed for the enforcement of such systems.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 281
UMC 2024 Section: 1310.3.5, Table 1701.1

SUBMITTER: David Dias
Sheet Metal Workers Local 104

RECOMMENDATION:
Revise text

1310.0 Gas Piping Installation.

1310.3 Installation of Aboveground Piping. (remaining text unchanged)

1310.3.5 Hangers, Supports, and Anchors. Piping shall be supported with metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers, or building structural components, suitable for the size of piping, of adequate strength and quality, and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected appliances and equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58. [NFPA 54:7.2.6.1] Pipe support hangers and hooks shall comply with IAPMO PS 95.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAPMO PS 95-2018</td>
<td>Pipe Support Hangers and Hooks</td>
<td>Hangers and Supports</td>
<td>1310.3.5</td>
</tr>
</tbody>
</table>

(Note: portions of the table not shown remain unchanged)

Note: IAPMO PS 95 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Pipe hangers and supports can meet either the requirements of MSS SP-58 or IAPMO PS 95. Therefore, a reference to the IAPMO standard is being added for completeness.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

1310.0 Gas Piping Installation.

1310.3 Installation of Aboveground Piping. (remaining text unchanged)

1310.3.5 Hangers, Supports, and Anchors. Piping shall be supported with metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers, or building structural components, suitable for the size of piping, of adequate strength and quality, and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected appliances and equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58 or IAPMO PS 95. [NFPA 54:7.2.6.1] Pipe support hangers and hooks shall comply with IAPMO PS 95.
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</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**COMMITTEE STATEMENT:**
The IAPMO PS 95 standard is being relocated to after MSS SP-58 for clarity regarding pipe hangers and supports.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**  
**AFFIRMATIVE:** 29  
**NOT RETURNED:** 1  
Heine
Proposals

Item #: 282
UMC 2024  Section: Chapter 16

SUBMITTER: IAPMO Staff - Update Extracts
NFPA 54 Extract Update

RECOMMENDATION:
Revise text

1601.0 Stationary Fuel Cell Power Plants.
1601.1 General. Fuel cell power plants with a power output of less than 50 kW shall be listed in accordance with ANSI/CSA FC 1 and installed in accordance with the manufacturer’s instructions. Fuel cell power plants with a power output of greater than 50 kW shall be installed in accordance with NFPA 853. [NFPA 54:10.29] Stationary fuel cell power plants shall be tested in accordance with CSA FC-1.

1602.1 General. The installation of gas engines shall conform to NFPA 37. [NFPA 54:10.22]
1602.2 Connection to the Gas Supply Piping. Stationary gas engines shall not be rigidly connected to the gas supply piping. [NFPA 54:10.22.1]

Note: ANSI/CSA FC 1 standard meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
In accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines), Chapter 16 is being revised to the latest edition of NFPA 54-2021.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1  Heine
Proposals

Item #: 283

UMC 2024  Section: Chapter 17, Table 1701.1

SUBMITTER: Jeff Hutcher
Building in California
Rep. Self

RECOMMENDATION:
Add new text

Chapter 17
(renumber remaining chapters)

Indoor Cannabis and Horticultural Facilities

1701.0 General.
1701.1 Indoor Spaces. Indoor spaces using environmental controls for cannabis and horticultural cultivation and processing of plants for human ingestion, inhalation, and topical application shall comply with this section. Equipment and appliances shall be installed in accordance with the manufacturer’s installation instructions and this code. Piping, tubing, materials, and structures shall be protected in accordance with Section 316.0.

1702.0 Classification of Facilities.
1702.1 General. Facilities used for indoor cannabis and horticultural cultivation and processing shall be as classified in accordance with the building code, the electrical code, and the Authority Having Jurisdiction.
1702.2 Approved Locations. Facilities used for indoor cannabis and horticultural cultivation and processing shall be located in accordance with the building code and the Authority Having Jurisdiction.

1703.0 Documentation.
1703.1 General. Documentation for permitting shall be provided in accordance with the requirements of Section 104.0 and the Authority Having Jurisdiction. The documentation shall show compliance with this section and other requirements in accordance with the Authority Having Jurisdiction.

1704.0 Fire Protection.
1704.1 General. Fire protection shall be provided for indoor cannabis and horticultural facilities in accordance with the building code, fire code, Section 1704.1.1 through Section 1704.1.3, and the Authority Having Jurisdiction.
1704.1.1 Smoke Detectors and Fire Alarms. Smoke detectors, heat detectors, and fire alarms shall be provided in accordance with NFPA 72 and shall provide visible and audible notification. Smoke detectors shall comply with UL 268. In spaces where smoke detectors cannot be utilized due to ambient conditions, approved automatic heat detectors shall be permitted in lieu of smoke detectors in accordance Section 1704.2.
1704.1.2 Heat Detectors. Where ambient conditions prohibit installation of smoke detectors, an automatic heat detector in accordance with UL 521 shall be permitted where approved by the Authority Having Jurisdiction.
1704.1.3 Fire Suppression. Where fire suppression is required, an automatic fire suppression system shall be provided within hoods, enclosures, and ductwork in accordance with the following:
   (1) A carbon dioxide extinguishing system in accordance with NFPA 12.
   (2) An automatic water sprinkler system in accordance with NFPA 13.
   (3) A dry chemical extinguishing system in accordance with NFPA 17.

1705.0 Carbon Dioxide Detection System.
1705.1 General. A gas detection system shall be provided in indoor spaces using a carbon dioxide enrichment process.
in indoor spaces where carbon dioxide containers and/or generating systems are located, and in other adjoining indoor spaces where fugitive carbon dioxide is expected to accumulate. The gas detection system shall activate audible alarms distinguishable from the fire alarm system and visual alarms with visual notification and shall be calibrated for the types of fuels or gases used.

1705.1.1 Listings. The gas detection control units shall comply with UL 864 or UL 2017. Gas detectors shall comply with UL 2075.

1705.1.2 Carbon Dioxide Sensor Location. Carbon dioxide sensors shall be located not more than 12 inches (305 mm) above the finished floor.

1705.1.3 Activation. Activation of the gas detection system shall be in accordance with Section 1705.1.3.1 through Section 1705.1.3.2.

1705.1.3.1 Low-Level Activation. Upon detection of a carbon dioxide concentration of 5,000 ppm (9000 mg/m$^3$), the following shall be automatically performed:

1. Stop the flow of carbon dioxide to the supply piping system.
2. Activate the mechanical purge ventilation system.
3. Activate an audible and visual supervisory alarm signal at an approved location within the facility.

1705.1.3.2 High-Level Activation. Upon detection of a carbon dioxide concentration of 30,000 ppm (54 000 mg/m$^3$), the following shall be automatically performed:

1. Stop the flow of carbon dioxide to the supply piping system.
2. Activate the mechanical purge ventilation system.
3. Activate audible and visual alarms inside and outside of the indoor space using a carbon dioxide enrichment process, and inside and outside the space where carbon dioxide containers, generating systems, or both are located. Visual notification of the carbon dioxide alarms shall be colored as required by the Authority Having Jurisdiction.

1705.2 Carbon Dioxide Enrichment System. Indoor spaces using a carbon dioxide enrichment process shall have carbon dioxide detectors, audible and visual alarms, and mechanical purge ventilation with odor control which shall independently exhaust directly to the exterior. The design, installation, and maintenance of carbon dioxide enrichment systems with more than 100 pounds (45.4 kg) of carbon dioxide, and carbon dioxide enrichment systems with any quantity of carbon dioxide having a remote fill connection shall comply with Sections 1705.2.1 through 1705.2.3.

1705.2.1 Equipment. Pressure relief, vent piping, fill indicators, fill connections, vent terminations, piping systems and the storage, use and handling of the carbon dioxide shall be in accordance with this section and NFPA 55.

1705.2.2 Carbon Dioxide Control. Indoor spaces using a carbon dioxide enrichment process shall be maintained with a negative pressure in relation to adjoining indoor spaces or with a positive pressure and intervening entrance/exit pressurization vestibules with the adjoining indoor spaces.

1705.2.3 Carbon Dioxide Supply Piping. Carbon dioxide supply piping shall be in accordance with ASME B31.3.

1706.0 Flammable Solvents.

1706.1 General. Processes using flammable solvents shall be provided with a flammable gas detection system in accordance with the fire code. The flammable gas detection system shall be installed in accordance with the manufacturer’s installation instructions and shall not be interlocked with other equipment. The flammable gas detection system shall be calibrated to detect gas levels of not more than 10 percent of the Lower Flammable Limit (LFL) and to activate audible and visual alarms of not more than 25 percent of the LFL.

1706.2 Control Area. Pumps, motors, chemical fume hoods, equipment, and wiring in control areas and containment booths used for flammable solvent processing shall be as Class 1/Division 1 location for potentially explosive gas and vapor Groups A, B, C, and D in accordance with NFPA 70. Containment booths shall be listed and labeled in accordance with UL 1389.

1706.3 Extraction Equipment. Extraction equipment using flammable solvents and located in an indoor space shall be listed for the intended use. Plant extraction booths shall comply with UL 1389. Extraction equipment using LPG, Butane or other volatile solvents shall be a closed-loop control system and shall comply with ASME BPVC Section VIII.1, ASME B31.3, and NFPA 58, as applicable.

1707.0 Ventilation and Exhaust System.

1707.1 General. The indoor air quality in indoor spaces using environmental controls for cannabis and horticultural cultivation, and processing shall comply with Chapter 4 and Section 1707.1.1. The ventilation and exhaust system shall comply with Section 1707.1.2 through Section 1707.1.6. Indoor spaces used for cannabis and horticultural cultivation shall have an independent ventilation system.

1707.1.1 Breathing Zone Outdoor Airflow Rate. The outdoor airflow required in the breathing zone ($V_{bz}$) of the occupiable space or spaces in a ventilation zone shall be not less than the value determined in accordance with Equation 1707.1.1.

$$V_{bz} = R_p P_z + R_a A_z \quad \text{(Equation 1707.1.1)}$$

Where:
1707.1.4 Exhaust Ventilation Rate. The exhaust and ventilation system required in this section shall not create a lesser standard of installation than prescribed by the minimum safety standards adopted by the Authority Having Jurisdiction. Exhaust airflow shall be provided at not less than 0.2 CFM/ft² [0.001016 (m³/s)/m²] of floor area. Exhaust air shall not be used as makeup air, recirculated air, or transfer air. Makeup air shall be provided for more than 150 CFM exhaust.

1707.1.5 Exhaust System Requirements. An exhaust system shall be installed in accordance with Section 505.0 and the following requirements:

1. Exhaust outlet location(s) in accordance with Section 502.2.2 for product conveying ducts as classified in Section 505.8.
2. Exhaust air shall terminate directly to the outdoors.
3. The exhaust inlet shall be not less than 12 inches (305 mm) above the finished floor.
4. Chemical fume hoods shall be required for flammable solvent processing, shall be listed, and shall be installed in accordance with the manufacturer’s installation instructions.
5. Exhaust ducts shall be independent of all other exhaust systems.

1707.1.6 Automatic Shutoff. Automatic shutoff in air moving systems shall be provided in accordance with Section 608.0.

1708.0 Particulate and Odor Control.

1708.1 General. Particulates and odors from indoor cannabis and horticultural cultivation and processing of plants for human ingestion, inhalation, and topical application shall be filtered and controlled so that it is not detectable above nuisance levels not exceeding applicable exposure limits at the exterior of the facility or at adjoining properties or as required by the Authority Having Jurisdiction. Odor control shall be required in the exhaust system and shall include, but not be limited to, one of the following types:

1. Charcoal filters shall be installed on the discharge of all exhaust ducts and shall be installed in accordance with the manufacturer’s installation instructions.
2. Ozone generators shall be installed in all exhaust ducts to neutralize odor by oxidizing such odors with ozone.
3. Ionizers shall be installed in accordance with the manufacturer’s installation instructions.
4. Photo-catalytic oxidation shall be installed in accordance with the manufacturer’s installation instructions.
5. Photo-hydroxyl oxidation shall be installed in accordance with the manufacturer’s installation instructions.
6. Carbon filtration shall be installed in accordance with the manufacturer’s installation instructions.
7. UV-C lights shall be installed in accordance with the manufacturer’s installation instructions.
8. Where approved by the Authority Having Jurisdiction, a plume discharge termination method shall be permitted to be used for odor control. The exhaust fan of such a system shall discharge exhaust air vertically into the outdoors. The plume heights shall be not less than 20 feet above the nozzle. Escaping air at the nozzle shall be no less than 3,000 feet per minute.

1708.2 Filters. Where filters are used, the minimum filtration rate shall be in accordance with Equation 1709.2. The design airflow velocity across the face area of the chemical absorption filter(s) shall not exceed 350 feet per minute (1.8 m/s).
Minimum Filtration Rate = (Room Volume)/3 \quad \text{(Equation 1709.2)}

**1709.0 Duct Construction and Installation.**

**1709.1 General.** Ducts shall be in accordance with Section 506.0 and Chapter 6. Ducts less than 18 inches (457 mm) in diameter shall be constructed of rigid metal with a thickness of not less than 0.018 of an inch (0.457 mm) (26 gauge). Ducts greater than 18 inches (457 mm) in diameter shall be constructed of rigid metal with a thickness of not less than 0.024 of an inch (0.508 mm) (24 gauge). All ducts and duct connections shall be mechanically fastened and supported in accordance with Chapter 6 at intervals not exceeding 12 feet (3658 mm). Where approved by the Authority Having Jurisdiction, flexible air ducts shall be permitted in accordance with Section 603.4.

**1710.0 Motors and Fans.**

**1710.1 General.** Motors and fans used shall comply with the applicable requirements in Section 503.0.

**1711.0 Storage of Chemicals.**

**1711.1 General.** Storage of chemicals shall comply with the building code and fire code, and NFPA 58 for liquid petroleum gas and NFPA 400 for the storage, use and handling of hazardous materials. Hazardous, combustible, and flammable materials shall not be stored in cultivation rooms.

**1712.0 Walls and Ceilings.**

**1712.1 General.** Walls and ceilings of indoor spaces used for cannabis and horticultural cultivation shall be in accordance with the following requirements:

1. Be of corrosion resistant materials.
2. Include air and vapor barriers.
3. Be insulated in accordance with the building code.

**1713.0 Dehumidification.**

**1713.1 General.** Dehumidification shall be required to maintain humidity levels in accordance with the requirements of the Authority Having Jurisdiction, cultivator, and equipment listing. Dehumidification shall be permitted to be accomplished by means of standalone dehumidifiers, desiccant wheels, or reheat coils.

**1714.0 Fumigation.**

**1714.1 General.** Any cannabis or horticultural growing facility that is fumigated shall comply with Section 1714.1.1 through Section 1714.1.3 and the Authority Having Jurisdiction.

**1714.1.1 Sources of Ignition.** Areas intended to be fumigated shall not contain any open flames or any other sources of ignition.

**1714.1.2 Fumigation Activity Warning.** Areas and entrances to areas intended for fumigation, repellant, pesticide, or insecticide fogging operation shall be clearly marked to indicate fumigation activity.

**1714.1.3 Ventilation.** Areas intended for fumigation shall be continuously mechanically ventilated in accordance with Section 1707.0.

**1715.0 Luminaires.**

**1715.1 General.** Horticultural lighting equipment and systems used for indoor cannabis and horticultural cultivation shall be listed and labeled in accordance with UL 8800. Luminaires installed in ductwork shall be installed in accordance with NFPA 90A and the manufacturer’s installation instructions.

**1716.0 Signage.**

**1716.1 General.** Caution or warning signs complying with NFPA 704 shall be provided at the entrance of the facility and/or indoor spaces identifying hazards such as flammables, asphyxiants, and toxics.

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**205.0 – C – Cannabis Facility.** A business, facility, or establishment where retail Cannabis is grown, cultivated, tested, stored, dried, extracted, weighed, packaged, sold, or processed, including dispensaries, cultivators, manufacturers, distributors, or testing laboratories.

**Cultivation Room.** A room of any size where plants are grown under controlled conditions. Also known as a grow room.

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**207.0 – E – Extraction Equipment.** Equipment used to extract cannabinoids such as tetrahydrocannabinol (THC), cannabidiol (CBD), and terpenes from cannabis plants.

**Extraction Equipment, Non-Volatile.** Extraction equipment utilizing any solvent that is not considered volatile (i.e., carbon dioxide).

**Extraction Equipment, Volatile.** Extraction equipment utilizing any solvent that is considered flammable and hazardous...
(i.e., Butane, propane, hexene, or ethanol).

209.0 – G –
**Gas Detection Control Units.** A digital or analog controller that continuously monitors the presence of toxic, anoxic, and explosive gases in the ambient air to prevent the risks of explosion linked to such gases.

211.0 – I –
**Indoor Horticulture.** The cultivation and processing of floricultural and horticultural plants, including cannabis, in an indoor space by controlling various interior environmental variables including, but not limited to, temperature, air quality, humidity, artificial lighting, nutrients, and carbon dioxide.

### TABLE 1701.1
**REFERENCED STANDARDS**

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFPA 55-2020</td>
<td>Compressed Gases and Cryogenic Fluids Code</td>
<td>Compressed Gases</td>
<td>1705.2.1</td>
</tr>
<tr>
<td>NFPA 72-2019</td>
<td>National Fire Alarm and Signaling Code</td>
<td>Fire Alarms</td>
<td>1704.1.1</td>
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<tr>
<td>NFPA 400-2019</td>
<td>Hazardous Materials Code</td>
<td>Fire Alarms</td>
<td>1711.1</td>
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<tr>
<td>NFPA 2001-2018</td>
<td>Clean Agent Fire Extinguishing Systems</td>
<td>Fire Extinguishing</td>
<td>1704.1.3</td>
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<tr>
<td>UL 268-2016</td>
<td>Smoke Detectors for Fire Alarm Systems (with revisions through October 31, 2019)</td>
<td>Smoke Detectors</td>
<td>1704.1.1</td>
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<td>UL 864-2014</td>
<td>Control Units and Accessories for Fire Alarm Systems (with revisions through May 7, 2020)</td>
<td>Control Units</td>
<td>1705.1.1</td>
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<td>UL 1389-2019</td>
<td>Plant Oil Extraction Equipment for Installation and Use in Ordinary (Unclassified) Locations and Hazardous (Classified) Locations (with revisions through October 13, 2020)</td>
<td>Plant Oil Extraction</td>
<td>1706.2, 1706.3</td>
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<td>UL 2017-2008</td>
<td>General-Purpose Signaling Devices and Systems (with revisions through December 14, 2018)</td>
<td>Signaling Devices</td>
<td>1705.1.1</td>
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<td>UL 2075-2013</td>
<td>Gas and Vapor Detectors and Sensors (with revisions through December 21, 2017)</td>
<td>Gas Detectors</td>
<td>1705.1.1</td>
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<tr>
<td>UL 8800-2019</td>
<td>Horticultural Lighting Equipment and Systems</td>
<td>Electrical</td>
<td>1715.1</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**Note:** The ASME, NFPA, and UL standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

**SUBSTANTIATION:**
This code change adds requirements for controlling the indoor environment of cannabis and horticulture facilities, including ventilation and exhaust rates, filter requirements, odor control, humidity control, and duct requirements. These HVAC requirements have been used by jurisdictions for cannabis and horticulture facilities and are commonly used in the industry. Growing plants transpire water vapor, causing very high humidity if not controlled, and creates a conducive environment for mold and pathogenic organisms. The basic necessities of cannabis are light, air, water, nutrients, a growing medium, and heat to create the necessary energy to grow. When growing indoors, the requirements are the same, though it is necessary that the indoor environment remain safe for occupants. To maximize public health and safety, safe indoor air quality conditions must be maintained.

**COMMITTEE ACTION:** REJECT

**COMMITTEE STATEMENT:**
The Technical Committee Chair called for the formation of a Task Group to further address "indoor horticulture facilities." There are concerns with the current language as written. For example, carbon dioxide enrichment systems is inadequate and may create health and safety concerns for occupants. There is no mention of what type of detectors to be used. The proposed ventilation requirements may be inadequate. There may also be requirements missing for certain necessary systems for removal of flammable solvents when they reach the LFL. The language should be reworked by a task group.
Additionally, some proposed language may be outside the scope of the mechanical code. For example, fire protection and storage of chemicals be be better suited in the fire code. The provisions may also conflict with the fire code. In addition, there is no technical justification provided for the values listed in the proposal. Data needs to be included for review and evaluation. NFPA has developed an ANSI standard for cannabis facilities and should be reviewed.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine

EXPLANATION OF AFFIRMATIVE:

TRAFTON, P; YOUNG: As discussed at the TC Meeting, I wish to participate in this task group for cultivation and processing facilities.
Proposals

Item #: 284
UMC 2024  Section: B 103.1

SUBMITTER: IAPMO Staff - Update Extracts  
NFPA 54 Extract Update

RECOMMENDATION:
Revise text

B 103.0 Safety Shutoff Devices.
B 103.1 General. Where a safety shutoff device is provided, it shall be checked for proper operation and adjustment in accordance with the appliance manufacturer’s instructions. Where the device does not function properly to turn off the gas supply in the event of pilot outage or other improper operation, it ignition malfunction, the device shall be properly serviced or replaced with a new device. [NFPA 54:11.3]

SUBSTANTIATION:
In accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines), Appendix B is being revised to the latest edition of NFPA 54-2021.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 285
UMC 2024 Section: C 102.1, E 101.2, E 201.1, F 102.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

C 102.0 Definitions.
C 102.1 General. For the purpose of this appendix, the following definitions shall apply:

E 101.0 General.
E 101.2 Definition of Terms. For the purposes of this code, the definitions shall apply to this appendix. No attempt is made to define ordinary words, which are used in accordance with their established dictionary meanings, except where a word has been used loosely, and it is necessary to define its meaning as used in this appendix to avoid misunderstanding.
The definitions of terms are arranged alphabetically according to the first word of the term.

E 201.0 Definitions.
E 201.1 Definitions. For the purpose of this appendix, the following definitions shall apply:

F 102.0 Definitions.
F 102.1 Definitions. For the purpose of this appendix, the following definitions shall apply:

(below shown for reference only)

201.0 General.
201.1 Applicability. For the purpose of this code, the following terms have the meanings indicated in this chapter.

No attempt is made to define ordinary words, which are used in accordance with their established dictionary meanings, except where a word has been used loosely, and it is necessary to define its meaning as used in this code to avoid misunderstanding.

SUBSTANTIATION:
The above change intends to correlate the opening statement for definitions used throughout the code. Currently the appendices' opening statement for definitions are different. The change updates all appropriate sections to the same statement to clarify that the definitions in the appendices are specific to the appendices. The main appendix statement already clarifies that Chapter 2 definitions apply to all sections of the code. Furthermore, Appendix E is being modified to match the other appendices as the statement is a repeat of what is in Chapter 2.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 286
UMC 2024  Section: D 107.1

SUBMITTER: IAPMO Staff - Update Extracts
NFPA 501A Extract Update

RECOMMENDATION:
Revise text

D 107.0 Required Gas Supply.
D 107.1 General. The minimum hourly volume of gas required at each manufactured home site outlet or any section of the manufactured home community gas piping system shall be calculated as shown in Table D 107.1. [NFPA 501A:4.3.4.1]
In extreme climate areas, additional capacities other than those shown in Table D 107.1 shall be considered. [NFPA 501A:4.3.4.1, 4.3.4.2]

SUBSTANTIATION:

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
D 112.3 Oil Supply Connections. Oil supply connections at manufactured home sites, where provided from a centralized oil distribution system, shall be located and arranged to permit attachment to a manufactured home utilizing the stand. [NFPA 501A:4.3.11.1] The installation of such facilities shall comply with the following requirements:

1. The main distribution pipeline shall be permitted to be connected to a tank or tanks having an aggregate capacity not exceeding 20,000 gallons (75,708 L) at a point below the liquid level.
2. Where this piping is so connected, a readily accessible internal or external shutoff valve shall be installed in the piping as close as practicable to the tank.
3. If external and aboveground, the shutoff valve and its tank connections shall be made of steel.
4. Connections between the tank(s) and the main pipeline shall be made with double swing joints or flexible connectors, or shall otherwise be arranged to permit the tank(s) to settle without damaging the system.
5. If located aboveground, the connections specified in Section D 112.3(4) shall be located within the diked area.
6. A readily accessible and identified manual shutoff valve shall be installed either inside or outside of the structure in each branch supply pipeline that enters a building, mobile home, travel trailer, or other structure. If outside, the valve shall be protected from weather and damage. If inside, the valve shall be located directly adjacent to the point at which the supply line enters the structure. If outside, the valve shall be protected from weather and damage.
7. If located aboveground, the connections specified in Section D 112.3(4) shall be located within the diked area.
8. A device shall be provided in the supply line at or ahead of the point where it enters the interior of the structure that will automatically shut off the oil supply, if the supply line between this device and the appliance is broken. This device shall be located on the appliance side of the manual shutoff valve required in Section D 112.3(6) and shall be solidly supported and protected from damage.
9. Means shall be provided to limit the oil pressure at the appliance inlet to a maximum gauge pressure of 3 pound-force per square inch gauge (psig) (21 kPa). If a pressure-reducing valve is used, it shall be a type approved for the service.
10. A device shall be provided that will automatically shut off the oil supply to the appliance if the oil pressure at the appliance inlet exceeds a gauge pressure of 8 psig (55 kPa). The device shall not be required under either of the following conditions:
   a. Where the distribution system is supplied from a gravity tank and the maximum hydrostatic head of oil in the tank is such that the oil pressure at the appliance inlet will not exceed a gauge pressure of 8 psig (55 kPa).
   b. Where a means is provided to automatically shut off the oil supply if the pressure-regulating device provided in accordance with Section D 112.3(6) fails to regulate the pressure as required.

SUBSTANTIATION:
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Appendix D is being revised to the latest edition of NFPA 31-2020.
E 605.1.3 Dwelling-Unit Ventilation. A Mechanical exhaust system, supply system, or combination thereof shall be installed designed and provided with the capacity to operate for each deliver outdoor air ventilation to the whole dwelling unit to provide a continuous dwelling-unit ventilation with outdoor air at a rate not less than the rate that specified in Section E 605.1.3.1 through Section E 605.1.3.5. [ASHRAE 62.2:4.1]

E 605.1.3.2 Effective Annual Average Infiltration Rate (Qinf) Using a Single-Point Envelope Leakage Test. Effective Annual Average Infiltration Rate (Qinf) shall be calculated using Equation E 605.1.3.2: a single-point test at 50 Pa. The Effective Annual Average Infiltration Rate (Qinf) shall be calculated using Equation 605.1.3.2:

(Equation E 605.1.3.2)

\[ Q_{inf} \text{(CFM)} = \frac{(NL \times wsf \times Afloor)}{7.3} \]

Where:
\( NL \) = normalized leakage
\( wsf \) = weather and shielding factor from ASHRAE 62.2.
\( Afloor \) = floor area of residence, \( \text{ft}^2 \) (\( \text{m}^2 \)).
* Replace 7.3 with 1.44 for metric units. [ASHRAE 62.2:4.1.2(e)]

\[ Q_{inf} = 0.052 \times Q_{50} \times wsf \times (H/H_r)^z \quad \text{(Equation 605.1.3.2)} \]

Where:
\( Q_{inf} \) = estimated infiltration rate, cfm (L/s).
\( Q_{50} \) = leakage rate at 50 Pa depressurization or pressurization, cfm (L/s).
\( wsf \) = weather and shielding factor from ASHRAE 62.2.
\( H \) = vertical distance between the lowest and highest above-grade points within the pressure boundary, \( \text{ft} \) (\( \text{m} \)).
\( H_r \) = reference height, 8.2 ft (2.5 m).
\( z \) = 0.4 for the purpose of calculating the Effective Annual Average Infiltration Rate. [ASHRAE 62.2:4.1.2.1]

E 605.1.3.3 Required Mechanical Ventilation Rate (Qfan). If a blower door test has been performed, then a credit for estimated infiltration may be taken for detached dwelling units using either the procedure in Section E 605.1.3.2 or E 605.1.3.4. Attached dwelling units other than horizontally attached shall not be permitted to take an infiltration credit. Horizontally attached dwelling units shall be permitted to use a blower door test result to take this credit, subject to the reduction factor Aext in Equation E 605.1.3.3.

If this credit is taken, then the Required Mechanical Ventilation Rate (Qfan) shall be calculated using Equation E 605.1.3.3:

(Equation E 605.1.3.3)
\[ Q_{fan} = Q_{tot} - \Phi(Q_{inf} \times A_{ext}) \]

Where:
- \( Q_{fan} \) = required mechanical ventilation rate, CFM (L/s)
- \( Q_{tot} \) = total required ventilation rate, CFM (L/s)
- \( Q_{inf} \) = may be not greater than \( \frac{2}{3} \times Q_{tot} \) infiltration, cfm (L/s)
  (see ASHRAE 62.2 for exceptions for existing buildings)
- \( A_{ext} \) = 1 for single-family detached homes; for horizontally attached dwelling units, or the ratio of exterior envelope surface area that is not attached to garages or other dwelling units to total envelope surface area for single-family attached homes.
- \( \Phi = 1 \) for balanced ventilation systems, and \( Q_{inf} / Q_{tot} \) otherwise

**Exception:** Where \( Q_{fan} \), calculated for unbalanced ventilation, is less than or equal to 15 cfm (7 L/s), a dwelling-unit ventilation system is not required.  [ASHRAE 62.2:4.1.2(f)]

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**E 605.1.3.4 Effective Annual Average Infiltration Rate (\( Q_{inf} \)) Using a Multipoint Envelope Leakage Test.** Effective Annual Average Infiltration Rate (\( Q_{inf} \)) shall be calculated using the normalized leakage calculated from measurements of envelope leakage using a multipoint test from either ASTM E779 in accordance with Section E 605.1.3.4(A) or CGSB 149.10 in accordance with Section E 605.1.3.4(B).

**E 605.1.3.4(A) ASTM Procedure.** To calculate the effective leak area (\( ELA \)) from ASTM E779, the leakage area for pressurization and depressurization (using a 4 Pa reference pressure) shall be averaged using Equation E 605.1.3.4(A):

\[ ELA = \frac{L_{press} + L_{depress}}{2} \quad \text{[Equation E 605.1.3.4(A)]} \]

Where:
- \( ELA \) = effective leakage area, ft\(^2\) (m\(^2\))
- \( L_{press} \) = leakage area from pressurization, ft\(^2\) (m\(^2\))
- \( L_{depress} \) = leakage area from depressurization, ft\(^2\) (m\(^2\))

**E 605.1.3.4(B) CGSB Procedure.** To calculate the \( ELA \) from CGSB 149.10, the following modifications to the test procedure must be made:

a. All vents and intentional openings must be in the same configuration as specified in ASTM E779 (i.e., HVAC dampers and registers should be in the normal operating position; fireplace and other dampers should be closed unless they are required for test operation).

b. Height and floor area must be reported consistently with the definitions of this standard.

c. The leakage area as calculated from the CGSB procedure must be converted using Equation E 605.1.3.4(B):

\[ ELA = 0.61 \times (0.4)^n - 0.5 \times L_{cgsb} \quad \text{[Equation E 605.1.3.4(B)]} \]

Where:
- \( n \) = exponent measured from the CGSB 149.10
- \( L_{cgsb} \) = CGSB leakage area as modified above, ft\(^2\) (m\(^2\))

**E 605.1.3.4(C) Normalized Leakage.** Normalized leakage shall be calculated using Equation E 605.1.3.4(C):

\[ NL = 1000 \times \frac{ELA}{A_{floor}} \times \left[ \frac{H}{H_r} \right]^{\frac{3}{z}} \quad \text{[Equation E 605.1.3.4(C)]} \]

Where:
- \( NL \) = normalized leakage
- \( ELA \) = effective leakage area, ft\(^2\) (m\(^2\))
- \( A_{floor} \) = floor area of residence, ft\(^2\) (m\(^2\))
- \( H \) = vertical distance between the lowest and highest above-grade points within the pressure boundary, ft (m)
- \( H_r \) = reference height, 8.2 ft (2.5 m)
- \( z = 0.4 \) for the purpose of calculating the Effective Annual Infiltration Rate

**E 605.1.3.4(D) Effective Annual Average Infiltration Rate.** Effective Annual Average Infiltration Rate (\( Q_{inf} \)) shall be calculated using Equation E 605.1.3.4(D):

\[ \]
E 605.1.4 System Type. The dwelling-unit mechanical ventilation system shall consist of one or more supply or exhaust fans and associated ducts and controls. Local exhaust fans shall be permitted to be part of a mechanical exhaust system. Where local exhaust fans are used to provide dwelling-unit ventilation, the local exhaust airflow shall be permitted to be credited toward the dwelling-unit ventilation airflow requirement. Outdoor air ducts connected to the return side of an air handler shall be permitted as supply ventilation where manufacturer’s requirements for return air temperature are met. See ASHRAE 62.2 Indoor Air Quality Guide for guidance on selection of methods. [ASHRAE 62.2:4.4.2]

E 605.1.5 Airflow Measurement. The airflow required by this section shall be the quantity of outdoor ventilation air supplied and/or indoor air exhausted by the mechanical ventilation system as installed and shall be measured according to the ventilation equipment manufacturer’s installation instructions, or by using a flow hood, flow grid, or other airflow measuring device at the mechanical ventilation fan’s inlet terminals/grilles, outlet terminals/grilles, or in the connected ventilation ducts. Balanced mechanical ventilation system airflow shall be the average of the supply fan and exhaust fan flows. Ventilation airflow of systems with multiple operating modes shall be tested in all modes designed to meet this section. [ASHRAE 62.2:4.4.3]

E 605.1.6 Control and Operation. A Control shall include text or an icon indicating the system’s function. Occupant controls shall include text or an icon indicating the system’s function.

Exception: For multifamily dwelling units, the manual ON-OFF control shall not be required to be readily accessible to the dwelling-unit occupant. [ASHRAE 62.2:4.4.1]

E 605.1.7 Variable Mechanical Ventilation. Dwelling-unit mechanical ventilation systems designed to provide variable ventilation shall comply with Section E 605.1.7.1 or Section E 605.1.7.2 or Section E 605.1.7.3. Section E 605.1.7.2 and Section E 605.1.7.3 also require compliance with ASHRAE 62.2 and require verification with supporting documentation from the manufacturer, designer, or specifier of the ventilation control system that the system meets the requirements of these sections. Where the dwelling-unit ventilation rate varies based on occupancy, occupancy shall be determined by occupancy sensors or by an occupant-programmable schedule. Operation shall comply with Section E 605.1.6.1. [ASHRAE 62.2:4.4.5]

E 605.1.7.1 Short-Term Average Ventilation. To comply with this section, a variable ventilation system shall be installed to provide an average dwelling-unit ventilation rate over any consecutive period of three-hours or less that is greater than or equal to \(Q_{\text{fan}}\) as calculated using Section E 605.1.3.3, and shall not provide a ventilation rate of zero over any three-hour interval. [ASHRAE 62.2:4.5.1]

E 605.1.7.2 Scheduled Ventilation. This section shall only be allowed to be used when one or more fixed patterns of designed ventilation are known at the time compliance to Section E 605.0 is being determined. Such patterns include those both clock-driven and driven by typical meteorological data. Compliance with this section shall be demonstrated with either Section E 605.1.7.2.1 or Section E 605.1.7.2.2. [ASHRAE 62.2:4.5.2]

E 605.1.7.2.1 Annual Average Schedule. An annual schedule of ventilation complies with this section when the annual average relative exposure during occupied periods is not more than one, and the peak relative exposure shall not exceed five for any time step as calculated in accordance with ASHRAE 62.2. [ASHRAE 62.2:4.5.2.1]

E 605.1.7.2.2 Block Scheduling. The schedule of ventilation complies with this section when if it is broken into blocks of time and each block individually has an average relative exposure during occupied periods that is not more than one as calculated in ASHRAE 62.2. All blocks shall end with a relative exposure less than or equal to one. [ASHRAE 62.2:4.5.2.2]

E 605.1.7.3 Real-Time Control. A real-time ventilation controller complies with this section when it is designed to adjust the ventilation system based on real-time input to the ventilation calculations so that the average relative exposure during occupied periods is not more than unity, and the peak relative exposure shall not exceed five for any time step as calculated in ASHRAE 62.2. The averaging period shall be not less than one day but not more than one year and shall be based on simple, recursive or running average, but not extrapolation.
For the purposes of calculating average relative exposure, a dwelling unit shall be permitted to be treated as unoccupied during a time step only if it is unoccupied for the entire time step. [ASHRAE 62.2:4.5.3]

### TABLE E 605.1.3.1
VENTILATION AIR REQUIREMENTS, (cubic foot per minute)
[ASHRAE 62.2:TABLE 4-1a 4-1a]

(portion of table not shown remains unchanged)

### TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAN/CGSB 149.10-2019</td>
<td>Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method</td>
<td>Ventilation</td>
</tr>
</tbody>
</table>

(portion of table not shown remains unchanged)

**SUBSTANTIATION:**
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Appendix E is being revised to the latest edition of ASHRAE 62.2-2019 and Addendum x as published on March 2, 2020 to ASHRAE 62.2-2019.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 289

UMC 2024  Section: Appendix E, Table 1701.2

SUBMITTER: IAPMO Staff - Update Extracts
ASHRAE 90.1 Extract Update

RECOMMENDATION:
Revise text

E 201.0 Definitions.

Fan, Embedded. A fan that is part of a manufactured assembly where the assembly includes functions other than air movement. [ASHRAE 90.1:3.2]

Fan Array. Multiple fans in parallel between two plenum sections in an air distribution system. [ASHRAE 90.1:3.2]

Fan Nameplate Electrical Input Power. The nominal electrical input power rating stamped on a fan assembly nameplate. [ASHRAE 90.1:3.2]

Fan Energy Index (FEI). The ratio of the electric input power of a reference fan to the electric input power of the actual fan as calculated per AMCA 208. [ASHRAE 90.1:3.2]

Fan System Electrical Input Power. The sum of the fan electrical power of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the conditioned spaces and/or return it to the source or exhaust it to the outdoors. [ASHRAE 90.1:3.2]

On-Site Renewable Energy. Energy generated from renewable energy resources produced harvested at the building site. [ASHRAE 90.1:3.2]

Site-Recovered Energy. Waste energy recovered at the building site that is used to offset consumption of purchased fuel or electrical energy supplies. [ASHRAE 90.1:3.2]

Renewable Energy Resources. Energy from solar, wind, biomass or hydro, or extracted from hot fluid or steam heated within the earth. [ASHRAE 90.1:3.2]

E 503.1.3 Alterations to Heating, Ventilating, Air-Conditioning, and Refrigeration in Existing Buildings. New HVACR equipment as a direct replacement of existing HVACR equipment shall be in accordance with the following sections as applicable for the equipment being replaced:

(1) Section E 503.3 “Simplified Approach Option for HVAC Systems”
(2) Section E 503.4 “Equipment Efficiencies, Verification, and Labeling Requirements”
(3) Section E 503.4.6 “Zone Thermostatic Controls”
(4) Section E 503.4.6.2 “Setpoint Overlap Restriction”
(5) Section E 503.4.6.3 “Off-Hour Controls”
(6) Section E 503.4.6.4 “Ventilation System Controls”
(7) Section E 503.4.6.8 “Freeze Protection and Snow or Ice Melting Systems”
(8) Section E 503.4.6.9 “Ventilation Controls for High-Occupancy Areas”
(9) Section E 503.4.6.11 “Heated or Cooled Vestibules”
(10) Section E 503.4.8 “Walk-In Coolers and Walk-In Freezers”
(11) Section E 503.5.1 “Air Economizers, Design Capacity”
(12) Section E 503.5.3 “Integrated Economizer Control”
(13) Section E 503.5.4 “Economizer Heating System Impact”
(14) Section E 503.5.6.1.2 “Fan Efficiency”
(15) Section E 503.5.6.2 “Supply Fan Airflow Control”
(16) Section E 503.5.6.5 “Fractional Horsepower Fan Motors”
(17) Section E 503.5.7 “Boiler Turndown”
(18) Section E 503.5.7.2 “Chiller and Boiler Isolation”
E 503.4.8 Walk-In Coolers and Walk-In Freezers. Site-assembled or site-constructed walk-in coolers and walk-in freezers shall conform to the following requirements:

1. Shall be equipped with automatic door closers that firmly close walk-in doors that have been closed to within 1 inch (25.4 mm) of full closure.
   **Exception:** Doors wider than 3 feet 9 inches (1143 mm) or taller than 7 feet (2134 mm).

2. Doorways shall have strip doors (curtains), spring-hinged doors, or other method of minimizing infiltration when doors are open.

3. Walk-in coolers shall contain wall, ceiling, and door insulation of at least R-25 and at least R-32 for walk-in freezers.
   **Exception:** Glazed portions of doors or structural members.

4. Walk-in freezers shall contain floor insulation of at least R-28.

5. Evaporator fan motors that are less than 1 hp and less than 460 V shall use electronically commutated motors (brushless direct-current motors) or three-phase motors.

6. Lights shall use light sources with an efficacy of 40 lm/W or more, including ballast losses (if any). Light sources with lower may be used in conjunction with a timer or device that turns off the lights within 15 minutes of when the walk-in cooler or walk-in freezer is not occupied by people.

7. Transparent reach-in doors for walk-in freezers, and windows in walk-in freezer doors, shall be of triple-pane glass, either filled with inert gas or with heat-reflective treated glass or vacuum insulating glazing.

8. Transparent reach-in doors for walk-in coolers, and windows in walk-in cooler doors, shall be double-pane glass with heat-reflective treated glass and gas filled, or triple-pane glass, either filled with inert gas or with heat-reflective treated glass or vacuum insulating glazing.

9. Antisweat heaters without antisweat heater controls shall have a total door rail, glass, and frame heater power draw of not more than 7.1 W/ft² of door opening for walk-in freezers and 3.0 W/ft² of door opening for walk-in coolers.

10. Antisweat heater controls shall reduce the energy use of the antisweat heater as a function of the relative humidity in the air outside the door or to the condensation on the inner glass pane.

11. Condenser fan motors that are less than 1 hp shall use electronically commutated motors, permanent split-capacitor-type motors, or three-phase motors.

12. All walk-in freezers shall incorporate temperature-based defrost termination control with a time limit default. The defrost cycle shall terminate first on an upper temperature limit breach and second upon a time limit breach.
   **Exception:** Walk-in coolers and walk-in freezers combined in a single enclosure greater than 3000 ft² (278 m²).

13. Doors in walk-in coolers and walk-in freezers shall meet the requirements of ASHRAE 90.1. Walk-in cooler and walk-in freezer refrigeration systems, except for walk-in process cooling refrigeration systems as defined in 10 CFR 431.302, shall meet the requirements of ASHRAE 90.1. [ASHRAE 90.1:6.4.5]

E 503.2 Compliance Path(s). Mechanical equipment and systems providing heating, cooling, ventilating, or refrigeration shall comply with Section E 503.2.1 and Section E 503.2.2.

Section E 503.0 shall be achieved in accordance with the requirements of Section E 503.1.1 through Section E 503.6, Section E 503.7, and one of the following:

1. Section E 503.3 and Section E 503.3.1
2. Section E 503.4
3. Section E 503.4 and Section E 503.8 [ASHRAE 90.1:6.2.1, 6.2]

E 503.2.1 Requirements For All Compliance Paths. Mechanical equipment and systems shall comply with the following:

1. Section E 503.0. “General”
2. Section E 503.4. “Equipment Efficiencies, Verification, and Labeling Requirements”
3. Section E 503.6. “Submittals”

E 503.2.2 Additional Requirements. Mechanical equipment and systems shall comply with one of the following:

1. Section E 503.3. “Simplified Approach Building Compliance Path for HVAC Systems”
   **Exception:** When compliance is shown using Section E 503.2.2(1), compliance with Section E 503.4 is not required.
2. Section E 503.5. “Prescriptive Compliance Path”
   **Exception:** HVAC systems only serving the heating, cooling, or ventilating needs of a computer room with IT equipment load greater than 10 kW shall be permitted to comply with Section E 503.4. “Equipment Efficiencies, Verification, and Labeling Requirements” and Section E 503.8. “Alternative Compliance Path, Computer Room Systems.” [ASHRAE 90.1:6.2.2]

E 503.2.1 Projects Using Energy Cost Budget Method. Projects using the energy cost budget method in accordance with ASHRAE 90.1 shall comply with Section E 503.4, the mandatory provisions of this section, as a portion of that compliance path. [ASHRAE 90.1:6.2.2]

E 503.3.1 Criteria. The HVAC system shall comply with all of the following criteria:
(1) The system serves a single HVAC zone.
(2) The equipment shall comply with the variable flow requirements of Section E 503.5.6.2.
(3) Cooling (where any) shall be provided by a unitary packaged or split-system air conditioner that is either air-cooled or evaporatively cooled, with efficiency that is in accordance with the requirements shown in Table E 503.7.1(1) for air conditioners, Table E 503.7.1(2) for heat pumps, or Table E 503.7.1(4) for packaged terminal and room air conditioners and heat pumps for the applicable equipment category.
(4) The system shall have an air economizer in accordance with Section E 503.5 and Section E 503.4.6.13.
(5) Heating (where any) shall be provided by a unitary packaged or split-system heat pump that is in accordance with the applicable efficiency requirements shown in Table E 503.7.1(2) for heat pumps or Table E 503.7.1(4) for packaged terminal and room air conditioners and heat pumps, a fuel-fired furnace that is in accordance with the applicable efficiency requirements shown in Table E 503.7.1(5) for furnaces, duct furnaces, and unit heaters, an electric resistance heater, or a baseboard system connected to a boiler that is in accordance with the applicable efficiency requirements shown in Table E 503.7.1(6) for boilers.
(6) The system shall comply with the exhaust air energy recovery requirements in accordance with Section E 503.5.10.
(7) The system shall be controlled by a manual changeover or dual setpoint thermostat.
(8) Where a heat pump equipped with auxiliary internal electric resistance heaters is installed, controls shall be provided that prevent supplemental heater operation where the heating load is capable of being met by the heat pump alone during both steady-state operation and setback recovery. Supplemental heater operation shall be permitted during outdoor coil defrost cycles. The heat pump shall be controlled in accordance with one of the following:
(a) A digital or electronic thermostat designed for heat pump use that energizes auxiliary heat where the heat pump has insufficient capacity to maintain setpoint or to warm up the space at a sufficient rate.
(b) A multistage space thermostat and an outdoor air thermostat wired to energize auxiliary heat on the last stage of the space thermostat and where outdoor air temperature is less than 40°F (4°C).

**Exceptions:** Heat Pumps that comply with the following:
(1) Have a minimum efficiency regulated by NAECA.
(2) In accordance with the requirements shown in Table E 503.7.1(2).
(3) Include all usage of internal electric resistance heating.
(9) The system controls shall not permit reheat or other form of simultaneous heating and cooling for humidity control.
(10) Systems serving spaces other than hotel or motel guest rooms, and other than those requiring continuous operation, which have both a cooling or heating capacity more than 15 000 Btu/h (4.4 kW) and a supply fan motor power more than 0.75 horsepower (hp) (0.56 kW), shall be provided with a time clock that is in accordance with the following:
   (a) Can start and stop the system under different schedules for seven different day-types per week.
   (b) Is capable of retaining programming and time setting during a loss of power for a period of not less than 10 hours.
   (c) Includes an accessible manual override that allows temporary operation of the system for up to 2 hours.
   (d) Is capable of and configured with temperature setback down to 55°F (13°C) during off hours.
   (e) Is capable of and configured with temperature setup to 90°F (32°C) during off hours.
(11) Systems serving hotel/motel guest rooms shall comply with Section E 503.4.6.3.5.
(12) Except for piping within manufacturer’s units, HVAC piping shall be insulated in accordance with Table E 503.7.3(1) and Table E 503.7.3(2). Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation.
(13) Ductwork and plenums shall be insulated in accordance with Table E 503.7.2 and shall be sealed in accordance with Section E 503.4.7.2.
(14) Construction documents shall require a ducted system to be air balanced in accordance with industry-accepted procedures.
(15) Outdoor air intake and exhaust systems shall comply with Section E 503.4.6.4 through Section E 503.4.6.5.
(16) Where separate heating and cooling equipment serves the same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling.
(17) Systems with a design supply air capacity more than 10 000 ft³/min (4.7195 m³/s) shall have optimum start controls.
(18) The system shall comply with the demand control ventilation requirements of Section E 503.4.6.9. occupied-stay controls in Section E 503.5.6.7, and the ventilation design requirements of Section E 503.5.6.6.
(19) The system shall comply with the door switch requirements of Section E 503.5.14. [ASHRAE 90.1:16.3.2]

**E 503.5.6.7 Occupied-Standby Controls.** Zones serving only rooms that are required to have automatic partial OFF or automatic full OFF lighting controls in accordance with ASHRAE 90.1, where the Chapter 4 or ASHRAE 62.1 occupancy category permits ventilation air to be reduced to zero when the space is in occupied-stay mode, and when using the Ventilation Rate Procedure, shall meet the following within 5 minutes of all rooms in that zone entering occupied-stay mode.
(1) Active heating set point shall be setback at least 1°F.
(2) Active cooling set point shall be setup at least 1°F.
(3) All airflow supplied to the zone shall be shut off whenever the space temperature is between the active heating and cooling set points.
Exception: Multiple zone systems without automatic zone flow control dampers. [ASHRAE 90.1:6.5.3.8]

E 503.4 Mandatory Provisions-Equipment Efficiencies, Verification, and Labeling Requirements. Equipment shown in Table E 503.7.1(1) through Table E 503.7.1(16) shall have a minimum performance at the specified rating conditions where tested in accordance with the specified test procedure. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy the all stated requirements unless otherwise exempted by footnotes in the table. Equipment covered under the Federal Energy Policy Act of 1992 (EPACT) shall have no minimum efficiency requirements for operation at minimum capacity or other than standard rating conditions. Equipment used to provide service water-heating functions as part of a combination system shall satisfy the all stated requirements for the appropriate space heating or cooling category.

Tables are as follows:
(1) Table E 503.7.1(1), “Electrically Operated Unitary Air Conditioners and Condensing Units-Minimum Efficiency Requirements”
(2) Table E 503.7.1 (2), “Electrically Operated Air-Cooled Unitary and Applied Heat Pumps-Minimum Efficiency Requirements”
(3) Table E 503.7.1 (3), “Water-Chilling Packages-Minimum Efficiency Requirements” (See Section E 503.4.1 for water-cooled centrifugal water-chilling packages that are designed to operate at nonstandard conditions.)
(4) Table E 503.7.1 (4), “Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps-Minimum Efficiency Requirements”
(5) Table E 503.7.1 (5), “Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters-Minimum Efficiency Requirements”
(6) Table E 503.7.1 (6), “Gas- and Oil-Fired Boilers-Minimum Efficiency Requirements”
(7) Table E 503.7.1 (7), “Performance Requirements for Heat-Rejection Equipment—Minimum Efficiency Requirements”
(8) Table E 503.7.1 (8), “Heat Transfer Equipment”
(9) Table E 503.7.1 (9), “Electrically Operated Variable-Refrigerant-Flow Air Conditioners- Minimum Efficiency Requirements”
(10) Table E 503.7.1 (10), “Electrically Operated Variable-Refrigerant-Flow and Applied Heat Pumps-Minimum Efficiency Requirements”
(11) Table E 503.7.1 (11), “Floor-Mounted Air Conditioners and Condensing Units Serving Computer Rooms”
(12) Table E 503.7.1 (12), “Commercial Refrigerators, Commercial and Freezers, and Refrigeration-Minimum Efficiency Requirements”
(13) Table E 503.7.1 (13), “Commercial Refrigeration Minimum Efficiency Requirements”
(14) Table E 503.7.1 (14), “Vapor-Compression-Based Indoor Pool Dehumidifiers-Minimum Efficiency Requirements”
(17) Table E 503.7.1 (17), “Ceiling-Mounted Computer-Room Air Conditioners-Minimum Efficiency Requirements”
(18) Table E 503.7.1 (18), “Walk-In Cooler and Freezer Display Door Efficiency Requirements”
(19) Table E 503.7.1 (19), “Walk-In Cooler and Freezer Non-display Door Efficiency Requirements”
(20) Table E 503.7.1 (20), “Walk-In Cooler and Freezer Refrigeration System Efficiency Requirements”

All furnaces with input ratings of 225 000 Btu/h (66 kW) or more, including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75 percent of the input rating. Air conditioners primarily serving computer rooms and covered by ASHRAE 127 shall comply with the requirements in Table E 503.7.1(11). All other air conditioners shall meet the requirements in Table E 503.7.1(1). [ASHRAE 90.1:6.4.1.1]

E 503.4.1 Water-Cooled Centrifugal Chilling Packages. Equipment not designed for operation in accordance with AHRI 550/590 test conditions of 44.00°F (6.67°C) leaving and 54.00°F (12.22°C) entering chilled-fluid temperatures, and with 85.00°F (29.44°C) entering and 94.30°F (34.61°C) leaving condenser-fluid temperatures, shall have maximum full-load kW/ton (FL) and part-load rating requirements adjusted in accordance with Equation E 503.4.1(1) through Equation E 503.4.1(3):

\[
F_{L_{adj}} = \frac{F_L}{K_{adj}} \quad \text{[Equation E 503.4.1(1)]}
\]

\[
P_{LV_{adj}} = \frac{IPLV}{IPL_{adj}} \quad \text{[Equation E 503.4.1(2)]}
\]

\[
K_{adj} = AxB \quad \text{[Equation E 503.4.1(3)]}
\]

Where:
FL = full-load kW/ton value from Table E 503.7.1(3)
FL_adj = maximum full-load kW/ton rating, adjusted for nonstandard conditions
IPLV(IP) = IPLV(IP) value from Table E 503.7.1(3)
PLV_adj = maximum NPLV rating, adjusted for nonstandard conditions

\[
A = 0.00000014592 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times (LIFT) + 3.93073
\]
\[
B = 0.0015 \times LvgEvap + 0.934
\]
LIFT = LvgCond - LvgEvap
LvgCond = Full-load condenser leaving fluid temperature (°F)
LvgEvap = Full-load evaporator leaving temperature (°F)

The FL_adj and PLV_adj values shall only be applicable for centrifugal chillers meeting all of the following full-load design ranges:
1. 36.00°F (2.22°C) = LvgEvap = 60.00°F (15.56°C)
2. LvgCond = 115.00°F (46.11°C)
3. 20.00°F (-6.67°C) = LIFT = 80.00°F (26.67°C)

Manufacturers shall calculate the FL_adj and PLV_adj before determining whether to label the chiller in accordance with Section E 503.4.4. Chillers that are in accordance with ASHRAE 90.1 shall be labeled on chillers in accordance with the scope of ASHRAE 90.1.

Centrifugal chillers designed to operate outside of these ranges shall not be covered under this appendix.

Example: Path A, 600 ton (600 000 kg) centrifugal chiller Table E 503.7.1(3) efficiencies.
FL = 0.5600 kW/ton
IPLV(IP) = 0.5000 kW/ton
LvgCond = 91.16°F
LvgEvap = 42.00°F
LIFT = 91.16°F – 42.00°F = 49.16°F

\[
A = 0.00000014592 \times (49.16)^4 - 0.0000346496 \times (49.16)^3 + 0.00314196 \times (49.16)^2 - 0.147199 \times (49.16) + 3.93073 = 1.02331
\]
\[
B = 0.0015 \times 42.00 + 0.934 = 0.99700
\]

\[
K_{adj} = A \times B = 1.02024
\]

FL_adj = 0.5600/1.02024 = 0.5489 kW/ton
PLV_adj = 0.5000/1.02024 = 0.4901 kW/ton [ASHRAE 90.1:6.4.1.2.1]

For SI units: 1 metric ton = 1000 kg, 1000 British thermal units per hour = 0.293 kW, 1 gallon per minute = 0.06 L/s, °C = (°F-32)/1.8

**E 503.4.2 Equipment not Listed.** Equipment not listed in the tables referenced in Section E 503.4 and Section E 503.4.1 shall be permitted to be used. [ASHRAE 90.1:6.4.1.3 6.4.1.4]

**E 503.4.3 Verification of Equipment Efficiencies.**

Equipment efficiency information supplied by manufacturers shall be verified in accordance with one of the following:
1. Equipment covered under EPACT shall be in accordance with U.S. Department of Energy certification requirements.
2. Where a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program.
3. Where a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, but the product is not listed in the existing certification program, the ratings shall be verified by an independent laboratory test report.
4. Where no certification program exists for a covered product, the equipment efficiency ratings shall be supported by data furnished by the manufacturer.
5. Where components such as indoor or outdoor coils from different manufacturers are used, the system designer shall specify component efficiencies whose combined efficiency is in accordance with the minimum equipment efficiency requirements in Section E 503.4 through Section E 503.4.4.1.
6. Requirements for plate type liquid-to-liquid heat exchangers are listed in Table E 503.7.1(8). [ASHRAE 90.1:6.4.1.4]

**E 503.4.9 Liquid-to-Liquid Heat Exchangers.** Plate-type liquid-to-liquid heat exchangers shall be rated in accordance with AHRI 400. [ASHRAE 90.1:6.4.7]

**E 503.4.4 Mechanical Equipment Labeling.** Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment is in accordance with the requirements of ASHRAE 90.1. [ASHRAE 90.1:6.4.4.5.4 6.4.1.6.1]

**E 503.4.4.1 Packaged Terminal Air Conditioners.** Nonstandard-size packaged terminal air conditioners and heat pumps with existing sleeves having an external wall opening of less than 16 inches (406 mm) high or less than 42
E 503.4.6.4.1 Shutoff Damper Controls. Outdoor air intake and exhaust systems shall be equipped with motorized dampers that will automatically shut when the systems or spaces served are not in use. Ventilation outdoor air and exhaust or relief dampers shall be capable of and configured to automatically shut off during preoccupancy building warm-up, cooldown, and setback, except when ventilation the supply of outdoor air reduces energy costs or when ventilation outdoor air shall be supplied to comply with the code requirements.

Exceptions:

1. Back-draft Nonmotorized (gravity back draft) (nonmotorized) dampers shall be permitted for exhaust and relief in buildings less than three stories in height and for ventilation outdoor air intakes and exhaust and relief dampers in buildings of any height located in Climate Zones 0, 1, 2, and 3. Back-draft Nonmotorized dampers for ventilation outdoor air intakes shall be protected from direct exposure to wind.

2. Back-draft (gravity) (nonmotorized) Nonmotorized dampers shall be permitted in systems with a design outdoor air intake or exhaust capacity of 300 ft³/min (0.142 m³/s) or less.

3. Dampers shall not be required in ventilation or exhaust systems serving unconditioned spaces.

4. Dampers shall not be required in exhaust systems serving Type 1 kitchen exhaust hoods.

5. Dampers are not required in systems intended to operate continuously. [ASHRAE 90.1:6.4.3.4.2]

E 503.4.6.4.2 Dampers Leakage. Where outdoor air supply, and exhaust or relief dampers are required in Section E 503.4.6.4, they shall have a maximum leakage rate in accordance with Table E 503.4.6.4.2 where tested in accordance with AMCA 500D. [ASHRAE 90.1:6.4.3.4.3]

E 503.4.6.7 Humidification and Dehumidification Control.
Humidification control shall prevent the use of fossil fuel or electricity to produce relative humidity above 30 percent in the warmest zone served by the humidification system and to reduce relative humidity below 60 percent in the coldest zone served by the dehumidification system.

Humidification and dehumidification control shall be in accordance with Section E 503.4.6.7.1 through E 503.4.6.7.3.

E 503.4.6.7.1 Dehumidification. Humidistatic controls shall not use mechanical cooling to reduce the humidity below the lower of a dew point of 55°F or relative humidity of 60 percent in the coldest zone served by the system.

Exceptions:

1. Lower humidity shall be permitted when operating mechanical cooling for temperature control.

2. Systems serving zones where specific humidity levels are required, such as museums and hospitals, and approved by the Authority Having Jurisdiction or required by accreditation standards, and where humidistatic controls are capable of and configured to maintain a dead band of at least 10 percent relative humidity where no active humidification or dehumidification takes place.

3. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as approved by the Authority Having Jurisdiction. [ASHRAE 90.1:6.4.3.6.1]

E 503.4.6.7.2 Humidification. Humidistatic controls shall not use fossil fuel or electricity to produce relative humidity above 30 percent in the warmest zone served by the system.

Exceptions:

1. Systems serving zones where specific humidity levels are required, such as museums and hospitals, and approved by the Authority Having Jurisdiction or required by accreditation standards, and where humidistatic controls are capable of and configured to maintain a dead band of at least 10 percent relative humidity where no active humidification or dehumidification takes place.

2. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as approved by the Authority Having Jurisdiction. [ASHRAE 90.1:6.4.3.6.2]

E 503.4.6.7.3 Control Interlock. Where a zone is served by a system or systems with both humidification and dehumidification capability, means (such as limit switches, mechanical stops, or, for DDC systems, software programming) shall be provided capable of and configured to prevent simultaneous operation of humidification and dehumidification equipment.

Exceptions:

1. Zones served by desiccant systems, used with direct evaporative cooling in series.

2. Systems serving zones where specific humidity levels are required, such as museums and hospitals, and approved by the Authority Having Jurisdiction or required by accreditation standards, and humidistatic controls capable of and configured to maintain a dead band of at least 10 percent relative humidity where no active humidification or dehumidification takes place.

3. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as approved by the Authority Having Jurisdiction. [ASHRAE 90.1:6.4.3.6.3]
E 201.6 Humidistatic Controls. Automatic controls used to maintain humidity at a fixed or adjustable set point. [ASHRAE 90.1:3.2]

(renumber remaining sections)

E 503.4.7.1 Insulation. Insulation required by this section shall be installed in accordance with industry-accepted standards. These requirements shall not apply to HVAC equipment. Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind, but not limited to the following:

1. Insulation exposed to weather shall be suitable for outdoor service (e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover). Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that is capable of causing degradation of the material.

2. Insulation covering chilled-water piping, refrigerant suction piping, or cooling ducts located outside the conditioned space shall include a vapor retardant located outside the insulation (unless the insulation is inherently vapor retardant), all penetrations and joints of which shall be sealed. [ASHRAE 90.1:6.4.4.1.1]

E 503.4.7.1.1 Duct and Plenum Insulation. Supply and return ducts and plenums installed as part of an HVAC air distribution system shall be thermally insulated in accordance with Table E 503.7.2.

Exceptions:
(1) Factory-installed plenums, casings, or ductwork furnished as a part of HVAC equipment tested and rated in accordance with Section E 503.4 through Section E 503.4.4.1.
(2) Ducts or plenums located in heated spaces, semi-heated spaces, or cooled spaces.
(3) For runouts less than 10 feet (3048 mm) in length to air terminals or air outlets, the rated R-value of insulation shall not be required to exceed R-3.5.
(4) Backs of air outlets and outlet plenums exposed to unconditioned space or indirectly conditioned spaces with face areas exceeding 5 square feet (0.5 m²) shall not be required to exceed R-2; those not exceeding 5 square feet (0.5 m²) shall not be required to be insulated. [ASHRAE 90.1:6.4.4.1.2]

E 503.4.7.1.3 Sensible Heating Panel Insulation. Thermally ineffective panel surfaces of sensible heating panels, including U-bends and headers, shall be insulated with a minimum of R-3.5. Adjacent building envelope insulation counts toward this requirement. [ASHRAE 90.1:6.4.4.1.4]

E 503.5 Prescriptive Compliance Path, Economizers. Each cooling systems shall include either an air economizer or fluid economizer in accordance with Section E 503.5.1 through Section E 503.5.4.1.

Exceptions: Economizers shall not be required for the following systems:
(1) Individual fan-cooling units with a supply capacity less than the minimum listed in Table E 503.5(1).
(2) Chilled-water cooling systems without a fan or that use induced airflow, where the total capacity of these systems is less than 1 000 000 Btu/h (293 kW) in Climate Zones 0, 1B, and 2 through 4; less than 1 400 000 Btu/h (410 kW) in Climate Zones 5 through 8; or any size in Climate Zone 1A.
(3) Systems that include nonparticulate air treatment in accordance with ASHRAE 62.1.
(4) In hospitals and ambulatory surgery centers, where more than 75 percent of the air designed to be supplied by the system is to spaces that are required to be humidified more than 35°F (2°C) dew-point temperature to comply with applicable codes or accreditation standards; in all other buildings, where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified more than 35°F (2°C) dew-point temperature to satisfy process application needs. This exception shall not apply to computer rooms.
(5) Systems that include a condenser heat recovery system with a minimum capacity in accordance with Section E 503.5.10.1.2.
(6) Systems that serve residential spaces where the system capacity is less than five times the requirement listed in Table E 503.5(1).
(7) Systems that serve spaces whose sensible cooling load at design conditions, excluding transmission and infiltration loads, is less than or equal to transmission and infiltration losses at an outdoor temperature of 60°F (16°C).
(8) Systems expected to operate less than 20 hours per week.
(9) Where the use of outdoor air for cooling will affect supermarket open refrigerated casework systems.
(10) For comfort cooling where the cooling efficiency is not less than the efficiency improvement requirements in accordance with Table E 503.5(2).
(11) Systems primarily serving computer rooms where in accordance with one of the following:
   a. The total design cooling load of all computer rooms in the building is less than 3 000 000 Btu/h (879 kW) and the building in which they are located is not served by a centralized chilled water plant.
   b. The room total design cooling load is less than 600 000 Btu/h (176 kW) and the building in which they are located is served by a centralized chilled water plant.
   c. The local water authority does not permit cooling towers.
   d. Less than 600 000 Btu/h (176 kW) of computer room cooling equipment capacity is being added to an existing building.
(12) Dedicated systems for computer rooms where a minimum of 75 percent of the design load serves one of the following:
(a) Spaces classified as an essential facility.
(b) Spaces having a design of Tier IV in accordance with TIA 942.
(c) Spaces classified as Critical Operations Power Systems (COPS) in accordance with NFPA 70.
(d) Spaces where core clearing and settlement services are performed such that their failure to settle pending financial transactions is capable of systemic risk in accordance with "The Interagency Paper on Sound Practices to Strengthen the Resilience of the US Financial System" (April 7, 2003). [ASHRAE 90.1:6.5.1]

E 201.12 Process Application. A manufacturing, industrial, or commercial procedure or activity where the primary purpose is other than conditioning spaces and maintaining comfort and amenities for the occupants of a building. [ASHRAE 90.1:3.2]

(renumber remaining sections)

E 503.5.1.3 Dampers. Return, exhaust or Exhaust or relief, and outdoor air dampers shall comply with meet the requirements of Section Table E 503.4.6.4.2. Return dampers shall meet the requirements of motorized exhaust or relief dampers in Table E 503.4.6.4.2.

Exception: Exhaust or relief and outdoor air intake dampers on systems intended to operate continuously. [ASHRAE 90.1:6.5.1.1.4]

E 503.5.5 Simultaneous Heating and Cooling Limitation, Zone Controls. Zone thermostatic controls shall prevent the following:
(1) Reheating.
(2) Recooling.
(3) Mixing or simultaneously supplying air that has been previously mechanically heated and air that has been previously cooled, either by mechanical cooling or by economizer systems.
(4) Other simultaneous operation of heating and cooling systems to the same zone.

Exceptions:
(1) Zones for which the volume of air that is reheated, recooled, or mixed is less than the larger of the following:
(a) Twenty percent For systems without DDC, 30 percent of the zone design peak supply for systems with DDC and 30 percent for other systems.
(b) The outdoor airflow rate required to be in accordance with the For systems with DDC, the minimum primary airflow rate required to meet the Simplified Procedure ventilation requirements of Chapter 4 or ASHRAE 62.1 for the zone, permitted to be the average airflow rate as allowed by Chapter 4 or ASHRAE 62.1.
(c) Any higher rate that can be demonstrated, to the satisfaction of the Authority Having Jurisdiction, to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system.
(d) The airflow rate required to be in accordance with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.
(2) Zones with DDC that comply with the following:
(a) The airflow rate in dead band between heating and cooling does not exceed the larger of the following:
(1) Twenty percent of the zone design peak supply rate.
(2) The outdoor airflow rate required to be in accordance with the The minimum primary airflow rate required to meet the Simplified Procedure ventilation requirements of Chapter 4 or ASHRAE 62.1 for the zone, permitted to be the average airflow rate as allowed by Chapter 4 or ASHRAE 62.1.
(3) A higher rate that can be demonstrated, to the satisfaction of the Authority Having Jurisdiction, to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake.
(4) The airflow rate required with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.
(b) The airflow rate that is reheated, recooled, or mixed shall be less than 50 percent of the zone design peak supply rate.
(c) The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the dead band flow rate.
(d) The second stage of heating consists of modulating the airflow rate from the dead band flow rate up to the heating maximum flow rate.
(3) Laboratory exhaust systems that comply with Section E 503.5.11.3.
(4) Zones where at least 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from site-recovered energy (including condenser heat) or on-site renewable energy. [ASHRAE 90.1:6.5.2.1]

E 503.5.5.3 Dehumidification. Where humidity controls are provided, such controls shall prevent reheating, mixing of hot and cold airstreams, or other means of simultaneous heating and cooling of the same airstream.
Exceptions:
(1) The system is capable of and configured to reduce supply air volume to 50 percent or less of the design airflow rate or the minimum outdoor air ventilation rate in accordance with Chapter 4 or ASHRAE 62.1 or other applicable federal, state, or local code or recognized standard, whichever is larger before simultaneous heating and cooling takes place.
(2) The individual fan cooling unit has a design cooling capacity of not more than 65 000 Btu/h (19 kW) and is capable of and configured to unload to 50 percent capacity before simultaneous heating and cooling takes place.
(3) The individual mechanical cooling unit has a design cooling capacity of not more than 40 000 Btu/h (11.7 kW). An individual mechanical cooling unit is a single system composed of a fan or fans and a cooling coil capable of providing mechanical cooling.
(4) Systems serving spaces where specific humidity levels are required to satisfy process application needs, such as vivariums, museums, surgical suites, pharmacies, and buildings with refrigerating systems, such as supermarkets, refrigerated warehouses, and ice arenas, and where the building includes site-recovered energy or on-site renewable energy that provide energy equal to 75 percent or more of the annual energy for reheating or for providing warm air in mixing systems. This exception shall not apply to computer rooms.
(5) Not less than 90 percent of the annual energy for reheating or for providing warm air in mixing systems is provided from site-recovered energy (including condenser heat) or on-site renewable energy.
(6) Systems where the heat added to the airstream is the result of the use of a desiccant system and 75 percent of the heat added by the desiccant system is removed by a heat exchanger, either before or after the desiccant system with energy recovery. [ASHRAE 90.1:6.5.2.3]

E 503.5.6.1.1 Motor Nameplate Horsepower Fan Motor Selection. Fan motor selection shall be in accordance with the following:
(1) For each fan less than 6 bhp (4.5 kW), the selected fan motor shall be no larger than the first available motor size with a nameplate rating greater than 1.5 times the bhp.
(2) For fans 6 bhp (4.5 kW) and larger, the selected fan motor shall be no larger than the first available motor with a nameplate rating greater than 1.3 times the bhp. The fan bhp must be indicated on the design documents to allow for compliance verification by the Authority Having Jurisdiction.

Exceptions:
(1) Motors equipped with electronic speed control devices to vary the fan airflow as a function of load. For fans less than 6 bhp (4.5 kW), where the first available motor larger than the bhp (kW) has a nameplate rating within 50 percent of the bhp (kW), the next larger nameplate motor size shall be permitted to be selected.
(2) For fans 6 bhp (4.5 kW) and larger, where the first available motor larger than the bhp (kW) has a nameplate rating within 30 percent of the bhp (kW), the next larger nameplate motor size shall be permitted to be selected.
(3) Fans with motor nameplate horsepower of less than 1 hp (0.7 kW). [ASHRAE 90.1:6.5.3.1.2]

E 503.5.6.1.2 Fan Efficiency. Each fan and fan array shall have a fan efficiency grade (FEG) of 67 or more, based on manufacturers’ certified data in accordance with AMCA 205. The total efficiency of the fan at the design point of operation shall be within 16 percentage points of the maximum total efficiency of the fan energy index (FEI) of 1.00 or higher. Each fan and fan array used for a variable-air-volume system that meets the requirements of Section E 503.5.6.2 shall have an FEI of 0.95 or higher. The FEI for fan arrays shall be calculated in accordance with AMCA 208.

Exceptions:
(1) Individual fans that are not embedded fans with a motor nameplate horsepower of 5 hp (3.7 kW) or less that are not part of a group operated as the functional equivalent of a single fan-less than 1.0 hp (0.7 kW) or with a fan nameplate electrical input power of less than 0.89 kW.
(2) Multiple fans in series or parallel (e.g., and fan arrays) that have-with a combined motor nameplate horsepower of 5 hp (3.7 kW) or less and are operated as the functional equivalent of a single fan or with a fan system electrical input power of 4.1 kW or less.
(3) Embedded fans that are part of equipment listed under Section E 503.4.
(4) Embedded fans included in equipment bearing a third-party-certified seal for air or energy performance of the equipment package.
(5) Powered wall/roof ventilators (PRV) — Ceiling fans.
(6) Fans used for moving gases at temperatures above 482°F (250 °C).
(7) Fans used for operation in explosive atmospheres.
(8) Reversible fans used for tunnel ventilation.
(9) Systems that are in accordance with Section E 503.5.6.1, Option 1.
(10) Reversible fans used for tunnel ventilation.

E 503.5.6.3 Multiple-Zone VAV System Ventilation Optimization Control. Multiple-zone VAV systems with DDC of
individual zone boxes reporting to a central control panel shall include means to automatically reduce outdoor air intake flow below design rates in response to changes in system ventilation efficiency in accordance with Section 404.0 or ASHRAE 62.1.

Exceptions:
1. VAV systems with zonal transfer fans that recirculate air from other zones without directly mixing it with outdoor air, dual-duct dual-fan VAV systems, and VAV systems with fan-powered terminal units.
2. Systems where total design exhaust airflow is more than 70 percent of total design outdoor air intake flow requirements. [ASHRAE 90.1:6.5.3.3]

E 503.5.6.4 Supply Air Temperature Reset Controls. Multiple zone HVAC systems shall include controls that are capable of and configured to automatically reset the supply air temperature in response to representative building loads, or to outdoor air temperature. The controls shall reset the supply air temperature to at least 25 percent of the difference between the design supply air temperature and the design room air temperature. Controls that adjust the reset based on zone humidity shall be permitted in Climate Zones 0B, 1B, 2B, 3B, 3C, and 4 through 8. HVAC zones that are expected to experience relatively constant loads, such as electronic equipment rooms, shall be have maximum airflow designed for to accommodate the fully reset supply air temperature.

E 503.5.7 Hydronic System Design and Control. Hydronic system design and control shall be in accordance with Section E 503.5.7.1 and Section E 503.5.7.2.

E 503.5.7.1 Boiler Turndown. Boiler systems with design input of 1 000 000 Btu/h (293 kW) or more shall comply with the turndown ratio in accordance with Table E 503.5.7. The system turndown requirement shall use multiple single-input boilers, one or more modulating boilers, or a combination of single-input and modulating boilers. Boilers shall comply with the minimum efficiency requirements in Table E 503.7.1(6). [ASHRAE 90.1:6.5.4.1]

E 503.5.7.3 Chilled- and Hot-Water Temperature Reset Controls. Chilled- and hot-water systems with a design capacity exceeding 300 000 Btu/h (88 kW) supplying chilled or heated water to comfort conditioning systems shall include controls that automatically reset supply water temperatures by representative building loads (including return water temperature) or by outdoor air temperature. Where DDC is used to control valves, the set point shall be reset based on valve positions unless one valve is nearly wide open or setpoint limits of the system equipment or application have been reached.

Exceptions:
1. Where chilled-water supply is already cold, such as chilled water supplied from a district cooling or thermal energy storage system, such that blending would be required to achieve the reset chilled-water supply temperature.
2. Where a specific temperature is required for a process application.
3. Water temperature reset is not required where valve position is used to comply with Section E 503.5.7. [ASHRAE 90.1:6.5.4.4]

E 503.5.7.4 Hydronic (Water Loop) Heat Pump and Water-Cooled Unitary Air Conditioners. Hydronic heat pumps and water-cooled unitary air-conditioners shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.

Exception: Units employing water-fluid economizers. [ASHRAE 90.1:6.5.4.5.1]

E 503.5.10 Energy Recovery. Energy recovery shall be in accordance with Section E 503.5.10.1, through Section E 503.5.10.3.

E 503.5.10.1 Exhaust Air Energy Recovery. Exhaust air energy recovery shall be in accordance with Section E 503.5.10.1.1 through Section E 503.5.10.1.2.

E 503.5.10.1.1 Exhaust Air Energy Recovery for Nontransient Dwelling Units. Nontransient dwelling units shall be provided with outdoor air energy recovery ventilation systems. For nontransient dwelling units, energy recovery systems shall result in an enthalpy recovery ratio of at least 50 percent at cooling design condition and at least 60 percent at heating design condition. The energy recovery system shall provide the required enthalpy recovery ratio at both heating...
and cooling design conditions, unless one mode is not required for the climate zone by the exceptions below.

Exceptions:
(1) Nontransient dwelling units in Climate Zone 3C.
(2) Nontransient dwelling units with no more than 500 ft² (46.45 m²) of conditioned floor area in Climate Zone 0, 1, 2, 3, 4C, and 5C.
(3) Enthalpy recovery ratio requirements at heating design condition in Climate Zones 0, 1, and 2.
(4) Enthalpy recovery ratio requirements at cooling design condition in Climate Zones 4, 5, 6, 7, 8. [ASHRAE 90.1:6.5.6.1.1]

E 503.5.10.1.2 Exhaust Air Energy Recovery for Spaces Other than Nontransient Dwelling Units. Each fan system serving spaces other than nontransient dwelling units shall have an energy recovery system where the design supply fan airflow rate exceeds the value listed in Table E 503.5.10(1) and Table E 503.5.10(2), based on the climate zone and percentage of outdoor air at design airflow conditions. Table E 503.5.10(1) shall be used for all ventilation systems that operate less than 8000 hours per year and Table E 503.5.10(2) shall be used for all ventilation systems that operate 8000 or more hours per year.

Energy Recovery: For spaces other than nontransient dwelling units, energy recovery systems required by this section shall result in an enthalpy recovery ratio of not less than 50 percent. A fifty percent energy recovery system shall provide the required enthalpy recovery ratio which shall mean a change in the enthalpy of the outdoor air supply equal to 50 percent of the difference between the outdoor air and entering exhaust air enthalpies at both heating and cooling design conditions, unless one mode is not required for the climate zone by the exceptions below. Provision shall be provided to bypass or control the energy recovery system to permit air economizer operation in accordance with Section E 503.5.1.

Exceptions:
(1) Laboratory systems that are in accordance with Section E 503.5.11.3.
(2) Systems serving spaces that are not cooled and that are heated to less than 60°F (16°C).
(3) Heating energy recovery where more than 60 percent of the outdoor air heating energy is provided from site-recovered energy or on-site-solar renewable energy.
(4) Cooling energy recovery in climate zones 3C, 4C, 5C, 6B, 6C, 7, and 8.
(6) Where the sum of the airflow rates exhausted and relieved within 20 feet (6096 mm) of each other is less than 75 percent of the design outdoor airflow rate, excluding exhaust air that is;
(a) used for another energy recovery system,
(b) not allowed by ASHRAE 170 for use in energy recovery systems with leakage potential, or
(c) of Class 4 as defined in Chapter 2 or ASHRAE 62.1.
(7) Systems requiring dehumidification during heating mode that employ energy recovery in series with the cooling coil and have a minimum SERR of 0.40.
(8) Systems expected to operate less than 20 hours per week at the outdoor air percentage in accordance with Table E 503.5.10(1).
(9) Indoor pool dehumidifiers meeting Section E 503.5.10.4. [ASHRAE 90.1:6.5.6.6.1.1.2]

E 503.5.10.3 Heat Recovery for Space Conditioning. Where heating water is used for space heating, a condenser heat recovery system shall be installed, provided all of the following are true:
(1) The building is an acute inpatient hospital, where the building or portion of a building is used on a 24-hour basis for the inpatient medical, obstetric, or surgical care for patients.
(2) The total design chilled-water capacity of the acute inpatient hospital, either air cooled or water cooled, required at cooling design conditions exceeds 3 600 000 Btu/h of cooling.
(3) Simultaneous heating and cooling occurs above 60°F (16°C) outdoor air temperature. The required heat recovery system shall have a cooling capacity that is at least 7 percent of the total design chilled-water capacity of the acute inpatient hospital at peak design conditions.
[ASHRAE 90.1:6.5.6.3]

E 503.5.10.4 Indoor Pool Dehumidifier Energy Recovery. An indoor pool dehumidifier serving a natatorium with a heated indoor pool over 500 ft² (46.45 m²) in size shall include one of the following:
(1) An exhaust air sensible energy recovery system with a sensible energy recovery ratio of at least 50 percent.
(2) A condenser heat recovery system capable of and configured to use 100 percent of the heat generated through dehumidification to heat the pool water when there is a pool water heating load.
(3) An exhaust air energy recovery system that results in an enthalpy recovery ratio of at least 50 percent. [ASHRAE 90.1:6.5.6.4]

E 503.5.10.1 E 503.5.10.2 Heat Recovery for Service Water Heating. Heat recovery shall comply with Section E 503.5.10.1.1 and Section E 503.5.10.1.2.

E 503.5.10.4.1 Condenser Heat Recovery Systems. Condenser heat recovery systems shall be installed for the heating or preheating of service hot water where all of the following conditions exist:
(1) The facility operates 24 hours a day.
(2) The total installed heat rejection capacity of the water-cooled system is more than 6 000 000 Btu/h (1757 kW) of heat rejection.
(3) The design service water heating load is more than 1 000 000 Btu/h (293 kW). [ASHRAE 90.1:6.5.6.2.1]
E 503.5.10.1.2 Capacity. The required heat recovery system shall have the capacity to provide the smaller of:
(1) Sixty percent of the peak heat-rejection load at design conditions or
(2) Preheat of the peak service hot-water draw to 85°F (29°C).

Exceptions:
(1) Facilities that employ condenser heat recovery for space heating with a heat recovery design exceeding 30 percent of the peak water-cooled condenser load at design conditions.
(2) Facilities that provide 60 percent of their service water heating from on-site or site-recovered energy or from other sources. [ASHRAE 90.1:6.5.6.2.2]

E 503.5.12 Radiant Heating Systems. Radiant heating systems shall be in accordance with Section E 503.5.12.1 through Section E 503.5.12.2.

E 503.5.12.1 Heating Unenclosed Spaces. Radiant heating shall be used when heating is required for unenclosed spaces.

Exception: Loading docks equipped with air curtains. [ASHRAE 90.1:6.5.8.1]

E 503.5.12.2 Heating Enclosed Spaces. (remaining text unchanged)

E 503.6.1 Construction Details. Compliance documents shall show all the pertinent data and features of the building, equipment, and systems in sufficient detail to permit a determination of compliance by the building official and to indicate compliance with the requirements of this appendix. [ASHRAE 90.1:4.2.2.1]

E 503.6.3.1 Required Information. Construction documents shall require that an operating manual and maintenance manual be provided to the building owner. The manuals shall include, at a minimum, the following:
(1) Submittal data stating equipment rating and selected options for each piece of equipment requiring maintenance.
(2) Operation manuals and maintenance manuals for each piece of equipment requiring maintenance. Required routine maintenance actions shall be clearly identified.
(3) Names and addresses of not less than one qualified service agency.
(4) A complete narrative of how each system is intended to operate.

The Authority Having Jurisdiction shall only check to ensure that the construction documents require this information to be transmitted to the owner and should not expect copies of any of the materials. [ASHRAE 90.1:8.7.2-8.7.3.2]

E 503.6.3.2 Lighting Manuals. Construction documents shall require for all lighting equipment and lighting controls that an operating manual and maintenance manual be provided to the building owner or the designated representative of the building owner within 90 days after the date of system acceptance. These manuals shall include, at a minimum, the following:
(1) Submittal data indicating all selected options for each piece of lighting equipment, including but not limited to lamps, ballasts, drivers, and lighting controls.
(2) Operation and maintenance manuals for each piece of lighting equipment and lighting controls with routine maintenance clearly identified including, as a minimum, a recommended relamping or cleaning program and a schedule for inspecting and recalibrating all lighting controls.
(3) A complete narrative of how each lighting control system is intended to operate including recommended settings. [ASHRAE 90.1:9.7.2.2-9.7.3.2]

E 503.6.5.1 Drawings. Construction documents shall require that, within 90 days after the date of system acceptance, record drawings of the actual installation documents be provided to the building owner or the designated representative of the building owner. Record drawings shall include, as a minimum, the location and performance data on each piece of equipment, general configuration of the duct and pipe distribution system including sizes, and the terminal air or water design flow rates. [ASHRAE 90.1:6.7.2.1]

E 503.6.5.2 Manuals. Construction documents shall require that an operating manual and a maintenance manual be provided to the building owner or the designated representative of the building owner within 90 days after the date of system acceptance. These manuals shall be in accordance with industry-accepted standards and shall include, at a minimum, the following:
(1) Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
(2) Operation manuals and maintenance manuals for each piece of equipment and system requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
(3) Names and addresses of not less than one service agency.
(4) HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in programming comments.
(5) A complete narrative of how each system is intended to operate, including suggested setpoints. [ASHRAE 90.1:6.7.2.3-6.7.3.2]

E 503.6.5.3 System Balancing. Construction documents shall require that HVAC systems be balanced in accordance with generally accepted engineering standards. Construction documents shall require that a written balance report be provided to the building owner or the designated representative of the building owner for HVAC systems serving zones with a total conditioned area exceeding 5000 square feet (464.52 m²). [ASHRAE 90.1:6.7.2.3.1-6.7.3.1]
**E 503.6.5.3.1 Air System Balancing.** Air systems shall be balanced in a manner to first minimize throttling losses. Then, for fans with fan system power greater than 1 hp (0.7 kW), fan speed shall be adjusted to meet design flow conditions. [ASHRAE 90.1: 6.7.2.3.2-6.7.3.3.2]

**E 503.6.5.4 System Commissioning.** HVAC control systems shall be tested to ensure that control elements are calibrated, adjusted, and in proper working condition. For projects larger than 50,000 square feet (4645.15 m²) conditioned area, except warehouses and semiheated spaces, detailed instructions for commissioning HVAC systems shall be provided by the designer in plans and specifications. [ASHRAE 90.1: 6.7.2.4]

**E 503.8 Alternative Compliance Path,** **Computer Room Systems.** HVAC systems only serving the heating, cooling, or ventilation-ventilating needs of a computer room with IT equipment load greater than 13.4 hp (10 kW) shall be in accordance with Section E 503.1, Section E 503.4, Section E 503.8.1 or Section E 503.8.2, Section E 502.7 through Section E 502.7.2, and Section E 502.7 ASHRAE 90.4. [ASHRAE 90.1: 6.6.1]

**E 503.8.1 Computer Room (PUE₁).** The computer room PUE₁ shall be not more than the values listed in Table E 503.8.1. Hourly simulation of the proposed design, for purposes of calculating PUE₁, shall be in accordance with ASHRAE 90.1.

**Exception:** The compliance path shall not be permitted for a proposed computer room design utilizing a combined heat and power system. [ASHRAE 90.1: 6.6.1.1]

**E 503.8.2 Computer Room (PUE₀).** The computer room PUE₀ is less than or equal to the values listed in Table E 503.8.1, shall be the highest value determined at outdoor cooling design temperatures, and shall be limited to systems only using electricity for an energy source. PUE₀ shall be calculated for two conditions:

1. One hundred percent design IT equipment energy and
2. Fifty percent design IT equipment energy. [ASHRAE 90.1: 6.6.1.2]

**E 503.8.3 Documentation.** Documentation on the following components shall be provided, including a breakdown of energy consumption or demand:

1. IT equipment
2. Power distribution losses external to the IT equipment
3. HVAC systems
4. Lighting [ASHRAE 90.1: 6.6.1.3]

**TABLE E 503.4.6.4.2**

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>VENTILATION OUTDOOR AIR INTAKE (CFM/ft²)</th>
<th>EXHAUST/RELIEF (CFM/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NONMOTORIZED ¹</td>
<td>MOTORIZED</td>
</tr>
<tr>
<td>0, 1, 2</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>Any height</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>4, 5b, 5eC</td>
<td>not-allowed ²</td>
<td>20</td>
</tr>
<tr>
<td>less Fewer than 3-three stories</td>
<td>not-allowed ²</td>
<td>20</td>
</tr>
<tr>
<td>3Three or more stories</td>
<td>not-allowed ²</td>
<td>20</td>
</tr>
<tr>
<td>5aA, 6, 7, 8</td>
<td>not-allowed ²</td>
<td>4</td>
</tr>
<tr>
<td>less Fewer than 3-three stories</td>
<td>not-allowed ²</td>
<td>4</td>
</tr>
<tr>
<td>3Three or more stories</td>
<td>not-allowed ²</td>
<td>4</td>
</tr>
</tbody>
</table>

Notes:

1. When tested in accordance with AMCA 500D.
2. Dampers smaller than 12 inches (305 mm) in height, width, or diameter need not be tested but shall be of the same design and construction as the smallest tested damper meeting the listed leakage rate requirement.
3. Nonmotorized dampers smaller than 24 inches (610 mm) in height, width, or diameter shall be permitted to have a leakage of 40 ft³/min per square foot [0.203 (m³/s)/m²].

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 square foot = 0.0929 m², 1 inch water gauge = 0.249 kPa

¹ - Dampers smaller than 24 inches (610 mm) in either dimension shall be permitted to have leakage of 40 ft³/min per square foot [0.203 (m³/s)/m²].
leakage rate of 40 CFM/ft² [0.203 (m³/s)/m²].

Where permitted by Section E 503.4.6.4.1, exception 2.

### TABLE E 503.5.1.2
HIGH-LIMIT SHUTOFF CONTROL SETTINGS FOR AIR ECONOMIZERS
[ASHRAE 90.1: TABLE 6.5.1.1.3]

<table>
<thead>
<tr>
<th>CONTROL TYPE</th>
<th>ALLOWED ONLY IN CLIMATE ZONE AT LISTED SETPOINT</th>
<th>REQUIRED HIGH LIMIT (ECONOMIZER OFF WHERE):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EQUATION</td>
</tr>
<tr>
<td>Fixed dry-bulb temperature</td>
<td>0B, 1B, 2B, 3B, 4B, 5B, 5C, 6B, 7, 8</td>
<td>$T_{\text{oa}} &gt; 75^\circ\text{F}$</td>
</tr>
<tr>
<td></td>
<td>5A, 6A</td>
<td>$T_{\text{oa}} &gt; 70^\circ\text{F}$</td>
</tr>
<tr>
<td></td>
<td>0A, 1A, 2A, 3A, 4A</td>
<td>$T_{\text{oa}} &gt; 65^\circ\text{F}$</td>
</tr>
<tr>
<td>Differential dry-bulb temperature</td>
<td>0B, 1B, 2B, 3B, 4B, 5B, 5A, 5C, 6A, 6B, 7, 8</td>
<td>$T_{\text{oa}} &gt; T_{\text{ra}}$</td>
</tr>
<tr>
<td>Fixed enthalpy with fixed dry-bulb temperature</td>
<td>All</td>
<td>$h_{\text{oa}} &gt; 28 \text{ Btu/lb}$ or $T_{\text{oa}} &gt; 75^\circ\text{F}$</td>
</tr>
<tr>
<td>Differential enthalpy with fixed dry-bulb temperature</td>
<td>All</td>
<td>$h_{\text{oa}} &gt; h_{\text{ra}}$ or $T_{\text{oa}} &gt; 75^\circ\text{F}$</td>
</tr>
</tbody>
</table>

For SI units: °C = (°F-32)/1.8, 1 British thermal unit per pound = 2326 J/kg

**Notes:**
1. At altitudes substantially different than sea level, the fixed enthalpy limit shall be set to the enthalpy value at 75°F (24°C) and 50 percent relative humidity. As an example, at approximately 6000 feet (1829 m) elevation, the fixed enthalpy limit shall be approximately 30.7 Btu/lb (71 408 J/kg).
2. Devices with selectable rather than adjustable setpoints shall be capable of being set to within 2°F (1°C) and 2 Btu/lb (4649 J/kg) of the setpoint listed.

### TABLE E 503.5.2
WATER-FLUID ECONOMIZER SIZING DRY-BULB AND WET-BULB REQUIREMENTS FOR COMPUTER ROOMS
[ASHRAE 90.1: TABLE 6.5.1.2.1]

(portions of table not shown remain unchanged)

### TABLE E 503.5.6.1(1)
FAN POWER LIMITATION*
[ASHRAE 90.1: TABLE 6.5.3.1-1]

<table>
<thead>
<tr>
<th>LIMIT</th>
<th>CONSTANT VOLUME</th>
<th>VARIABLE VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Fan system motor nameplate (hp)</td>
<td>Allowable motor nameplate</td>
<td>$hp = \text{CFMS} \times 0.0011$</td>
</tr>
<tr>
<td>Option 2: Fan system (bhp)</td>
<td>Allowable fan system (bhp)</td>
<td>$bhp = \text{CFMS} \times 0.00094 + A$</td>
</tr>
</tbody>
</table>

For SI units: 1 horsepower = 0.746 kW, 1 cubic foot per minute = 0.00047 m³/s

*Where:
- $\text{CFMS}$ = the maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute (m³/s)
- $hp$ = the maximum combined motor nameplate horsepower (kW)
- $bhp$ = the maximum combined fan-brake horsepower (kW)
- $A$ = sum of $(PD \times \text{CFMD}/4131)$
- $PD$ = each applicable pressure drop adjustment from Table E 503.5.6.1(2) in inch water column (kPa)
\[ CFMD = \text{the design airflow through each applicable device from Table E 503.5.6.1(2) in cubic feet per minute (m}^3/\text{s}) \]

**TABLE E 503.5.6.1(2)**  
**FAN POWER LIMITATION PRESSURE DROP ADJUSTMENT**  
[ASHRAE 90.1: TABLE 6.5.3.1-2]

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>ADJUSTMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CREDITS</strong></td>
<td></td>
</tr>
<tr>
<td>Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms</td>
<td>0.5 in. ( w.e.-\text{of water} ). (2.15 in. ( w.e.-\text{of water} ) for laboratory and vivarium systems)</td>
</tr>
<tr>
<td>Return, and/or exhaust, or both airflow control devices</td>
<td>0.5 in. ( w.e.-\text{of water} )</td>
</tr>
<tr>
<td>Exhaust filters, scrubbers, or other exhaust treatment</td>
<td>The pressure drop of device calculated at fan system design condition</td>
</tr>
<tr>
<td>Particulate Filtration Credit: MERV 9 through 12</td>
<td>0.5 in. ( w.e.-\text{of water} )</td>
</tr>
<tr>
<td>Particulate Filtration Credit: MERV 13 through 15</td>
<td>0.9 in. ( w.e.-\text{of water} )</td>
</tr>
<tr>
<td>Particulate Filtration Credit: MERV 16 and greater, and electronically enhanced filters</td>
<td>Pressure drop calculated at 2x clean filter pressure drop at fan system design condition</td>
</tr>
<tr>
<td>Carbon and other gas-phase air cleaners</td>
<td>Clean filter pressure drop at fan system design condition</td>
</tr>
<tr>
<td>Biosafety cabinet</td>
<td>Pressure drop of device at fan system design condition</td>
</tr>
<tr>
<td>Energy recovery device, other than coil runaround loop</td>
<td>For each airstream ([2.2 \times E\text{enthalpy}_{Recovery} \times R\text{atio}] - 0.5) in. ( w.e.-\text{of water} )</td>
</tr>
<tr>
<td>Coil runaround loop</td>
<td>0.6 in. ( w.e.-\text{of water} ), for each airstream</td>
</tr>
<tr>
<td>Evaporative humidifier or cooler in series with another cooling coil</td>
<td>Pressure drop of device at fan system design condition</td>
</tr>
<tr>
<td>Sound attenuation section (fans serving spaces with design background noise goals below NC35)</td>
<td>0.15 in. ( w.e.-\text{of water} )</td>
</tr>
<tr>
<td>Exhaust system serving fume hoods</td>
<td>0.35 in. ( w.e.-\text{of water} )</td>
</tr>
<tr>
<td>Laboratory and vivarium exhaust systems in high-rise buildings</td>
<td>0.25 in. ( w.e.-\text{of water/ per 100 feet}^{\text{ft}} ) of vertical duct exceeding 75 ft</td>
</tr>
</tbody>
</table>

**DEDUCTIONS**

| Systems without central cooling device | –0.6 in. \( w.e.-\text{of water} \) |
| Systems without central heating device | –0.3 in. \( w.e.-\text{of water} \) |
| Systems with central electric resistance heat | –0.2 in. \( w.e.-\text{of water} \) |

For SI units: 1 inch water column = 0.249 kPa, 1 foot = 304.8 mm

**TABLE E 503.5.6.5(1)**  
**MINIMUM AVERAGE FULL-LOAD EFFICIENCY FOR POLYPHASE SMALL ELECTRIC MOTORS***  
[ASHRAE 90.1: TABLE 10.8-3]

<table>
<thead>
<tr>
<th>NUMBER OF POLES</th>
<th>FULL-LOAD EFFICIENCY, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OPEN MOTORS</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>SYNCHRONOUS SPEED (RPM rpm)</td>
<td>3600</td>
</tr>
<tr>
<td>MOTOR HORSEPOWER SIZE (hp)</td>
<td>EFFICIENCY, %</td>
</tr>
<tr>
<td>0.25</td>
<td>65.6</td>
</tr>
<tr>
<td>0.33</td>
<td>69.5</td>
</tr>
<tr>
<td>0.50</td>
<td>73.4</td>
</tr>
<tr>
<td>0.75</td>
<td>76.8</td>
</tr>
<tr>
<td>1</td>
<td>77.0</td>
</tr>
<tr>
<td>1.5</td>
<td>84.0</td>
</tr>
</tbody>
</table>
TABLE E 503.5.6.5(2)
MINIMUM AVERAGE FULL-LOAD EFFICIENCY FOR CAPACITOR-START CAPACITOR-RUN AND CAPACITOR-START INDUCTION-RUN SMALL ELECTRIC MOTORS*
[ASHRAE 90.1: TABLE 10.8-4]

<table>
<thead>
<tr>
<th>NUMBER OF POLES</th>
<th>OPEN MOTORS</th>
<th>EFFICIENCY,%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYNCHRONOUS SPEED (RPM rpm)</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3600</td>
<td>1800</td>
<td>1200</td>
</tr>
</tbody>
</table>

*Average full-load efficiencies shall be established in accordance with 10 CFR 431.

TABLE E 503.5.10(1)
EXHAUST AIR ENERGY RECOVERY REQUIREMENTS FOR VENTILATION SYSTEMS OPERATING LESS THAN 8000 HOURS PER YEAR*
[ASHRAE 90.1: TABLE 6.5.6.1-1 6.5.6.1.2-1]

(portions of table not shown remain unchanged)

TABLE E 503.5.10(2)
EXHAUST AIR ENERGY RECOVERY REQUIREMENTS FOR VENTILATION SYSTEMS OPERATING NOT LESS GREATER THAN OR EQUAL TO 8000 HOURS PER YEAR*
[ASHRAE 90.1: TABLE 6.5.6.1-2 6.5.6.1.2-2]

(portions of table not shown remain unchanged)

TABLE E-503.8.1
POWER USAGE EFFECTIVENESS (PUE) MAXIMUM
[ASHRAE 90.1: TABLE 6.6.1]

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>PUE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0A</td>
<td>1.64</td>
</tr>
<tr>
<td>0B</td>
<td>1.62</td>
</tr>
<tr>
<td>1A</td>
<td>1.61</td>
</tr>
<tr>
<td>1B</td>
<td>1.53</td>
</tr>
<tr>
<td>2A</td>
<td>1.49</td>
</tr>
<tr>
<td>2B</td>
<td>1.45</td>
</tr>
<tr>
<td>3A</td>
<td>1.44</td>
</tr>
<tr>
<td>3B</td>
<td>1.42</td>
</tr>
</tbody>
</table>

*Average full-load efficiencies shall be established in accordance with 10 CFR 431.
*PUE0 and PUE1 shall not include energy for battery charging.

**TABLE E 503.7.1(1)**

**ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS**

[ASHRAE 90.1: TABLE 6.8.1-1]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air conditioners, air cooled</td>
<td>&lt;65 000 Btu/h2</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S. single phase(^2)</td>
<td>13.0 SEER before 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td>Through the wall</td>
<td>&lt;=30 000 Btu/h2</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S. single phase(^2)</td>
<td>14.0 SEER before 1/1/2023</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td>Small duct, high velocity, air cooled</td>
<td>&lt;65 000 Btu/h2</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S. single phase(^2)</td>
<td>12.0 SEER before 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td>Air conditioners, air cooled</td>
<td>&gt;=65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>Split system and single package</td>
<td>11.2 EER</td>
<td>AHRI 340/360</td>
</tr>
<tr>
<td></td>
<td>&gt;=135 000 Btu/h</td>
<td>Electric</td>
<td></td>
<td>11.0 EER</td>
<td></td>
</tr>
</tbody>
</table>

\(\text{\^2\text{U.S. single phase}}\)
<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air conditioners, water cooled</td>
<td>&lt;65 000 Btu/h</td>
<td>All</td>
<td>Electric resistance (or none)</td>
<td>12.1 EER 12.3 IEER</td>
<td>AHRI 210/240</td>
</tr>
<tr>
<td></td>
<td>&gt;/=65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>All</td>
<td>Electric resistance (or none)</td>
<td>12.1 EER 13.9 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>All</td>
<td>Electric resistance (or none)</td>
<td>12.5 EER 13.9 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=240 000 Btu/h and &lt;760 000 Btu/h</td>
<td>All</td>
<td>Electric resistance (or none)</td>
<td>12.2 EER 13.4 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=760 000 Btu/h</td>
<td>All</td>
<td>Electric resistance (or none)</td>
<td>12.2 EER 13.5 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;240 000 Btu/h and &lt;760 000 Btu/h</td>
<td>All</td>
<td>Electric resistance (or none)</td>
<td>12.4 IEER 14.2 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=760 000 Btu/h</td>
<td>All</td>
<td>Electric resistance (or none)</td>
<td>12.2 IEER 13.3 IEER</td>
<td></td>
</tr>
</tbody>
</table>

TABLE E 503.7.1(1) (continued)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-1]
<table>
<thead>
<tr>
<th>Air conditioners, evaporatively cooled</th>
<th>&lt;65 000 Btu/h2</th>
<th>All</th>
<th>Split system and single package</th>
<th>12.1 EER</th>
<th>12.3 IEER</th>
<th>AHRI 210/240</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;/=65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td>12.1 EER</td>
<td>12.3 IEER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All other</td>
<td>11.9 EER</td>
<td>12.1 IEER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;/=135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td>12.0 EER</td>
<td>12.2 IERR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All other</td>
<td>11.8 EER</td>
<td>12.0 IEER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;/=240 000 Btu/h and &lt;760 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td>11.9 EER</td>
<td>12.1 IEER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All other</td>
<td>11.7 EER</td>
<td>11.9 IEER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;/=760 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td>11.7 EER</td>
<td>11.9 IEER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All other</td>
<td>11.5 EER</td>
<td>11.7 IEER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condensing units, air cooled</td>
<td>&gt;/=135 000 Btu/h</td>
<td>–</td>
<td>–</td>
<td>10.5 EER</td>
<td>11.8 IEER</td>
<td>AHRI 365</td>
</tr>
<tr>
<td>Condensing units, water cooled</td>
<td>&gt;/=135 000 Btu/h</td>
<td>–</td>
<td>–</td>
<td>13.5 EER</td>
<td>14.0 IEER</td>
<td>AHRI 365</td>
</tr>
<tr>
<td>Condensing units, evaporatively cooled</td>
<td>&gt;/=135 000 Btu/h</td>
<td>–</td>
<td>–</td>
<td>13.5 EER</td>
<td>14.0 IEER</td>
<td>AHRI 365</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

**Notes:**
1. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2. Single-phase, **U.S.** air-cooled air conditioners less than 65 000 Btu/h (19 kW) are regulated as consumer products by the U.S. Department of Energy Code of Federal Regulations 10 CFR 430. SEER and SEER2 values for single-phase products are set by the U.S. Department of Energy.

**TABLE E 503.7.1(2)**

**ELECTRICALLY OPERATED AIR-COOLED UNITARY AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS**

[ASHRAE 90.1: TABLE 6.8.1-2]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled (cooling mode)</td>
<td>&lt;65 000 Btu/h²</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S. single phase²</td>
<td>14.0 SEER before 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Single package, three phase and applications outside U.S. single phase²</td>
<td>14.0 SEER before 1/1/2023</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td>Through the wall</td>
<td>Space constrained, air cooled (cooling mode)</td>
<td>&lt;=30 000 Btu/h&lt;sup&gt;2&lt;/sup&gt;</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S., single phase&lt;sup&gt;2&lt;/sup&gt;</td>
<td>12.0 SEER before 1/1/2023 11.7 SEER after 1/1/2023</td>
</tr>
<tr>
<td>Small duct, high velocity, air cooled (cooling mode)</td>
<td>&lt;65 000 Btu/h&lt;sup&gt;2&lt;/sup&gt;</td>
<td>All</td>
<td>Split System, three phase and applications outside U.S., single phase&lt;sup&gt;2&lt;/sup&gt;</td>
<td>11.0 SEER 12.0 SEER before 1/1/2023 12.0 SEER after 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td>Air cooled (cooling mode)</td>
<td>&gt;=65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>11.0 EER 12.2 IEER before 1/1/2023 14.1 IEER after 1/1/2023</td>
<td>10.8 EER 12.0 IEER before 1/1/2023 13.9 IEER after 1/1/2023</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;=135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>10.6 EER 11.6 IEER before 1/1/2023 13.5 IEER after 1/1/2023</td>
<td>10.4 EER 11.4 IEER before 1/1/2023 13.3 IEER after 1/1/2023</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;=240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>9.5 EER 10.6 IEER before 1/1/2023 12.5 IEER after 1/1/2023</td>
<td>9.3 EER 10.4 IEER before 1/1/2023 12.3 IEER after 1/1/2023</td>
<td></td>
</tr>
<tr>
<td>Water-to-air, water</td>
<td>&lt;17 000 Btu/h</td>
<td>All</td>
<td>86°F entering water</td>
<td>12.2 EER</td>
<td>ISO-13256-1</td>
</tr>
<tr>
<td>System Type</td>
<td>Capacity Range</td>
<td>Operating Temperature</td>
<td>EER</td>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>----------------</td>
<td>-----------------------</td>
<td>-----</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Loop (cooling mode)</td>
<td>(17,000 \text{ Btu/h and } &lt;65,000 \text{ Btu/h} )</td>
<td>-</td>
<td>13.0</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Loop (cooling mode)</td>
<td>(65,000 \text{ Btu/h and } &lt;135,000 \text{ Btu/h} )</td>
<td>-</td>
<td>13.0</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Water-to-air, groundwater (cooling mode)</td>
<td>(&lt;135,000 \text{ Btu/h} )</td>
<td>All</td>
<td>59°F entering water</td>
<td>18.0</td>
<td>ISO-13256-1</td>
</tr>
<tr>
<td>Brine-to-air, ground loop (cooling mode)</td>
<td>(&lt;135,000 \text{ Btu/h} )</td>
<td>All</td>
<td>77°F entering water</td>
<td>14.1</td>
<td>ISO-13256-1</td>
</tr>
<tr>
<td>Water-to-water, water loop (cooling mode)</td>
<td>(&lt;135,000 \text{ Btu/h} )</td>
<td>All</td>
<td>86°F entering water</td>
<td>10.6</td>
<td>ISO-13256-2</td>
</tr>
<tr>
<td>Water-to-water, groundwater (cooling mode)</td>
<td>(&lt;135,000 \text{ Btu/h} )</td>
<td>All</td>
<td>59°F entering water</td>
<td>16.3</td>
<td>ISO-13256-2</td>
</tr>
<tr>
<td>Brine-to-water, ground loop (cooling mode)</td>
<td>(&lt;135,000 \text{ Btu/h} )</td>
<td>All</td>
<td>77°F entering water</td>
<td>12.1</td>
<td>ISO-13256-2</td>
</tr>
<tr>
<td>Air cooled (heating mode)</td>
<td>(&lt;65,000 \text{ Btu/h}^2 ) (cooling capacity)</td>
<td>-</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>8.2 HSPF before 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td>Air cooled (heating mode)</td>
<td>-</td>
<td></td>
<td>Single package, three phase and applications outside U.S. single phase</td>
<td>7.5 HSPF after 1/1/2023</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td>Through the wall, space constrained, air cooled (heating mode)</td>
<td>(&lt;=30,000 \text{ Btu/h}^2 ) (cooling capacity)</td>
<td>-</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>7.4 HSPF before 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td>Through the wall, space constrained, air cooled (heating mode)</td>
<td>-</td>
<td></td>
<td>Single package, three phase and applications outside U.S. single phase</td>
<td>6.3 HSPF after 1/1/2023</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td>Small duct high velocity, air cooled (heating mode)</td>
<td>(&lt;65,000 \text{ Btu/h}^2 )</td>
<td>-</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>6.8 HSPF before 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td>Small duct high velocity, air cooled (heating mode)</td>
<td>-</td>
<td></td>
<td>Single package, three phase and applications outside U.S. single phase</td>
<td>7.2 HSPF after 1/1/2023</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
</tr>
</tbody>
</table>

Notes:

- \(\text{Btu/h}^2\) represents a specific cooling capacity.
- Single phase and applications outside U.S. single phase are indications of the system's phase and application compatibility.
- HSPF stands for Heating Seasonal Performance Factor, which is a measure of the heating efficiency of the system.
<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY TEST PROCEDURE</th>
<th>TEST PROCEDURE1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled (heating mode)</td>
<td>&gt;/=65 000 Btu/he and &lt;135 000 Btu/h (cooling capacity)</td>
<td>–</td>
<td>47°F db/43°F wb outdoor air</td>
<td>3.3 COPH before 1/1/2023 3.40 COPH before 1/1/2023</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17°F db/15°F wb outdoor air</td>
<td>2.25 COPH</td>
<td>AHRI 340/360</td>
</tr>
<tr>
<td></td>
<td>&gt;/=135 000 Btu/he (cooling capacity) and &lt;240 000 Btu/h</td>
<td>–</td>
<td>47°F db/43°F wb outdoor air</td>
<td>3.20 COPH</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17°F db/15°F wb outdoor air</td>
<td>2.05 COPH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=240 000 Btu/h (cooling capacity)</td>
<td>–</td>
<td>47°F db/43°F wb outdoor air</td>
<td>3.20 COPH</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17°F db/15°F wb outdoor air</td>
<td>2.05 COPH</td>
<td></td>
</tr>
<tr>
<td>Water to air, water loop (heating mode)</td>
<td>&lt;135 000 Btu/h (cooling capacity)</td>
<td>–</td>
<td>68°F entering water</td>
<td>4.3 COPH</td>
<td>ISO-13256-1</td>
</tr>
<tr>
<td>Water to air, ground-water (heating mode)</td>
<td>&lt;125 000 Btu/h (cooling capacity)</td>
<td>–</td>
<td>60°F entering water</td>
<td>3.7 COPH</td>
<td>ISO-13256-1</td>
</tr>
<tr>
<td>Brine to air, ground loop (heating mode)</td>
<td>&lt;125 000 Btu/h (cooling capacity)</td>
<td>–</td>
<td>32°F entering fluid</td>
<td>3.2 COPH</td>
<td>ISO-13256-1</td>
</tr>
<tr>
<td>Water to water, water loop (heating mode)</td>
<td>&lt;135 000 Btu/h (cooling capacity)</td>
<td>–</td>
<td>68°F entering water</td>
<td>3.7 COPH</td>
<td>ISO-13256-2</td>
</tr>
<tr>
<td>Water to water, groundwater (heating mode)</td>
<td>&lt;135 000 Btu/h (cooling capacity)</td>
<td>–</td>
<td>60°F entering water</td>
<td>3.1 COPH</td>
<td>ISO-13256-2</td>
</tr>
<tr>
<td>Brine to water, ground loop (heating mode)</td>
<td>&lt;135 000 Btu/h (cooling capacity)</td>
<td>–</td>
<td>32°F entering fluid</td>
<td>2.5 COPH</td>
<td>ISO-13256-2</td>
</tr>
</tbody>
</table>
For SI units: 1000 British thermal units per hour = 0.293 kW, °C = (°F-32)/1.8

**Notes:**
1. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2. Single-phase, U.S. air-cooled heat pumps less than <65 000 Btu/h (19 kW) are regulated as consumer products by the U.S. Department of Energy Code of Federal Regulations 10 CFR 430. SEER, SEER2, and HSPF values for single-phase products are set by the U.S. Department of Energy.

### TABLE E 503.7.1(4)
**ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS, PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS, SINGLE-PACKAGE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS, AND ROOM AIR CONDITIONER HEAT PUMPS - MINIMUM EFFICIENCY REQUIREMENTS**

[ASHRAE 90.1: TABLE 6.8.1-4]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY (INPUT)</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY4</th>
<th>TEST PROCEDURE1</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTAC (cooling mode) standard size</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>95°F db/75°F wb outdoor air³</td>
<td>13.8 – (0.300 × Cap/1000)³ (before 1/1/2015) 11.9 EER</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>14.0 – (0.300 × Cap/1000)³ EER⁵ 11.9 EER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;15 000Btu/h</td>
<td></td>
<td>9.5 EER</td>
<td></td>
</tr>
<tr>
<td>PTAC (cooling mode) nonstandard size¹</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>95°F db/75°F wb outdoor air³</td>
<td>9.4 EER</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>10.9 – (0.213 × Cap/1000)³ EER⁵ 7.7 EER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;15 000Btu/h</td>
<td></td>
<td>7.7 EER</td>
<td></td>
</tr>
<tr>
<td>PTHP (cooling mode) standard size</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>95°F db/75°F wb outdoor air³</td>
<td>11.9 EER</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>14.0 – (0.300 × Cap/1000)³ EER⁵ 9.5 EER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;15 000Btu/h</td>
<td></td>
<td>9.5 EER</td>
<td></td>
</tr>
<tr>
<td>PTHP (cooling mode) nonstandard size²</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>95°F db/75°F wb outdoor air³</td>
<td>9.5 EER</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>10.8 – (0.213 × Cap/1000)³ EER⁵ 7.6 EER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;15 000Btu/h</td>
<td></td>
<td>7.6 EER</td>
<td></td>
</tr>
<tr>
<td>PTHP (heating mode) standard size</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>47°F db/43°F wb outdoor air³</td>
<td>3.3 COPₕ</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>3.7 – (0.052 × Cap/1000)³ COPₕ⁵ 2.90 COPₕ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;15 000Btu/h</td>
<td></td>
<td>2.90 COPₕ</td>
<td></td>
</tr>
<tr>
<td>PTHP (heating mode) nonstandard size²</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>47°F db/43°F wb outdoor air³</td>
<td>2.7 COPₕ</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>2.9 – (0.026 × Cap/1000)³ COPₕ⁵ 2.5 COPₕ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;15 000Btu/h</td>
<td></td>
<td>2.5 COPₕ</td>
<td></td>
</tr>
<tr>
<td>SPVAC (cooling mode) single and three phase</td>
<td>&lt;65, 000 Btu/h</td>
<td>95°F db/75°F wb outdoor air³</td>
<td>10.0 11.0 EER</td>
<td>AHRI 390</td>
</tr>
<tr>
<td></td>
<td>≥65 000 Btu/h and ≤135 000 Btu/h</td>
<td></td>
<td>10.0 EER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;135 000 Btu/h</td>
<td></td>
<td>10.0 EER</td>
<td></td>
</tr>
</tbody>
</table>
### Table E 503.7.1(4) (continued)

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY (INPUT)</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room air conditioners without louvered sides</td>
<td>&lt;8000-6000 Btu/h</td>
<td>–</td>
<td>9.0 9.0 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>&gt;/=6000 Btu/h and &lt;8000 Btu/h</td>
<td>9.0 CEER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=8000 Btu/h and &lt;14 000 Btu/h</td>
<td>8.5 9.6 CEER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=14 000 Btu/h and &lt;20 000 Btu/h</td>
<td>9.5 CEER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=20 000 Btu/h</td>
<td>8.5 9.4 CEER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room air conditioner/heat pump with reverse cycle, with louvered sides for applications outside U.S.</td>
<td>&lt;20,000 Btu/h</td>
<td>–</td>
<td>9.0 9.8 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>----------------</td>
<td>---</td>
<td>----------------</td>
<td>------------</td>
</tr>
<tr>
<td>Room air conditioner/heat pump with reverse cycle, without louvered sides for applications outside U.S.</td>
<td>&gt;=20,000 Btu/h</td>
<td>–</td>
<td>8.5 9.3 CEER</td>
<td>–</td>
</tr>
<tr>
<td>Room air conditioner, casement only for applications outside U.S.</td>
<td>&lt;14,000 Btu/h</td>
<td>–</td>
<td>8.5 9.3 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td>Room air conditioner, casement slider for applications outside U.S.</td>
<td>&gt;=14,000 Btu/h</td>
<td>–</td>
<td>8.0 8.7 CEER</td>
<td>–</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW, °C = (°F - 32)/1.8

Notes:
1 ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2 Nonstandard size units must be factory labeled as follows: “MANUFACTURED FOR NONSTANDARD SIZE APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW STANDARD PROJECTS.” Nonstandard size efficiencies apply only to units being installed in existing sleeves having an external wall opening of less than 16 inch (406 mm) high or less than 42 inch (1067 mm) wide and having a cross-sectional area less than 670 square inches (0.432 m²).
3 “Cap” means the rated cooling capacity of the product in Btu/h (kW). If the unit’s capacity is less than 7000 Btu/h (2.05 kW), use 7000 Btu/h (2.05 kW) in the calculation. Where the unit’s capacity is more than 15,000 Btu/h (4.4 kW), use 15,000 Btu/h (4.4 kW) in the calculation.
4 The cooling-mode wet bulb temperature requirement only applies for units that reject condensate to the condenser coil.
5 Room air conditioners are regulated as consumer products by 10 CFR 430. For U.S. applications of room air conditioners, refer to Informative Appendix F, Table F-3, for the USDOE minimum efficiency requirements for U.S. applications.

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**TABLE E 503.7.1(5)**

WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES, AND UNIT HEATERS - MINIMUM EFFICIENCY REQUIREMENTS [ASHRAE 90.1: TABLE 6.8.1-5]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY (INPUT)</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-air furnace, gas fired for application outside the U.S.²</td>
<td>&lt;225,000 Btu/h</td>
<td>Maximum capacity³</td>
<td>78% AFUE or 80% EER², 80% AFUE (nonweatherized) or 81% AFUE</td>
<td>DOE-Appendix N of 10 CFR Part 430 or Section 2.39, Thermal Efficiency, CSA Z21.47</td>
</tr>
<tr>
<td>Warm-air furnace, oil fired for application outside the U.S.</td>
<td>&lt;225,000 Btu/h</td>
<td>Maximum capacity</td>
<td>83% AFUE (nonweatherized) or 78% AFUE (weatherized) or 80% Et&lt;sup&gt;2,4&lt;/sup&gt;</td>
<td>Appendix N of 10 CFR 430 or Section 42, Combustion, UL 727</td>
</tr>
<tr>
<td>Warm-air furnace, oil fired</td>
<td>≥225,000 Btu/h</td>
<td>Maximum capacity</td>
<td>84% Et&lt;sup&gt;4&lt;/sup&gt; 80% Et&lt;sup&gt;4&lt;/sup&gt; before 1/1/2023 82% Et&lt;sup&gt;4&lt;/sup&gt; after 1/1/2023</td>
<td>Section 42, Combustion, UL 727</td>
</tr>
<tr>
<td>Electric furnaces for applications outside the U.S.</td>
<td>≤225,000 Btu/h</td>
<td>All</td>
<td>96% AFUE</td>
<td>Appendix N of 10 CFR 430</td>
</tr>
<tr>
<td>Warm-air duct furnaces, gas fired</td>
<td>All capacities</td>
<td>Maximum capacity</td>
<td>80% Ec&lt;sup&gt;5&lt;/sup&gt;</td>
<td>Section 2.10, Efficiency, CSA Z83.8</td>
</tr>
<tr>
<td>Warm-air unit heaters, gas fired</td>
<td>All capacities</td>
<td>Maximum capacity</td>
<td>80% Ec&lt;sup&gt;5,6&lt;/sup&gt;</td>
<td>Section 2.10, Efficiency, CSA Z83.8</td>
</tr>
<tr>
<td>Warm-air unit heaters, oil fired</td>
<td>All capacities</td>
<td>Maximum capacity</td>
<td>80% Ec&lt;sup&gt;5,6&lt;/sup&gt;</td>
<td>Section 40, Combustion, UL 731</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

**Notes:**
1. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2. Combination units (i.e., furnaces contained within the same cabinet as an air conditioner) not covered by the U.S. Department of Energy Code of Federal Regulations 10 CFR 430 ([i.e., three-phase power or with cooling capacity greater than or equal to 65,000 Btu/h (19 kW)]) may comply with either rating. All other units greater than 225,000 Btu/h (66 kW) sold in the U.S. must meet the AFUE standards for consumer products and test using USDOE’s AFUE test procedure at 10 CFR 430, Subpart B, Appendix N.
3. Compliance of multiple firing rate units shall be at the maximum firing rate.
4. Et = thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
5. Ec = combustion efficiency (100 percent less flue losses). See test procedure for detailed discussion.
6. As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.
7. For U.S. applications of federal covered greater than 225,000 Btu/h (66 kW), products, see Informative Appendix F.
### Table E 503.7.1(6)
**GAS- AND OIL-FIRED BOILERS - MINIMUM EFFICIENCY REQUIREMENTS**[^2-^3]  
[ASHRAE 90.1: TABLE 6.8.1-6]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Boilers, steam</td>
<td>Gas fired— all, except natural draft</td>
<td>&lt;300 000 Btu/h[^6,^7] for applications outside U.S.[^9]</td>
<td>80% AFUE</td>
<td>80% AFUE</td>
<td>Appendix N of 10 CFR Part 430</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

**Notes:**

[^1]: These requirements apply to boilers with rated input of 8 000 000 Btu/h (2343 kW) or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged...
boilers.

2 $Ec =$ combustion efficiency (100 percent less flue losses). See reference document for detailed information.

3 $Et =$ thermal efficiency. See reference document for detailed information.

4 Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit’s controls.

5 Includes oil-fired (residual).

6 Boilers shall not be equipped with a constant burning pilot light.

7 A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an automatic means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.

8 For new construction, refer to Section E 503.4 for additional system compliance requirements.

9 See Informative Appendix F, Table F-4 of ASHRAE 90.1, for U.S. minimum efficiencies for residential products covered by USDOE requirements for U.S. applications.

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**TABLE E 503.7.1(7)**

**PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT—MINIMUM EFFICIENCY REQUIREMENTS**

[ASHRAE 90.1: TABLE 6.8.1-7]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>TOTAL SYSTEM HEAT-REJECTION CAPACITY AT RATED CONDITIONS</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>PERFORMANCE REQUIRED</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propeller or axial fan open-circuit cooling towers</td>
<td>All</td>
<td>95°F entering water 85°F leaving water 75°F entering wb</td>
<td>$\geq 40.2$ gpm/hp</td>
<td>CTI ATC-105 and CTI STD-201 RS</td>
</tr>
<tr>
<td>Centrifugal fan open-circuit cooling towers</td>
<td>All</td>
<td>95°F entering water 85°F leaving water 75°F entering wb</td>
<td>$\geq 20.0$ gpm/hp</td>
<td>CTI ATC-105 and CTI STD-201 RS</td>
</tr>
<tr>
<td>Propeller or axial fan closed-circuit cooling towers</td>
<td>All</td>
<td>102°F entering water 90°F leaving water 75°F entering wb</td>
<td>$\geq 16.1$ gpm/hp</td>
<td>CTI ATC-105S and CTI STD-201 RS</td>
</tr>
<tr>
<td>Centrifugal closed-circuit cooling towers</td>
<td>All</td>
<td>102°F entering water 90°F leaving water 75°F entering wb</td>
<td>$\geq 7.0$ gpm/hp</td>
<td>CTI ATC-105S and CTI STD-201 RS</td>
</tr>
<tr>
<td><strong>Propeller or axial fan dry coolers (air-cooled fluid coolers)</strong></td>
<td>All</td>
<td>115°F entering water 105°F leaving water 95°F entering wb</td>
<td>$\geq 4.5$ gpm/hp</td>
<td>CTI ATC-105DS</td>
</tr>
<tr>
<td>Propeller or axial fan evaporative condensers</td>
<td>All</td>
<td>R-507A R-448A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb</td>
<td>$\geq 157 000$ 160 000 Btu/h·hp</td>
<td>CTI ATC-106</td>
</tr>
<tr>
<td>Propeller or axial fan evaporative condensers</td>
<td>All</td>
<td>Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb</td>
<td>$\geq 134 000$ Btu/h·hp</td>
<td>CTI ATC-106</td>
</tr>
<tr>
<td>Centrifugal fan evaporative condensers</td>
<td>All</td>
<td>R-507A R-448A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb</td>
<td>$\geq 135 000$ 137 000 Btu/h·hp</td>
<td>CTI ATC-106</td>
</tr>
<tr>
<td>Centrifugal fan evaporative</td>
<td>All</td>
<td>Ammonia test fluid 140°F entering gas</td>
<td>$\geq 110 000$ Btu/h·hp</td>
<td>CTI ATC-106</td>
</tr>
</tbody>
</table>
condensers

- Temperature: 96.3°F
- Condensing temperature: 75°F entering wb

Air cooled condensers
- All
- Temperature: 125°F condensing temperature 190°F entering gas temperature 15°F subcooling 95°F entering db
- >=176 000 Btu/h·hp
- AHRI 460

For SI units: °C = (°F-32)/1.8, 1 gallon per minute per horsepower = 0.085 [(L/s)/kW], 1000 British thermal units per hour = 0.293 kW, 1 horsepower = 0.746 kW

Notes:
1. For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table E 503.7.1(7) divided by the fan motor nameplate power.
2. For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of the tower at the thermal rating condition listed in Table E 503.7.1(7) divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
3. For purposes of this table, dry-cooler performance is defined as the process water flow rating of the unit at the thermal rating condition listed in this table divided by the total fan motor nameplate power of the unit. Air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the total fan motor nameplate power of the unit.
4. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
5. The efficiencies and test procedures for both open- and closed-circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field-erected cooling towers.
6. All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project-specific accessories and/or options included in the capacity of the cooling tower.
7. For purposes of this table, evaporative condenser performance is defined as the heat rejected at the specified rating condition in the table, divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.
8. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A 448A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A 448A must meet the minimum efficiency requirements listed above with R-507A 448A as the test fluid. For ammonia, the condensing temperature is defined as the saturation temperature corresponding to the refrigerant pressure at the condenser entrance. For R-448A, which is a zeotropic refrigerant, the condensing temperature is defined as the arithmetic average of the dew point and the bubble point temperatures corresponding to the refrigerant pressure at the condenser entrance.

### TABLE E 503.7.1(8)
**HEAT TRANSFER EQUIPMENT - MINIMUM EFFICIENCY REQUIREMENTS**

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid to liquid heat exchangers</td>
<td>Plate type</td>
<td>NR</td>
<td>AHRI 400</td>
</tr>
</tbody>
</table>

Notes:
4. NR = No Requirement
2. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

### TABLE E 503.7.1(9) 503.7.1(8)
**ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR CONDITIONERS - MINIMUM EFFICIENCY REQUIREMENTS**

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>SIZE</th>
<th>HEATING</th>
<th>SUBCATEGORY OR</th>
<th>MINIMUM</th>
<th>TEST</th>
</tr>
</thead>
</table>

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### TABLE E 503.7.1(10) 503.7.1(9)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMPS - MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-10 6.8.1-9]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRF air conditioners, air cooled (cooling mode)</td>
<td>&lt;65 000 Btu/h</td>
<td>All</td>
<td>VRF multisplit system</td>
<td>13.0 SEER</td>
<td>AHRI 1230</td>
</tr>
<tr>
<td></td>
<td>&gt;/=65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>VRF multisplit system</td>
<td>11.2 EER 13.1 IEER (before 4/1/2017) 15.5 IEER (as of 4/1/2017)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>VRF multisplit system</td>
<td>11.0 EER 12.9 IEER (before 4/1/2017) 14.9 IEER (as of 4/1/2017)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>VRF multisplit system</td>
<td>10.0 EER 11.6 IEER (before 4/1/2017) 13.9 IEER (as of 4/1/2017)</td>
<td></td>
</tr>
<tr>
<td>VRF water source (cooling mode)</td>
<td>&lt;65 000 Btu/h</td>
<td>All</td>
<td>VRF multisplit systems 86°F entering water</td>
<td>12.0 EER 16.0 IEER (as of 4/1/2018)</td>
<td>AHRI 1230</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW
TABLE E 503.7.1(10) 503.7.1(9) (continued)

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRF groundwater source (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>VRF multisplit system with heat recovery 59°F entering water</td>
<td>16.2 EER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=135 000 Btu/h</td>
<td>All</td>
<td>VRF multisplit system with heat recovery 59°F entering water</td>
<td>16.0 EER</td>
<td>AHRI 1230</td>
</tr>
<tr>
<td>VRF groundwater source (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>VRF multisplit system with heat recovery 59°F entering water</td>
<td>13.8 EER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;/=135 000 Btu/h</td>
<td>All</td>
<td>VRF multisplit system with heat recovery 59°F entering water</td>
<td>13.6 EER</td>
<td></td>
</tr>
<tr>
<td>VRF Air cooled (heating mode)</td>
<td>&lt;65 000 Btu/h (cooling capacity)</td>
<td>—</td>
<td>VRF Multi-split system</td>
<td>7.7 HSPF</td>
<td>AHRI 1230</td>
</tr>
<tr>
<td></td>
<td>&gt;/=65 000 Btu/h and</td>
<td>—</td>
<td>VRF Multi-split system 47°F db/43°F wb</td>
<td>3.3 COPH</td>
<td></td>
</tr>
</tbody>
</table>
For SI units: 1000 British thermal units per hour = 0.293 kW, °C=(°F-32)/1.8

### TABLE E 503.7.1(11)
#### AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-11]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>NET-SENSIBLE COOLING CAPACITY</th>
<th>STANDARD MODEL</th>
<th>MINIMUM NET-SENSIBLE COPc RETURN AIR DRY-BULB TEMPERATURE/DEW-POINT TEMPERATURE</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air-cooled</td>
<td>&lt;65 000 Btu/h (cooling capacity)</td>
<td>Downflow unit</td>
<td>2.30</td>
<td>75°F/52°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upflow-unit-ducted</td>
<td>2.40</td>
<td>85°F/52°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upflow-unit-nonducted</td>
<td>2.09</td>
<td>95°F/52°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal-flow unit</td>
<td>2.45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;=65 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Downflow unit</td>
<td>2.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upflow-unit-ducted</td>
<td>2.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upflow-unit-nonducted</td>
<td>1.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal-flow unit</td>
<td>2.35</td>
<td></td>
</tr>
</tbody>
</table>

VRF Water source (heating mode)

- <135 000 Btu/h (cooling capacity) 17°F db/15°F wb outdoor air 2.25 COPH
- >=135 000 Btu/h and <240 000 Btu/h (cooling capacity) 47°F db/43°F wb outdoor air 3.2 COPH
- >=240 000 Btu/h (cooling capacity) 17°F db/15°F wb outdoor air 2.05 COPH

VRF Groundwater source (heating mode)

- <135 000 Btu/h (cooling capacity) 68°F entering water 4.2 COPH (before 1/1/2018)
  4.3 COPH (as of 1/1/2018)
- >=135 000 Btu/h and <240 000 Btu/h (cooling capacity) 68°F entering water 3.9 COPH (before 1/1/2018)
  4.0 COPH (as of 1/1/2018)
- >=240 000 Btu/h (cooling capacity) 68°F entering water 3.9 COPH

VRF Ground source (heating mode)

- <135 000 Btu/h (cooling capacity) 32°F entering water 3.1 COPH
- >=135 000 Btu/h (cooling capacity) 32°F entering water 2.8 COPH
<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>NET SENSIBLE COOLING CAPACITY</th>
<th>STANDARD MODEL</th>
<th>MINIMUM NET SENSIBLE COPc</th>
<th>RETURN AIR DRY-BULB TEMPERATURE/DEW-POINT TEMPERATURE</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CLASS 1  75°F/52°F</td>
<td>CLASS 2  85°F/52°F</td>
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<tr>
<td>Glycol-cooled</td>
<td>&lt;65,000 Btu/h</td>
<td>Downflow unit</td>
<td>2.30</td>
<td>2.40</td>
<td>2.00</td>
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<tr>
<td></td>
<td></td>
<td>Upflow unit-ducted</td>
<td>2.90</td>
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<td></td>
<td>Upflow unit-nonducted</td>
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<td></td>
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<td></td>
<td></td>
<td>Horizontal-flow unit</td>
<td>2.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycol-cooled</td>
<td>=65,000-240,000 Btu/h</td>
<td>Downflow unit</td>
<td>2.05</td>
<td>2.10</td>
<td>1.85</td>
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<td></td>
<td>Upflow unit-ducted</td>
<td>2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upflow unit-nonducted</td>
<td>2.10</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Horizontal-flow unit</td>
<td>2.15</td>
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</tr>
<tr>
<td>Glycol-cooled</td>
<td>&gt;240,000 Btu/h</td>
<td>Downflow unit</td>
<td>2.25</td>
<td>2.40</td>
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<td>Upflow unit-ducted</td>
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</tr>
<tr>
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<td></td>
<td>Upflow unit-nonducted</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal-flow unit</td>
<td>2.90</td>
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**TABLE E 503.7.1(11) (continued)**

**AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS MINIMUM EFFICIENCY REQUIREMENTS [ASHRAE 90.1: TABLE 6.9.1-11]**
<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Standard Model</th>
<th>Net Sensible Cooling Capacity</th>
<th>Minimum Net Sensible COP</th>
<th>Rating Conditions (dry bulb/dew point)</th>
<th>Test Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled</td>
<td>Downflow</td>
<td>&lt;80,000 Btu/h</td>
<td>2.70</td>
<td>85°F/52°F (Class 2)</td>
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<tr>
<td></td>
<td></td>
<td>&gt;/=80,000 Btu/h and &lt;295,000 Btu/h</td>
<td>2.58</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>&gt;/=295,000 Btu/h</td>
<td>2.36</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Upflow—ducted</td>
<td>&lt;80,000 Btu/h</td>
<td>2.67</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;/=80,000 Btu/h and &lt;295,000 Btu/h</td>
<td>2.55</td>
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</tr>
<tr>
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<td></td>
<td>&gt;/=295,000 Btu/h</td>
<td>2.33</td>
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<tr>
<td></td>
<td>Upflow—nonducted</td>
<td>&lt;65,000 Btu/h</td>
<td>2.16</td>
<td>75°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
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<tr>
<td></td>
<td></td>
<td>&gt;/=65,000 Btu/h and &lt;240,000 Btu/h</td>
<td>2.04</td>
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<td></td>
<td></td>
<td>&gt;/=240,000 Btu/h</td>
<td>1.89</td>
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<td>Horizontal</td>
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<td>95°F/52°F (Class 3)</td>
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<td></td>
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<td></td>
<td>&gt;/=240,000 Btu/h</td>
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<tr>
<td>Air cooled with fluid economizer</td>
<td>Downflow</td>
<td>&lt;80,000 Btu/h</td>
<td>2.70</td>
<td>85°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;/=80,000 Btu/h and &lt;295,000 Btu/h</td>
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<td></td>
<td></td>
<td>&gt;/=295,000 Btu/h</td>
<td>2.36</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Upflow—ducted</td>
<td>&lt;80,000 Btu/h</td>
<td>2.67</td>
<td></td>
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<td></td>
<td></td>
<td>&gt;/=80,000 Btu/h and &lt;295,000 Btu/h</td>
<td>2.55</td>
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<td></td>
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<tr>
<td>Equipment Type</td>
<td>Standard Model</td>
<td>Net Sensible Cooling Capacity</td>
<td>Minimum Net Sensible COP</td>
<td>Rating Conditions Return air (dry bulb/dew point)</td>
<td>Test Procedure</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------</td>
<td>-----------------------------</td>
<td>-------------------------</td>
<td>-----------------------------------------------</td>
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</tr>
<tr>
<td>Water cooled</td>
<td>Downflow</td>
<td>&lt;80,000 Btu/h</td>
<td>2.82</td>
<td>85°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
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<tr>
<td></td>
<td></td>
<td>≥80,000 Btu/h and &lt;295,000 Btu/h</td>
<td>2.73</td>
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<td></td>
<td>≥295,000 Btu/h</td>
<td>2.67</td>
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<tr>
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<td>Upflow—ducted</td>
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<td>≥80,000 Btu/h and &lt;295,000 Btu/h</td>
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<td>≥295,000 Btu/h</td>
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<td>2.43</td>
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<tr>
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<td>≥65,000 Btu/h and &lt;240,000 Btu/h</td>
<td>2.32</td>
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<td>Horizontal</td>
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<td>≥65,000 Btu/h and &lt;240,000 Btu/h</td>
<td>2.68</td>
<td>95°F/52°F (Class 3)</td>
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<td></td>
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<td>≥295,000 Btu/h</td>
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<td></td>
<td>Upflow—nondon ducted</td>
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<td>2.35</td>
<td>75°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
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<td>≥65,000 Btu/h and &lt;240,000 Btu/h</td>
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<td>Horizontal</td>
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<td>2.60</td>
<td>95°F/52°F (Class 3)</td>
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<td>≥240,000 Btu/h</td>
<td>2.54</td>
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### TABLE E 503.7.1(10)
FLOOR-MOUNTED AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS—MINIMUM EFFICIENCY REQUIREMENTS (CONTINUED)
[ASHRAE 90.1: TABLE 6.8.1-10]

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Standard Model</th>
<th>Net Sensible Cooling Capacity</th>
<th>Minimum Net Sensible COP</th>
<th>Rating Conditions Return air (dry bulb/dew point)</th>
<th>Test Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycol cooled</td>
<td>Downflow</td>
<td>&lt;80,000 Btu/h</td>
<td>2.56</td>
<td>85°F/52°F (Class 1)</td>
<td></td>
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<tr>
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<td>&gt;=80,000 Btu/h and &lt;295,000 Btu/h</td>
<td>2.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycol cooled</td>
<td>Upflow, ducted</td>
<td>&lt;80,000 Btu/h</td>
<td>2.53</td>
<td>85°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
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<td>&gt;=80,000 Btu/h and &lt;295,000 Btu/h</td>
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<tr>
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<td>Upflow, nonducted</td>
<td>&lt;65,000 Btu/h</td>
<td>2.08</td>
<td>75°F/52°F (Class 1)</td>
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<td>&gt;=65,000 Btu/h and &lt;240,000 Btu/h</td>
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<tr>
<td></td>
<td></td>
<td>&gt;=240,000 Btu/h</td>
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<td>Horizontal</td>
<td>&lt;65,000 Btu/h</td>
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<td>95°F/52°F (Class 3)</td>
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<td>&gt;=65,000 Btu/h and &lt;240,000 Btu/h</td>
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<td>Glycol cooled</td>
<td>Downflow</td>
<td>&lt;80,000 Btu/h</td>
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<td>85°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
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<td>2.19</td>
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<tr>
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<td>&lt;80,000 Btu/h</td>
<td>2.48</td>
<td>75°F/52°F (Class 1)</td>
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<td>&gt;=80,000 Btu/h and &lt;295,000 Btu/h</td>
<td>2.16</td>
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<td>Upflow, nonducted</td>
<td>&lt;65,000 Btu/h</td>
<td>2.00</td>
<td>75°F/52°F (Class 1)</td>
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<td></td>
<td>&gt;=65,000 Btu/h and &lt;240,000 Btu/h</td>
<td>1.82</td>
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<tr>
<td></td>
<td></td>
<td>&gt;=240,000 Btu/h</td>
<td>1.73</td>
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<td></td>
<td>Horizontal</td>
<td>&lt;65,000 Btu/h</td>
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<td>95°F/52°F (Class 3)</td>
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<td>&gt;=65,000 Btu/h and &lt;240,000 Btu/h</td>
<td>2.10</td>
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### TABLE E 503.7.1(12)
COMMERCIAL REFRIGERATOR AND FREEZERS—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-12]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>APPLICATION</th>
<th>ENERGY USE LIMITS, KWH/DAY*</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerator with solid doors</td>
<td>Holding-temperature</td>
<td>0.10 x V + 2.04</td>
<td>AHRI 1200</td>
</tr>
<tr>
<td>Refrigerator with transparent doors</td>
<td>Holding-temperature</td>
<td>0.12 x V + 3.34</td>
<td>AHRI 1200</td>
</tr>
<tr>
<td>Freezers with solid doors</td>
<td>Holding-temperature</td>
<td>0.40 x V + 1.38</td>
<td>AHRI 1200</td>
</tr>
<tr>
<td>Freezers with transparent doors</td>
<td>Holding-temperature</td>
<td>0.75 x V + 4.10</td>
<td>AHRI 1200</td>
</tr>
<tr>
<td>Refrigerators/freezers with solid doors</td>
<td>Holding-temperature</td>
<td>the greater of 0.12 x V + 3.34 or 0.70</td>
<td>AHRI 1200</td>
</tr>
<tr>
<td>Commercial refrigerators</td>
<td>Pulldown</td>
<td>0.126 x V + 3.54</td>
<td>AHRI 1200</td>
</tr>
</tbody>
</table>
For SI units: 1000 British thermal units per hour per day = 0.293 kW/day
* V = the chiller or frozen compartment volume (ft³) as defined in Association of Home Appliance Manufacturers.

<table>
<thead>
<tr>
<th>EQUIPMENT CATEGORY</th>
<th>CONDENSING UNIT CONFIGURATION</th>
<th>EQUIPMENT FAMILY</th>
<th>RATING TEMP., °F</th>
<th>OPERATING TEMP., °F</th>
<th>EQUIPMENT CLASSIFICATION</th>
<th>MAXIMUM DAILY ENERGY CONSUMPTION, KWH/DAY</th>
<th>TEST STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote condensing commercial refrigerators and commercial freezers</td>
<td>Remote (RC)</td>
<td>Vertical open (VOP)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>VOP.RC.M</td>
<td>0.64 × TDA + 4.07</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>VOP.RC.L</td>
<td>2.20 × TDA + 6.85</td>
<td>AHRI 1200</td>
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<td></td>
<td>Semivertical open (SVO)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>SVO.RC.M</td>
<td>0.66 × TDA + 3.18</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>SVO.RC.L</td>
<td>2.20 × TDA + 6.85</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal open (HZO)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>HZO.RC.M</td>
<td>0.35 × TDA + 2.88</td>
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<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>HZO.RC.L</td>
<td>0.55 × TDA + 6.88</td>
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<tr>
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<td>Vertical closed transparent (VCT)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>VCT.RC.M</td>
<td>0.15 × TDA + 1.95</td>
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</tr>
<tr>
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<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>VCT.RC.L</td>
<td>0.49 × TDA + 2.61</td>
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<tr>
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<td>Horizontal closed transparent (HCT)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>HCT.RC.M</td>
<td>0.16 × TDA + 0.13</td>
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<td>0 (L)</td>
<td>&lt;32</td>
<td>HCT.RC.L</td>
<td>0.34 × TDA + 0.26</td>
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<tr>
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<td>Vertical closed solid (VCS)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>VCS.RC.M</td>
<td>0.10 × V + 0.26</td>
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<tr>
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<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>VCS.RC.L</td>
<td>0.21 × V + 0.54</td>
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<tr>
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<td></td>
<td>Horizontal closed solid (HCS)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>HCS.RC.M</td>
<td>0.10 × V + 0.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>HCS.RC.L</td>
<td>0.21 × V + 0.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service over counter (SOC)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>SOC.RC.M</td>
<td>0.44 × TDA + 0.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>SOC.RC.L</td>
<td>0.93 × TDA + 0.22</td>
<td></td>
</tr>
<tr>
<td>Self-contained commercial refrigerators and commercial freezers with and without doors</td>
<td>Self-contained (SC)</td>
<td>Vertical open (VOP)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>VOP.SC.M</td>
<td>1.69 × TDA + 4.71</td>
<td>AHRI 1200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>VOP.SC.L</td>
<td>4.25 × TDA + 11.82</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semivertical open (SVO)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>SVO.SC.M</td>
<td>1.70 × TDA + 4.59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>SVO.SC.L</td>
<td>4.26 × TDA + 11.51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal open (HZO)</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>HZO.SC.M</td>
<td>0.72 × TDA + 5.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>HZO.RC.L</td>
<td>1.90 × TDA + 7.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical closed</td>
<td>38 (M)</td>
<td>&gt;/=32</td>
<td>VCT.SC.M</td>
<td>0.10 × V + 0.86</td>
<td></td>
</tr>
</tbody>
</table>
### Table E 503.7.1(11)

**Commercial Refrigerators, Commercial Freezers, and Refrigeration—Minimum Efficiency Requirements (Continued)**

**[ASHRAE 90.1: TABLE 6.8.1-11]**

<table>
<thead>
<tr>
<th>Equipment Category</th>
<th>Condensing Unit Configuration</th>
<th>Equipment Family</th>
<th>Operating Temp., °F</th>
<th>Equipment Classification</th>
<th>Maximum Daily Energy Consumption, KWh/Day</th>
<th>Test Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Ice-cream freezers</td>
<td>Remote (RC) Vertical Open (VOP)</td>
<td>-15 (I)</td>
<td>&lt;=52</td>
<td>VOP.RC.I</td>
<td>2.79 x TDA + 8.70</td>
<td>AHRI 1200</td>
</tr>
<tr>
<td></td>
<td>Semivertical Open (SVO)</td>
<td></td>
<td></td>
<td>SVO.RC.I</td>
<td>2.79 x TDA + 8.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horizontal Open (HZO)</td>
<td></td>
<td></td>
<td>HZO.RC.I</td>
<td>0.70 x TDA + 8.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical Closed Transparent (VCT)</td>
<td></td>
<td></td>
<td>VCT.RC.I</td>
<td>0.58 x TDA + 3.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horizontal Closed Transparent (HCT)</td>
<td></td>
<td></td>
<td>HCT.RC.I</td>
<td>0.40 x TDA + 0.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical Closed Solid (VCS)</td>
<td></td>
<td></td>
<td>VCS.RC.I</td>
<td>0.25 x V + 0.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horizontal Closed Solid (HCS)</td>
<td></td>
<td></td>
<td>HCS.RC.I</td>
<td>0.25 x V + 0.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Service Over Counter (SOC)</td>
<td>0 (L)</td>
<td>&lt;=32</td>
<td>SOC.RC.I</td>
<td>1.09 x TDA + 585</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. TDA = Outdoor dry bulb temperature.
2. Table values are rounded to two decimal places.
3. Equipment classification depends on the configuration and type of unit.
4. Maximum daily energy consumption is calculated using the formula provided for each configuration.
5. Test standard AHRI 1200 applies to the listed equipment categories.
<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>ENERGY USE LIMITS2,3 KWH/DAY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOP.RC.M</td>
<td>0.82 × TDA + 4.07</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SVO.RC.M</td>
<td>0.83 × TDA + 3.18</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.RC.M</td>
<td>0.35 × TDA + 2.88</td>
<td>AHRI-1200</td>
</tr>
</tbody>
</table>

Notes:
1. The meaning of the letters in this column is indicated in the columns to the left.
2. “Ice-cream freezer” is defined in 10 CFR 431.62 as a commercial freezer that is designed to operate at or below – 5°F and that the manufacturer designs, markets, or intends for the storing, displaying, or dispensing of ice cream.
3. Equipment class designations consist of a combination (in sequential order separated by periods (AAA).(BB).(C)) of the following:
   a. (AAA)—An equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical closed transparent doors, VCS = vertical closed solid doors, HCT = horizontal closed transparent doors, HCS = horizontal closed solid doors, and SOC = service over counter);
   b. (BB)—An operating mode code (RC = remote condensing and SC = self-contained); and
   c. (C)—A rating temperature code (M = medium temperature [38°F], L = low temperature [0°F], or I = ice cream temperature [–15°F]). For example, “VOP.RC.M” refers to the “vertical open, remote condensing, medium temperature” equipment class.
4. V is the volume of the case (ft³) as measured in AHRI 1200, Appendix C.
5. TDA is the total display area of the case (ft²) as measured in AHRI 1200, Appendix D.
<table>
<thead>
<tr>
<th>Model Code</th>
<th>Door Type</th>
<th>Condenser Location</th>
<th>Temperature</th>
<th>Load Calculation</th>
<th>AHRI Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOP.RC.L</td>
<td>Vertical-open</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>$2.27 \times TDA + 6.85$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.RC.L</td>
<td>Horizontal-open</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>$0.57 \times TDA + 6.88$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCT.RC.M</td>
<td>Vertical-transparent door</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>$0.22 \times TDA + 1.96$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCT.RC.L</td>
<td>Vertical-transparent door</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>$0.66 \times TDA + 2.64$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SOC.RC.M</td>
<td>Service-over-counter</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>$0.51 \times TDA + 0.11$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VOP.SC.M</td>
<td>Vertical-open</td>
<td>Self-contained</td>
<td>Medium-temperature</td>
<td>$1.74 \times TDA + 4.71$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SVO.SC.M</td>
<td>Semivertical-open</td>
<td>Self-contained</td>
<td>Medium-temperature</td>
<td>$1.73 \times TDA + 4.59$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.SC.M</td>
<td>Horizontal-open</td>
<td>Self-contained</td>
<td>Medium-temperature</td>
<td>$0.77 \times TDA + 5.56$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.SC.L</td>
<td>Horizontal-open</td>
<td>Self-contained</td>
<td>Low-temperature</td>
<td>$1.02 \times TDA + 7.08$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCT.SC.I</td>
<td>Vertical-transparent door</td>
<td>Self-contained</td>
<td>Ice-cream</td>
<td>$0.67 \times TDA + 3.29$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCS.SC.I</td>
<td>Vertical-solid-door</td>
<td>Self-contained</td>
<td>Ice-cream</td>
<td>$0.38 \times V + 0.88$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCT.SC.I</td>
<td>Horizontal-transparent-door</td>
<td>Self-contained</td>
<td>Ice-cream</td>
<td>$0.66 \times TDA + 0.43$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SVO.RC.L</td>
<td>Semivertical-open</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>$2.27 \times TDA + 6.85$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VOP.RC.I</td>
<td>Vertical-open</td>
<td>Remote-condensing</td>
<td>Ice-cream</td>
<td>$2.89 \times TDA + 8.7$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SVO.RC.I</td>
<td>Semivertical-open</td>
<td>Remote-condensing</td>
<td>Ice-cream</td>
<td>$2.89 \times TDA + 8.7$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.RC.I</td>
<td>Horizontal-open</td>
<td>Remote-condensing</td>
<td>Ice-cream</td>
<td>$0.72 \times TDA + 8.74$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCT.RG.I</td>
<td>Vertical-transparent-door</td>
<td>Remote-condensing</td>
<td>Ice-cream</td>
<td>$0.66 \times TDA + 3.05$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCT.RC.M</td>
<td>Horizontal-transparent-door</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>$0.16 \times TDA + 0.13$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCT.RL.L</td>
<td>Horizontal-transparent-door</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>$0.34 \times TDA + 0.26$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCT.RC.I</td>
<td>Horizontal-transparent-door</td>
<td>Remote-condensing</td>
<td>Ice-cream</td>
<td>$0.4 \times TDA + 0.34$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCS.RC.M</td>
<td>Vertical-solid-door</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>$0.11 \times V + 0.26$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCS.RG.L</td>
<td>Vertical-solid-door</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>$0.23 \times V + 0.64$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCS.RC.I</td>
<td>Vertical-solid-door</td>
<td>Remote-condensing</td>
<td>Ice-cream</td>
<td>$0.27 \times V + 0.63$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCS.RC.M</td>
<td>Horizontal-solid-door</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>$0.11 \times V + 0.26$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCS.RC.L</td>
<td>Horizontal-solid-door</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>$0.23 \times V + 0.64$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCS.RC.I</td>
<td>Horizontal-solid-door</td>
<td>Remote-condensing</td>
<td>Ice-cream</td>
<td>$0.27 \times V + 0.63$</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCS.RC.I</td>
<td>Horizontal-solid</td>
<td>Remote-condensing</td>
<td>Ice-cream</td>
<td>$0.27 \times V + 0.63$</td>
<td>AHRI-1200</td>
</tr>
</tbody>
</table>
### Table E 503.7.1(14) 503.7.1(12)

**Vapor Compression-Based Indoor Pool Dehumidifiers – Minimum Efficiency Requirements**

[ASHRAE 90.1: TABLE 6.8.1-14 6.8.1-12]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single package indoor* (with or without economizer)</td>
<td>Rating Conditions: A or C</td>
<td>3.5 MRE</td>
<td></td>
</tr>
<tr>
<td>Single package indoor water-cooled (with or without economizer)</td>
<td>Rating Conditions: A, B, or C</td>
<td>3.5 MRE</td>
<td>AHRI 910</td>
</tr>
<tr>
<td>Single package indoor air-cooled (with or without economizer)</td>
<td></td>
<td>3.5 MRE</td>
<td></td>
</tr>
<tr>
<td>Split system indoor air-cooled (with or without economizer)</td>
<td></td>
<td>3.5 MRE</td>
<td></td>
</tr>
</tbody>
</table>

*Units without air-cooled condenser

---

For SI units: 1000 British thermal units per hour per day = 0.293 kWh/day, 
°F = (°C × 9/5) + 32

**Notes:**

1. Equipment class designations consist of a combination [in sequential order separated by periods (AAA).(BB).(C)] of the following:
   (a) (AAA)—An equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical transparent doors, VCS = vertical solid doors, HCT = horizontal transparent doors, HCS = horizontal solid doors, and SOC = service over counter).
   (b) (BB)—An operating mode code (RC = remote condensing and SC = self contained).
   (c) (C)—A rating temperature code (M = medium temperature [38°F], L = low temperature [0°F], or I = ice cream temperature [15°F]). For example, “VOP.RC.M” refers to the “vertical open, remote condensing, medium temperature” equipment class.

2. V is the volume of the case (ft) as measured in accordance with AHRI 1200.

3. TDA is the total display area of the case (ft) as measured in accordance with AHRI 1200.
## WITHOUT ENERGY RECOVERY – MINIMUM EFFICIENCY REQUIREMENTS


<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY OR CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled (dehumidification mode)</td>
<td>–</td>
<td>4.0 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Air source heat pumps (dehumidification mode)</td>
<td>–</td>
<td>4.0 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water cooled (dehumidification mode)</td>
<td>Cooling tower condenser water</td>
<td>4.9 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Chilled Water</td>
<td>6.0 ISMRE</td>
<td></td>
</tr>
<tr>
<td>Air source heat pump (heating mode)</td>
<td>–</td>
<td>2.7 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water source heat pump (heating mode)</td>
<td>Ground source, closed loop</td>
<td>4.8 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Ground-water source</td>
<td>5.0 ISMRE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water source</td>
<td>4.0 ISMRE</td>
<td></td>
</tr>
<tr>
<td>Water source heat pump (heating mode)</td>
<td>Ground source, closed loop</td>
<td>2.0 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Ground-water source</td>
<td>3.2 ISCOP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water source</td>
<td>3.5 ISCOP</td>
<td></td>
</tr>
</tbody>
</table>

## ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITH ENERGY RECOVERY – MINIMUM EFFICIENCY REQUIREMENTS

[ASHRAE 90.1: TABLE 6.8.1-16 6.8.1-14]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled (dehumidification mode)</td>
<td>–</td>
<td>5.2 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Air source heat pumps (dehumidification mode)</td>
<td>–</td>
<td>5.2 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water cooled (dehumidification mode)</td>
<td>Cooling tower condenser water</td>
<td>5.3 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Chilled Water</td>
<td>6.6 ISMRE</td>
<td></td>
</tr>
<tr>
<td>Air source heat pump (heating mode)</td>
<td>–</td>
<td>3.3 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water source heat pump (heating mode)</td>
<td>Ground source, closed loop</td>
<td>5.2 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Ground-water source</td>
<td>5.8 ISMRE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water source</td>
<td>4.8 ISMRE</td>
<td></td>
</tr>
<tr>
<td>Water source heat pump (heating mode)</td>
<td>Ground source, closed loop</td>
<td>3.8 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Ground-water source</td>
<td>4.0 ISCOP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water source</td>
<td>4.8 ISCOP</td>
<td></td>
</tr>
</tbody>
</table>

## ELECTRICALLY OPERATED WATER-SOURCE HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS

[ASHRAE 90.1: TABLE 6.8.1-15]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-to-air, water loop (cooling mode)</td>
<td>&lt;17 000 Btu/h</td>
<td>All</td>
<td>86°F entering water</td>
<td>12.2 EER</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td></td>
<td>&gt;=17 000 Btu/h and</td>
<td></td>
<td></td>
<td>13.0 EER</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE E 503.7.1(16)
HEAT-PUMP AND HEAT RECOVERY CHILLER PACKAGES—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-16]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>COOLING-ONLY OPERATION</th>
<th>HEATING OPERATION</th>
<th>HEAT RECOVERY CHILLER FULL-LOAD EFFICIENCY (COPHR)</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>COOLING EFFICIENCY1</td>
<td>HEATING SOURCE CONDITIONS (ENTERING/LEAVING WATER)</td>
<td>(COPHR)2, WW</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AIR SOURCE EER (FL/IPLV), Btu/W·h</td>
<td>(FL/IPLV), °F</td>
<td>LEAVING HEATING WATER</td>
<td>LEAVING HEATING WATER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WATER SOURCE POWER INPUT PER CAPACITY (FL/IPLV), kW/ton</td>
<td>OR OAT (db/wb), °F</td>
<td>TEMPERATURE</td>
<td>TEMPERATURE</td>
</tr>
<tr>
<td>WATER-TO-AIR, GROUNDWATER (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>59°F entering water</td>
<td>18.0 EER</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Brine-to-air, ground loop (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>77°F entering water</td>
<td>14.1 EER</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>WATER-TO-WATER, WATER LOOP (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>86°F entering water</td>
<td>10.6 EER</td>
<td>ISO 13256-2</td>
</tr>
<tr>
<td>WATER-TO-WATER, GROUNDWATER (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>59°F entering water</td>
<td>16.3 EER</td>
<td>ISO 13256-2</td>
</tr>
<tr>
<td>Brine-to-water, ground loop (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>77°F entering water</td>
<td>12.1 EER</td>
<td>ISO 13256-2</td>
</tr>
<tr>
<td>Water-to-water, water loop (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>77°F entering water</td>
<td>4.3 COPH</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>WATER-TO-AIR, GROUNDWATER (heating mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>68°F entering water</td>
<td>3.7 COPH</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Brine-to-air, ground loop (heating mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>50°F entering water</td>
<td>3.2 COPH</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>WATER-TO-WATER, WATER LOOP (heating mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>68°F entering water</td>
<td>3.7 COPH</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Brine-to-water, ground loop (heating mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>32°F entering water</td>
<td>3.1 COPH</td>
<td>ISO 13256-2</td>
</tr>
<tr>
<td>WATER-TO-AIR, GROUNDWATER (heating mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>50°F entering water</td>
<td>2.5 COPH</td>
<td>ISO 13256-2</td>
</tr>
<tr>
<td>Brine-to-water, ground loop (heating mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>32°F entering water</td>
<td>2.5 COPH</td>
<td>ISO 13256-2</td>
</tr>
</tbody>
</table>

**Notes:**
1. Section 12 of ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2. Single-phase, U.S. air-cooled heat pumps less than 19 kW are regulated as consumer products by 10 CFR 430.
   - SCOPC, SCOP2C, SCOPH and SCOP2H values for single-phase products are set by the USDOE. See Informative Appendix F for the USDOE minimum.
<table>
<thead>
<tr>
<th>WATER SOURCE ELECTRICALLY OPERATED</th>
<th>NET SENSIBLE COOLING CAPACITY</th>
<th>MINIMUM NET SENSIBLE COP</th>
<th>RATING CONDITIONS RETURN AIR (DRY BULB/DEW POINT)</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER SOURCE ELECTRICALLY OPERATED</td>
<td>&lt;75 54/44 FL</td>
<td>2.05</td>
<td>75°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
</tr>
<tr>
<td>WATER SOURCE ELECTRICALLY OPERATED</td>
<td>&gt;=75 and &lt;150 54/44 FL</td>
<td>&gt;=2.60</td>
<td>&gt;=2.680</td>
<td>&gt;=3.680</td>
</tr>
<tr>
<td>WATER SOURCE ELECTRICALLY OPERATED</td>
<td>&gt;=150 and &lt;300 54/44 FL</td>
<td>&gt;=2.60</td>
<td>&gt;=3.680</td>
<td>&gt;=3.300</td>
</tr>
<tr>
<td>WATER SOURCE ELECTRICALLY OPERATED</td>
<td>&gt;=300 and &lt;600 54/44 FL</td>
<td>&gt;=2.60</td>
<td>&gt;=3.680</td>
<td>&gt;=3.300</td>
</tr>
<tr>
<td>WATER SOURCE ELECTRICALLY OPERATED</td>
<td>&gt;=600 54/44 FL</td>
<td>&gt;=2.60</td>
<td>&gt;=3.680</td>
<td>&gt;=3.300</td>
</tr>
</tbody>
</table>

Note:

1. Cooling-only rating conditions are standard rating conditions defined in AHRI 550/590, Table 1.
2. Heating full-load rating conditions are at rating conditions defined in AHRI 550/590, Table 1.
3. For water-cooled heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser, the COP<sub>HR</sub> applies to operation at full load with 100 percent heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table E 503.7.1(3).
4. Outdoor air entering dry-bulb (db) temperature and wet-bulb (wb) temperature.
5. Source-water entering and leaving water temperature.
# TABLE E 503.7.1(17)
## CEILING-MOUNTED COMPUTER-ROOM AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS
(Continued)

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>STANDARD MODEL</th>
<th>NET SENSIBLE COOLING CAPACITY</th>
<th>MINIMUM NET SENSIBLE COP</th>
<th>RATING CONDITIONS RETURN AIR (DRY BULB/DEW POINT)</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water cooled with fluid economizer</td>
<td>Ducted</td>
<td>&lt;29 000 Btu/h</td>
<td>2.33</td>
<td>75°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
</tr>
<tr>
<td></td>
<td>Ducted</td>
<td>&gt;=29 000 Btu/h and &lt;65 000 Btu/h</td>
<td>2.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ducted</td>
<td>&gt;=65 000 Btu/h</td>
<td>2.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonducted</td>
<td>&lt;29 000 Btu/h</td>
<td>2.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonducted</td>
<td>&gt;=29 000 Btu/h and &lt;65 000 Btu/h</td>
<td>2.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonducted</td>
<td>&gt;=65 000 Btu/h</td>
<td>2.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycol cooled</td>
<td>Ducted</td>
<td>&gt;=65000 Btu/h</td>
<td>2.16</td>
<td>75°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
</tr>
<tr>
<td>Nonducted</td>
<td>&lt;29000 Btu/h</td>
<td>1.97</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycol cooled with fluid economizer</td>
<td>Ducted</td>
<td>&lt;29000 Btu/h</td>
<td>1.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;=65000 Btu/h</td>
<td>1.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;65000 Btu/h</td>
<td>1.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;=65000 Btu/h</td>
<td>1.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonducted</td>
<td>&lt;29000 Btu/h</td>
<td>1.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;=65000 Btu/h</td>
<td>1.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;65000 Btu/h</td>
<td>1.78</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE E 503.7.1(18)
WALK-IN COOLER AND FREEZER DISPLAY DOOR EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-18]

<table>
<thead>
<tr>
<th>CLASS DESCRIPTOR</th>
<th>CLASS</th>
<th>MAXIMUM ENERGY CONSUMPTION, kWh/day*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display door, medium temperature</td>
<td>DD, M</td>
<td>0.04 × A_{dd} + 0.41</td>
</tr>
<tr>
<td>Display door, low temperature</td>
<td>DD, L</td>
<td>0.15 × A_{dd} + 0.29</td>
</tr>
</tbody>
</table>

* A_{dd} is the surface area (ft^2) of the display door.

<table>
<thead>
<tr>
<th>CLASS DESCRIPTOR</th>
<th>CLASS</th>
<th>MAXIMUM ENERGY CONSUMPTION, kWh/DAY*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage door, medium temperature</td>
<td>PD, M</td>
<td>0.05 × A_{nd} + 1.7</td>
</tr>
<tr>
<td>Passage door, low temperature</td>
<td>PD, L</td>
<td>0.14 × A_{nd} + 4.8</td>
</tr>
<tr>
<td>Freight door, medium temperature</td>
<td>FD, M</td>
<td>0.04 × A_{nd} + 1.9</td>
</tr>
<tr>
<td>Freight door, low temperature</td>
<td>FD, L</td>
<td>0.12 A_{nd} + 5.6</td>
</tr>
</tbody>
</table>

* A_{nd} is the surface area (ft^2) of the non-display door.

### TABLE E 503.7.1(20)
WALK-IN COOLER AND FREEZER REFRIGERATION SYSTEM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-20]

<table>
<thead>
<tr>
<th>CLASS DESCRIPTOR</th>
<th>CLASS</th>
<th>MINIMUM ANNUAL WALK-IN ENERGY FACTOR AWEF, Btu/W·h*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedicated condensing, medium temperature, indoor system</td>
<td>DC.M.I</td>
<td>5.61</td>
</tr>
<tr>
<td>Dedicated condensing, medium temperature, outdoor system</td>
<td>DC.M.O</td>
<td>7.60</td>
</tr>
<tr>
<td>Dedicated condensing, low temperature, indoor system, net</td>
<td>DC.L.I &lt;6500</td>
<td>9.091 × 10–5 × q_{net} + 1.81</td>
</tr>
</tbody>
</table>
### TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHRI 550/590-2020</td>
<td>Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle</td>
<td>Water-Chilling and Water-Heating Packages</td>
</tr>
<tr>
<td>AHRI 1200-2013</td>
<td>Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets</td>
<td>Commercial Refrigerators</td>
</tr>
<tr>
<td>AHRI 1250-2020</td>
<td>Performance Rating of Walk-in Coolers and Freezers</td>
<td>Walk-in Coolers and Freezers</td>
</tr>
<tr>
<td>AMCA 208-2018</td>
<td>Calculation of the Fan Energy Index</td>
<td>Fan Energy Index</td>
</tr>
<tr>
<td>AMCA 500D-2018</td>
<td>Laboratory Methods of Testing Dampers for Rating</td>
<td>Dampers</td>
</tr>
<tr>
<td>ASHRAE 90.4-2019</td>
<td>Energy Standard for Data Centers</td>
<td>Data Centers</td>
</tr>
<tr>
<td>10 CFR 430</td>
<td>Energy Conservation Program for Consumer Products</td>
<td>Energy Conservation</td>
</tr>
<tr>
<td>10 CFR 431</td>
<td>Energy Efficiency Program for Certain Commercial and Industrial Equipment</td>
<td>Energy Efficiency</td>
</tr>
<tr>
<td>10 CFR 431.62</td>
<td>Definitions Concerning Commercial Refrigerators, Freezers and Refrigerator-Freezers</td>
<td>Commercial Refrigerators, Freezers and Refrigerator-Freezers</td>
</tr>
<tr>
<td>10 CFR 431.302</td>
<td>Definitions Concerning Walk-In Coolers and Walk-In Freezers</td>
<td>Walk-in Coolers and Freezers</td>
</tr>
</tbody>
</table>

* $q_{\text{net}}$ is net capacity (Btu/h) as determined in accordance with AHRI 1250.

---

**Substantiation:**

- capacity ($q_{\text{net}}$) < 6500 Btu/h
- Dedicated condensing, low temperature, indoor system, net capacity ($q_{\text{net}}$) >\= 6500 Btu/h
  - DC.L.I, >\=6500 Btu/h
  - $2.40$ AHRI 1250 July 10, 2020

- Dedicated condensing, low temperature, outdoor system, net capacity ($q_{\text{net}}$) < 6500 Btu/h
  - DC.L.O, <6500 Btu/h
  - $6.522 \times 10^{-5} \times q_{\text{net}} + 2.73$ AHRI 1250 July 10, 2020

- Dedicated condensing, low temperature, outdoor system, net capacity ($q_{\text{net}}$) >\= 6500 Btu/h
  - DC.L.O, >\=6500 Btu/h
  - $3.15$ AHRI 1250 July 10, 2020

- Unit cooler, medium
  - UC.M
  - $9.00$ AHRI 1250 July 10, 2020

- Unit cooler, low temperature, net capacity ($q_{\text{net}}$) < 15 500 Btu/h
  - UC.L, <15 500 Btu/h
  - $1.575 \times 10^{-5} \times q_{\text{net}} + 3.91$ AHRI 1250 July 10, 2020

- Unit cooler, low temperature, net capacity ($q_{\text{net}}$) >\= 15 500 Btu/h
  - UC.L, >\=15 500 Btu/h
  - $4.15$ AHRI 1250 July 10, 2020

(Portion of table not shown remains unchanged)
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Appendix E is being revised to the latest edition of ASHRAE 90.1-2019 with Addenda by, ck, and cp published on August 3, 2020.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29 NOT RETURNED: 1  Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 009, Section E 503.6.5.3 (System Balancing) and UMC Item # 289, Section E 503.6.5.3 (System Balancing) resulted in conflicting language within the code. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:

**E 503.6.5.3 System Balancing.** Construction documents shall require that HVAC systems be balanced in accordance with generally accepted engineering standards. Construction documents shall require that a written balance report be provided to the building owner or the designated representative of the building owner for HVAC systems serving zones with a total conditioned area space or zone exceeding 5000 square feet (464.52 m$^2$). {[ASHRAE 90.1: 6.7.3.3.1]}

**TCC ACTION:** ACCEPT AS SUBMITTED

**TCC STATEMENT:**
The language in UMC Item # 289, Section E 503.6.5.3 (System Balancing) is being revised to correlate with the action taken by the UMC TC for Item # 009, Section E 503.6.5.3 (System Balancing) regarding the reference to conditioned “space or zone.” Additionally, the TCC further modified UMC Item # 289 by striking out the phrase “zones with” to correct a grammatical error in redundancy.

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for Section E 503.6.5.3 regarding the reference to conditioned “space or zone” and striking out the phrase “zones with.”
Proposals

Item #: 290

UMC 2024  Section: 210.0, E 201.0

SUBMITTER:  Phil Pettit
             Control Air Conditioning Corporation
             Rep. Self

RECOMMENDATION:
Revise text

E 201.0 Definitions.

Packaged Terminal Air Conditioner (PTAC). A self-contained unit used to heat or cool a conditioned space with a combination of heating and cooling components, assemblies, or sections and typically installed through an external wall.

Packaged Terminal Heat Pump (PTHP): A self-contained refrigerating system similar to a packaged terminal air conditioner (PTAC) that uses reverse cycle refrigeration to provide heat to a conditioned space.

210.0 – H –
Heat Pump. A refrigeration system that extracts heat from one substance and transfers it to another portion of the same substance or to a second substance at a higher temperature for a beneficial purpose.

SUBSTANTIATION:
Definitions for “Packaged Terminal Air Conditioner” and “Packaged Terminal Heat Pump” are recommended. Packaged Terminal Air Conditioners (PTACs) and Packaged Terminal Heat Pumps (PTHPs) provide both heating and cooling from one unit and are commonly installed in commercial and institutional spaces such as hotel rooms, senior living facilities, hospital rooms, apartment complexes, etc. PTACs utilize electric resistance heat, while PTHPs utilize heat pump heating along with back-up electric resistance heat. When a PTHP is heating in heat pump mode, the coolant reverses with the use of a reversing valve. Minimum efficiency requirements for PTACs and PTHPs are found in Table E 503.7.1(4) of the 2021 UMC.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed definitions are inconsistent with the definitions used by DOE, AHRI and the California Energy Commission. The definitions should be consistent with at least one of these organizations and be resubmitted as a public comment.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 291
UMC 2024  Section: E 201.0

SUBMITTER: Bruce A Pfeiffer
Retired - City of Topeka

RECOMMENDATION:
Add new text

E 201.0 Definitions.

Storm Water. Natural precipitation, including rain, snow and ice melt, that discharges across land surfaces, including manmade surfaces, or through other conveyances to one or more waterways and has not been put to beneficial use.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

E 201.0 Definitions.

Storm Water. Natural precipitation, including rain, snow and ice melt, that discharges across land surfaces, including manmade surfaces, or through other conveyances to one or more waterways that has contacted a surface at or below grade or aboveground parking structures and has not been put to beneficial use.

COMMITTEE STATEMENT:
The term originated in the Green Plumbing Code and the modification clarifies that storm water is water that ends up in a street or parking lot or runs through a storm sewer.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

The TCC has the responsibility to resolve conflicts and achieve correlation among the recommendations of the Technical Committee. The TCC has the authority to choose between alternative text recommended by the Technical Committee, but only as necessary for correlation, consistency, and the correction of errors and omissions in accordance with Section 3-4 of the Regulations Governing Committee Projects.

Actions taken on UMC Item # 291 and UPC Item # 022 resulted in conflicting language between the codes. In order to correlate the language, the Technical Correlating Committee proposed the following modifications to the UMC:
E 201.0 Definitions.

**Storm Water Stormwater.** Natural precipitation that has contacted a surface at grade or below grade and has not been put to beneficial use or aboveground parking structures.

**TCC ACTION:** ACCEPT AS SUBMITTED

**TCC STATEMENT:**
The definition of “Storm Water” in UMC Item # 291 is being revised to correlate with the action taken by the UPC TC for Item # 022 and to correlate with the existing definition in the 2021 UPC for “Stormwater.”

The action moves forward as approved by the TCC and supersedes the recommendation from the UMC TC for actions taken for the definition of “Storm Water” to correlate with the definition in the 2021 UPC.
Proposals

Item #: 292
UMC 2024  Section: E 201.0

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Add new text

E 201.0 Definitions.

**Thermal Energy.** The amount of sensible heat energy stored within a material or fluid. The product of the mass, specific thermal capacity and temperature increase/decrease of the material or fluid. Also known as sensible heat energy.

SUBSTANTIATION:
A definition is needed in the UMC for the term “Thermal Energy,” which is used in Appendix E. The change correlates with the actions taken by the USHGC Technical Committee. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  
AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 293

UMC 2024  Section: E 201.0

SUBMITTER: Lance MacNevin, P.Eng.
Chair, USHGC Technical Committee

RECOMMENDATION:
Add new text

E 201.0 Definitions.

**Thermal Storage.** A tank or vessel used in a solar thermal, hydronic, or geothermal system, in which thermal energy is stored.

SUBSTANTIATION:
The term “Thermal Storage” is used in Appendix E and requires a definition for clarity. The change correlates with the USHGC. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 294
UMC 2024  Section: E 201.0

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Add new text

E 201.0 Definitions.

**Total Dissolved Solids (TDS).** A measure (by electrical conductivity) of the amount of soluble matter that is present in the water.

SUBSTANTIATION:
UMC Section E 403.4.3 references the term “Total Dissolved Solids (TDS),” however there is no definition. A definition is needed for clarity. The code change correlates with the USHGC. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Item #: 295

UMC 2024 Section: E 402.1

SUBMITTER: Julius Ballanco, P.E.
JB Engineering and Code Consulting, P.C.
Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Revise text

E 402.0 Meters.
E 402.1 Required. A water meter shall be required for buildings connected to a public water system, including municipally supplied reclaimed (recycled) water. In other than single-family houses, multi-family structures not exceeding three stories above grade, and modular houses, a separate meter or submeter shall be installed in the following locations:
1. The makeup water supply to cooling towers, evaporative condensers, and fluid coolers, and domestic hot water systems.
(2) through (4) (remaining text unchanged)

SUBSTANTIATION:
This code change was submitted and discussed during the UMC Legionella Task Group and the decision was made by the Task Group to submit as a separate code change so as to focus on the scope of the Task Group in the new Appendix H (Impact of Water Temperature on The Potential for Legionella Growth).

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as no technical substantiation was provided to justify the language. Furthermore, the proposal is outside of the scope of the UMC. There is also concern with requiring a water meter for domestic hot water, which is not the intent of the original language.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 296
UMC 2024  Section: 218.0, Table 1701.2, E 503.3.1, E 503.4.6.5, E 503.5.6.6

SUBMITTER: Emily Toto
ASHRAE

RECOMMENDATION:
Revise text

218.0        – P –

Parking Garage Section. A part of a parking garage where airflow is restricted from other parts of the garage by solid walls.

E 503.4.6.5 Enclosed-Parking Garage Ventilation Systems. Enclosed parking garage ventilation systems shall automatically detect contaminant levels and stage fans or modulate fan airflow rates to 50 percent or less of design capacity, provided acceptable contaminant levels are maintained.
Parking garage ventilation systems shall meet all of the following:
(1) Separate ventilation systems and control systems shall be provided for each parking garage section.
(2) Control systems for each parking garage section shall automatically detect and control contaminant levels and shall be capable of and configured to reduce fan airflow to 20 percent or less of design capacity.
(3) The ventilation system for each parking garage section shall have controls and devices that result in fan motor demand of no more than 30 percent of design wattage at 50 percent of the design airflow.

Exceptions:
(1) Garages less than 30,000 square feet (2787.09 m$^2$) with ventilation systems that do not utilize mechanical cooling or mechanical heating.
(2) Garages that have a garage area to ventilation system motor nameplate horsepower ratio that exceeds 1500 square feet per horsepower (ft$^2$/hp) (186.8 m$^2$/kW) and do not utilize mechanical cooling or mechanical heating.
(3) Where not permitted by the Authority Having Jurisdiction.
Garage ventilation systems serving a single parking garage section having a total ventilation system motor nameplate horsepower [kilowatts] not exceeding 5 hp [3.7 kW] at fan system design conditions and where the parking garage section has no mechanical cooling or mechanical heating. [ASHRAE 90.1:6.4.3.4.5]

E 503.5.6.6 Low Power Fans. Fans that are not covered by Section E 503.5.6.5 and having a fan nameplate electrical input power of less than 180 W or having a motor nameplate horsepower less than 1/12 HP (62.1 W) shall meet the fan efficacy requirements specified in ASHRAE 90.1. [ASHRAE 90.1:6.5.3.7]

E 503.5.6.6 E 503.5.6.7 Ventilation Design. The required minimum outdoor air rate is the larger of the minimum outdoor air rate or the minimum exhaust air rate required by Chapter 4, ASHRAE 62.1, ASHRAE 62.2, ASHRAE 170, or applicable codes or accreditation standards. Outdoor air ventilation systems shall comply with one of the following:
(1) Design minimum outdoor air provided shall not exceed 135 percent of the required minimum outdoor air rate.
(2) Dampers, ductwork, and controls shall be provided that allow the system to supply no more than the required minimum outdoor air rate with a single setpoint adjustment.
(3) The system includes exhaust air energy recovery complying with Section E 503.5.10. [ASHRAE 90.1:6.5.3.7]

E 503.3.1 Criteria. The HVAC system shall comply with the following criteria:
(1) through (17) (remaining text unchanged)
(18) The system shall comply with the demand control ventilation requirements of Section E 503.4.6.9 and the ventilation design requirements of Section E-503.5.6.6 E 503.5.6.7.
TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI/AMCA 210-2016/ASHRAE 51-2016</td>
<td>Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating</td>
<td>Low Power Fans</td>
</tr>
</tbody>
</table>

Note: ANSI/AMCA 210/ASHRAE 51 and ANSI/ASHRAE/IES 90.1 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The changes to Section E 503.4.6.5 including the new definition for parking garage section are based on addendum d to ASHRAE 90.1-2019 for parking garage ventilation. This proposal increases stringency for these systems, with additional requirements for pollutant sensors and fan variable speed drives that SSPC 90.1 has determined to be cost effective.

The changes to Section E 503.5.6.6 align the UMC with the latest requirements in published addendum a to ASHRAE 90.1-2019 for low-power ventilation fans. The proposal also establishes ASHRAE Standard 62.2 as the reference for determining the minimum ventilation rates for non-transient dwelling units, in accordance with the scope of ASHRAE Standards 62.2 and 62.1.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

218.0 – P –

Parking Garage Section. A part of a parking garage where airflow is restricted from other parts of the garage by solid walls.

E 201.0 Definitions.

Parking Garage Section. A part of a parking garage where airflow is restricted from other parts of the garage by solid walls.

E 503.4.6.5 Parking Garage Ventilation Systems. Parking garage ventilation systems shall meet all of the following:
(1) Separate ventilation systems and control systems shall be provided for each parking garage section.
(2) Control systems for each parking garage section shall automatically detect and control contaminant levels and shall be capable of and configured to reduce fan airflow to 20 percent or less of design capacity.
(3) The ventilation system for each parking garage section shall have controls and devices that result in fan motor demand of no more than 30 percent of design wattage at 50 percent of the design airflow.

Exception:
Garage ventilation systems serving a single parking garage section having a total ventilation system motor nameplate horsepower [kilowatts] not exceeding 5 hp [3.7 kW] at fan system design conditions and where the parking garage section has no mechanical cooling or mechanical heating. [ASHRAE 90.1:6.4.3.4.5]

E 503.5.6.6 Low Power Fans. Fans that are not covered by Section E 503.5.6.5 and having a fan nameplate electrical input power of less than 180 W or having a motor nameplate horsepower less than 1/12 HP (62.1 W) shall meet the fan efficacy requirements specified in ASHRAE 90.1. [ASHRAE 90.1:6.5.3.7]

E 503.5.6.7 Ventilation Design. The required minimum outdoor air rate is the larger of the minimum outdoor air rate or the minimum exhaust air rate required by Chapter 4, ASHRAE 62.1, ASHRAE 62.2, ASHRAE 170, or applicable codes or accreditation standards. Outdoor air ventilation systems shall comply with one of the following:
(1) Design minimum system outdoor air provided shall not exceed 135 percent of the required minimum outdoor air rate.
(2) Dampers, ductwork, and controls shall be provided that allow the system to supply no more than the required minimum outdoor air rate with a single setpoint adjustment.
(3) The system includes exhaust air energy recovery complying with Section E 503.5.10. [ASHRAE 90.1:6.5.3.7]

E 503.3.1 Criteria. The HVAC system shall comply with the following criteria:
The system shall comply with the demand control ventilation requirements of Section E 503.4.6.9 and the ventilation design requirements of Section E 503.5.6.7. [ASHRAE 90.1:6.3.2]

### Table 1701.2

**STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES**

<table>
<thead>
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<tbody>
<tr>
<td>ANSI/AMCA 210-2016/ASHRAE 51-2016</td>
<td>Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating</td>
</tr>
</tbody>
</table>

COMMITTEE STATEMENT:
Table 1701.2 is being modified to correctly reference the standard document number for ANSI/ASHRAE/IES 90.1. Furthermore, the definition for "Parking Garage Section" is better suited in Appendix E than in the Chapter 2 definitions.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 297
UMC 2024  Section: E 603.1.3

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

E 603.0 Pollutant Control.

E 603.1 Indoor Air Quality During Construction. (remaining text unchanged)

E 603.1.3 Covering of Duct Openings and Protection of Mechanical Equipment During Construction. At the time of rough installation, or during storage on the construction site and until final startup of the heating and cooling equipment, duct and other related air distribution component openings shall be covered with tape, plastic, sheet metal, or other methods acceptable to the enforcing agency Authority Having Jurisdiction to reduce the amount of dust or debris that collects in the system.

SUBSTANTIATION:
The term “enforcing agency” is not defined in the code. The term “Authority Having Jurisdiction” should be used as it is defined in the code and consistent with other requirements within the code.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
E 608.0 Low VOC Solvent Cement and Primer.

E 608.1.1 Solvent Cement. Solvent cement, including one-step solvent cement, shall have a volatile organic compound (VOC) content of less than or equal to 65 ounces per gallon (oz/gal) (487 g/L) for CPVC cement, 68 oz/gal (509 g/L) for PVC cement, and 43 oz/gal (322 g/L) for ABS cement, as determined by the South Coast Air Quality Management District’s Laboratory Methods of Analysis for Enforcement Samples, Method 316A. Solvent cement shall comply with ASTM F493 for CPVC or CPVC/AL/CPVC joints, or ASTM D2564 for PVC joints.

E 608.1.2 Primer. Primer shall have a volatile organic compound (VOC) content of less than or equal to 73 oz/gal (546 g/L), as determined by the South Coast Air Quality Management District’s Laboratory Methods of Analysis for Enforcement Samples, Method 316A. Primer shall comply with ASTM F656 for CPVC, CPVC/AL/CPVC, or PVC.

Note: ASTM D2564, ASTM F493, and ASTM F656 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
Section 608.1.1 applies to solvent cement, including one-step solvent cement. The applicable standards for solvent cements are ASTM D2235 for ABS joints, ASTM F493 for CPVC joints, or ASTM D2564 for PVC joints. This change makes it clear that solvent cements must comply with these criteria.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposed standards do not belong in Appendix E for sustainable practices in the "Low VOC" section. The standards already exist within the body of the code and there is no need to add them again to the proposed locations in Appendix E.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
F 101.0 General.

F 101.1 Applicability. Part I of this appendix shall apply to all geothermal energy systems such as, but not limited to, building systems coupled with a ground-heat exchanger, submerged heat exchanger using water-based fluid as a heat transfer medium, or groundwater (well). The regulations of this appendix shall govern the construction, location and installation of geothermal energy systems. Indoor piping, fittings, and accessories that are part of the groundwater system shall be in accordance with Section F 104.4 and Chapter 12.

F 101.1.1 Prior to Construction. Documents for permits shall be submitted prior to the construction of a building system, ground-heat exchanger, submerged heat exchanger, or water well. Permits shall be issued by the Authority Having Jurisdiction.

F 101.1.2 Equipment, Accessories, Components, and Materials. The mechanical equipment, accessories, components, and materials used shall be of the type and rating approved for the specific use.

F 101.1.3 Indoor Piping. Indoor piping, fittings, and accessories that are part of the groundwater system shall be in accordance with Section F 104.4 and Chapter 12.

F 102.0 Definitions.

Ambient Temperature Loop (ATL). A closed loop piping system with central pumping that includes various heat sources and heat sinks to hold the loop fluid near the long-term average ambient air temperature. The sources/sinks can be passive (e.g., a ground loop, a body of water, sewer effluent) or active (e.g., a cooling tower) and further can include opportunistic, or unique locally available waste or byproduct heat sources (e.g., data center, industrial process). The closed loop piping system typically controls or engages these sources/sinks to maintain the loop temperature to meet the seasonal requirements as well as specific building needs.

Substantiation:
Section F 101.1 has been updated to clarify that Part I applies to all geothermal energy systems. The included paragraph expands the applicability of Part I to all ambient temperature loop systems and further describes the nature of the ambient temperature central systems. The paragraph further details that the ambient loop may consist of multiple sources and sinks as well as other district geothermal distribution systems. Finally, the Indoor piping
clause has been relocated to Section F 101.1 sub paragraphs for continuity and separation of other applicable components.

In addition, since the revision to F 101.1 includes district ambient temperature loop, the title of the Appendix F has been revised to address such system. With the addition of Geothermal district energy systems, the name of the section will reflect the inclusion of code language for ambient temperature loops and district systems.

Lastly, the definition for "ambient temperature loop (ATL)" was added to define such system. An ATL system is a closed loop piping system that includes various heat sources and heat sinks. There are installations for such systems and should be defined in Appendix F.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
SUBMITTER: Cary Smith (Sound Geothermal Corporation); Garen Ewbank (GreyEdge Group, LLC); Hugh Henderson (Owahgena Consulting, Inc.); Richard Bostian (Water Furnace International)

RECOMMENDATION:
Add new text

Part V – District Ambient Temperature Loop (ATL) Geothermal

F 501.0 Ambient Temperature Loop (ATL) Distributed Energy Systems.

F 501.1 General. An Ambient Temperature Loop (ATL) distributed energy system shall be installed in accordance with Section F 501.2 through Section F 501.6.2 and Section F 502.0. ATL systems shall comply with Part I through Part IV of this appendix, as applicable.

F 501.1.1 Fourth Generation (4G) System Configuration. A fourth-generation system configuration shall be a district geothermal energy system distributing hot water, cold water, or both to the conditioned space or building for a specific use. Where a geothermal energy source is used, such system shall comply with Part I through Part IV of this appendix, Chapter 11, and Chapter 12.

F 501.1.2 Fifth Generation (5G) System Configurations. An advanced Ambient Temperature Loop (ATL) System or fifth generation (5G) ATL system shall also be capable of interacting with the electric utility system as well as other utility systems and systems components. The system components shall include, but not limited to, the following:

1. Thermally diverse buildings with independent hydronic systems
2. Circulation loop
3. Global control system
4. Segment isolation capability

The system components may include, but not limited to, the following:

1. Electric grid-interactive enabled buildings
2. Hybrid components
3. Other renewable systems

F 501.2 Permits. Permits required for the installation and application of an ATL distributed energy system shall be obtained as required by the Authority Having Jurisdiction.

F 102.0 Definitions.

Ambient Temperature Loop (ATL). A closed loop piping system with central pumping that includes various heat sources and heat sinks to hold the loop fluid near the long-term average ambient air temperature. The sources/sinks can be passive (e.g., a ground loop, a body of water, sewer effluent) or active (e.g., a cooling tower) and further can include, opportunistic, or unique locally available waste or byproduct heat sources (e.g., data center, industrial process). The closed loop piping system typically controls or engages these sources/sinks to maintain the loop temperature to meet the seasonal requirements as well as specific building needs.

Fifth Generation (5G) System Configurations. An advanced ambient temperature (ATL) system that distributes near-ambient-temperature water among and between end-use buildings that are equipped with water-source heat pumps or other water-source HVAC equipment. Such systems stand in contrast to fourth generation (4G) systems that distribute hot water or chilled water to buildings to serve facility loads.

Fourth Generation (4G) System Configurations. A district geothermal energy system that distributes hot water and cold water for direct use in the conditioned space.
This section is being added in response to the attention drawn to ambient temperature loop district systems in many state due to carbon reduction plans and non-combustion alternatives. Ambient Temperature loops are high efficiency systems that recover wasted energy that is normally rejected to the atmosphere. The current language in Appendix F does not address these systems. The provisions in proposed Section F 501.0 through Section F 501.3 will address the general requirements for fourth generation systems and fifth generation systems; along with permitting requirements.

The definitions for "fourth generation (4G) system configuration" and "fifth generation (5G) system configuration" are included as such systems are not currently defined in the code. The definition for "ambient temperature loop (ATL)" was also added to define such system. ATL systems is a closed loop piping system that includes various heat sources and heat sinks.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 301

UMC 2024  Section: F 501.3 - F 501.5, Table 1701.2

SUBMITTER: Cary Smith (Sound Geothermal Corporation); Garen Ewbank (GreyEdge Group, LLC); Hugh Henderson (Owahgena Consulting, Inc.); Richard Bostian (Water Furnace International)

RECOMMENDATION:
Add new text

F 501.3 Ambient Loop Temperature Range. The operating loop temperature range of an ambient temperature loop (ATL) system shall be not less than the freeze point of the circulating fluid and not more than the maximum temperature as required by the manufacturer’s installation instructions for the attached heat pump equipment in accordance with Section F 501.3.1 and Section F 501.3.2. The ATL system shall use treated water as the heat transfer medium.

F 501.3.1 ATL Operating Temperature. For equipment listed to AHRI/ASHRAE/ISO 13256-1 and AHRI/ASHRAE/ISO 13256-2, the controlled temperature range of the ambient closed loop shall be not less than 7°F (4°C) above the freeze point of the transport fluid and 10°F (6°C) below the (collective) heat pump lowest maximum inlet supply temperature as recommended by the manufacturer’s instructions.

Exception: Equipment that is not listed to AHRI/ASHRAE/ISO 13256-1 and AHRI/ASHRAE/ISO 13256-2, The controlled temperature range of the ambient closed loop shall be in accordance with Section F 501.4 for minimum and maximum temperatures.

F 501.3.2 ATL Operating Temperature Range for Mixed Equipment Certifications. The source inlet temperature range of any attached equipment shall govern the design operating temperature range. Such equipment shall be identified in the design documentation. In any case the most restrictive minimum and maximum inlet supply temperatures, as recommended by the manufacturer’s instructions, shall determine the System Operating temperature range.

F 501.4 Shutoff Valve. An automatic shutoff valve shall be provided for each individual building or facility transferring energy to or from an ATL distribution system. The automatic shutoff valve shall automatically shutoff upon operating command.

F 501.4.1 Shutoff Valve Operation. The operation of the automatic shutoff valve shall be in accordance with the system operating procedures. Where the operation of a shutoff valve was due to an emergency response, an auxiliary hearing or cooling methodology shall be provided in accordance with Section F 502.1.2.

F 501.5 Bypass. The ATL distributed energy system shall be provided with bypass path(s) to reroute the circulating fluid when necessary.

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(portions of table not shown remain unchanged)
SUBSTANTIATION:
Section F 501.3 through Section F 501.5 further address the characteristics and required components of an ATL system that include system safety and appropriate minimum emergency or operational temperatures. The section also recognizes that there may be equipment attached to the loop with unique operation limits and that this will govern the temperature limits for standard operation of the ATL.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 302

UMC 2024   Section: F 501.6 - F 501.6.3

SUBMITTER: Cary Smith (Sound Geothermal Corporation); Garen Ewbank (GreyEdge Group, LLC); Hugh Henderson (Owahgena Consulting, Inc.); Richard Bostian (Water Furnace International)

RECOMMENDATION:
Add new text

F 501.6 Metering. Where meters are required by the system design, meter(s) shall be located as specified by the manufacturer on each consumptive or supply source and the range of the metering shall be appropriate to the thermal properties and flow rate(s) of the transport fluid.

F 501.6.1 Sub-Metering System Specification. The entire energy measurement system shall be provided with a sub-metering system. The metering system shall be calibrated and shall consist of a flow meter, temperature sensors, temperature thermowells, or other required mechanical installation metering. The sub-meter traceable calibration shall comply with the National Institute of Standards Technology (NIST) traceable calibration program or in accordance with the Authority Having Jurisdiction and shall be provided with an ATL distributed energy system.

F 501.6.2 BTU/Thermal Meters. Where used, the Btu/thermal meter shall be bidirectional and shall provide the following information via digital or analog display:
1. LCD, and via serial network communications.
2. Total energy.
3. Energy rate.
4. Total flow.
5. Flow rate.
7. Return temperature.
   Each Btu/thermal meter shall be factory programmed for its specific application and shall be re-programmable to adjust for specific site conditions.

F 501.6.3 Flow Meter. Where used, the flow meter shall be provided with the following information via digital or analog display:
1. LCD, and via serial network communications.
2. Instantaneous fluid rate.

SUBSTANTIATION:
Section F 501.6 through Section F 501.6.3 are intended to require energy movement data with sufficient accuracy to both measure system performance and individual asset performance. The respective metering methods also provide the basis for a use or energy transfer custody platform. In addition, this section is recognizing that there are multiple ways to effectively measure energy transfer.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 303

UMC 2024  Section: F 502.0 - F 502.1.2, Table 1701.2

SUBMITTER: Cary Smith (Sound Geothermal Corporation); Garen Ewbank (GreyEdge Group, LLC); Hugh Henderson (Owahgena Consulting, Inc.); Richard Bostian (Water Furnace International)

RECOMMENDATION:
Add new text

F 502.0 ATL Distributed Energy Systems Design Requirements.

F 502.1 Thermal Resources. The ambient temperature loop shall be permitted to connect to a thermal resource(s). Such resources may be an alternative energy source and sink, such as but not limited to solar photovoltaic (PV), solar thermal, combined heat power (CHP), and phase change thermal storage. These systems shall be installed and comply with the respective system requirements. ATL distributed energy systems coupled with solar thermal systems shall comply with the Uniform, Solar, Hydronics and Geothermal Code (USHGC) or equivalent. ATL systems coupled with a solar PV system shall comply with the USHGC or NFPA 70, or equivalent. These systems shall optimize the use of the equipment and energy based on the system design intent.

F 502.1.1 System Performance. The System Coefficient of Performance (SCOP) of the system shall take the net COP of each individual members in the district. The SCOP shall be provided by the designer and included in the system design documents.

F 502.1.2 Emergency Response. An auxiliary heating or cooling methodology shall be provided with the ATL controls and shall be adequate to provide temporary service in the absence of an ATL energy transfer. Emergency source/sink measures such as but not limited to control subroutines that move energy between spaces in the building, use of locally connected ground source assets, combined heat and power (CHP), conventional equipment, other renewables systems may be used.

F 102.0 Definitions.

Thermal Resources. A source for a heating and a sink for a cooling. There are two types of sources:
(1) Conventional-type: such systems are known as geothermal energy systems, such as air-source resources and ground-source resources.
(2) Opportunistic-type: such systems use water-source resources (e.g., oceans, rivers, raw sewage pipes, treated sewage outfall, potable water pipes, etc.), process byproduct heat resources (e.g., data center cooling process reject heat, industrial process reject heat, etc.), and other resources.

System Coefficient of Performance (SCOP). A ratio of the total system energy moved divided by the total system purchased energy.

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SUBSTANTIATION:
By definition, the ATL will use multiple types of sources and sinks and multiple heat transfer devices. This section is intended to demonstrate both different assets that are commonly used in conjunction with the ATL to meet specific system needs and the requirement to ensure that temporary service reductions or losses must be anticipated in the
A standard metric, system coefficient of performance (SCOP) must be used to evaluate the ATL design intent performance to include transport energy and wasted energy recovered. Sources and sinks are usually spread across the ATL system, GeoMicrodistrict, or thermal highway and provisions should be made to handle temporary reduction or loss of service utilizing assets currently connected to the ATL. Section F 502.1 is not intended to include a redundant system but rather to address use of existing or attached thermal resources.

Further, definitions to "thermal resource" and "system coefficient of performance (SCOP)" are being added as they are addressed in the proposed language and will assist the user as they are currently not defined, and the Authority Having Jurisdiction in enforcing these systems.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 304
UMC 2024 Section: F 102.0, F 502.2 - F 502.2.3

SUBMITTER: Cary Smith (Sound Geothermal Corporation); Garen Ewbank (GreyEdge Group, LLC); Hugh Henderson (Owahgena Consulting, Inc.); Richard Bostian (Water Furnace International)

RECOMMENDATION:
Add new text

F 502.2 District Load Profiles. The district load profile of an ambient temperature loop (ATL) distributed energy system shall be identified and shall be included in the basis-of-design (BOD).

F 502.2.1 System Asset Identification. System assets shall be listed and included in the system design. The system asset shall include, but not be limited to, the following:
(1) Building type and quantity.
(2) Natural or constructed sources and sinks such as ground water, boreholes, etc.
(3) Other renewable assets.
(4) Wasted heat recovery.
(5) Potable and non-potable water or fluid sources.
(6) Conventional assets such as boilers and cooling towers.
(7) Other GeoMicroDistrict or thermal highway.

F 502.2.2 Driver Building. The driver building profile shall be identified in an ATL distributed energy system and shall be reported in the design documents.

F 502.2.3 Diversity Factor. The diversity factor and/or anticipated wasted energy recovery component of the GeoMicroDistrict shall be identified by the designer and this information shall be included in the drawings and specifications.

F 102.0 Definitions.

Driver Building. One or more building(s) or facility(s) that determined the upper and lower temperature limits of hot fluid or cold fluid delivery system.

GeoMicroDistrict. A collection of building and facilities on an independently pumped ambient temperature loop (ATL) that supplies or receives energy. An independent segment served by a thermal highway.

Thermal Highway. A collection one or more GeoMicroDistricts that acts as an energy transport system and supplies or accepts energy from multiple GeoMicroDistricts, individual buildings, or other sources. Also known as convective circulation circuit.

SUBSTANTIATION:
Along with System Coefficient of Performance (SCOP), there are several additional unique characteristics and components that must be identified in the ATL design documents. These components must be identified to accurately communicate design intent. In addition, identification of system assets, the driver building(s) and diversity factor (e.g. wasted energy recovery) are imperative for the building management system-code-development, and the validation/commissioning process and long term operations management as well as later system expansion.

Furthermore, the definitions for "driver building," "GeoMicroDistrict," and "thermal highway" are being added as they are addressed in the proposed language and will assist with the enforcement of the section.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 305

UMC 2024  Section: F 102.0

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Add new text

F 102.0 Definitions.

**Borehole.** A vertical or horizontal narrow shaft typically cored, drilled or bored into the earth for geothermal system installations.

**SUBSTANTIATION:**
Boreholes are created during geothermal system installations and have provisions within Section F 201.3 (Borehole Piping and Tubing). Boreholes are also mentioned throughout Appendix F (Geothermal Energy Systems), and for this reason, such terminology is an appropriate addition to the Appendix F definitions. The terminology provided depicts what a borehole is, how it is created, and defines its purpose. This also correlates with the action taken by the USHGC Technical Committee.

**COMMITTEE ACTION:** ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

F 102.0 Definitions.

**Borehole.** A vertical or horizontal narrow shaft typically cored, drilled or bored into the earth for geothermal system installations.

**COMMITTEE STATEMENT:**
The definition is being revised to remove the adjective “narrow” as this is not always true.

Additionally, the Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

**TOTAL_ELIGIBLE_TO_VOTE:** 30

**VOTING RESULTS:**  
AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 306
UMC 2024 Section: F 102.0

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

F 102.0 Definitions.

**Geothermal Energy System, Closed-Loop System.**
(1) A hydronic system where the fluid is enclosed in piping that is not vented to the atmosphere. The system at any point, is typically under pressure that is greater than the ambient pressure.

(2) In a geothermal system, a liquid-source heat pump system using a continuous, sealed, underground, or submerged heat exchanger through which a heat-transfer fluid passes to and returns from a heat pump. The system at any point, is typically under pressure that is greater than the ambient pressure.

SUBSTANTIATION:
The definition of closed-loop system is being modified as the current definition may be true in some HVAC circulating systems, but I am not sure that “not vented to the atmosphere” is a clear and definitive characteristic of all HVAC closed-loop systems. The differentiation is typically that the fluid is or is NOT under “ambient” pressure. The change clarifies that there are 2 different applications for a closed-loop system. In definition (1), we account for things like drain down systems or recirculating through a storage vessel. The storage system may or may not be directly vented to the atmosphere and is typically held at ambient pressure. In definition (2), we use the “specific technology” application of the term.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 307
UMC 2024  Section: F 102.0

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Add new text

F 102.0 Definitions.

Geoexchange. See Geothermal Energy System.

SUBSTANTIATION:
Geoexchange is another term used for Geothermal Energy System, therefore, the term is being added to the Appendix F definitions. This also correlates with the action taken by the USHGC Technical Committee.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The term "Geoexchange" is a trademarked term and and should not be used without permission.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 308

UMC 2024  Section: E 201.0, F 102.0

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

E 201.0 Definitions.

E 201.4 Geothermal. Renewable energy generated by deep-earth.

F 102.0 Definitions.

Geothermal. Renewable energy generated by deep-earth conduction.

SUBSTANTIATION:
The definition of “Geothermal” in Appendix E (Sustainable Practices) must be relocated to Appendix F (Geothermal Energy Systems) as geothermal provisions are no longer located in Appendix E. Geothermal requirements have been relocated to Appendix F. In addition, there are both solar and deep earth influences on GX systems.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 309
UMC 2024  Section: F 102.0

SUBMITTER: Cary Smith
      Sound Geothermal Corporation

RECOMMENDATION:
Revise text

F 102.0 Definitions.

Geothermal Energy System; Open-Loop System.
(1) A hydronic system where the fluid is enclosed in piping that is vented to the atmosphere, or is replaced, all or in part, during every circulation of the system.
(2) In a geothermal system, a liquid-source heat pump system, inclusive of heat pump systems, that uses ground water or surface water to extract or reject heat.

SUBSTANTIATION:
The definition of open-loop system is being modified as the current definition may be true in some HVAC circulating systems, but I am not sure that “vented to the atmosphere” is a clear and definitive characteristic of all HVAC open-loop systems. The differentiation is typically that the fluid is or is NOT under “ambient” pressure. Even an open system can be continuously recirculated if it is circulated through a vented tank but the vent may be normally closed. The change clarifies that there are 2 different applications for an open-loop system. In definition (1), we account for things like drain down systems or recirculating through a storage vessel. The storage system may or may not be directly vented to the atmosphere and is typically held at ambient pressure. In definition (2), we use the “specific technology” application of the term.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 310
UMC 2024  Section: F 102.0

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Add new text

F 102.0 Definitions.

pH. The log of the reciprocal of the hydrogen ion concentration of a solution, and a measure of the acidity or alkalinity of the water. It is determined by the concentration of hydrogen ions in a specific volume of water.

SUBSTANTIATION:
UMC Section F 301.2 references the term "pH," however there is no definition. A definition is needed for clarity. The code change correlates with the USHGC. This is necessary to ensure correlation between the codes.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

F 102.0 Definitions.

pH. The log of the reciprocal of the hydrogen ion concentration of a solution, and a measure of the acidity or alkalinity of the water. It is determined by the concentration of hydrogen ions in a specific volume of water.

COMMITTEE STATEMENT:
The definition is being modified to remove the phrase “the log of the reciprocal of the hydrogen ion concentration of a solution.” The modification clears up the terminology since pH is simply a measure of acidity and alkalinity of water.

Additionally, the Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 311
UMC 2024  Section: Table F 104.2, Table 1701.2

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

TABLE F 104.2
PLASTIC GROUND SOURCE LOOP PIPING

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-linked polyethylene (PEX)</td>
<td>ASTM F876, CSA B137.5, <a href="https://example.com/CSA-B137.5">CSA B137.5</a>, CSA C448, NSF 358-3</td>
</tr>
</tbody>
</table>

(PORTION OF TABLE NOT SHOWN REMAIN UNCHANGED)

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA B137.5-2020</td>
<td>Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications</td>
<td>Piping</td>
</tr>
</tbody>
</table>

(PORTION OF TABLE NOT SHOWN REMAIN UNCHANGED)

SUBSTANTIATION:
This change is being made to further enhance Table F 104.2 by providing an additional applicable material standard for plastic ground source loop piping to be used in geothermal systems. This also correlates with the action taken by the USHGC Technical Committee.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The item is being rejected as the standard is already found in the section. Including the standard in the table is repetitive and, therefore, unnecessary.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 312
UMC 2024  Section: Table F 104.2, Table F 104.3

**SUBMITTER:** Cary Smith  
Sound Geothermal Corporation

**RECOMMENDATION:**  
Revise text

### TABLE F 104.2
**PLASTIC GROUND SOURCE LOOP PIPING**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-linked polyethylene (PEX)</td>
<td>ASTM F876, CSA B137.5, CSA/IGSHPA C448, NSF 358-3</td>
</tr>
<tr>
<td>High Density Polyethylene (HDPE)</td>
<td>ASTM D2737, ASTMD 3035, ASTM F714, AWWA C901, CSA B137.1, CSA/IGSHPA C448, NSF 358-1</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>ASTM F2623, ASTM F2769, CSA B137.18, CSA/IGSHPA C448, NSF 358-4</td>
</tr>
<tr>
<td>Polyethylene Raised Temperature (PE-RT)</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE F 104.3
**GROUND SOURCE LOOP PIPE FITTINGS**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Density Polyethylene (HDPE)</td>
<td>ASTM D2683, ASTM D3261, ASTM F1055, CSA B137.1, CSA/IGSHPA C448, NSF 358-1</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>ASTM F2389, CSA B137.11, NSF 358-2</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)
Note: CSA/IGSHPA C448 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
This code change adds IGSHPA to the CSA C448 standard as it is a harmonized standard. Table 1701.2 already shows the standard correctly. This also correlates with the action taken by the USHGC Technical Committee.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 313
UMC 2024  Section: Table F 104.3, Table 1701.2

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

TABLE F 104.3
GROUND SOURCE LOOP PIPE FITTINGS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-linked polyethylene</td>
<td>ASTM F877, ASTM F1055, ASTM F1807, ASTM F1960, ASTM F2080, ASTM F2159,</td>
</tr>
<tr>
<td>(PEX)</td>
<td>ASTM F2434, **ASTM F3253, ASTM F3347, ASTM F3348, CSA B137.5, CSA C448,</td>
</tr>
<tr>
<td></td>
<td>NSF 358-3</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM F3347-2020a</td>
<td>Metal Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
</tr>
<tr>
<td>ASTM F3348-2020b</td>
<td>Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

SUBSTANTIATION:
This change is being made to further enhance Table F 104.3 by providing additional applicable material standards for ground source loop pipe fittings to be used in geothermal systems. This also correlates with the action taken by the USHGC Technical Committee.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
The proposal is being rejected as the changes pertaining to PEX fittings used in ground source loops in this proposal are already being addressed in Item # 314.

Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Item #: 314
UMC 2024 Section: Table F 104.3, Table 1701.2

SUBMITTER: Michael Cudahy
PPFA

RECOMMENDATION: Revise text

TABLE F 104.3
GROUND SOURCE LOOP PIPE FITTINGS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene Raised Temperature (PE-RT)</td>
<td>ASTM D3261, ASTM F1055, ASTM F1807, ASTM F2080, ASTM F2159, ASTM F2769, ASTM F3347, ASTM F3348, CSA B137.18, CSA C448; NSF 358-4</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
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<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM F3347-2020a</td>
<td>Metal Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
</tr>
<tr>
<td>ASTM F3348-2020b</td>
<td>Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: The ASTM standard meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 315
UMC 2024  Section: F 106.2

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

F 106.0 Valves.

F 106.2 Heat Exchangers. Shutoff valves shall be installed on the supply and return side of a heat exchanger, except
Exception: Where the heat exchanger is integral with a boiler or is a component of a manufacturer’s boiler and heat
exchanger packaged unit, and is capable of being isolated from the hydronic system by the supply and return valves.

SUBSTANTIATION:
The proposed change to Section F 106.2 removes the lengthy, run on sentence and makes it clear that there is an
exception within the section. This also correlates with the action taken by the USHGC Technical Committee.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the
need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 316
UMC 2024  Section:  F 107.1, Table  F 107.1, Table  1701.2

SUBMITTER:  Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

F 107.0 Specific System Components Design.
F 107.1 General.  Heat pumps shall be in compliance with Table F 107.1, as applicable.  Heat pumps shall also be listed and labeled in accordance with UL 1995 or UL 60335-2-40.  Ground coupled and water source heat pumps shall be certified listed in accordance with AHRI/ASHRAE/ISO 13256-1 for water-to-air heat pumps and AHRI/ASHRAE/ISO 13256-2 for water-to-water heat pumps.  DX heat pumps shall be certified listed in accordance with ASHRAE 194.  All heat pump equipment used in DX systems shall comply with AHRI 870.  Heat pumps shall be fitted with a means to indicate that the compressor is locked out.

**TABLE F 107.1**

<table>
<thead>
<tr>
<th>TYPE OF HEAT PUMP</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-to-Air</td>
<td>AHRI/ASHRAE/ISO 13256-1</td>
</tr>
<tr>
<td>Water-to-Water</td>
<td>AHRI/ASHRAE/ISO 13256-2</td>
</tr>
</tbody>
</table>

**TABLE 1701.2**

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
</table>

(portions of table not shown remain unchanged)

**SUBSTANTIATION:**
Standards are being added to Section F 107.1 to address water source heat pumps. The standards provide detailed test methods, performance requirements and marking provisions for water-source heat pumps. AHRI/ASHRAE/ISO 13256-1 addresses water-to-water and brine-to-water heat pumps. AHRI/ASHRAE/ISO 13256-2 addresses water-to-air and brine-to-air heat pumps. AHRI/ASHRAE/ISO 13256-1 and AHRI/ASHRAE/ISO 13256-2 have been used in the industry since 1998 and have been reaffirmed two times without substantive changes to the requirements.

**COMMITTEE ACTION:**  ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:**  30

**VOTING RESULTS:**  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 317
UMC 2024  Section: F 108.18.8, Table 1701.2

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

F 108.0 Installation Practices.

F 108.18 Trenches, Excavation, and Backfill. (remaining text unchanged)

F 108.18.8 Tracer and Warning Markings. Means shall be provided for underground detection or utility location of the buried pipe system. This shall include, but is not limited to, metallic detectable tape, with a thickness of not less than 11/64 of an inch (4.4 mm) and a width of 6 inches (152 mm), or non-metallic warning tape used in conjunction with tracer wire that is listed and labeled in accordance with UL 2989. Tracer and Warning markings shall be permanent, conspicuous and resistant to the environmental conditions and shall be placed within 1 foot to 2 feet (305 mm to 610 mm) on top of the horizontal piping of the heat exchanger installation.

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 2989-2016</td>
<td>Outline of Investigation for Tracer Wire</td>
<td>Tracer Wire</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

SUBSTANTIATION:
Tracer wire that is listed and labeled in accordance with UL 2989 has undergone specific testing to determine its suitability for use underground as a detectable tracer wire. The tests include:
- Physical Properties of Insulation
- Mechanical Water Absorption
- Cold-Bend Test
- Crushing Resistance
- Impact Resistance
- Unwinding of Low Temperature
- Dielectric-Voltage Withstand

Including the use of listed tracer wire in conjunction with a non-metallic warning tape in Section F 108.18.8 provides an alternative to metallic detectable warning tape. UL currently has 15 manufacturers that have tracer wire listed to UL 2989. This also correlates with the action taken by the USHGC Technical Committee.

COMMITTEE ACTION: REJECT

COMMITTEE STATEMENT:
There is concern that the current code references 14 AWG and the UL 2989 standard references 18 AWG, which may create a conflict. The Technical Committee recommends the submitter to come back with a public comment after additional research and review has been done.
Additionally, the Technical Committee disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 318
UMC 2024  Section: F 108.7

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

F 108.0 Installation Practices.

F 108.7 Ground-Heat Exchanger Installation Practices. A ground-heat exchanger system shall be installed as follows:
(1) through (6) (remain unchanged)
(7) Wells and boreholes shall be sealed in accordance with the Authority Having Jurisdiction. Where grout is required, it shall be applied in a single continuous operation from the bottom of the borehole by pumping through a tremie pipe.

SUBSTANTIATION:
Section F 108.7 (7) is being revised as sealing is a batch process and it is not always in a single continuous operation. Therefore, the term is being removed to allow for such process. The process can be either single, continuous, or multi-batch.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Item #: 319
UMC 2024 Section: F 110.1, F 201.6, F 201.6.2, F 401.4

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

F 110.0 Decommissioning and Abandonment.
F 110.1 General. Decommissioning of geothermal systems shall comply with CSA/IGSHPA C448. Prior to the abandonment or decommissioning of geothermal systems, the owner shall obtain the necessary permits from the Authority Having Jurisdiction.

F 201.0 General.
F 201.6 Vertical Bores. Vertical bores shall be drilled to a depth to provide complete insertion of the u-bend pipe to its specified depth. The borehole diameter shall be sized for the installation and placement of the heat exchange u-bend and the tremie used to place the grouting material. CSA/IGSHPA C448 shall be used for vertical loop depth and borehole diameter sizing guidance. The u-bend joint and pipe shall be visually inspected for integrity in accordance with the manufacturer’s installation instructions. The u-bend joint and pipe shall be pressurized to not less than 100 psi (689 kPa), not to exceed the pressure rating of the pipe at the test temperature, for 1 hour to check for leaks before insertion into the borehole.

F 201.6.2 U-Bends and Headers. Headers, u-bends and ground loop pipes shall be pressure-tested in accordance with CSA/IGSHPA C448, or as required by the Authority Having Jurisdiction. Before testing, heat fusion joints shall be cooled to ambient temperature. Mechanical joints shall be completely assembled. Flushing and purging to remove air and debris shall be completed before testing. The assembly shall be filled with water (or water/antifreeze solution) and purged at a minimum flow rate of 2 feet per second (0.6 m/s) to remove air, but not more than the maximum flow velocity recommended by the pipe and fittings manufacturer to remove debris.

F 401.0 Direct Exchange (DX) Systems.
F 401.4 DX System Testing. For direct exchange (DX) systems, each u-bend shall be tested and proved tight with an inert gas at not less than 315 psi (2172 kPa) and maintained for 15 minutes without pressure drop. The pressure reading after tremie grouting of the boreholes shall be maintained in the ground-heat exchanger for not less than 2 hours, in accordance with CSA/IGSHPA C448.

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA/IGSHPA C448-2016</td>
<td>Design and Installation of Ground Source Heat Pump Systems for Commercial and Residential Buildings</td>
<td>Miscellaneous</td>
</tr>
</tbody>
</table>

SUBSTANTIATION:
This code change adds IGSHPA to the CSA C448 standard as it is a harmonized standard. Table 1701.2 already shows the standard correctly. This also correlates with the action taken by the USHGC Technical Committee.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 320
UMC 2024  Section: F 401.4

SUBMITTER: Cary Smith
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

F 401.0 Direct Exchange (DX) Systems.

F 401.4 DX System Testing. For direct exchange (DX) systems, each refrigerant u-bend shall be tested and proved tight with an inert gas at not less than 315 psi (2172 kPa) and maintained for 15 minutes without pressure drop. The pressure reading after tremie grouting of the boreholes shall be maintained in the ground-heat exchanger for not less than 2 hours, in accordance with CSA C448.

SUBSTANTIATION:
This change adds the term “refrigerant” to clarify which u-bend is being referred to. This also correlates with the action taken by the USHGC Technical Committee.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

COMMITTEE STATEMENT:
The Technical Committee agrees with the proposal but disagrees with the substantiation reference regarding the need for correlation with the USHGC.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 321
UMC 2024  Section: Appendix F

SUBMITTER: Cary Smith  
Sound Geothermal Corporation

RECOMMENDATION:
Revise text

APPENDIX F Chapter 17
GEOTHERMAL ENERGY SYSTEMS
(renumber remaining chapters)

SUBSTANTIATION:
Geothermal energy systems are commonly used. Therefore, requirements for these systems should be in the body of the UMC and not in the appendix. Appendices are only enforceable is adopted. Currently, there is no geothermal code in the U.S. Therefore, relocating Appendix F to Chapter 17 will aid users of the UMC and the Authority Having Jurisdiction in enforcing the installation requirement of geothermal energy systems.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  
AFFIRMATIVE: 29  NOT RETURNED: 1  Heine

EXPLANATION OF AFFIRMATIVE:

BALLANCO: While I am voting affirmative, I have concerns that still need to be addressed. Currently, the requirements in the Appendix have been extracted from the Uniform Solar, Hydronics, and Geothermal Code. There needs to be a correlation between the USHGC and the UMC. Who will be responsible for reviewing code changes? If two committees review the changes, how will the two codes be correlated? Also, there are definitions that only apply to geothermal systems. If these definitions are added to Chapter 2 there may be conflicts with other sections of the code. I think there needs to be a subcommittee that develops the complete proposal and method of correlating the requirements between the two codes.
Proposals

Item #: 322
UMC 2024  Section: Appendix G

SUBMITTER: IAPMO Staff - Update Extracts
NFPA 54 Extract Update

RECOMMENDATION:
Revise text

APPENDIX G
SIZING OF VENTING SYSTEMS AND OUTDOOR COMBUSTION AND VENTILATION OPENING DESIGN
(The content of this Appendix is based on Annex F and Annex I of NFPA 54)

G 101.0 General.
G 101.1 Applicability. This appendix provides general guidelines for sizing venting systems serving appliances equipped with draft hoods, Category I appliances, and appliances listed for use with Type B vents.

G 101.2 Examples Using Single Appliance Venting Tables. See Figure G 101.2(1) through Figure G 101.2(14).

(portion of figure not shown remains unchanged)
FIGURE G 101.2(1)
TYPE B DOUBLE-WALL VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A TYPE B DOUBLE-WALL VENT
[NFPA 54: FIGURE F.1(a)]

(portion of figure not shown remains unchanged)
FIGURE G 101.2(2)
TYPE B DOUBLE-WALL VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A SINGLE-WALL METAL VENT CONNECTOR
[NFPA 54: FIGURE F.1(b)]

(portion of figure not shown remains unchanged)
FIGURE G 101.2(3)
VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A MASONRY CHIMNEY AND A TYPE B DOUBLE-WALL VENT CONNECTOR
[NFPA 54: FIGURE F.1(c)]

(portion of figure not shown remains unchanged)
FIGURE G 101.2(4)
VENT SYSTEM SERVING A SINGLE APPLIANCE USING A MASONRY CHIMNEY AND A SINGLE-WALL METAL VENT CONNECTOR
[NFPA 54: FIGURE F.1(d)]

(portion of figure not shown remains unchanged)
G 101.3 Example 1: Single Draft Hood-Equipped Appliance. An installer has a 120 000 British thermal units per hour (Btu/h) (35 kW) input appliance with a 5 inch (127 mm) diameter draft hood outlet that needs to be vented into a 10 foot (3048 mm) high Type B vent system. What size vent should be used assuming: (1) a 5 foot (1524 mm) lateral single-wall metal vent connector is used with two 90 degree (1.57 rad) elbows or (2) a 5 foot (1524 mm) lateral single-wall metal vent connector is used with three 90 degree (1.57 rad) elbows in the vent system? (See Figure G 101.3)
Solution:
Table 803.1.2(2) should be used to solve this problem because single-wall metal vent connectors are being used with a Type B vent, as follows:

(1) Read down the first column in Table 803.1.2(2) until the row associated with a 10 foot (3048 mm) height and 5 foot (1524 mm) lateral is found. Read across this row until a vent capacity greater than 120 000 Btu/h (35 kW) is located in the shaded columns labeled NAT Max for draft hood-equipped appliances. In this case, a 5 inch (127 mm) diameter vent has a capacity of 122 000 Btu/h (35.7 kW) and can be used for this application.

(2) If three 90 degree (1.57 rad) elbows are used in the vent system, the maximum vent capacity listed in the tables must be reduced by 10 percent. This implies that the 5 inch (127 mm) diameter vent has an adjusted capacity of only 110 000 Btu/h (32 kW). In this case, the vent system must be increased to 6 inches (152 mm) in diameter. See the following calculations:

\[
122 000 \text{ Btu/h (35.7 kW)} \times 0.90 = 110 000 \text{ Btu/h (32 kW)} \quad \text{for 5 inch (127 mm) vent}
\]

From Table 803.1.2(2), select 6 inches (152 mm) vent.

\[
186 000 \text{ Btu/h (54.5 kW)} \times 0.90 = 167 000 \text{ Btu/h (49 kW)}
\]

This figure is greater than the required 120 000 Btu/h (35 kW). Therefore, use a 6 inch (152 mm) vent and connector where three elbows are used. \[NFPA 54:F.1.1\]

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**G 101.4 Example 2: Single Fan-Assisted Appliance.** An installer has an 80 000 Btu/h (23.4 kW) input fan-assisted appliance that must be installed using 10 feet (3048 mm) of lateral connector attached to a 30 foot (9144 mm) high Type B vent. Two 90-degree (1.57 rad) elbows are needed for the installation. Can a single-wall metal vent connector be used for this application? (See Figure G 101.4)

Solution:
Table 803.1.2(2) refers to the use of single-wall metal vent connectors with Type B vent. In the first column find the row associated with a 30 foot (9144 mm) height and a 10 foot (3048 mm) lateral. Read across this row, looking at the FAN Min and FAN Max columns, to find that a 3 inch (76 mm) diameter single-wall metal vent connector is not recommended. Moving to the next larger size single-wall connector [4 inch (102 mm)] we find that a 4 inch (102 mm) diameter single-wall metal connector has a recommended minimum vent capacity of 91 000 Btu/h (26.7 kW) and a recommended maximum vent capacity of 144 000 Btu/h (42 kW). The 80 000 Btu/h (23.4 kW) fan-assisted appliance is outside this range, so the conclusion is that a single-wall metal vent connector cannot be used to vent this appliance using 10 feet (3048 mm) of lateral for the connector. However, if the 80,000 Btu/h (23.4 kW) input appliance could be moved to within 5 feet (1524 mm) of the vertical vent, a 4 inch (102 mm) single-wall metal connector could be used to vent the appliance. Table 803.1.2(2) shows the acceptable range of vent capacities for a 4 inch (102 mm) vent with 5 feet (1524 mm) of lateral to be between 72 000 Btu/h (21.1 kW) and 157 000 Btu/h (46 kW).

If the appliance cannot be moved closer to the vertical vent, a Type B vent could be used as the connector material. In this case, Table 803.1.2(1) shows that, for a 30 foot (9144 mm) high vent with 10 feet (3048 mm) of lateral, the acceptable range of vent capacities for a 4 inch (102 mm) diameter vent attached to a fan-assisted appliance is between 37 000 Btu/h (10.8 kW) and 150 000 Btu/h (44 kW). \[NFPA 54:F.1.2\]

---

(portion of figure not shown remains unchanged)
G 101.5 Example 3: Interpolating Between Table Values. An installer has an 80 000 Btu/h (23.4 kW) input appliance with a 4 inch (102 mm) diameter draft hood outlet that needs to be vented into a 12 foot (3658 mm) high Type B vent. The vent connector has a 5 foot (1524 mm) lateral length and is also Type B. Can this appliance be vented using a 4 inch (102 mm) diameter vent?

Solution:
Table 803.1.2(1) is used in the case of an all Type B Vent system. However, Table 803.1.2(1) does not have an entry for a height of 12 feet (3658 mm), and interpolation must be used. Read down the 4 inch (102 mm) diameter NAT Max column to the row associated with 10 foot (3048 mm) height and 5 foot (1524 mm) lateral to find the capacity value of 77 000 Btu/h (22.6 kW). Read further down to the 15 foot (4572 mm) height, 5 foot (1524 mm) lateral row to find the capacity value of 87 000 Btu/h (25.5 kW). The capacity for a vent system with a 12 foot (3658 mm) height is equal to the capacity for a 10 foot (3048 mm) height plus two-fifths of the difference between the 10 foot (3048 mm) and 15 foot (4572 mm) height values, or 77 000 Btu/h (22.6 kW) + \( \frac{2}{5} \times 10 000 \text{ Btu/h} \) (3 kW) = 81 000 Btu/h (23.7 kW). Therefore, a 4 inch (102 mm) diameter vent can be used in the installation. [NFPA 54:F.1.3]

G 102.0 Examples Using Common Venting Tables.

G 102.1 Example 4: Common Venting Two Draft Hood-Equipped Appliances. A 35 000 Btu/h (10.3 kW) water heater is to be common vented with a 150 000 Btu/h (44 kW) furnace, using a common vent with a total height of 30 feet (9144 mm). The connector rise is 2 feet (610 mm) for the water heater with a horizontal length of 4 feet (1219 mm). The connector rise for the furnace is 3 feet (914 mm) with a horizontal length of 8 feet (2438 mm). Assume single-wall metal connectors will be used with Type B vent. What size connectors and combined vent should be used in this installation? (See Figure G 102.1)

Solution:
Table 803.2(2) should be used to size single-wall metal vent connectors attached to Type B vertical vents. In the vent connector capacity portion of Table 803.2(2), find the row associated with a 30 foot (9144 mm) vent height. For a 2 foot (610 mm) rise on the vent connector for the water heater, read the shaded columns for draft hood-equipped appliances to find that a 3 inch (76 mm) diameter vent connector has a capacity of 37 000 Btu/h (10.8 kW). Therefore, a 3 inch (76 mm) single-wall metal vent connector can be used with the water heater. For a draft hood-equipped furnace with a 3 foot (914 mm) rise, read across the appropriate row to find that a 5 inch (127 mm) diameter vent connector has a maximum capacity of 120 000 Btu/h (35 kW) (which is too small for the furnace), and a 6 inch (152 mm) diameter vent connector has a maximum vent capacity of 172 000 Btu/h (50 kW). Therefore, a 6 inch (152 mm) diameter vent connector should be used with the 150 000 Btu/h (44 kW) furnace. Because both vent connector horizontal lengths are less than the maximum lengths listed in Section 803.2.1, the table values can be used without adjustments.

In the common vent capacity portion of Table 803.2(2), find the row associated with a 30 foot (9144 mm) vent height and read over to the NAT + NAT portion of the 6 inch (152 mm) diameter column to find a maximum combined capacity of 257 000 Btu/h (75 kW). Since the two appliances total only 185 000 Btu/h (54 kW), a 6 inch (152 mm) common vent can be used. [NFPA 54:F.2.1]

G 102.2 Example 5(a): Common Venting a Draft Hood-Equipped Water Heater with a Fan-Assisted Furnace into a Type B Vent. In this case, a 35 000 Btu/h (10.3 kW) input draft hood-equipped water heater with a 4 inch (102 mm) diameter draft hood outlet, 2 feet (610 mm) of connector rise, and 4 feet (1219 mm) of horizontal length is to be common vented with a 100 000 Btu/h (29 kW) fan-assisted furnace with a 4 inch (102 mm) diameter flue collar, 3 feet (914 mm) of connector rise, and 6 feet (1829 mm) of horizontal length. The common vent consists of a 30 foot (9144 mm) height of Type B vent. What are the recommended vent diameters for each connector and the common vent? The installer would like to use a single-wall metal vent connector. (See Figure G 102.2)

Solution:
Water Heater Vent Connector Diameter. Since the water heater vent connector horizontal length of 4 feet (1219 mm) is less than the maximum value listed in Table 803.2(2), the venting table values can be used without adjustments. Using the Vent Connector Capacity portion of Table 803.2(2), read down the Total Vent Height (H) column to 30 feet (9144 mm) and read across the 2 feet (610 mm) Connector Rise (R) row to the first Btu/h rating in the NAT Max column that is equal to or greater than the water heater input rating. The table shows that a 3 inch (76 mm) vent connector has a
maximum input rating of 37 000 Btu/h (10.8 kW). Although this rating is greater than the water heater input rating, a 3 inch (76 mm) vent connector is prohibited by Section 803.2.18. A 4 inch (102 mm) vent connector has a maximum input rating of 67 000 Btu/h (19.6 kW) and is equal to the draft hood outlet diameter. A 4 inch (102 mm) vent connector is selected. Since the water heater is equipped with a draft hood, there are no minimum input rating restrictions.

Furnace Vent Connector Diameter. Using the Vent Connector Capacity portion of Table 803.2(2), read down the Total Vent Height \((H)\) to 30 feet (9144 mm) and across this row to the first Btu/h (R) row. Because the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating greater than the furnace input rating. The 4 inch (102 mm) vent connector has a maximum input rating of 119 000 Btu/h (34.9 kW) and a minimum input rating of 85 000 Btu/h (24.9 kW).

The 100 000 Btu/h (29 kW) furnace in this example falls within this range, so a 4 inch (102 mm) connector is adequate. Because the furnace vent connector horizontal length of 6 feet (1829 mm) is less than the maximum value listed in Section 803.2.1, the venting table values can be used without adjustment. If the furnace had an input rating of 80 000 Btu/h (23.4 kW), a Type B vent connector would be needed in order to meet the minimum capacity limit.

Common Vent Diameter. The total input to the common vent is 135 000 Btu/h (40 kW). Using the Common Vent Capacity portion of Table 803.2(2), read down the Total Vent Height \((H)\) to 30 feet (9144 mm) and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu/h rating equal to or greater than 135 000 Btu/h (39 kW) and the 5 inch (127 mm) common vent has a capacity of 202 000 Btu/h (59 kW). Therefore, the 5 inch (127 mm) common vent should be used in this example.

Summary: In this example, the installer can use a 4 inch (102 mm) diameter, single-wall metal vent connector for the water heater and a 4 inch (102 mm) diameter, single-wall metal vent connector for the furnace. The common vent should be a 5 inch (127 mm) diameter Type B vent. [NFPA 54:F.2.2]

G 102.4 Example 5(c): Common Venting into an Exterior Masonry Chimney. In this case, the water heater and fan-assisted furnace of Example 5(a) are to be common-vented into a claytile-lined masonry chimney with a 30 foot (9144 mm) height. The chimney is not exposed to the outdoors below the roof line. The internal dimensions of the clay tile liner are nominally 8 inches (203 mm) by 12 inches (305 mm). Assuming the same vent connector heights, laterals, and materials found in Example 5(a), what are the recommended vent connector diameters, and is this an acceptable installation?

Solution:

Table 803.2(4) is used to size common venting installations involving single-wall connectors into masonry chimneys.

Water Heater Vent Connector Diameter. Using Table 803.2(4), Vent Connector Capacity, read down the Total Vent Height \((H)\) column to 30 feet (9144 mm), and read across the 2 feet (610 mm) Connector Rise \((R)\) row to the first Btu/h rating in the NAT Max column that is equal to or greater than the water heater input rating. The table shows that a 3 inch (76 mm) vent connector has a maximum input of only 31 000 Btu/h (9 kW), while a 4 inch (102 mm) vent connector has a maximum input of 57 000 Btu/h (16.7 kW). A 4 inch (102 mm) vent connector must therefore be used.

Furnace Vent Connector Diameter. Using the Vent Connector Capacity portion of Table 803.2(4), read down the Total Vent Height \((H)\) column to 30 feet (9144 mm) and across the 3 feet (914 mm) Connector Rise \((R)\) row. Because the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating greater than the furnace input rating. The 4 inch (102 mm) vent connector has a maximum input rating of 127 000 Btu/h (37 kW) and a minimum input rating of 95 000 Btu/h (27.8 kW). The 100 000 Btu/h (29 kW) furnace in this example falls within this range, so a 4 inch (102 mm) connector is adequate.

Masonry Chimney. From Table G 102.3, the Equivalent Area for a Nominal Liner size of 8 inches (203 mm) by 12 inches (305 mm) is 63.6 of a square inches (0.041 m²). Using Table 803.2(4), Common Vent Capacity, read down the FAN + NAT column under the Minimum Internal Area of Chimney value of 63 to the row for 30 foot (9144 mm) height to find a capacity value of 739 000 Btu/h (217 kW). The combined input rating of the furnace and water heater, 135 000 Btu/h (39 kW), is less than the table value so this is an acceptable installation.

Section 803.2.17 requires the common vent area to be no greater than seven times the smallest listed appliance categorized vent area, flue collar area, or draft hood outlet area. Both appliances in this installation have 4 inch (102 mm) diameter outlets. From Table G 102.3, the equivalent area for an inside diameter of 4 inches (102 mm) is 12.2 of a square inches (0.008 m²). Seven times 12.2 equals 85.4, which is greater than 63.6, so this configuration is acceptable. [NFPA 54:F.2.3]
assisted furnace of Examples 5(a) and 5(b) are to be common-vented into an exterior masonry chimney. The chimney height, clay-tile-liner dimensions, and vent connector heights and laterals are the same as in Example 5(b). This system is being installed in Charlotte, North Carolina. Does this exterior masonry chimney need to be relined? If so, what corrugated metallic liner size is recommended? What vent connector diameters are recommended? [See Table G 102.3 and Figure 803.1.2(6)]

Solution:

According to Section 803.2.20, Type B vent connectors are required to be used with exterior masonry chimneys. Use Table 803.2(8) and Table 803.2(9) to size FAN+NAT common venting installations involving Type-B double-wall connectors into exterior masonry chimneys.

The local 99 percent winter design temperature needed to use Table 803.2(8) and Table 803.2(9) can be found in ASHRAE Handbook – Fundamentals. For Charlotte, North Carolina, this design temperature is 19°F (-7.2°C).

Chimney Liner Requirement. As in Example 5(b), use the 63 square inch (0.04 m²) internal area columns for this size clay tile liner. Read down the 63 square inches (0.04 m²) column of Table 803.2(8) to the 30 foot (9144 mm) height row to find that the combined appliance maximum input is 747 000 Btu/h (218.9 kW). The combined input rating of the appliances in this installation, 135 000 Btu/h (40 kW), is less than the maximum value, so this criterion is satisfied. Table 803.2(9), at a 19°F (-7.2°C) design temperature, and at the same vent height and internal area used earlier, shows that the minimum allowable input rating of a space-heating appliance is 470 000 Btu/h (137.7 kW). The furnace input rating of 100 000 Btu/h (29 kW) is less than this minimum value. So this criterion is not satisfied, and an alternative venting design needs to be used, such as a Type B vent shown in Example 5(a) or a listed chimney liner system shown in the remainder of the example.

According to Section 803.2.19, Table 803.2(1) or Table 803.2(2) is used for sizing corrugated metallic liners in masonry chimneys, with the maximum common vent capacities reduced by 20 percent. This example will be continued assuming Type B vent connectors.

Water Heater Vent Connector Diameter. Using Table 803.2(1) Vent Connector Capacity, read down the total Vent Height (H) column to 30 feet (9144 mm), and read across the 2 feet (610 mm) Connector Rise (R) row to the first Btu/hour rating in the NAT Max column that is equal to or greater than the water heater input rating. The table shows that a 3 inch (76 mm) vent connector has a maximum capacity of 39 000 Btu/h (11.4 kW). Although this rating is greater than the water heater input rating, a 3 inch (76 mm) vent connector is prohibited by Section 803.2.20. A 4 inch (102 mm) vent connector has a maximum input rating of 70 000 Btu/h (20.5 kW) and is equal to the draft hood outlet diameter. A 4 inch (102 mm) vent connector is selected.

<table>
<thead>
<tr>
<th>TABLE G 102.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>MASONRY CHIMNEY LINER DIMENSIONS WITH CIRCULAR EQUIVALENTS*</td>
</tr>
<tr>
<td>[NFPA 54: TABLE F.2.3]</td>
</tr>
<tr>
<td>(portion of table not shown remains unchanged)</td>
</tr>
</tbody>
</table>

Furnace Vent Connector Diameter. Using Table 803.2(1), Vent Connector Capacity, read down the total Vent Height (H) column to 30 feet (9144 mm), and read across the 3 feet (914 mm) Connector Rise (R) row to the first Btu/h rating in the FAN MAX column that is equal to or greater than the furnace input rating. The 100 000 Btu/h (29 kW) furnace in this example falls within this range, so a 4 inch (102 mm) connector is adequate.

Chimney Liner Diameter. The total input to the common vent is 135 000 Btu/h (40 kW). Using the Common Vent Capacity portion of Table 803.2(1), read down the total Vent Height (H) column to 30 feet (9144 mm) and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu/h rating greater than 135 000 Btu/h (40 kW). The 4 inch (102 mm) common vent has a capacity of 138 000 Btu/h (40.4 kW). Reducing the maximum capacity by 20 percent results in a maximum capacity for a 4 inch (102 mm) corrugated liner of 110 000 Btu/h (32 kW), less than the total input of 135 000 Btu/h (40 kW). So a larger liner is needed. The 5 inch (127 mm) common vent capacity listed in Table 803.2(1) is 210 000 Btu/h (62 kW), and after reducing by 20 percent is 168 000 Btu/h (49.2 kW). Therefore, a 5 inch (127 mm) corrugated metal liner should be used in this example.

Single Wall Connectors. Once it has been established that relining the chimney is necessary, Type B double-wall vent connectors are not specifically required. This example could be redone using Table 803.2(2) for single-wall vent connectors. For this case, the vent connector and liner diameters would be the same as found for Type B double-wall connectors. [NFPA 54: F.2.4]

G 103.0 Example of Combination Indoor and Outdoor Combustion Air Opening Design. Determine the required combination of indoor and outdoor combustion air opening sizes for the following appliance installation example.

Example Installation: A fan-assisted furnace and a draft hood-equipped water heater with the following inputs are located in a 15 foot by 30 foot (4572 mm by 9144 mm) basement with an 8 foot (2438 mm) ceiling. No additional indoor spaces can be used to help meet the appliance combustion air needs.
Fan-Assisted Furnace Input: 100 000 Btu/h (29 kW)

Draft Hood-Equipped Water Heater Input: 40 000 Btu/h (11.7 kW)  

Solution:
(1) Determine the total available room volume.
   Appliance room volume.
   15 feet by 30 feet (4572 mm by 9144 mm) with an 8 foot (2438 mm) ceiling = 3600 cubic feet (101.94 m³)

(2) Determine the total required volume.
   The Standard Method to determine combustion air is used to calculate the required volume.
   The combined input for the appliances located in the basement is calculated as follows:
   100 000 Btu/h (29 kW) + 40 000 Btu/h (11.7 kW) = 140 000 Btu/h (41 kW)
   The Standard Method requires that the required volume be determined based on 50 cubic feet per 1000 Btu/h (4.83 m³/kW).
   Using Table G 103.0 the required volume for a 140 000 Btu/h (41 kW) water heater combined input is 7000 cubic feet (198.22 m³).

Conclusion:
The indoor volume is insufficient to supply combustion air since the total of 3600 cubic feet (101.94 m³) does not meet the required volume of 7000 cubic feet (198.22 m³). Therefore, additional combustion air must be provided from the outdoors.

(3) Determine the ratio of the available volume to the required volume:

\[
\frac{3600 \text{ cubic feet}}{7000 \text{ cubic feet}} = 0.51
\]

(4) Determine the reduction factor to be used to reduce the full outdoor air opening size to the minimum required based on ratio of indoor spaces:

\[1.00 - 0.51 \text{ (from Step 3)} = 0.49\]

(5) Determine the single outdoor combustion air opening size as though all combustion air is to come from outdoors. In this example, the combustion air opening directly communicates with the outdoors:

\[\frac{140 000 \text{ Btu/h}}{3000 \text{ British thermal units per square inch (Btu/in²)}} = 47 \text{ square inches (0.03 m²)}\]

(6) Determine the minimum outdoor combustion air opening area:

Outdoor opening area = 0.49 (from Step 4) x 47 square inches (0.03 m²)
   = 23 square inches (0.01 m²)
Section 701.7.3(3) requires the minimum dimension of the air opening should not be less than 3 inches (76 mm). [NFPA 54:1.1]

SUBSTANTIATION:
In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Appendix G is being revised to the latest edition of NFPA 54-2021.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 323
UMC 2024 Section: Appendix H, Table 1701.2

SUBMITTER: Julius Ballanco, P.E.
JB Engineering and Code Consulting, P.C.
Rep. Chair, UMC Legionella Task Group

RECOMMENDATION:
Add new text

APPENDIX H
IMPACT OF WATER TEMPERATURE ON THE POTENTIAL FOR LEGIONELLA GROWTH

Part I – General

H 101.0 General.
H 101.1 Applicability. Part I of this appendix provides guidelines on the impact of water temperature in minimizing Legionella growth potential associated with occupiable commercial, institutional, multi-unit residential, and industrial building mechanical systems. Legionella control for plumbing systems shall be in accordance with the plumbing code. This appendix shall not include single-family residential buildings. This appendix shall not be considered a risk management guidance document for scalding or Legionella.

Note: Published documents which address Legionella risk management include ASHRAE 188 or ASHRAE Guideline 12.
Published documents which address professional qualifications for Legionella risk assessment include ASSE Series 12000.

There are additional factors associated with the potential for scalding and Legionella growth other than temperature. For scalding potential, other factors include, but are not limited to, user age, health, body part, length of contact time, and water source.
For Legionella growth potential other factors include, but are not limited to, water source and plumbing system: size, design, circulation rate, water age, disinfectant residual, piping material and component complexity.

H 102.0 Definitions.
H 102.1 General. For the purpose of this appendix, the following definitions shall apply.
Biofilm. Microorganisms and the slime they secrete that grow on any continually moist surface.
Control. The management to maintain compliance with established criteria.
Disinfection. Chemical or physical control measures or procedures used to kill or inactivate pathogens.
Disinfection, Online. The procedure while the equipment is in operation.
Disinfection, Offline. The procedure while the equipment is not in operation.
Halogenation. A chemical reaction that involves the addition of one or more halogens, including, but not limited to, chlorine, bromine, or iodine, commonly used to disinfect water systems.
Hazard. See Risk.
Legionella Concentrations. The extent of colonization of Legionella measured in Colony Forming Units per milliliter (CFU/mL).
Legionella Growth Potential. The likelihood that Legionella bacteria will reproduce.
Monitor. Observing and checking the progress or quality of (something) or measuring the physical and chemical characteristics of control measures.
Nutrient. Any element or compound essential as a raw material for an organism’s growth and development.
Risk. The potential to cause harm resulting from exposure.
Test. The measurement of the physical, chemical, or microbial characteristics or quality of water.
**Water Management Plan.** A comprehensive risk management plan for controlling Legionella growth in building water systems.

**H 103.0 Building Water Systems and System Equipment Documentation.**
**H 103.1 Design Documentation.** Construction documents shall be required for new construction, renovation, refurbishment, replacement, or repurposing of an occupiable building water system, including a water management plan, and shall be submitted to the Authority Having Jurisdiction.
**H 103.2 Onsite Documentation.** Documentation shall be maintained onsite and shall be readily accessible to the Authority Having Jurisdiction.

**H 104.0 Potential Exposure.**
**H 104.1 Legionella Growth Potential.** The Authority Having Jurisdiction shall have the authority to require documentation to address Legionella growth potential, where water temperatures in a water system are within ranges shown in Figure H 104.1 that pose a Legionella growth potential.
**H 104.2 Scald Potential.** Where the water system’s temperature(s) range pose(s) a scald potential, protection shall be provided in accordance with the plumbing code.

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**FIGURE H 104.1**
WATER TEMPERATURE RANGES AND LEGIONELLA GROWTH POTENTIAL*

For SI units: °C = (°F-32)/1.8

* Temperature ranges reported are experimentally determined in a laboratory setting in the absence of a realistic microbial community. Legionella can survive for longer periods of time at temperatures higher and lower than the growth temperature ranges indicated due to changes in their metabolic state and/or protection from thermal disinfection within biofilm or amoeba host organisms.

**H 105.0 Disinfection.**
**H 105.1 Disinfection Documentation.** Where required by the Authority Having Jurisdiction, documentation for disinfection of building mechanical systems shall be provided by the registered design professional in the construction documents.
**H 105.1.1 Copper-Silver Ionization.** Copper-silver ionization methods and procedures shall include the following documentation:
(1) Copper and silver ionization concentrations.
(2) Methods and documentation for monitoring ion levels.
(3) Electrode cleaning cycles and methods.
**H 105.1.2 Ultraviolet Light.** Ultraviolet light methods shall include the following documentation:
(1) Locations of ultraviolet light units.
(2) Cleaning cycles and methods of the quartz sleeves and housing.
**H 105.2 Chemical Disinfection.** Chemical biocide treatment shall be permitted to be used in accordance with the following:
(1) Oxidizing biocides in accordance with manufacturer’s guidelines.
(2) Non-oxidizing biocides in accordance with manufacturer’s guidelines.
Alternating the use of different types of biocides, dose, and frequency is recommended.

These treatment methods can be used for continuous, online disinfection or shock treatment online or offline.

**H 105.3 Non-Chemical Treatment.** Non-chemical treatment devices shall be permitted to be used in accordance with manufacturer’s guidelines.

**H 105.3.1 Thermal Shock.** Thermal treatment using heat shock at 158°F (70°C) for 30 minutes shall be permitted in accordance with applicable guidelines and the manufacturer’s instructions.

**H 105.3.2 Physical Cleaning.** When implemented, physical cleaning shall only be performed as an offline method and shall be performed before the chemical disinfection methods in Section 105.1 have been performed. Building outdoor air intakes shall be closed during physical cleaning prior to commencing. Physical cleaning shall be in accordance with the manufacturer’s instructions.

**H 105.4 Inspection and Maintenance.** The system shall be monitored and maintained to prevent scale buildup, sediment, corrosion, and biofouling.

**H 105.5 Frequency of Cleaning and Disinfection.** Where a water management plan is implemented, the frequency of cleaning and disinfection logs shall be readily accessible to the water management team and the Authority Having Jurisdiction.

**H 105.6 Control Measures.** Evaluation of control measures for Legionella shall consider potential unintended consequences of such measures that may affect overall health risk, including the formation of toxic disinfection byproducts (whether regulated or unregulated), resultant increase in other plumbing-associated pathogens, and scalding.

**Part II – Minimizing Legionella Growth Potential in Cooling Towers and Other Mechanical Systems.**

**H 201.0 General.**

**H 201.1 Applicability.** Part II of this appendix applies to water sources that frequently provide optimal conditions for growth of Legionella organisms in accordance with Figure H 104.1, including, but not limited to, cooling towers, evaporative condensers, decorative water features, filters, ice makers, evaporative air coolers, fluid coolers that use evaporation to reject heat, industrial processes that use water to remove excess heat, industrial and municipal waste treatment plants, and other mechanical systems.

**H 201.2 Water Management Plan, Where Required.** A water management plan shall be established when required by the criteria of the Authority Having Jurisdiction.

**H 201.3 Water Management Plan, Where Implemented.** Where a water management plan is implemented, the plan shall be in accordance with the following;

1. Determine a water management plan team.
2. Provide description of the building’s water system.
3. Identify areas of Legionella growth potential in accordance with temperature ranges as shown in Figure H 104.1.
4. Determine applicable control measures and monitoring procedures.
5. Ensure the water management plan is effective and operating as designed.
6. Document and communicate all the activities of the water management plan.

**H 201.4 Water Sampling.** An analysis of water samples from a source capable of being contaminated with Legionella bacteria shall be performed as required by the Authority Having Jurisdiction to determine the number of organisms present in Colony Forming Units per milliliter (CFU/mL) of Legionella in the sample. The minimum remediation action shall be in accordance with Table H 201.5 and Figure H 201.5.

**H 201.5 Legionella Test Levels.** A means of controlling Legionella shall be established in accordance with applicable levels as stated in Section H 201.5.1 through Section H 201.5.4.

**H 201.5.1 Levels Less than 10 CFU/ML.** Water samples containing Legionella levels less than 10 CFU/mL shall be permitted to maintain the established water treatment plan in accordance with Table H 201.5.

**H 201.5.2 Levels Between 10 CFU/ML and 100 CFU/ML.** Water samples containing Legionella levels greater than 10 CFU/mL but less than 100 CFU/mL shall require the water treatment plan to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5.

**H 201.5.3 Levels Between 100 CFU/ML and 1000 CFU/ML.** Water samples containing Legionella levels greater than 100 CFU/mL but less than 1,000 CFU/mL shall require the water treatment plan to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5. Prepare to execute emergency response plan in case Legionella levels reach over 1000 CFU/mL in accordance with H 202.14.

**H 201.5.4 Levels Greater than 1000 CFU/ML.** Water samples containing Legionella levels greater than 1,000 CFU/mL shall require the water treatment plan to be reviewed, notify Authority Having Jurisdiction, institute immediate online disinfection, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5.
### TABLE H 201.5
LEGIONELLA REMEDIATION ACTIONS FOR COOLING TOWERS

<table>
<thead>
<tr>
<th>LEGIONELLA CONCENTRATIONS IN COLONY FORMING UNITS (CFU/mL)</th>
<th>REMEDIATION ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>Maintain the established water treatment plan.</td>
</tr>
<tr>
<td>/=10 and &lt;100</td>
<td>Review water treatment plan, institute immediate online decontamination, and retest water 3 to 7 days after decontamination.</td>
</tr>
<tr>
<td>/=100 and &lt;1000</td>
<td>Review water treatment plan, institute immediate online decontamination, and retest water 3 to 7 days after decontamination. Prepare to execute emergency response plan in case Legionella levels reach over 1000 CFU/mL. *The emergency response plan for cooling towers is addressed in Section H 202.14.</td>
</tr>
<tr>
<td>/=1000</td>
<td>Review water treatment plan, notify Authority Having Jurisdiction (if required), institute immediate online disinfection, and retest water 3 to 7 days after decontamination. If retest /=1000 CFU/mL, repeat system decontamination.</td>
</tr>
</tbody>
</table>

H 201.6 **Air Sampling.** Air sampling for Legionella shall not be used as a means of measuring potential Legionella exposure.

H 202.0 **Cooling Towers.**

H 202.1 **General.** Cooling towers shall be installed, maintained, and tested as required by this Appendix and the Authority Having Jurisdiction.

H 202.2 **Risk Factors.** The following risk factors shall be identified, assessed, controlled, and monitored:
1. Stagnant water due to dead legs, intermittent operation, or seasonal usage.
2. The presence of nutrients or biofilm.
3. Water temperature within a range that supports microbial growth as specified in Figure H 104.1.
4. Water exposed to direct sunlight which promotes algae growth.
5. Water quality, including, but not limited to, the following factors:
   a. System cleanliness
   b. pH levels
   c. Presence of corrosion
   d. Presence of scale and biofouling
   e. Conductivity levels
   f. Dissolved and suspended solids
   g. Control of water treatment chemicals
   h. Control of bleed-off or blowdown
6. System size
7. Physical condition of system
8. Aerosol generation, dispersion, and drift elimination
9. System site location
10. Access for inspection, cleaning, and maintenance
11. Concentration of Legionella as specified in Table H 201.5.

H 202.3 **Water Temperature.** The system shall be designed to maintain low sump-water operating temperatures.

H 202.4 **Drift Eliminators.** Drift eliminators shall be installed in accordance with Section 1126.0, Section E 403.2, and Section E 403.5.1; and shall be accessible to allow inspection, maintenance, and cleaning of internal components.

H 202.5 **Side Stream Filtration.** When suspended solids are visible in the cooling tower water system, side stream filtration shall be permitted to be used to control suspended solids in cooling tower circulating water. Makeup water quality, design of cooling tower fill, recirculation rate, and total system volume shall be included in the design of such equipment.

H 202.6 **Equipment Site Location.** The site location of new or replacement open- or closed-circuit cooling towers or evaporative condensers shall be in accordance with the following:
1. Shall not be located where contamination from building systems or facility processes can be drawn into the equipment. Equipment shall be installed no less than 10 feet (3048 mm) away from building exhaust or plumbing vents.
2. Shall not be located where equipment discharges into occupied spaces, roadways, walkways, outdoor air intakes, and building openings. Equipment shall be installed no less than 10 feet (3048 mm) away from building intakes or plumbing vents.

H 202.7 **System Commissioning.** System commissioning shall include procedures for cleaning of the cooling system. Ongoing water treatment in accordance with Section H 201.5 shall be initiated once the system is charged with water.

H 202.8 **System Start-Up and Shutdown.** System start-up and shutdown procedures shall include, but not be limited to the following:
hed in accordance with Table H 203.6.

Table H 203.6

<table>
<thead>
<tr>
<th>Part</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 203.3</td>
<td>Water Softeners</td>
</tr>
<tr>
<td>H 203.4</td>
<td>Dehumidifiers</td>
</tr>
<tr>
<td>H 203.5</td>
<td>Misters, Atomizers, Air Washers, Nebulizers, and Humidifiers</td>
</tr>
</tbody>
</table>

Dehumidifiers shall be maintained in accordance with ASHRAE 188 and the manufacturer’s instructions.

Misters, atomizers, air washers, nebulizers, and humidifiers shall be disinfected in accordance with ASHRAE 188. The minimum remediation action for humidifiers shall be in accordance with Table H 203.6.
### TABLE H 203.6
LEGIONELLA REMEDIATION ACTIONS IN HUMIDIFIERS

<table>
<thead>
<tr>
<th>LEGIONELLA CONCENTRATIONS IN COLONY FORMING UNITS (CFU/mL)</th>
<th>REMEDIATION ACTION</th>
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<td>( \geq 1) and &lt;10</td>
<td>Prompt cleaning and/or biocide treatment of the system.</td>
</tr>
<tr>
<td>( \geq 10 )</td>
<td>Immediate cleaning and/or biocide treatment. Take prompt steps to prevent employee exposure.</td>
</tr>
</tbody>
</table>

### H 203.7 Evaporative Air Coolers.
Evaporative air coolers shall be completely drained and cleaned in accordance with the manufacturer’s instructions. When not in use, evaporative air coolers shall be completely drained.

### H 203.8 Ice Machines.
Ice machines not used for human consumption shall be flushed and maintained in accordance with ASHRAE 188.

### H 203.9 Spas and Hot Tubs.
Spas and hot tubs shall be maintained and tested in accordance with ASHRAE Guideline 12 and cleaned and disinfected in accordance with the manufacturer’s recommendations.

### H 203.10 Decorative Water Features.
Decorative water features shall be maintained in accordance with ASHRAE 188. Decorative water features shall be drained, cleaned, and disinfected in accordance with the manufacturer’s instructions and the Authority Having Jurisdiction.

### H 203.11 Water Supply Systems.
The minimum remediation action for water supply systems shall be in accordance with the plumbing code.

### TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

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<td>Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)</td>
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<tr>
<td>ASSE Series 12000-2018</td>
<td>Infection Control Risk Assessment for All Building Systems</td>
<td>Risk Management</td>
</tr>
</tbody>
</table>

(portion of table not shown remains unchanged)

### SUBSTANTIATION:
The purpose of the new Appendix H is to establish minimum Legionellosis risk management requirements for building mechanical systems. Cooling towers’ potential for spreading Legionella bacteria is especially pressing given the associated diseases’ symptomatic similarities to COVID-19 and the propensity they have for exacerbating respiratory illnesses.

### COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC
Amend proposal as follows:

#### APPENDIX H
IMPACT OF WATER TEMPERATURE ON THE POTENTIAL FOR LEGIONELLA GROWTH

Part I – General

### H 101.0 General.
### H 101.1 Applicability.
Part I of this appendix provides guidelines on the impact of water temperature in minimizing Legionella growth potential associated with occupiable commercial, institutional, multi-unit residential, and industrial building mechanical systems. Legionella control for plumbing systems shall be in accordance with the plumbing code.

This appendix shall not include single-family residential buildings. This appendix shall not be considered a risk management guidance document for scalding or Legionella.

### Note: Published documents which address Legionella risk management include ASHRAE 188 or ASHRAE Guideline 12.
Published documents which address professional qualifications for Legionella risk assessment include ASSE Series 12000.
There are additional factors associated with the potential for scalding and Legionella growth other than temperature.
For scalding potential, other factors include, but are not limited to, user age, health, body part, length of contact time, and water source.

For Legionella growth potential other factors include, but are not limited to, water source and plumbing system: size, design, circulation rate, water age, disinfectant residual, piping material and component complexity.

**H 102.0 Definitions.**

**H 102.1 General.** For the purpose of this appendix, the following definitions shall apply.

**Biofilm.** Microorganisms and the slime they secrete that grow on any continually moist surface.

**Control.** The management to maintain compliance with established criteria.

**Disinfection.** Chemical or physical control measures or procedures used to kill or inactivate pathogens.

- **Disinfection, Online.** The procedure while the equipment is in operation.
- **Disinfection, Offline.** The procedure while the equipment is not in operation.

**Halogenation.** A chemical reaction that involves the addition of one or more halogens, including, but not limited to, chlorine, bromine, or iodine, commonly used to disinfect water systems.

**Hazard.** See Risk.

**Legionella Concentrations.** The extent of colonization of Legionella measured in Colony Forming Units per milliliter (CFU/mL).

**Legionella Growth Potential.** The likelihood that Legionella bacteria will reproduce.

**Monitor.** Observing and checking the progress or quality of (something) or measuring the physical and chemical characteristics of control measures.

**Nutrient.** Any element or compound essential as a raw material for an organism’s growth and development.

**Risk.** The potential to cause harm resulting from exposure.

**Test.** The measurement of the physical, chemical, or microbial characteristics or quality of water.

**Water Management Plan.** A comprehensive risk management plan for controlling Legionella growth in building water systems.

**H 103.0 Building Water Systems and System Equipment Documentation.**

**H 103.1 Design Documentation.** Construction documents shall be required for new construction, renovation, refurbishment, replacement, or repurposing of an occupiable building water system, including a water management plan, and shall be submitted to the Authority Having Jurisdiction.

**H 103.2 Onsite Documentation.** Documentation shall be maintained onsite and shall be readily accessible to the Authority Having Jurisdiction.

**H 104.0 Potential Exposure.**

**H 104.1 Legionella Growth Potential.** The Authority Having Jurisdiction shall have the authority to require documentation to address Legionella growth potential, where water temperatures in a water system are within ranges shown in Figure H 104.1 that pose a Legionella growth potential.

**H 104.2 Scald Potential.** Where the water system’s temperature(s) range pose(s) a scald potential, protection shall be provided in accordance with the plumbing code.

**FIGURE H 104.1 WATER TEMPERATURE RANGES AND LEGIONELLA GROWTH POTENTIAL**

For SI units: °C = (°F-32)/1.8
Temperature ranges reported are experimentally determined in a laboratory setting in the absence of a realistic microbial community. Legionella can survive for longer periods of time at temperatures higher and lower than the growth temperature ranges indicated due to changes in their metabolic state and/or protection from thermal disinfection within biofilm or amoeba host organisms.

H 105.0 Disinfection.
H 105.1 Disinfection Documentation. Where required by the Authority Having Jurisdiction, documentation for disinfection of building mechanical systems shall be provided by the registered design professional in the construction documents.
H 105.1.1 Copper-Silver Ionization. Copper-silver ionization methods and procedures shall include the following documentation.
(1) Copper and silver ionization concentrations.
(2) Methods and documentation for monitoring ion levels.
(3) Electrode cleaning cycles and methods.
H 105.1.2 Ultraviolet Light. Ultraviolet light methods shall include the following documentation:
(1) Locations of ultraviolet light units.
(2) Cleaning cycles and methods of the quartz sleeves and housing.
H 105.2 Chemical Disinfection. Chemical biocide treatment shall be permitted to be used in accordance with the following:
(1) Oxidizing biocides in accordance with manufacturer’s guidelines.
(2) Non-oxidizing biocides in accordance with manufacturer’s guidelines.
(3) Alternating the use of different types of biocides, dose, and frequency is recommended.
(4) These treatment methods can be used for continuous, online disinfection or shock treatment online or offline.
H 105.3 Non-Chemical Treatment. Non-chemical treatment devices shall be permitted to be used in accordance with manufacturer’s guidelines.
H 105.3.1 Thermal Shock. Thermal treatment using heat shock at 158°F (70°C) for 30 minutes shall be permitted in accordance with applicable guidelines and the manufacturer’s instructions.
H 105.3.2 Physical Cleaning. When implemented, physical cleaning shall only be performed as an offline method and shall be performed before the chemical disinfection methods in Section 105.1 have been performed. Building outdoor air intakes shall be closed during physical cleaning prior to commencing. Physical cleaning shall be in accordance with the manufacturer’s instructions.
H 105.4 Inspection and Maintenance. The system shall be monitored and maintained to prevent scale buildup, sediment, corrosion, and biofouling.
H 105.5 Frequency of Cleaning and Disinfection. Where a water management plan is implemented, the frequency of cleaning and disinfection logs shall be readily accessible to the water management team and the Authority Having Jurisdiction.

H 105.6 Control Measures. Evaluation of control measures for Legionella shall consider potential unintended consequences of such measures that may affect overall health risk, including the formation of toxic disinfection byproducts (whether regulated or unregulated), resultant increase in other plumbing-associated pathogens, and scalding.

Part II – Minimizing Legionella Growth Potential in Cooling Towers and Other Mechanical Systems.

H 201.0 General.
H 201.1 Applicability. Part II of this appendix applies to water sources that frequently provide optimal conditions for growth of Legionella organisms in accordance with Figure H 104.1, including, but not limited to, cooling towers, evaporative condensers, decorative water features, filters, ice makers, evaporative air coolers, fluid coolers that use evaporation to reject heat, industrial processes that use water to remove excess heat, industrial and municipal waste treatment plants, and other mechanical systems.
H 201.2 Water Management Plan, Where Required. A water management plan shall be established when required by the criteria of the Authority Having Jurisdiction.
H 201.3 Water Management Plan, Where Implemented. Where a water management plan is implemented, the plan shall be in accordance with the following:
(1) Determine a water management plan team.
(2) Provide description of the building’s water system.
(3) Identify areas of Legionella growth potential in accordance with temperature ranges as shown in Figure H 104.1.
(4) Determine applicable control measures and monitoring procedures.
(5) Ensure the water management plan is effective and operating as designed.
(6) Document and communicate all the activities of the water management plan.
H 201.4 Water Sampling. An analysis of water samples from a source capable of being contaminated with Legionella bacteria shall be performed as required by the Authority Having Jurisdiction to determine the number of organisms present in Colony Forming Units per milliliter (CFU/mL) of Legionella in the sample. The minimum remediation action shall be in accordance with Table H 201.5 and Figure H 201.5.

H 201.5 Legionella Test Levels. A means of controlling Legionella shall be established in accordance with applicable levels as stated in Section H 201.5.1 through Section H 201.5.4.

H 201.5.1 Levels Less than 10 CFU/ML. Water samples containing Legionella levels less than 10 CFU/mL shall be permitted to maintain the established water treatment plan in accordance with Table H 201.5.

H 201.5.2 Levels Between 10 CFU/ML and 100 CFU/ML. Water samples containing Legionella levels greater than 10 CFU/mL but less than 100 CFU/mL shall require the water treatment plan to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5.

H 201.5.3 Levels Between 100 CFU/ML and 1000 CFU/ML. Water samples containing Legionella levels greater than 100 CFU/mL but less than 1,000 CFU/mL shall require the water treatment plan to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5. Prepare to execute emergency response plan in case Legionella levels reach over 1000 CFU/mL in accordance with H 202.14.

H 201.5.4 Levels Greater than 1000 CFU/ML. Water samples containing Legionella levels greater than 1,000 CFU/mL shall require the water treatment plan to be reviewed, notify Authority Having Jurisdiction, institute immediate online disinfection, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5.

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</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>Maintain the established water treatment plan.</td>
</tr>
<tr>
<td>&gt;=10 and &lt;100</td>
<td>Review water treatment plan, institute immediate online decontamination, and retest water 3 to 7 days after decontamination.</td>
</tr>
<tr>
<td>&gt;=100 and &lt;1000</td>
<td>Review water treatment plan, institute immediate online decontamination, and retest water 3 to 7 days after decontamination. Prepare to execute emergency response plan in case Legionella levels reach over 1000 CFU/mL. *The emergency response plan for cooling towers is addressed in Section H 202.14.</td>
</tr>
<tr>
<td>&gt;=1000</td>
<td>Review water treatment plan, notify Authority Having Jurisdiction (if required), institute immediate online disinfection, and retest water 3 to 7 days after decontamination. If retest &gt;=1000 CFU/mL, repeat system decontamination.</td>
</tr>
</tbody>
</table>

H 201.6 Air Sampling. Air sampling for Legionella shall not be used as a means of measuring potential Legionella exposure.

H 202.0 Cooling Towers.
H 202.1 General. Cooling towers shall be installed, maintained, and tested as required by this Appendix and the Authority Having Jurisdiction.
H 202.2 Risk Factors. The following risk factors shall be identified, assessed, controlled, and monitored:
(1) Stagnant water due to dead legs, intermittent operation, or seasonal usage.
(2) The presence of nutrients or biofilm.
(3) Water temperature within a range that supports microbial growth as specified in Figure H 104.1.
(4) Water exposed to direct sunlight which promotes algae growth.
(5) Water quality, including, but not limited to, the following factors:
(a) System cleanliness
(b) pH levels
(c) Presence of corrosion
(d) Presence of scale and biofouling
(e) Conductivity levels
(f) Dissolved and suspended solids
(g) Control of water treatment chemicals
(h) Control of bleed-off or blowdown
(6) System size
(7) Physical condition of system
H 202.3 Water Temperature. The system shall be designed to maintain low sump-water operating temperatures.

H 202.4 Drift Eliminators. Drift eliminators shall be installed in accordance with Section 1126.0, Section E 403.2, and Section E 403.5.1, and shall be accessible to allow inspection, maintenance, and cleaning of internal components.

H 202.5 Side Stream Filtration. When suspended solids are visible in the cooling tower water system, side stream filtration shall be permitted to be used to control suspended solids in cooling tower circulating water. Makeup water quality, design of cooling tower fill, recirculation rate, and total system volume shall be included in the design of such equipment.

H 202.6 Equipment Site Location. The site location of new or replacement open- or closed-circuit cooling towers or evaporative condensers shall be in accordance with the following:

1. Shall not be located where contamination from building systems or facility processes can be drawn into the equipment. Equipment shall be installed no less than 10 feet (3048 mm) away from building exhaust or plumbing vents.
2. Shall not be located where equipment discharges into occupied spaces, roadways, walkways, outdoor air intakes, and building openings. Equipment shall be installed no less than 10 feet (3048 mm) away from building intakes or plumbing vents.

H 202.7 System Commissioning. System commissioning shall include procedures for cleaning of the cooling system. Ongoing water treatment in accordance with Section H 201.5 shall be initiated once the system is charged with water.

H 202.8 System Start-Up and Shutdown. System start-up and shutdown procedures shall include, but not be limited to the following:

1. Management of hazardous conditions associated with untreated water, including the following:
   a. Shutdown that includes all chemical pretreatment steps, pump cycling protocols, and procedures for system drainage for shutdown periods longer than 3 days, or the duration specified by the water management plan.
   b. Start-up from a drained system shall be in accordance with manufacturer’s recommendations.
   c. Start-up from an undrained or stagnant system that exceeds 3 days, or the number of idle days specified by the water management plan or the manufacturer’s recommendations.

H 202.9 System Maintenance and Inspection. System components requiring maintenance and inspection shall be accessible. A schedule for maintenance and inspection of system shall be included in the water management plan documents. Cooling tower maintenance and inspection shall include, but not be limited to, the following areas:

1. Water treatment system
2. Louvers
3. Piping dead legs
4. Cold water basins
5. Crossflow hot water basin
6. Counterflow spray system
7. Drift eliminators
8. Fill material and fill air entrance and exit surfaces
9. Purging of stagnant water or low-flow zones within the basin

H 202.10 Water Treatment. Water treatment shall control microbiological activity, scale, corrosion, sediment, and solids in the system, and shall be in accordance with the following:

1. All equipment and chemicals used shall be specified for the purpose of treating the open recirculating loop.
2. The minimum required schedule for inspection, maintenance, cleaning, and monitoring, and a corrective action plan.
3. The minimum requirements for documenting system water treatment.

H 202.11 Disinfection. Methods for disinfection of cooling towers shall include, but not be limited to, the halogenation methods and procedures for flushing and disinfection in accordance with Section 1122.0 and for reclaimed (recycled) and onsite treated nonpotable water in accordance with Section E 403.5.2.

The responsible person for initiating disinfection shall be identified in the water management plan documents and the disinfection process shall include the following:

1. Online disinfection.
2. Emergency disinfection.

H 202.12 Water Treatment Chemicals. Water treatment chemicals, such as biocides, shall be applied using an automated dosing system at regular intervals. The frequency and quantity of chemical dosing shall be based on the microbial activity of the system and the chemical parameters of the circulating water.

H 202.13 Makeup Valves. The location of cooling tower makeup valves shall be in accordance with the registered design professional construction documents and approved by the Authority Having Jurisdiction. Makeup valves shall be provided with backflow prevention in accordance with ASME A112.1.2 for air gaps or backflow preventers in accordance with the plumbing code.

H 202.14 Emergency Response Plan. An emergency response plan shall be provided when required by with the Authority Having Jurisdiction and shall include, but not be limited to, the following:

1. Procedures to be followed if there are cases of Legionellosis associated with the use of cooling towers or evaporative condensers.
2. Procedures to be followed if cooling towers or evaporative condensers reach Legionella levels of 1000 CFU/mL or greater.
3. Testing for Legionella shall be performed. Procedures shall include the type of tests to be performed, sampling, and the interpretation of test results.
4. Procedures for emergency disinfection.
5. Procedures for other actions identified by the water management plan to prevent exposure to contaminated water.

H 202.15 Control of Bleed-Off. An automated bleed-off, or blowdown, system shall be used to remove water from the
system and replace with makeup water to limit the concentration of dissolved and suspended solids. Additional manual bleed-off shall be permitted to be used to control scale or biofouling. The water for bleed-off shall be taken from the return line of the cooling water system to the cooling tower. Bleed-off shall only occur while chemical dosing is turned off.

H 202.16 Alternative Systems. Alternative systems and technologies that do not pose microbial risk and do not provide the opportunity for Legionella bacteria to grow shall be evaluated, including but not limited to off-peak thermal storage and geothermal coupled options.

H 203.0 Other Mechanical Systems.
H 203.1 General. Other mechanical systems and portions thereof shall be installed, maintained, and tested as required by this section and the Authority Having Jurisdiction.
H 203.2 Sand Filters. Sand filters shall be maintained or replaced in accordance with applicable guidelines as determined by the Authority Having Jurisdiction.
H 203.3 Water Softeners. Water softeners shall be installed and maintained in accordance with the plumbing code.
H 203.4 Dehumidifiers. Dehumidifiers shall be required in enclosed areas with swimming pools, spas, and hot tubs. Dehumidifiers shall be maintained in accordance with ASHRAE 188 and the manufacturer’s instructions.
H 203.5 Misters, Atomizers, Air Washers, Nebulizers, and Humidifiers. Misters, atomizers, air washers, nebulizers, and humidifiers shall be disinfected in accordance with ASHRAE 188. The minimum remediation action for humidifiers shall be in accordance with Table H 203.6.

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H 203.7 Evaporative Air Coolers. Evaporative air coolers shall be completely drained and cleaned in accordance with the manufacturer’s instructions. When not in use, evaporative air coolers shall be completely drained.
H 203.8 Ice Machines. Ice machines not used for human consumption shall be flushed and maintained in accordance with ASHRAE 188.
H 203.9 Spas and Hot Tubs. Spas and hot tubs shall be maintained and tested in accordance with ASHRAE Guideline 12 and cleaned and disinfected in accordance with the manufacturer’s recommendations.
H 203.10 Decorative Water Features. Decorative water features shall be maintained in accordance with ASHRAE 188. Decorative water features shall be drained, cleaned, and disinfected in accordance with the manufacturer’s instructions and the Authority Having Jurisdiction.
H 203.11 Water Supply Systems. The minimum remediation action for water supply systems shall be in accordance with the plumbing code.

TABLE 1701.2
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</table>

(portion of table not shown remains unchanged)

COMMITTEE STATEMENT:
Section H 203.8 is being revised to remove the phrase “not used for human consumption” as all ice machines must be flushed and maintained, not only those that are not used for human consumption.

TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Submitter: Jay Egg
Egg Geothermal
Rep. Chair, Mechanical Systems Working Group

Recommendation:
Add new text

Appendix J
The Safe Operation, Closure and Restarting of Cooling Towers

J 101.0 General.
J 101.1 Applicability. The provisions of this appendix address risk management practices of mechanical systems for safe operation during normal operation, interruption to normal operation (system shutdown), and restarting of cooling towers.

J 101.2 Building Water Systems. This appendix shall be applicable to building water systems for cooling towers.

J 101.3 Building Types. This appendix shall be applicable to the following building types:
(1) Non-residential (low- and high-rise)
   (a) Office buildings
   (b) Mercantile (seasonal retail)
   (c) Schools/dormitories
   (d) Hotels/motels
   (e) Assemblies
   (f) Healthcare facilities
(2) Residential
   (a) All except single and double family residence

J 201.0 Definitions.
J 201.1 General. For the purposes of this appendix, the following definitions shall apply:
Building Water. Water collected, conveyed, circulated, stored, drained, or discharged by building plumbing systems for use in and around buildings.
Building Water Systems. Potable and non-potable water systems in the building, or on-site.
Normal Operation. The state of a building water system when the building is open and being used as intended. This includes the normal hours of operation and the number of people that occupy the building.
Risk. The potential for harm to humans resulting from exposure to Legionella.
Risk Management. Systematic activities to reduce risk.
System Restarting. The set of actions that should be taken to ready a mechanical system for normal operations after an extended period of no or limited operations.

Substantiation:
General: The new appendix will identify the standards for risk management of building mechanical systems specifically associated with cooling towers. Legionnaires' disease linked to aerosolization of contaminated water vapor from cooling towers has increased in recent decades, and these standards are presented to provide reasonable control measures established for Legionella levels.

Definitions: The definitions in this new appendix have been added and are necessary for clarity and enforcement of standards Legionella levels in cooling towers.

Committee Action: Accept as Submitted
TOTAL ELIGIBLE TO VOTE: 30
VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
J 301.0 Normal Operation, Cooling Towers.

J 301.1 Legionella. Section J 301.2 through Section J 301.4.1.1 shall apply to cooling towers under normal operation.

Note: Water based mechanical system are generally closed and pressurized and have no potential to affect the health of occupants, except at the cooling tower. Cooling towers can carry Legionella on aerosolized water droplets and infect occupants in and outside of the building.

J 301.2 Water Management Program, Cooling Towers. For each cooling tower system, the owner shall have a maintenance program and plan prepared by a qualified person in accordance with ASHRAE 188, the manufacturer’s instructions, and the requirements of this section.

The plan shall be kept current and amended by a qualified person or building owner designee as needed to reflect any changes in the management and maintenance team, system design, operation or system control requirements for the cooling tower system. The plan shall be kept in the building where a cooling tower or cooling tower system is located, or in an adjacent building or structure on the same location and shall be made available to the Authority Having Jurisdiction for inspection.

The water management program shall include, but not be limited to, the following:

1. Management and maintenance team. Identification, including names and contact information (such as mail, email addresses and telephone numbers) and description of the function of each person on the cooling tower system management and maintenance team, including:
   a. The owner of the building where each cooling tower system is located, and any manager or other person designated by the owner as responsible for compliance with the requirements of the Authority Having Jurisdiction.
   b. Person designated by the owner as a responsible person, as defined by the Authority Having Jurisdiction.
   c. Consultants, service company and qualified person who cleans, disinfects, delivers chemicals or services the cooling tower system.

2. Cooling tower system. Identification, specifications and description of each cooling tower system and all components located at a specific address, including:
   a. The number of cooling towers in the cooling tower system.
   b. The location of each cooling tower in relation to the building and the building address, block and lot number.
   c. The dimensions and characteristics of the cooling tower system including total recirculating water volume, cooling tower tonnage, biocide delivery method, flow rate and other key characteristics.
   d. The purpose of the cooling tower system and seasonal or year-round operation including start and end date, if applicable. For systems with multiple cooling towers, conditional operation, such as cycling or scaling related to cooling demand, shall also be noted.
   e. The identification and/or registration number for each cooling tower where required by the Authority Having Jurisdiction.
   f. The cooling tower manufacturer, model number and serial number, if applicable.
   g. Flow diagram or schematic of the cooling tower system, identifying all of the principal components and appurtenances of the cooling tower system including makeup water and waste stream plumbing locations.

3. Risk management assessment. The assessment shall identify risk factors for Legionella proliferation and specify risk management procedures for all or parts of each cooling tower system, and anticipated conditions including:
   a. Any dead legs or stagnant water in the recirculation system.
(b) Operating configurations and conditions that may occur after periods of extended inactivity lasting more than three
days, including idling or low circulation while not being fully drained.
(c) System parts that require continual operation throughout the year making regular, periodic offline cleaning and
disinfection difficult.
(d) Any components that may add additional risk factors for organic material buildup and microbial growth such as
strainers and out-of-use filters.
(e) Sources of elevated organic contamination, including, but not limited to windblown debris, bird waste and plant
material.
(f) Design configurations that present risk of direct sun exposure on basin, deck or fill.
(g) Ventilation intakes or other routes for human exposure to cooling tower aerosols.
(h) System components adversely affecting water quality management procedures.
(i) Other risks or limiting factors or constraints in the cooling tower system's design and functioning.
(4) Cooling tower operation:
(a) Control measures, corrective actions, documentation, including a written checklist for routine monitoring, and
reporting as required by the Authority Having Jurisdiction, and any routine maintenance activities recommended by the
manufacturer's instructions, including performance measures, which may sufficiently demonstrate adequate
implementation of the operation requirements described in the maintenance program and plan. Where there is a conflict
between the requirements of this Section and the manufacturer's instructions, the maintenance program and plan shall
reflect the most stringent requirement.
(b) Specific, detailed seasonal and temporary shutdown and start-up procedures.
(c) Notification and communication strategies among management and maintenance team members regarding the
required corrective actions in response to process control activities, monitoring, sampling results and other actions taken
to maintain the cooling tower system.

J 201.0 Definitions.
J 201.1 General. For the purposes of this appendix, the following definitions shall apply:
Water Management Program (WMP). A risk management plan to help building managers identify risks to water quality
and establish clear guidelines for managing these risks at various points in the building lifecycle, including start-up,
normal operation, under occupancy, water system shutdown, and water system restart. Such programs are often
focused on Legionella risk prevention and are required in some states for certain building types to combat waterborne
pathogens such as Legionellosis.
Legionella. The name of the genus of bacteria that can cause a pneumonia called Legionnaires' disease or a flu-like
illness called Pontiac fever when inhaled, aspirated or directly introduced into the lungs of susceptible individuals. It is a
common aquatic bacteria found in natural and building water systems, as well as in some soils.
Legionellosis. The term used to describe Legionnaires' disease, Pontiac fever, and any illness caused by exposure to
Legionella bacteria.
Monitoring. Conducting a planned sequence of observations or measurements of the physical and chemical
characteristics of control measures.

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Systems</td>
<td></td>
</tr>
</tbody>
</table>

(portionsof table not shown remain unchanged)

SUBSTANTIATION:
The new appendix will address the necessary risk management practices needed for mechanical systems such as
cooling towers.

Definitions: The definitions in this new appendix have been added and are necessary for clarity and enforcement of
standards Legionella levels in cooling towers.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
**Proposals**

**Item #:** 326

UMC 2024  Section: J 301.3 - J 301.4.1.1

**SUBMITTER:** Jay Egg  
Egg Geothermal  
Rep. Chair, Mechanical Systems Working Group

**RECOMMENDATION:**

Add new text

**J 301.3 Water Treatment and Filtration Equipment.** Water treatment and filtration of cooling towers shall be in accordance with Section J 301.3.1 through Section J 301.4.1.1.

**J 301.3.1 Water Treatment.** Water treatment shall be provided to control microbiological activity, scale, corrosion, sediment, and solids in the system, and shall be in accordance with the following:

1. Equipment and chemicals used shall be specified for the purpose of treating the open recirculating loop.
2. The required schedule for inspection, maintenance, cleaning, and monitoring, and a corrective action plan.
3. The requirements for documenting system water treatment.

**J 301.3.2 Disinfection.** The responsible person for initiating disinfection shall be identified in the water management program documents and the disinfection process shall include the following:

1. Online disinfection.
2. Emergency disinfection.

**J 301.3.3 Water Treatment Chemicals.** Water treatment chemicals, such as biocides, shall be applied using an automated dosing system, where possible, at regular intervals. The frequency and quantity of chemical dosing shall be defined in the water management program and performed accordingly, based on the microbial activity of the system and the chemical parameters of the circulating water.

Prior to changing an existing chemical treatment system or introducing a new chemical treatment agent, cooling tower design, installation, operation, and maintenance shall be evaluated by a qualified person or building owner designee to ensure compatibility between the chemicals and the cooling tower system’s materials, and to minimize microbial growth and the release of aerosols.

The evaluation shall describe the optimum level of chemicals required to achieve the desired result in a manner which can be used as a system performance measure.

1. Daily automatic treatment while in operation. Water in a cooling tower system shall be treated at least once a day when the system is in operation and such treatment shall be automated, unless the water management program and plan explicitly state how manual or less frequent biocide additions will provide effective control of Legionella growth.
2. Recirculating system. A cooling tower system shall be operated and programmed to continually recirculate the water, irrespective of the building’s cooling demand of the system.

**Exception:** Where the water management program specifies in detail how the intended water treatment schedule will be carried out, and how effective biofilm and microorganism control will be achieved when the whole or a part of the system is idle during the scheduled chemical injection.

3. Chemicals and biocides. Chemicals and biocides shall be used in quantities and combinations sufficient to control the presence of Legionella, minimize biofilms, and prevent scaling and corrosion that may facilitate microbial growth. It is recommended that oxidizing chemicals be used as the primary biocide control. For systems where oxidizing chemicals cannot be used as the primary biocide to control the presence of Legionella, building owners shall submit an alternative plan for effective bacteriological control for approval by the Authority Having Jurisdiction.

(a) Biocide applications. Any person who performs cleaning and disinfection or applies biocides in a cooling tower system shall be a certified person as required by the Authority Having Jurisdiction.

(b) Registered biocides. Only biocide products registered with the Authority Having Jurisdiction may be used to meet the disinfection requirements of this Appendix.
Records. Water treatment records shall be kept for all chemicals and biocides added, noting the purpose of their use, the manufacturer's name, the brand name, the safety data sheet, the date and time of each addition, and the amount added each week.

(d) Chemical and biocide additions. Chemicals and biocides shall be added in accordance with this appendix and the procedures described in the water management program addressing, as applicable, feeding mechanism, feeding location, frequency, set timer, duration, triggering events, control procedures, and target biocide residuals. Water treatment chemicals and biocides shall be used in accordance with the product label and manufacturer's instructions.

J 301.4 Water Quality Monitoring. Water quality in the cooling tower shall be monitored as follows:

1. Water quality parameters, including but not limited to pH, temperature, conductivity and biocidal indicators, shall be measured and recorded as specified in the water management program and plan as follows:
   (a) Manual measurements as required by the manufacturer's recommendation and the Authority Having Jurisdiction.
   (b) When continuous, automated and/or remote measurements and recordings are used, the water management program and plan shall show how effective measurements of system process control are being monitored.

2. A bacteriological indicator to estimate microbial content of recirculating water shall be collected and interpreted in accordance with Table J 301.4(2) at least once each week while the cooling tower system is operating. Indicators shall be taken at times and from water sampling points, as detailed in the water management program, that will be representative of water microbial content. Indicators may be taken at any time from constant chemical treatment systems. Indicators from systems that use intermittent biocide applications shall be taken before biocide application and reflect normal cooling tower operating conditions.

3. Legionella culture testing shall be conducted not less than every 90 days during cooling tower system operation. A Legionella sample shall be analyzed by an accredited laboratory where Legionella appears on the laboratory's scope of accreditation, or other laboratory approved by the Authority Having Jurisdiction. When required, the test results of all Legionella bacteria at or above the magnitude of (1000 CFU/mL) as indicated in Table J 301.4(1) shall be reported to the Authority Having Jurisdiction within 24 hours of receiving the test results.
   (a) Additional emergency Legionella sampling shall be conducted if any of the following occur:
      (a) Power failure, system shutdown, or equipment failure of sufficient duration to allow for growth of bacteria.
      (b) Loss of biocide treatment sufficient to allow for growth of bacteria.
      (c) Failure of conductivity controls to maintain proper cycles of concentration.
      (d) At the request of the Authority Having Jurisdiction upon a determination that one or more cases of legionellosis is or may be associated with the cooling tower, based on epidemiological data or laboratory testing.
      (e) Any time two consecutive bacteriological indicator sample results are above 1000 CFU/mL as indicated in Table J 301.4(1).
      (f) Any other conditions specified by the Authority Having Jurisdiction.

4. System monitoring and sampling locations shall be representative of the entire cooling tower system. The system shall be operating with water circulating in the system for at least one hour prior to water quality measurements or collection of samples.

5. The maintenance program and plan shall identify the procedures, responsible parties, required response time(s) and notification protocol for corrective actions and shall include, at a minimum, corrective actions that shall be implemented according to the result levels in Table J 301.4(1).

J 301.4.1 Water Sampling. An analysis of water samples from a location capable of being contaminated with Legionella bacteria shall be performed as required by the Authority Having Jurisdiction to determine the number of organisms present in Colony Forming Units per milliliter (CFU/mL) of Legionella in the sample. The minimum remediation action shall be in accordance with Table J 301.4(1).

J 301.4.1.1 Legionella Test Levels. A means of controlling Legionella shall be established in accordance with applicable levels in accordance with the following:

1. Levels Less than 10 CFU/mL. Water samples containing Legionella levels less than 10 CFU/mL shall be permitted to maintain the established water treatment program in accordance with Table J 301.4(1).

2. Levels Between 10 CFU/mL and 1000 CFU/mL. Water samples containing Legionella levels greater than 10 CFU/mL but less than 1000 CFU/mL shall require the water treatment program to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table J 301.4(1).

3. Levels Greater than 1000 CFU/mL. Water samples containing Legionella levels greater than 1,000 CFU/mL shall require the water treatment program to be reviewed, notify Authority Having Jurisdiction, institute immediate online disinfection, and retesting of water 3 to 7 days after decontamination in accordance with Table J 301.4(1).
### TABLE J 301.4(1)
#### LEGIONELLA REMEDIATION ACTIONS FOR COOLING TOWERS

<table>
<thead>
<tr>
<th>LEGIONELLA CONCENTRATIONS IN COLONY FORMING UNITS (CFU/mL)</th>
<th>REMEDIATION ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>Maintain the established water treatment program</td>
</tr>
<tr>
<td>&gt;=10 and &lt;100</td>
<td>Review water treatment program, institute immediate online disinfection, and retest water 3 days to 7 days after disinfection.</td>
</tr>
<tr>
<td>&gt;=100 and &lt;1000</td>
<td>Review water treatment program, institute immediate online disinfection, and retest water 3 days to 7 days after disinfection.</td>
</tr>
<tr>
<td>&gt;=1000</td>
<td>Review water treatment program, institute immediate online disinfection, and retest water 3 days to 7 days after disinfection.</td>
</tr>
<tr>
<td></td>
<td>If the results of a retest are still &gt;= 1000 CFU/mL, carry out system decontamination.</td>
</tr>
</tbody>
</table>

### TABLE J 301.4(2)
#### CORRECTIVE ACTIONS REQUIRED FOR BACTERIOLOGICAL INDICATOR RESULTS

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>HETEROTROPHIC PLATE COUNT AND DIP SLIDE RESULT (CFU/mL)</th>
<th>PROCESS TRIGGERED BY TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;10 000</td>
<td>Maintain water chemistry and biocide levels.</td>
</tr>
<tr>
<td>2</td>
<td>&gt;=10 000 to &lt;100 000</td>
<td>Initiate immediate disinfection by increasing biocide concentration or using a different biocide within 24 hours, review treatment program, retest water within 3 days to 7 days.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsequent test results shall be interpreted in accordance with this table until level 1 is reached.</td>
</tr>
<tr>
<td>3</td>
<td>&gt;=100 000 to &lt;1 000 000</td>
<td>Initiate immediate disinfection by increasing biocide concentration or using a different biocide within 24 hours, reviewing treatment program, performing visual inspection to evaluate need to perform cleaning and further disinfection. Retest water within 3 days to 7 days.</td>
</tr>
</tbody>
</table>
Subsequent test results shall be interpreted in accordance with this Table until level 1 is reached.

<table>
<thead>
<tr>
<th>Level</th>
<th>HPC Limit</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>( \geq 1 \times 10^5 )</td>
<td>Initiate immediate disinfection by increasing biocides within 24 hours. Within 48 hours perform remediation of the tower by hyperhalogenating(^2), cleaning, and flushing. Review treatment program, retest water within 3 days to 7 days. Subsequent test results shall be interpreted in accordance with this Table until level 1 is reached.</td>
</tr>
</tbody>
</table>

Notes:
1. Performed by an accredited laboratory
2. At a minimum, dose the cooling water system with 5 ppm to 10 ppm free halogen residual for at least 1 hour; pH 7.0 to 7.6

Note: There is no evidence that HPC values alone directly relate to human health risk, based on epidemiological studies and a lack of correlation with the occurrence of waterborne pathogens. Threshold concentrations of HPC were selected based on interference with the coliform test and not health-related considerations. HPC is an analytic method used to measure the variety of heterotrophic bacteria that are common in water. Legionella require specialized culture media for isolation and detection, do not grow on the media used for HPC testing, and their presence is not correlated with HPC values. HPC is a useful tool for monitoring the efficiency of the water treatment process, measuring bacterial regrowth, and evaluating the function of disinfection systems.

SUBSTANTIATION:
Legionella Monitoring: The verbiage and tables in this new appendix will clearly identify the standards for water treatment, sampling, and acceptable Legionella levels in cooling tower water systems.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 327

UMC 2024  Section: J 401.0 - J 401.1.3

SUBMITTER: Jay Egg
Egg Geothermal
Rep. Chair, Mechanical Systems Working Group

RECOMMENDATION:
Add new text

J 401.0 Interruption to Normal Operation.
J 401.1 Shutdown Date. When an interruption to normal operation occurs (system shutdown), a shutdown date shall be established prior to shutting down a cooling tower. A shutdown date of a cooling tower shall be a date after which the cooling tower is unlikely to be restarted for the season. Where shutdown of the cooling tower is required, a shutdown date shall be determined, and the requirements of Section J 401.1.1 through Section 401.1.4 shall be completed.
J 401.1.1 Reduce Solids and Sterilize the System. The cooling tower shall be drained prior to system shutdown. Biocide shall be applied in accordance with the manufacturer’s instructions to kill any bacteria or contaminants.
J 401.1.2 Drain, Inspect and Clean the System. Where an interruption to normal operation occurs, the following actions shall be performed:
(1) The cooling tower fill, sump, heat exchangers, chillers, and piping shall be drained.
(2) The system shall be cleaned as required by the manufacturer’s instructions.
(3) The system shall be inspected, and maintenance shall be performed as required by the manufacturer.
(4) The controllers shall be taken offline.
(5) The protective probes shall be removed.
(6) The tower fill and sump shall be drained.
(7) The heat exchangers, chillers and piping shall be drained and protected in accordance with the manufacturer’s instructions.
J 401.1.3 Refill, Flush and Drain the Cooling Tower System. Where an interruption to normal operation occurs, the following additional actions shall be performed:
(1) The system shall be refilled.
(2) A nonoxidizing biocide shall be added and recirculated in accordance with the manufacturer’s instructions.
(3) The cooling tower system shall be fully drained.
Note: It is possible that the cooling tower equipment is drained, but the cooling tower system remains in operation. A system operating on standby mode is not considered shut down. If water remains in the cooling tower system, the system is not considered shut down and water must circulate with regular biocide additions and active management.
J 401.1.4 Records. Records of all procedures and actions performed shall be kept.

SUBSTANTIATION:
Building Closure / Reduced Operation Procedures: The building closure procedures section of this new appendix will identify the best practices for placing the building cooling tower water system on minimum or reduced capacity, while maintaining acceptable levels of Legionella in the cooling tower water system.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 328

UMC 2024  Section: J 201.0 - J 201.1, J 501.0 - J 501.3.1, Table 1701.2

SUBMITTER:  Jay Egg
Egg Geothermal
Rep. Chair, Mechanical Systems Working Group

RECOMMENDATION:
Add new text

J 501.0 System Shutdown.

J 501.1 General. Cooling towers that are in shutdown mode shall comply with the following:
(1) Operating configurations and conditions that may occur after periods of extended inactivity lasting more than three
days, including idling or low circulation while not being fully drained.
(2) Specific, detailed seasonal and temporary shutdown and start-up procedures.

J 501.2 Shutdown Procedures. System start-up and shutdown procedures shall include, but not be limited to, the
following:
(1) Management of hazardous conditions associated with untreated water, including the following:
(a) Shutdown that includes all chemical pretreatment steps, pump cycling protocols, and procedures for system
drainage for shutdown periods longer than three days, or the duration specified by the water management program.
(b) Start-up from a drained system shall be in accordance with manufacturer’s recommendations.
(c) Start-up from an undrained or stagnant system that exceeds three days, or the number of idle days specified by the
water management program or the manufacturer’s recommendations.

J 501.3 Legionella Prevention. The mechanical hydronic system shall be checked that it is safe to use after a
prolonged shutdown to minimize the risk of Legionnaires’ disease and other diseases associated with water.

Note: Stagnant or standing water in a mechanical hydronic system can increase the risk for growth and spread
of Legionella and other biofilm-associated bacteria. When water is stagnant, hot water temperatures can decrease to
the Legionella growth range (77 °F (25°C) through 110°F (43°C). Stagnant water can also lead to low or undetectable
levels of disinfectant, such as chlorine.

J 501.3.1 Maintenance Personnel. Personal protective equipment shall be provided for maintenance personnel.
Maintenance personnel shall wear personal protective equipment in accordance with the facilities’ risk assessment.
Respiratory protection may be appropriate in enclosed spaces where aerosol generation is likely. Personal protective
equipment shall be used in accordance with all local state and Federal requirements. Where respirators are used, a
respiratory protection program in accordance with 29 CFR 1910.134 shall be required.

Note: Maintenance personnel at increased risk of developing Legionnaires’ disease, such as those with weakened
immune systems, should consult with a medical provider regarding participation in flushing, cooling tower cleaning, or
other activities that may generate aerosols.

J 201.0 Definitions.

J 201.1 General. For the purposes of this appendix, the following definitions shall apply:
Disinfectant. Chemical agent or physical treatments used to kill or inactivate pathogens.
Disinfection. The process of killing or inactivating pathogens.
System Reopening. The set of actions that should be taken to ready a building for normal operations after an extended
period of no or limited operations.
SUBSTANTIATION:
Cooling Tower Shutdown Procedures: The Cooling Tower Shutdown procedure section of this new appendix will identify the best practices for shutting down operation building Water Systems associated with cooling towers to minimize Legionella risk upon restart.

Definitions: The definitions in this new appendix have been added and are necessary for clarity and enforcement of standards Legionella levels in cooling towers.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Item #: 329

UMC 2024  Section: J 601.0 - J 601.1

SUBMITTER: Jay Egg
Egg Geothermal
Rep. Chair, Mechanical Systems Working Group

RECOMMENDATION:
Add new text

**J 601.0 System Restart.**

**J 601.1 Startup Procedures.** When a cooling tower has been shut down or left untreated for five or more days, a full startup procedure shall be completed before startup or continuing operation. The startup procedure shall be completed as follows:

1. Clean the cooling tower through power washing and/or scrubbing, not more than 15 days before the first use, to remove biofilm, scale or other debris. Once cleaned, disinfect with an approved biocide(s) to kill pathogens, such as *Legionella*.
2. Enlist a qualified person or building owner designee to conduct and document the pre-startup inspection. The required inspection shall be as follows:
   a. Visually assessing the cooling tower system.
   b. Inspecting all components for the presence of contaminants and other adverse conditions.
   c. Checking that the water treatment equipment is working properly.
   d. Records of the procedure shall be completed.
3. Once disinfected, the cooling tower system shall be filled with water and begin circulating biocides and chemicals, as specified in the water management program. At this point, the system shall be considered operational and shall meet the requirements of the Authority Having Jurisdiction.
4. Collect and analyze a water sample for the presence of *Legionella*. The sample shall be analyzed by a laboratory as approved by the Authority Having Jurisdiction. The results shall be interpreted and the actions described in Table J 301.4(2) shall be performed.
5. Startup records of all procedures and actions performed shall be kept on file. Startup records shall include, but not be limited to, the following:
   a. Cooling tower system ID
   b. System startup date
   c. Individual cooling tower startup date (if different than the system startup date)
   d. Dates and procedures for startup cleaning and disinfection
   e. Service provider
   f. Pre-startup inspection
   g. *Legionella* sampling and test results
   h. Disinfection dose and circulation time
   i. Water monitoring
   j. Treatment logs

SUBSTANTIATION:
Building and Cooling Tower Reopening Procedures: The cooling tower reopening procedure section of this new appendix will identify best practices by which a cooling tower that has been offline for an extended period may be restarted while maintaining acceptable levels of *Legionella* in the cooling tower water system.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
APPENDIX J
PROFESSIONAL QUALIFICATIONS

J 101.0 General.  
J 101.1 Scope. The provisions of this appendix address minimum qualifications for installers, inspectors, or employers for systems covered within the scope of this code.

J 102.0 Qualifications.  
J 102.1 General. Where permits are required, the Authority Having Jurisdiction shall have the authority to require contractors, installers, or service technicians to demonstrate competency. Where determined by the Authority Having Jurisdiction, the contractor or technician shall be licensed or certified to perform such work. Professional qualifications shall be required for an individual to demonstrate the required level of competency.

J 102.2 Inspectors and Plans Examiners. Professional qualification for mechanical system inspectors and mechanical plans examiners shall be in accordance with ASSE/IAPMO/ANSI Series 16000.

J 102.2.1 Qualification for Mechanical Inspector. Professional qualification for mechanical inspectors shall be in accordance with ASSE 16020.

J 102.2.2 Qualification for Mechanical Plan Examiner. Professional qualification for mechanical plan examiners shall be in accordance with ASSE 16020.

J 102.3 Residential Mechanical Service Technician. Professional qualification for residential mechanical service technicians shall be in accordance with ASSE/IAPMO/ANSI Series 13000.

J 102.3.1 Qualification for Residential Mechanical Service Technician. Professional qualification for residential mechanical service technicians shall be with accordance ASSE 13020.

J 102.4 Hydronic Systems. Personnel qualification for installers and designers of hydronic heating and cooling systems, as well as installers of solar water heaters shall be in accordance with ASSE/IAPMO/ANSI Series 19000.

J 102.4.1 Qualification for Solar Water Heating System Installer. Professional qualification for solar water heating system installers shall be in accordance with ASSE 19100.

J 102.4.2 Qualification for Hydronic Heating and Cooling System Installer. Professional qualification for hydronic heating and cooling system installers shall be in accordance with ASSE 19210.

J 102.4.3 Qualification for Hydronic Heating and Cooling System Designer. Professional qualification for hydronic heating and cooling system designers shall be in accordance with ASSE 19220.

J 102.5 Water Management and Infection Control Risk Assessment for Building Systems. Professional qualification for construction and maintenance personnel and employers to identify and manage potentially hazardous exposure to bloodborne, waterborne and airborne pathogens. Also includes qualifications for members of a water safety team involved in the development of a risk assessment analysis, and water management and sampling plan, for protection from Legionella and other waterborne pathogens and persons who conduct a facility risk assessment and implement a water safety and management program to reduce the risk of infections due to Legionella. Qualifications are in accordance with ASSE/IAPMO/ANSI Series 12000.

J 102.5.1 Qualification for Environment of Care, Infection Control and Construction Risk Assessment. Professional qualification for general knowledge of the environment of care, infection control and construction risk assessment procedures to protect facility operations, occupants, workers or any individual who has the potential for harm caused by construction activities shall be in accordance with ASSE 12010.

J 102.5.2 Qualification for Environment of Care, Infection Control and Construction Risk Assessment Professional Qualification Standard for Construction and Maintenance Employers. Professional qualification for general knowledge of the environment of care, infection control and construction risk assessment requirements and
procedures to protect facility operations, occupants, workers, or any individual who has the potential for harm caused by construction activities shall be in accordance with ASSE 12020. It also provides general knowledge of employer responsibilities to the worker and to the facility.

**J 102.5.3 Qualification for Water Quality Program, Pipefitters and HVAC Technicians.** Professional qualification for water quality program for pipefitters and HVAC technicians shall be in accordance with ASSE 12062.

**J 102.5.4 Legionella Water Safety and Management Personnel.** Professional qualification of persons who conduct a facility risk assessment and implement a water safety and management program to reduce the risk of infections due to Legionella shall be in accordance with ASSE 12080.

### TABLE 1701.2
**STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES**

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
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<tbody>
<tr>
<td>ASSE/IAPMO/ANSI Series 16000-2019</td>
<td>Professional Qualifications Standard for Inspectors and Plans Examiners</td>
<td>Professional Qualifications</td>
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<td>ASSE 16020-2019</td>
<td>Professional Qualifications Standard for the Mechanical Inspector</td>
<td>Professional Qualifications</td>
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<tr>
<td>ASSE 16050-2019</td>
<td>Professional Qualifications Standard for the Mechanical Plan Examiner</td>
<td>Professional Qualifications</td>
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<tr>
<td>ASSE 13020-2015 (R2020)</td>
<td>Professional Qualifications Standard for the Residential Mechanical Service Technician</td>
<td>Professional Qualifications</td>
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<tr>
<td>ASSE 12010-2021</td>
<td>Environment of Care, Infection Control and Construction Risk Assessment Professional Qualification Standard</td>
<td>Professional Qualifications</td>
</tr>
<tr>
<td>ASSE 12020-2021</td>
<td>Environment of Care, Infection Control and Construction Risk Assessment Professional Qualification Standard for Construction and Maintenance Employers</td>
<td>Professional Qualifications</td>
</tr>
<tr>
<td>ASSE 12062-2021</td>
<td>Water Quality Program Professional Qualifications Standard for Pipefitters and HVAC Technicians</td>
<td>Professional Qualifications</td>
</tr>
<tr>
<td>ASSE 12080-2021</td>
<td>Professional Qualifications Standard for Legionella Water Safety and Management Specialist</td>
<td>Professional Qualifications</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

**Note:** The ASSE standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

**SUBSTANTIATION:**
By including these Professional Qualification Standards in the Appendix of this code it creates a base line for what an AHJ may or should expect from installers and inspectors of these systems.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:** AFFIRMATIVE: 24 NEGATIVE: 4 ABSTAIN: 1 NOT RETURNED: 1 Heine
EXPLANATION OF NEGATIVE:

**BALLANCO:** This change should be rejected. This does not belong in the code. Furthermore, the charging statement does not address all of the listed qualification standards. Section J 102.1 states that is applies to contractors, installers, and service technicians. Then the first section applies to plans examiners and inspectors. Yet, they are not included in the charging section. The Code should never be a licensing document. If ASSE wants to put this out as a separate document, they can do so. But this does not belong in the UMC.

**KOERBER:** Outside of the scope of the UMC and should be rejected.

**WHITE:** This is beyond the scope of the UMC and should be rejected.

**WISEMAN:** ACCA has never reviewed this document. We do not know what kind of qualifications are included and how they will impact the contractor. In addition, this seeks to supplant the current California licensing requirements for mechanical contractors. We should not have multiple and/or potentially conflicting or unnecessary requirements for qualifying contractors in jurisdictions. The new edition of the UMC eventually is considered as the basis for the California Mechanical Code.

EXPLANATION OF ABSTAIN:

**MACNEVIN:** I am abstaining because I have the ASSE 19210 certification and want to avoid the perception of conflict of interest.
Proposals

Item #: 331
UMC 2024  Section: Table 1701.1

SUBMITTER: Karl Best
AHRI

RECOMMENDATION:
Revise text

TABLE 1701.1
REFERRED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHRI 700-2047a-2019</td>
<td>Specifications for Refrigerants</td>
<td>Refrigerants</td>
<td>1104.7, 1104.7.3</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

Note: The AHRI standard meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The above revision reflect the latest update to the AHRI standard that is referenced in Table 1701.1.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 332
UMC 2024  Section: Table 1701.1

SUBMITTER: Joseph Brooks
AMCA

RECOMMENDATION:
Revise text

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMCA 540-2013</td>
<td>Test Method for Louvers Impacted by Wind Borne Debris</td>
<td>Louvers</td>
<td>315.1.2</td>
</tr>
<tr>
<td>AMCA 550-2015</td>
<td>Test Method for High Velocity Wind Driven Rain Resistant Louvers <em>(with revisions through September 2018)</em></td>
<td>Louvers</td>
<td>315.1.1</td>
</tr>
</tbody>
</table>

Note: The AMCA standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The above revisions reflect the latest updates to the AMCA standards that are referenced in Table 1701.1.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

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<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
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</thead>
<tbody>
<tr>
<td>AMCA 540-2013</td>
<td>Test Method for Louvers Impacted by Wind Borne Debris</td>
<td>Louvers</td>
<td>315.1.2</td>
</tr>
<tr>
<td>AMCA 550-2015</td>
<td>Test Method for High Velocity Wind Driven Rain Resistant Louvers <em>(with revisions through September 2018)</em></td>
<td>Louvers</td>
<td>315.1.1</td>
</tr>
</tbody>
</table>

COMMITTEE STATEMENT:
The proposed modification is being submitted to update the standard number to reflect the revision date, rather than in the standard title.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29   NOT RETURNED: 1   Heine
Proposals

Item #: 333
UMC 2024  Section: Table 1701.1, Table 1701.2

SUBMITTER: Emily Toto
ASHRAE

RECOMMENDATION:
Revise text

### TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 15-2016</td>
<td>Safety Standard for Refrigeration Systems</td>
<td>Refrigeration Systems</td>
<td>1102.1, 1106.1, Table 1113.5</td>
</tr>
<tr>
<td>ASHRAE 34-2016</td>
<td>Designation and Safety Classification of Refrigerants</td>
<td>Refrigeration Classifications</td>
<td>1102.3, 1103.1, Table 1102.3, Table 1106.2.5.2</td>
</tr>
<tr>
<td>ASHRAE 62.1-2016</td>
<td>Ventilation for and Acceptable Indoor Air Quality</td>
<td>Indoor Air Quality</td>
<td>402.4.1</td>
</tr>
<tr>
<td>ASHRAE 170-2017</td>
<td>Ventilation of Health Care Facilities</td>
<td>Ventilation</td>
<td>402.1.2</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

Note: The ASHRAE standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

### TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
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<tbody>
<tr>
<td>ASHRAE 52.2-2012 2017</td>
<td>Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size</td>
<td>Cleaning Devices</td>
</tr>
<tr>
<td>ASHRAE 62.2-2016 2019</td>
<td>Ventilation and Acceptable Indoor Air Quality in Residential Buildings</td>
<td>Ventilation</td>
</tr>
<tr>
<td>ASHRAE Handbook-2016 2020</td>
<td>HVAC Systems and Equipment</td>
<td>Design</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)
SUBSTANTIATION:
The above revisions reflect the latest updates to the ASHRAE standards that are referenced in Table 1701.1 and Table 1701.2.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29    NOT RETURNED: 1    Heine
Proposals

Item #: 334
UMC 2024  Section: Table 1701.1, Table 1701.2

SUBMITTER: Carlton Ramcharran
ASME

RECOMMENDATION:
Revise text

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B1.20.1-2013</td>
<td>Pipe Threads, General Purpose (Inch)</td>
<td>Joints</td>
<td>1211.2(3), 1211.4(7), 1211.12(3), 1211.13(2), 1308.5.6</td>
</tr>
<tr>
<td>ASME B31.3-2018</td>
<td>Process Piping</td>
<td>Process Piping</td>
<td>1406.1</td>
</tr>
<tr>
<td>ASME B31.5-2019</td>
<td>Refrigeration Piping and Heat Transfer Components</td>
<td>Refrigeration Piping</td>
<td>1109.1.1, 1109.1.3</td>
</tr>
<tr>
<td>ASME BPVC Section I-2017</td>
<td>Rules for Construction of Power Boilers</td>
<td>Boilers</td>
<td>1002.1(1), Table 1003.2.1</td>
</tr>
<tr>
<td>ASME BPVC Section IV-2019</td>
<td>Rules for Construction of Heating Boilers</td>
<td>Boilers</td>
<td>1002.1(2)</td>
</tr>
<tr>
<td>ASME BPVC Section VIII.1-2017</td>
<td>Rules for Construction of Pressure Vessels Division 1</td>
<td>Pressure Vessels</td>
<td>1002.1, 1004.3, 1112.10.1, 1112.13, 1113.1, 1115.4, 1115.4.1, 1117.1(2), 1117.1(3), 1117.2, 1209.4</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

Note: The ASME standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME A13.1-2015</td>
<td>Scheme for the Identification of Piping Systems</td>
<td>Piping</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

SUBSTANTIATION:
The above revisions reflect the latest updates to the ASME standards that are referenced in Table 1701.1 and Table 1701.2.

COMMITTEE ACTION: ACCEPT AS SUBMITTED
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<tbody>
<tr>
<td>VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine</td>
</tr>
</tbody>
</table>

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**Proposals**

Item #: 335  
UMC 2024  Section: Table 1701.1

**SUBMITTER:** Terry Burger  
ASSE

**RECOMMENDATION:**  
Revise text

### TABLE 1701.1  
REFERENCE STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSE 1061-2015 2020</td>
<td>Push-Fit Fittings</td>
<td>Fittings</td>
<td>1211.2(1), 1211.4(5), Table 1210.1</td>
</tr>
<tr>
<td>ASSE 1079-2012 (R2021)</td>
<td>Dielectric Pipe Fittings</td>
<td>Fittings</td>
<td>1211.14.1</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

**Note:** The ASSE standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

**SUBSTANTIATION:**  
The above revisions reflect the latest updates to the ASSE standards that are referenced in Table 1701.1.

**COMMITTEE ACTION:** ACCEPT AS SUBMITTED

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**  
AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 336
UMC 2024  Section: 303.8.4.1, Table 1701.1

SUBMITTER: Lauren Bauerschmidt
ASSP

RECOMMENDATION:
Revise text

303.8.4.1 Guards and Rails. Guards or rails shall be required where the following exist:
(1) The clearance between the appliance and a roof edge or open end of an equipment platform is less than 6 feet (1829 mm).
(2) The open end of the equipment platform is located more than 30 inches (762 mm) above the roof, floor, or grade below.
Where guards or rails are installed, they shall be constructed so as to prevent the passage of a 21 inch (533 mm) diameter ball, resist the imposed loading conditions, and shall extend not less than 30 inches (762 mm) beyond each side of the equipment or appliance.
Exception: Guards shall not be required where a permanent fall arrest anchorage connector system in accordance with ASSE ASSP Z359.1 is installed.

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSE ASSP Z359.1-2020</td>
<td>The Fall Protection Code</td>
<td>Miscellaneous</td>
<td>303.8.4.1</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

Note: ASSP Z359.1 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The above revisions reflect the latest updates to the ASSP standards that are referenced in Table 1701.1.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29 NOT RETURNED: 1  Heine
Proposals

Item #: 337  
UMC 2024  Section: Table 1701.1, Table 1701.2

SUBMITTER: Steve Mawn  
ASTM

RECOMMENDATION:  
Revise text

**TABLE 1701.1**  
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A53/A53M-2018 2020</td>
<td>Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless</td>
<td>Piping</td>
<td>1308.5.2.1(1), Table 1210.1</td>
</tr>
<tr>
<td>ASTM A106/A106M-2018 2019a</td>
<td>Seamless Carbon Steel Pipe for High-Temperature Service</td>
<td>Piping</td>
<td>1308.5.2.1(2), Table 1210.1</td>
</tr>
<tr>
<td>ASTM A254/A254M-2012 (R2019)</td>
<td>Copper-Brazed Steel Tubing</td>
<td>Piping</td>
<td>1308.5.3.2, Table 1210.1</td>
</tr>
<tr>
<td>ASTM A268/A268M-2010 (R2014) 2020</td>
<td>Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service</td>
<td>Tubing</td>
<td>1308.5.3.1(1)</td>
</tr>
<tr>
<td>ASTM A269/A269M-2015a (R2019)</td>
<td>Seamless and Welded Austenitic Stainless Steel Tubing for General Service</td>
<td>Piping, Tubing</td>
<td>1308.5.3.1(2), Table 1210.1</td>
</tr>
<tr>
<td>ASTM A312/A312M-2018a 2019</td>
<td>Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes</td>
<td>Piping Ferrous</td>
<td>1308.5.2.1(3), Table 1210.1</td>
</tr>
<tr>
<td>ASTM A420/A420M-2016-2020</td>
<td>Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM B32-2008 (R2014)-2020</td>
<td>Solder Metal</td>
<td>Joints</td>
<td>1211.4(6)</td>
</tr>
<tr>
<td>ASTM B42-2015a-2020</td>
<td>Seamless Copper Pipe, Standard Sizes</td>
<td>Piping</td>
<td>Table 1210.1</td>
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<tr>
<td>ASTM B43-2015-2020</td>
<td>Seamless Red Brass Pipe, Standard Sizes</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM B75/B75M-2014 2020</td>
<td>Seamless Copper Tube</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM B88-2016-2020</td>
<td>Seamless Copper Water Tube</td>
<td>Piping</td>
<td>1308.5.3.3, Table 1210.1</td>
</tr>
<tr>
<td>ASTM B210-2042-2019a</td>
<td>Aluminum and Aluminum-Alloy Drawn Seamless Tubes</td>
<td>Piping</td>
<td>1308.5.3.4</td>
</tr>
<tr>
<td>ASTM B280-2014-2020</td>
<td>Seamless Copper Tube for Air Conditioning and Refrigeration Field Service</td>
<td>Piping</td>
<td>1109.1.2, 1308.5.3.3</td>
</tr>
<tr>
<td>ASTM C411-2017</td>
<td>Hot-Surface Performance of High-Temperature Thermal Insulation</td>
<td>Duct Coverings and Linings</td>
<td>605.1.2</td>
</tr>
<tr>
<td>ASTM D1693-2018</td>
<td>Environmental Stress-Cracking of Ethylene Plastics</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM D2241-2015-2020</td>
<td>Poly-(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>STANDARD NUMBER</td>
<td>STANDARD TITLE</td>
<td>APPLICATION</td>
<td>REFERENCED SECTION</td>
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<tr>
<td>ASTM D2467-2015-2020</td>
<td>Poly-(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM D2513-2018a 2020</td>
<td>Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings</td>
<td>Piping</td>
<td>1308.5.4, 1308.5.4.2.2, 1308.5.8.2, 1310.1.7.1(1), Table 1210.1</td>
</tr>
<tr>
<td>ASTM D2564-2042 (R2018)-2020</td>
<td>Solvent Cements for Poly-(Vinyl Chloride) (PVC) Plastic Piping Systems</td>
<td>Joints</td>
<td>1211.12(2)</td>
</tr>
<tr>
<td>ASTM D2846/D2846M-2017b-2019a</td>
<td>Chlorinated Poly-(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems</td>
<td>Piping</td>
<td>1211.2(2), 1211.3(2), Table 1210.1</td>
</tr>
<tr>
<td>ASTM E84-2018b-2021</td>
<td>Surface Burning Characteristics of Building Materials</td>
<td>Miscellaneous</td>
<td>508.3.4, 602.2, 605.1.1, 605.1.2, 1201.2</td>
</tr>
<tr>
<td>ASTM E2231-2018-2019</td>
<td>Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics</td>
<td>Insulation of Ducts</td>
<td>605.1.2</td>
</tr>
<tr>
<td>ASTM E2336-2046-2020</td>
<td>Fire Resistive Grease Duct Enclosure Systems</td>
<td>Grease Ducts</td>
<td>507.4.2.2, 507.4.4</td>
</tr>
<tr>
<td>ASTM F439-2013-2019</td>
<td>Chlorinated Poly-(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F441/F441M-2016-2020</td>
<td>Chlorinated Poly-(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F442/F442M-2013+2020</td>
<td>Chlorinated Poly-(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)</td>
<td>Piping</td>
<td>1210.1, 1211.2(2)</td>
</tr>
<tr>
<td>ASTM F493-2014-2020</td>
<td>Solvent Cements for Chlorinated Poly-(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings</td>
<td>Joints</td>
<td>1211.2(2), 1211.3(2)</td>
</tr>
<tr>
<td>ASTM F714-2043 2021</td>
<td>Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter</td>
<td>Piping, Plastic</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F876-2017-2020b</td>
<td>Crosslinked Polyethylene (PEX) Tubing</td>
<td>Piping</td>
<td>1211.5, Table 1210.1</td>
</tr>
<tr>
<td>ASTM F877-2018a-2020</td>
<td>Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F1476-2007 (R2013) (R2019)</td>
<td>Performance of Gasketed Mechanical Couplings for Use in Piping Applications</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F1807-2018a 2019b</td>
<td>Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F1960-2018a 2020</td>
<td>Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F1970-2042+2019</td>
<td>Special Engineered Fittings, Appurtenances or Valves for Use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
</tbody>
</table>
### TABLE 1701.1 REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM F1974-2009 (R2015) (R2020)</td>
<td>Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Crosslinked Polyethylene/Aluminum/ Crosslinked Polyethylene Composite Pressure Pipe</td>
<td>Fittings</td>
<td>1211.6(1), 1211.9(1), Table 1210.1</td>
</tr>
<tr>
<td>ASTM F2080-2018-2019</td>
<td>Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR9 Polyethylene of Raised Temperature (PE-RT) Pipe</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F2159-2018a 2020</td>
<td>Plastic Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps for SDR9 Cross-linked Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F2389-2017a 2019</td>
<td>Pressure-Rated Polypropylene (PP) Piping Systems</td>
<td>Piping</td>
<td>1211.11(1), Table 1210.1</td>
</tr>
<tr>
<td>ASTM F2434-2018-2019</td>
<td>Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Tubing</td>
<td>Fittings</td>
<td>1211.6(1), Table 1210.1</td>
</tr>
<tr>
<td>ASTM F2620-2013-2020</td>
<td>Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings</td>
<td>Joints</td>
<td>1211.8(1), 1211.8(3)</td>
</tr>
<tr>
<td>ASTM F2623-2014-2019</td>
<td>Polyethylene of Raised Temperature (PE-RT) SDR9 Tubing for Non-Potable Water Applications</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F2855-2012-2019</td>
<td>Specification for Chlorinated Poly-(Vinyl Chloride)/Aluminum/Chlorinated Poly-(Vinyl Chloride) (CPVC-AL-CPVC) Composite Pressure Tubing</td>
<td>Piping, Plastic</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F3226/F3226M-2014e1 2019</td>
<td>Metallic Press-Connect Fittings for Piping and Tubing Systems</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>ASTM F3253-2018-2019</td>
<td>Crosslinked Polyethylene (PEX) Tubing with Oxygen Barrier for Hot- and Cold-Water Hydronic Distribution Systems</td>
<td>Piping</td>
<td>Table 1210.1</td>
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(portion of table not shown remain unchanged)

Note: The ASTM standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

### TABLE 1701.2 STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
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<tbody>
<tr>
<td>ASTM A568/A568M-2014a 2019a</td>
<td>Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for</td>
<td>Piping</td>
</tr>
<tr>
<td>ASTM A653/A653M-2014-2020</td>
<td>Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process</td>
<td>Piping, Ferrous</td>
</tr>
<tr>
<td>ASTM D93-2014-2020</td>
<td>Flash Point by Pensky-Martens Closed Cup Tester</td>
<td>Certification</td>
</tr>
<tr>
<td>ASTM D396-2014a</td>
<td>Fuel Oils</td>
<td>Boiler</td>
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</table>
SUBSTANTIATION:
The above revisions reflect the latest updates to the ASTM standards that are referenced in Table 1701.1 and Table 1701.2.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Item #: 338

UMC 2024 Section: Table 1701.1

SUBMITTER: Peter Portela
AWS

RECOMMENDATION:
Revise text

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
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<tbody>
<tr>
<td>AWS A5.8M/A5.8-2011-AMD1-2019</td>
<td>Filler Metals for Brazing and Braze Welding</td>
<td>Joints</td>
<td>1211.4(1)</td>
</tr>
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</table>

Note: The AWS standard meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

SUBSTANTIATION:
The above revision reflects the latest update to the AWS standard that is referenced in Table 1701.1.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Item #: 339
UMC 2024  Section: Table 1701.1

SUBMITTER: Paul Olson
AWWA

RECOMMENDATION:
Revise text

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<thead>
<tr>
<th>STANDARD NUMBER</th>
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<tbody>
<tr>
<td>AWWA C115-2011</td>
<td>Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Treaded Flanges</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>AWWA C153-2011</td>
<td>Ductile-Iron Compact Fittings</td>
<td>Fittings</td>
<td>Table 1210.1</td>
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(portion of table not shown remain unchanged)

Note: The AWWA standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

SUBSTANTIATION:
The above revisions reflect the latest updates to the AWWA standards that are referenced in Table 1701.1.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
### TABLE 1701.1
**REFERENCED STANDARDS**

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
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<tbody>
<tr>
<td><strong>CSA B137.1-2017 2020</strong></td>
<td>Polyethylene (PE) Pipe, Tubing, and Fittings for Cold-Water Pressure Services</td>
<td>Piping</td>
<td>Table 1210.1</td>
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<tr>
<td><strong>CSA B137.5-2017 2020</strong></td>
<td>Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td><strong>CSA B137.6-2017 2020</strong></td>
<td>Chlorinated Polyvinylchloride (CPVC) Pipe, Tubing, and Fittings for Hot- and Cold-Water Distribution Systems</td>
<td>Piping, Plastic</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td><strong>CSA B137.9-2017 2020</strong></td>
<td>Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure-Pipe Systems</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td><strong>CSA B137.10-2017 2020</strong></td>
<td>Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Composite Pressure-Pipe Systems</td>
<td>Piping</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td><strong>CSA B137.11-2017 2020</strong></td>
<td>Polypropylene (PP-R &amp; PP-RCT) Pipe and Fittings for Pressure Applications</td>
<td>Piping</td>
<td>1211.11(1), Table 1210.1</td>
</tr>
<tr>
<td><strong>CSA B137.18-2017 2020</strong></td>
<td>Polyethylene of Raised Temperature Resistance (PE-RT) Tubing Systems for Pressure Applications</td>
<td>Piping, Plastic</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td><strong>CSA/ANSI Z21.10.1-2017 2019/CSA 4.1-2019</strong></td>
<td>Gas Water Heaters, Volume I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less (same as CSA 4.1)</td>
<td>Fuel Gas, Appliances</td>
<td>Table 1203.2</td>
</tr>
<tr>
<td><strong>CSA/ANSI Z21.10.3-2017 2019/CSA 4.3-2019</strong></td>
<td>Gas-Fired Water Heaters, Volume III, Storage Water Heaters with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous (same as CSA 4.3)</td>
<td>Fuel Gas, Appliances</td>
<td>Table 1203.2</td>
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</table>
### TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
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<th>APPLICATION</th>
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<tr>
<td>CSA/ANSI Z21.11.2-2016-2019</td>
<td>Gas-Fired Room Heaters, Volume II, Unvented Room Heaters</td>
<td>Room Heaters, Unvented Heaters</td>
</tr>
<tr>
<td>CSA/ANSI Z21.17a-2008(R2014) (R2019)/CSA 2.7a-2008 (R2019)</td>
<td>Domestic Gas Conversion Burners (same as CSA 2.7a)</td>
<td>Conversion Burner Installation, Gas Burners</td>
</tr>
<tr>
<td>CSA/ANSI Z21.18b-2012(R2016) 2019/CSA 6.3-2019</td>
<td>Gas Appliance Pressure Regulators (same as CSA 6.3b)</td>
<td>Appliance Regulators, Gas Refrigerators, Pressure Regulators</td>
</tr>
<tr>
<td>CSA/ANSI Z21.50-2016/CSA 2.22-2019</td>
<td>Vented Decorative Gas Appliances (same as CSA 2.22)</td>
<td>Appliances, Decorative Appliances</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Note: The CSA standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.
SUBSTANTIATION:
The above revisions reflect the latest updates to the CSA standards that are referenced in Table 1701.1 and Table 1701.2.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 341
UMC 2024  Section: Table 1701.1, Table 1701.2

SUBMITTER: Kyle Thompson
IAPMO

RECOMMENDATION:
Revise text

TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
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<tbody>
<tr>
<td>IAPMO PS 117-2017-2019</td>
<td>Press and Nail Connections</td>
<td>Fittings</td>
<td>Table 1210.1</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

Note: The IAPMO standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
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<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
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<tbody>
<tr>
<td>IAPMO IGC 293-2012 (R2020)</td>
<td>Tubing and Fittings for Special Hydronic Radiant Drywall Panels</td>
<td>HVAC, Fittings, Tubing</td>
</tr>
<tr>
<td>IAPMO PS 120-2004 2019</td>
<td>Flashing and Stand Combination for Air Conditioning Units (Residential or Commercial Unit Curb)</td>
<td>Air Conditioning Flashing Stand</td>
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</table>

(portion of table not shown remain unchanged)

SUBSTANTIATION:
The above revisions reflect the latest updates to the IAPMO standards that are referenced in Table 1701.1 and Table 1701.2.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 342

UMC 2024  Section: 218.0, Table 1701.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

### TABLE 1701.1
REFERENCED STANDARDS

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<th>REFERENCED SECTION</th>
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<tbody>
<tr>
<td>IAPMO/ANSI UPC 1-2021</td>
<td>Uniform Plumbing Code</td>
<td>Plumbing Systems</td>
<td>218.0</td>
</tr>
</tbody>
</table>

Note: IAPMO/ANSI UPC 1 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

(portion of table not shown remain unchanged)

218.0 – P –

Plumbing Code. The Uniform Plumbing Code (UPC) promulgated by the International Association of Plumbing and Mechanical Officials (IAPMO), as adopted by this jurisdiction.

SUBSTANTIATION:
Table 1701.1 is being updated to include the reference to the Uniform Plumbing Code (UPC), an ANSI standard, which is referenced in Section 218.0.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 343
UMC 2024  Section: Table 1701.1

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Revise text

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<tr>
<td>IAPMO/ANSI USHGC 1-2021</td>
<td>Uniform Solar, Hydronics and Geothermal Code</td>
<td>Solar, Hydronics, Geothermal</td>
<td>1207.4, 1501.1</td>
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</tbody>
</table>

(portions of table not shown remain unchanged)

Note: IAPMO/ANSI USHGC 1 meets the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

(below shown for reference only)

1207.0 Heating Appliances and Equipment.

1207.4 Solar Heat Collector Systems. Solar water heating systems used in hydronic panel radiant heating systems shall be installed in accordance with the Uniform Solar, Hydronics and Geothermal Code (USHGC).

1501.0 General.
1501.1 Applicability. See Section 1203.0 and the Uniform Solar, Hydronics and Geothermal Code (USHGC), published by the International Association of Plumbing and Mechanical Officials. The Uniform Solar, Hydronics and Geothermal Code (USHGC) provides requirements that shall be permitted to be adopted as part of the code by the Authority Having Jurisdiction.

SUBSTANTIATION:
Table 1701.1 is being updated to include the reference to the Uniform Solar, Hydronics and Geothermal Code (USHGC), an ANSI standard, which is referenced in Section 1207.4 and Section 1501.1, in accordance with the IAPMO Rules and Regulations.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 344
UMC 2024 Section: Table 1701.1

SUBMITTER: Eric Smith
IIAR

RECOMMENDATION:
Revise text

### TABLE 1701.1
**REFERENCED STANDARDS**

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<th>REFERENCED SECTION</th>
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</thead>
</table>

(portion of table not shown remain unchanged)

Note: IIAR 4 and IIAR 5 meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

Note: IIAR 2 is a working draft and is not completed at the time of this monograph.

SUBSTANTIATION:
The above revisions reflect the latest updates to the IIAR standards that are referenced in Table 1701.1.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

### TABLE 1701.1
**REFERENCED STANDARDS**

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
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<tr>
<td>IIAR/ANSI 4-2020</td>
<td>Installation of Closed-Circuit Ammonia Refrigeration Systems</td>
<td>Ammonia Refrigeration Systems</td>
<td>1102.2</td>
</tr>
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<td>IIAR 5-2019</td>
<td>Startup of Closed-Circuit Ammonia Refrigeration Systems</td>
<td>Ammonia Refrigeration Systems</td>
<td>1102.2</td>
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(portion of table not shown remain unchanged)
COMMITTEE STATEMENT:
IIAR 2-2021 was a working draft and was not completed at the time of this monograph. Therefore, IIAR 2 is being modified to remain as the 2014 edition.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
**TABLE 1701.1**
**REFERENCED STANDARDS**

<table>
<thead>
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<th>REFERENCE NUMBER</th>
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<th>REFERENCED SECTION</th>
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<tr>
<td>NFPA 2-2016-2020</td>
<td>Hydrogen Technologies Code</td>
<td>Gaseous Hydrogen Systems</td>
<td>937.1</td>
</tr>
<tr>
<td>NFPA 17-2017-2021</td>
<td>Dry Chemical Extinguishing Systems</td>
<td>Fire Extinguishing</td>
<td>513.2.3(3), 513.3.5</td>
</tr>
<tr>
<td>NFPA 17A-2017-2021</td>
<td>Wet Chemical Extinguishing Systems</td>
<td>Fire Extinguishing</td>
<td>513.2.3(4), 513.2.5.6, 513.3.5</td>
</tr>
<tr>
<td>NFPA 30A-2018-2021</td>
<td>Motor Fuel Dispensing Facilities and Repair Garages</td>
<td>Miscellaneous</td>
<td>303.11.1</td>
</tr>
<tr>
<td>NFPA 31-2018-2020</td>
<td>Installation of Oil-Burning Equipment</td>
<td>Fuel Gas, Appliances</td>
<td>301.5, 1002.2.2, 1301.1</td>
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<tr>
<td>NFPA 58-2017-2020</td>
<td>Liquefied Petroleum Gas Code</td>
<td>Fuel Gas</td>
<td>303.7, 516.2.1, 1308.5.4.2.3, 1308.5.8.4, 1310.6(7), 1312.11</td>
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<td>NFPA 70-2017-2020</td>
<td>National Electrical Code</td>
<td>Miscellaneous</td>
<td>301.4(1), 301.4(3), 511.1.6, 512.2.5, 516.2.7, 516.2.9(4), 602.2.1, 905.8.2, 1104.4(5), 1107.1.7, 1107.1.8, 1217.8.1, 1310.14.5(2), 1311.2.4, 1311.7</td>
</tr>
<tr>
<td>NFPA 90B-2018-2021</td>
<td>Installation of Warm Air Heating and Air-Conditioning Systems</td>
<td>HVAC</td>
<td>604.1</td>
</tr>
<tr>
<td>NFPA 654-2018-2020</td>
<td>Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids</td>
<td>Dust Explosion Prevention, Gutters</td>
<td>506.6, Table 505.9</td>
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</table>
Note: The NFPA standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO's Regulations Governing Committee Projects.

TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFPA 30-2018-2021</td>
<td>Flammable and Combustible Liquids Code</td>
<td>Combustible Liquids, Flammable Liquids</td>
</tr>
<tr>
<td>NFPA 91-2016-2020</td>
<td>Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids</td>
<td>Product Conveying Ducts</td>
</tr>
<tr>
<td>NFPA 221-2018-2021</td>
<td>High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls</td>
<td>Building Fire Walls, Fire Barrier</td>
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</tbody>
</table>

SUBSTANTIATION:
The above revisions reflect the latest updates to the NFPA standards that are referenced in Table 1701.1 and Table 1701.2.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1
Proposals

Item #: 346
UMC 2024 Section: Table 1701.1, Table 1701.2

SUBMITTER: Jeremy Brown
NSF

RECOMMENDATION:
Revise text

### TABLE 1701.1
REFERENCED STANDARDS

<table>
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<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF/ANSI 358-1-2017</td>
<td>Polyethylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems</td>
<td>Piping, Plastic</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>NSF/ANSI 358-2-2017</td>
<td>Polypropylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems</td>
<td>Piping, Plastic</td>
<td>Table 1210.1</td>
</tr>
<tr>
<td>NSF/ANSI 358-3-2016</td>
<td>Cross-linked polyethylene (PEX) pipe and fittings for water-based ground-source (geothermal) heat pump systems</td>
<td>Piping, Plastic</td>
<td>Table 1210.1</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

Note: The NSF standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.

### TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
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<tbody>
<tr>
<td>NSF/ANSI/CAN 60-2017</td>
<td>Drinking Water Treatment Chemicals - Health Effects</td>
<td>Miscellaneous</td>
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(portion of table not shown remain unchanged)

SUBSTANTIATION:
The above revisions reflect the latest updates to the NSF standards that are referenced in Table 1701.1 and Table 1701.2.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 29 NOT RETURNED: 1 Heine
Proposals

Item #: 347
UMC 2024  Section: Table 1701.1, Table 1701.2

SUBMITTER: John Taecker
UL LLC

RECOMMENDATION:
Revise text

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<tr>
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<td>UL 127-2011</td>
<td>Factory-Built Fireplaces (with revisions through July 27–2016 February 25, 2020)</td>
<td>Fireplaces</td>
<td>802.5.1.1, 913.1, 913.1.1</td>
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<td>Commercial Electric Cooking Appliances (with revisions through January 26–2018 July 10, 2020)</td>
<td>Appliances, Commercial Cooking, Electric Appliances</td>
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<td>UL 207-2009</td>
<td>Refrigerant-Containing Components and Accessories, Nonelectrical (with revisions through June 27–2014 January 21, 2020)</td>
<td>Refrigeration Components</td>
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<td>UL 268A-2008</td>
<td>Smoke Detectors for Duct Application (with revisions through August 12–2016 August 18, 2020)</td>
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<td>UL 295-2017</td>
<td>Commercial-Industrial Gas Burners (with revisions through August 22, 2019)</td>
<td>Gas Burners</td>
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<td>UL 296-2017</td>
<td>Oil Burners (with revisions through November 29, 2017 January 8, 2021)</td>
<td>Fuel Gas, Appliances</td>
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<td>UL 300-2006 2019</td>
<td>Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment (with revisions through December 16, 2014)</td>
<td>Certification</td>
<td>513.2.2, 513.2.5, 517.3.1.1(6)</td>
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<td>UL 391-2010</td>
<td>Solid-Fuel and Combination-Fuel Central and Supplementary Furnaces (with revisions through June 42-2014 August 28, 2019)</td>
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<td>Gas Vents (with revisions through July 27–2016 August 28, 2019)</td>
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<td>Grounding and Bonding Equipment (with revisions through June 7, 2017)</td>
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<td>Commercial Refrigerators and Freezers (with revisions through November 8–2016 September 12, 2019)</td>
<td>Freezers, Refrigerators</td>
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<td>UL 555-2006</td>
<td>Fire Dampers (with revisions through October 21, 2016 October 9, 2020)</td>
<td>Dampers</td>
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<td>UL 555S-2014</td>
<td>Smoke Dampers (with revisions through October 27, 2016 October 9, 2020)</td>
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<td>606.1</td>
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<td>UL 651-2011</td>
<td>Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings (with revisions through June 15–2016 March 24, 2019)</td>
<td>Piping, Plastic</td>
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<td>Description</td>
<td>Reference Dates</td>
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<td>705-2017</td>
<td>Power Ventilators (with revisions through October 8, 2018 August 30, 2019)</td>
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<td>Exhaust Hoods for Commercial Cooking Equipment (with revisions through June 25, 2018 August 20, 2019)</td>
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<td>710B-2011</td>
<td>Recirculating Systems (with revisions through August 14, 2014 February 1, 2019)</td>
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<td>737-2011</td>
<td>Fireplace Stoves (with revisions through August 19, 2015 February 25, 2020)</td>
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<td>778-2016</td>
<td>Motor Operated Water Pumps (with revisions through October 20, 2017 August 11, 2020)</td>
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<td>795-2016</td>
<td>Commercial-Industrial Gas Heating Equipment (with revisions through September 29, 2020)</td>
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<td>834-2004</td>
<td>Heating, Water Supply, and Power Boilers - Electric (with revisions through September 24, 2018 July 17, 2019)</td>
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<td>858-2014</td>
<td>Household Electric Ranges (with revisions through June 4, 2018 September 12, 2019)</td>
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<td>907-2016</td>
<td>Fireplace Accessories (with revisions through August 28, 2019)</td>
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<td>921-2016</td>
<td>Commercial Dishwashers (with revisions through September 29, 2017)</td>
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<tr>
<td>923-2013</td>
<td>Microwave Cooking Appliances (with revisions through July 49, 2017 August 27, 2020)</td>
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<td>959-2010</td>
<td>Medium Heat Appliance Factory-Built Chimneys (with revisions through June 12, 2014 August 28, 2019)</td>
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<td>1240-2005</td>
<td>Electric Commercial Clothes-Drying Equipment (with revisions through March 16, 2018 March 25, 2019)</td>
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<td>1482-2011</td>
<td>Solid-Fuel Type Room Heaters (with revisions through August 19, 2015 February 25, 2020)</td>
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<td>1738-2010</td>
<td>Venting Systems for Gas-Burning Appliances, Categories II, III, and IV (with revisions through November 7, 2014 February 6, 2020)</td>
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<tr>
<td>1777-2015</td>
<td>Chimney Liners (with revisions through April 11, 2019)</td>
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<td>1995-2015</td>
<td>Heating and Cooling Equipment (with revisions through August 17, 2018)</td>
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<td>1996-2009</td>
<td>Electric Duct Heaters (with revisions through July 15, 2016 August 7, 2020)</td>
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<tr>
<td>2158-2018</td>
<td>Electric Clothes Dryers (with revisions through September 20, 2019)</td>
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<td>2162-2014</td>
<td>Commercial Wood-Fired Baking Ovens, Refractory Type (with revisions through August 1, 2019)</td>
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<tr>
<td>2200-2014</td>
<td>Stationary Engine Generator Assemblies (with revisions through July 29, 2014)</td>
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<tr>
<td>2790-2010</td>
<td>Commercial Incinerators (with revisions through October 8, 2014 June 18, 2019)</td>
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</table>

Note: The UL standards meet the requirements for mandatory reference standards in accordance with Section 3-3.7.1 of IAPMO’s Regulations Governing Committee Projects.
### TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
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</thead>
<tbody>
<tr>
<td>UL 33-2010</td>
<td>Heat Responsive Links for Fire-Protection Service (with revisions through April 14, 2016 April 28, 2020)</td>
<td>Fusible Links</td>
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<tr>
<td>UL 80-2007 2009</td>
<td>Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids (with revisions through January 16, 2014 April 26, 2019)</td>
<td>Fuel Gas</td>
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<tr>
<td>UL 125-2014 2020</td>
<td>Flow Control Valves for Anhydrous Ammonia and LP-Gas (with revisions through January 12, 2018)</td>
<td>Fuel Gas</td>
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<tr>
<td>UL 132-2015</td>
<td>Safety Relief Valves for Anhydrous Ammonia and LP-Gas (with revisions through January 12, 2016 January 16, 2020)</td>
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<tr>
<td>UL 144-2012</td>
<td>LP-Gas Regulators (with revisions through November 05, 2014 December 10, 2019)</td>
<td>Fuel Gas</td>
</tr>
<tr>
<td>UL 174-2004</td>
<td>Household Electric Storage Tank Water Heaters (with revisions through December 16, 2016 September 15, 2020)</td>
<td>Appliances</td>
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<tr>
<td>UL 180-2012 2019</td>
<td>Liquid Level Gauges for Oil Burner Fuels and other combustible liquids (with revisions through May 12, 2017) Combustible Liquid Tank Accessories (with revisions through May 8, 2020)</td>
<td>Gauges, Level Gauges</td>
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<tr>
<td>UL 429-2013</td>
<td>Electrically Operated Valves (with revisions through January 16, 2020)</td>
<td>Valves</td>
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<tr>
<td>UL 733-1993 2019</td>
<td>Oil-Fired Air Heaters and Oil-Fired Direct-Fired Heaters (with revisions through October 9, 2013)</td>
<td>Water Heaters, Direct Fired Oil Fired</td>
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<tr>
<td>UL 842-2015 2020</td>
<td>Valves for Flammable Fluids and Combustible Liquids (with revisions through October 27, 2017)</td>
<td>Valves</td>
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</table>

(portion of table not shown remain unchanged)

**SUBSTANTIATION:**
The above revisions reflect the latest updates to the UL standards that are referenced in Table 1701.1 and Table 1701.2.

**COMMITTEE ACTION:** ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

### TABLE 1701.1
REFERENCED STANDARDS

<table>
<thead>
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<td>UL 268A-2008</td>
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<td>910.2</td>
</tr>
<tr>
<td>UL 296-2017</td>
<td>Oil Burners (with revisions through January 8, 2021)</td>
<td>Fuel Gas, Appliances</td>
<td>910.1</td>
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<tr>
<td>UL 300-2019</td>
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<td>Certification</td>
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<td>Solid-Fuel and Combination-Fuel Central and Supplementary</td>
<td>Furnaces, Solid</td>
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<td>UL 441-2016</td>
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<td>Heating, Water Supply, and Power Boilers - Electric (with revisions through July 17, 2019)</td>
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<td>1002.3, Table 1203.2</td>
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<td>Household Electric Ranges (with revisions through September 12, 2019)</td>
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<td>Fireplace Accessories (with revisions through August 28, 2019)</td>
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<td>UL 180-2019</td>
<td>Combustible Liquid Tank Accessories (with revisions through May 8, 2020)</td>
<td>Gauges, Level Gauges</td>
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<td>Electrically Operated Valves (with revisions through January 16, 2020)</td>
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<td>Valves for Flammable and Combustible Liquids</td>
<td>Valves</td>
</tr>
</tbody>
</table>

(portion of table not shown remain unchanged)

**COMMITTEE STATEMENT:**
The modification removes UL 207 based on the action take in Item # 225.

**TOTAL ELIGIBLE TO VOTE:** 30

**VOTING RESULTS:**
- **AFFIRMATIVE:** 16
- **NEGATIVE:** 12
- **ABSTAIN:** 1
- **NOT RETURNED:** 1 Heine

**Note:** Item # 347 failed to achieve the necessary 2/3 affirmative vote of return ballots. In accordance with Section 4-3.5.2 of the Regulations Governing Committee Projects, a public comment is requested for this proposal. The Technical Committee will reconsider this proposal as a public comment.

**EXPLANATION OF NEGATIVE:**

**BALLANCO:** UL 207 should not be stricken in the modification. The standard regulates many refrigerant components, including tubing and fittings. This change should have been accepted as submitted.

**CUDAHY, TRAFTON, A; WISEMAN:** UL 207 should remain.

**FEEHAN, KREITENBERG:** UL 207 needs to remain in the code.

**GUNZNER:** Similar reasons given for Item # 225 regarding UL 207.

**KOERBER:** UL 207 should not be stricken in the modification.

**MACNEVIN:** Item should have been accepted as submitted, with the inclusion of Item # 347, for reasons stated by others.

**TRAFTON, P:** I am in complete agreement with Julius Ballanco's comments and believe UL 207 belongs here.

**VAN RITE:** UL 207 should remain in the code.

**WHITE:** UL 207 is an important standard and should remain in the code.

**EXPLANATION OF ABSTAIN:**

**TERZIGNI:** I am waiting to see what happens with Item # 225.
Proposals

Item #: 348

UMC 2024  Section: Table 1701.2

SUBMITTER: Kaley Garubba
Manufacturers Standardization Society (MSS)

RECOMMENDATION:
Revise text

### TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

<table>
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<tr>
<td>MSS SP-80-2013</td>
<td>Bronze Gate, Globe, Angle, and Check Valves</td>
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<tr>
<td>MSS SP-106-2042</td>
<td>Cast Copper Alloy Flanges and Flanged Fittings: Class 125, 150, and 300</td>
<td>Fittings</td>
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</table>

(portion of table not shown remain unchanged)

SUBSTANTIATION:
The above revisions reflect the latest updates to the MSS standards that are referenced in Table 1701.2.

COMMITTEE ACTION: ACCEPT AS SUBMITTED

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS:  AFFIRMATIVE: 29  NOT RETURNED: 1  Heine
Proposals

Item #: 349

UMC 2024  Section: Table 1701.2

SUBMITTER: Phillip H Ribbs
PHR Consultants

RECOMMENDATION:
Add new text

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
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</thead>
<tbody>
<tr>
<td>10 CFR 431</td>
<td>Energy Efficiency Program for Certain Commercial and Industrial Equipment</td>
<td>Energy</td>
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<tr>
<td>10 CFR 430</td>
<td>Energy Conservation Program for Consumer Products</td>
<td>Energy</td>
</tr>
<tr>
<td>29 CFR 1910.1000</td>
<td>Air Contaminants</td>
<td>Air Quality</td>
</tr>
<tr>
<td>49 CFR 192</td>
<td>Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards</td>
<td>Gas Piping</td>
</tr>
<tr>
<td>49 CFR 192.123</td>
<td>Design Limitations for Plastic Pipe</td>
<td>Piping, Plastic</td>
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<td>ASHRAE GRP 158-1979</td>
<td>Cooling and Heating Load Calculation Manual</td>
<td>Ventilation</td>
</tr>
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<td>AMCA 205-2019</td>
<td>Energy Efficiency Classification for Fans</td>
<td>Energy</td>
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<td>UL 263-2011</td>
<td>Fire Tests of Building Construction and Materials (with revisions through September 09, 2020)</td>
<td>Fire Resistance</td>
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<td>ASHRAE 169-2020</td>
<td>Climatic Data for Building Design Standards</td>
<td>Miscellaneous</td>
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<tr>
<td>AHRI 550/590-2020</td>
<td>Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle</td>
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<tr>
<td>AHRI 560-2000</td>
<td>Absorption Water Chilling and Water Heating Packages</td>
<td>Refrigeration Systems</td>
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<tr>
<td>AHRI 310/380-2017</td>
<td>Packaged Terminal Air Conditioners and Heat Pumps (Same as CSA C744)</td>
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<tr>
<td>AHRI 390-2003</td>
<td>Performance Rating of Single Package Vertical Air-Conditioners and Heat Pumps</td>
<td>Air Conditioners</td>
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<tr>
<td>AHRI 910-2014</td>
<td>Performance Rating of Indoor Pool Dehumidifiers</td>
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<tr>
<td>AHRI 920-2020</td>
<td>Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units</td>
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<tr>
<td>AHRI 400-2015</td>
<td>Performance Rating of Liquid to Liquid Heat Exchangers</td>
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<tr>
<td>AHRI 1360-2017</td>
<td>Performance Rating of Computer and Data Processing Room Air Conditioners</td>
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<tr>
<td>AHAM RAC-1-2020</td>
<td>Energy Measurement Test Procedure for Room Air Conditioners</td>
<td>Air Conditioners</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)
SUBSTANTIATION:
The above list of standards exist in the appendices, but are not addressed in Table 1701.1. The standards are being added to the Table 1701.2 Referenced Standards table in accordance with IAPMO Rules Governing Committee Projects.

COMMITTEE ACTION: ACCEPT AS AMENDED BY THE TC

Amend proposal as follows:

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 CFR 431</td>
<td>Energy Efficiency Program for Certain Commercial and Industrial Equipment</td>
<td>Energy</td>
</tr>
<tr>
<td>10 CFR 430</td>
<td>Energy Conservation Program for Consumer Products</td>
<td>Energy</td>
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<tr>
<td>29 CFR 1910.1000</td>
<td>Air Contaminants</td>
<td>Air Quality</td>
</tr>
<tr>
<td>49 CFR 192</td>
<td>Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards</td>
<td>Gas Piping</td>
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<tr>
<td>49 CFR 192.123</td>
<td>Design Limitations for Plastic Pipe</td>
<td>Piping, Plastic</td>
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<tr>
<td>ASHRAE GRP 158-1979</td>
<td>Cooling and Heating Load Calculation Manual</td>
<td>Ventilation</td>
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<td>AMCA-205-2019</td>
<td>Energy Efficiency Classification for Fans</td>
<td>Energy</td>
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<tr>
<td>UL 263-2011</td>
<td>Fire Tests of Building Construction and Materials (with revisions through September 09, 2020)</td>
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</tr>
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<tr>
<td>AHAM RAC-1-2020</td>
<td>Energy Measurement Test Procedure for Room Air Conditioners</td>
<td>Air Conditioners</td>
</tr>
<tr>
<td>UL 207-2009</td>
<td>Refrigerant-Containing Components and Accessories, Nonelectrical (with revisions through January 21, 2020)</td>
<td>Refrigeration Components</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

COMMITTEE STATEMENT:
AMCA 205 is being removed from Table 1701.2 as it is not needed for the enforcement of energy efficiency classification for fans. UL 207 is being added to Table 1701.2 as it was removed from Table 1701.1 and is needed to enforce products that comply with UL 207.

TOTAL ELIGIBLE TO VOTE: 30

VOTING RESULTS: AFFIRMATIVE: 20 NEGATIVE: 8 ABSTAIN: 1 NOT RETURNED: 1 Heine

EXPLANATION OF AFFIRMATIVE:
BERGER: The UL 207-2009 (Revisions through January 21, 2020) is not referenced anywhere within the body of the UMC. The TC action is correct.

EXPLANATION OF NEGATIVE:

BALLANCO: UL 207 should not be added to this table. UL 207 should remain in Table 1701.1.

CUDAHY, WISEMAN: UL 207 should remain in Table 1701.1.

FEEHAN: UL 207 needs to remain in the code.

GUNZNER: UL 207 should remain in Table 1701.1. Similar reasons as given for Item # 225.

MACNEVIN: UL 207 should not be added to this table, as it should remain in Table 1701.1. This item should be accepted as submitted.

VAN RITE: UL 207 should remain in the code.

WHITE: UL 207 should remain in Table 1701.1 for reasons previously stated.

EXPLANATION OF ABSTAIN:

TERZIGNI: This is linked to other proposed changes in the code and I may change my vote based on changes to those other portions of the code.
Task Group Reports
UMC A2L Task Group Report

Roster:

<table>
<thead>
<tr>
<th>Member</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jay Egg (Chair)</td>
<td>Egg Geothermal, LLC</td>
</tr>
<tr>
<td>Julius Ballanco</td>
<td>JB Engineering and Code Consulting, P.C.</td>
</tr>
<tr>
<td>Rich Benkowski</td>
<td>United Association Department of Education</td>
</tr>
<tr>
<td>David Bixby</td>
<td>Air Conditioning Contractors of America (ACCA)</td>
</tr>
<tr>
<td>Dave Dias</td>
<td>Sheet Metal Workers Local 104</td>
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<tr>
<td>Eli Howard</td>
<td>SMACNA</td>
</tr>
<tr>
<td>Harshad Inamdar</td>
<td>Rheem Manufacturing</td>
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<tr>
<td>Philip Johnston</td>
<td>Daikin Applied Americas, Inc.</td>
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<tr>
<td>Jim Kendzel</td>
<td>ASA and HARDI</td>
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<tr>
<td>Robert Kuks</td>
<td>Sheet Metal Workers Local 104</td>
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<tr>
<td>David Mann</td>
<td>Self</td>
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<tr>
<td>Jay Peters</td>
<td>Codes and Standards International</td>
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<tr>
<td>Christopher Ruch</td>
<td>National Energy Management Institute Committee (NEMIC)</td>
</tr>
<tr>
<td>Stephen Spletzer</td>
<td>The Chemours Company</td>
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<tr>
<td>John Taecker</td>
<td>UL LLC</td>
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<tr>
<td>Rusty Tharp</td>
<td>Goodman Manufacturing</td>
</tr>
<tr>
<td>Helen Walter-Terrinoni</td>
<td>Air Conditioning, Heating, and Refrigeration Institute (AHRI)</td>
</tr>
<tr>
<td>Randy Young</td>
<td>Sacramento Joint Apprenticeship Training Committee</td>
</tr>
</tbody>
</table>

Overview:

The IAPMO Standards Council and Board of Directors requested that a task group be formed to address A2L since there were concerns and issues with A2L for human comfort applications, such as refrigerant detectors, refrigerant concentration limits, and exhaust termination requirements. Although there was not much concern with A2L for mechanical room applications, there was a need to also address such applications.

On May 2, 2019 in Denver, Colorado, the UMC TC Chair, Harvey Kreitenberg, approved the formation of a UMC A2L Task Group to address exposure risk to the public from mechanical equipment in the UMC and to provide guidance to assist in the control and intervention of Legionella associated with building mechanical systems.

The scope of the Uniform Mechanical Code (UMC) A2L Task Group was to develop recommendations to further this technology, determine the methods available to address A2L exposure risk to public health and safety, expand on the usage and control of A2L refrigerants associated with mechanical systems and equipment, and address related issues such as
flammability risk, toxicity, permissible exposure limit, leak detection systems, chemical compatibility and stability, and maintenance procedures for mechanical systems. The task group recommendations will be forwarded to the UMC Technical Committee for consideration in the development of the 2024 edition of the UMC.

The Task Group met four times via teleconference on July 8, 2020, August 24, 2020, October 19, 2020, and November 12, 2020. Proposed recommendations were obtained from members of the task group and any interested parties.

The Task Group generated recommendations based on ASHRAE 15 with several modifications to address the concerns of the committee regarding health and safety and enforceable code language. The Task Group generated four separate recommendations, as follows:
Recommendation 1 - Human Comfort
Recommendation 2 - Machinery Rooms
Recommendation 3 - Table 1104.1
Recommendation 4 - Labeling and Identification

A2L Task Group Recommendations

Recommendation 1 - Human Comfort:

1103.0 Classification.
1103.1 Classification of Refrigerants. Refrigerants shall be classified in accordance with Table 1102.3 or in accordance with ASHRAE 34 where approved by the Authority Having Jurisdiction.
1103.1.1 Safety Group. Table 1102.3 classifies refrigerants by toxicity and flammability, and assigns safety groups using combinations of toxicity class and flammability class. For the purposes of this chapter, the refrigerant Groups A1, A2L, A2, A3, B1, B2L, B2, and B3 shall be considered to be individual and distinct safety groups, as shown in Table 1103.1.1. Each refrigerant is assigned into not more than one group.

<table>
<thead>
<tr>
<th>Refrigerant Safety Group Classifications</th>
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<tbody>
<tr>
<td>Higher Flammability</td>
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<tr>
<td>Flammable</td>
</tr>
<tr>
<td>Lower Flammability</td>
</tr>
<tr>
<td>No Flame Propagation</td>
</tr>
</tbody>
</table>

1104.0 Requirements for Refrigerant and Refrigeration System Use.
1104.6 Group A2L Refrigerants for Human Comfort. High-probability systems using Group A2L refrigerants for human comfort applications shall comply with this section. [ASHRAE 15:7.6]
1104.6.1 Refrigerant Concentration Limits. Occupied spaces shall comply with Section 1104.2. Unoccupied spaces with refrigerant containing equipment, including but not limited to piping or tubing, shall comply with Section 1104.6.4. [ASHRAE 15:7.6.1-7.6.1.2]
1104.6.2 Listing and Installation Requirements. Refrigeration systems shall be listed and shall be installed in accordance with listing, the manufacturer’s instructions, and any markings on the equipment restricting the installation. [ASHRAE 15:7.6.2]
1104.6.2.1 Nameplate. The nameplate required by Section 1115.5 shall include a symbol indicating that a flammable refrigerant is used, as specified by the product listing. [ASHRAE 15:7.6.2.1]
1104.6.2.2 Labeling. A label indicating a flammable refrigerant is used shall be placed adjacent to service ports and other locations where service involving components containing refrigerant is performed, as specified by the product listing. [ASHRAE 15:7.6.2.2]
1104.6.2.3 Refrigerant Detectors. A refrigerant detector shall be provided in accordance with Section 1104.6.5 as a part of the listed equipment where any of the following apply:
   (1) The charge size of any independent circuit exceeds $0.212 \times LFL$ (lb), where $LFL$ is in pounds per 1000 ft$^3$ (6...
LFL [kg] where LFL is in kg/m³).

(2) When the occupancy classification is institutional.
(3) When using the provisions of Section 1104.6.4.

**Exception:** For commercial, public assembly, and large mercantile occupancies, when the refrigerant charge of any independent circuit does not exceed 50 percent of the RCL, a detector shall not be required.

**1104.6.2.4 Refrigerant Concentration Above Limit.** When the refrigerant detector senses a refrigerant concentration at the maximum value specified in Section 1104.6.5(2), the following actions shall be taken:

(1) The minimum airflow rate of the supply air fan shall be in accordance with the following equation.

\[ Q_{\text{min}} = 1000 \times \frac{M}{LFL} \]  

Where:
- \( Q_{\text{min}} \) = minimum airflow rate, ft³/min
- \( M \) = refrigerant charge of the largest independent refrigerating circuit of the system, lb
- \( LFL \) = lower flammability limit, lb per 1000 ft³

For SI units: \[ Q = 60000 \times \frac{M}{LFL}, \] where \( Q \) is the supply air flow rate (m³/h), \( M \) is the refrigerant charge (kg), \( LFL \) is the lower flammability limit (g/m³).

(2) Turn off the compressor and all other electrical devices, excluding the control power transformers, control systems, and the supply air fan. The supply air fan shall continue to operate for at least five minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the value specified in Section 1104.6.5(2).
(3) Any device that controls airflow located within the product or in ductwork that supplies air to the occupied space shall be fully open. Any device that controls airflow shall be listed.
(4) Turn off any heaters and electrical devices located in the ductwork. The heaters and electrical devices shall remain off for at least five minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the value specified in Section 1104.6.5(2). {ASHRAE 15:7.6.2.4}

**1104.6.3 Ignition Sources Located in Ductwork.** Open-flame-producing devices shall not be permanently installed in the ductwork that serves the space. Unclassified electrical devices shall not be located within the ductwork that serves the space. Devices containing hot surfaces exceeding 1290°F (700°C) shall not be located in the ductwork that serves the space unless there is a minimum airflow of 200 ft²/min (1.0 m/s) across the heating device(s) and there is proof of airflow before the heating device(s) is energized. [ASHRAE 15:7.6.3-7.6.3.3]

**1104.6.4 Compressors and Pressure Vessel Located Indoors.** For refrigeration compressors and pressure vessels located in an indoor space that is accessible only during service and maintenance, it shall be permissible to exceed the RCL if all of the following provisions are met:

(1) The refrigerant charge of largest independent refrigerating circuit shall not exceed:
   (a) 6.6 lb (3 kg) for residential and institutional occupancies and
   (b) 22 lb (10 kg) for commercial and public/large mercantile occupancies.
(2) The space where the equipment is located shall be provided with a mechanical ventilation system in accordance with Section 1104.6.4(3) and a refrigerant detector in accordance with Section 1104.6.5. The mechanical ventilation system shall be started when the refrigerant detector senses refrigerant in accordance with Section 1104.6.5. The mechanical ventilation system shall continue to operate for at least five minutes after the refrigerant detector has sensed a drop in the refrigerant concentration below the value specified in Section 1104.6.5(2).
(3) A mechanical ventilation system shall be provided that will mix air with leaked refrigerant and remove it from the space where the equipment is located. The space shall be provided with an exhaust fan. The exhaust fan shall remove air from the space where the equipment is located in accordance with the following equation.

\[ Q_{\text{min}} = 1000 \times \frac{M}{LFL} \]  

Where:
- \( Q_{\text{min}} \) = minimum airflow rate, ft³/min
- \( M \) = refrigerant charge of the largest independent refrigerating circuit of the system, lb
- \( LFL \) = lower flammability limit in lb per 1000 ft³

For SI units: \[ Q = 60000 \times \frac{M}{LFL}, \] where \( Q \) is the supply air flow rate (m³/h), \( M \) is the refrigerant charge (kg), \( LFL \) is the lower flammability limit (g/m³).

(4) The exhaust air inlet shall be located where refrigerant from a leak is expected to accumulate. The bottom of the air inlet elevation shall be within 12 inches (30 cm) of the lowest elevation in the space where the compressor or pressure vessel is located. Provision shall be made for make-up air to replace that being exhausted. Openings for the make-up air shall be positioned such that air will mix with leaked refrigerant.
(5) Air that is exhausted from the ventilation system shall be either:
   (a) discharged outside of the building envelope or
   (b) discharged to an indoor space, provided that the refrigerant concentration will not exceed the limit specified in Section
In addition to the requirements of Section 1104.6.3, there shall be no open-flame-producing devices that do not contain a flame arrester, or hot surfaces exceeding 1290°F (700 °C) that are installed within space where the equipment is located. [ASHRAE 15:7.6.4]

**1104.6.5 Refrigerant Detectors.** Refrigerant detectors required by Section 1104.6.2 shall meet the following requirements:

1. Refrigerant detectors that are part of the listing shall be evaluated by the testing laboratory as part of the equipment listing.
2. Refrigerant detectors, as installed, shall activate the functions required by Section 1104.6.2.4 within a time not to exceed 15 seconds when the refrigerant concentration reaches 25 percent of the lower flammability limit (LFL).
3. Refrigerant detectors shall be located such that refrigerant will be detected if the refrigerating system is operating or not operating. Use of more than one refrigerant detector shall be permitted.
   a. For refrigerating systems that are connected to the occupied space through ductwork, refrigerant detectors shall be located within the listed equipment.
   b. For refrigerating systems that are directly connected to the occupied space without ductwork, the refrigerant detector shall be located in the equipment, or shall be located in the occupied space at a height of not more than 12 inches (30 cm) above the floor and within a horizontal distance of not more 3.3 feet (1.0 m) with a direct line of sight of the unit.
4. Refrigerant detectors shall provide a means for an automatic operational self-test as provided in the product listing. Use of a refrigerant test gas is not required. If a failure is detected, a trouble alarm shall be activated, and the actions required by Section 1104.6.2.4 shall be initiated. [ASHRAE 15:7.6.5]

**1104.6 1104.7 Applications for Human Comfort and for Nonindustrial Occupancies.** In nonindustrial occupancies, Group A2, A2L, A3, B1, B2L, B2, and B3 refrigerants shall not be used in high-probability systems for human comfort. Use of Group A2L refrigerants shall be in accordance with Section 1104.6.

(renumber remaining sections)

**Substantiation:**
Task Group Recommendation 1 - Human Comfort: These are the extracted requirements from ASHRAE 15-2019 that regulate low GWP refrigerants used in direct systems that fall into the safety classification of Group A2L. The A2L Task Group modified various portions of the extracted language as needed to address enforceability and health and safety concerns. The requirements follow the extraction policy of IAPMO.

**Recommendation 2 - Machinery Rooms:**

**1104.0 Requirements for Refrigerant and Refrigeration System Use.**

**1104.5 Flammable Refrigerants.** The total of Group A2, B2, A3, and B3 refrigerants, other than Group A2L and B2L refrigerants shall not exceed 1100 pounds (498.9 kg) without approval by the Authority Having Jurisdiction. Institutional Occupancies shall comply with Section 1104.3. Machinery rooms required in accordance with Section 1106.0 based on flammability shall be constructed and maintained in accordance with Section 1106.2.1 through Section 1106.2.6 and Section 1106.13 for Group A2L and B2L refrigerants.

**1106.0 Refrigeration Machinery Rooms.**

**1106.1 Where Required.** (remaining text unchanged)

**1106.2 Refrigeration Machinery Room, General Requirements.** Where a refrigeration system is located indoors and a machinery room is required in accordance with Section 1106.1, the machinery room shall be in accordance with Section 1106.2.1 through Section 1106.2.5.2.

**1106.2.1 Access.** Machinery rooms shall not be prohibited from housing other mechanical equipment unless specifically prohibited elsewhere in this chapter. A machinery room shall be so dimensioned that parts are accessible with space for service, maintenance, and operations. There shall be clear head room of not less than 7.25 feet (2210 mm) below equipment situated over passageways. [ASHRAE 15:8.11.1]

**1106.2.2 Openings.** Each refrigeration machinery room shall have a tight-fitting door or doors opening outward, self-closing where they open into the building and adequate in number to ensure freedom for persons to escape in an emergency. With the exception of access doors and panels in air ducts and air-handling units in accordance with Section 1106.6 1106.2.3, there shall be no openings that will permit passage of escaping refrigerant to other parts of the building. [ASHRAE 15: 8.11.2]

**1106.6 1106.2.3 Airflow.** There shall be no airflow to or from an occupied space through a machinery room unless the air is ducted and sealed in such a manner as to prevent a refrigerant leakage from entering the airstream. Access doors and panels in ductwork and air-handling units shall be gasketed and tight fitting. [ASHRAE 15:8.11.3]
**1106.2.4 Restricted Access.** Access to the refrigeration machinery room shall be restricted to authorized personnel. Doors shall be clearly marked or permanent signs shall be posted at each entrance to indicate this restriction. [ASHRAE 15:8.11.8.11.4]

**1106.2.5 Detectors and Alarms.** Each refrigeration machinery room shall contain one or more refrigerant detectors in accordance with Section 1106.2.6, located in areas where refrigerant from a leak will concentrate, that actuate an alarm and mechanical ventilation in accordance with Section 1106.2.2 and Section 1106.2.4 at a set point not more than the corresponding Occupational Exposure Limit, OEL, in accordance with Table 1102.3, a set point determined in accordance with the OEL as defined in Chapter 2 shall be approved by the Authority Having Jurisdiction. The alarm shall annunciate visual and audible alarms inside the refrigeration machinery room and outside each entrance to the refrigeration machinery room. The alarms required in this section shall be of the manual reset type with the reset located inside the refrigeration machinery room. Alarms set at other levels, such as IDLH, and automatic reset alarms shall be permitted in addition to those required in accordance with this section. The meaning of each alarm shall be clearly marked by signage near the annunciator.

**Exception:** Refrigerant detectors are not required where only systems using R-718 (water) are located in the refrigeration machinery room. For Group A2L and B2L, refrigerant detectors shall comply with Section 1106.13.

**1106.2.6 Refrigerant Detectors.** Refrigerant detectors required in accordance with Section 1106.2.2 or Section 1107.1.7 shall meet all of the following conditions:

1. The refrigerant detector shall perform automatic self-testing of sensors. Where a failure is detected, a trouble signal shall be activated.
2. The refrigerant detector shall have one or more set points to activate responses in accordance with Section 1106.2.2 or Section 1107.1.7.
3. The refrigerant detector as installed, including any sampling tubes, shall activate responses within a time not to exceed 30 seconds after exposure to refrigerant concentration exceeding the set point value specified in Section 1106.2.2 or Section 1107.1.7.

**1106.2.5 Emergency Ventilation-Required Airflow.** An emergency ventilation system shall be required to exhaust an accumulation of refrigerant due to leaks or a rupture of the system. The emergency ventilation required shall be capable of removing air from the machinery room in not less than the airflow quantity in Section 1106.2.5.1 or Section 1106.2.5.2. Where multiple refrigerants are present, then the highest airflow quantity shall apply.

**1106.2.5.1 Ventilation - A1, A2, A3, B1, B2L, B2 and B3 Refrigerants.** The emergency ventilation for A1, A2, A3, B1, B2L, B2 and B3 refrigerants shall have the capacity to provide mechanical exhaust at a rate as determined in accordance with Equation 1106.2.5.1:

\[ Q = 100 \sqrt{G} \quad \text{(Equation 1106.2.5.1)} \]

Where:
- \( Q \) = Air flow rate, cubic feet per minute.
- \( G \) = Refrigerant mass in largest system, pounds.
For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 pound = 0.453 kg

**1106.2.5.2 Ventilation - Group A2L Refrigerants.** The emergency ventilation for A2L refrigerants shall have the capacity to provide mechanical exhaust at a rate determined in accordance with Table 1106.2.5.2:

<table>
<thead>
<tr>
<th>REFRIGERANT</th>
<th>MINIMUM AIR FLOW (CFM)</th>
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<tbody>
<tr>
<td>R-32</td>
<td>32,500</td>
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<tr>
<td>R-143a</td>
<td>28,600</td>
</tr>
<tr>
<td>R-444A</td>
<td>13,700</td>
</tr>
<tr>
<td>R-444B</td>
<td>23,400</td>
</tr>
<tr>
<td>R-445A</td>
<td>16,600</td>
</tr>
<tr>
<td>R-446A</td>
<td>50,500</td>
</tr>
<tr>
<td>R-447A</td>
<td>50,200</td>
</tr>
</tbody>
</table>
For SI units: 1 cubic foot per minute = 0.00047 m³/s

* The values were tabulated from the following equation:

\[
Q_{A2L} = \left( \frac{P \cdot V \cdot A}{LFL \cdot 0.50} \right) \quad \text{(Equation 1106.2.5.2)}
\]

Where:

\( P \) = Refrigerant density, pounds per cubic feet (kg/m³).

\( V \) = Refrigerant velocity equal to the refrigerant acoustic velocity (speed of sound), feet per second (m/s).

\( A \) = Cross-section flow area of refrigerant leak, square feet (m²), \( A = 0.00136 \text{ ft}^2 (0.000126 \text{ m}^2) \).

\( LFL \) = Lower Flammability Limit, or ETFL₆₀ where no LFL exist, published value in accordance with ASHRAE 34.

\( Q_{A2L} \) = Minimum required air flow rate, conversion to other units of measures is permitted, cubic feet per second (m³/s).

For exact ventilation rates and for refrigerants not listed, the ventilation rate shall be calculated using this equation.

---

1106.4 Natural Ventilation. Where When a refrigerating system is located outdoors more than 20 feet (6096 mm) from buildings openings and is enclosed by a penthouse, lean-to, or other open structure, natural or mechanical ventilation shall be provided. The requirements for such natural ventilation shall be in accordance with the following:

1. The free-aperture cross section for the ventilation of a machinery room shall be not less than as determined in accordance with Equation 1106.4.

\[ F = \sqrt{G} \quad \text{(Equation 1106.4)} \]

Where:

\( F \) = The free opening area, square feet.

\( G \) = The mass of refrigerant in the largest system, any part of which is located in the machinery room, pounds.

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 pound = 0.453 kg

2. The locations of the gravity ventilation openings shall be based on the relative density of the refrigerant to air. [ASHRAE 15:8.11.5(a), (b)8.14]

---

1106.13 Machinery Room, A₂L and B₂L. When required by Section 1106.1, machinery rooms shall comply with Section 1106.13.1 through Section 1106.13.6. [ASHRAE 15:8.13]

1106.13.1 Flame-Producing Device. There shall be no flame-producing device or hot surface over 1290°F (700°C) in the room, other than that used for maintenance or repair, unless installed in accordance with Section 1106.5. [ASHRAE 15:8.13.1]

1106.13.2 Communicating Spaces. Doors communicating with the building shall be approved, self-closing, tight-fitting fire doors. [ASHRAE 15:8.13.2]

1106.13.3 Noncombustible Construction. Walls, floor, and ceiling shall be tight and of noncombustible construction. Walls, floor, and ceiling separating the refrigerating machinery room from other occupied spaces shall be of at least one-hour fire-resistive construction. [ASHRAE 15:8.13.3]

1106.13.4 Exterior Openings. Exterior openings, if present, shall not be under any fire escape or any open stairway. [ASHRAE 15:8.13.4]

1106.13.5 Pipe Penetrations. All pipes piercing the interior walls, ceiling, or floor of such rooms shall be tightly sealed to the walls, ceiling, or floor through which they pass. [ASHRAE 15:8.13.5]

1106.13.6 Machinery Room Designation. When any refrigerant of Groups A₂, A₃, B₂, or B₃ are used, the machinery room shall be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with NFPA 70. When the only flammable refrigerants used are from Group A₂L or B₂L, the machinery room shall comply with both Section 1106.13.6.1 for ventilation and Section 1106.13.6.2 for refrigerant detection, or shall be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with NFPA 70. [ASHRAE 15:8.13.6]

1106.13.6.1 Mechanical Ventilation. The machinery room shall have a mechanical ventilation system in accordance with Section 1106.13.11. The mechanical ventilation system shall:

1. Run continuously, and failure of the mechanical ventilation system actuates an alarm, or
2. Be activated by one or more refrigerant detectors, conforming to requirements of Section 1106.13.8. [ASHRAE 15:8.13.6.1]
1106.13.6.2 Detection System. Detection of refrigerant concentration that exceeds 25 percent of the LFL or the upper detection limit of the refrigerant detector, whichever is lower, shall automatically de-energize the following equipment in the machinery room:

(1) Refrigerant compressors
(2) Refrigerant pumps
(3) Normally closed automatic refrigerant valves
(4) Other unclassified electrical sources of ignition with apparent power rating greater than 1 kVA, where the apparent power is the product of the circuit voltage and current rating. [ASHRAE 15:8.13.6.2]

1106.13.7 Mechanical Equipment Control. Remote control of the mechanical equipment in the refrigerating machinery room shall be provided immediately outside the machinery room door solely for the purpose of shutting down the equipment in an emergency. Ventilation fans shall be on a separate electrical circuit and have a control switch located immediately outside the machinery room door. [ASHRAE 15:8.13.7]

1106.13.8 Refrigerant Detectors. Each refrigerating machinery room in accordance with Section 1106.13 shall contain one or more refrigerant detectors in accordance with Section 1106.13.9. The detector(s) sensing element shall be located in areas where refrigerant from a leak will concentrate, with one or more set points that activate responses in accordance with Section 1106.13.10 for alarms and Section 1106.13.11 for mechanical ventilation. Multiport-type devices shall be prohibited. [ASHRAE 15:8.13.8]

1106.13.9 Refrigerant Detectors Requirements. Refrigerant detectors required by Section 1106.13 shall meet all of the following conditions:

(1) A refrigerant detector shall be capable of detecting each of the specific refrigerant designations in the machinery room.
(2) The refrigerant detector shall activate responses within a time not to exceed a limit specified in Section 1106.13.10 and Section 1106.13.11 after exposure to refrigerant concentration exceeding a limit value specified in Section 1106.13.10 and Section 1106.13.11.
(3) The refrigerant detector shall have a set point not greater than the applicable Occupational Exposure Limit (OEL) value in accordance with Table 1102.3. The applicable OEL value shall be the lowest OEL value for any refrigerant designation in the machinery room. For refrigerants that do not have an OEL value in Table 1102.3, use a value determined in accordance with the OEL as defined by ASHRAE 34 where approved by the Authority Having Jurisdiction.
(4) The refrigerant detector shall have a set point not more than the applicable Refrigerant Concentration Limit (RCL) value in accordance with Table 1102.3. The applicable RCL value shall be the lowest RCL value for any refrigerant designation in the machinery room. For refrigerants that do not have a RCL value in Table 1102.3, use a value determined in accordance with the RCL as defined by ASHRAE 34 where approved by the Authority Having Jurisdiction.
(5) The refrigerant detector shall provide a means for automatic self-testing and shall be in accordance with Section 1106.13.9(5). The refrigerant detector shall be tested during installation and annually thereafter in accordance with the fire code, or at an interval not exceeding the manufacturer’s installation instructions, whichever is less. Testing shall verify compliance with the alarm set points and response times per Section 1106.13.10 and Section 1106.13.11. [ASHRAE 15:8.13.9]

1106.13.10 Alarms. Alarms required by Section 1106.13.8 shall comply with Section 1106.13.10.1 through Section 1106.13.10.4.

1106.13.10.1 Visual and Audio. The alarm shall have visual and audible annunciation inside the refrigerating machinery room and outside each entrance to the refrigerating machinery room. [ASHRAE 15:8.13.10.1]

1106.13.10.2 Detector Activation. The refrigerant detector set points shall activate an alarm in accordance with the type of reset in Table 1106.13.10.2. Manual reset type alarms shall have the reset located inside the refrigerating machinery room. [ASHRAE 15:8.13.10.2]

<table>
<thead>
<tr>
<th>LIMIT VALUE</th>
<th>RESPONSE TIME (seconds)</th>
<th>ALARM TYPE</th>
<th>ALARM RESET TYPE</th>
<th>VENTILATION RATE</th>
<th>VENTILATION RESET TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set point ≤ OEL</td>
<td>≤ 300</td>
<td>Trouble Alarm</td>
<td>Automatic</td>
<td>Level 1</td>
<td>Automatic</td>
</tr>
<tr>
<td>Set point ≤ RCL</td>
<td>≤ 15</td>
<td>Emergency Alarm</td>
<td>Manual</td>
<td>Level 2</td>
<td>Manual</td>
</tr>
</tbody>
</table>

1106.13.10.3 Alarm Levels. Alarms set at levels other than Table 1106.13.10.2 (such as IDLH) and automatic reset alarms are permitted in addition to those required by Section 1106.13.10. The meaning of each alarm shall be clearly marked by signage near the annunciators. [ASHRAE 15:8.13.10.3]

1106.13.10.4 Emergency. In the event of a failure during a refrigerant detector self-test in accordance with Section 1106.13.9(5), a trouble alarm signal shall be transmitted to an approved monitored location. [ASHRAE 15:8.13.10.4]

1106.13.11 Mechanical Ventilation. Machinery rooms, in accordance with Section 1106.13, shall be vented to the outdoors, using mechanical ventilation in accordance with Section 1106.13.11.1, Section 1106.13.11.2, and Section 1106.13.11.3. [ASHRAE 15:8.13.11]
1106.13.11.1 Mechanical Ventilation Requirements. Mechanical ventilation referred to in Section 1106.13.11 shall be in accordance with all of the following:
(1) Include one or more power-driven fans capable of exhausting air from the machinery room; multispeed fans shall be permitted.
(2) Electric motors driving fans shall not be placed inside ducts; fan rotating elements shall be nonferrous or non-sparking, or the casing shall consist of or be lined with such material.
(3) Include provision to supply make-up air to replace that being exhausted; ducts for supply to and exhaust from the machinery room shall serve no other area; the makeup supply locations shall be positioned relative to the exhaust air locations to avoid short circuiting.
(4) Inlets to the exhaust ducts shall be located in an area where refrigerant from a leak will concentrate, in consideration of the location of the replacement supply air paths, refrigerating machines, and the density of the refrigerant relative to air.
(5) Inlets to exhaust ducts shall be within 1 foot (0.3 m) of the lowest point of the machinery room for refrigerants that are heavier than air and shall be within 1 foot (0.3 m) of the highest point for refrigerants that are lighter than air.
(6) The discharge of the exhaust air shall be to the outdoors in such a manner as not to cause a nuisance or danger. [ASHRAE 15:8.13.11.1]

<table>
<thead>
<tr>
<th>TABLE 1106.13.11.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL 1 VENTILATION RATE FOR CLASS 2L REFRIGERANTS</td>
</tr>
<tr>
<td>[ASHRAE 15: Table 8-2]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STATUS</th>
<th>AIRFLOW</th>
</tr>
</thead>
</table>
| Operated when occupied and operated when activated in accordance with Section 1106.13.10.2 and Table 1106.13.10.2 | The greater of the following:
- (1) 0.5 ft³/min per ft² (2.54 L/s per m²) of machinery room area, or
- (2) 20 ft³/min (9.44 L/s) per person |
| Operable when occupied | With or without mechanical cooling of the machinery room, the greater of:
- (1) The airflow rate required to not exceed a temperature rise of 18°F (10°C) above inlet air temperature or
- (2) The airflow rate required to not exceed a maximum air temperature of 122°F (50°C) in the machinery room. |

1106.13.11.2 Level 1 Ventilation Rate. The refrigerating machinery room mechanical ventilation in Section 1106.13.11 shall exhaust at an airflow rate not less than shown in Table 1106.13.11.2. [ASHRAE 15:8.13.11.2]

1106.13.11.3 Level 2 Ventilation. A part of the refrigerating machinery room mechanical ventilation referred to in Section 1106.13.11 shall exhaust an accumulation of refrigerant due to leaks or a rupture of a refrigerating system, or portion thereof, in the machinery room. The refrigerant detectors required in accordance with Section 1106.13.8 shall activate ventilation at a set point and response time in accordance with Table 1106.13.10.2, at an airflow rate not less than the value determined in accordance with Section 1106.13.11.4.

When multiple refrigerant designations are in the machinery room, evaluate the required airflow according to each refrigerating system, and the highest airflow quantity shall apply.

Ventilation reset shall be in accordance with the type of reset in Table 1106.13.10.2. Manual-type ventilation reset shall have the reset located inside the refrigerating machinery room. [ASHRAE 15:8.13.11.3]

1106.13.11.4 Level 2 Ventilation Rate. When required by Section 1106.13.11.3, the total airflow for Level 2 ventilation shall be not less than the airflow rate determined by Figure 1106.13.11.4. [ASHRAE 15:8.13.11.4]

1107.1.7 Group A2L and B2L Refrigerants. Where refrigerant of Groups A2L or B2L are used, the requirements of Class 1, Division 2, of NFPA 70, shall not apply to the machinery room provided that the conditions in Section 1107.1.7.1 through Section 1107.1.7.3 are met.

1107.1.7.1 Mechanical Ventilation. The mechanical ventilation system in the machinery room is run continuously in accordance with Section 1106.2.5 and 1106.13.6.1 and failure of the mechanical ventilation system actuates an alarm, or the mechanical ventilation system in the machinery room is activated by one or more refrigerant detectors, in accordance with the requirements of Section 1106.2.2.1 and Section 1106.2.2.2.

1107.1.7.2 Refrigeration Detectors. For the refrigerant detection required in Section 1106.2.2.1, detection of refrigerant concentration that exceeds 25 percent of the LFL or the upper detection limit of the refrigerant detector, whichever is lower, shall automatically de-energize the following equipment in the machinery room:
- (a) refrigerant compressors
- (b) refrigerant pumps
- (c) normally-closed automatic refrigerant valves

1107.1.7.3 Machinery Rooms. The machinery room shall comply with Section 1107.1.7.3.1106.13.

1112.1.1 Discharge from Pressure-Relief Devices. Pressure-relief systems designed for vapor shall comply with Section 1112.11.1 through Section 1112.11.4.1.
1112.11.1 Discharging Location Interior to Building. Pressure-relief devices, including fusible plugs, serving refrigeration systems shall be permitted to discharge to the interior of a building where in accordance with the following:

1. The system contains less than 110 pounds (49.9 kg) of a Group A1 or A2L refrigerant.
2. The system contains less than 6.6 pounds (2.99 kg) of a Group A2, B1, or B2 or B2L refrigerant.
3. The system does not contain any quantity of a Group A3 or B3 refrigerant.
4. The system is not required to be installed in a machinery room in accordance with Section 1106.0.
5. The refrigerant concentration limits in Section 1104.0 are not exceeded. Refrigeration systems that do not comply with the above requirements shall comply with the requirements of Section 1112.11.2 through Section 1112.11.4.

[ASHRAE 15:9.7.8.1]
FIGURE 1106.13.11.4(2)
LEVEL 2 VENTILATION RATE FOR CLASS 2L REFRIGERANTS (SI)
[ASHRAE 15: FIGURE 8-2]
Chapter 2
Definitions

220.0 – R –
Refrigerant Concentration Limit (RCL). The refrigerant concentration limit, in air, determined in accordance with this code and intended to reduce the risks of acute toxicity, asphyxiation, and flammability hazards in normally occupied, enclosed spaces. [ASHRAE 34:3.1]

Table 1701.1
REFERENCED STANDARDS

<table>
<thead>
<tr>
<th>STANDARD NUMBER</th>
<th>STANDARD TITLE</th>
<th>APPLICATION</th>
<th>REFERENCED SECTION</th>
</tr>
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<tbody>
<tr>
<td>ASHRAE 15-2016</td>
<td>Safety Standard for Refrigeration Systems</td>
<td>Refrigeration Systems</td>
<td>1102.1, 1106.1, Table 1113.5</td>
</tr>
<tr>
<td>ASHRAE 34-2016</td>
<td>Designation and Safety Classification of Refrigerants</td>
<td>Refrigeration Classifications</td>
<td>1102.3, 1103.1, Table 1102.3, Table 1106.2.5.2, 1106.13.9(3), 1106.13.9(4)</td>
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<tr>
<td>NFPA 70-2017</td>
<td>National Electrical Code</td>
<td>Miscellaneous</td>
<td>301.4(1), 301.4(3), 511.1.6, 512.2.5, 516.2.7, 516.2.9(4), 602.2.1, 905.8.2, 1104.4(5), 1106.13.6, 1107.1.7, 1107.1.8, 1217.8.1, 1310.14.5(2), 1311.2.4, 1311.7</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

Substantiation:
Task Group Recommendation 2 - Machinery Rooms: The proposed modification would bring the Uniform Mechanical Code in line with ASHRAE 15. The 3rd edition of UL/CSA 60335-2-40 has requirements for testing (and listing) of equipment using Group A2L refrigerants. The A2L Task Group modified various portions of the extracted language as needed to address enforceability and health and safety concerns. The requirements follow the extraction policy of IAPMO. Furthermore, a definition for Refrigerant Concentration Limit (RCL) is being added from ASHRAE 34 as the term is used but currently not defined in the code.

Recommendation 3 - Table 1104.1:

<table>
<thead>
<tr>
<th>OCCUPANCY GROUP3</th>
<th>HIGH-PROBABILITY SYSTEM</th>
<th>LOW PROBABILITY SYSTEM</th>
<th>MACHINERY ROOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>Group A1 or A2L only</td>
<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>A-2</td>
<td>Group A1 or A2L only</td>
<td>Any</td>
<td>Any</td>
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<td>A-3</td>
<td>Group A1 or A2L only</td>
<td>Any</td>
<td>Any</td>
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<tr>
<td>A-4</td>
<td>Group A1 or A2L only</td>
<td>Any</td>
<td>Any</td>
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<tr>
<td>B</td>
<td>Group A1 or A2L only</td>
<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>E</td>
<td>Group A1 or A2L only</td>
<td>Any</td>
<td>Any</td>
</tr>
</tbody>
</table>
F-1 | Group A1 or A2L only | Any | Any
F-2 | Any² | Any | Any
H-1 | Any | Any | Any
H-2 | Any | Any | Any
H-3 | Any | Any | Any
H-4 | Group A1 or A2L only | Any | Any
H-5 | Group A1 or A2L only | Any | Any
I-1 | None | Any | Any
I-2 | Group A1 or A2L only | Any | Any
I-3 | None | Any | Any
I-4 | Group A1 or A2L only | Any | Any
M | Group A1 or A2L only | Any | Any
R-1 | Group A1 or A2L only | Any | Any
R-2 | Group A1 or A2L only | Any | Any
R-3 | Group A1 or A2L only | Any | Any
R-4 | Group A1 or A2L only | Any | Any
S-1 | Group A1 or A2L only | Any | Any
S-2 | Any² | Any | Any
U | Any | Any | Any

Notes:
1 See Section 1104.0.
2 A refrigerant shall be permitted to be used within a high-probability system where the room or space is in accordance with Section 1104.4.
3 Occupancy classifications are defined in the building code.
4 See Section 1104.6 for requirements applicable to A2L equipment.

Substantiation:
Task Group Recommendation 3 - Table 1104.1: This change clarifies the acceptance of Group A2L refrigerants in high probability systems used for human comfort applications. Section 1104.6 already permits Group A2L refrigerants to be used for human comfort in direct systems provided the equipment is listed for A2L refrigerants. Footnote 4 identifies the requirements in Section 1104.6 for A2L refrigerants. This will assure that the equipment meets the listing and safety requirements of Section 1104.6.

Recommendation 4 - Labeling and Identification:

307.0 Labeling.
307.3 Heat Pump and Electric Cooling Appliances.
Heat pumps and electric cooling appliances shall bear a permanent and legible factory-applied nameplate on which shall appear:
1. The name or trademark of the manufacturer.
2. The model number or equivalent.
3. The serial number.
4. The amount of refrigerant, and type of
5. The refrigerant designation.
(56) The factory test pressures or pressures applied.
67 The electrical rating in volts, amperes, and, for other than single phase, the number of phases.
8 The output rating in Btu/h (kW).
9 The electrical rating in volts, amperes, or watts of each field replaceable electrical component.
10 The symbol of an approved agency certifying compliance of the equipment with recognized standards.
11 Required clearances from combustible surfaces on which or adjacent to which it is permitted to be mounted.
An appliance shall be accompanied by clear and complete installation instructions, including required clearances from combustible other than mounting or adjacent surfaces, and temperature rating of field-installed wiring connections exceeding 140°F (60°C).
307.4 Absorption Units. Absorption units shall bear a permanent and legible factory-applied nameplate on which shall appear:
(1) The name or trademark of the manufacturer.
(2) The model number or equivalent.
(3) The serial number.
(4) The amount of refrigerant, and type of
(5) The refrigerant designation.
(6) Hourly rating in Btu/h (kW).
(7) The type of fuel approved for use with the unit.
(8) Cooling capacity Btu/h (kW).

1115.0 Labeling and Identification.
1115.5 Nameplate. Each self-contained system and each separate condensing unit, compressor, or compressor unit sold for field assembly in a refrigerating system shall carry a nameplate marked with the manufacturer’s name, nationally registered trademark or trade name, identification number, design pressures, and refrigerant for which it is designed. The refrigerant shall be designated by the refrigerant number (“R-” number) as shown in Table 1102.3. [ASHRAE 15:9.15]
Heat pumps and electric cooling appliances shall bear a factory-applied nameplate in accordance with Section 307.3.

Substantiation:
Task Group Recommendation 4 - Labeling and Identification: The nameplate requirements in Section 307.3 are specifically for heat pumps and electric cooling appliances. These requirements include electrical ratings. The scope of Section 1115.5 is a broader scope, including products that do not have electrical ratings. Because the scope of Section 1115.5 is specific to products used in Chapter 11, this requirement belongs in Chapter 11 to provide a complete set of requirements for refrigeration installations.
UMC Legionella Task Group Report

**Roster:**

<table>
<thead>
<tr>
<th>Member</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Julius Ballanco (Chair)</td>
<td>JB Engineering and Code Consulting, P.C.</td>
</tr>
<tr>
<td>Richard Benkowski</td>
<td>United Association Department of Education</td>
</tr>
<tr>
<td>Julianne Baron</td>
<td>Special Pathogens Laboratory</td>
</tr>
<tr>
<td>Michael Cudahy</td>
<td>Plastic Pipe and Fittings Association (PPFA)</td>
</tr>
<tr>
<td>Scott Deitchman</td>
<td>Gordon &amp; Rosenblatt, LLC</td>
</tr>
<tr>
<td>Jay Egg</td>
<td>Egg Geo, LLC</td>
</tr>
<tr>
<td>Roger W Griffith</td>
<td>Griffith Engineering &amp; Consulting, Inc.</td>
</tr>
<tr>
<td>Chris Haldiman</td>
<td>Watts Water Technologies</td>
</tr>
<tr>
<td>Tim Keane</td>
<td>Legionella Risk Management, Inc.</td>
</tr>
<tr>
<td>Lance MacNevin</td>
<td>Plastics Pipe Institute</td>
</tr>
<tr>
<td>William F McCoy</td>
<td>Phigenics</td>
</tr>
<tr>
<td>Kevin McDonough</td>
<td>United Association</td>
</tr>
<tr>
<td>Joshua Petersen</td>
<td>Water Control Corporation</td>
</tr>
<tr>
<td>William Rhoads</td>
<td>Virginia Polytechnic Institute and State University</td>
</tr>
<tr>
<td>Phil Ribbs</td>
<td>PHR Consultants</td>
</tr>
<tr>
<td>April Trafton</td>
<td>Donald F. Dickerson Associates</td>
</tr>
<tr>
<td>Phil Trafton</td>
<td>Donald F. Dickerson Associates</td>
</tr>
<tr>
<td>Randy Young</td>
<td>Sacramento Joint Apprenticeship Training Committee</td>
</tr>
<tr>
<td>Andrew Zeigler</td>
<td>Waterline Technology</td>
</tr>
</tbody>
</table>

**Overview:**

During the May 2, 2019 UMC Technical Committee meeting in Denver, Colorado, the UMC Technical Committee requested that a task group be formed to develop criteria to address the Legionella risk to the public from mechanical systems. The request included recommended objectives for the task group to provide guidance to assist in the control and intervention of legionella associated with building mechanical systems, including: cooling towers, portable humidifiers, steam humidifiers, hydronic heating systems, ice machines, direct evaporative air coolers, air washers, and hydronic cooling systems, and address related issues such as: temperature, dead legs, sampling, maintenance procedures, etc.

The scope of the Legionella Task Group was to develop recommendations and guidance to assist in the control and intervention of Legionella associated with mechanical systems and equipment, determine the methods available to address Legionella exposure risk to public health and safety, and explore related issues such as water temperature, dead legs, sampling, and maintenance procedures for mechanical systems including, but not limited to: cooling
towers, ice machines, humidifiers, direct evaporative air coolers, and hydronic heating and cooling systems. The Task Group recommendations will be forwarded to the Uniform Mechanical Code (UMC) Technical Committee for consideration in the development of the 2024 edition of the UMC.

The Task Group met eight times via teleconference on March 2, 2020, April 22, 2020, June 8, 2020, August 12, 2020, October 16, 2020, November 23, 2020, December 10, 2020 and December 16, 2020. The proposed recommendations were obtained from members of the task group and any interested parties.

The Task Group generated a new Appendix H to the UMC based on the 2021 UPC Appendix N (Impact of Water temperature on the Potential for scalding and legionella Growth) relating to Legionella. The new Appendix H includes provisions for documentation, disinfection, cooling towers, and other mechanical systems.

Recommendation:

APPENDIX H
IMPACT OF WATER TEMPERATURE ON THE POTENTIAL FOR LEGIONELLA GROWTH

Part I – General

H 101.0 General. Part I of this appendix provides guidelines on the impact of water temperature in minimizing Legionella growth potential associated with occupiable commercial, institutional, multi-unit residential, and industrial building mechanical systems. Legionella control for plumbing systems shall be in accordance with the plumbing code.

This appendix shall not include single-family residential buildings. This appendix shall not be considered a risk management guidance document for scalding or Legionella.

Note: Published documents which address Legionella risk management include ASHRAE 188 or ASHRAE Guideline 12.

Published documents which address professional qualifications for Legionella risk assessment include ASSE Series 12000.

There are additional factors associated with the potential for scalding and Legionella growth other than temperature.

For scalding potential, other factors include, but are not limited to, user age, health, body part, length of contact time, and water source.

For Legionella growth potential other factors include, but are not limited to, water source and plumbing system: size, design, circulation rate, water age, disinfectant residual, piping material and component complexity.

H 102.0 Definitions.

H 102.1 General. For the purpose of this appendix, the following definitions shall apply.

Biofilm. Microorganisms and the slime they secrete that grow on any continually moist surface.

Control. The management to maintain compliance with established criteria.
Disinfection. Chemical or physical control measures or procedures used to kill or inactivate pathogens.
Disinfection, Online. The procedure while the equipment is in operation.
Disinfection, Offline. The procedure while the equipment is not in operation.
Halogenation. A chemical reaction that involves the addition of one or more halogens, including, but not limited to, chlorine, bromine, or iodine, commonly used to disinfect water systems.
Hazard. See Risk.
Legionella Concentrations. The extent of colonization of Legionella measured in Colony Forming Units per milliliter (CFU/mL).
Legionella Growth Potential. The likelihood that Legionella bacteria will reproduce.
Monitor. Observing and checking the progress or quality of (something) or measuring the physical and chemical characteristics of control measures.
Nutrient. Any element or compound essential as a raw material for an organism’s growth and development.
Risk. The potential to cause harm resulting from exposure.
Test. The measurement of the physical, chemical, or microbial characteristics or quality of water.

H 103.0 Building Water Systems and System Equipment Documentation.
H 103.1 Design Documentation. Construction documents shall be required for new construction, renovation, refurbishment, replacement, or repurposing of an occupiable building water system, including a water management plan, and shall be submitted to the Authority Having Jurisdiction.
H 103.2 Onsite Documentation. Documentation shall be maintained onsite and shall be readily accessible to the Authority Having Jurisdiction.

H 104.0 Potential Exposure.
H 104.1 Legionella Growth Potential. The Authority Having Jurisdiction shall have the authority to require documentation to address Legionella growth potential, where water temperatures in a water system are within ranges shown in Figure H 104.1 that pose a Legionella growth potential.
H 104.2 Scald Potential. Where the water system’s temperature(s) range pose(s) a scald potential, protection shall be provided in accordance with the plumbing code.

FIGURE H 104.1
WATER TEMPERATURE RANGES AND LEGIONELLA GROWTH POTENTIAL*
For SI units: °C = (°F - 32) / 1.8

* Temperature ranges reported are experimentally determined in a laboratory setting in the absence of a realistic microbial community. Legionella can survive for longer periods of time at temperatures higher and lower than the growth temperature ranges indicated due to changes in their metabolic state and/or protection from thermal disinfection within biofilm or amoeba host organisms.

**H 105.0 Disinfection.**

**H 105.1 Disinfection Documentation.** Where required by the Authority Having Jurisdiction, documentation for disinfection of building mechanical systems shall be provided by the registered design professional in the construction documents.

**H 105.1.1 Copper-Silver Ionization.** Copper-silver ionization methods and procedures shall include the following documentation:

1. Copper and silver ionization concentrations.
2. Methods and documentation for monitoring ion levels.
3. Electrode cleaning cycles and methods.

**H 105.1.2 Ultraviolet Light.** Ultraviolet light methods shall include the following documentation:

1. Locations of ultraviolet light units.
2. Cleaning cycles and methods of the quartz sleeves and housing.

**H 105.2 Chemical Disinfection.** Chemical biocide treatment shall be permitted to be used in accordance with the following:

1. Oxidizing biocides in accordance with manufacturer’s guidelines.
2. Non-oxidizing biocides in accordance with manufacturer’s guidelines.
3. Alternating the use of different types of biocides, dose, and frequency is recommended.
4. These treatment methods can be used for continuous, online disinfection or shock treatment online or offline.
**H 105.3 Non-Chemical Treatment.** Non-chemical treatment devices shall be permitted to be used in accordance with manufacturer’s guidelines.

**H 105.3.1 Thermal Shock.** Thermal treatment using heat shock at 158°F (70°C) for 30 minutes shall be permitted in accordance with applicable guidelines and the manufacturer’s instructions.

**H 105.3.2 Physical Cleaning.** When implemented, physical cleaning shall only be performed as an offline method and shall be performed before the chemical disinfection methods in Section 105.1 have been performed. Building outdoor air intakes shall be closed during physical cleaning prior to commencing. Physical cleaning shall be in accordance with the manufacturer’s instructions.

**H 105.4 Inspection and Maintenance.** The system shall be monitored and maintained to prevent scale buildup, sediment, corrosion, and biofouling.

**H 105.5 Frequency of Cleaning and Disinfection.** Where a water management plan is implemented, the frequency of cleaning and disinfection logs shall be readily accessible to the water management team and the Authority Having Jurisdiction.

**H 105.6 Control Measures.** Evaluation of control measures for Legionella shall consider potential unintended consequences of such measures that may affect overall health risk, including the formation of toxic disinfection byproducts (whether regulated or unregulated), resultant increase in other plumbing-associated pathogens, and scalding.

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**Part II – Minimizing Legionella Growth Potential in Cooling Towers and Other Mechanical Systems.**

**H 201.0 General.**

**H 201.1 Applicability.** Part II of this appendix applies to water sources that frequently provide optimal conditions for growth of Legionella organisms in accordance with Figure H 104.1, including, but not limited to, cooling towers, evaporative condensers, decorative water features, filters, ice makers, evaporative air coolers, fluid coolers that use evaporation to reject heat, industrial processes that use water to remove excess heat, industrial and municipal waste treatment plants, and other mechanical systems.

**H 201.2 Water Management Plan, Where Required.** A water management plan shall be established when required by the criteria of the Authority Having Jurisdiction.

**H 201.3 Water Management Plan, Where Implemented.** Where a water management plan is implemented, the plan shall be in accordance with the following:

1. Determine a water management plan team.
2. Provide description of the building’s water system.
3. Identify areas of Legionella growth potential in accordance with temperature ranges as shown in Figure H 104.1.
4. Determine applicable control measures and monitoring procedures.
5. Ensure the water management plan is effective and operating as designed.
6. Document and communicate all the activities of the water management plan.

**H 201.4 Water Sampling.** An analysis of water samples from a source capable of being contaminated with Legionella bacteria shall be performed as required by the Authority Having Jurisdiction to determine the number of organisms present in Colony Forming Units per milliliter (CFU/mL) of Legionella in the sample. The minimum remediation action shall be in accordance with Table H 201.5 and Figure H 201.5.
**H 201.5 Legionella Test Levels.** A means of controlling Legionella shall be established in accordance with applicable levels as stated in Section H 201.5.1 through Section H 201.5.3.

**H 201.5.1 Levels Less than 10 CFU/ML.** Water samples containing Legionella levels less than 10 CFU/mL shall be permitted to maintain the established water treatment plan in accordance with Table H 201.5.

**H 201.5.2 Levels Between 10 CFU/ML and 100 CFU/ML.** Water samples containing Legionella levels greater than 10 CFU/mL but less than 100 CFU/mL shall require the water treatment plan to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5.

**H 201.5.3 Levels Between 100 CFU/ML and 1000 CFU/ML.** Water samples containing Legionella levels greater than 100 CFU/mL but less than 1,000 CFU/mL shall require the water treatment plan to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5. Prepare to execute emergency response plan in case Legionella levels reach over 1000 CFU/mL in accordance with H 202.14.

**H 201.5.3 Levels Greater than 1000 CFU/ML.** Water samples containing Legionella levels greater than 1,000 CFU/mL shall require the water treatment plan to be reviewed, notify Authority Having Jurisdiction, institute immediate online disinfection, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5.

---

**TABLE H 201.5**

**LEGIONELLA REMEDIATION ACTIONS FOR COOLING TOWERS**

<table>
<thead>
<tr>
<th>LEGIONELLA CONCENTRATIONS IN COLONY FORMING UNITS (CFU/mL)</th>
<th>REMEDIATION ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>Maintain the established water treatment plan.</td>
</tr>
<tr>
<td>&gt;10 and &lt;100</td>
<td>Review water treatment plan, institute immediate online decontamination, and retest water 3 to 7 days after decontamination.</td>
</tr>
<tr>
<td>≥100 and &lt;1000</td>
<td>Review water treatment plan, institute immediate online decontamination, and retest water 3 to 7 days after decontamination. Prepare to execute emergency response plan in case Legionella levels reach over 1000 CFU/mL. <em>The emergency response plan for cooling towers is addressed in Section H 202.14.</em></td>
</tr>
<tr>
<td>≥1000</td>
<td>Review water treatment plan, notify Authority Having Jurisdiction (if required), institute immediate online disinfection, and retest water 3 to 7 days after decontamination. If retest ≥1000 CFU/mL, repeat system decontamination.</td>
</tr>
</tbody>
</table>
H 201.6 Air Sampling. Air sampling for Legionella shall not be used as a means of measuring potential Legionella exposure.

H 202.0 Cooling Towers.
H 202.1 General. Cooling towers shall be installed, maintained, and tested as required by this Appendix and the Authority Having Jurisdiction.

H 202.2 Risk Factors. The following risk factors shall be identified, assessed, controlled, and monitored:

1. Stagnant water due to dead legs, intermittent operation, or seasonal usage.
2. The presence of nutrients or biofilm.
3. Water temperature within a range that supports microbial growth as specified in Figure H 104.1.
4. Water exposed to direct sunlight which promotes algae growth.
5. Water quality, including, but not limited to, the following factors:
   a. System cleanliness
   b. pH levels
   c. Presence of corrosion
   d. Presence of scale and biofouling
   e. Conductivity levels
   f. Dissolved and suspended solids
   g. Control of water treatment chemicals
   h. Control of bleed-off or blowdown
6. System size
7. Physical condition of system
8. Aerosol generation, dispersion, and drift elimination
9. System site location
10. Access for inspection, cleaning, and maintenance
11. Concentration of Legionella as specified in Table H 201.5.

H 202.3 Water Temperature. The system shall be designed to maintain low sump-water operating temperatures.

H 202.4 Drift Eliminators. Drift eliminators shall be installed in accordance with Section 1126.0, Section E 403.2, and Section E 403.5.1; and shall be accessible to allow inspection, maintenance, and cleaning of internal components.

H 202.5 Side Stream Filtration. When suspended solids are visible in the cooling tower water system, side stream filtration shall be permitted to be used to control suspended solids in cooling tower circulating water. Makeup water quality, design of cooling tower fill, recirculation rate, and total system volume shall be included in the design of such equipment.

H 202.6 Equipment Site Location. The site location of new or replacement open- or closed-circuit cooling towers or evaporative condensers shall be in accordance with the following:

1. Shall not be located where contamination from building systems or facility processes can be drawn into the equipment. Equipment shall be installed no less than 10 feet (3048 mm) away from building exhaust or plumbing vents.
2. Shall not be located where equipment discharges into occupied spaces, roadways, walkways, outdoor air intakes, and building openings. Equipment shall be installed no less than 10 feet (3048 mm) away from building intakes or plumbing vents.
**H 202.7 System Commissioning.** System commissioning shall include procedures for cleaning of the cooling system. Ongoing water treatment in accordance with Section H 201.5 shall be initiated once the system is charged with water.

**H 202.8 System Start-Up and Shutdown.** System start-up and shutdown procedures shall include, but not be limited to the following:

1. Management of hazardous conditions associated with untreated water, including the following:
   1. Shutdown that includes all chemical pretreatment steps, pump cycling protocols, and procedures for system drainage for shutdown periods longer than 3 days, or the duration specified by the water management plan.
   2. Start-up from a drained system shall be in accordance with manufacturer’s recommendations.
   3. Start-up from an undrained or stagnant system that exceeds 3 days, or the number of idle days specified by the water management plan or the manufacturer’s recommendations.

**H 202.9 System Maintenance and Inspection.** System components requiring maintenance and inspection shall be accessible. A schedule for maintenance and inspection of system shall be included in the water management plan documents. Cooling tower maintenance and inspection shall include, but not be limited to, the following areas:

1. Water treatment system
2. Louvers
3. Piping dead legs
4. Cold water basins
5. Crossflow hot water basin
6. Counterflow spray system
7. Drift eliminators
8. Fill material and fill air entrance and exit surfaces
9. Purging of stagnant water or low-flow zones within the basin

**H 202.10 Water Treatment.** Water treatment shall control microbiological activity, scale, corrosion, sediment, and solids in the system, and shall be in accordance with the following:

1. All equipment and chemicals used shall be specified for the purpose of treating the open recirculating loop.
2. The minimum required schedule for inspection, maintenance, cleaning, and monitoring, and a corrective action plan.
3. The minimum requirements for documenting system water treatment.

**H 202.11 Disinfection.** Methods for disinfection of cooling towers shall include, but not be limited to, the halogenation methods and procedures for flushing and disinfection in accordance with Section 1122.0 and for reclaimed (recycled) and onsite treated nonpotable water in accordance with Section E 403.5.2. The responsible person for initiating disinfection shall be identified in the water management plan documents and the disinfection process shall include the following:

1. Online disinfection.
2. Emergency disinfection.

**H 202.12 Water Treatment Chemicals.** Water treatment chemicals, such as biocides, shall be applied using an automated dosing system at regular intervals. The frequency and quantity of chemical dosing shall be based on the microbial activity of the system and the chemical parameters of the circulating water.

**H 202.13 Makeup Valves.** The location of cooling tower makeup valves shall be in accordance with the registered design professional construction documents and approved by the Authority Having Jurisdiction. Makeup valves shall be provided with backflow prevention in accordance with ASME A112.1.2 for air gaps or backflow preventers in accordance with the plumbing code.
H 202.14 Emergency Response Plan. An emergency response plan shall be provided when required by the Authority Having Jurisdiction and shall include, but not be limited to, the following:
(1) Procedures to be followed if there are cases of Legionellosis associated with the use of cooling towers or evaporative condensers.
(2) Procedures to be followed if cooling towers or evaporative condensers reach Legionella levels of 1000 CFU/mL or greater.
(3) Testing for Legionella shall be performed. Procedures shall include the type of tests to be performed, sampling, and the interpretation of test results.
(4) Procedures for emergency disinfection.
(5) Procedures for other actions identified by the water management plan to prevent exposure to contaminated water.
H 202.15 Control of Bleed-Off. An automated bleed-off, or blowdown, system shall be used to remove water from the system and replace with makeup water to limit the concentration of dissolved and suspended solids. Additional manual bleed-off shall be permitted to be used to control scale or biofouling. The water for bleed-off shall be taken from the return line of the cooling water system to the cooling tower. Bleed-off shall only occur while chemical dosing is turned off.
H 202.16 Alternative Systems. Alternative systems and technologies that do not pose microbial risk and do not provide the opportunity for Legionella bacteria to grow shall be evaluated, including but not limited to off-peak thermal storage and geothermal coupled options.

H 203.0 Other Mechanical Systems.
H 203.1 General. Other mechanical systems and portions thereof shall be installed, maintained, and tested as required by this section and the Authority Having Jurisdiction.
H 203.2 Sand Filters. Sand filters shall be maintained or replaced in accordance with applicable guidelines as determined by the Authority Having Jurisdiction.
H 203.3 Water Softeners. Water softeners shall be installed and maintained in accordance with the plumbing code.
H 203.4 Dehumidifiers. Dehumidifiers shall be required in enclosed areas with swimming pools, spas, and hot tubs. Dehumidifiers shall be maintained in accordance with ASHRAE 188 and the manufacturer’s instructions.
H 203.5 Misters, Atomizers, Air Washers, Nebulizers, and Humidifiers. Misters, atomizers, air washers, nebulizers, and humidifiers shall be disinfected in accordance with ASHRAE 188. The minimum remediation action for humidifiers shall be in accordance with Table H 203.6.

<table>
<thead>
<tr>
<th>LEGIONELLA CONCENTRATIONS IN COLONY FORMING UNITS (CFU/mL)</th>
<th>REMEDIATION ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1 and &lt;10</td>
<td>Prompt cleaning and/or biocide treatment of the system.</td>
</tr>
<tr>
<td>≥10</td>
<td>Immediate cleaning and/or biocide treatment. Take prompt steps to prevent employee exposure.</td>
</tr>
</tbody>
</table>

H 203.7 Evaporative Air Coolers. Evaporative air coolers shall be completely drained and cleaned in accordance with the manufacturer’s instructions. When not in use, evaporative air coolers shall be completely drained.
**H 203.8 Ice Machines.** Ice machines not used for human consumption shall be flushed and maintained in accordance with ASHRAE 188.

**H 203.9 Spas and Hot Tubs.** Spas and hot tubs shall be maintained and tested in accordance with ASHRAE Guideline 12 and cleaned and disinfected in accordance with the manufacturer’s recommendations.

**H 203.10 Decorative Water Features.** Decorative water features shall be maintained in accordance with ASHRAE 188. Decorative water features shall be drained, cleaned, and disinfected in accordance with the manufacturer’s instructions and the Authority Having Jurisdiction.

**H 203.11 Water Supply Systems.** The minimum remediation action for water supply systems shall be in accordance with the plumbing code.

**TABLE 1701.2**

<table>
<thead>
<tr>
<th>DOCUMENT NUMBER</th>
<th>DOCUMENT TITLE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME A112.1.2-2012 (R2017)</td>
<td>Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)</td>
<td>Fittings</td>
</tr>
<tr>
<td>ASSE Series 12000-2018</td>
<td>Infection Control Risk Assessment for All Building Systems</td>
<td>Risk Management</td>
</tr>
</tbody>
</table>

(portion of table not shown remains unchanged)

**Substantiation:**
The purpose of the new Appendix H is to establish minimum Legionellosis risk management requirements for building mechanical systems. Cooling towers’ potential for spreading Legionella bacteria is especially pressing given the associated diseases’ symptomatic similarities to COVID-19 and the propensity they have for exacerbating respiratory illnesses.
Technical Correlating Committee Report for UPC/UMC
2021 IAPMO UPC-UMC Technical Correlation Committee (TCC) Report
Correlation Items Between the UPC and UPC
RECOMMENDATION:

608.0 Water Pressure, Pressure Regulators, Pressure Relief Valves, and Vacuum Relief Valves.

608.3 Expansion Tanks, and Combination Temperature and Pressure-Relief Valves. A water system provided with a check valve, backflow preventer, or other normally closed device that prevents dissipation of building pressure back into the water main, independent of the type of water heater used, shall be provided with an approved, listed, and adequately sized expansion tank or other approved device having a similar function to control thermal expansion. Prepressurized water expansion tanks shall comply with IAPMO Z1088. Such expansion tank or other approved device shall be installed on the building side of the check valve, backflow preventer, or other device and shall be sized, securely fastened to the structure, and installed in accordance with the manufacturer’s installation instructions.

A water system containing storage water heating equipment shall be provided with an approved, listed, adequately sized combination temperature and pressure-relief valve, except for listed nonstorage instantaneous heaters having an inside diameter of not more than 3 inches (80 mm). Each such approved combination temperature and pressure-relief valve shall be installed on the water-heating device in an approved location based on its listing requirements and the manufacturer’s installation instructions. Each such combination temperature and pressure-relief valve shall be provided with a drain in accordance with Section 608.5.

X | Accept recommendation as submitted. | No action needed.

Substantiation:

The language in UPC Item # 161, Section 608.3 (Expansion Tanks, and Combination Temperature and Pressure-Relief Valves) is being revised to correlate with the action taken by the UPC TC for Item # 160, Section 608.3 (Expansion Tanks, and Combination Temperature and Pressure-Relief Valves) regarding expansion tanks being “securely fastened to the structure.”

The following is provided for informational purpose only:

The substantiation provided for proposal Item # 160 of the UPC is as follows: Expansion tanks range in sizes and types. Many tanks are being left to be supported by the piping onto which it is mounted, however this is a concern as piping is not meant to be a supporting device, actually piping is required to be supported, not the other way around. The addition of this language will require that all expansion tanks be supported where the installation instructions fail to mention this.

The substantiation provided for proposal Item # 161 of the UPC is as follows: Water does not compress so when it is heated and it expands it can create damaging pressure. Expansion tanks are designed to compensate for this. Instantaneous water heaters do not store water so there is no water to expand and create the excess pressure. Water is heated on demand only so there is no issue of the water heating, expanding and building pressure as the water is flowing out by the demand.
TCC ITEM # 002

RECOMMENDATION:

1501.7 Minimum Water Quality Requirements. The minimum water quality for alternate water source systems shall meet the applicable water quality requirements for the intended application as determined by the Authority Having Jurisdiction. In the absence of water quality requirements, for on-site treated nonpotable systems, the water quality requirements of IAPMO IGC 324 or NSF 350 shall apply.

Exception: Water treatment is not required for gray water used for subsurface irrigation.

Accept recommendation as submitted.

No action needed.

Substantiation:
The language in UPC Item # 257, Section 1501.7 (Minimum Water Quality Requirements) is being revised to correlate with the action taken by the UPC TC for Item # 256, Section 1501.7 (Minimum Water Quality Requirements) regarding the reference to IAPMO IGC 324.

The substantiation provided for proposal Item # 256 of the UPC is as follows: The 2019 edition of the IAPMO IGC 324 has been greatly improved. There was input from the San Francisco Department of Public Health (SFDPH) in developing this latest edition.

In addition to the below substantiation, please see support letter from LADWP for the Technical Committee review.

IAPMO IGC 324 covers residential, multi-family, and commercial use applications intended to process water from alternate water sources such as greywater, rainwater, stormwater air conditioning condensate, cooling tower makeup, vehicle wash and other non-potable reuse applications not specifically listed, for use in subsurface and/or surface irrigation and toilet/urinal flushing applications, and specifies requirements for materials, physical characteristics, performance testing, and markings. The standard also covers test plans and safety check (failure modes effects) that ensures the safety of the treated water.

Additionally, Section 1603.5.1 is being stricken as appropriate references are being proposed for inclusion in Section 1603.5. The proposed text in Section 1603.5 will provide guidance to the standards that apply to water treatment as options for harvested rainwater.

Supporting document(s) has been provided to the Technical Committee for review.

The Committee Statement provided for amending proposal Item # 256 by the UPC TC is as follows: The modification removes reference to EPA/600/R-12/618-2012 as it is not written in mandatory language. EPA/600/R-12/618-2012 will remain as a reference guide in Table 1701.2. Also, in Section 1506.7, the phrase “listed or labeled” is being updated to “listed and labeled” for consistency in the code.

The 2019 edition of the IAPMO IGC 324 has been greatly improved. There was input from the San Francisco Department of Public Health (SFDPH) in developing this latest edition.

In addition to the below substantiation, please see support letter from the Los Angeles Department of Water and Power (LADWP) for the Technical Committee review.

IAPMO IGC 324 covers residential, multi-family, and commercial use applications intended to process water from alternate water sources such as greywater, rainwater, stormwater air conditioning condensate, cooling tower makeup, vehicle wash and other non-potable reuse applications not specifically listed, for use in subsurface and/or surface irrigation and toilet/urinal flushing applications, and specifies requirements for materials, physical charac-
The standard also covers test plans and safety check (failure modes effects) that ensures the safety of the treated water.

Additionally, Section 1603.5.1 is being stricken as appropriate references are being proposed for inclusion in Section 1603.5. The proposed text in Section 1603.5 will provide guidance to the standards that apply to water treatment as options for harvested rainwater.

The substantiation provided for proposal Item # 257 of the UPC is as follows: The above revisions reflect the latest edition (title) to the EPA standard (Guidelines for Water Reuse) that is referenced in Table 1701.1 and Table 1701.2. EPA/600/R-12/618-2012 is the latest edition of EPA/625/R04-108-2004. Since the latest standard edition is being updated in Table 1701.1 and being removed from Table 1701.2 since it is used in the body of the code. Additionally, two sections (1501.7 and K 101.7) are being revised to show the latest edition of the Guidelines for Water Reuse standard. All provisions remain the same, this is just a clean up for the latest document.

The Committee Statement provided for amending proposal Item # 257 by the UPC TC is as follows: The modification removes reference to EPA/600/R-12/618-2012 from Section 1501.7 as it is not written in mandatory language. The reference for EPA/600/R-12/618-2012 will remain in that appendix in Section K 101.7 and in Table 1701.2.
RECOMMENDATION:

Table 1701.1 is being shown for informational purposes only:

<table>
<thead>
<tr>
<th>TABLE 1701.1</th>
<th>MATERIALS FOR BUILDING SUPPLY AND WATER DISTRIBUTION PIPING AND FITTINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD NUMBER</td>
<td>STANDARD TITLE</td>
</tr>
<tr>
<td>ASTM F1986- 2001 (R2011)</td>
<td>Multilayer Pipe Type 2, Compression Fittings, and Compression Joints for Hot and Cold Drinking Water Systems</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>BUILDING SUPPLY PIPE AND FITTINGS</th>
<th>WATER DISTRIBUTION PIPE AND FITTINGS</th>
<th>REFERENCED STANDARD(S) PIPE</th>
<th>REFERENCED STANDARD(S) FITTINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE-AL-PEX</td>
<td>X</td>
<td>X</td>
<td>ASTM F1986</td>
<td>ASTM F1986</td>
</tr>
</tbody>
</table>

(portions of table not shown remain unchanged)

X Accept recommendation as submitted. No action needed.

**Substantiation:**
The row containing the ASTM F1986 standard in UPC Table 604.1 (Materials for Building Supply and Water Distribution Piping and Fittings) is being stricken to correlate with the action taken by the UPC TC for Item # 330, Table 1701.1 (Referenced Standards) as the ASTM F1986 standard has been withdrawn by the promulgator.

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 330 of the UPC is as follows:** The above revisions reflect the latest updates to the ASTM standards that are referenced in Table 1701.1 and Table 1701.2.
Correlation Items Between the UMC and UMC
**TCC ITEM # 004**

**2024 UNIFORM MECHANICAL CODE**

**ITEM # 009**

**RECOMMENDATION:**

**E 503.6.5.3 System Balancing.** Construction documents shall require that HVAC systems be balanced in accordance with generally accepted engineering standards. Construction documents shall require that a written balance report be provided to the building owner or the designated representative of the building owner for HVAC systems serving zones with a total conditioned space or zone exceeding 5000 square feet (464.52 m²). {ASHRAE 90.1:6.7.2.3.1}

**E 503.6.5.3 System Balancing.** Construction documents shall require that HVAC systems be balanced in accordance with generally accepted engineering standards. Construction documents shall require that a written balance report be provided to the building owner or the designated representative of the building owner for HVAC systems serving zones with a total conditioned space or zone exceeding 5000 square feet (464.52 m²). {ASHRAE 90.1:6.7.3.3.1}

<table>
<thead>
<tr>
<th>Accept recommendation as submitted.</th>
<th>No action needed.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substantiation:</strong></td>
<td></td>
</tr>
<tr>
<td>The language in UMC Item # 289, Section E 503.6.5.3 (System Balancing) is being revised to correlate with the action taken by the UMC TC for Item # 009, Section E 503.6.5.3 (System Balancing) regarding the reference to conditioned “space or zone.” Additionally, the TCC further modified UMC Item # 289 by striking out the phrase “zones with” to correct a grammatical error in redundancy.</td>
<td></td>
</tr>
<tr>
<td>The substantiation provided for proposal Item # 009 of the UMC is as follows: This proposal changes all phrasing of “conditioned area” to “conditioned space” as there is no definition for “conditioned area” but there is a definition for “conditioned space.”</td>
<td></td>
</tr>
<tr>
<td>The Committee Statement provided for amending proposal Item # 009 by the UMC TC is as follows: A modification is being made to add the wording “or zone” wherever the term “conditioned space” is used. This will allow for consistency throughout the code.</td>
<td></td>
</tr>
<tr>
<td>The substantiation provided for proposal Item # 289 of the UMC is as follows: In accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines), Appendix E is being revised to the latest edition of ASHRAE 90.1-2019 with Addenda by, ck, and cp published on August 3, 2020.</td>
<td></td>
</tr>
</tbody>
</table>
RECOMMENDATION:

403.0 Ventilation Rates.

403.10 Air Balance. All mechanical ventilation systems shall be tested, balanced, and operated to demonstrate that the installation and performance of the systems are in accordance with the design intent. All testing and balancing shall be performed by a technician certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), the Testing, Adjusting and Balancing Bureau (TABB), or other ANSI-accredited equivalent approved agencies.

Exception: For single family residential, compliance with Section 403.10 shall not be required.

ITEM # 110

504.0 Environmental Air Ducts.

504.3 Domestic Range Hoods. All kitchen exhaust ducts used in domestic range hoods shall be constructed of metal and shall have a smooth surface, fastened and sealed with duct mastic or metal tapes that meet the requirements of UL 181. Range hoods shall discharge to the outdoors through a single wall duct and shall not terminate in an attic or crawl space.

A physical verification of air volume, operation, and design intent shall be performed by a certified Testing, Adjusting, and Balancing (TAB) technician. The TAB technician shall be certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB), or other equivalent approved agencies.

Exception: Ducts for domestic kitchen downdraft grill-range ventilation installed under a concrete slab floor shall be permitted to be of approved Schedule 40 PVC provided:
1. The under-floor trench in which the duct is installed shall be completely backfilled with sand or gravel.
2. Not more than 1 inch (25.4 mm) of 6 inch diameter (152 mm) PVC coupling shall be permitted to protrude above the concrete floor surface.
3. PVC pipe joints shall be solvent cemented to provide an air and greasetight duct.
4. The duct shall terminate above grade outside the building and shall be equipped with a backdraft damper.

ITEM # 161

603.0 Installation of Ducts.

603.9 Joints and Seams of Ducts. (remaining text unchanged)

603.9.2 Duct Leakage Tests. Ductwork shall be leak-tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual. Duct leakage tests shall be performed by a technician certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB), or other equivalent approved agencies. Representative sections totaling not less than 10 percent of the total installed duct area shall be tested. Where the tested 10 percent fail to comply with the requirements of this section, then 40 percent of the total installed duct area shall be tested. Where the tested 40 percent fail to comply with the requirements of this section, then 100 percent of the total installed duct area shall be tested. Sections shall be selected
by the building owner or designated representative of the building owner. Positive pressure leakage testing shall be permitted for negative pressure ductwork. The permitted duct leakage shall be not more than the following:

(remaining text unchanged)

<table>
<thead>
<tr>
<th>ITEM # 097</th>
<th>ITEM # 110 and # 161</th>
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</thead>
<tbody>
<tr>
<td>Accept recommendation as submitted.</td>
<td>No action needed.</td>
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</tbody>
</table>

**Substantiation:**

The language in UMC Item # 097, Section 403.10 (Air Balance) modifies the phrase “or other ANSI accredited agencies” to “or other equivalent approved agencies” to comply with the ANSI Essential Requirements for referencing products or services. Additionally, UMC Item # 110, Section 504.3 (Domestic Range Hoods) and UMC Item # 161, Section 603.9.2 (Duct Leakage Tests) were modified to correlate with the updated UMC Item # 097 by adding the phrase “or other equivalent approved agencies.”

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 097 of the UMC is as follows:** Concerns over airborne transmission of pathogens and the benefits of proper ventilation have highlighted the need for verified adequate ventilation. Inadequate ventilation is a recognized and documented concern (See Supporting Material: CEC-500-2020-049). If the ventilation system is not tested, adjusted, and balanced by a skilled, trained, and certified technician the public has little assurance that the ventilation system conforms to design intent. The listed organizations have significant certification programs which ensure the certified technician, and associated contractors, have the knowledgebase and skillset to accurately perform the Air Balance. (See Supporting Material: TAB-Technical-Report-051220) Section E 802.1 (Commissioning Requirements) of the Uniform Mechanical Code set a precedent for similar requirements where an accurate verification of design intent is required.

[Supporting documentation provided in KAVI for TC review]

**The Committee Statement provided for amending proposal Item # 097 by the UMC TC is as follows:** Modifications have been made by the Technical Committee to add the language “or other ANSI-accredited agencies” to prevent overly restrictive language.

**The substantiation provided for proposal Item # 110 of the UMC is as follows:** There are currently no provisions to properly seal and test range hoods and ducts. This also clarifies that ducts shall terminate outside and be tested in accordance with the nationally recognized testing standards.

**The substantiation provided for proposal Item # 161 of the UMC is as follows:** Duct Air Leakage Testing should be limited to a certified Testing, Adjusting, and Balancing Technician (AABC, NEBB, or TABB). To provide accurate testing results, certified technicians must complete extensive training in the proper use of the SMACNA test methods, mechanical system understanding and the knowledge of the principles of air flow and pressure measurements. The listed certification organizations have proven methods for quality control. (See Supporting Material: TAB-Technical-Report-051220)

**The Committee Statement provided for accepting proposal Item # 161 by the UMC TC is as follows:** The Technical Committee recommends adding the language "or other ANSI-accredited agencies" via public comment.
**TCC ITEM # 006**

**RECOMMENDATION:**

**508.0 Type I Hoods.**

**508.1 Where Required.** Type I hoods shall be installed at or above commercial-type deep-fat fryers, broilers, grills, hot-top ranges, ovens, barbecues, rotisseries, and similar equipment that emits comparable amounts of smoke or grease in a food-processing establishment. For the purpose of this section, a food-processing establishment shall include a building or portion thereof used for the processing of food, but shall not include a dwelling unit.

**Exceptions:**

1. Cooking appliances that comply with UL 197 for reduced emissions where the grease discharge does not exceed 2.9 E-09 ounces per cubic inch (oz/in³) (5.0 E-06 kg/m³) where operated with a total airflow of 500 cubic feet per minute (CFM) (0.236 m³/s).
2. Recirculating systems listed in accordance with UL 710B and installed in accordance with Section 516.0.
3. Solid-fuel-fired ovens that comply with UL 2162 and that are vented in accordance with the manufacturer's instructions with venting systems complying with UL 103 and UL 1978.
4. Listed and labeled cooking appliances with integral downdraft systems that comply with Section 518.0.

---

X Accept recommendation as submitted.  
No action needed.

**Substantiation:**

The language in UMC Item # 125, Section 508.1 (Where Required) is being revised to correlate with the action taken by the UMC TC for Item # 124, Section 508.1 (Where Required) regarding the reference to UL 197, the term “comply,” and the addition of Exceptions (3) and (4).

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 124 of the UMC is as follows:** The requirements for the reduced emissions testing for cooking appliances, as covered by Exception 1, have been incorporated into UL 197. NFPA 96 includes requirements for cooking appliances with integral downdraft exhaust systems which do not require a Type I hood above. Solid fuel fired ovens that are listed and labeled to UL 2162 that have been evaluated for connection with venting systems that comply with both UL 103 (chimneys) and UL 1978 (grease ducts) do not need to have a Type I hood above. The downdraft appliances covered in Section 518.0 of this code do not need a Type I hood above.

**The Committee Statement provided for amending proposal Item # 124 by the UMC TC is as follows:** The proposal is being modified to change "listed and labeled" to "comply" since "comply" already implies that the product must be listed and labeled in accordance with the referenced standard. Also, Chapter 3 already has listing and marking requirements.

**The substantiation provided for proposal Item # 125 of the UMC is as follows:** Section 508.1 exception (1) is being revised as exception (1) is creating confusion during plan check and in the field for AHJs. Many in the field are interpreting this section as excepting hoods altogether. However, this section only exempts the use of Type I hoods, not the use of Type II hoods. Type II hoods shall be required when excessive heat and/or steam is being emitted. UL 710B only tests hoods to be exempt from grease applications but not for excessive heat or steam such as bread ovens. In addition, exception (1) does not have language specifying that the cooking appliance must be "listed" in accordance with UL 710B, which is causing issues for AHJs. The phrase "listed in accordance with" should be used in exception (1) the same way as exception (2).
Correlation Items Between the UPC and UMC
**TCC ITEM # 007**

<table>
<thead>
<tr>
<th>2024 UNIFORM PLUMBING CODE</th>
<th>2024 UNIFORM MECHANICAL CODE</th>
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**RECOMMENDATION:**

210.0  –  H –

**Heat-Fusion Weld Joints.** A joint used in some thermoplastic systems to connect the pipe to fittings or pipe lengths directly to one another (butt-fusion). This method of joining pipe to fittings includes butt-fusion, socket-fusion, electro-fusion, and saddle-fusion. This method of welding involves the application of heat and pressure to the components, allowing them to fuse together forming a bond between the pipe and fitting.

212.0  –  J –

**Joint, Heat Fusion.** A joint used in some thermoplastic systems to connect the pipe to fittings or pipe lengths directly to one another (butt-fusion) by applying heat and pressure to the components to form a bond between the materials. This joining method of joining pipe to fittings includes butt-fusion, socket-fusion, electro-fusion, and saddle-fusion. This method of welding involves the application of heat and pressure to the components, allowing them to fuse together forming a bond between the pipe and fitting.

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<th>Accept recommendation as submitted.</th>
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**Substantiation:**

The definition for “Joint, Heat Fusion” in UMC Item # 037 is being revised to correlate with the definition found in the 2021 UPC for “Heat-Fusion Weld Joints.”

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 037 of the UMC is as follows:** A new definition for “Heat Fusion Joint” is being added as it is currently used in the code but not defined. See Sections 1211.11, 1308.5.8.2, and F 201.6.2. Section F 104.4.1.1 lists butt-fusion, socket-fusion, and electro-fusion as acceptable heat fusion methods. The definition is based on the existing definition in the UPC with improvements.

**The Committee Statement provided for amending proposal Item # 037 by the UMC TC is as follows:** The proposed definition is being modified to clarify that heat fusion joints connect the pipe to fittings or pipe lengths "directly to one another by applying" heat and pressure.
**TCC ITEM # 008**

<table>
<thead>
<tr>
<th>ITEM # 027</th>
<th>ITEM # 052</th>
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<td>RECOMMENDATION:</td>
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224.0 – V –

**Vent Connector, Gas.** That portion of a gas venting system that connects a listed gas appliance beginning at the draft hood or flue collar to a gas vent and is installed entirely within the space or area in which the appliance is located.

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**Substantiation:**
The definition for "Vent Connector, Gas" in UMC Item # 052 is being revised to correlate with the action taken by the UPC TC for Item # 027 by adding the term "entirely."

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 027 of the UPC is as follows:** The current simple definition of a vent connector is not clear. It can be interpreted under the current language that you could install a single wall vent for a water heater starting in the garage and run it up into the attic. This change state specifically where it begins and that it remains in the space where it begins.

**The substantiation provided for proposal Item # 052 of the UMC is as follows:** A simple definition of a vent connector is elusive. You will know it when you see it, but accurately defining it is difficult. However, we can state specifically where it begins and that it remains in the space where it begins.
**RECOMMENDATION:**

508.4 Appliances in Attics and Under-Floor Spaces. An attic or under-floor space in which an appliance is installed shall be accessible through an opening and passageway at least as large as larger than the largest component of the appliance, and not less than 22 inches by 30 inches (559 mm by 762 mm). {NFPA 54:9.5.1}

304.4 Appliances in Attics and Under-Floor Spaces. An attic or under-floor space in which an appliance is installed shall be accessible through an opening and passageway not less larger than the largest component of the appliance, and not less than 22 inches by 30 inches (559 mm by 762 mm). {NFPA 54:9.5.1}

<table>
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<th>Action</th>
<th>Substantiation:</th>
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| Accept recommendation as submitted | The language in UPC Item # 101, Section 508.4 (Appliances in Attics and Under-Floor Spaces) is being revised to correlate with the action taken by the UMC TC Item # 056, Section 304.4 (Appliances in Attics and Under-Floor Spaces) regarding the phrase "or under-floor space."

Additionally, the TCC further modified UPC Item # 101 to change the phrase “at least as large as” to "larger than" and UMC Item # 056 from "not less than" to "larger than" as the TCC felt such revision of text was necessary to correct an error in the original text as sufficient accessibility through an opening is required.

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 101 of the UPC is as follows:** The above sections have been revised to correlate with NFPA 54-2021 (latest version) in accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines).

**The substantiation provided for proposal Item # 056 of the UMC is as follows:** In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 3 is being revised to the latest edition of NFPA 54-2021.
**RECOMMENDATION:**

**507.26 Accessibility for Service.** All appliances shall be located with respect to building construction and other equipment so as to permit access for repair or replacement of the appliance. **Sufficient clearance** shall be maintained to permit removal of the appliance; cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls, and vent connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and the proper functioning of explosion vents, if provided. For attic installation, the passageway and servicing area adjacent to the appliance shall be **floored in accordance with Section 508.4.** [NFPA 54:9.2.1]

Unless otherwise specified, clearances of not less than 30 inches (762 mm) in depth, width, and height of working space shall be maintained.

**304.1 General.** All appliances shall be located with respect to building construction and other equipment so as to permit access for repair or replacement of the appliance. Clearance shall be maintained to permit removal of the appliance; cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls, and vent connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and the proper functioning of explosion vents, if provided. For attic installation, the passageway and servicing area adjacent to the appliance shall be in accordance with Section 304.4. [NFPA 54:9.2.1]

Unless otherwise specified, clearances of not less than 30 inches (762 mm) in depth, width, and height of working space shall be maintained.

**Exception:** A platform shall not be required for unit heaters or room heaters.

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<th>Accept recommendation as submitted.</th>
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**Substantiation:**

The language in UPC Item # 110, Section 507.26 (Accessibility for Service) is being revised to correlate with the action taken by the UMC TC for Item # 059, Section 304.1 (General) by striking the term “sufficient,” adding the reference to Section 508.4, and adding clearances for working space. Additionally, the TCC is not adding the UMC Exception as unit heaters and room heaters are not within the scope of the UPC.

The following is provided for informational purpose only:

The substantiation provided for proposal Item # 110 of the UPC is as follows: The Code requires access for the repair of appliances in Section 507.26, but does not require access for the removal of appliances without the need to remove building construction or other appliances.

The substantiation provided for proposal Item # 059 of the UMC is as follows: The change is a cleanup of the language to improve Section 304.1. The term “sufficient” is being removed as it is poor code language.

The Committee Statement provided for amending proposal Item # 059 by the UMC TC is as follows: The Code requires access for the repair of appliances in Section 304.1, but does not require access for the removal of appliances without the need to remove building construction or other appliances.
**TCC ITEM # 011**

### 2024 UNIFORM PLUMBING CODE

**ITEM # 108**

#### RECOMMENDATION:

507.0 Appliance and Equipment Installation Requirements.

507.13 Installation in Residential Garages. Appliances in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit shall be installed so that all heating elements, switches, burners, and burner-ignition devices are located not less than 18 inches (457 mm) above the floor, unless **Exception:** Listed as flammable vapor ignition resistant (FVIR) appliances. [NFPA 54:9.1.10.1]

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<th>Accept recommendation as submitted.</th>
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**Substantiation:**

The language in UPC Item # 108, Section 507.13 (Installation in Residential Garages) is being revised to correlate with the action taken by the UMC TC for Item # 061, Section 305.1 (Installation in Residential Garages) to relocate the phrase “listed flammable vapor ignition resistant appliances” to an exception. Furthermore, UMC Item # 061 is being modified editorially to relocate the extract reference to the end of the section for consistency with the UPC.

The following is provided for informational purposes only:

**The substantiation provided for proposal Item # 108 of the UPC is as follows:** Requirements for electric water heaters have been missing since the 2003 UPC. The reasons for this may no longer exist and are perhaps unimportant. The fact is that electric water heaters are still installed by plumbers and still need inspections. What document do plumbers and inspectors seek for these installation requirements?

Elements and switches (thermostats) are just as dangerous as burners and burner ignition devices, perhaps more so with the advent of FVIR for gas burning water heaters.

**The substantiation provided for proposal Item # 061 of the UMC is as follows:** Several years ago, this language was added at the end of the sentence. As more of these appliances are now equipped with Flammable Vapor Ignition Resistant (FVIR) technology it seems that moving it to an exception makes sense to make sure it is not overlooked.

**The Committee Statement provided for amending proposal Item # 061 by the UMC TC is as follows:** Requirements for electric water heaters have been missing since the 2003 UPC. The reasons for this may no longer exist and are perhaps unimportant. The fact is that electric water heaters are still installed by plumbers and still need inspections. What document do plumbers and inspectors seek for these installation requirements?

Elements and switches (thermostats) are just as dangerous as burners and burner ignition devices, perhaps more so with the advent of FVIR for gas burning water heaters.

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**TCC ITEM # 061**

### 2024 UNIFORM MECHANICAL CODE

**ITEM # 061**

#### 305.0 Location.

305.1 Installation in Residential Garages. Appliances in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit shall be installed so that all heating elements, switches, burners, and burner-ignition devices are located not less than 18 inches (457 mm) above the floor. [NFPA 54:9.1.10.1]

**Exception:** Listed flammable vapor ignition resistant (FVIR) appliances. [NFPA 54:9.1.10.1]
**TCC ITEM # 012**

**2024 UNIFORM PLUMBING CODE**

**ITEM # 104**

**RECOMMENDATION:**

**507.0 Appliance and Equipment Installation Requirements.**

**507.5 Drainage Pan.** Where a water heater is located in an attic, in or on an attic ceiling assembly, floor-ceiling assembly, floor-subfloor assembly or where damage results from a leaking water heater, a watertight pan of corrosion-resistant materials shall be installed beneath the water heater in accordance with the following:

1. The drainage pan shall be provided with not less than 3/4 of an inch (20 mm) diameter drain to an approved location. The terminating end of the drainpipe shall be readily visible.
2. The drainage pan shall be not less than 1 1/2 inches (38 mm) in depth.
3. Where a drainage pan pipe is installed, the material of the piping shall be rated for the temperature rating of the water heater and shall be approved for use with the liquid being discharged.
4. Discharge from a relief valve into a drainage pan shall be prohibited.

**305.0 Location.**

**305.5 Drainage Pan.** Where a water heater is located in an attic, in or on an attic ceiling assembly, floor-ceiling assembly, floor-subfloor assembly or where damage results from a leaking water heater, a watertight pan of corrosion-resistant materials shall be installed beneath the water heater in accordance with the following:

1. The drainage pan shall be provided with not less than 3/4 of an inch (20 mm) diameter drain to an approved location. The terminating end of the drainpipe shall be readily visible.
2. The drainage pan shall be not less than 1 1/2 inches (38 mm) in depth.
3. Where a drainage pan pipe is installed, the material of the piping shall be rated for the temperature rating of the water heater and shall be approved for use with the liquid being discharged.
4. Discharge from a relief valve into a drainage pan shall be prohibited.

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<tr>
<th>X</th>
<th>Accept recommendation as submitted.</th>
<th>No action needed.</th>
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</table>

**Substantiation:**

The language in UMC Item # 064, Section 305.5 (Drainage Pan) is being revised to correlate with the action taken by the UPC TC for Item # 104, Section 507.5 (Drainage Pan) to separate drainage pan requirements into a numbered list format and add items (3) and (4) for temperature rating and discharge from a relief valve.

The following is provided for informational purpose only:

The **substantiation provided for proposal Item # 104 of the UPC is as follows:** The new text will add provisions which clarify that piping used on hot water applications shall be rated for such temperatures as there are drain line to be used for cold water applications only. Additionally, the provisions for the drainage pan are being placed in a list which makes the provisions easy to find.

The **Committee Statement provided for amending proposal Item # 104 by the UPC TC is as follows:** The modification adds parts of Item #105, Item #106, and Item #107.

The modification clarifies that Section 507.5 is applicable to all locations where a leaking water heater can cause damage and not only the locations indicated in the section. The intent of the section is to prevent damage from occurring in the surrounding vicinity of the water heater should a leak occur. Additionally, the terminating end of the drain pipe shall be visible to alert the owner or inspector that the water heater is leaking.

This modification also adds (4) as the same prohibition of not allowing discharging the relief valve into a water heater pan that is in Section 608.5(7). It is a common mistake and needs to be stated in both sections.

The **substantiation provided for proposal Item # 064 of the UMC is as follows:** The proposed change will clarify that Section 305.5 is applicable to all water heaters, regardless of the type of water heater. The intent of the section is to prevent damage from occurring in the surrounding vicinity of the water heater should a leak occur.
TCC ITEM # 013

<table>
<thead>
<tr>
<th>ITEM # 033</th>
<th>ITEM # 067</th>
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<tbody>
<tr>
<td><strong>RECOMMENDATION:</strong></td>
<td><strong>RECOMMENDATION:</strong></td>
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<tr>
<td><strong>308.0 Prohibited Locations.</strong></td>
<td><strong>308.0 Improper Location.</strong></td>
</tr>
<tr>
<td><strong>308.1 General.</strong> Piping, fixtures, appliances, or equipment shall not be so located as to interfere with the normal use thereof or with the normal operation and use of windows, doors, or other required facilities.</td>
<td><strong>308.1 General.</strong> Piping or equipment shall not be so located as to interfere with the normal use thereof or with the normal operation and use of windows, doors, or other required facilities.</td>
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</tbody>
</table>

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<tr>
<th>Accept recommendation as submitted.</th>
<th>X No action needed.</th>
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</table>

**Substantiation:**
No action is needed by the TCC for UPC Item # 033 or UMC Item # 067. The TCC agrees with the actions taken by the UPC TC to “accept as submitted” Item # 033 with regards to Section 308.1 (General) and the actions taken by the UMC TC to “reject” Item # 067 with regards to Section 305.6.1 (General).

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 033 of the UPC is as follows:** This change adds “appliance” as an appliance can also interfere with the normal use of windows, doors, and facilities. Furthermore, the term “improper” is a subjective term and “prohibited” is clear, concise, and enforceable.

**The substantiation provided for proposal Item # 067 of the UMC is as follows:** The code change provides a list of spaces where fuel burning appliances shall not be installed for public health and safety. For example, Section 303.2 allows central heating furnaces and boilers installed in closets or alcoves shall be listed for such installation.

**The Committee Statement provided for rejecting proposal Item # 067 by the UMC TC is as follows:** The proposal needs additional revisions and is currently vague and poorly written.
**TCC ITEM # 014**

**2024 UNIFORM PLUMBING CODE**

**ITEM # 206 and 207**

**RECOMMENDATION:**

Item # 206

**814.0 Condensate Waste and Control.**

**814.2 Condensate Control.** Where any equipment or appliance is installed in a space where damage is capable of resulting from condensate overflow, a drain line shall be provided and shall be drained in accordance with Section 814.1. An additional protection method for condensate overflow shall be provided in accordance with one of the following:

1. A water level detecting device that will shut off the equipment or appliance in the event the primary drain is blocked. Such detecting device shall be in accordance with the manufacturer’s installation instructions.
2. An additional watertight pan of corrosion-resistant material, with a separate drain line, installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain.
3. An additional drain line at a level that is higher than the primary drain line connection of the drain pan.
4. An additional watertight pan of corrosion-resistant material with a water level detection device installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain and to shut off the equipment.

The additional pan or the additional drain line connection shall be provided with a drain pipe of not less than 3/4 of an inch (20 mm) nominal pipe size, discharging at a point that is readily observed.

Item # 207

**814.0 Condensate Waste and Control.**

**814.2 Condensate Control.** Where any equipment or appliance is installed in a space where damage is capable of resulting from condensate overflow, a drain line shall be provided and shall be drained in accordance with Section 814.1. An additional protection method for condensate overflow shall be provided in accordance with one of the following:

1. A water level detecting device that will shut off the equipment or appliance in the event the primary drain is blocked. Such detecting device shall be in accordance with the manufacturer’s installation instructions.
2. An additional watertight pan of corrosion-resistant material, with a separate drain line, installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain.
3. An additional separate drain line at a level that is higher than the primary drain line connection of the drain pan.
4. An additional watertight pan of corrosion-resistant material with a water level detection device installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain.

The additional pan or the additional drain line connection shall be provided with a drain pipe of not less than 3/4 of an inch (20 mm) nominal pipe size, discharging at a point that is readily observed.

**310.0 Condensate Wastes and Control.**

**310.2 Condensate Control.** Where any equipment or appliance is installed in a space where damage is capable of resulting from condensate overflow, a drain line shall be provided and shall be drained in accordance with Section 310.1. An additional protection method for condensate overflow shall be provided in accordance with one of the following:

1. A water level detecting device that will shut off the equipment or appliance in the event the primary drain is blocked. Such detecting device shall be in accordance with the manufacturer’s installation instructions.
2. An additional watertight pan of corrosion-resistant material, with a separate drain line, installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain.
3. An additional separate drain line at a level that is higher than the primary drain line connection of the drain pan.
4. An additional watertight pan of corrosion-resistant material with a water level detection device installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain.

The additional pan or the additional drain line connection shall be provided with a drain pipe of not less than 3/4 of an inch (20 mm) nominal pipe size, discharging at a point that is readily observed.
ITEM # 206 and 207

(3) An additional separate drain line at a level that is higher than the primary drain line connection of the drain pan.

(4) An additional watertight pan of corrosion-resistant material with a water level detection device installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain and to shut off the equipment.

The additional pan or the additional drain line connection shall be provided with a drain pipe of not less than 3/4 of an inch (20 mm) nominal pipe size, discharging at a point that is readily observed.

X | Accept recommendation as submitted. | No action needed.
---|-----------------------------------|---------------------
Substantiation:
The language in UMC Item # 070, Section 310.2(1) (Condensate Control) and UPC Item # 207, Section 814.2(1) (Condensate Control) are being revised to correlate with the action taken by the UPC TC for Item # 206, Section 814.2(1) (Condensate Control) to add the sentence “Such detecting device shall be in accordance with the manufacturer’s installation instructions.”

The following is provided for informational purpose only:

The substantiation provided for proposal Item # 206 of the UPC is as follows: As written, option (1) is not clear where a water detecting device shall be installed. The language gives clear direction to the location and will prevent installers from placing such devices in the drain line.

The Committee Statement provided for amending proposal Item # 206 by the UPC TC is as follows: The modification will clarify that the directions and guidance for such detecting devices are found in the manufacturer’s installation instructions. Additionally, there may be devices that are not installed directly inside the pan.

The substantiation provided for proposal Item # 207 of the UPC is as follows: The addition of “separate” ensures that the primary and secondary condensate drains are not tied together. They must be run separate in case the primary is clogged.

The substantiation provided for proposal Item # 070 of the UMC is as follows: The recommended change will assist in identifying whether the condensate waste is coming from the primary or secondary drain. If there is condensate coming from the secondary line, it must be investigated.

The addition of "separate" is to ensure that the primary and secondary are not tied together.

It used to have proposed language to make sure it was visible and marked, but it was removed.
RECOMMENDATION:

814.0 Condensate Waste and Control.

814.5 Point of Discharge. Air-conditioning condensate waste pipes shall connect indirectly to the drainage system through an air gap or air break to trapped and vented receptors, dry wells, mop sinks, or leach pits. A condensate drain shall be trapped in accordance with the appliance manufacturer’s instructions or as approved.

Exception: Direct connections as permitted in accordance with Section 814.6.

310.0 Condensate Wastes and Control.

310.5 Point of Discharge. Air-conditioning condensate waste pipes shall connect indirectly to the drainage system through an air gap or air break to trapped and vented receptors, dry wells, mop sinks, or leach pits. A condensate drain shall be trapped in accordance with the appliance manufacturer’s instructions or as approved.

Exception: Direct connections in accordance with Section 310.6.

X Accept recommendation as submitted. No action needed.

Substantiation:
The language in UPC Item # 212, Section 814.5 (Point of Discharge) is being revised to correlate with the action taken by the UMC TC for Item # 074, Section 310.5 (Point of Discharge) to change the phrase “as permitted in” to “in accordance with” for consistency throughout the code.

The following is provided for informational purpose only:

The substantiation provided for proposal Item # 212 of the UPC is as follows: The first sentence of Section 814.5 starts with indirect connection and then gives the exception. The change relocates language in Section 814.5 to an exception for clarity and to ensure it is not overlooked. Such "direct" connection to the tailpiece is covered in Section 814.6. Additionally, the term “tailpiece of plumbing fixtures” is grouped with the list of locations allowed for “air gap” or “air breaks.” A connection to a tailpiece of a plumbing fixture is neither through an air break or air gap.

The Committee Statement provided for amending proposal Item # 212 by the UPC TC is as follows: The modification includes "mop sinks" which was accepted in Item # 211. The modification clarifies that mop sinks are an option for indirect connections for condensate waste pipes. Condensate drainage through mop sinks is common and will assist the end user in installing indirect waste piping.

The substantiation provided for proposal Item # 074 of the UMC is as follows: The first sentence of Section 310.5 starts with indirect connection and then gives the exception. The change relocates language in Section 310.5 to an exception for clarity and to ensure it is not overlooked. Such "direct" connection to the tailpiece is covered in Section 310.6. Additionally, the term “tailpiece of plumbing fixtures” is grouped with the list of locations allowed for “air gap” or “air breaks.” A connection to a tailpiece of a plumbing fixture is neither through an air break or air gap.

The Committee Statement provided for amending proposal Item # 074 by the UMC TC is as follows: The change clarifies that mop sinks are an option for indirect connections for condensate waste discharge. Condensate drainage through mop sinks is common and the modification will assist the end user in installing indirect condensate waste piping.
### RECOMMENDATION:

**313.0 Hangers, Supports, and Anchors.**

**313.1 General.** Piping, tubing, fixtures, appliances, and appurtenances shall be supported in accordance with this code, the manufacturer’s installation instructions, and in accordance with the Authority Having Jurisdiction. Seismic restraints shall be in accordance with the building code.

**313.2 Material.** Hangers, supports, and anchors shall be of sufficient strength to support the weight of the pipe or tubing and its contents. Piping or tubing shall be isolated from incompatible materials.

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<td><strong>Substantiation:</strong></td>
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<td></td>
<td>The language in UPC Item # 041, Section 313.1 (General) and Section 313.2 (Material) are being revised to correlate with the action taken by the UMC TC for Item # 080, Section 313.1 (General) and Section 313.2 (Material) to include the term “tubing.” Additionally, UMC Item # 080, Section 313.1 (General) is being revised to correlate with the action taken by the UPC TC for Item # 041, Section 313.1 (General) to change the phrase “as required by” to “in accordance with” for consistency throughout the code.</td>
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The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 041 of the UPC is as follows:** *The proposed text is adding seismic restraints to ensure these provisions are not overlooked when designing or working in areas prone to seismic conditions. Additionally, “anchors” is being added to the title as the subsections also include anchors.*

**The substantiation provided for proposal Item # 080 of the UMC is as follows:** *The proposed text is adding seismic restraints to ensure these provisions are not overlooked when designing in areas prone to seismic conditions. Additionally, Section 313.0 and Section 313.2 are being modified as the sections address hangers, supports, and anchors.*
**TCC ITEM # 017**

**2024 UNIFORM PLUMBING CODE**

**ITEM # 039**

**RECOMMENDATION:**

312.0 Protection of Piping, **Tubing**, Materials, and Structures.

312.9 **Steel Nail Plates.** Plastic **piping or tubing**, and copper or copper alloy piping or tubing penetrating framing members to within 1 inch (25.4 mm) of the exposed framing shall be protected by steel nail plates not less than No. 18 gauge (0.0478 inches) (1.2 mm) in thickness. The steel nail plate shall extend along the framing member not less than 1 1/2 inches (38 mm) beyond the outside diameter of the pipe or tubing. Fuel gas piping shall be protected in accordance with Section 1210.4.3.

**2024 UNIFORM MECHANICAL CODE**

**ITEM # 086**

316.0 Protection of Piping, **Tubing**, Materials, and Structures.

316.6 **Steel Nail Plates.** Plastic piping or tubing, copper or copper alloy piping or tubing, and ducts penetrating framing members to within 1 inch (25.4 mm) of the exposed framing shall be protected by steel nail plates not less than No. 18 gauge (0.0478 inches) (1.2141 mm) in thickness. The steel nail plate shall extend along the framing member not less than 1 1/2 inches (38 mm) beyond the outside diameter of the pipe or tubing. **Exception:** See Fuel gas piping shall be protected in accordance with Section 1310.4.3.

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<th>X</th>
<th>Accept recommendation as submitted.</th>
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**Substantiation:**

The language in UPC Item # 039, Section 312.9 (Steel Nail Plates) are being revised to correlate with the action taken by the UMC TC for Item # 086, Section 316.6 (Steel Nail Plates) to include the phrase "piping or tubing" and add “tubing” to the title.

Additionally, UMC Item # 086, Section 316.6 (Steel Nail Plates) is being revised to correlate with the action taken by the UPC TC for Item # 039, Section 312.9 (Steel Nail Plates) for referencing Section 1310.4.3 for fuel gas piping protection.

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 039 of the UPC is as follows:** The section is being revised to add the existing standard for safety plates for the protection of concealed pipes running through the framing of a building. These plates are used in the industry on a daily basis and the standard will ensure such plates meet minimum safety requirements. Additionally, fuel gas tubing is required to be protected by specific requirements in Section 1210.4.3 which may include steel plates. Therefore, not an exception.

**The Committee Statement provided for amending proposal Item # 039 by the UPC TC is as follows:** The reference to IAPMO IGC 193 is overly restrictive since there are field fabricated nail plates that meet the thickness requirements in the code. The last sentence clarifies that fuel gas piping plates shall comply with Section 1210.4.3 and is a good update for clarity and direction.

**The substantiation provided for proposal Item # 086 of the UMC is as follows:** The section is being revised to add the existing standard for safety plates for the protection of concealed pipes running through the framing of a building. These plates are used in the industry on a daily basis and the standard will ensure such plates meet minimum safety requirements. Additionally, fuel gas tubing is required to be protected by specific requirements in Section 1310.4.3 which may include steel plates. Therefore, not an exception.

**The Committee Statement provided for rejecting proposal Item # 086 by the UMC TC is as follows:** The reference to IAPMO IGC 193 is overly restrictive since there are field-fabricated steel nail plates that can meet the thickness requirements in Section 316.6.
TCC ITEM # 018

2024 UNIFORM PLUMBING CODE

ITEM # 043

RECOMMENDATION:

314.0 Trenching, Excavation, and Backfill.

314.2 Tunneling and Driving. Tunneling and driving shall be permitted to be done in yards, courts, or driveways of a building site. Where sufficient depth is available to permit, tunnels shall be permitted to be used between open-cut trenches.

Tunnels shall have a clear height of 2 feet (610 mm) above the pipe and shall be limited in length to one-half the depth of the trench, with a maximum length of 8 feet (2438 mm). Where pipes are driven, the drive pipe shall be not less than one size larger than the pipe to be laid.

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<th>Accept recommendation as submitted.</th>
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Substantiation:
The language in UMC Item # 087, Section 317.2 (Tunneling and Driving) is being revised to correlate with the action taken by the UPC TC for Item # 043, Section 314.2 (Tunneling and Driving) by striking the sentence “The length of the tunneling shall be the distance required to clear the obstacle above.”

The following is provided for informational purpose only:

The substantiation provided for proposal Item # 043 of the UPC is as follows: Where pipe is to be installed by jacketing or tunneling to clear a slab, driveway, or other paved area, such tunnels should not be longer than necessary, as it is difficult to refill with the appropriate backfill in longer tunnels. Furthermore, a new section is being added to address the earth loads that must be taken into account for any tunneling and to account for any earth settlement in order to protect the piping within.

The Committee Statement provided for rejecting proposal Item # 043 by the UPC TC is as follows: The proposal is being rejected as it is overly restrictive and unenforceable. Furthermore, it is outside of the scope of the UPC.

The substantiation provided for proposal Item # 087 of the UMC is as follows: Where pipe is to be installed by jacketing or tunneling to clear a slab, driveway, or other paved area, such tunnels should not be longer than necessary, as it is difficult to refill with the appropriate backfill in longer tunnels. Furthermore, a new section is being added to address the earth loads that must be taken into account for any tunneling and to account for any earth settlement in order to protect the piping within.

The Committee Statement provided for amending proposal Item # 087 by the UMC TC is as follows: Section 317.2.1 is being stricken as it is overly restrictive and unenforceable. Walls, structures, and ceilings are outside of the scope of the mechanical code and are better suited in a building code.
### TCC ITEM # 019

**2024 UNIFORM PLUMBING CODE**

**ITEM # 115**

### RECOMMENDATION:

**509.0 Venting of Appliances.**

**509.10 Vent Connectors for Category I Appliances.**

**509.10.5 Joints.** Joints between sections of connector piping and connections to flue collars or draft hood outlets shall be fastened in accordance with one of the following methods:
1. Mechanically fastened by means of not less than three sheet-metal screws equally spaced around the joint.
2. Vent connectors of listed vent material assembled and connected to flue collars or draft hood outlets in accordance with the manufacturer’s instructions.
3. Other approved means. {NFPA 54:12.11.6}

### 2024 UNIFORM MECHANICAL CODE

**ITEM # 174**

**802.0 Venting of Appliances.**

**802.10 Vent Connectors for Category I Appliances.**

**802.10.5 Joints.** Joints between sections of connector piping and connections to flue collars or draft hood outlets shall be fastened in accordance with one of the following methods:
1. Mechanically fastened by means of not less than three sheet-metal screws equally spaced around the joint.
2. Vent connectors of listed vent material assembled and connected to flue collars or draft hood outlets in accordance with the manufacturer’s instructions.
3. Other approved means. {NFPA 54:12.11.6}

### Actions

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### Substantiation:

The language in UMC Item # 174, Section 802.10.5(1) (Joints) is being revised to correlate with the action taken by the UPC TC for Item # 115, Section 509.10.5(1) (Joints) by rephrasing the sentence to "Mechanically fastened by means of not less than three sheet-metal screws equally spaced around the joint."

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 115 of the UPC is as follows:**

One: There is a potential conflict with the 2021 UMC Section 603.9: "UMC - 603.9 Joints and Seams of Ducts. Joints and seams for duct systems shall comply with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Joints of duct systems shall be made substantially airtight by means of tapes, mastics, gasketing, or other means. Crimp joints for round ducts shall have a contact lap of not less than 1-1/2 inches (38 mm) and shall be mechanically fastened by means of not less than three sheet-metal screws equally spaced around the joint, or an equivalent fastening method."

Two: A common practice is to use one or two screws which can allow the vent to swivel and become dislodges and leak carbon monoxide and other exhaust gases.

Three: Some installers use an aluminum tape typically used for HVAC plenums. This product cannot take the heat and will fall off many times again exhausting gas into the space.

**The substantiation provided for proposal Item # 174 of the UMC is as follows:** In accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines), Chapter 8 is being revised to the latest edition of NFPA 54-2021.
### TCC ITEM # 020

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<td>ITEM # 101</td>
<td>ITEM # 174</td>
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**RECOMMENDATION:**

**509.2.6 Direct-Vent Appliances.** Listed direct vent appliances shall be installed in accordance with the manufacturer’s installation instructions. [NFPA 54:12.3.5.1]

**802.2.6 Direct Vent Appliances.** Listed direct vent appliances shall be installed in accordance with the manufacturer’s installation instructions. [NFPA 54:12.3.5.1]

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**Substantiation:**

The language in UPC Item # 101, Section 509.2.6 (Direct-Vent Appliances) is being revised to correlate with the action taken by the UMC TC for Item # 174, Section 802.2.6 (Direct Vent Appliances) by adding the term “instructions” to the end of the section.

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 101 of the UPC is as follows:** The above sections have been revised to correlate with NFPA 54-2021 (latest version) in accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines).

**The substantiation provided for proposal Item # 174 of the UMC is as follows:** In accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines), Chapter 8 is being revised to the latest edition of NFPA 54-2021.
### TCC ITEM # 021

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<tr>
<td><strong>ITEM # 116</strong></td>
<td><strong>ITEM # 175</strong></td>
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#### RECOMMENDATION:

**509.10.12 Passage Through Ceilings, Floors, or Walls.** A vent connector shall not pass through a ceiling, floor, or fire-resistance-rated wall. A single-wall metal pipe connector shall not pass through an interior wall.

**Exceptions:**

1. Vent connectors made of listed Type B or Type L vent material and serving listed appliances with draft hoods and other appliances listed for use with Type B gas vents that pass through walls or partitions constructed of combustible material shall be installed with not less than the listed clearance to combustible material.
2. Vent connectors shall be permitted to **be installed pass through ceilings, floors, or walls** in accordance with Section 509.7.3.1 and Section 509.7.3.5.

**802.10.12 Passage Through Ceilings, Floors, or Walls.** A vent connector shall not pass through a ceiling, floor, or fire-resistance-rated wall. A single-wall metal pipe connector shall not pass through an interior wall.

**Exceptions:**

1. Vent connectors made of listed Type B or Type L vent material and serving listed appliances with draft hoods and other appliances listed for use with Type B gas vents that pass through walls or partitions constructed of combustible material shall be installed with not less than the listed clearance to combustible material.
2. Vent connectors shall be permitted to **pass through ceilings, floors, or walls** in accordance with Section 802.7.3.1 and Section 802.7.3.4.

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<th>Accept recommendation as submitted.</th>
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#### Substantiation:

The language in UPC Item # 116, Section 509.10.12 (Passage Through Ceilings, Floors, or Walls) is being revised to correlate with the action taken by the UMC TC for Item # 175, Section 802.10.12 (Passage Through Ceilings, Floors, or Walls) by changing the phrase “be installed” to “pass through ceilings, floors, or walls” in Exception (2).

Furthermore, UMC Item # 175, Section 802.10.12 (Passage Through Ceilings, Floors, or Walls) is being revised to correlate with the action taken by the UPC TC for Item # 116, Section 509.10.12 (Passage Through Ceilings, Floors, or Walls) by adding the term “vent” to the beginning of Exception (2).

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 116 of the UPC is as follows:** The intent of the exception to Section 509.10.12 is further clarified by directing the end user to Section 509.7.3.1 and Section 509.7.3.5 which permit connectors to pass through ceilings, floors, or wall and are specified in the indicated sections. This change will clarify the intent of Section 509.10.12 and avoid any confusion between the sections.

**The substantiation provided for proposal Item # 175 of the UMC is as follows:** The intent of the exception to Section 802.10.12 is further clarified by directing the end user to Section 802.7.3.1 and Section 802.7.3.4 which permit connectors to pass through ceilings, floors, or wall and are specified in the indicated sections. This change will clarify the intent of Section 802.10.12 and avoid any confusion between the sections.
# TCC ITEM # 022

## 2024 UNIFORM PLUMBING CODE

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### RECOMMENDATION:

510.0 Sizing of Category I Venting Systems.

510.2 Multiple Appliance Vent Table 510.2(1) through Table 510.2(9). (remaining text unchanged)

510.2.11 Vent Connector Rise. The vent connector rise \((R)\) for each appliance shall be measured from the draft hood outlet or flue collar to the centerline where the vent gas streams come together. \(\text{NFPA 54:13.2.12}\)

## 2024 UNIFORM MECHANICAL CODE

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### 803.0 Sizing of Category I Venting Systems.

803.2 Multiple Appliance Vent Table 803.2(1) through Table 803.2(9). (remaining text unchanged)

803.2.11 Vent Connector Rise. The vent connector rise \((R)\) for each appliance shall be measured from the draft hood outlet or flue collar to the centerline where the vent gas streams come together. \(\text{NFPA 54:13.2.12}\)

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<th>Accept recommendation as submitted.</th>
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### Substantiation:

The language in UPC Item # 117, Section 510.2.11 (Vent Connector Rise) is being revised to correlate with the action taken by the UMC TC for Item # 178, Section 803.2.11 (Vent Connector Rise) to clarify the term "vent connector rise" and its application to "each appliance."

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 117 of the UPC is as follows:** This is about the vent connector, not the appliance it connects to so eliminates unnecessary wording and focuses on the vent connector.

**The substantiation provided for proposal Item # 178 of the UMC is as follows:** The language in Section 803.2.11 is being revised for clarity and ease of use.
TCC ITEM # 023

2024 UNIFORM PLUMBING CODE

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<th>ITEM # 179</th>
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<td>RECOMMENDATION:</td>
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705.10.3 Plastic Pipe to Other Materials. Where connecting plastic pipe to other types of plastic or other types of piping material; approved listed adapter or transition fittings and listed for the specific transition intended shall be used. Except as provided in Section 705.9.4, PVC and ABS pipe and fittings shall not be solvent welded to any other unlike material.

2024 UNIFORM MECHANICAL CODE

| ITEM # 264 |

| 1211.14.2 Plastic Pipe to Other Materials. Where connecting plastic pipe to other types of plastic or other types of piping material; approved types of listed adapter or transition fittings designed for and listed for the specific transition intended shall be used. Except as provided in the plumbing code, PVC and ABS pipe and fittings shall not be solvent welded to any other unlike material. |

| X | Accept recommendation as submitted. | No action needed. |

Substantiation:
The language in UMC Item # 264, Section 1211.14.2 (Plastic Pipe to Other Materials) is being revised to correlate with the action taken by the UPC TC for Item # 179, Section 705.10.3 (Plastic Pipe to Other Materials) with regards to adapters and transition fittings. Additionally, the TCC fixed an error by striking ABS as ABS is not listed as one of the approved materials in Table 1210.1 (Materials for Hydronic System Piping, Tubing, and Fittings).

The following is provided for informational purpose only:

The substantiation provided for proposal Item # 179 of the UPC is as follows: The current language under Section 705.9.4 allows for a single transition from ABS to PVC or PVC to ABS exterior of the structure. Transition glue is not being represented to be allowable to make transition joints between ABS and PVC anywhere in the building. This code change clarifies that this practice is not approved. I have seen residences where the below slab plumbing was PVC and then the above slab plumbing all PVC with the joints being made with transition glue. This is an improper use of the product. While there is a code change to place this change in Chapter 3 as a prohibited practice it is also important that this be in this section as a prohibited practice to aid the end user and AHJ.

The substantiation provided for proposal Item # 264 of the UMC is as follows: The current language allows for a single transition from ABS to PVC or PVC to ABS exterior of the structure. Transition glue is not being represented to be allowable to make transition joints between ABS and PVC anywhere in the building. This code change clarifies that this practice is not approved. I have seen residences where the below slab plumbing was PVC and then the above slab plumbing all PVC with the joints being made with transition glue. This is an improper use of the product. While there is a code change to place this change in Chapter 3 as a prohibited practice it is also important that this be in this section as a prohibited practice to aid the end user and AHJ.
RECOMMENDATION:

1208.6.6 Regulator Vent Piping. Plastic pipe and fittings used to connect regulator vents to remote vent terminations shall be PVC (Schedule 40 and 80). PVC vent piping shall not be installed indoors. [NFPA 54:5.5.4.2]

1208.6.9.3 Thread Joint Sealing. Threaded joints shall be made using a thread joint sealing material. [NFPA 54: 5.5.6.4.1] Thread joint sealing materials shall be compatible with the pipe and fitting material on which the compounds are used. [NFPA 54: 5.5.6.4.2] Thread joint sealing materials shall be resistant to the chemical constituents of the gases to be conducted through the piping. [NFPA 54:5.5.6.4.3]

1210.3 Installation of Aboveground Piping. Piping installed aboveground shall comply with all of the following:
(1) Piping shall be securely supported and located where it will be protected from physical damage.
(2) Where passing through an exterior wall, the piping shall also be protected from corrosion by coating or wrapping with an inert material approved for such applications.
(3) The piping shall be sealed around its circumference at the point of the exterior penetration to prevent the entry of water, insects, and rodents.
(4) Where piping is encased in a protective pipe sleeve, the annular spaces between the gas piping and the sleeve and between the sleeve and the wall opening shall be sealed.
(5) Piping installed outdoors shall be elevated not less than 3½ inches (89 mm) above the ground.
(6) Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.2.1]

1210.3.5.3 Piping on Roofs. Gas piping installed on the roof surfaces shall be supported in accordance with Table 1210.3.5.1. Gas piping shall be elevated not less than 3½ inches (89 mm) above the roof surface. [NFPA 54:7.2.6.4.1, 7.2.6.4.2]

1308.5.4.1 Regulator Vent Piping. Plastic pipe and fittings used to connect regulator vents to remote vent terminations shall be PVC (Schedule 40 and 80) conforming to UL 651. PVC vent piping shall not be installed indoors. [NFPA 54:5.5.4.2]

1308.5.6.3 Thread Joint Sealing. Threaded joints shall be made using a thread joint sealing material. [NFPA 54: 5.5.6.4.1] Thread joint sealing materials shall be compatible with the pipe and fitting material on which the compounds are used. [NFPA 54: 5.5.6.4.2] Thread joint sealing materials shall be nonhardening and shall be resistant to the chemical constituents of the gases to be conducted through the piping. [NFPA 54:5.5.6.4.3]

1310.3 Installation of Aboveground Piping. Piping installed aboveground shall comply with all of the following:
(1) Piping shall be securely supported and located where it will be protected from physical damage.
(2) Where passing through an exterior wall, the piping shall also be protected from corrosion by coating or wrapping with an inert material approved for such applications.
(3) The piping shall be sealed around its circumference at the point of the exterior penetration to prevent the entry of water, insects, and rodents.
(4) Where piping is encased in a protective pipe sleeve, the annular spaces between the gas piping and the sleeve and between the sleeve and the wall opening shall be sealed.
(5) Piping installed outdoors shall be elevated not less than 3½ inches (89 mm) above the ground.
(6) Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.2.1]

1310.3.5.3 Piping on Roofs. Gas piping installed on the roof surfaces shall be elevated above the roof surface and shall be supported in accordance with Table 1310.3.5.1. Gas piping shall be elevated not less than 3½ inches (89 mm) above the roof surface. [NFPA 54-2018:7.2.6.4.1, 7.2.6.4.2]
ITEM # 246

1212.1 Connecting Appliances and Equipment. Appliances and equipment shall be connected to the building piping in compliance with Section 1212.6 through Section 1212.8 by one of the following:
(1) Rigid metallic pipe and fittings.
(2) Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.
(3) A connector for gas appliances listed in accordance with ANSI Z21.24/CSA 6.27. The connector shall be used in accordance with the manufacturer’s installation instructions and shall be in the same room as the appliance. Only one connector shall be used per appliance.
(4) A connector for outdoor gas appliances and manufactured homes listed in accordance with ANSI Z21.75/CSA 6.27. Only one connector shall be used per appliance.
(5) CSST where installed in accordance with the manufacturer’s installation instructions. CSST shall not be directly routed into a metallic appliance enclosure where the appliance is connected to a metallic vent that terminates above a roofline. CSST shall connect only to appliances that are fixed in place.
(6) Listed nonmetallic gas hose connectors in accordance with Section 1212.3.
(7) Unlisted gas hose connectors for use in laboratories and educational facilities in accordance with Section 1212.4. [NFPA 54:9.6.1]

1212.2 Suspended Low-Intensity Infrared Tube Heaters. Suspended low-intensity infrared tube heaters shall be connected to the building piping system with a connector listed for the application in accordance with ANSI Z21.24/CSA 6.27 CSA Z21.24 as follows:
(1) The connector shall be installed in accordance with the tube heater installation instructions and shall be in the same room as the appliance.
(2) Only one connector shall be used per appliance. [NFPA 54:9.6.1.5]

ITEM # 274

1312.1 Connecting Appliances and Equipment. Appliances and equipment shall be connected to the building piping in compliance with Section 1312.6 through Section 1312.8 by one of the following:
(1) Rigid metallic pipe and fittings.
(2) Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.
(3) A connector for gas appliances listed in accordance with ANSI Z21.24/CSA 6.27 CSA Z21.24. The connector shall be used in accordance with the manufacturer’s installation instructions and shall be in the same room as the appliance. Only one connector shall be used per appliance.
(4) A connector for outdoor gas appliances and manufactured homes listed in accordance with ANSI Z21.75/CSA 6.27 CSA Z21.75. Only one connector shall be used per appliance.
(5) CSST where installed in accordance with the manufacturer’s installation instructions. CSST shall not be directly routed into a metallic appliance enclosure where the appliance is connected to a metallic vent that terminates above a roofline. CSST shall connect only to appliances that are fixed in place.
(6) Listed nonmetallic gas hose connectors in accordance with Section 1312.3.
(7) Unlisted gas hose connectors for use in laboratories and educational facilities in accordance with Section 1312.4. [NFPA 54:9.6.1]

1312.2 Suspended Low-Intensity Infrared Tube Heaters. Suspended low-intensity infrared tube heaters shall be connected to the building piping system with a connector listed for the application in accordance with ANSI Z21.24/CSA 6.27 CSA Z21.24 as follows:
(1) The connector shall be installed in accordance with the tube heater installation instructions, and shall be in the same room as the appliance.
(2) Only one connector shall be used per appliance. [NFPA 54:9.6.1.5]

X | Accept recommendation as submitted. | No action needed.

Substantiation:
The language in UMC Item # 274, Section 1308.5.4.1 (Regulator Vent Piping) is being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1208.6.6 (Regulator Vent Piping) with regards to the addition of “Schedule 40 and 80” and striking the UL 651 standard. Additionally, the UL 651 standard is being stricken from Table 1701.1 (Referenced Standards) for both the UPC and UMC.

The language in UMC Item # 274, Section 1308.5.6.3 (Thread Joint Sealing) is being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1208.6.9.3 (Thread Joint Sealing) by striking the language pertaining to “nonhardening.”

The language in UMC Item # 274, Section 1310.3 (Installation of Aboveground Piping) is being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1210.3 (Installation of Aboveground Piping) with regards to elevating piping installed outdoors to not less than 3 ½ inches above the ground.

The language in UMC Item # 274, Section 1310.3.5.3 (Piping on Roofs) is being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1210.3.5.3 (Piping on Roofs) with regards to elevating gas piping installed on roofs to not less than 3 ½ inches above the roof surface.

Lastly, the language in UMC Item # 274, Section 1312.1 (Connecting Appliances and Equipment) and 1312.2.

32
<table>
<thead>
<tr>
<th>ITEM # 246</th>
<th>ITEM # 274</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Suspended Low-Intensity Infrared Tube Heaters) and UPC Section 1212.2</strong> (Suspended Low-Intensity Infrared Tube Heaters) are being revised to correlate with the action taken by the UPC TC for Item # 246, Section 1212.1 (Connecting Appliances and Equipment) regarding the designation of the CSA standards.</td>
<td><strong>The following is provided for informational purpose only:</strong></td>
</tr>
<tr>
<td>The substantiation provided for proposal Item # 246 of the UPC is as follows: The above sections have been revised to correlate with NFPA 54-2021 (latest version) in accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines).</td>
<td></td>
</tr>
<tr>
<td>The Committee Statement provided for amending proposal Item # 246 by the UPC TC is as follows: UL 651 is a standard for electric conduit and not vent piping. The reference to UL 651 is being removed to avoid confusion and to avoid the use of an incorrect fuel gas vent piping. Furthermore, the reference to the PVC &quot;Schedule 40 and 80&quot; is needed to prevent the use of thinner materials.</td>
<td></td>
</tr>
<tr>
<td>The substantiation provided for proposal Item # 274 of the UMC is as follows: In accordance with IAPMO's Regulations Governing Committee Projects (Extract Guidelines), Chapter 13 is being revised to the latest edition of NFPA 54-2021.</td>
<td></td>
</tr>
<tr>
<td>The Committee Statement provided for amending proposal Item # 274 by the UMC TC is as follows: There is no technical justification provided for changing the gas piping elevation to 3-1/2 inches above the roof surface. For example, 2x4 lumber has been used for years to elevate gas piping on roofs and is considered acceptable by the industry.</td>
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### TCC ITEM # 025

<table>
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<th>2024 UNIFORM PLUMBING CODE</th>
<th>2024 UNIFORM MECHANICAL CODE</th>
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<tbody>
<tr>
<td>ITEM # 022</td>
<td>ITEM # 291</td>
</tr>
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</table>

#### RECOMMENDATION:

**L 201.0 Definitions.**

**Stormwater.** Natural precipitation that has contacted a surface at grade or below grade and has not been put to beneficial use.

**E 201.0 Definitions.**

**Storm Water-Stormwater.** Natural precipitation that has contacted a surface at grade or below grade and has not been put to beneficial use or aboveground parking structures.

<table>
<thead>
<tr>
<th>X</th>
<th>Accept recommendation as submitted.</th>
<th>No action needed.</th>
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#### Substantiation:

The definition of “Storm Water” in UMC Item # 291 is being revised to correlate with the action taken by the UPC TC for Item # 022 and to correlate with the existing definition in the 2021 UPC for “Stormwater.”

The following is provided for informational purpose only:

**The substantiation provided for proposal Item # 022 of the UPC is as follows:** *This term is being relocated to Chapter 2 as it is used throughout the UPC.*

**The Committee Statement provided for rejecting proposal Item # 022 by the UPC TC is as follows:** *The definition provided should remain in Appendix L. In addition, the definition should not be removed from Appendix L as the term is relevant to the language within the appendix. It should be noted that the term should be modified throughout the code for consistency.*

**The substantiation provided for proposal Item # 291 of the UMC is as follows:** *A definition of stormwater is needed to clarify that stormwater includes runoff water from concrete surfaces, some of which may include pollutants. This would require pretreatment of the stormwater prior to use as a non-potable water source.*

**The Committee Statement provided for amending proposal Item # 291 by the UMC TC is as follows:** *The term originated in the Green Plumbing Code and the modification clarifies that storm water is water that ends up in a street or parking lot or runs through a storm sewer.*
RECOMMENDATION:

J 101.2 Example of Combination Indoor and Outdoor Combustion Air Opening Design. (remaining text unchanged)

Solution:
(1) Determine the total available room volume. Appliance room volume:
15 feet by 30 feet (4572 mm by 9144 mm) with an 8 foot (2438 mm) ceiling = 3600 cubic feet (101.94 m³)
(2) Determine the total required volume. The standard method to determine combustion air is used to calculate the required volume. The combined input for the appliances located in the basement is calculated as follows:

100 000 Btu/h (29 kW) + 40 000 Btu/h (11.7 kW) = 140 000 Btu/h (41 kW)

The standard method requires that the required volume be determined based on 50 cubic feet per 1000 Btu/h (4.83 m³/kW). Using Table J 101.2, the required volume for a 140 000 Btu/h (41 kW) water heater combined input is 7000 cubic feet (198.22 m³).

G 103.0 Example of Combination Indoor and Outdoor Combustion Air Opening Design. (remaining text unchanged)

Solution:
(1) Determine the total available room volume. Appliance room volume:
15 feet by 30 feet (4572 mm by 9144 mm) with an 8 foot (2438 mm) ceiling = 3600 cubic feet (101.94 m³)
(2) Determine the total required volume. The Standard Method to determine combustion air is used to calculate the required volume.

The combined input for the appliances located in the basement is calculated as follows:

100 000 Btu/h (29 kW) + 40 000 Btu/h (11.7 kW) = 140 000 Btu/h (41 kW)

The Standard Method requires that the required volume be determined based on 50 cubic feet per 1000 Btu/h (4.83 m³/kW).

Using Table G 103.0 the required volume for a 140 000 Btu/h (41 kW) combined input is 7000 cubic feet (198.22 m³).

X Accept recommendation as submitted. | No action needed.

Substantiation:
The language in UPC Item # 283, Section J 101.2 (Example of Combination Indoor and Outdoor Combustion Air Opening) is being revised to correlate with the action taken by the UMC TC for Item # 322, Section G 103.0 (Example of Combination Indoor and Outdoor Combustion Air Opening Design) with regards to replacing the term “water heater” with “combined input” and adding the term “Design” to the title to correlate with the latest edition of the NFPA 54 extract.

The following is provided for informational purpose only:

The substantiation provided for proposal Item # 283 of the UPC is as follows: The above sections have been revised to correlate with NFPA 54-2021 (latest version) in accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines).

The substantiation provided for proposal Item # 322 of the UMC is as follows: In accordance with IAPMO’s Regulations Governing Committee Projects (Extract Guidelines), Appendix G is being revised to the latest edition of NFPA 54-2021.
RECOMMENDATION:

225.0  –  W –
Water Heater, Dual Purpose. An appliance utilized as intended to be a heat source for both space heating and domestic hot water applications.

206.0  –  D –
Dual Purpose Water Heater. An appliance intended to be a heat source for both space heating and domestic hot water applications.

X | Accept recommendation as submitted. | No action needed.

Substantiation:
The definition of “Dual Purpose Water Heater” in UMC Item # 022 is being added to correlate with the action taken by the UPC TC for Item # 100. Additionally, UPC Item # 100 and UMC Item # 022 are being revised to correct an oversight by replacing the phrase “utilized as” to “intended to be.”

The following is provided for informational purpose only:

The substantiation provided for proposal Item # 100 of the UPC is as follows: The code is currently silent on dual purpose type water heaters. There are types water heaters specially designed to supply both potable water fixtures and space heating systems. The addition of this language will serve as a safety measure to ensure such designs are not overlooked. Also, the addition of a definition will clarify the intent of the code.

The substantiation provided for proposal Item # 022 of the UMC is as follows: UMC Sections 1002.5, 1202.3, 1203.2, 1207.3, and 1219.1 reference Dual Purpose Water Heaters. Therefore, a definition for the term is being added to clarify what a dual purpose water is and the intent of the code.
### RECOMMENDATION:

**301.0 General.**

301.3 Alternate Materials and Methods of Construction Equivalency. Unless specifically prohibited, nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code. Technical documentation shall be submitted to the Authority Having Jurisdiction to demonstrate equivalency prior to installation. The Authority Having Jurisdiction shall have the authority to approve or disapprove the system, method, or device for the intended purpose.

However, the exercise of this discretionary approval by the Authority Having Jurisdiction shall have no effect beyond the jurisdictional boundaries of said Authority Having Jurisdiction. An alternate material or method of construction so approved shall not be considered as in accordance with the requirements, intent, or both of this code for a purpose other than that granted by the Authority Having Jurisdiction where the submitted data does not prove equivalency.

### Materials – Standards and Alternates.

**302.0 Materials – Standards and Alternates.**

302.2 Alternate Materials and Methods of Construction Equivalency. Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code. Technical documentation shall be submitted to the Authority Having Jurisdiction to demonstrate equivalency. The Authority Having Jurisdiction shall have the authority to approve or disapprove the system, method, or device for the intended purpose.

However, the exercise of this discretionary approval by the Authority Having Jurisdiction shall have no effect beyond the jurisdictional boundaries of said Authority Having Jurisdiction. An alternate material or method of construction so approved shall not be considered as in accordance with the requirements, intent, or both of this code for a purpose other than that granted by the Authority Having Jurisdiction where the submitted data does not prove equivalency.

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<td><strong>Substantiation:</strong></td>
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<tr>
<td>No action is needed by the TCC for UPC Item # 030 or UMC Item # 057. The TCC believes this topic should be discussed during the next Technical Committee meeting with the entire Committee.</td>
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<td>The following is provided for informational purpose only:</td>
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<td>The substantiation provided for proposal Item # 030 of the UPC is as follows: Section 301.3 grants authority to AHJ’s to approve materials or products at their discretion. However, Section 301.3 places an obligation on the AHJ to approve only those alternate materials or products which comply “with the intent of this code,” which are “at least the equivalent of that prescribed in this code,” and are not specifically prohibited elsewhere in the code.</td>
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<tr>
<td>The substantiation provided for proposal Item # 057 of the UMC is as follows: Section 302.2 grants authority to AHJ’s to approve materials or products at their discretion. However, Section 302.2 places an obligation on the AHJ to approve only those alternate materials or products which comply “with the intent of this code,” which are “at least the equivalent of that prescribed in this code,” and are not specifically prohibited elsewhere in the code.</td>
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MEMORANDUM

TO: UPC-UMC Technical Correlating Committee
FROM: Zalmie Hussein, Staff Liaison
DATE: August 5, 2021
SUBJECT: UPC-UMC TCC Final Ballot Results - July 2021

Dear Technical Correlating Committee Members:

Attached are the final ballot results for the committee recommendations as a result of the actions taken during your recent meeting.

6 Members eligible to Vote
All ballots were received by the final closing date of August 3, 2021
(See attached voting results for details)

There are two criteria necessary to pass the letter ballot for each item as follows:
1. The number of affirmative votes needed for each item to pass is ¾ affirmative.
2. In all cases, an affirmative vote of at least a simple majority of the total members eligible to vote is required.

All of the committee actions for the Technical Correlating Committee Report achieved the necessary ¾ affirmative votes and simple majority on returned ballots.

Thank you for your willingness to participate in this Committee. If you have any questions, please contact Enrique Gonzalez at (909) 230-5535 or email at Enrique.Gonzalez@iapmo.org or Zalmie Hussein at (909) 218-8122 or email at Zalmie.Hussein@iapmo.org.

Best Regards,

Zalmie Hussein
### Ballot Name: TCC Item # 001 July 2021

**Total Votes:** 6

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### Ballot Name: TCC Item # 002 July 2021

**Total Votes:** 6

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### Ballot Name: TCC Item # 003 July 2021

**Total Votes:** 6

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### UPC-UMC TCC Final Ballot Results - July 2021

#### Ballot Name: TCC Item # 004 July 2021

**Total Votes:** 6

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#### Ballot Name: TCC Item # 005 July 2021

**Total Votes:** 6

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#### Ballot Name: TCC Item # 006 July 2021

**Total Votes:** 6

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# UPC-UMC TCC Final Ballot Results - July 2021

**Ballot Name:** TCC Item # 007 July 2021  
**Total Votes:** 6

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**Ballot Name:** TCC Item # 008 July 2021  
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**Ballot Name:** TCC Item # 009 July 2021  
**Total Votes:** 6

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## UPC-UMC TCC Final Ballot Results - July 2021

### Ballot 010 July 2021

**Total Votes:** 6

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### UPC-UMC TCC Final Ballot Results - July 2021

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CHAPTER 1
ADMINISTRATION

101.0 General.
101.1 Title. This document shall be known as the “Uniform Mechanical Code,” may be cited as such, and will be referred to herein as “this code.”

101.2 Scope. The provisions of this code shall apply to the erection, installation, alteration, repair, relocation, replacement, addition to, use, or maintenance of mechanical systems within this jurisdiction.

101.3 Purpose. This code is an ordinance providing minimum requirements and standards for the protection of the public health, safety, and welfare.

101.4 Unconstitutional. Where a section, subsection, sentence, clause, or phrase of this code is, for a reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this code. The legislative body hereby declares that it would have passed this code, and each section, subsection, sentence, clause, or phrase thereof, irrespective of the fact that one or more sections, subsections, sentences, clauses, and phrases are declared unconstitutional.

101.5 Validity. Where a provision of this code, or the application thereof to a person or circumstance, is held invalid, the remainder of the code, or the application of such provision to other persons or circumstances, shall not be affected thereby.

102.0 Applicability.
102.1 Conflicts Between Codes. Where the requirements within the jurisdiction of this mechanical code conflict with the requirements of the plumbing code, the plumbing code shall prevail. In instances where this code, applicable standards, or the manufacturer’s installation instructions conflict, the more stringent provisions shall prevail. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall prevail.

102.2 Existing Installations. Mechanical systems lawfully in existence at the time of the adoption of this code shall be permitted to have their use, maintenance, or repair continued where the use, maintenance, or repair is in accordance with the original design and location and no hazard to life, health, or property has been created by such mechanical system.

102.3 Maintenance. Mechanical systems, materials, and appurtenances, both existing and new, of a premise under the Authority Having Jurisdiction shall be maintained in operating condition. Devices or safeguards required by this code shall be maintained in accordance with the code edition under which installed.

The owner or the owner’s designated agent shall be responsible for maintenance of mechanical systems. To determine compliance with this subsection, the Authority Having Jurisdiction shall be permitted to cause a mechanical system to be reinspected.

102.4 Additions, Alterations, Renovations, or Repairs. Additions, alterations, renovations, or repairs to existing mechanical system installations shall comply with the provisions for new construction, unless such deviations are found to be necessary and are first approved by the Authority Having Jurisdiction.

102.5 Health and Safety. Where compliance with the provisions of this code fails to eliminate or alleviate a nuisance, or other dangerous or insanitary condition that involves health or safety hazards, the owner or the owner’s agent shall install such additional mechanical system facilities or shall make such repairs or alterations as ordered by the Authority Having Jurisdiction.

102.6 Changes in Building Occupancy. Mechanical systems that are a part of a building or structure undergoing a change in use or occupancy, as defined in the building code, shall be in accordance with the requirements of this code that are applicable to the new use or occupancy.

102.7 Moved Structures. Parts of the mechanical system of a building and part thereof that is moved from one foundation to another, or from one location to another, shall be in accordance with the provisions of this code for new installations and completely tested as prescribed elsewhere in this section for new work, except that walls or floors need not be removed during such test where equivalent means of inspection acceptable to the Authority Having Jurisdiction are provided.

102.8 Appendices. The provisions in the appendices are intended to supplement the requirements of this code and shall not be considered part of this code unless formally adopted as such.
103.0 Duties and Powers of the Authority Having Jurisdiction.

103.1 General. The Authority Having Jurisdiction shall be the Authority duly appointed to enforce this code. For such purposes, the Authority Having Jurisdiction shall have the powers of a law enforcement officer. The Authority Having Jurisdiction shall have the power to render interpretations of this code and to adopt and enforce rules and regulations supplemental to this code as deemed necessary in order to clarify the application of the provisions of this code. Such interpretations, rules, and regulations shall comply with the intent and purpose of this code.

In accordance with the prescribed procedures and with the approval of the appointing authority, the Authority Having Jurisdiction shall be permitted to appoint such number of technical officers, inspectors, and other employees as shall be authorized from time to time. The Authority Having Jurisdiction shall be permitted to deputize such inspectors or employees as necessary to carry out the functions of the code enforcement agency.

The Authority Having Jurisdiction shall be permitted to request the assistance and cooperation of other officials of this jurisdiction so far as required in the discharge of the duties required by this code or other pertinent law or ordinance.

103.2 Liability. The Authority Having Jurisdiction charged with the enforcement of this code, acting in good faith and without malice in the discharge of the Authority Having Jurisdiction’s duties, shall not thereby be rendered personally liable for damage that accrues to persons or property as a result of an act or by reason of an act or omission in the discharge of such duties. A suit brought against the Authority Having Jurisdiction or employee because of such act or omission performed in the enforcement of provisions of this code shall be defended by legal counsel provided by this jurisdiction until final termination of such proceedings.

103.3 Applications and Permits. The Authority Having Jurisdiction shall be permitted to require the submission of plans, specifications, drawings, and such other information in accordance with the Authority Having Jurisdiction, prior to the commencement of, and at a time during the progress of, work regulated by this code.

The issuance of a permit upon construction documents shall not prevent the Authority Having Jurisdiction from thereafter requiring the correction of errors in said construction documents or from preventing construction operations being carried on thereunder where in violation of this code or of other pertinent ordinance or from revoking a certificate of approval where issued in error.

103.3.1 Licensing. Provision for licensing shall be determined by the Authority Having Jurisdiction.

103.4 Right of Entry. Where it is necessary to make an inspection to enforce the provisions of this code, or where the Authority Having Jurisdiction has reasonable cause to believe that there exists in a building or upon a premises a condition or violation of this code that makes the building or premises unsafe, insanitary, dangerous, or hazardous, the Authority Having Jurisdiction shall be permitted to enter the building or premises at reasonable times to inspect or to perform the duties imposed upon the Authority Having Jurisdiction by this code, provided that where such building or premises is occupied, the Authority Having Jurisdiction shall present credentials to the occupant and request entry. Where such building or premises is unoccupied, the Authority Having Jurisdiction shall first make a reasonable effort to locate the owner or other person having charge or control of the building or premises and request entry. Where entry is refused, the Authority Having Jurisdiction has recourse to every remedy provided by law to secure entry.

Where the Authority Having Jurisdiction shall have first obtained an inspection warrant or other remedy provided by law to secure entry, no owner, occupant, or person having charge, care or control of a building or premises shall fail or neglect, after a request is made as herein provided, to promptly permit entry herein by the Authority Having Jurisdiction for the purpose of inspection and examination pursuant to this code.

104.0 Permits.

104.1 Permits Required. It shall be unlawful for a person, firm, or corporation to make an installation, alteration, repair, replacement, or remodel a mechanical system regulated by this code except as permitted in Section 104.2, or to cause the same to be done without first obtaining a separate mechanical permit for each separate building or structure.

104.2 Exempt Work. A permit shall not be required for the following:

1. A portable heating appliance, portable ventilating equipment, a portable cooling unit, or a portable evaporative cooler.
2. A closed system of steam, hot, or chilled water piping within heating or cooling equipment regulated by this code.
3. Replacement of a component part that does not alter its original approval and is in accordance with other applicable requirements of this code.
4. Refrigerating equipment that is part of the equipment for which a permit has been issued pursuant to the requirements of this code.
5. A unit refrigerating system.

Exemption from the permit requirements of this code shall not be deemed to grant authorization for work to be done in violation of the provisions of the code or other laws or ordinances of this jurisdiction.

104.3 Application for Permit. To obtain a permit, the applicant shall first file an application therefor in writing on a form furnished by the Authority Having Jurisdiction for that purpose. Such application shall:

1. Identify and describe the work to be covered by the permit for which application is made.
(2) Describe the land upon which the proposed work is to be done by legal description, street address, or similar description that will readily identify and definitely locate the proposed building or work.

(3) Indicate the use or occupancy for which the proposed work is intended.

(4) Be accompanied by construction documents and other data in accordance with Section 104.3.1.

(5) Be signed by the permittee or the permittee’s authorized agent. The Authority Having Jurisdiction shall be permitted to require evidence to indicate such authority.

(6) Give such other data and information in accordance with the Authority Having Jurisdiction.

104.3.1 Construction Documents. Construction documents, engineering calculations, diagrams, and other data shall be submitted in two or more sets, or in a digital format where permitted by the Authority Having Jurisdiction, with each application for a permit. The construction documents, computations, and specifications shall be prepared by, and the mechanical system designed by, a registered design professional. Construction documents shall be drawn to scale with clarity to identify that the intended work to be performed is in accordance with the code.

Exception: The Authority Having Jurisdiction shall be permitted to waive the submission of construction documents, calculations, or other data where the Authority Having Jurisdiction finds that the nature of the work applied for is such that reviewing of construction documents is not necessary to obtain compliance with the code.

104.3.2 Plan Review Fees. Where a plan or other data is required to be submitted in accordance with Section 104.3.1, a plan review fee shall be paid at the time of submitting construction documents for review.

The plan review fees for mechanical system work shall be determined and adopted by this jurisdiction.

The plan review fees specified in this subsection are separate fees from the permit fees specified in Section 104.5.

Where plans are incomplete or changed so as to require additional review, a fee shall be charged at the rate shown in Table 104.5.

104.3.3 Time Limitation of Application. Applications for which no permit is issued within 180 days following the date of application shall expire by limitation, plans and other data submitted for review thereafter, shall be returned to the applicant or destroyed by the Authority Having Jurisdiction. The Authority Having Jurisdiction shall be permitted to extend the time for action by the applicant for a period not to exceed 180 days upon request by the applicant showing that circumstances beyond the control of the applicant have prevented action from being taken. No application shall be extended more than once. In order to renew action on an application after expiration, the applicant shall resubmit plans and pay a new plan review fee.

104.4 Permit Issuance. The application, construction documents, and other data filed by an applicant for a permit shall be reviewed by the Authority Having Jurisdiction. Such plans shall be permitted to be reviewed by other departments of this jurisdiction to verify compliance with applicable laws under their jurisdiction. Where the Authority Having Jurisdiction finds that the work described in an application for permit and the plans, specifications, and other data filed therewith are in accordance with the requirements of the code and other pertinent laws and ordinances and that the fees specified in Section 104.5 have been paid, the Authority Having Jurisdiction shall issue a permit therefore to the applicant.

104.4.1 Approved Plans or Construction Documents. Where the Authority Having Jurisdiction issues the permit where plans are required, the Authority Having Jurisdiction shall endorse in writing or stamp the construction documents, “APPROVED.” Such approved construction documents shall not be changed, modified, or altered without authorization from the Authority Having Jurisdiction, and the work shall be done in accordance with approved plans.

The Authority Having Jurisdiction shall be permitted to issue a permit for the construction of a part of a mechanical system before the entire construction documents for the whole system have been submitted or approved, provided adequate information and detailed statements have been filed in accordance with pertinent requirements of this code. The holder of such permit shall be permitted to proceed at the holder’s risk without assurance that the permit for the entire building, structure, or mechanical system will be granted.

104.4.2 Validity of Permit. The issuance of a permit or approval of construction documents shall not be construed to be a permit for, or an approval of, a violation of the provisions of this code or other ordinance of the jurisdiction. No permit presuming to give authority to violate or cancel the provisions of this code shall be valid.

The issuance of a permit based upon plans, specifications, or other data shall not prevent the Authority Having Jurisdiction from thereafter requiring the correction of errors in said plans, specifications, and other data or from preventing building operations being carried on thereunder where in violation of this code or of other ordinances of this jurisdiction.

104.4.3 Expiration. A permit issued by the Authority Having Jurisdiction under the provisions of this code shall expire by limitation and become null and void where the work authorized by such permit is not commenced within 180 days from the date of such permit, or where the work authorized by such permit is suspended or abandoned at a time after the work is commenced for a period of 180 days. Before such work is recommenced, a new permit shall first be obtained to do so, and the fee, therefore, shall be one-half the amount required for a new permit for such work, provided no changes have been
made or will be made in the original construction documents for such work, and provided further that such suspension or abandonment has not exceeded 1 year.

104.4.4 Extension. A permittee holding an unexpired permit shall be permitted to apply for an extension of the time within which work shall be permitted to commence under that permit where the permittee is unable to commence work within the time required by this section. The Authority Having Jurisdiction shall be permitted to extend the time for action by the permittee for a period not exceeding 180 days upon written request by the permittee showing that circumstances beyond the control of the permittee have prevented action from being taken. No permit shall be extended more than once. In order to renew action on a permit after expiration, the permittee shall pay a new full permit fee.

104.4.5 Suspension or Revocation. The Authority Having Jurisdiction shall be permitted to suspend or revoke a permit issued under the provisions of this code where the permit is issued in error or on the basis of incorrect information supplied or in violation of other ordinance or regulation of the jurisdiction.

104.4.6 Retention of Plans. One set of approved construction documents and computations shall be retained by the Authority Having Jurisdiction until final approval of the work is covered therein.

One set of approved construction documents, computations, and manufacturer’s installation instructions shall be returned to the applicant, and said set shall be kept on the site of the building or work at times during which the work authorized thereby is in progress.

104.5 Fees. Fees shall be assessed in accordance with the provisions of this section and as set forth in the fee schedule, Table 104.5. The fees are to be determined and adopted by this jurisdiction.

104.5.1 Work Commencing Before Permit Issuance. Where work for which a permit is required by this code has been commenced without first obtaining said permit, a special investigation shall be made before a permit is issued for such work.

104.5.2 Investigation Fees. An investigation fee, in addition to the permit fee, shall be collected whether or not a permit is then or subsequently issued. The investigation fee shall be equal to the amount of the permit fee that is required by this code if a permit were to be issued. The payment of such investigation fee shall not exempt a person from compliance with other provisions of this code, nor from a penalty prescribed by law.

104.5.3 Fee Refunds. The Authority Having Jurisdiction shall be permitted to authorize the refunding of a fee as follows:

(1) The amount paid hereunder that was erroneously paid or collected.

(2) Refunding of not more than a percentage, as determined by this jurisdiction where no work has been done under a permit issued in accordance with this code.

The Authority Having Jurisdiction shall not authorize refunding of a fee paid except upon written application filed by the original permittee not to exceed 180 days after the date of fee payment.

105.0 Inspections and Testing.

105.1 General. Mechanical systems for which a permit is required by this code shall be inspected by the Authority Having Jurisdiction.

No mechanical system or portion thereof shall be covered, concealed, or put into use until inspected and approved as prescribed in this code. Neither the Authority Having Jurisdiction nor the jurisdiction shall be liable for expense entailed in the removal or replacement of material required to permit inspection. Mechanical systems regulated by this code shall not be connected to the energy fuel supply lines until authorized by the Authority Having Jurisdiction.

105.2 Required Inspections. New mechanical system work and such portions of existing systems as affected by new work, or changes, shall be inspected by the Authority Having Jurisdiction to ensure compliance with the requirements of this code and to ensure that the installation and construction of the mechanical system are in accordance with approved plans. The Authority Having Jurisdiction shall make the following inspections and other such inspections as necessary. The permittee or the permittee’s authorized agent shall be responsible for the scheduling of such inspections as follows:

(1) Underground inspection shall be made after trenches or ditches are excavated and bedded, piping installed, and before backfill is put in place.

(2) Rough-in inspection shall be made prior to the installation of wall or ceiling membranes.

(3) Final inspection shall be made upon completion of the installation.

105.2.1 Uncovering. Where a mechanical system, or part thereof, which is installed, altered, or repaired, is covered or concealed before being inspected, tested, and approved as prescribed in this code, it shall be uncovered for inspection after notice to uncover the work has been issued to the responsible person by the Authority Having Jurisdiction. The requirements of this section shall not be considered to prohibit the operation of mechanical systems installed to replace existing equipment serving an occupied portion of the building in the event a request for inspection of such equipment has been filed with the Authority Having Jurisdiction not more than 72 hours after such replacement work is completed, and before a portion of such mechanical system is concealed by a permanent portion of the building.

105.2.2 Other Inspections. In addition to the inspections required by this code, the Authority Having Jurisdiction shall be permitted to require other inspections to ascertain compliance with the provisions of this code and other laws that are enforced by the Authority Having Jurisdiction.

105.2.3 Inspection Requests. It shall be the duty of the person doing the work authorized by a permit to
notify the Authority Having Jurisdiction that such work is ready for inspection. The Authority Having Jurisdiction shall be permitted to require that a request for inspection be filed not less than 1 working day before such inspection is desired. Such request shall be permitted to be made in writing or by telephone, at the option of the Authority Having Jurisdiction.

It shall be the duty of the person requesting inspections in accordance with this code to provide access to and means for inspection of such work.

105.2.4 Advance Notice. It shall be the duty of the person doing the work authorized by the permit to notify the Authority Having Jurisdiction, orally or in writing that said work is ready for inspection. Such notification shall be given not less than 24 hours before the work is to be inspected.

105.2.5 Responsibility. It shall be the duty of the holder of a permit to make sure that the work will stand the test prescribed before giving the notification.

The equipment, material, and labor necessary for inspection or tests shall be furnished by the person to whom the permit is issued or by whom inspection is requested.

105.2.6 Reinspections. A reinspection fee shall be permitted to be assessed for each inspection or reinspection where such portion of work for which inspection is called is not complete or where required corrections have not been made.

This provision shall not be interpreted as requiring reinspection fees the first time a job is rejected for failure to be in accordance with the requirements of this code, but as controlling the practice of calling for inspections before the job is ready for inspection or reinspection.

Reinspection fees shall be permitted to be assessed where the approved plans are not readily available to the inspector, for failure to provide access on the date for which the inspection is requested, or for deviating from plans requiring the approval of the Authority Having Jurisdiction.

To obtain reinspection, the applicant shall file an application therefore in writing upon a form furnished for that purpose and pay the reinspection fee in accordance with Table 104.5.

In instances where reinspection fees have been assessed, no additional inspection of the work will be performed until the required fees have been paid.

105.3 Testing of Systems. Mechanical systems shall be tested and approved in accordance with this code or the Authority Having Jurisdiction. Tests shall be conducted in the presence of the Authority Having Jurisdiction or the Authority Having Jurisdiction’s duly appointed representative.

No test or inspection shall be required where a mechanical system, or part thereof, is set up for exhibition purposes and has no connection with water or an energy fuel supply. In cases where it would be impractical to provide the required water or air tests, or for minor installations and repairs, the Authority Having Jurisdiction shall be permitted to make such inspection as deemed advisable in order to be assured that the work has been performed in accordance with the intent of this code. Joints and connections in the mechanical system shall be airtight, gastight, or watertight for the pressures required by the test.

105.3.1 Defective Systems. In buildings or premises condemned by the Authority Having Jurisdiction because of an insanitary condition of the mechanical system, or part thereof, the alterations in such system shall be in accordance with the requirements of this code.

105.3.2 Retesting. Where the Authority Having Jurisdiction finds that the work will not pass the test, necessary corrections shall be made, and the work shall be resubmitted for test or inspection.

105.3.3 Approval. Where prescribed tests and inspections indicate that the work is in accordance with this code, a certificate of approval shall be issued by the Authority Having Jurisdiction to the permittee on demand.

105.4 Connection to Service Utilities. No person shall make connections from a source of energy or fuel to a mechanical system or equipment regulated by this code and for which a permit is required until approved by the Authority Having Jurisdiction. The Authority Having Jurisdiction shall be permitted to authorize temporary connection of the mechanical system equipment to the source of energy or fuel for the purpose of testing the equipment.

106.0 Violations and Penalties.

106.1 General. It shall be unlawful for a person, firm, or corporation to erect, construct, enlarge, alter, repair, move, improve, remove, convert, demolish, equip, use, or maintain a mechanical system or permit the same to be done in violation of this code.

106.2 Notices of Correction or Violation. Notices of correction or violation shall be written by the Authority Having Jurisdiction and shall be permitted to be posted at the site of the work or mailed or delivered to the permittee or their authorized representative.

Refusal, failure, or neglect to comply with such notice or order within 10 days of receipt thereof, shall be considered a violation of this code and shall be subject to the penalties set forth by the governing laws of the jurisdiction.

106.3 Penalties. A person, firm, or corporation violating a provision of this code shall be deemed guilty of a misdemeanor, and upon conviction thereof, shall be punishable by a fine, imprisonment, or both set forth by the governing laws of the jurisdiction. Each separate day or a portion thereof, during which a violation of this code occurs or continues, shall be deemed to constitute a separate offense.

106.4 Stop Orders. Where work is being done contrary to the provisions of this code, the Authority Having Jurisdiction shall be permitted to order the work stopped by notice in writ-
ing served on persons engaged in the doing or causing such work to be done, and such persons shall forthwith stop work until authorized by the Authority Having Jurisdiction to proceed with the work.

106.5 Authority to Disconnect Utilities in Emergencies. The Authority Having Jurisdiction shall have the authority to disconnect a mechanical system to a building, structure, or equipment regulated by this code in case of emergency where necessary to eliminate an immediate hazard to life or property.

106.6 Authority to Condemn. Where the Authority Having Jurisdiction ascertains that a mechanical system or portion thereof, regulated by this code, has become hazardous to life, health, or property, or has become insanitary, the Authority Having Jurisdiction shall order in writing that such mechanical system either be removed or placed in a safe or sanitary condition. The order shall fix a reasonable time limit for compliance. No person shall use or maintain a defective mechanical system after receiving such notice.

Where such mechanical system is to be disconnected, written notice shall be given. In cases of immediate danger to life or property, such disconnection shall be permitted to be made immediately without such notice.

107.0 Board of Appeals.

107.1 General. In order to hear and decide appeals of orders, decisions, or determinations made by the Authority Having Jurisdiction relative to the application and interpretations of this code, there shall be and is hereby created a Board of Appeals consisting of members who are qualified by experience and training to pass upon matters pertaining to mechanical system design, construction, and maintenance and the public health aspects of mechanical systems and who are not employees of the jurisdiction. The Authority Having Jurisdiction shall be an ex-officio member and shall act as secretary to said board but shall have no vote upon a matter before the board. The Board of Appeals shall be appointed by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business and shall render decisions and findings in writing to the appellant with a duplicate copy to the Authority Having Jurisdiction.

107.2 Limitations of Authority. The Board of Appeals shall have no authority relative to interpretation of the administrative provisions of this code, nor shall the board be empowered to waive requirements of this code.
## TABLE 104.5
### MECHANICAL PERMIT FEES

#### Permit Issuance
1. For the issuance of each permit: ................................................................. 1
2. For issuing each supplemental permit for which the original permit has not expired or been canceled or finalized: ................................. 1

#### Unit Fee Schedule
1. **Furnaces:**
   - For the installation or relocation of each forced-air or gravity-type furnace or burner, including ducts and vents attached to such appliance, not exceeding 100,000 British thermal units per hour (Btu/h): 1
   - For the installation or relocation of each forced-air or gravity-type furnace or burner, including ducts and vents attached to such appliance, exceeding 100,000 Btu/h: 1
   - For the installation or relocation of each floor furnace, including vent: 1
   - For the installation or relocation of each suspended heater, recessed wall heater, or floor-mounted unit heater: 1
2. **Appliance Vents:**
   - For the installation, relocation, or replacement of each appliance vent installed and not included in an appliance permit: 1
3. **Repairs or Additions:**
   - For the repair of, alteration of, or addition to each heating appliance, refrigeration unit, cooling unit, absorption unit, or each heating, cooling, absorption, or evaporative cooling system including installation of controls regulated by this code: 1
4. **Boilers, Compressors, and Absorption Systems:**
   - For the installation or relocation of each boiler or compressor, not exceeding 3 horsepower (hp), or each absorption system not exceeding 100,000 Btu/h: 1
   - For the installation or relocation of each boiler or compressor exceeding 3 hp, not exceeding 15 hp, or each absorption system exceeding 100,000 Btu/h: 1
   - For the installation or relocation of each boiler or compressor exceeding 15 hp, not exceeding 30 hp, or each absorption system exceeding 500,000 Btu/h: 1
   - For the installation or relocation of each boiler or compressor exceeding 30 hp, not exceeding 50 hp, or each absorption system exceeding 1,000,000 Btu/h: 1
   - For the installation or relocation of each boiler or compressor exceeding 50 hp, or each absorption system exceeding 1,750,000 Btu/h: 1
5. **Air Handlers:**
   - For each air-handling unit not exceeding 10,000 cubic feet per minute (CFM), including ducts attached thereto: 1
6. **Evaporative Coolers:**
   - For each air-handling unit exceeding 10,000 CFM: 1
   - For each evaporative cooler other than portable type: 1
7. **Ventilation and Exhaust:**
   - For each ventilation fan connected to a single duct: 1
   - For each ventilation system that is not a portion of a heating or air-conditioning system authorized by a permit: 1
   - For the installation of each hood that is served by mechanical exhaust, including the ducts for such hood: 1
8. **Incinerators:**
   - For the installation or relocation of each domestic-type incinerator: 1
   - For the installation or relocation of each commercial or industrial-type incinerator: 1
9. Miscellaneous:
   For each appliance or piece of equipment regulated by this code, but not classed in other appliance
categories, or for which no other fee is listed in this table.......................................................... 1

10. Fuel Gas Piping:
    Where Chapter 13 or Appendix B is applicable (See Section 101.2), permit fees for fuel-gas piping shall
    be as follows:
    For each gas piping system of one to five outlets ................................................................. 1
    For each additional gas piping system, per outlet ................................................................. 1

11. Process Piping:
    For each hazardous process piping system (HPP) of one to four outlets.......................... 1
    For each HPP piping system of five or more outlets, per outlet ......................................... 1
    For each nonhazardous process piping system (NPP) of one to four outlets ................. 1
    For each NPP piping system of five or more outlets, per outlet .................................... 1

**Other Inspections and Fees**

1. Inspections outside of normal business hours, per hour (minimum charge – 2 hours)............ 1
2. Reinspection fees assessed under provisions of Section 105.2.6, per inspection .................. 1
3. Inspections for which no fee is specifically indicated, per hour (minimum charge – 1
   hour)........................................................................................................................................ 1
4. Additional plan review required by changes, additions, or revisions to plans or to plans for which an
   initial review has been completed, per hour (minimum charge – 1/2 hour)........................ 1

For SI units: 1000 British thermal units per hour = 0.293 kW, 1 horsepower = 0.746 kW, 1 cubic foot per minute = 0.00047 m³/s

**Notes:**

1 Jurisdiction will indicate their fees here.
2 This fee shall not apply to an air-handling unit that is a portion of a factory-assembled appliance, cooling unit, evaporative cooler, or absorption unit for which a permit is required elsewhere in this code.
CHAPTER 2
DEFINITIONS

201.0 General.
201.1 Applicability. For the purpose of this code, the following terms have the meanings indicated in this chapter.

No attempt is made to define ordinary words, which are used in accordance with their established dictionary meanings, except where a word has been used loosely, and it is necessary to define its meaning as used in this code to avoid misunderstanding.

202.0 Definition of Terms.
202.1 General. The definitions of terms are arranged alphabetically according to the first word of the term.

203.0 – A –
Absorption Unit. An absorption refrigeration system that has been factory-assembled and tested prior to its installation.

Accepted Engineering Practice. That which conforms to technical or scientific-based principles, test, or standards that are accepted by the engineering profession.

Access Panel. A closure device used to cover an opening into a duct, an enclosure, equipment, or an appurtenance. [NFPA 96:3.3.1]

Accessible. Where applied to a device, appliance, or equipment, “accessible” means having access thereto, but which first may require the removal of an access panel, door, or similar obstruction.

Accessible, Readily. Having a direct access without the necessity of removing a panel, door, or similar obstruction.

Air, Class 1. Air with low contaminant concentration, low sensory-irritation intensity, and inoffensive odor. [ASHRAE 62.1:5.16.1.15.18.1]

Air, Class 2. Air with moderate contaminant concentration, mild sensory-irritation intensity, or mildly offensive odors. Class 2 air also includes air that is not necessarily harmful or objectionable, but that is inappropriate for transfer or recirculation to spaces used for different purposes. [ASHRAE 62.1:5.16.1.15.18.1]

Air, Class 3. Air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor. [ASHRAE 62.1:5.16.1.15.18.1]

Air, Class 4. Air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols, or gases, at concentrations high enough to be considered as harmful. [ASHRAE 62.1:5.16.1.15.18.1]

Air, Combustion. See Combustion Air.

Air, Conditioned. Air that has been treated to achieve a desired level of temperature, humidity, or cleanliness.

Air, Dilution. Air that enters a draft hood or draft regulator and mixes with the flue gases. [NFPA 54:3.3.2.2]

Air, Exhaust. Air being removed from any space or piece of equipment and conveyed directly to the atmosphere by means of openings or ducts.

Air, Makeup. Air that is provided to replace air being exhausted.

Air, Outside. Air from outside the building intentionally conveyed by openings or ducts to rooms or to conditioning equipment.

Air, Recirculated. Air that is removed from a conditioned space or zone and reused as supply air.

Air, Return. Air from the conditioned area space or zone that is returned through ducts or plenums to the conditioning equipment for reconditioning.

Air, Supply. Air being conveyed to a conditioned area space or zone through ducts or plenums from a heat exchanger of a heating, cooling, absorption, or evaporative cooling system.

Air, Transfer. Air that is relocated from one conditioned space or zone to another space through ducts, plenums, or transfer grills.

Air Dispersion Systems. Materials intended for use in air handling systems in exposed locations operating under positive pressure.

Air Exfiltration. Leakage of air from a conditioned space(s) to an unconditioned space(s) or to the outdoors through openings in the building envelope, often attributable to wind pressure, stack pressure, or positive pressurization of the building. Also known as air leakage.

Air-Handling Unit. A blower or fan used for the purpose of distributing supply air to a room, space, zone, or area.

Air Infiltration. Leakage of outdoor air or air from an unconditioned space(s) into a conditioned space(s) through openings in the building envelope, often attributable to wind pressure, stack pressure, or negative pressurization of the building. Also known as air leakage.

Air Intakes. An opening in a building’s envelope whose purpose is to allow outside air to be drawn into the structure to replace inside air that is removed by exhaust systems or to improve the quality of the inside air by providing a source of air having a lower concentration of odors, suspended particles, or heating content. [NFPA 96:3.3.2]

Air-Moving System. A system designed to provide heating, cooling, or ventilation in which one or more air-handling units are used to supply air to a common space or are drawing air from a common plenum or space.

Air Pollution Control Devices. Equipment and devices used for the purpose of cleaning air passing through them or by them in such a manner as to reduce or remove the impurities contained therein. [NFPA 96:3.3.3]
Ambient Temperature Loop (ATL). A closed loop piping system with central pumping that includes various heat sources and heat sinks to hold the loop fluid near the long-term average ambient air temperature. The sources/sinks can be passive (e.g., a ground loop, a body of water, sewer effluent) or active (e.g., a cooling tower) and further can include opportunistic, or unique locally available waste or by product heat sources (e.g., data center, industrial process). The closed loop piping system typically controls or engages these sources/sinks to maintain the loop temperature to meet the seasonal requirements as well as specific building needs.

Anchors. See Supports.

Anodeless Riser. An assembly of steel-cased plastic pipe used to make the transition between plastic piping installed underground and metallic piping installed aboveground. [NFPA 54:3.3.3]

Appliance. A device that utilizes fuel or electricity as an energy source to produce light, heat, power, refrigeration, or air conditioning, or compressed fuel gas. [NFPA 54:3.3.4]

Appliance Categorized Vent Diameter/Area. The minimum vent diameter/area permissible for Category I appliances to maintain a nonpositive vent static pressure when tested in accordance with nationally recognized standards. [NFPA 54:3.3.63.3.5]

Appliance Flue Outlet. The opening or openings in a cooking device where vapors, combustion gases, or both leave the cooking device. [NFPA 96:3.3.4] There might or might not be ductwork attached to this opening.

Appliance Fuel Connector. An assembly of listed semi-rigid or flexible tubing and fittings to carry fuel between a fuel-piping outlet and a fuel-burning appliance.

Approved. Acceptable to the Authority Having Jurisdiction.

Approved Testing Agency. An organization primarily established for purposes of testing to approved standards and approved by the Authority Having Jurisdiction.

Appurtenance. An accessory or a subordinate part that enables the primary device to perform or improves its intended function. [NFPA 96:3.3.5]

Assembly Building. A building or a portion of a building used for the gathering together of 50 or more persons for such purposes as deliberation, education, instruction, worship, entertainment, amusement, drinking, dining, or awaiting transportation.

Authority Having Jurisdiction. The organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, installations, or procedures. The Authority Having Jurisdiction shall be a federal, state, local, or other regional department or an individual such as a plumbing official, mechanical official, labor department official, health department official, building official, or others having statutory authority. In the absence of statutory authority, the Authority Having Jurisdiction may be some other responsible party. This definition shall include the Authority Having Jurisdiction’s duly authorized representative.

Automatic. That which provides a function without the necessity of human intervention.

Automatic Boiler. A boiler equipped with certain controls and limit devices.

Azeotrope. A refrigerant blend containing two or more refrigerants whose equilibrium vapor and liquid phase compositions are the same at a given pressure. At this pressure, the slope of the temperature versus composition curve equals zero, which mathematically is expressed as \( \frac{dt}{dx} \bigg|_p = 0 \), which, in turn, implies the occurrence of a maximum, minimum, or saddle point temperature. Azeotropic blends exhibit some segregation of components at other conditions. The extent of the segregation depends on the particular azeotrope and the application. [ASHRAE 34:3]

Backflow. The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from sources other than its intended source.
**Baffle Plate.** An object placed in or near an appliance to change the direction or retard the flow of air, air-fuel mixtures, or flue gases. [NFPA 96:3.3.8]

**Boiler.** A closed vessel used for heating water or liquid, or for generating steam or vapor by direct application of heat from combustible fuels or electricity.

- **Boiler, Automatic.** A boiler equipped with certain controls and limit devices.
- **Boiler, High-Pressure.** A boiler for generating steam at gauge pressures in excess of 15 psig (103 kPa), or for heating water to a temperature in excess of 250°F (121°C) or at a gauge pressure in excess of 160 psig (gauge pressure of 1103 kPa). [NFPA 211:3.3.14.2]
- **Boiler, Hot-Water-Heating.** A boiler having a volume exceeding 120 gallons (454 L), a heat input exceeding 200 000 Btu/h (58.6 kW), or an operating temperature exceeding 210°F (99°C) that provides hot water to be used externally to itself.
- **Boiler, Low-Pressure Hot-Water-Heating.** A boiler furnishing hot water at pressures not exceeding 160 psig (1103 kPa) and at temperatures not exceeding 250°F (121°C).
- **Boiler, Low-Pressure Steam-Heating.** A boiler furnishing steam at pressures not exceeding 15 psig (103 kPa).
- **Boiler, Miniature.** A power boiler having an internal shell diameter of 16 inches (406 mm) or less, a gross volume of 5 cubic feet (0.14 m³) or less, a heating surface of 20 square feet (1.86 m²) or less (not applicable to electric boilers), and not exceeding 100 psig (689 kPa).
- **Boiler, Package.** A class of boiler defined herein and shall be a boiler equipped and shipped complete with fuel-burning equipment, automatic controls and accessories, and mechanical draft equipment.
- **Boiler, Power.** A boiler in which steam is generated at pressures exceeding 15 psig (103 kPa).
- **Boiler, Power Hot Water (High Temperature Water Boiler).** A boiler used for heating water or liquid to a pressure exceeding 160 psig (1103 kPa) or to a temperature exceeding 250°F (121°C).
- **Boiler, Steam-Heating.** A boiler operated at pressures not exceeding 15 psig (103 kPa) for steam.
- **Boiler, Water Heater or Hot-Water-Heating.** An appliance designed primarily to supply hot water for domestic or commercial purposes and equipped with automatic controls limiting water temperature to a maximum of 210°F (99°C).
- **Boiler, High-Pressure.** A boiler for generating steam at gauge pressures in excess of 15 psig (103 kPa), or for heating water to a temperature in excess of 250°F (121°C) or at a gauge pressure in excess of 160 psig (gauge pressure of 1103 kPa). (NFPA 54:3.3.15)

**Boiler Room.** A room where boilers are installed.

**Bonding Conductor or Jumper.** A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected. [NFPA 70:100(i)]

**Borehole.** A vertical or horizontal shaft typically cored, drilled or bored into the earth for geothermal system installations.

**Breathing Zone.** The region within an occupiable space between planes 3 inches and 72 inches (76 mm and 1829 mm) above the floor and exceeds 2 feet (610 mm) from the walls or fixed air-conditioning equipment. [ASHRAE 62.1:3]

**Breathing Zone Outdoor Airflow.** The outdoor airflow required in the breathing zone of the occupiable space or spaces in a ventilation zone. [ASHRAE 62.1:6.2.2.1]

**Breeching.** A metal connector for medium- and high-heat appliances.

**Broiler.** A general term including broilers, salamanders, barbecues, and other devices cooking primarily by radiant heat, excepting toasters. [NFPA 54:3.3.14.3]

**BTU/H.** The listed maximum capacity of any appliance, absorption unit, or burner expressed in British thermal units input per hour, unless otherwise noted.

**Building Code.** The building code that is adopted by this jurisdiction.

**Building Official.** See Authority Having Jurisdiction.

**Burner, Automatic Boiler.** A device to convey fuel into the combustion chamber in proximity to its combustion air supply so as to permit a stable, controlled heat release compatible with the burner design and that is equipped with an ignition system to reliably ignite the entire heat release surface of the burner assembly.

**Central Heating Plant or Heating Plant.** Environmental heating equipment installed in a manner to supply heat by means of ducts or pipes to areas other than the room or space in which the equipment is located.

**Certified.** A formally stated recognition and approval of an acceptable level of competency, acceptable to the Authority Having Jurisdiction. [NFPA 96:3.3.10]

**Certified Person.** A person trained and certified by the equipment manufacturer, or by a recognized organization through a formal certification program for the system to be serviced or cleaned; that is acceptable to the Authority Having Jurisdiction.

**Chimney.** One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outdoors. [NFPA 54:3.3.18.3.3.17]

**Chimney, Factory-Built.** A chimney composed of listed factory-built components assembled in accordance with the manufacturer’s installation instructions to form the completed chimney. [NFPA 54:3.3.18.23.3.17.2]
In a geothermal system, a hydronic system where the fluid is enclosed in piping that is not vented to the atmosphere, the system at any point, is typically under pressure that is greater than the ambient pressure.

**Geothermal Energy System, Closed-Loop System.**

1. A hydronic system where the fluid is enclosed in piping that is not vented to the atmosphere. The system at any point, is typically under pressure that is greater than the ambient pressure.

2. In a geothermal system, a liquid-source heat pump system using a continuous, sealed, underground, or submerged heat exchanger through which a heat-transfer fluid passes to and returns from a heat pump. The system at any point, is typically under pressure that is greater than the ambient pressure.

**Chimney.** A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units, or reinforced Portland cement concrete, lined with suitable chimney flue liners. [NFPA 54:3.3.18.3]

**Chimney, Masonry.** A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units, or reinforced Portland cement concrete, lined with suitable chimney flue liners. [NFPA 54:3.3.18.3]

**Chimney, Metal.** A field-constructed chimney of metal. [NFPA 54:3.3.18.4]

#### Chimney Classifications:

**Chimney, High-Heat Appliance-Type.** A factory-built, masonry, or metal chimney suitable for removing the products of combustion from fuel-burning high-heat appliances producing combustion gases in excess of 2000°F (1093°C), measured at the appliance flue outlet.

**Chimney, Low-Heat Appliance-Type.** A factory-built, masonry, or metal chimney suitable for removing the products of combustion from fuel-burning low-heat appliances producing combustion gases not in excess of 1000°F (538°C) under normal operating conditions, but capable of producing combustion gases of 1400°F (760°C) during intermittent forced firing for periods up to one hour. All temperatures are measured at the appliance flue outlet.

**Chimney, Medium-Heat Appliance-Type.** A factory-built, masonry, or metal chimney suitable for removing the products of combustion from fuel-burning medium-heat appliances producing combustion gases not in excess of 1000°F (538°C) under normal operating conditions, but capable of producing combustion gases of 1400°F (760°C) during intermittent forced firing for periods up to one hour. All temperatures are measured at the appliance flue outlet.

**Chimney, Residential Appliance-Type.** A factory-built or masonry chimney suitable for removing products of combustion from residential-type appliances producing combustion gases not in excess of 1000°F (538°C), measured at the appliance flue outlet. Factory-built Type HT chimneys have high-temperature thermal shock resistance.

**Chimney Connector.** The pipe that connects a fuel-burning appliance to a chimney. [NFPA 211:3.3.48.1]

**Circulators (Circulating Pump).** A device that circulates liquids within a closed circuit for an intended purpose.

**Classification.** See Listed (Third Party Certified).

**Clean(ing).** For kitchen exhaust systems and cooking equipment, the act of removing grease, oil deposits, and other residue. [NFPA 96:3.3.12]

**Clearly Identified.** Capable of being recognized by a person of normal vision without causing uncertainty and indefinitiveness about the location or operating process of the identified item. [NFPA 96:3.3.13]

**Closed Combustible Construction.** Combustible building construction, including walls, structural framing, roofs, roof ceilings, floors, and floor-ceiling assemblies, continuously enclosing a grease duct on four sides where one or more sides require protection in accordance with Section 507.4.

**Closed Combustion Solid-Fuel-Burning Appliance.** A heat-producing appliance that employs a combustion chamber that has no openings other than the flue collar, fuel charging door, and adjustable openings provided to control the amount of combustion air that enters the combustion chamber.

**Closet.** See Confined Space.

**Clothes Dryer.** An appliance used to dry wet laundry by means of heat. [NFPA 54:3.3.18.1]

**Clothes Dryer, Type 1.** Primarily used in family living environment. May or may not be coin-operated for public use. [NFPA 54:3.3.18.1]

**Clothes Dryer, Type 2.** Used in business with direct intercourse of the function with the public. May or may not be operated by public or hired attendant. May or may not be coin-operated. [NFPA 54:3.3.18.2]

**Coastal High Hazard Areas.** An area within the flood hazard area that is subject to high-velocity wave action, and shown on a Flood Insurance Rate Map or other flood hazard map as Zone V, VO, VE, or V1-30.

**Code.** A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

**Combustible Material.** A material that, in the form in which it is used and under the conditions anticipated, will ignite and burn; a material that does not meet the definition of noncombustible. [NFPA 54:3.3.64.1]

**Combustion Air.** The total amount of air provided to the space that contains fuel-burning equipment. Includes air for fuel combustion, draft hood dilution, and ventilation of the equipment enclosure.

**Combustion Chamber.** The portion of an appliance within which combustion occurs. [NFPA 54:3.3.24.3.20]

**Commercial Food Heat-Processing Equipment.** Equipment used in a food establishment for heat-processing food or utensils and that produces grease vapors, steam, fumes, smoke, or odors that are required to be removed through a local exhaust ventilation system.

**Compensating Hood.** A hood for commercial food heat-processing equipment that has an outside air supply with air delivered below or within the hood. Where makeup air is directed into the exhaust within the hood cavity, it becomes a short-circuit hood.

**Compressor, Positive Displacement.** A compressor in which increase in pressure is attained by changing the internal volume of the compression chamber.
**Compressor, Refrigerant.** A machine, with or without accessories, for compressing a refrigerant vapor.

**Concealed Spaces.** That portion(s) of a building behind walls, over suspended ceilings, in pipe chases, attics, and elsewhere whose size might normally range from 1⁄4 inch (44 mm) stud spaces to 8 foot (2438 mm) interstitial truss spaces and that might contain combustible materials such as building structural members, thermal, electrical insulation, or both, and ducting. Such spaces have sometimes been used as HVAC plenum chambers.

**Condensate.** The liquid phase produced by condensation of a particular gas or vapor.

**Condenser.** The part of the system designed to liquefy refrigerant vapor by removal of heat.

**Condensing Appliance.** An appliance that condenses part of the water vapor generated by the burning of hydrogen in fuels.

**Condensing Unit.** A mechanical refrigeration system, consisting of one or more power-driven compressors, condensers, liquid receivers where provided, and the regularly furnished accessories that have been factory assembled and tested prior to its installation.

**Conditioned Space.** An area, room, or zone normally occupied and being heated or cooled for human comfort by any appliance or equipment.

**Confined Space.** A room or space having a volume less than 50 cubic feet per 1000 British thermal units per hour (Btu/h) (4.83 m³/kW) of the aggregate input rating of all fuel-burning appliances installed in that space. [NFPA 96:3.3.47.2]

**Construction Documents.** Plans, specifications, written, graphic, and pictorial documents prepared or assembled for describing the design, location, and physical characteristics of the elements of a project necessary for obtaining a permit.

**Continuous Enclosure.** A recognized architectural or mechanical component of a building having a fire resistance rating as required for the structure and whose purpose is to enclose the vapor removal duct for its full length to its termination point outside the structure without any portion of the enclosure having a fire resistance rating less than the required value. [NFPA 96:3.3.22.1]

**Continuous Pilot.** A pilot that burns without turndown throughout the entire period that the boiler is in service, whether or not the main burner is firing.

**Continuous Weld.** A metal-joining method that produces a product without visible interruption or variation in quality. [NFPA 96:3.3.15] For the purpose of the definition, it specifically includes the exhaust compartment of hoods and welded joints of exhaust ducts, yet specifically does not include filter support frames or appendages inside hoods.

**Conversion Burner, Gas.** A unit consisting of a burner and its controls utilizing gaseous fuel for installation in an appliance originally utilizing another fuel. [NFPA 54:3.2.17.2 3.3.16.2]

**Cooling.** Air cooling to provide a room or space temperature of 68°F (20°C) or above.

**Cooling System.** All of the equipment, ducts and components, including associated refrigeration, intended or installed for the purpose of cooling air by mechanical means and discharging such air into any room or conditioned space. This definition shall not include an evaporative cooler.

**Cooling Unit.** A self-contained refrigeration system that has been factory assembled, tested, and installed with or without conditioned air and ducts, without connecting any refrigerant-containing parts. This definition shall not include a portable cooling unit or an absorption unit.

**Copper Alloy.** A homogenous mixture of two or more metals in which copper is the primary component, such as brass and bronze.

**Crawl Space.** In a building, an area accessible by crawling, having a clearance less than human height, for access to plumbing or wiring, storage, etc.

**CSST.** An acronym for corrugated stainless steel tubing.

**206.0 – D –**

**Damper.** A valve or plate for controlling draft or the flow of gases, including air. [NFPA 211:3.3.52]

**Ceiling Radiation Damper.** A listed device installed in a ceiling membrane of a fire-resistance-rated floor-ceiling or roof-ceiling assembly to automatically limit the radiative heat transfer through an air inlet/outlet opening. [NFPA 5000:3.3.140.1]

**Combination Fire/Smoke Damper.** An automatic-closing metal assembly consisting of one or more louvers, blades, slats, or vanes that closes upon detection of heat or smoke as to restrict the passage of flame and smoke.

**Corridor Damper.** An automatic-closing metal assembly consisting of one or more louvers, blades, slats, or vanes that closes upon detection of heat or smoke as to restrict the passage of flame and smoke.

**Fire Damper.** An automatic-closing metal assembly consisting of one or more louvers, blades, slats, or vanes that closes upon detection of heat so as to restrict the passage of flame.

**Smoke Damper.** A damper arranged to seal off airflow automatically through a part of an air duct system so as to restrict the passage of smoke.

**Volume Damper.** A device that, when installed, will restrict, retard, or direct the flow of air in any duct, or the products of combustion in any heat-producing equipment, its vent connector, vent, or chimney.

**Design Flood Elevation.** The elevation of the “design flood,” including wave height, relative to the datum specified on the community’s legally designated flood hazard map. In areas designated as Zone AO, the design flood elevation is the elevation of the highest existing grade of the building’s...
DEFINITIONS

perimeter plus the depth number (in feet) specified on the flood hazard map. In areas designated as Zone AO where a depth number is not specified on the map, the depth number is taken as being equal to 2 feet (610 mm).

Detection Devices. Electrical, pneumatic, thermal, mechanical, or optical sensing instruments, or subcomponents of such instruments, whose purpose is to cause an automatic action upon the occurrence of some preselected event. [NFPA 96:3.3.17] In the context of this document, the event in question could be extreme temperature or flame, and the action could be the operation of a fire-extinguishing system.

Dips. Depression or cup like places in horizontal duct runs in which liquids could accumulate.

Direct Gas-Fired Nonrecirculating Industrial Air Heater Heating and Forced Ventilation Appliances for Commercial and Industrial Application. A nonrecirculating industrial air heater, direct gas-fired heating and forced ventilation appliance in which all the products of combustion generated by the appliance are released into the outdoor airstream being heated. [NFPA 54:3.3.56.13.3.56.2]

Direct Gas-Fired Recirculating Industrial Air Heater Heating and Forced Ventilation Appliances for Commercial and Industrial Application. An air recirculating heater, direct gas-fired heating and forced ventilation appliance in which all of the products of combustion generated by the appliance are released into the airstream being heated. [NFPA 54:3.3.56.4]

Direct Vent Appliances. Appliances that are constructed and installed so that all air for combustion is derived directly from the outdoors and all flue gases are discharged to the outdoors. [NFPA 54:3.3.5.3]

Discharge. The final portion of a duct or pipe where the product being conveyed is emptied or released from confinement; the termination point of the pipe or duct. [NFPA 96:3.3.18]

Discrete Products in Plenums. Individual, distinct products which are non-continuous such as pipe hangers, duct registers, duct fittings, and duct straps.

District Heating Plant. A power boiler plant designed to distribute hot water or steam to users located off the premises.

Draft Hood. A nonadjustable device built into an appliance, or made a part of the vent connector from an appliance, that is designed to:

1. Provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood.
2. Prevent a backdraft from entering the appliance.
3. Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [NFPA 54:3.3.343.3.30]

Driver Building. One or more building(s) or facility(ies) that determined the upper and lower temperature limits of hot fluid or cold fluid delivery system.

Dual Purpose Water Heater. An appliance intended to be a heat source for both space heating and domestic hot water applications.

Duct. A tube or conduit for transmission of air, fumes, vapors, or dust. This definition shall not include:

1. A vent, vent connector, or chimney connector.
2. A tube or conduit wherein the pressure of the air exceeds 1 psi (7 kPa).
3. The air passages of listed self-contained systems.

Duct, Environmental Air. Ducting used for conveying air at temperatures not exceeding 250°F (121°C) to or from occupied areas of any occupancy other than heating or air-conditioning systems, such as ventilation for human usage, domestic kitchen range exhaust, bathroom exhaust ducts, locker room exhaust ducts, shower room exhaust ducts, janitor’s closet exhaust ducts, and domestic-type clothes dryer exhaust ducts.

Duct, Grease. A containment system for the transportation of air and grease vapor that is designed and installed to reduce the possibility of the accumulation of combustible condensation and the occurrence of damage if a fire occurs within the system. [NFPA 96:3.3.20.2]

Duct, Product-Conveying. Ducting used for conveying solid particulates, such as refuse, dust, fumes, and smoke; liquid particulate matter, such as spray residue, mists, and fogs; vapors, such as vapors from flammable or corrosive liquids; noxious and toxic gases; and air at temperatures exceeding 250°F (121°C).

Duct Furnace. A furnace normally installed in distribution ducts of air-conditioning systems to supply warm air for heating. This definition applies only to an appliance that, for air circulation, depends on a blower not furnished as part of the furnace. [NFPA 54:3.3.45.3]

Duct Sealing. The use of approved adhesives, gaskets, tape, mastics, or combination thereof to close openings in the surface of the ductwork, field erected plenums, equipment, and casings through which air leakage would occur, or the use of continuous welds.

Duct Sealing Classes.

- Seal Class A. All transverse joints, longitudinal seams, and duct wall penetrations.
- Seal Class B. All transverse joints and longitudinal seams.
- Seal Class C. Transverse joints.

Duct System. A continuous passageway for the transmission of air and vapors that, in addition to the containment components themselves, might include duct fittings, dampers, plenums, other items, and air-handling equipment. [NFPA 96:3.3.20]

Ductless Mini-Split System. A heating and cooling equipment that includes one or multiple indoor evaporator, air handler, or both units, an outdoor condensing unit that is connected by refrigerant piping, and electrical wiring. A ductless mini-split system is capable of cooling or heating one or more rooms without the use of traditional ductwork.
DEFINITIONS

Dwelling. A building or portion thereof that contains not more than two dwelling units.

Dwelling Unit. A building or portion thereof that contains living facilities, including provisions for sleeping, eating, cooking, and sanitation, as required by this code, for not more than one family.

Effective Ground-Fault Current Path. An intentionally constructed, low impedance electrically conductive path designed and intended to carry current under ground-fault conditions from the point of a ground fault on a wiring system to the electrical supply source and that facilitates the operation of the overcurrent protective device or ground-fault detectors. [NFPA 54:3.3.34]

Electric Duct Heaters. A heater located in the airstream of a forced-air system where the air-moving unit is not provided as an integral part of the equipment.

Effective Ground-Fault Current Path. A device that produces heat energy to create a warm environment by the application of electric power to resistance elements, refrigerant compressors, or dissimilar material junctions.

Effective Ground-Fault Current Path. The National Electrical Code promulgated by the National Fire Protection Association, as adopted by this jurisdiction.

Emergency Alarm System. A system intended to provide notification and warning of abnormal conditions and summon appropriate aid.

Emergency Control Station. An approved location on the premises where signals from emergency equipment are received.

Energy Recovery Ventilation (ERV) System. A device intended to provide outdoor ventilation air, and in the process transfer energy between the intake and exhaust airstreams for the purpose of preheating, precooling, humidifying, or dehumidifying outdoor ventilation air prior to supplying such air to a conditioned space.

Environmental Air Duct. Ducting used for conveying air at temperatures not exceeding 250°F (121°C) to or from occupied areas of any occupancy through other than heating or air conditioning systems, such as ventilation for human usage, domestic kitchen range exhaust, bathroom exhaust ducts, and domestic-type clothes dryer exhaust ducts.

Equipment. A general term including materials, fittings, devices, appliances, and apparatus used as part of or in connection with installations regulated by this code.

Evaporative Cooling System. Equipment intended or installed for the purpose of environmental cooling by an evaporative cooler from which the conditioned air is distributed through ducts or plenums to the conditioned area or zone.

Evaporator. Part of a refrigeration system in which liquid refrigerant is vaporized to produce refrigeration.

Excess Flow Valve (EFV). A valve designed to activate when the fuel gas passing through it exceeds a prescribed flow rate. [NFPA 54:3.3.99.3]

Expansion Tank. A vessel used to protect closed systems from excessive pressure.

Fabrication Area (Fab Area). An area within a Group H Occupancy semiconductor fabrication facility and related research and development areas in that there are processes involving hazardous production materials. Such areas are allowed to include ancillary rooms or areas such as dressing rooms and offices that are directly related to the fab area processes.

Field-Applied Grease Duct Enclosures. A listed factory-built grease duct system evaluated as an enclosure system for reduced clearances to combustibles and as an alternative to a duct with its fire-rated enclosure. [NFPA 96:3.3.22.1.1]

Field-Applied Grease Duct Enclosures. A listed system evaluated for reduced clearances to combustibles and as an alternative to a duct with its fire-rated enclosure. [NFPA 96:3.3.22.2.2]

Fifth Generation (5G) System Configurations. An advanced ambient temperature (ATL) system that distributes near-ambient-temperature water among and between end-use buildings that are equipped with water-source heat pumps or other water-source HVAC equipment. Such systems stand in contrast to fourth generation (4G) systems that distribute hot water or chilled water to buildings to serve facility loads.

Fire Code. The fire code adopted by this jurisdiction.

Fire Barrier. A fire-resistance-rated wall or assembly of materials designed to restrict the spread of fire in which continuity is maintained.

Fire Partition. An interior wall or partition of a building that separates two areas and serves to restrict the spread of fire but does not qualify as a fire wall.

Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with ASTM E1119 or UL 263. [NFPA 96:3.3.25]

Fire-Resistive Construction. Construction in accordance with the requirements of the building code for the time period specified.

Fire Wall. A wall separating buildings or subdividing a building to prevent the spread of the fire and having a fire resistance rating and structural stability. [NFPA 96:3.3.26]
Fireplace Stove. A chimney-connected, solid-fuel-burning stove (appliance) having part of its fire chamber open to the room.

Flammable Vapor or Fumes. The concentration of flammable constituents in air that exceeds 25 percent of its Lower Flammability Limit (LFL).

Flood Hazard Area. The greater of the following two areas:
1. The area within a floodplain subject to a 1 percent or greater chance of flooding in any given year.
2. The area designated as a flood hazard area on a community’s flood hazard map, or otherwise legally designated.

Floor Furnace. A completely self-contained unit furnace suspended from the floor of the space being heated, taking air for combustion from outside this space. [NFPA 54:3.3.45.5] With means for observing flames and lighting the appliance from such space.

Flue Collar. That portion of an appliance designed for the attachment of a draft hood, vent connector, or venting system. [NFPA 54:3.3.44]

Forced-Air Furnace. A furnace equipped with a fan or blower that provides the primary means for circulation of air. [NFPA 54:3.3.45.6]

Downflow-Type Furnace. A forced-air-type furnace designed with airflow essentially in a vertical path, discharging air at or near the bottom of the furnace. [NFPA 211:3.3.79.2]

Enclosed Furnace. A specific heating or heating and ventilating furnace incorporating an integral total enclosure and using only outside air for combustion.

Horizontal-Type Furnace. A forced-air-type furnace designed with airflow through the furnace, essentially in a horizontal path. [NFPA 211:3.3.79.3]

Upflow-Type Furnace. A forced-air-type furnace designed with airflow essentially in a vertical path, discharging air at or near the top of the furnace. [NFPA 211:3.3.79.4]

Fourth Generation (4G) System Configurations. A district geothermal energy system that distributes hot water and cold water for use in conditioned space. [211:3.3.79.4]

Fractionation. A change in composition of a blend by preferential evaporation of the more volatile component or condensation of the less volatile component.

Fuel Gas. A substance used as fuel, such as natural, manufactured, liquefied petroleum (LP-Gas), and mixtures of these gases, with gas-air mixtures within the flammable range.

Fuel Gas. Natural, manufactured, liquefied petroleum, or a mixture of these.

Flue Gas. Products of combustion with excess air in an appliance flues or heat exchangers. [NFPA 54:3.3.49.1]

Liquefied Petroleum Gas (LP-Gas). Means and includes a material composed predominantly of any of the following hydrocarbons or mixtures of them: propane, propylene, butanes (normal butane or isobutane), and butylenes. When reference is made to liquefied petroleum gas in this code, it shall refer to liquefied petroleum gases in either the liquid or gaseous state.

Utility Gas. See Fuel Gas.

Gas Convenience Outlet. A permanently mounted, hand-operated device providing a means for connecting and disconnecting an appliance or an appliance connector to the gas supply piping. [NFPA 54:3.3.48]

Gas Piping. An installation of pipe, valves, or fittings that are used to convey fuel gas, installed on any premises or in a building, but not including:
1. A portion of the service piping.
2. An approved piping connection 6 feet (1829 mm) or less in length between an existing gas outlet and an appliance in the same room with the outlet.

Gas Piping System. An arrangement of gas piping or regulators after the point of delivery and each arrangement of gas piping serving a building, structure, or premises, whether individually metered or not.

Generator. A device equipped with a means of heating used in an absorption system to drive refrigerant out of solution.

GeoMicroDistrict. A collection of building and facilities on an independently pumped ambient temperature loop (ATL) that supplies or receives energy. An independent segment served by a thermal highway.

Geothermal. Renewable energy generated by deep-earth conduction.

Geothermal Energy System. A system that uses thermal energy for space heating and cooling, and water heating.

Grade. A reference plane representing the average finished ground level adjoining the building at exterior walls.
Gravity Heating System. A heating system consisting of a gravity-type warm air furnace, together with all air ducts or pipes and accessory apparatus installed in connection therewith.

Gravity-Type Floor Furnace. A floor furnace depending primarily on circulation of air by gravity. This classification also includes floor furnaces equipped with booster-type fans that do not materially restrict free circulation of air by gravity flow when such fans are not in operation. [NFPA 211:3.3.79.12.2]

Grease. Rendered animal fat, vegetable shortening, and other such oily matter used for the purposes of and resulting from cooking, preparing foods, or both. [NFPA 96:3.3.29] Grease might be liberated and entrained with exhaust air or might be visible as a liquid or solid.

Grease Ducts. A containment system for the transportation of air and grease vapors that is designed and installed to reduce the possibility of the accumulation of combustible condensation and the occurrence of damage if a fire occurs within the system. [NFPA 96:3.3.20.2]

Grease Filter. A removable component of the grease removal system designed to capture grease and direct it to a safe collection point. [NFPA 96:3.3.24.1]

Grease Filter, Mesh-Type. A filter construction consisting of a net made from intersecting strands with a space between each strand. [NFPA 96:3.3.24.2]

Grease Removal Devices. A system of components designed and intended to process vapors, gases, or air as it is drawn through such devices by collecting the airborne grease particles and concentrating them for further action at some future time, leaving the exiting air with a lower amount of combustible matter.

Greasetight. Constructed and performing in such a manner as not to permit the passage of grease under normal cooking conditions. [NFPA 96:3.3.31]

Groundwater. Water that exists beneath the earth’s surface.

Groundwater Source. A geothermal energy system that uses the groundwater as a heat source or sink.

Ground-Heat Exchanger. An underground closed-loop heat exchanger through which a heat-transfer medium passes to and from a heat pump or other rated mechanical equipment. It includes the buried pipe and connecting main(s) up to and terminating with the building.

Ground-Source Heat Pump. A term that is applied to a variety of systems that use the ground, groundwater, or surface water as a heat source and sink. The general terms include ground-coupled (GCHP), groundwater (GWHP), and surface-water (SWHP) heat pumps. Many parallel terms exist [e.g., geothermal heat pumps (GHP), geo-exchange, and ground-source (GS) systems] and are used to meet a variety of marketing or institutional needs.

Grounding Electrode. A conducting object through which a direct connection to earth is established. [NFPA 70:100(I)]
DEFINITIONS

makeup air is diffused directly into the exhaust within the hood cavity, it becomes a short-circuit hood.

**Hood, Fixed Baffle.** A listed unitary exhaust hood design where the grease removal device is a nonremovable assembly that contains an integral fire-activated water-wash fire-extinguishing system listed for this purpose. [NFPA 96-2014:3.3.33.1]

**Hood, Type I.** A kitchen hood for collecting and removing grease and smoke.

**Hood, Type II.** A general kitchen hood for collecting and removing steam, vapor, heat, or odors.

**Hot Water Heating Boiler.** A boiler having a volume exceeding 120 gallons (454 L), a heat input exceeding 200,000 Btu/h (58.6 kW), or an operating temperature exceeding 210°F (99°C) that provides hot water to be used externally to itself.

**HPM Storage Room.** A room used for the storage or dispensing of hazardous production material (HPM) and that is classified as a Group H, Division 1, Division 2, Division 3, Division 4, or Division 5 Occupancy.

**Hydronics.** Of or relating to a heating or cooling system that transfers energy by circulating a fluid through a system of pipes or tubing.

**Hydronic System.** Relating to, or being a system of, heating or cooling that involves the transfer of heat by a circulating fluid (such as water or vapor).

**IDLH (Immediately Dangerous to Life and Health).** A concentration of airborne contaminant’s, normally expressed in parts per million (ppm) or milligrams per cubic meter (mg/m³), that represents the maximum level from which one is capable of escaping within 30 minutes without escape impairing symptoms or irreversible health effects. This level is established by the National Institute of Occupational Safety and Health (NIOSH).

**Incinerator.** An appliance or combustion chamber for the reduction, by burning, of rubbish, garbage, and other wastes. [NFPA 211:3.3.91]

**Industrial Heating Equipment.** Includes appliances, devices, or equipment used, or intended to be used, in an industrial, manufacturing, or commercial occupancy for applying heat to any material being processed, but shall not include water heaters, boilers, or portable equipment used by artisans in pursuit of a trade.

**Insanitary Location.** An area, space, or room where the air is unfit or undesirable for circulation to occupiable parts of a building.

**Interconnected.** Mutually assembled to another component in such a manner that the operation of one directly affects the other or that the contents of one specific duct system are allowed to encounter or contact the products being moved by another duct system. [NFPA 96:3.3.34]

**Interlock.** A device that senses a limit or off-limit condition or improper sequence of events and shuts down the offending or related piece of equipment or prevents proceeding in an improper sequence in order to prevent a hazardous condition from developing.

**Intermittent Pilot.** A pilot that burns during light-off and while the main burner is firing, and that is shut off with the main burner.

**Interrupted Pilot.** A pilot that burns during light-off and that is shut off during normal operation of the main burner.

**Joint, Brazed.** A joint obtained by joining of metal parts with alloys that melt at temperatures exceeding 840°F (449°C) but less than the melting temperature of the parts being joined.

**Joint, Compression.** A multipiece joint with cup-shaped threaded nuts that, when tightened, compress tapered sleeves so that they form a tight joint on the periphery of the tubing they connect.

**Joint, Flanged.** One made by bolting together a pair of flanged ends.

**Joint, Flared.** A metal-to-metal compression joint in which a conical spread is made on the end of a tube that is compressed by a flare nut against a mating flare.

**Joint, Heat Fusion.** A joint used in some thermoplastic systems to connect pipe to fittings or pipe lengths directly to one another (butt-fusion). This method of joining pipe to fittings includes butt-fusion, socket-fusion, electro-fusion, and saddle-fusion. This method of welding involves the application of heat and pressure to the components, allowing them to fuse together forming a bond between the pipe and fitting.

**Joint, Mechanical.** General form for gastight or liquid-tight joints obtained by the joining of parts through a positive holding mechanical construction.

**Joint, Press-Connect.** A permanent mechanical joint consisting of an elastomeric seal or an elastomeric seal and corrosion-resistant grip ring. The joint is made with a pressing tool and jaw or ring approved by the fitting manufacturer.

**Joint, Soldered.** A joint obtained by the joining of metal parts with metallic mixtures or alloys that melt at a temperature up to and including 840°F (449°C).

**Joint, Welded.** A gastight joint obtained by the joining of metal parts in the plastic molten state.

**LER (Lower Explosive Limit).** See LFL.

**LEL (Lower Flammable Limit or Lower Limit of Flammability).** The minimum concentration of a substance that propagates a flame through a homogeneous mixture of the
substance and air under the specified test conditions. The LFL is sometimes referred to as LEL (Lower Explosive Limit). For the purposes of this definition, LFL and LEL are identical.

**Limited-Combustible Material.** Refers to a building construction material that does not comply with the definition of noncombustible material that, in the form in which it is used, has a potential heat value not exceeding 3500 British thermal units per pound-force (Btu/lb) (8141 kJ/kg), where tested in accordance with NFPA 259, and includes either of the following:

1. Materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of ⅛ of an inch (3.2 mm), that has a flame-spread index not greater than 50.
2. Materials, in the form and thickness used, having neither a flame-spread index greater than 25 nor evidence of continued progressive combustion, and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame-spread index greater than 25 nor evidence of continued progressive combustion, where tested in accordance with ASTM E84.

**Line Contact Installation.** An installation in which a furnace is installed so that building joists, studs, or framing are contacted by the furnace jacket upon the lines formed by the intersection of the jacket sides with the top surface.

**Lineset.** A set of two refrigerant pipes that extends from the condenser to the evaporator (cooling coil) in direct systems, consisting of a suction line and a liquid line.

**Liquefied Petroleum Gas (LP-Gas).** Means a material composed predominantly of any of the following hydrocarbons or mixtures of them: propane, propylene, butanes (normal butane or isobutane), and butylenes. When reference is made to liquefied petroleum gas in this code, it shall refer to liquefied petroleum gases in either the liquid or gaseous state.

**Liquefied Petroleum Gas (LP-Gas) Facilities.** Liquefied petroleum gas (LP-Gas) facilities include tanks, containers, container valves, regulating equipment, meters, appurtenances, or any combination thereof for the storage and supply of liquefied petroleum gas for a building, structure, or premises.

**Liquid-Tight.** Constructed and performing in such a way that prevents the passage of liquid at any temperature. [NFPA 96:3.3.35]

**Listed (Third Party Certified).** Equipment or materials included in a list published by a listing agency (accredited conformity assessment body) that maintains periodic inspection of current production of listed equipment or materials and whose listing states either that the equipment or material complies with approved standards or has been tested and found suitable for use in a specified manner.

**Listing Agency.** An agency accredited by an independent and authoritative conformity assessment body to operate a material and product listing and labeling (certification) system and that are accepted by the Authority Having Jurisdiction, which is in the business of listing or labeling. The system includes initial and ongoing product testing, a periodic inspection on current production of listed (certified) products, and that makes available a published report of such listing in which specific information is included that the material or product is in accordance with applicable standards and found safe for use in a specific manner.

**Low-Pressure Hot-Water-Heating Boiler.** A boiler furnishing hot water at pressures not exceeding 160 psi (1103 kPa) and at temperatures not exceeding 250°F (121°C).

**Low-Pressure Steam-Heating Boiler.** A boiler furnishing steam at pressures not exceeding 15 psi (103 kPa).

**Low-Probability Pump.** A pump that (a) is permanently sealed to prevent atmospheric release of the pumped fluid, (b) incorporates a static seal to prevent atmospheric release of the pumped fluid, or (c) incorporates not less than two sequential dynamic shaft seals and automatically shuts down upon failure of any seal to prevent atmospheric release of the pumped fluid. [ASHRAE'15:3]

**Lowside.** Refers to the parts of a refrigeration system subjected to approximate evaporator pressure.

**Mid-Story Guide.** A support designed to keep piping in alignment, located mid-way between floors or a floor and ceiling.

**Miniature Boiler.** A power boiler having an internal shell diameter of 16 inches (406 mm) or less, a gross volume of 5 cubic feet (0.14 m³) or less, a heating surface of 20 square feet (1.86 m²) or less (not applicable to electric boilers), and not exceeding 100 psi (689 kPa).

**Natural Ventilation.** Ventilation provided by thermal, wind, or diffusion effects through doors, windows, or other intentional openings in the building. [ASHRAE 62.1:3]

**Noncombustible Material.** As applied to building construction material, means a material that in the form in which it is used is either one of the following:

1. A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials that are reported as passing ASTM E136 are considered noncombustible material.
(2) Material having a structural base of noncombustible material as defined in item 1 above, with a surfacing material not over ⅛ of an inch (3.2 mm) thick that has a flame-spread index not higher than 50.

Noncombustible does not apply to surface finish materials. Material required to be noncombustible for reduced clearances to flues, heating appliances, or other sources of high temperature shall refer to material in accordance with item 1 above. No material shall be classed as noncombustible that is subject to increase in combustibility or flame-spread index beyond the limits herein established, through the effects of age, moisture, or other atmospheric condition.

Nonhazardous Process Piping (NPP). Production material piping or tubing conveying a liquid or gas that is not classified as hazardous production material piping.

217.0 – O –
Occupancy. The purpose for which a building or part thereof is used or intended to be used.

Occupancy, Nontransient. Occupancy of a dwelling unit or sleeping unit for more than 30 days. [ASHRAE 62:1:3]

Occupancy Classification. Classifications are defined in the building code.

Occupational Exposure Limit (OEL). The time-weighted average (TWA) concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers can be repeatedly exposed without adverse effect, based on the OSHA PEL, ACGIH TLV-TWA, TERA OARS-WEEL, or consistent value. [ASHRAE 34:3]

Occupiable Space. An enclosed space intended for human activities, excluding spaces that are intended to be occupied occasionally and for short periods of time, such as storage rooms, equipment rooms, and emergency exitways. [ASHRAE 62:1:3]

Open Combustible Construction. Combustible building construction, including wall, structural framing, roof, roof ceiling, floor, and floor-ceiling assemblies, adjacent to a grease duct on three or fewer sides where one or more sides require protection in accordance with Section 507.4.

Geothermal Energy System, Open-Loop System.
(1) A hydronic system where the fluid is enclosed in piping that is vented to the atmosphere, or is replaced, all or in part, during every circulation of the system.
(2) In a geothermal system, a liquid-source heat pump system, inclusive of heat pump systems, that uses ground water or surface water to extract or reject heat.

218.0 – P –
Package Boiler. A class of boiler defined herein and shall be a boiler equipped and shipped complete with fuel burning equipment, automatic controls and accessories, and mechanical draft equipment.

PE. Polyethylene.
PE-AL-PE. Polyethylene-aluminum-polyethylene.
**Portable Heating Appliance.** A heating appliance designed for environmental heating that may have a self-contained fuel supply and is not secured or attached to a building by any means other than by a factory-installed power supply cord.

**Portable Ventilating Equipment.** Ventilating equipment that can be readily transported from place to place without dismantling a portion thereof and that is not connected to a duct.

**Power Boiler.** A boiler in which steam is generated at pressures exceeding 15 psi (103 kPa).

**Power Boiler Plant.** One or more power steam boilers or power hot water boilers and connecting piping and vessels within the same premises.

**Power Hot Water Boiler (High Temperature Water Boiler).** A boiler used for heating water or liquid to a pressure exceeding 160 psi (1103 kPa) or to a temperature exceeding 250°F (121°C).

**Power Ventilator, Dryer Exhaust Duct.** A fan used to boost airflow through a clothes dryer duct.

**PP.** Polypropylene.

**Pressure, Design.** The maximum working pressure for which a specific part of a refrigeration system is designed.

**Pressure, Field Test.** A test performed in the field to prove system tightness.

**Pressure-Imposing Element.** A device or portion of the equipment used for the purpose of increasing the pressure of the refrigerant vapor.

**Pressure-Limiting Device.** A pressure-responsive mechanism designed to automatically stop the operation of the pressure-imposing element at a predetermined pressure.

**Pressure-Relief Device.** A pressure-actuated valve or rupture member or fusible plug designed to automatically relieve excessive pressure.

**Pressure Test.** The minimum gauge pressure to which a specific system component is subjected under test condition.

**Pressure Vessel (Unfired).** A closed container, having a nominal internal diameter exceeding 6 inches (152 mm) and a volume exceeding 1 1/2 cubic feet (0.04 m³), for liquids, gases, vapors subjected to pressures exceeding 15 psi (103 kPa), or steam under a pressure exceeding 160 psi (1103 kPa).

**Pressure Vessel, Refrigerant.** A refrigerant-containing receptacle that is a portion of a refrigeration system, but shall not include evaporators, headers, or piping of certain limited size and capacity.

**Process Piping.** Piping or tubing that conveys liquid or gas, which is used directly in research, laboratory, or production processes.

**Product Conveying Duct.** Ducting used for conveying solid particulates, such as refuse, dust, fumes, and smoke; liquid particulate matter, such as spray residue, mists, and fogs; vapors, such as vapors from flammable or corrosive liquids; noxious and toxic gases; and air at temperatures exceeding 250°F (121°C).

**Purge.** The acceptable method of scavenging the combustion chamber, boiler passes, and breeching to remove combustible gases.

**PVC.** Polyvinyl chloride.

219.0  
**Qualified.** A competent and capable person or company that has met the requirements and training for a given field acceptable to the Authority Having Jurisdiction.

**Quick-Disconnect Device, Fuel Gas.** A hand-operated device that provides a means for connecting and disconnecting an appliance or an appliance connector to a gas supply and that is equipped with an automatic means to shut off the gas supply when the device is disconnected. [NFPA 54:2022:3.3.27.3]

220.0  
**Radiant Room Heater.** A room heater designed to transfer heat primarily by direct radiation. [NFPA 211:3.3.88.2.2]

**Receiver, Liquid.** A vessel permanently connected to a refrigeration system by inlet and outlet pipes for storage of liquid.

**Recirculating Systems.** Systems for control of smoke or grease-laden vapors from commercial cooking equipment that do not exhaust to the outside. [NFPA 96:3.3.41]

**Reclaimed Refrigerants.** Refrigerants reprocessed to the same specifications as new refrigerants by any means, including distillation. Such refrigerants have been chemically analyzed to verify that those specifications have been met. [ASHRAE 15:3]

**Recovered Refrigerants.** Refrigerants removed from a system in any condition without necessarily testing or processing them. [ASHRAE 15:3]

**Recycled Refrigerants.** Refrigerants for which contaminants have been reduced by oil separation, removal of non-condensable gases, and single or multiple passes through filter driers or other devices that reduce moisture, acidity, and particulate matter. [ASHRAE 15:3]

**Refrigerant Concentration Limit (RCL).** The refrigerant concentration limit, in air, determined in accordance with this code and intended to reduce the risks of acute toxicity, asphyxiation, and flammability hazards in normally occupied enclosed spaces. [ASHRAE 34:3.1]

**Refrigerant Designation.** The unique identifying alphanumeric value assigned to an individual refrigerant.

**Refrigerant Safety Classifications.** Made up of a letter (A or B), that indicates the toxicity class, followed by a number (1, 2, or 3), that indicates the flammability class. Refrigerant blends are similarly classified, based on the compositions at their worst cases of fractionation, as separately determined for toxicity and flammability. In some cases, the worst case of fractionation is the original formulation.

**Flammability Classification.** Refrigerants shall be classified for flammability in accordance with one of the following:
Refuge Handling Rule

**Class 1.** Refrigerants that do not show flame propagation where tested in air at 14.7 pound-force per square inch absolute (psia) and 140°F (60°C).

**Class 2.** Refrigerants having a lower flammability limit (LFL) of more than 0.00625 pound per cubic foot (lb/ft³) (0.10012 kg/m³) at 140°F (60°C), 14.7 psia (101 kPa), and a heat of combustion of less than 8169 British thermal units per pound (Btu/lb) (1.8988 E+07 J/kg).

**Class 3.** Refrigerants that are highly flammable having a LFL of not more than 0.00625 lb/ft³ (0.10012 kg/m³) at 140°F (60°C) and 14.7 psia (101 kPa) or a heat of combustion not less than 8169 Btu/lb (1.8988 E+07 J/kg).

**Toxicity Classification.** Refrigerants shall be classified for the toxicity in accordance with one of the following:

- **Class A.** Refrigerants have an occupational exposure limit (OEL) of not less than 400 parts per million (ppm).
- **Class B.** Refrigerants have an OEL of less than 400 ppm.

**Refrigeration Machinery Room.** A room designed to house compressors and refrigerant pressure vessels.

**Refrigeration Room or Space.** A room or space in which an evaporator or brine coil is located for the purpose of reducing or controlling the temperature within the room or space to less than 68°F (20°C).

**Refrigeration System, Absorption.** A heat-operated closed refrigeration cycle in which a secondary fluid, the absorbent, absorbs a primary fluid, the refrigerant that has been vaporized in the evaporator.

**Refrigeration System, Direct.** A system in which the evaporator or condenser of the refrigerating system is in direct contact with the air or other substances to be cooled or heated. [ASHRAE 15:5.1.1]

**Refrigeration System, Indirect.** A system in which a secondary coolant cooled or heated by the refrigerating system is circulated to the air or other substance to be cooled or heated. Indirect systems are distinguished by the method of application given below. [ASHRAE 15:5.1.2]

- **Indirect Open Spray System.** A system in which a secondary coolant is in direct contact with the air or other substance to be cooled or heated. [ASHRAE 15:5.1.2.1]
- **Double Indirect Open Spray System.** A system in which the secondary substance for an indirect open spray system is heated or cooled by the secondary coolant circulated from a second enclosure. [ASHRAE 15:5.1.2.2]
- **Indirect Closed System.** A system in which a secondary coolant passes through a closed circuit in the air or other substance to be cooled or heated. [ASHRAE 15:5.1.2.3]

**Refrigeration System, Mechanical.** A combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat and in which a compressor(s) is/are used for compressing the refrigerant vapor.

**Refrigeration System, Self-Contained.** A complete factory-assembled and tested system that is shipped in one or more sections and has no refrigerant-containing parts that are joined in the field by other than companion or block valves.

**Registered Design Professional.** An individual who is registered or licensed by the laws of the state to perform such design work in the jurisdiction.

**Relief Valve, Vacuum.** A device which automatically opens or closes for relieving a vacuum with the system, depending on whether the vacuum is above or below a predetermined value.

**Removable.** Capable of being transferred to another location with a limited application of effort and tools. [NFPA 96:3.3.42]

**Replacement Air.** See Air, Makeup.

**Residential Building.** A building or portion thereof designed or used for human habitation.

**Riser Heat Pipe.** A duct that extends at an angle of 45 degrees (0.79 rad) from the horizontal. This definition shall not include any boot connection.

**Room Heater.** A freestanding, nonrecessed, environmental heating appliance installed in the space being heated and not connected to ducts.

**Room Heater, Unvented.** An unvented, self-contained, freestanding, nonrecessed, fuel gas-burning appliance for furnishing warm air by gravity or fan circulation to the space in which installed, directly from the heater without duct connection. [NFPA 54:3.3.56.6]

**Rupture Member.** A pressure-relief device that operates by the rupture of a diaphragm within the device on a rise to a predetermined pressure.

221.0 – S –

**Seam, Welded.** See Joint, Welded.

**Secondary Filtration.** Fume incinerators, thermal recovery units, air pollution control devices or other filtration media installed in ducts or hoods located in the path of travel of exhaust products after the initial filtration.

**Self-Contained.** Having all essential working parts, except energy and control connections, so contained in a case or framework that they do not depend on appliances or fastenings outside of the machine.

**Service Corridor.** A fully enclosed passage used for transporting hazardous production materials and purposes other than required exiting.

**Service Piping.** The piping and equipment between the street gas main and the gas piping system inlet that is installed by, and is under the control and maintenance of, the serving gas supplier.
Shaft. An interior space enclosed by walls or construction extending through one or more stories or basements that connect openings in successive floors, or floors and roof, to accommodate elevators, dumbwaiters, mechanical equipment, or similar devices to transmit light or ventilation air.

Shaft Enclosure. The walls or construction forming the boundaries of a shaft.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Single Hazard Area. Where two or more hazards can be simultaneously involved in fire by reason of their proximity, as determined by the Authority Having Jurisdiction. [NFPA 96:3.3.44]

Smoke Detector. An approved device that senses visible or invisible particles of combustion.

Solid Cooking Fuel. Any solid, organic, consumable fuel such as briquettes, mesquite, hardwood, or charcoal. [NFPA 96:3.3.45]

Solid-Fuel Cooking Equipment. Cooking equipment that utilizes solid fuel. [NFPA 96:3.3.23.2] This equipment includes ovens, tandoori charcoal pots, grills, broilers, rotisseries, barbecue pits, or other type of cooking equipment that derives all or part of its heat source from the burning of solid cooking fuel.

Solvent. A substance (usually liquid) capable of dissolving or dispersing another substance; a chemical compound designed and used to convert solidified grease into a liquid or semiliquid state in order to facilitate a cleaning operation. [NFPA 96:3.3.46]

Spark Arrester. A device or method that minimizes the passage of airborne sparks and embers into a plenum, duct, and flue. [NFPA 96:3.3.48]

Standard. A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

Stationary Fuel Cell Power Plant. A self-contained package or factory-matched packages that constitute an automatically operated assembly of integrated systems for generating useful electrical energy and recoverable energy that is permanently connected and fixed in place.

Steam-Heating Boiler. A boiler operated at pressures not exceeding 15 psig (103 kPa) for steam.

Strength, Ultimate. The highest stress level that the component can tolerate without rupture.

Supports. Supports, hangers, and anchors are devices for properly supporting and securing pipe, duct, and equipment.

System Coefficient of Performance (SCOP). A ratio of the total system energy moved divided by the total system purchased energy.

System Outdoor Airflow. The rate of outdoor airflow required at the ventilation system outdoor air intake.

Termination, Duct. The final or intended end portion of a duct system that is designed and functions to fulfill the obligations of the system in a satisfactory manner. [NFPA 96:3.3.19]

Thermal Highway. A collection one or more GeoMicroDistricts that acts as an energy transport system and supplies or accepts energy from multiple GeoMicroDistricts, individual buildings, or other sources. Also known as convective circulation circuit.

Thermal Recovery Unit. A device or series of devices whose purpose is to reclaim only the heat content of air, vapors, gases, or fluids that are being expelled through the exhaust system and to transfer the thermal energy so reclaimed to a location whereby a useful purpose can be served. [NFPA 96:3.3.49]

Thermal Resources. A source for a heating and a sink for a cooling. There are two types of sources:

1. Conventional-type: such systems are known as geothermal energy systems, such as air-source resources and ground-source resources.
2. Opportunistic-type: such systems use water-source resources (e.g., oceans, rivers, raw sewage pipes, treated sewage outfall, potable water pipes, etc.), process byproduct heat resources (e.g., data center cooling process reject heat, industrial process reject heat, etc.), and other resources.

Thermosiphon. The natural circulation of fluids due to temperature differential.

Trained. A person who has become proficient in performing a skill reliably and safely through instruction and practice/field experience acceptable to the Authority Having Jurisdiction. [NFPA 96:3.3.50]

Transition Gas Riser. A listed or approved section or sections of pipe and fittings used to convey fuel gas and installed in a gas piping system for the purpose of providing a transition from belowground to aboveground.

Trap. A cuplike or U-shaped configuration located on the inside of a duct system component where liquids can accumulate. [NFPA 96:3.3.51]

Type B Gas Vent. A factory made gas vent listed by a nationally recognized testing agency for venting listed or approved appliances equipped to burn only gas.

Type B-W Gas Vent. A factory made gas vent listed by a nationally recognized testing agency for venting listed or approved gas-fired vented wall furnaces.

Type L Gas Vent. A venting system consisting of listed vent piping and fittings for use with oil-burning appliances listed for use with Type L or with listed gas appliances.
DEFINITIONS

223.0 – U –

Unconditioned Space. An area, room, or space not being heated or cooled by any equipment.

Unit Heater. A heating appliance designed for nonresidential space heating and equipped with an integral means for circulation of air.

Unusually Tight Construction. Construction where:

(1) Walls and ceilings exposed to the outdoors have a continuous water vapor retarder with a rating of 1 perm or less with openings gasketed or sealed.
(2) Weatherstripping is on openable windows and doors.
(3) Caulking or sealants are applied to areas such as joints around window and door frames, between sole plates and floors, between wall-ceiling joints, between wall panels, and at penetrations for plumbing, electrical, and gas lines and at other openings.

Use (Material). The placing in action or making available for service by opening or connecting a container utilized for confinement of material, whether a solid, liquid, or gas.

224.0 – V –

Vacuum. A pressure less than that exerted by the atmosphere.

Valve, Pressure-Relief. A pressure-actuated valve held closed by a spring or other means and designed to automatically relieve pressure in excess of its setting.

Valve, Stop. A device in a piping system to shut off the flow of the fluid.

Valve, Three-Way-Type Stop. A manually operated valve with one inlet that alternately can stop flow to either of two outlets.

Valves, Companion or Block. Pairs of mating stop valves valving off sections of refrigeration systems and arranged so that these sections may be joined before opening these valves or separated after closing them.

Vent. A pipe or other conduit composed of factory-made components, containing a passageway for conveying combustion products and air to the atmosphere, listed and labeled for use with a specific type or class of appliance.

Vent, Type B Gas. A factory-made gas vent listed by a nationally recognized testing agency for venting listed or approved appliances equipped to burn only gas.

Vent, Type B-W Gas. A factory-made gas vent listed by a nationally recognized testing agency for venting listed or approved gas-fired vented wall furnaces.

Vent, Type L Gas. A venting system consisting of listed vent piping and fittings for use with oil-burning appliances listed for use with Type L or with listed gas appliances.

Vent, Gas. A passageway composed of listed factory-built components assembled in accordance with the manufacturer’s installation instructions for conveying vent gases from appliances or their vent connectors to the outdoors. [NFPA 54:3.3.53]

Vent Connector, Gas. That portion of a gas-venting system that connects a listed gas appliance beginning at the draft hood or flue collar to a gas vent and is installed entirely within the space or area in which the appliance is located.

Vent Offset. An arrangement of two or more fittings and pipe installed for the purpose of locating a vertical section of vent pipe in a different but parallel plane with respect to an adjacent section of vertical vent pipe. [NFPA 54:3.3.102 3.3.101]

Vented Appliance Categories.

Category I. An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent. [NFPA 54:3.3.5.11.1 3.3.5.10.1]

Category II. An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that can cause excessive condensate production in the vent. [NFPA 54:3.3.5.11.1 3.3.5.10.2]

Category III. An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent. [NFPA 54:3.3.5.11.3 3.3.5.10.3]

Category IV. An appliance that operates with a positive vent static pressure and with a vent gas temperature that can cause excessive condensate production in the vent. [NFPA 54:3.3.5.11.4 3.3.5.10.4]

Vented Decorative Appliance. A vented appliance whose only function is providing an aesthetic effect of flames.

Vented Wall Furnace. A self-contained, vented, fuel gas-burning appliance complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building and furnishing heated air, circulated by gravity or by a fan, directly into the space to be heated through openings in the casing. [NFPA 54:3.3.45.7]

Ventilating Ceiling. A suspended ceiling containing many small apertures through which air, at low pressure, is forced downward from an overhead plenum dimensioned by the concealed space between the suspended ceiling and the floor or roof above.

Ventilation System. All of that equipment intended or installed for the purpose of supplying air to or removing air from, any room or space by mechanical means, other than equipment that is a portion of an environmental heating, cooling, absorption, or evaporative cooling system.

Venting Collar. The outlet opening of an appliance provided for connection of the vent system.

Venting System. The vent or chimney and its connectors, assembled to form a continuous open passageway from an appliance to the outdoors for the purpose of removing products of combustion. This definition also shall include a venting assembly that is an integral part of an appliance.

Venting System, Gravity-Type. A system that depends entirely on the heat from the fuel being used to provide the energy required to vent an appliance.
**Venting System, Power-Type.** A system that depends on a mechanical device to provide a positive draft within the venting system.

**Volume, Internal Gross.** The volume as determined from internal dimensions of the container, with no allowance for the volume of the internal parts.

225.0 - W -

**Wall Heater.** See Vented Wall Furnace.

**Warm Air Furnace.** An environmental heating appliance designed or arranged to discharge heated air through any duct or ducts. This definition shall not include a unit heater.

**Water Well.** An excavation that is drilled, cored, bored, washed, driven, dug, jetted, or otherwise constructed for the purposes of extracting groundwater, using the geothermal properties of the earth or injecting water into an aquifer or subsurface reservoir.

**Water Heater or Hot-Water-Heating Boiler.** An appliance designed primarily to supply hot water for domestic or commercial purposes and equipped with automatic controls limiting water temperature to a maximum of 210°F (99°C).

226.0 - X -

No definitions.

227.0 - Y -

No definitions.

228.0 - Z -

**Zeotropic.** Blends comprising multiple components of different volatilities that, when used in refrigeration cycles, change volumetric composition and saturation temperatures as they evaporate (boil) or condense at constant pressure. [ASHRAE 34:3]
CHAPTER 3
GENERAL REGULATIONS

301.0 General.
301.1 Applicability. This chapter covers general requirements for heating, ventilating, air-conditioning, refrigeration, miscellaneous heat-producing, and energy-utilizing equipment or appliances. Such equipment or appliances shall comply with the requirements of this code.

301.2 Approval. Equipment or appliance shall be approved by the Authority Having Jurisdiction for safe use or comply with applicable nationally recognized standards as evidenced by the listing and label of an approved agency. A list of accepted standards is included in Chapter 17. Defective materials or parts shall be replaced in such a manner as not to invalidate an approval.

301.3 Design of Equipment. The installer or contractor shall furnish satisfactory evidence that the appliance is constructed in accordance with the requirements of this code. The permanently attached label of an approved agency shall be permitted to be accepted as such evidence.

301.4 Electrical Connections. For equipment regulated by this code:

(1) Equipment requiring electrical connections of more than 50 volts shall have a positive means of disconnect adjacent to and in sight from the equipment served. Exception: Other power disconnect means shall be acceptable where in accordance with NFPA 70.

(2) A 120 volt receptacle shall be located within 25 feet (7620 mm) of the equipment for service and maintenance purposes. The receptacle outlet shall be on the supply side of the disconnect switch. The receptacle need not be located on the same level as the equipment.

(3) Electrical wiring, controls, and connections to equipment and appliances regulated by this code shall be in accordance with NFPA 70.

301.5 Oil-Burning Appliances. The tank, piping, and valves for appliances burning oil shall be installed in accordance with the requirements of NFPA 31.

301.6 Personnel Protection. A metal guard shall be provided around exposed flywheels, fans, pulleys, belts, and moving machinery that are portions of a heating, ventilating, or refrigerating system.

302.0 Materials – Standards and Alternates.
302.1 Minimum Standards. Listed pipe, pipe fittings, appliances, appurtenances, equipment, materials, and devices used in a mechanical system shall be listed (third-party certified) by a listing agency (accredited conformity assessment body) as complying with the approved applicable recognized standards referenced in this code, and shall be free from defects. Unless otherwise provided for in this code, materials, appurtenances, or devices used or entering into the construction of mechanical systems, or parts thereof, shall be submitted to the Authority Having Jurisdiction for approval prior to being installed.

302.1.1 Marking. Each length of pipe and each pipe fitting, material, and device used in a mechanical system shall have cast, stamped, or indelibly marked on it any markings required by the applicable referenced standards and listing agency, and the manufacturer’s mark or name, which shall readily identify the manufacturer to the end user of the product. Where required by the approved standard that applies, the product shall be marked with the weight and the quality of the product. Materials and devices used or entering into the construction of mechanical systems, or parts thereof, shall be marked and identified in a manner satisfactory to the Authority Having Jurisdiction. Such marking shall be done by the manufacturer. Field markings shall not be acceptable.

Exception: Markings shall not be required on nipples created from cutting and threading of approved pipe.

302.1.2 Standards. Standards listed or referred to in this chapter or other chapters cover materials that will conform to the requirements of this code, where used in accordance with the limitations imposed in this or other chapters thereof and their listing. Where a standard covers materials of various grades, weights, quality, or configurations, the portion of the listed standard that is applicable shall be used. Design and materials for special conditions or materials not provided for herein shall be permitted to be used by special permission of the Authority Having Jurisdiction after the Authority Having Jurisdiction has been satisfied as to their adequacy. A list of mechanical standards that appear in specific sections of this code is referenced in Table 1701.1. Standards referenced in Table 1701.1 shall be applied as indicated in the applicable referenced section. A list of additional approved standards, publications, practices and guides that are not referenced in specific sections of this code appear in Table 1701.2.

302.1.3 Existing Buildings. In existing buildings or premises in which mechanical installations are to be altered, repaired, or renovated, the Authority Having Jurisdiction has discretionary powers to permit deviation from the provisions of this code, provided that such proposal to deviate is first submitted for proper determination in order that health and safety requirements, as they pertain to mechanical systems, shall be observed.

302.2 Alternate Materials and Methods of Construction Equivalency. Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code. Technical documentation shall be submitted to the Authority Having
Jurisdiction to demonstrate equivalency. The Authority Having Jurisdiction shall have the authority to approve or disapprove the system, method, or device for the intended purpose.

However, the exercise of this discretionary approval by the Authority Having Jurisdiction shall have no effect beyond the jurisdictional boundaries of said Authority Having Jurisdiction. An alternate material or method of construction so approved shall not be considered as in accordance with the requirements, intent, or both of this code for a purpose other than that granted by the Authority Having Jurisdiction where the submitted data does not prove equivalency.

302.2.1 Testing. The Authority Having Jurisdiction shall have authority to require tests, as proof of equivalency.

302.2.1.1 Tests. Tests shall be made in accordance with approved testing standards, by an approved testing agency at the expense of the applicant. In the absence of such standards, the Authority Having Jurisdiction shall have the authority to specify the test procedure.

302.2.1.2 Request by the Authority Having Jurisdiction. The Authority Having Jurisdiction shall have the authority to require tests to be made or repeated where there is reason to believe that a material or device no longer is in accordance with the requirements on which its approval was based.

302.3 Alternative Engineered Design. An alternative engineered design shall comply with the intent of the provisions of this code and shall provide an equivalent level of quality, strength, effectiveness, fire resistance, durability, and safety. Material, equipment, or components shall be designed and installed in accordance with the manufacturer’s installation instructions.

302.3.1 Permit Application. The registered design professional shall indicate on the design documents that the mechanical system, or parts thereof, is an alternative engineered design so that it is noted on the construction permit application. The permit and permanent permit records shall indicate that an alternative engineered design was part of the approved installation.

302.3.2 Technical Data. The registered design professional shall submit sufficient technical data to substantiate the proposed alternative engineered design and to prove that the performance meets the intent of this code.

302.3.3 Design Documents. The registered design professional shall provide two complete sets of signed and sealed design documents for the alternative engineered design for submittal to the Authority Having Jurisdiction. The design documents shall include floor plans of the work. Where appropriate, the design documents shall indicate location, sizing, and loading of appurtenances, equipment, appliances, and devices.

302.3.4 Design Approval. An approval of an alternative engineered design shall be at the discretion of the Authority Having Jurisdiction. The exercise of this discretionary approval by the Authority Having Jurisdiction shall have no effect beyond the jurisdictional boundaries of said Authority Having Jurisdiction. An alternative engineered design so approved shall not be considered as in accordance with the requirements, intent, or both of this code for a purpose other than that granted by the Authority Having Jurisdiction.

302.3.5 Design Review. The Authority Having Jurisdiction shall have the authority to require testing of the alternative engineered design in accordance with Section 302.2.1, including the authority to require an independent review of the design documents by a registered design professional selected by the Authority Having Jurisdiction and at the expense of the applicant.

302.3.6 Inspection and Testing. The alternative engineered design shall be tested and inspected in accordance with the submitted testing and inspection plan and the requirements of this code.

303.0 Installation.

303.1 Listed Appliances. The installation of equipment and appliances regulated by this code shall be in accordance with the conditions of the listing, the manufacturer’s installation instructions and this code. The manufacturer’s installation and operating instructions shall be attached to the appliance. Clearances of listed equipment and appliances from combustible materials shall be as specified in the listing or on the rating plate.

303.2 Closet or Alcove Installations. Central heating furnaces and boilers installed in closets or alcoves shall be listed for such installation. Central heating furnaces not listed for closet or alcove installation shall be installed in a room or space having a volume not less than 12 times the total volume of the furnace. Central heating boilers not listed for closet or alcove installation shall be installed in a room or space having a volume 16 times the volume of the boiler. Where the ceiling height of the room or space exceeds 8 feet (2438 mm), the volume shall be calculated on the basis of an 8 foot (2438 mm) height.

The installation clearances shall be in accordance with the appliance listing, shall not be reduced, and shall be installed in accordance with Section 904.1.

303.3 Unlisted Appliances. Except as otherwise permitted in this code, unlisted equipment and appliances shall be approved by the Authority Having Jurisdiction prior to being installed. Unlisted equipment and appliances shall be installed in accordance with the manufacturer’s installation instructions and with clearances from combustible materials in accordance with Section 303.10 or Section 303.10.1.

303.4 Anchorage of Appliances. Appliances designed to be fixed in position shall be securely fastened in place in accordance with the manufacturer’s installation instructions. Supports for appliances shall be designed and constructed to sustain vertical and horizontal loads within the stress limitations specified in the building code.
303.5 Movement Restraining Device. Movement of appliances with casters shall be limited by a restraining device installed in accordance with the connector and appliance manufacturer’s installation instructions. [NFPA 54:9.6.1.4]

303.6 Identification of Equipment. Where more than one heating, cooling, ventilating, or refrigerating system is installed on the roof of a building or within a building, it shall be permanently identified as to the area or space served by the equipment.

303.7 Liquefied Petroleum Gas (LP-Gas) Facilities. Containers, container valves regulating equipment, and appurtenances for the storage and supply of liquefied petroleum gas shall be installed in accordance with NFPA 58.

303.8 Appliances on Roofs. Appliances on roofs shall be designed or enclosed so as to withstand climatic conditions in the area in which they are installed. Where enclosures are provided, each enclosure shall permit easy entry and movement, shall be of reasonable height, and shall have at least a 30 inch (762 mm) clearance between the entire service access panel(s) of the appliance and the wall of the enclosure. [NFPA 54:9.4.1.1]

303.8.1 Load Capacity. Roofs on which appliances are to be installed shall be capable of supporting the additional load or shall be reinforced to support the additional load. [NFPA 54:9.4.1.2]

303.8.2 Fasteners. All access locks, screws, and bolts shall be of corrosion-resistant material. [NFPA 54:9.4.1.3]

303.8.3 Installation of Appliances on Roofs. Appliances shall be installed in accordance with the manufacturer’s installation instructions. [NFPA 54:9.4.2.1]

303.8.4 Edge of Roof Clearance. Appliances shall be installed on a well-drained surface of the roof. At least 6 feet (1829 mm) of clearance shall be available between any part of the appliance and the edge of a roof or similar hazard, or rigidly fixed rails, guards, parapets, or other building structures at least 42 inches (1067 mm) in height shall be provided on the exposed side. [NFPA 54:9.4.2.2]

303.8.4.1 Guards and Rails. Guards or rails shall be required where the following exist:

1. The clearance between the appliance and a roof edge or open end of an equipment platform is less than 6 feet (1829 mm).
2. The open end of the equipment platform is located more than 30 inches (762 mm) above the roof, floor, or grade below.

Where guards or rails are installed, they shall be constructed so as to prevent the passage of a 21 inch (533 mm) diameter ball, resist the imposed loading conditions, and shall extend not less than 30 inches (762 mm) beyond each side of the equipment or appliance.

Exception: Guards shall not be required where a permanent fall arrest anchorage connector system in accordance with ASSP Z359.1 is installed.

303.8.5 Electrical Power. Appliances requiring an external source of electrical power for its operation shall be installed in accordance with NFPA 70, provided with the following:

1. A readily accessible electrical disconnecting means within sight of the appliance that completely de-energizes the appliance.
2. A 120-V ac grounding-type receptacle outlet on the roof adjacent to the appliance on the supply side of the disconnect switch. [NFPA 54:9.4.2.3]

303.8.6 Platform or Walkway. Where water stands on the roof at the appliance or in the passageways to the appliance, or where the roof is of a design having a water seal, a suitable platform, walkway, or both shall be provided above the water line. Such platform(s) or walkway(s) shall be located adjacent to the appliance and control panels so that the appliance can be safely serviced where water stands on the roof. [NFPA 54:9.4.2.4]

303.9 Avoiding Strain on Gas Piping. Appliances shall be supported and connected to the piping so as not to exert undue strain on the connections. [NFPA 54:9.1.4.16]

303.10 Clearances to Combustible Materials. Appliances and their vent connectors shall be installed with clearances from combustible material so their operation does not create a hazard to persons or property. Minimum clearances between combustible walls and the back and sides of various conventional types of appliances and their vent connectors are specified in Chapter 8 and Chapter 9, or NFPA 211. [NFPA 54:9.2.2] Where not provided in this code, listed and unlabeled equipment or appliances shall be installed to maintain the required clearances for servicing and to combustible construction in accordance with the listing and the manufacturer’s installation instructions.

303.10.1 Clearance Reduction. Reduced clearances to combustible construction for listed equipment and appliances shall comply with the listing and Table 303.10.1. Where permitted by the manufacturer, and not provided in this code, reduced clearances to combustible construction for unlabeled equipment and appliances shall comply with Table 303.10.1.

303.10.1.1 Type I Hood Exhaust System. Reduced clearances for Type I exhaust systems shall be in accordance with Section 507.4.2 through Section 507.4.2.3. Clearances from the duct or the exhaust fan to the interior surface of enclosures of combustible construction shall be in accordance with Section 510.7.3 and clearances shall not be reduced.

303.10.1.2 Product Conveying Ducts. Reduced clearances to combustibles construction for product conveying ducts shall be in accordance with Section 506.10.3 through Section 506.11.6.3.

303.10.1.3 Solid-Fuel Burning Appliances. For solid-fuel burning appliances, the clearance shall not be less than 12 inches (305 mm) to combustible walls and not less than 18 inches (457 mm) to combustible ceilings. The clearance, after reduction, shall be permitted to be less than 12 inches (305 mm) to combustible walls and less than 18 inches...
(457 mm) to combustible ceilings. Solid-fuel burning appliances listed for lesser clearances shall be permitted to be installed in accordance with the manufacturer’s instructions and their listing.

303.11 Installation in Commercial Garages. Appliances installed in commercial garages shall be in accordance with Section 303.11.1 through Section 303.11.2.

303.11.1 Parking Structures. Appliances installed in enclosed, basement, and underground parking structures shall be installed in accordance with NFPA 88A. [NFPA 54:9.1.11.1]

303.11.2 Repair Garages. Appliances installed in repair garages shall be installed in accordance with NFPA 30A. [NFPA 54:9.1.11.2]

303.12 Installation in Aircraft Hangars. Heaters in aircraft hangars shall be installed in accordance with NFPA 409. [NFPA 54:9.1.11.2]

304.0 Accessibility for Service.

304.1 General. All appliances shall be located with respect to building construction and other equipment so as to permit access for repair or replacement of the appliance. Sufficient clearance Clearance shall be maintained to permit removal of the appliance; cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls, and vent connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and the proper functioning of explosion vents, if provided. For attic installation, the passageway and servicing area adjacent to the appliance shall be floored in accordance with Section 304.4. [NFPA 54:9.2.1.1]

Unless otherwise specified, clearances of not less than 30 inches (762 mm) in depth, width, and height of working space shall be maintained.

Exception: A platform shall not be required for unit heaters or room heaters.

304.2 Sloped Roof. Where equipment or appliances that require service are installed on a roof having a slope of 4 units vertical in 12 units horizontal (33 percent slope) or more, a level platform of not less than 30 inches by 30 inches (762 mm by 762 mm) shall be provided at the service side of the appliance or equipment.

304.3 Access to Appliances on Roofs. Appliances located on roofs or other elevated locations shall be accessible. [NFPA 54:9.4.3.1]

304.3.1 Access from the Inside. Buildings of more than 15 feet (4572 mm) in height shall have an inside means of access to the roof unless other means acceptable to the Authority Having Jurisdiction are used. [NFPA 54:9.4.3.2]

304.3.1.1 Access Type. The inside means of access shall be a permanent or foldaway inside stairway or ladder, terminating in an enclosure, scuttle, or trapdoor. Such scuttles or trapdoors shall be at least 22 inches by 24 inches (559 mm by 610 mm) in size, shall open easily and safely under all conditions, especially snow, and shall be constructed so as to permit access from the roof side unless deliberately locked on the inside.

At least 6 feet (1829 mm) of clearance shall be available between the access opening and the edge of the roof or similar hazard, or rigidity fixed rails or guards a minimum of 42 inches (1067 mm) in height shall be provided on the exposed side. Where parapets or other building structures are utilized in lieu of guards or rails, they shall be a minimum of 42 inches (1067 mm) in height. [NFPA 54:9.4.3.3]

304.3.1.2 Permanent Ladders. Permanent ladders required by Section 304.3.1.1 shall be constructed in accordance with the following:

1. Side railings shall extend not less than 30 inches (762 mm) above the roof or parapet wall.
2. Landings shall not exceed 18 feet (5486 mm) apart measured from the finished grade.
3. Width shall be not less than 14 inches (356 mm) on center.
4. Rungs spacing shall not exceed 12 inches (305 mm) on center, and each rung shall be capable of supporting a 300 pound (136.1 kg) load.
5. Toe space shall be not less than 6 inches (152 mm).

304.3.2 Permanent Lighting. Permanent lighting shall be provided at the roof access. The switch for such lighting shall be located inside the building near the access means leading to the roof. [NFPA 54:9.4.3.4]

304.4 Appliances in Attics and Under-Floor Spaces. An attic or under-floor space in which an appliance is installed shall be accessible through an opening and passageway not less larger than the largest component of the appliance, and not less than 22 inches by 30 inches (559 mm by 762 mm). [NFPA 54:9.5.1]

304.4.1 Length of Passageway. Where the height of the passageway is less than 6 feet (1829 mm), the distance from the passageway access to the appliance shall not exceed 20 feet (6096 mm) measured along the centerline of the passageway. [NFPA 54:9.5.1.1] Where the height of the passageway is 6 feet (1829 mm) or more, the distance from the passageway access to the appliance shall not exceed 50 feet (15 240 mm) measured along the centerline of the passageway.

304.4.2 Width of Passageway. The passageway shall be unobstructed and shall have solid flooring not less than 24 inches (610 mm) wide from the entrance opening to the appliance. [NFPA 54:9.5.1.2]

304.4.3 Work Platform. A level working platform not less than 30 inches by 30 inches (762 mm by 762 mm) shall be provided in front of the service side of the appliance. [NFPA 54:9.5.2]

Exception: A working platform need not be provided where the furnace is capable of being serviced from the required access opening. The furnace service side shall not exceed 12 inches (305 mm) from the access opening.
304.4.4 Lighting and Convenience Outlet. A permanent 120 V receptacle outlet and a luminaire shall be installed near the appliance. The switch controlling the luminaire shall be located at the entrance to the passageway. [[NFPA 54:9.5.3]]

305.0 Location.

305.1 Installation in Residential Garages. Appliances in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit shall be installed so that all heating elements, switches, burners, and burner-ignition devices are located not less than 18 inches (457 mm) above the floor unless listed as flammable vapor ignition resistant.

Exception: Listed flammable vapor ignition resistant (FVIR) appliances. [[NFPA 54:9.1.10.1]]

305.1.1 Physical Damage. Appliances installed in garages, warehouses, or other areas subject to mechanical damage shall be guarded against such damage by being installed behind protective barriers or by being elevated or located out of the normal path of vehicles.

305.1.2 Access from the Outside. Where appliances are installed in a separate, enclosed space having access only from outside of the garage, such appliances shall be permitted to be installed at floor level, providing the required combustion air is taken from the exterior of the garage. [NFPA 54:9.1.10.3]

305.1.3 Cellulose Nitrate Plastic Storage. Heating equipment located in rooms where cellulose nitrate plastic is stored or processed shall be in accordance with the fire code.

305.2 Pit Location. Where excavation is necessary to install an appliance, the depth shall extend not less than 6 inches (152 mm) below and 12 inches (305 mm) on all sides of the appliance, except on the service side, which shall have 30 inches (762 mm). Where the depth of the excavation for either the appliance or passageway exceeds 12 inches (305 mm), walls shall be lined with concrete or masonry 4 inches (102 mm) above the adjoining ground level.

305.3 Flood Hazard Areas. For buildings located in flood hazard areas, heating, ventilating, air-conditioning, refrigeration, miscellaneous heat-producing, and energy-utilizing equipment and appliances shall be elevated at or above the elevation in accordance with the building code for utilities and attendant equipment or the elevation of the lowest floor, whichever is higher.

Exception: Equipment and appliances shall be permitted to be located below the elevation in accordance with the building code for utilities and attendant equipment or the elevation of the lowest floor, whichever is higher, provided that the systems are designed and installed to prevent water from entering or accumulating within their components and the systems are constructed to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to such elevation.

305.3.1 Coastal High Hazard Areas. Mechanical systems in buildings located in coastal high hazard areas shall be in accordance with the requirements of Section 305.3, and mechanical systems, pipes, and appurtenances shall not be mounted on or penetrate through walls that are intended to breakaway under flood loads in accordance with the building code.

305.3.2 Air Exhaust and Intake Openings. Outside air exhaust openings and air intake openings shall be located at or above the elevation required by the building code for utilities and attendant equipment or the elevation of the lowest floor, whichever is higher.

305.4 Elevator Shaft. Unless required for the functionality and safety of the elevator system, mechanical systems shall not be located in an elevator shaft.

305.5 Drainage Pan. Where a water heater is located in an attic, in or on an attic ceiling assembly, floor-ceiling assembly, or floor-subfloor assembly or where damage results from a leaking water heater, a watertight pan of corrosion-resistant materials shall be installed beneath the water heater in accordance with the following:

1. The drainage pan shall be provided, with not less than 3⁄4 of an inch (20 mm) diameter drain to an approved location. The terminating end of the drainpipe shall be readily visible.
2. The drainage pan shall be not less than 1 1⁄2 inches (38 mm) in depth.
3. Where a drainage pan pipe is installed, the material of the piping shall be rated for the temperature rating of the water heater and shall be approved for use with the liquid being discharged.
4. Discharge from a relief valve into a drainage pan shall be prohibited.

305.6 Outdoor Locations. Appliances installed in outdoor locations shall be in accordance with the following:

1. Listed for outdoor installation.
2. Provided with approved protection from the outdoor elements that can affect the operation, durability, or safety of such appliances and in accordance with the manufacturer’s installation instructions.
3. Outdoor cooking appliances shall comply with Section 923.0.

306.0 Automatic Control Devices.

306.1 General. Heating appliances shall be equipped with a listed device or devices that will shut off the fuel supply to the main burner or burners in the event of pilot or ignition failure. Liquefied petroleum gas-air-burning heating appliances shall be equipped with a listed automatic device or devices that will shut off the flow of gas to the pilot in the event of ignition failure.

Exception: The listed shutoff devices shall not be required on range or cooking tops, log lighters, lights, or other open-burner manually operated appliances, or listed appliances not requiring such devices and specific industrial appliances as approved by the Authority Having Jurisdiction.
GENERAL REGULATIONS

Heating appliances whose manual fuel controls are not readily accessible from the main portion of the building being heated shall be equipped with remote controls.

Forced-air and gravity-type warm air furnaces shall be equipped with a listed air outlet temperature limit control that cannot be set for temperatures exceeding 250°F (121°C). Such controls shall be located in the bonnet or plenum, within 2 feet (610 mm) of the discharge side of the heating element of gravity furnaces or in accordance with the conditions of listing.

Electric duct heaters shall be equipped with an approved automatic reset air outlet temperature limit control that will limit the outlet air temperature to not exceed 200°F (93°C). The electric elements of the heater shall be equipped with fusible links or a manual reset temperature limit control that will prevent outlet air temperature in excess of 250°F (121°C).

307.0 Labeling.

307.1 Fuel-Burning Appliances. Fuel-burning heating appliances shall bear a permanent and legible factory-applied nameplate on which shall appear:
(1) The name or trademark of the manufacturer.
(2) The approved fuel input rating of the appliance, expressed in Btu/h (kW).
(3) The model number or equivalent.
(4) The serial number.
(5) Instructions for the lighting, operation, and shutdown of the appliance.
(6) The type of fuel approved for use with the appliance.
(7) The symbol of an approved agency certifying compliance of the equipment with recognized standards.
(8) Required clearances from combustible surfaces on which or adjacent to which it is permitted to be mounted.

307.2 Electric Heating Appliances. Electric heating appliances shall bear a permanent and legible factory-applied nameplate on which shall appear:
(1) The name or trademark of the manufacturer.
(2) The model number or equivalent.
(3) The serial number.
(4) The electrical rating in volts, amperes (or watts), and, for other than single phase, the number of phases.
(5) The output rating in Btu/h (kW).
(6) The electrical rating in volts, amperes, or watts of each field replaceable electrical component.
(7) The factory test pressures or pressures applied.

Heat pumps and electric cooling appliances shall bear a permanent and legible factory-applied nameplate on which shall appear:
(1) The name or trademark of the manufacturer.
(2) The model number or equivalent.
(3) The serial number.
(4) The amount of refrigerant, and type of
(5) The refrigerant designation.
(6) The type of fuel approved for use with the unit.
(7) Cooling capacity Btu/h (kW).
(8) Required clearances from combustible surfaces on which or adjacent to which it is permitted to be mounted.
(9) The symbol of an approved agency certifying compliance of the equipment with recognized standards.
(10) The symbol of an approved agency certifying compliance of the equipment with recognized standards.
(11) Required clearances from combustible surfaces on which or adjacent to which it is permitted to be mounted.

307.3 Heat Pump and Electric Cooling Appliances.

307.4 Absorption Units. Absorption units shall bear a permanent and legible factory-applied nameplate on which shall appear:
(1) The name or trademark of the manufacturer.
(2) The model number or equivalent.
(3) The serial number.
(4) The amount of refrigerant, and type of
(5) The refrigerant designation.
(6) The type of fuel approved for use with the unit.
(7) Cooling capacity Btu/h (kW).
(8) Required clearances from combustible surfaces on which or adjacent to which it is permitted to be mounted.
(9) The symbol of an approved agency certifying compliance of the equipment with recognized standards.

308.0 Improper Location.

308.1 General. Piping or equipment shall not be so located as to interfere with the normal use thereof or with the normal operation and use of windows, doors, or other required facilities.

309.0 Workmanship.

309.1 Engineering Practices. Design, construction, and workmanship shall comply with accepted engineering practices and shall be of such character as to secure the results sought to be obtained by this code.
309.2 Concealing Imperfections. It shall be unlawful to conceal cracks, holes, or other imperfections in materials by welding, brazing, or soldering, by using therein or thereon paint, wax, tar, solvent cement, other leak-sealing or repair agent.

309.3 Installation Practices. Mechanical systems shall be installed in a manner that is in accordance with this code, applicable standards, and the manufacturer’s installation instructions.

310.0 Condensate Wastes and Control.

310.1 Condensate Disposal. Condensate from air washers, air-cooling coils, condensing appliances, and the overflow from evaporative coolers and similar water-supplied equipment or similar air-conditioning equipment shall be collected and discharged to an approved plumbing fixture or disposal area. Where discharged into the drainage system, equipment shall drain by means of an indirect waste pipe. The waste pipe shall have a slope of not less than 1/8 inch per foot (10.4 mm/m) or 1 percent slope and shall be of approved corrosion-resistant material not smaller than the outlet size in accordance with Section 310.3 or Section 310.4 for air-cooling coils or condensing appliances, respectively. Condensate or wastewater shall not drain over a public way.

310.1.1 Condensate Pumps. Where approved by the Authority Having Jurisdiction, condensate pumps shall be installed in accordance with the manufacturer’s installation instructions. Pump discharge shall rise vertically to a point where it is possible to connect to a gravity condensate drain and discharged to an approved disposal point. Each condensing unit shall be provided with a separate sump and interlocked with the equipment to prevent the equipment from operating during a failure. Separate pumps shall be permitted to connect to a single gravity indirect waste where equipped with check valves and approved by the Authority Having Jurisdiction.

310.2 Condensate Control. Where any equipment or appliance is installed in a space where damage is capable of resulting from condensate overflow, a drain line shall be provided and shall be drained in accordance with Section 310.1. An additional protection method for condensate overflow shall be provided in accordance with one of the following:

1. A water level detecting device that will shut off the equipment or appliance in the event the primary drain is blocked. Such detecting device shall be in accordance with the manufacturer’s installation instructions.

2. An additional watertight pan of corrosion-resistant material, with a separate drain line, installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain.

3. An additional separate drain line at a level that is higher than the primary drain line connection of the drain pan.

4. An additional watertight pan of corrosion-resistant material with a water level detection device installed beneath the cooling coil, unit, or the appliance to catch the overflow condensate due to a clogged primary condensate drain and to shut off the equipment.

The additional pan or the additional drain line connection shall be provided with a drain pipe of not less than 3/4 of an inch (20 mm) nominal pipe size, discharging at a point that is readily observed.

310.2.1 Protection of Appurtenances. Where insulation or appurtenances are installed where damage is capable of resulting from a condensate drain pan overfill, such installations shall occur above the rim of the drain pan with supports. Where the supports are in contact with the condensate waste, the supports shall be of approved corrosion-resistant material.

310.3 Condensate Waste Pipe Material and Sizing. Condensate waste pipes from air-cooling coils shall be sized in accordance with the equipment capacity as specified in Table 310.3. The material of the piping shall comply with the pressure and temperature rating of the appliance or equipment, and shall be approved for use with the liquid being discharged.

\[ \text{Table 310.3 MINIMUM CONDENSATE PIPE SIZE} \]

<table>
<thead>
<tr>
<th>EQUIPMENT CAPACITY IN TONS OF REFRIGERATION</th>
<th>MINIMUM CONDENSATE PIPE DIAMETER (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 20</td>
<td>3/8</td>
</tr>
<tr>
<td>21 – 40</td>
<td>1</td>
</tr>
<tr>
<td>41 – 90</td>
<td>1/2</td>
</tr>
<tr>
<td>91 – 125</td>
<td>1 1/4</td>
</tr>
<tr>
<td>126 – 250</td>
<td>2</td>
</tr>
</tbody>
</table>

For SI units: 1 ton of refrigeration = 3.52 kW, 1 inch = 25 mm

The size of condensate waste pipes is for one unit or a combination of units, or as recommended by the manufacturer. The capacity of waste pipes assumes a 3/8 inch per foot (10.4 mm/m) or 1 percent slope, with the pipe running three-quarters full at the following pipe conditions:

<table>
<thead>
<tr>
<th>Outside Air – 20%</th>
<th>Room Air – 80%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>DB</td>
<td>WB</td>
</tr>
<tr>
<td>90°F</td>
<td>73°F</td>
</tr>
<tr>
<td>75°F</td>
<td>62.5°F</td>
</tr>
</tbody>
</table>

Condensate drain sizing for other slopes or other conditions shall be approved by the Authority Having Jurisdiction.

310.3.1 Cleanouts. Condensate drain lines shall be configured or provided with a cleanout to permit the clearing of blockages and for maintenance without requiring the drain line to be cut.

310.4 Appliance Condensate Drains. Condensate drain lines from individual condensing appliances shall be sized as required by the manufacturer’s instructions. Condensate drain lines serving more than one appliance shall be approved by the Authority Having Jurisdiction prior to installation.
310.5 Point of Discharge. Air-conditioning condensate waste pipes shall connect indirectly, except where permitted in Section 310.6, to the drainage system through an air gap or air break to trapped and vented receptors, dry wells, mop sinks, or leach pits, or the tailpiece of plumbing fixtures. A condensate drain shall be trapped in accordance with the appliance manufacturer’s instructions or as approved.

**Exception:** Direct connections in accordance with Section 310.6.

310.6 Condensate Waste from Air-Conditioning Coils. Where the condensate waste from air-conditioning coils discharges by direct connection to a lavatory tailpiece or to an approved accessible inlet on a bathtub overflow, the connection shall be located in the area controlled by the same person controlling the air-conditioned space.

310.7 Female Plastic Fittings Connections. Female plastic screwed fittings shall be used with plastic male fittings and plastic male threads. Female plastic threaded connections shall not be allowed to be used when threaded onto a male metallic connection.

### 311.0 Heating or Cooling Air System.

311.1 Source. A heating or cooling air system shall be provided with return air, outside air, or both. A heating or cooling air system regulated by this code and designed to replace required ventilation shall be arranged to discharge into a conditioned space not less than the amount of outside air specified in Chapter 4.

311.2 Air Filters. Air filters shall be installed in a heating, cooling, or makeup air system. Media-type air filters shall comply with UL 900. Electrostatic and high efficiency particulate filters shall comply with Section 935.0.

**Exceptions:**

(1) Systems serving single guest rooms or dwelling units shall not require a listed filter.

(2) Air filters used in listed appliances and in accordance with the manufacturer’s instructions.

311.3 Prohibited Source. Outside or return air for a heating or cooling air system shall not be taken from the following locations:

(1) Less than 10 feet (3048 mm) in distance from an appliance vent outlet, a vent opening of a plumbing drainage system, or the discharge outlet of an exhaust fan, unless the outlet is 3 feet (914 mm) above the outside-air inlet.

(2) Less than 10 feet (3048 mm) above the surface of an abutting public way, sidewalk, street, alley, or driveway.

(3) A hazardous or insanitary location, or a refrigeration machinery room as defined in this code.

(4) An area, the volume of which is less than 25 percent of the entire volume served by such system, unless there is a permanent opening to an area the volume of which is equal to 25 percent of the entire volume served.

**Exception:** Such openings where used for a heating or cooling air system in a dwelling unit shall be permitted to be reduced to not less than 50 percent of the required area, provided the balance of the required return air is taken from a room or hall having not less than three doors leading to other rooms served by the furnace.

(5) A closet, bathroom, toilet room, or kitchen.

(6) Rooms or spaces containing a fuel-burning appliance therein. Where such room or space serves as source of return-air.

**Exceptions:**

(1) This shall not apply to fireplaces, fireplace appliances, residential cooking appliances, direct vent appliances, enclosed furnaces, and domestic-type clothes dryers installed within the room or space.

(2) This shall not apply to a gravity-type or listed vented wall heating or cooling air system.

(3) This shall not apply to a blower-type heating or cooling air system installed in accordance with the following requirements:

(a) Where the return air is taken from a room or space having a volume exceeding 1 cubic foot (0.03 m³) for each 10 Btu/h (0.003 kW) fuel input rating of fuel-burning appliances therein.

(b) Not less than 75 percent of the supply air is discharged back into the same room or space.

(c) Return-air inlets shall not be located within 10 feet (3048 mm) from an appliance firebox or draft diverter in the same enclosed room or confined space.

311.4 Return-Air Limitations. Return air from one dwelling unit shall not discharge into another dwelling unit through the heating or cooling air system.

312.0 Plumbing Connections.

312.1 General. Water supply, sanitary drainage, and backflow protection shall be in accordance with the plumbing code.

313.0 Hangers, and Supports, and Anchors.

313.1 General. Piping, tubing, appliances, and appurtenances shall be supported in accordance with this code, the manufacturer’s installation instructions, and in accordance with the Authority Having Jurisdiction. Seismic restraints shall be in accordance with the building code.

313.2 Material. Hangers, supports, and anchors shall be of sufficient strength to support the weight of the pipe or tubing and its contents. Piping or tubing shall be isolated from incompatible materials.

313.3 Suspended Piping. Suspended piping or tubing shall be supported at intervals not to exceed those shown in Table 313.3.

313.4 Alignment. Piping or tubing shall be supported in such a manner as to maintain its alignment and prevent sagging.

313.5 Underground Installation. Piping or tubing in the ground shall be laid on a firm bed for its entire length; where
other support is otherwise provided, it shall be approved in accordance with Section 302.0.

### 313.6 Hanger Rod Sizes

Hanger rod sizes shall be not smaller than those shown in Table 313.6.

#### TABLE 313.6 HANGER ROD SIZES

<table>
<thead>
<tr>
<th>PIPE AND TUBE SIZE (inches)</th>
<th>ROD SIZES (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ - 4</td>
<td>½</td>
</tr>
<tr>
<td>5 - 8</td>
<td>½</td>
</tr>
<tr>
<td>10 - 12</td>
<td>¾</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm

### 313.7 Gas Piping

Gas piping shall be supported by metal straps or hooks at intervals not to exceed those shown in Table 1310.3.5.1.

### 314.0 Balancing

#### 314.1 General

Heating, ventilating, and air-conditioning systems (including hydronic systems) shall be balanced in accordance with one of the following methods:

1. AABC National Standards for Total System Balance
2. ACCA Manual B
3. ASHRAE 111
4. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems
5. SMACNA HVAC Systems Testing, Adjusting, and Balancing

### 315.0 Louvers in Hurricane Prone Regions

#### 315.1 General

Louvers located in areas within hurricane-prone regions that are within 1 mile (2 km) of the coastal mean high water line where the basic wind speed is 110 mi/h (53.6 m/s) or more; or, portions of hurricane-prone regions where the basic wind speed is 120 mi/h (55.2 m/s) or more; or, Hawaii, as described in ASCE 7 shall be tested in accordance with Section 315.1.1 and Section 315.1.2.

#### 315.1.1 Testing

Louvers that protect intake or exhaust openings shall be tested in accordance with AMCA 550 for resistance to wind-driven rain.

#### 315.1.2 Impact Resistance Test

Upon request by the Authority Having Jurisdiction, louvers protecting intake and exhaust ventilation ducts that are not fixed in the open position and located within 30 feet (9144 mm) of the grade shall be tested for impact resistance in accordance with AMCA 540.

### 316.0 Protection of Piping, Tubing, Materials, and Structures

#### 316.1 General

Piping or tubing passing under or through walls shall be protected from breakage. Piping passing through or under cinders or other corrosive materials shall be protected from external corrosion in an approved manner. Approved provisions shall be made for expansion of hot water piping. Voids around piping or tubing passing through concrete floors on the ground shall be sealed.

#### 316.2 Installation

Piping or tubing shall be installed so that the piping, tubing, or connections will not be subject to undue strains or stresses, and provisions shall be made for expansion, contraction, and structural settlement. No piping or tubing, unless designed and listed for such use, shall be directly embedded in concrete or masonry. No structural member shall be seriously weakened or impaired by cutting, notchig, or otherwise as defined in the building code.

#### 316.3 Corrosion, Erosion, and Mechanical Damage

Piping or tubing subject to corrosion, erosion, or mechanical damage shall be protected in an approved manner.

#### 316.4 Protectively Coated Pipe

Protectively coated pipe or tubing shall be inspected and tested, and a visible void, damage, or imperfection to the pipe coating shall be repaired in an approved manner.

#### 316.5 Fire-Resistant Construction

Piping, tubing, and duct system penetrations of fire-resistance-rated walls, partitions, floors, roof/ceiling assemblies, roof/ceiling assemblies, or shaft enclosures shall be protected in accordance with the requirements of the building code.

#### 316.6 Steel Nail Plates

Plastic piping or tubing, copper or copper alloy piping or tubing, and ducts penetrating framing members to within 1 inch (25.4 mm) of the exposed framing shall be protected by steel nail plates not less than No. 18 gauge (0.0478 inches) (1.2141 mm) in thickness. The steel nail plate shall extend along the framing member not less than 1½ inches (38 mm) beyond the outside diameter of the pipe or tubing. **Exception:** See Fuel gas piping shall be protected in accordance with Section 1310.4.3.

#### 316.7 Sleeves

Sleeves shall be provided to protect piping through concrete and masonry walls and concrete floors. **Exception:** Sleeves shall not be required where openings are drilled or bored.

#### 316.7.1 Building Loads

Piping or tubing through concrete or masonry walls shall not be subject to a load from building construction.

#### 316.7.2 Exterior Walls

In exterior walls, annular space between sleeves and pipes or tubing shall be sealed and made watertight, as approved by the Authority Having Jurisdiction. A penetration through fire-resistive construction shall be in accordance with Section 316.5.

#### 316.8 316.7.3 Firewalls

A pipe sleeve through a firewall shall have the space around the pipe or tubing completely sealed with an approved fire-resistive material in accordance with other codes.

#### 316.9 Structural Members

A structural member weakened or impaired by cutting, notchig, or otherwise shall be reinforced, repaired, or replaced so as to be left in a safe structural condition in accordance with the requirements of the building code.
316.10 Rodentproofing. Mechanical system shall be constructed in such a manner as to restrict rodents or vermin from entering a building by following the ductwork from the outside into the building.

316.11 Metal Collars. In or on buildings where openings have been made in walls, floors, or ceilings for the passage of ductwork or pipes, such openings shall be closed and protected by the installation of approved metal collars securely fastened to the adjoining structure.

317.0 Trenching, Excavation, and Backfill.

317.1 Trenches. Trenches deeper than the footings of a building or structure, and paralleling the same, shall be located not less than 45 degrees (0.79 rad) from the bottom exterior edge of the footing, or as approved in accordance with Section 302.0.

317.2 Tunneling and Driving. Tunneling and driving shall be permitted to be done in yards, courts, or driveways of a building site. Where sufficient depth is available to permit, tunnels shall be permitted to be used between open-cut trenches.

Tunnels shall have a clear height of 2 feet (610 mm) above the pipe and shall be limited in length to one-half the depth of the trench, with a maximum length of 8 feet (2438 mm). Where pipes are driven, the drive pipe shall be not less than one size larger than the pipe to be laid.

317.3 Open Trenches. Excavations required to be made for the installation of a mechanical system or part thereof, within the walls of a building, shall be open trench work and shall be kept open until it has been inspected, tested, and accepted.

317.4 Excavations. Excavations shall be completely backfilled as soon after inspection as practicable. Precaution shall be taken to ensure compactness of backfill around piping without damage to such piping. Trenches shall be backfilled in thin layers to 12 inches (305 mm) above the top of the piping with clean earth, which shall not contain stones, boulders, cinderfill, frozen earth, construction debris, or other materials that will damage or break the piping or cause corrosive action. Mechanical devices such as bulldozers, graders, etc., shall be permitted to then be used to complete backfill to grade. Fill shall be properly compacted. Precautions shall be taken to ensure permanent stability for pipe laid in filled or made ground.
### TABLE 303.10.1
REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION

[NFPA 54: TABLE 10.2.3
10.2.4]

<table>
<thead>
<tr>
<th>TYPE OF PROTECTION APPLIED TO AND COVERING ALL SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION</th>
<th>WHERE THE REQUIRED CLEARANCE WITH NO PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE-WALL METAL PIPE IS:</th>
<th>ALLOWABLE CLEARANCES WITH SPECIFIED PROTECTION (INCHES)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ABOVE (COLUMN 1)</td>
<td>SIDES AND REAR (COLUMN 2)</td>
</tr>
<tr>
<td>(1) 3½ inch thick masonry wall without ventilated air space</td>
<td>—</td>
<td>24</td>
</tr>
<tr>
<td>(2) ½ of an inch insulation board over 1 inch glass fiber or mineral wool bats</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>(3) 0.024 inch (nominal 24 gauge) sheet metal over 1 inch glass fiber or mineral wool bats reinforced with wire on rear face with ventilated air space</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>(4) 3½ inch thick masonry wall with ventilated air space</td>
<td>—</td>
<td>12</td>
</tr>
<tr>
<td>(5) 0.024 inch (nominal 24 gauge) sheet metal with ventilated air space</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>(6) ½ of an inch thick insulation board with ventilated air space</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>(7) 0.024 inch (nominal 24 gauge) sheet metal with ventilated air space over 0.024 inch (nominal 24 gauge) sheet metal with ventilated air space</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>(8) 1 inch glass fiber or mineral wool bats sandwiched between two sheets 0.024 inch (nominal 24 gauge) sheet metal with ventilated air space</td>
<td>18</td>
<td>12</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm

**Notes:**

1. Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.
2. All clearances shall be measured from the outer surface of the combustible material to the nearest point on the surface of the appliance, disregarding any intervening protection applied to the combustible material.
3. Spacers and ties shall be of noncombustible material. No spacer or tie shall be used directly opposite the appliance or connector.
4. Where all clearance reduction systems use a ventilated air space, adequate provision for air circulation shall be provided as described. [See Figure 303.10.1(2) and Figure 303.10.1(3)]
5. At least 1 inch (25.4 mm) shall be between clearance reduction systems and combustible walls and ceilings for reduction systems using a ventilated air space.
6. Where a wall protector is installed on a single flat wall away from corners, it shall have a minimum 1 inch (25.4 mm) air gap. To provide adequate air circulation, the bottom and top edges, or only the side and top edges, or all edges shall be left open.
7. Mineral wool bats (blanket or board) shall have a minimum density of 8 pounds per cubic foot (lb/ft³) (128 kg/m³) and a minimum melting point of 1500°F (816°C).
8. Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 0.04 British thermal unit inch per hour square foot degree Fahrenheit (Btu•in/(h•ft²•°F)) (0.1W/(m•K)) or less.
9. At least 1 inch (25.4 mm) shall be between the appliance and the protector. In no case shall the clearance between the appliance and the combustible surface be reduced below that allowed in Table 303.10.1.
10. All clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.
11. Listed single-wall connectors shall be installed in accordance with the manufacturer’s installation instructions.
Figure 303.10.1(1)1, 2, 3

Extent of protection necessary to reduce clearances from gas appliance or vent connectors

Notes:
1. A – Equals the clearance with no protection specified in Table 802.7.3.3 and Table 904.3.2 and in the sections applying to various types of equipment.
2. B – Equals the reduced clearance permitted in accordance with Table 303.10.1.
3. The protection applied to the construction using combustible material shall extend far enough in each direction to make C equal to A.

For SI units: 1 inch = 25.4 mm

Figure 303.10.1(3)

Masonry clearance reduction system

Notes:
(1) Masonry walls can be attached to combustible walls using wall ties.
(2) Spacers shall not be used directly behind appliance or connector.
<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>TYPES OF JOINTS</th>
<th>HORIZONTAL</th>
<th>VERTICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast</td>
<td>Lead and Oakum</td>
<td>5 feet, except 10 feet where 10 foot lengths are installed(^1,2,3)</td>
<td>Base and each floor, not to exceed 15 feet</td>
</tr>
<tr>
<td></td>
<td>Compression Gasket</td>
<td>Every other joint, unless over 4 feet then support each joint(^1,2,3)</td>
<td>Base and each floor, not to exceed 15 feet</td>
</tr>
<tr>
<td>Cast-Iron Hubless</td>
<td>Shielded Coupling</td>
<td>Every other joint, unless over 4 feet then support each joint(^1,2,3,4)</td>
<td>Base and each floor, not to exceed 15 feet</td>
</tr>
<tr>
<td>Copper &amp; Copper Alloys</td>
<td>Soldered, Brazed, Threaded, or Mechanical</td>
<td>1½ inches and smaller, 6 feet; 2 inches and larger, 10 feet</td>
<td>Each floor, not to exceed 10 feet(^5)</td>
</tr>
<tr>
<td>Steel Pipe for Water DWV</td>
<td>Threaded or Welded</td>
<td>½ inch and smaller, 10 feet; 1 inch and larger, 12 feet</td>
<td>Every other floor, not to exceed 25 feet(^5)</td>
</tr>
<tr>
<td>Steel Pipe for Gas</td>
<td>Threaded or Welded</td>
<td>½ inch, 6 feet; ¾ inch and 1 inch, 8 feet; 1½ inches and larger, 10 feet</td>
<td>½ inch, 6 feet; ¼ inch and 1 inch, 8 feet; 1½ inches every floor level</td>
</tr>
<tr>
<td>Schedule 40 PVC and ABS</td>
<td>Solvent Cemented</td>
<td>All sizes, 4 feet; allow for expansion every 30 feet(^3)</td>
<td>Base and each floor; provide mid-story guides; provide for expansion every 30 feet</td>
</tr>
<tr>
<td>CPVC</td>
<td>Solvent Cemented</td>
<td>1 inch and smaller, 3 feet; 1½ inches and larger, 4 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
<tr>
<td>CPVC-AL-CPVC</td>
<td>Solvent Cemented</td>
<td>½ inch, 5 feet; ¾ inch, 65 inches; 1 inch, 6 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
<tr>
<td>Lead</td>
<td>Wiped or Burned</td>
<td>Continuous Support</td>
<td>Not to exceed 4 feet</td>
</tr>
<tr>
<td>Steel</td>
<td>Mechanical</td>
<td>In accordance with standards acceptable to the Authority Having Jurisdiction</td>
<td></td>
</tr>
<tr>
<td>PEX</td>
<td>Cold Expansion, Insert and Compression</td>
<td>1 inch and smaller, 32 inches; 1½ inches and larger, 4 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
<tr>
<td>PEX-AL-PE</td>
<td>Metal insert and metal compression</td>
<td>(\frac{3}{4}) inch, 3 inch (\frac{3}{4}) inch</td>
<td>All sizes 98 inches</td>
</tr>
<tr>
<td>PE-AL-PE</td>
<td>Metal insert and metal compression</td>
<td>(\frac{3}{4}) inch, 1 inch (\frac{3}{4}) inch</td>
<td>All sizes 98 inches</td>
</tr>
<tr>
<td>PE-RT</td>
<td>Insert and Compression</td>
<td>1 inch and smaller, 32 inches; 1½ inches and larger, 4 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>Fusion weld (socket, butt, saddle, electrofusion), threaded (metal threads only), or mechanical</td>
<td>1 inch and smaller, 32 inches; 1½ inches and larger, 4 feet</td>
<td>Base and each floor; provide mid-story guides</td>
</tr>
</tbody>
</table>

For SI unit: 1 inch = 25.4 mm, 1 foot = 304.8 mm

Notes:
1 Support adjacent to joint, not to exceed 18 inches (457 mm).
2 Brace not to exceed 40 feet (12 192 mm) intervals to prevent horizontal movement.
3 Support at each horizontal branch connection.
4 Hangers shall not be placed on the coupling.
5 Vertical water lines shall be permitted to be supported in accordance with recognized engineering principles with regard to expansion and contraction, where first approved by the Authority Having Jurisdiction.
CHAPTER 4
VENTILATION AIR

401.0 General.

401.1 Applicability. This chapter contains requirements for ventilation air supply, exhaust, and makeup air requirements for occupiable spaces within a building. Spaces within buildings, except those within a dwelling unit in residential occupancies where occupants are nontransient, shall comply with Section 402.0 through Section 404.0. Requirements for ventilation air rate for dwelling units in residential occupancies, where the occupants are nontransient, shall be in accordance with Section 405.0.

401.2 Indoor Swimming Pools. The design of ventilation systems serving an indoor aquatic facility (natatorium) shall comply with the Uniform Swimming Pool, Spa and Hot Tub Code (USPSHTC).

402.0 Ventilation Air.

402.1 Occupiable Spaces. Occupiable spaces listed in Table 402.1 shall be designed to have ventilation (outdoor) air for occupants in accordance with this chapter.

402.1.1 Construction Documents. The outdoor air ventilation rate and air distribution assumptions made in the design of the ventilation system shall be clearly identified on the construction documents.

402.1.2 Ventilation in Health Care Facilities. Mechanical ventilation for health care facilities shall be designed and installed in accordance with this code, and ASHRAE 170, and NFPA 99.

402.2 Natural Ventilation Procedure. Natural ventilation systems shall comply with the requirements of either Section 402.2.1 through Section 402.2.1.6(A) or Section 402.2.2. Designers shall provide interior air barriers, insulation, or other means that separate naturally ventilated spaces from mechanically cooled spaces to prevent high-dew-point outdoor air from coming into contact with mechanically cooled surfaces. [ASHRAE 62.1:6.4.4.1]

402.2.1 Prescriptive Compliance Path. Any zone designed in accordance with this section and for natural ventilation shall include a mechanical ventilation system designed in accordance with Section 403.0, or both.

Exceptions:

(1) An engineered natural ventilation system where approved by the Authority Having Jurisdiction need not comply with Section 402.2.

(2) The mechanical ventilation systems shall not be required where:

(a) Zones in buildings that have all of the following:

(b) Controls that prevent the natural ventilation openings from being closed during periods of expected occupancy, or natural ventilation openings that are permanently open.

(2) Zones that are not served by heating or cooling equipment.

402.2.1.4 402.2.1.5 Ceiling Height. The ceiling height, H, to be used in Section 402.2.1.1 through Section 402.2.1.3 shall be the minimum ceiling height in the space. For ceilings that are parallel to the floor, the ceiling height (H) to be used in Section 402.2.1.3 through Section 402.2.1.5 shall be the minimum ceiling height in the zone.

Exception: For ceilings that are increasing in height zones where ceiling height increases as distance from the openings is increased, the ceiling height shall be determined as the average height of the ceiling within 20 feet (6096 mm) from the operable openings. [ASHRAE 62.1:6.4.4.1.1]

402.2.2.1 402.2.1.3 Ceiling Height. The ceiling height, H, to be used in Section 402.2.1.1 through Section 402.2.1.3 shall be the minimum ceiling height in the space. For ceilings that are parallel to the floor, the ceiling height (H) to be used in Section 402.2.1.3 through Section 402.2.1.5 shall be the minimum ceiling height in the zone.

Exception: For ceilings that are increasing in height zones where ceiling height increases as distance from the openings is increased, the ceiling height shall be determined as the average height of the ceiling within 20 feet (6096 mm) from the operable openings. [ASHRAE 62.1:6.4.4.1.1]

402.2.1.4 402.2.1.3 Single Side Opening. For spaces with operable openings on only one side of the space, the naturally ventilated area shall extend to a distance not greater than 2 times the height of the ceiling from the operable openings shall be not more than 2H, where H is the ceiling height. [ASHRAE 62.1:6.4.4.1.3]

402.2.1.4 402.2.1.4 Double Side Opening. For spaces with operable openings on two opposite sides of the space, the naturally ventilated area shall extend between distance from the operable openings shall be not more than 5H, where H is the ceiling height separated by a distance not greater than than 5 times the height of the ceiling. [ASHRAE 62.1:6.4.4.1.4]

402.2.1.3 402.2.1.5 Corner Openings. For spaces with operable openings on two adjacent
sides of a space zone, the distance from the operable openings shall be not more than $5H$ along a line drawn between the two openings that are farthest apart. Floor area outside that line shall comply with Section 402.2.1.1. [ASHRAE 62.1:6.4.1.6]  

**402.2.1.6 Location and Size of Openings.** Spaces Zones or portions of spaces zones to be naturally ventilated shall have a permanently open airflow path to openings directly connected to the outdoors. The minimum flow rate to the zone shall be determined in accordance with Section 402.2.1. The operable area shall be not less than 4 percent of the net occupiable floor area. Where openings are covered with louveres or otherwise obstructed, operable area shall be based on the net free unobstructed area through the opening. Where interior rooms, or portions of rooms, without direct openings to the outdoors are ventilated through adjoining rooms, the opening between rooms shall be permanently unobstructed and have a free area of not less than 8 percent of the area of the interior room or less than 25 square feet (2.3 m²). This flow rate shall be used to determine the required operable area of openings, accounting only for buoyancy-driven flow. Wind-driven flow shall be used only where it can be demonstrated that the minimum flow rate is provided during all occupied hours. Openings shall be sized in accordance with Section 402.2.1.6(A). Permanently open airflow path shall include, but not be limited to, pathways that would allow airflow unimpeded by partitions, walls, and furnishings. [ASHRAE 62.1:6.4.1.6.1]  

**402.2.1.6(A) Sizing Openings.** Where the zone is ventilated using a single opening or multiple single openings located at the same elevation, the operable area as a percent of the net occupiable floor area shall be greater than or equal to the value indicated in Table 402.2.1.6(A)(1). Where the zone is ventilated using two openings located at different elevations or multiple pairs of such openings, the operable area as a percent of the net occupiable floor area shall be greater than or equal to the value indicated in Table 402.2.1.6(A)(2). Where openings are obstructed by louveres or screens, the operable area shall be based on the net free area of the opening. Where interior zones, or portions of zones, without direct openings to the outdoors are ventilated through adjoining zones, the opening between zones shall be permanently unobstructed and have a free area of not less than twice the percent of occupiable floor area used to determine the opening size of adjacent exterior zones, or 25 square feet (2.3 m²), whichever is greater. Table 402.2.1.6(A)(1) and Table 402.2.1.6(A)(2) are based on buoyancy-driven flow and shall not address thermal comfort. [ASHRAE 62.1:6.4.1.6.1]  

### Table 402.2.1.6(A)(1)  
<table>
<thead>
<tr>
<th>$\frac{Vbz}{Az}$ ≤ (L/s/m²)</th>
<th>$\frac{Vbz}{Az}$ ≤ (cfm/ft²)</th>
<th>TOTAL OPENABLE AREAS IN ZONE AS A PERCENTAGE OF Az</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS/WS ≤ 0.1</td>
<td>0.1 &lt; HS/WS ≤ 1</td>
<td>HS/WS &gt; 1</td>
</tr>
<tr>
<td>1.0</td>
<td>0.2</td>
<td>4.0</td>
</tr>
<tr>
<td>2.0</td>
<td>0.4</td>
<td>6.9</td>
</tr>
<tr>
<td>3.0</td>
<td>0.6</td>
<td>9.5</td>
</tr>
<tr>
<td>4.0</td>
<td>0.8</td>
<td>12.0</td>
</tr>
<tr>
<td>5.5</td>
<td>1.1</td>
<td>15.5</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.0283 m³/min, 1 square foot = 0.0929 m²

Where:
- $Vbz$ = breathing zone outdoor airflow, per Table 402.1.
- $Az$ = zone floor area, the net occupiable floor area of the ventilation zone.
- $HS/WS$ = aggregated width of all single outdoor openings located at the same elevation.
- $Hvs$ = vertical dimension of the single opening or the least vertical dimension of the openings where there are multiple openings.

* Volumetric airflow rates used to estimate required operable area are based on the following:
  - Dry-air density of 0.075 lbda/ft³ (1.2 kgda/m³) at a barometric pressure of 1 atm (101.3 kPa) and an air temperature of 70°F (21°C)
  - Temperature difference between indoors and outdoors of 1.8°F (1°C)
  - Gravity constant of 32.2 ft/s² (9.81 m/s²)
  - Window discharge coefficient of 0.6

### Table 402.2.1.6(A)(2)  
<table>
<thead>
<tr>
<th>$\frac{Vbz}{As}$ ≤ (cfm/ft²)</th>
<th>TOTAL OPENABLE AREAS IN ZONE AS A PERCENTAGE OF Az</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS/WS ≤ 0.1</td>
<td>0.1 &lt; HS/WS ≤ 1</td>
</tr>
<tr>
<td>1.0</td>
<td>0.2</td>
</tr>
<tr>
<td>2.0</td>
<td>0.4</td>
</tr>
<tr>
<td>3.0</td>
<td>0.6</td>
</tr>
<tr>
<td>4.0</td>
<td>0.8</td>
</tr>
<tr>
<td>5.5</td>
<td>1.1</td>
</tr>
</tbody>
</table>

For SI unit: 1 foot = 304.8 mm

Where:
- $Vbz$ = breathing zone outdoor airflow, per Table 402.1.
- $As$ = zone floor area, the net occupiable floor area of the ventilation zone.
- $Hvs$ = vertical separation between the center of the top and bottom openings’ free operable area; in case of multiple horizontally spaced pairs of openings, use shortest distance encountered.
- $Vbz$ = operable area of smallest opening (top or bottom); in case of multiple horizontally spaced pairs of top-and-bottom openings, use aggregated areas.

* Volumetric airflow rates used to estimate required operable area are based on the following:
  - Dry-air density of 0.075 lbda/ft³ (1.2 kgda/m³) at a barometric pressure of 1 atm (101.3 kPa) and an air temperature of 70°F (21°C)
  - Temperature difference between indoors and outdoors of 1.8°F (1°C)
  - Gravity constant of 32.2 ft/s² (9.81 m/s²)
  - Window discharge coefficient of 0.6
402.2.2 Engineered System Compliance Path. For an engineered natural ventilation system, the following shall be included:

1. Determine hourly environmental conditions, including outdoor air dry-bulb temperature; dew-point temperature; outdoor concentration of contaminants, including PM2.5, PM10, and ozone where data are available; wind speed and direction; and internal heat gains during expected hours of natural ventilation operation.

2. Determine the effect of pressure losses along natural ventilation airflow paths on the resulting flow rates, including inlet openings, air transfer grills, ventilation stacks, and outlet openings during representative conditions of expected natural ventilation system use.

3. Quantify natural ventilation airflow rates of identified airflow paths accounting for wind induced and thermally induced driving pressures during representative conditions of expected natural ventilation system use.

4. Design to provide outdoor air in quantities sufficient to result in acceptable IAQ as established under Section 403.2.1 or ASHRAE 62.1 during representative conditions of expected natural ventilation system use. [ASHRAE 62.1:6.4.2]

402.2.3 Control and Accessibility. The means to open required operable openings shall be readily accessible to building occupants whenever the space is occupied. Controls shall be designed to coordinate operation of the natural and mechanical ventilation systems. [ASHRAE 62.1:6.4.3]

402.3 Mechanical Ventilation. Where natural ventilation is not permitted by this section or the building code, mechanical ventilation systems shall be designed, constructed, and installed to provide a method of supply air and exhaust air. Mechanical ventilation systems shall include controls, manual or automatic, that enable the fan system to operate whenever the spaces served are occupied. The system shall be designed to maintain minimum outdoor airflow as required by Section 403.0 under any load conditions.

402.4 Outdoor Air Intake Protection. Required outdoor-air intakes shall be covered with a corrosion-resistant screen having not more than ⅛ of an inch (6.4 mm) openings, and shall have not more than ⅛ of an inch (12.7 mm) openings.

402.4.1 Weather Protections. Outdoor air intakes that are part of the mechanical ventilation system shall be designed to manage rain entrainment, to prevent rain intrusion, and manage water from snow in accordance with ASHRAE 62.1.

403.0 Ventilation Rates.

403.1 General. The design outdoor air intake flow rate for a ventilation system shall be determined in accordance with Section 403.2 through Section 403.9.4.

403.2 Zone Calculations. Ventilation zone parameters shall be determined in accordance with Section 403.2.1 through Section 403.2.3 for each ventilation zone served by the ventilation system, except that the ventilation rates from ASHRAE/ASHE 170 shall be used for the occupancy categories, as applicable. [ASHRAE 62.1:6.2.2.1]

403.2.1 Breathing Zone Outdoor Airflow. The outdoor airflow required in the breathing zone \( V_{bz} \) of the occupiable space or spaces in a ventilation zone shall be not less than the value determined in accordance with Equation 403.2.1.

\[
V_{bz} = R_p \cdot P_z + R_a \cdot A_z \tag{Equation 403.2.1}
\]

Where:

\( A_z = \) zone floor area, the net occupiable floor area of the ventilation zone, square feet (m²).

\( P_z = \) zone population, the number of people in the ventilation zone during typical usage.

\( R_p = \) outdoor airflow rate required per person as determined from Table 402.1.

\( R_a = \) outdoor airflow rate required per unit area as determined from Table 402.1. [ASHRAE 62.1:6.2.2.1]

403.2.2 Zone Air Distribution Effectiveness. The zone air distribution effectiveness \( (E_z) \) shall be not greater than the default value determined in accordance with Table 403.2.2. [ASHRAE 62.1:6.2.1.2]

403.2.2.1 Stratified Air Distribution Systems. A stratified air distribution system shall be designed in accordance with Section 403.2.2.1.1 through Section 403.2.2.2.2, or the zone air distribution effectiveness \( (E_z) \) shall be determined in accordance with ASHRAE 62.1. [ASHRAE 62.1:6.2.1.2.1]

403.2.2.1.1 Supply Air. Cool air shall be at least 4°F (2°C) less than the average room air temperature. [ASHRAE 62.1:6.2.1.2.1.1]

403.2.2.1.2 Return Air. The return air openings or pathways shall be located not less than 9 feet (2.8 m) above the floor. [ASHRAE 62.1:6.2.1.2.1.2]

403.2.2.1.3 Stratification. The zone shall not contain any devices that mechanically mix the air, and shall be protected from impinging airstreams from adjacent ventilation zones. [ASHRAE 62.1:6.2.1.2.1.3]

403.2.2.2 Personalized Ventilation Systems. A personalized ventilation system shall be designed in accordance with the following subsections, or the zone air distribution effectiveness \( (E_z) \) shall be determined in accordance with ASHRAE 62.1. [ASHRAE 62.1:6.2.1.2.2]

403.2.2.2.1 Personalized Air. The personalized air shall be distributed in the breathing zone and designed such that the velocity is equal to or less than 50 feet per minute (0.25 m/s) at the head/facial region of the occupant. [ASHRAE 62.1:6.2.1.2.2.1]
403.2.2.2 Return Air. The return air openings or pathways shall be located more than 9 feet (2.8 m) above the floor. [ASHRAE 62.1:6.2.1.2.2.2]

403.2.3 Zone Outdoor Airflow. The zone outdoor airflow ($V_{oz}$) provided to the ventilation zone by the supply air distribution system shall be determined in accordance with Equation 403.2.3. [ASHRAE 62.1:6.2.2.3]

$$V_{oz} = V_{bz}/E_z$$

(Equation 403.2.3)

403.3 Single-Zone Systems. For ventilation systems where one or more air handlers supply a mixture of outdoor air and recirculated air to only one ventilation zone, the outdoor air intake flow ($V_{ot}$) shall be determined in accordance with Equation 403.3. [ASHRAE 62.1:6.2.3]

$$V_{ot} = V_{oz}$$

(Equation 403.3)

403.4 One Hundred Percent Outdoor Air Systems. For ventilation systems where one or more air handlers supply only outdoor air to one or more ventilation zones, the outdoor air intake flow ($V_{ot}$) shall be determined in accordance with Equation 403.4. [ASHRAE 62.1:6.2.4.1]

$$V_{ot} = \sum_{all\ zones} V_{oz}$$

(Equation 403.4)

403.5 Multiple-Zone Recirculating Systems. For ventilation systems where one or more air handlers supply a mixture of outdoor air and recirculated air to more than one ventilation zone, the outdoor air intake flow ($V_{ot}$) shall be determined in accordance with Section 403.5.1 through Section 403.5.2. [ASHRAE 62.1:6.2.5.4]

403.5.1 Uncorrected Outdoor Air Intake. The uncorrected outdoor air intake ($V_{ou}$) flow shall be determined in accordance with Equation 403.5.1. [ASHRAE 62.1:6.2.4.1]

$$V_{ou} = D \sum_{all\ zones} (R_p \cdot P_z) + \sum_{all\ zones} (R_a \cdot A_z)$$

(Equation 403.5.1)

403.5.1.1 Occupant Diversity. The occupant diversity ratio ($D$) shall be determined in accordance with Equation 403.5.1.1 to account for variations in population within the ventilation zones served by the system.

$$D = P_s/\sum_{all\ zones} P_z$$

(Equation 403.5.1.1)

Where the system population ($P_s$) is the total population in the area served by the system.

Exception: Alternative methods to account for occupant diversity shall be permitted, provided that the resulting ($V_{ou}$) value is not less than that determined in accordance with Equation 403.5.1. [ASHRAE 62.1:6.2.5.1.1]

403.5.1.2 System Ventilation Efficiency. The system ventilation efficiency ($E_v$) shall be determined in accordance with Section 403.5.1.3 for the simplified procedure or Section 404.0 for the alternate procedure. These procedures also establish zone minimum primary airflow rates for VAV systems. [ASHRAE 62.1:6.2.5.2]

403.5.1.3 Simplified Procedure for System Ventilation Efficiency. System ventilation efficiency ($E_v$) shall be determined in accordance with Equation 403.5.1.3(1) or Equation 403.5.1.3(2). [ASHRAE 62.1:6.2.5.3]

$$E_v = 0.88 \cdot D + 0.22$$

for $D < 0.60$

$$E_v = 0.75$$

for $D \geq 0.60$

(Equation 403.5.1.3)

403.5.1.4 Zone Minimum Primary Airflow. For each zone, the minimum primary airflow ($V_{pz-min}$) shall be determined in accordance with Equation 403.5.1.4. [ASHRAE 62.1:6.2.4.3.2]

$$V_{pz-min} = V_{oz} \times 1.5$$

(Equation 403.5.1.4)

403.5.2 Outdoor Air Intake. The design outdoor air intake flow ($V_{ot}$) shall be determined in accordance with Equation 403.5.2. [ASHRAE 62.1:6.2.4.4]

$$V_{ot} = V_{ou}/E_v$$

(Equation 403.5.2)

403.6 Design for Varying Operating Conditions. Ventilation systems shall be designed to be capable of providing not less than the minimum ventilation rates required in the breathing zone where the zones served by the system are occupied, including all full- and part-load conditions. The minimum outdoor air intake flow shall be permitted to be less than the design value at part-load conditions. [ASHRAE 62.1:6.2.5.4]

403.6.1 Short-Term Conditions. Where it is known that peak occupancy will be of short duration, ventilation will be varied or interrupted for a short period of time, or both, the design shall be permitted to be based on the average conditions over a time period ($T$) determined by Equation 403.6.1.

$$T = \frac{3v}{V_{bz}}$$

(Equation 403.6.1)
Where:

$T = \text{averaging time period, minutes.}$

$v = \text{the volume of the ventilation zone where averaging is being applied, cubic foot (m}^3).$

$V_{bz} = \text{the breathing zone outdoor airflow calculated in accordance with Equation 403.2.1 and design value of the zone population (P_z), cubic foot per minute (CFM) (m}^3/\text{min}).}$

Acceptable design adjustments based on this optional provision including the following:

1. Zones with fluctuating occupancy: The zone population ($P_z$) shall be permitted to be averaged over time ($T$).

2. Zones with intermittent interruption of supply air: The average outdoor airflow supplied to the breathing zone over time ($T$) shall be not less than the breathing zone outdoor airflow ($V_{bz}$) calculated using Equation 403.2.1.

3. Systems with intermittent closure of the outdoor air intake: The average outdoor air intake over time ($T$) shall be not less than the minimum outdoor air intake ($V_{ot}$) calculated using Equation 403.3, Equation 403.4, or Equation 403.5.2 as applicable. [ASHRAE 62.1:6.2.5.2]

### 403.7 Exhaust Ventilation

Exhaust airflow shall be provided in accordance with the requirements in Table 403.7. Exhaust makeup air shall be permitted to be a combination of outdoor air, recirculated air, and transfer air.

### 403.7.1 Parking Garages

Exhaust rate for parking garages shall be in accordance with Table 403.7. Exhaust rate shall not be required for enclosed parking garages having a floor area of 1000 square feet (92.9 m$^2$) or less and used for the storage of 5 or less vehicles.

### 403.7.2 Enclosed Parking Garages

Mechanical ventilation systems for enclosed parking garages shall operate continuously.

### Exceptions

1. Mechanical ventilation systems shall be permitted to operate intermittently where the system is designed to operate automatically upon detection of vehicle operation or the presence of occupants by approved automatic detection devices.

2. Approved automatic carbon monoxide sensing devices, and nitrogen dioxide detectors shall be permitted to modulate the ventilation system to not exceed a maximum average of 50 parts per million of carbon monoxide, or 1 part per million nitrogen dioxide during an eight-hour period with a concentration of not more than 200 parts per million for carbon monoxide, or 5 parts per million nitrogen dioxide, for a period not exceeding 15 minutes. Automatic sensing devices installed in modulated parking garage ventilation systems shall be approved in accordance with Section 301.2.

### 403.8 Dynamic Reset

The system shall be permitted to be designed to reset the outdoor air intake flow ($V_{ot}$), the space or ventilation zone airflow ($V_{ot}$) as operating conditions change, or both. [ASHRAE 62.1:6.2.7 6.2.6]

### 403.9 Air Classification and Recirculation

Air shall be classified, and its recirculation shall be limited in accordance with Section 403.9.1 through Section 403.9.4. [ASHRAE 62.1:5.16 5.18.1] Recirculated air shall not be taken from prohibited locations in accordance with Section 311.3.

Air (return, transfer, or exhaust air) leaving each space or location shall be designated at an expected air-quality classification not less than that shown in Table 402.1, Table 403.7, or Table 403.9 or as approved by the Authority Having Jurisdiction. Air leaving spaces or locations that are not listed in Table 402.1, Table 403.7, or Table 403.9 shall be designated with the same classification as air from the most similar space or location listed in terms of occupant activities and building construction.

**Exception:** Air from spaces where environmental tobacco smoke (ETS) is present. (Classification of air from spaces where ETS is present is not addressed. Spaces that are expected to include ETS do not have a classification listed in Table 402.1.) [ASHRAE 62.1:5.18.1]

### TABLE 403.9 AIRSTREAMS OR SOURCES DESCRIPTION AIR CLASS [ASHRAE 62.1:TABLE 6-3]

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial kitchen grease hoods</td>
<td>4</td>
</tr>
<tr>
<td>Commercial kitchen hoods other than grease</td>
<td>3</td>
</tr>
<tr>
<td>Diazo printing equipment discharge</td>
<td>4</td>
</tr>
<tr>
<td>Hydraulic elevator machine room</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory hoods</td>
<td>4</td>
</tr>
<tr>
<td>Paint spray booths</td>
<td>4</td>
</tr>
<tr>
<td>Refrigerating machinery rooms</td>
<td>3</td>
</tr>
<tr>
<td>Residential kitchen hoods in transient occupancy</td>
<td>3</td>
</tr>
</tbody>
</table>

### 403.9.1 Class 1 Air

Recirculation or transfer of Class 1 air to other spaces, any space shall be permitted. [ASHRAE 62.1:5.16.3.4 5.18.3.1]

### 403.9.2 Class 2 Air

Recirculation of Class 2 air within the space of origin shall be permitted. Recirculation or transfer of Class 2 air to other Class 2 or Class 3 spaces shall be permitted, provided that the other spaces are used for the same or similar purpose or task and involve the same or similar pollutant sources as the Class 2 space. Transfer of Class 2 air to toilet rooms shall be permitted. Recirculation or transfer of Class 2 air to Class 4 spaces shall be permitted. Class 2 air shall not be recirculated or transferred to Class 1 spaces. Where When using an energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device shall be permitted but shall not be counted as outdoor air, and the recirculated Exhaust air transfer ratio of Class 2 air shall not exceed 10 percent of the outdoor air intake flow. [ASHRAE 62.1:5.16.3.2 5.18.3.2 5.18.3.2-5.18.3.2.5]
403.9.3 Class 3 Air. Recirculation of Class 3 air within the space of origin shall be permitted. Class 3 air shall not be recirculated or transferred to any other spaces. Where using an energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device shall be permitted but shall not be counted as outdoor air, and the recirculated exhaust air transfer ratio of Class 3 air shall not exceed 5 percent of the outdoor air intake flow. [ASHRAE 62.1:5.16.3.4 5.18.3.3 – 5.18.3.3.2]

403.9.4 Class 4 Air. Class 4 air shall not be recirculated or transferred to any other space or be recirculated within the space of origin. [ASHRAE 62.1:5.16.3.4 5.18.3.4]

403.10 Air Balance. All mechanical ventilation systems shall be tested, balanced, and operated to demonstrate that the installation and performance of the systems are in accordance with the design intent. All testing and balancing shall be performed by a technician certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), the Testing, Adjusting and Balancing Bureau (TABB), or other equivalent approved agencies.

Exception: For single family residential, compliance with Section 403.10 shall not be required.

404.0 Alternative Procedure for Multiple-Zone Systems Ventilation Efficiency.

404.1 General System Ventilation Efficiency. This section presents an alternative procedure for calculating the system ventilation efficiency ($E_v$) for multiple-zone recirculating systems that shall be used when Section 403.5.1.2 is not used. The system ventilation efficiency shall equal the lowest zone ventilation efficiency among the ventilation zones served by the air handler in accordance with Equation 404.1, [ASHRAE 62.1:A1.3] This section presents an alternative procedure for calculating the system ventilation efficiency ($E_v$) for multiple zone recirculating systems that shall be used when Section 403.5.1.3 is not used.

$$E_v = \min (E_{vz}) \quad (\text{Equation 404.1})$$

404.2 Average Outdoor Air Fraction. The average outdoor air fraction ($X_s$) for the ventilation system shall be determined in accordance with Equation 404.2.

$$X_s = \frac{V_{ou}}{V_{ps}} \quad (\text{Equation 404.2})$$

404.3 Zone Ventilation Efficiency. The zone ventilation efficiency ($E_{vz}$) shall be determined in accordance with Section 404.3.1 or Section 404.3.2. [ASHRAE 62.1:A1.2]

404.3.1 Single Supply Systems. For single supply systems, where all of the air supplied to a each ventilation zone is a mixture of outdoor air and system-level recirculated air, zone ventilation efficiency ($E_{vz}$) shall be determined in accordance with Equation 404.3.1. Examples of single supply systems include constant-volume reheat, single-duct VAV, single-fan dual-duct, and multizone systems.

$$E_{vz} = 1 + X_s - Z_{pz} \quad (\text{Equation 404.3.1})$$

The average outdoor air fraction for the system ($X_s$) shall be determined in accordance with Equation 404.2 and the primary outdoor air fraction for the zone ($Z_{pz}$) shall be determined in accordance with Equation 404.3.1. [ASHRAE 62.1:A1.2.1]

$$Z_{pz} = \frac{V_{oz}}{V_{pz}} \quad (\text{Equation 404.3.1})$$

For VAV systems, $V_{oz}$ is the lowest zone primary airflow value expected at the design condition analyzed.

404.3.2 Secondary-Recirculation Systems. For secondary-recirculation systems where the supply air or a portion thereof to each ventilation zone is recirculated air (that has not been directly mixed with outdoor air) from other zones, zone ventilation efficiency ($E_{vz}$) shall be determined in accordance with Equation 404.3.2(1). Examples of secondary-recirculation systems include dual-fan dual-duct and fan-powered mixing-box systems, and systems that include transfer fans for conference rooms.

$$E_{vz} = (F_a + X_s F_b - Z_{pz} E_p F_c)/F_a \quad [\text{Equation 404.3.2(1)}]$$

The system air fractions $F_a$, $F_b$, and $F_c$ shall be determined in accordance with Equation 404.3.2(2), Equation 404.3.2(3), and Equation 404.3.2(4), as applicable.

$$E_a = E_p + (1 - E_p) E_r \quad [\text{Equation 404.3.2(2)}]$$

$$E_b = E_p \quad [\text{Equation 404.3.2(3)}]$$

$$E_c = 1 - (1 - E_z) (1 - E_r) (1 - E_p) \quad [\text{Equation 404.3.2(4)}]$$

The zone primary air fraction ($E_p$) shall be determined in accordance with Equation 404.3.2(5). For single zone and single supply systems $E_p$ shall equal to 1.0. The zone secondary recirculation fraction ($E_r$) shall be determined by the designer based on system configuration. The zone air distribution effectiveness ($E_z$) shall be determined in accordance with Section 403.2.2. [ASHRAE 62.1:A1.2.2]
Zone floor area: The net occupiable floor area of

Zone outdoor airflow: see Section 403.2.3.

System population: the simultaneous number of

Primary airflow: The

Occupant diversity: The ratio of the system popu

Breathing zone outdoor airflow: see Section

Outdoor air intake flow: see Section 403.3, Sec

System primary airflow: The total primary airflow

Uncorrected outdoor air intake: see Section

Zone population: see Section 403.2.1.

Area outdoor air rate: see Section 403.2.1.

Where:

\[ A_z = \text{Zone floor area: The net occupiable floor area of} \]

\[ D = \text{Occupant diversity: The ratio of the system population to the sum of the zone populations.} \]

\[ E_p = \text{Primary air fraction: The fraction of primary air in the discharge air to the ventilation zone.} \]

\[ E_r = \text{Secondary recirculation fraction: In systems with secondary recirculation of return air, the fraction of secondary recirculated air to the zone that is representative of average system return air rather than air directly recirculated from the zone.} \]

\[ E_{vz} = \text{Zone ventilation efficiency: The efficiency with which the system distributes air from the outdoor air intake to the breathing zone in the ventilation-critical zone, which requires the largest fraction of outdoor air in the primary airstream.} \]

\[ E_z = \text{Zone air distribution effectiveness: A measure of the effectiveness of supply air distribution to the breathing zone.} \]

\[ E_{az} = \text{Zone primary airflow: The system primary airflow.} \]

\[ E_{oz} = \text{Outdoor air fraction: The fraction of outdoor air intake flow in the air-handling unit at which the outdoor air intake is located.} \]

\[ C = \text{Secondary recirculation fraction: In systems with secondary recirculation of return air, the fraction of secondary recirculated air to the zone that is representative of average system return air rather than air directly recirculated from the zone.} \]

\[ A_{floor} = \text{Floor area, ft}^2 \]

\[ N_{br} = \text{Number of bedrooms more than 1} \]

\[ Q_{tot} = 0.03 A_{floor} + 7.5 (N_{br} + 1) \] (Equation 405.2)

Where:

\[ Q_{tot} = \text{Total required ventilation outdoor air rate, CFM} \]

\[ A_{floor} = \text{Floor area, ft}^2 \]

\[ N_{br} = \text{Number of bedrooms more than 1} \]

For SI Units: 1 cubic foot per minute = 0.00047 m³/s

405.2 Ventilation Air Rate. The required mechanical ventilation outdoor air rate \((Q_{tot})\) shall be as calculated in accordance with Equation 405.2.

Exception: For existing buildings and where permitted by the Authority Having Jurisdiction, the total mechanical ventilation \((Q_{tot})\) is not required where \(Q_{tot}\) is calculated to be less than 15 ft³/min (0.007 m³/s).

\[ Q_{tot} = 0.03 A_{floor} + 7.5 (N_{br} + 1) \] (Equation 405.2)

405.2.1 Reduced Ventilation Air Rate. Where permitted by the Authority Having Jurisdiction, the mechanical ventilation air rate required in Section 405.2 shall be permitted to be reduced where an infiltration rate is determined in accordance with ASTM E779.

405.3 Bathroom Exhaust. A mechanical exhaust directly to the outdoors shall be provided in each room containing a
bathtub, shower, or tub/shower combination. The fan shall run intermittently (on demand) or continuously. A readily accessible manual control designed to be operated as needed or an automatic control shall be provided for intermittent operations.

405.3.1 Exhaust Rate. The exhaust rate shall be not less than 50 ft³/min (0.02 m³/s) for intermittent operation and 20 to 25 ft³/min (0.009 m³/s) for continuous operation.

405.4 Kitchen Exhaust. A mechanical exhaust system that discharges directly to the outdoors shall be provided in each kitchen. The fan shall run intermittently (on demand) or continuously. A readily accessible manual control designed to be operated as needed or an automatic control shall be provided for intermittent operations.

**Exception:** Recirculating systems installed in accordance with Section 516.0 and the manufacturer’s installation instructions.

405.4.1 Exhaust Rate. For intermittent-controlled operations, the exhaust rate shall be not less than 100 ft³/min (0.047 m³/s) for range hoods or 300 ft³/min (0.141 m³/s) for mechanical exhaust fans including downdraft appliances. For continuous operated ventilation, the exhaust rate shall be not less than 5 air changes per hour based on kitchen volume for enclosed kitchens. 50 ft³/min (0.02 m³/s).

405.5 Ventilation Openings. Occupiable spaces shall be provided with a readily accessible ventilation opening openable to the outdoors. The opening shall be not less than 5 square feet (0.464 m²) or 4 percent of the occupied floor area. The openable area shall be based on free, unobstructed area through the opening.
**TABLE 402.1**
MINIMUM VENTILATION RATES IN BREATHING ZONE

[ASHRAE 62.1: TABLE 6.2.2.1: 6-1]

<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY</th>
<th>PEOPLE OUTDOOR</th>
<th>AREA OUTDOOR</th>
<th>DEFAULT OCCUPANT</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Air Rate $R_P$ (CFM/person)</td>
<td>Air Rate $R_a$ (CFM/ft²)</td>
<td>DENSITY (people/1000 ft²)</td>
<td></td>
</tr>
</tbody>
</table>

**ANIMAL FACILITIES**
- Animal exam room (veterinary office): 10, 0.12, 20, 2
- Animal imaging (MRI/CT/PET): 10, 0.18, 20, 3
- Animal operating rooms: 10, 0.18, 20, 3
- Animal postoperative recovery room: 10, 0.18, 20, 3
- Animal preparation rooms: 10, 0.18, 20, 3
- Animal procedure room: 10, 0.18, 20, 3
- Animal surgery scrub: 10, 0.18, 20, 3
- Large-animal holding room: 10, 0.18, 20, 3
- Necropsy: 10, 0.18, 20, 3
- Small-animal-cage room (static cages): 10, 0.18, 20, 3
- Small-animal-cage room (ventilated cages): 10, 0.18, 20, 3

**CORRECTIONAL FACILITIES**
- Booking/waiting: 7.5, 0.06, 50, 2
- Cell: 5, 0.12, 25, 2
- Day room: 5, 0.06, 30, 1
- Guard stations: 5, 0.06, 15, 1

**EDUCATIONAL FACILITIES**
- Art classroom: 10, 0.18, 20, 2
- Classrooms (ages 5-to 8): 10, 0.12, 25, 1
- Classrooms (age 9 plus): 10, 0.12, 35, 1
- Computer lab: 10, 0.12, 25, 1
- Daycare (through age 4): 49, 0.18, 25, 2
- Daycare sickroom: 10, 0.18, 25, 3
- Daycare (through age 4): 10, 0.18, 25, 3
- Lecture classroom*: 7.5, 0.06, 65, 1
- Lecture hall (fixed seats)*: 7.5, 0.06, 150, 1
- Libraries: 5, 0.12, 10, –
- Media center*: 10, 0.12, 25, 1
- Multi-use assembly*: 7.5, 0.06, 100, 1
- Music/theater/dance*: 10, 0.06, 35, 1
- Science laboratories: 10, 0.18, 25, 2
- University/college laboratories: 10, 0.18, 25, 2
- Wood/metal shop: 10, 0.18, 20, 2

**FOOD AND BEVERAGE SERVICE**
- Bars, cocktail lounges: 7.5, 0.18, 100, 2
- Cafeteria/fast-food dining: 7.5, 0.18, 100, 2
- Kitchen (cooking): 7.5, 0.12, 20, 2
- Restaurant dining rooms: 7.5, 0.18, 70, 2

**GENERAL**
- Break rooms*: 5, 0.06, 25, 1
- Coffee stations*: 5, 0.06, 20, 1
- Conference/meeting*: 5, 0.06, 50, 1
- Corridors*: 5, 0.06, 30, 1
- Occupiable storage rooms for liquids or gels*: 5, 0.12, 2, 2

**HOTELS, MOTELS, RESORTS, DORMITORIES**
- barracks sleeping areas*: 5, 0.06, 20, 1
- Bedrooms/living room*: 5, 0.06, 10, 1
- Laundry rooms, central: 5, 0.12, 10, 2
- Laundry rooms within dwelling units: 5, 0.12, 10, 1
- Lobbies/pre-function*: 7.5, 0.06, 30, 1
- Multipurpose assembly*: 5, 0.06, 120, 1

**CORRECTIONAL FACILITIES**

**EDUCATIONAL FACILITIES**

**FOOD AND BEVERAGE SERVICE**

**GENERAL**

**HOTELS, MOTELS, RESORTS, DORMITORIES**
### TABLE 402.1 (continued)
**MINIMUM VENTILATION RATES IN BREATHING ZONE**

[ASHRAE 62.1: TABLE 6.2.2.1-6.1]

<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY</th>
<th>PEOPLE OUTDOOR (CFM/person)</th>
<th>AREA OUTDOOR (CFM/ft²)</th>
<th>DEFAULT OCCUPANT DENSITY (people/1000 ft²)</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OFFICE BUILDINGS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Break Rooms</td>
<td>5</td>
<td>0.12</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>Main entry lobbies*</td>
<td>5</td>
<td>0.06</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Occupiable storage rooms for dry materials</td>
<td>5</td>
<td>0.06</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Office space*</td>
<td>5</td>
<td>0.06</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Reception areas*</td>
<td>5</td>
<td>0.06</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>Telephone/data entry*</td>
<td>5</td>
<td>0.06</td>
<td>60</td>
<td>4</td>
</tr>
<tr>
<td><strong>MISCELLANEOUS SPACES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banks or bank lobbies*</td>
<td>7.5</td>
<td>0.06</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Bank vaults/safe deposit*</td>
<td>5</td>
<td>0.06</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Computer (not printing)*</td>
<td>5</td>
<td>0.06</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Freezer and refrigerated spaces (&lt;50°F)*</td>
<td>10</td>
<td>0.06</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Manufacturing where hazardous materials are not used</td>
<td>10</td>
<td>0.18</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>General manufacturing Manufacturing where hazardous materials are used (excludes heavy industrial and processes using chemicals processes)</td>
<td>10</td>
<td>0.18</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Pharmacy (prep. area)</td>
<td>5</td>
<td>0.18</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Photo studios</td>
<td>5</td>
<td>0.12</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Shipping/receiving*</td>
<td>10</td>
<td>0.12</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sorting, packing, light assembly</td>
<td>7.5</td>
<td>0.12</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Telephone closets</td>
<td>–</td>
<td>0.06</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Transportation waiting*</td>
<td>7.5</td>
<td>0.06</td>
<td>100</td>
<td>1</td>
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<tr>
<td>Warehouses*</td>
<td>10</td>
<td>0.06</td>
<td>–</td>
<td>2</td>
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<tr>
<td><strong>OFFICE BUILDINGS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Break Rooms</td>
<td>5</td>
<td>0.12</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>Main entry lobbies*</td>
<td>5</td>
<td>0.06</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Occupiable storage rooms for dry materials</td>
<td>5</td>
<td>0.06</td>
<td>2</td>
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<tr>
<td>Office space</td>
<td>5</td>
<td>0.06</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Reception areas</td>
<td>5</td>
<td>0.06</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Telephone/data entry</td>
<td>5</td>
<td>0.06</td>
<td>60</td>
<td>1</td>
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<tr>
<td><strong>OUTPATIENT HEALTH CARE FACILITIES</strong></td>
<td></td>
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<tr>
<td>Birthing room</td>
<td>10</td>
<td>0.18</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Class 1 imaging rooms</td>
<td>5</td>
<td>0.12</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Dental operatory</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>General examination room</td>
<td>7.5</td>
<td>0.12</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Other dental treatment areas</td>
<td>5</td>
<td>0.06</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Physical therapy exercise area</td>
<td>20</td>
<td>0.18</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Physical therapy individual room</td>
<td>10</td>
<td>0.06</td>
<td>20</td>
<td>1</td>
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<tr>
<td>Physical therapeutic pool area</td>
<td>–</td>
<td>0.48</td>
<td>–</td>
<td>2</td>
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<tr>
<td>Prosthetics and orthotics room</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>1</td>
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<tr>
<td>Psychiatric consultation room</td>
<td>5</td>
<td>0.06</td>
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<tr>
<td>Psychiatric examination room</td>
<td>5</td>
<td>0.06</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Psychiatric group room</td>
<td>5</td>
<td>0.06</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>Psychiatric seclusion room</td>
<td>10</td>
<td>0.06</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Speech therapy room</td>
<td>5</td>
<td>0.06</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Urgent care examination room</td>
<td>7.5</td>
<td>0.12</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Urgent care observation room</td>
<td>5</td>
<td>0.06</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Urgent care treatment room</td>
<td>7.5</td>
<td>0.18</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Urgent care triage room</td>
<td>10</td>
<td>0.18</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td><strong>PUBLIC ASSEMBLY SPACES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditorium seating area*</td>
<td>5</td>
<td>0.06</td>
<td>150</td>
<td>1</td>
</tr>
</tbody>
</table>
### Table 402.1 (continued)
MINIMUM VENTILATION RATES IN BREATHING ZONE

<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY</th>
<th>PEOPLE OUTDOOR Air Rate $R_P$ (CFM/person)</th>
<th>AREA OUTDOOR Air Rate $R_A$ (CFM/ft²)</th>
<th>DEFAULT OCCUPANT DENSITY $\lambda$ (people/1000 ft²)</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courtrooms&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5</td>
<td>0.06</td>
<td>70</td>
<td>1</td>
</tr>
<tr>
<td>Legislative chambers&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5</td>
<td>0.06</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>Libraries</td>
<td>5</td>
<td>0.12</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Lobbies&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5</td>
<td>0.06</td>
<td>150</td>
<td>1</td>
</tr>
<tr>
<td>Museums (children’s)</td>
<td>7.5</td>
<td>0.12</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Museums/galleries&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.5</td>
<td>0.06</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Places of religious worship&lt;sup&gt;+&lt;/sup&gt;</td>
<td>5</td>
<td>0.06</td>
<td>120</td>
<td>1</td>
</tr>
<tr>
<td><strong>RESIDENTIAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common corridors&lt;sup&gt;b&lt;/sup&gt;</td>
<td>–</td>
<td>0.06</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td>Dwelling unit&lt;sup&gt;++&lt;/sup&gt;,&lt;sup&gt;+++&lt;/sup&gt;</td>
<td>5</td>
<td>0.06</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td><strong>RETAIL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales (except as below)</td>
<td>7.5</td>
<td>0.12</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Barber shop&lt;sup&gt;+&lt;/sup&gt;</td>
<td>7.5</td>
<td>0.06</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Beauty and nail salons</td>
<td>20</td>
<td>0.12</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Coin-operated laundries</td>
<td>7.5</td>
<td>0.12</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Mall common areas&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.5</td>
<td>0.06</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Pet shops (animal areas)</td>
<td>7.5</td>
<td>0.18</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Supermarket&lt;sup&gt;+&lt;/sup&gt;</td>
<td>7.5</td>
<td>0.06</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td><strong>SPORTS AND ENTERTAINMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bowling alley (seating)</td>
<td>10</td>
<td>0.12</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Disco/dance floors&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20</td>
<td>0.06</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Gambling casinos</td>
<td>7.5</td>
<td>0.18</td>
<td>120</td>
<td>1</td>
</tr>
<tr>
<td>Game arcades</td>
<td>7.5</td>
<td>0.18</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Gym, sports arena (play area)&lt;sup&gt;+&lt;/sup&gt;</td>
<td>20</td>
<td>0.18</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Health club/aerobics room</td>
<td>20</td>
<td>0.06</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Health club/weight rooms</td>
<td>20</td>
<td>0.06</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Spectator areas&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.5</td>
<td>0.06</td>
<td>150</td>
<td>1</td>
</tr>
<tr>
<td>Stages, studios&lt;sup&gt;+++&lt;/sup&gt;,&lt;sup&gt;++&lt;/sup&gt;</td>
<td>10</td>
<td>0.06</td>
<td>70</td>
<td>1</td>
</tr>
<tr>
<td>Swimming (pool &amp; deck)&lt;sup&gt;+&lt;/sup&gt;&lt;sup&gt;b&lt;/sup&gt;</td>
<td>–</td>
<td>0.48</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td><strong>TRANSIENT RESIDENTIAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common corridors</td>
<td>–</td>
<td>0.06</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td>Dwelling unit&lt;sup&gt;+++&lt;/sup&gt;</td>
<td>5</td>
<td>0.06</td>
<td>–</td>
<td>4</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.0283 m³/min, 1 square foot = 0.0929 m²

**Notes:**

1. This table applies to no-smoking areas. Rates for smoking-permitted spaces shall be determined using other methods.
2. Volumetric airflow rates are based on dry air density of 0.075 pounds of dry air per cubic foot (lbda/ft³) (1.201 kgda/m³) at a barometric pressure of 1 atm (101 kPa) and an air temperature of 70°F (21°C). Rates shall be permitted to be adjusted for actual density.
3. The default occupant density shall be used where actual occupant density is not known.
4. Where the occupancy category for a proposed space or zone is not listed, the requirements for the listed occupancy category that is most similar in terms of occupant density, activities, and building construction shall be used.

**ITEM SPECIFIC NOTES FOR TABLE 402.1**

- For high school and college libraries, the values shown for “Public Assembly Spaces—Libraries” shall be used.
- Rate may not be sufficient where stored materials include those having potentially harmful emissions.
- Rate does not allow for humidity control. “Deck area” refers to the area surrounding the pool that is capable of being wetted during pool use or when the pool is occupied. Deck area that is not expected to be wetted shall be designated as an occupancy category.
- Rate does not include special exhaust for stage effects such as dry ice vapors and smoke.
- Where combustion equipment is intended to be used on the playing surface or in the space, additional dilution ventilation, source control, or both shall be provided.
- Default occupancy for dwelling units shall be two persons for studio and one-bedroom units, with one additional person for each additional bedroom.
- Air from one residential dwelling shall not be recirculated or transferred to other spaces outside of that dwelling.
- Ventilation air for this occupancy category shall be permitted to be reduced to zero where the space is in occupied-standby mode.
- Outpatient facilities to which the rates apply are freestanding birth centers, urgent care centers, neighborhood clinics and physicians offices, Class 1 imaging facilities, outpatient psychiatric facilities, outpatient rehabilitation facilities, and outpatient dental facilities.
- The requirements of this table provide for acceptable IAQ. The requirements of this table do not address the airborne transmission of airborne viruses, bacteria, and other infectious contagions.
- These rates are intended only for outpatient dental clinics where the amount of nitrous oxide is limited. They are not intended for dental operatories in institutional buildings where nitrous oxide is piped.
### TABLE 403.2.2
ZONE AIR DISTRIBUTION EFFECTIVENESS¹, ², ³, ⁴, ⁵
[ASHRAE 62.1: TABLE 6.2.2.2 6-4]

<table>
<thead>
<tr>
<th>AIR DISTRIBUTION CONFIGURATION</th>
<th>$E_z$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WELL-MIXED AIR DISTRIBUTION SYSTEMS</strong></td>
<td></td>
</tr>
<tr>
<td>Ceiling supply of cool air.</td>
<td>1.0</td>
</tr>
<tr>
<td>Ceiling supply of warm air and floor return.</td>
<td>1.0</td>
</tr>
<tr>
<td>Ceiling supply of warm air 15°F or more above space temperature and ceiling return.</td>
<td>0.8</td>
</tr>
<tr>
<td>Ceiling supply of warm air less than 15°F above space temperature and ceiling return provided that the supply air-jet velocity is less than 150 feet per minute (fpm) supply air jet reaches to within 4.5 feet of the floor level and ceiling return.</td>
<td>1.0</td>
</tr>
<tr>
<td>Floor supply of cool air and ceiling return.</td>
<td>0.7</td>
</tr>
<tr>
<td>Makeup supply delivered near the outlet located less than half the length of the space from the exhaust, return, or both.</td>
<td>0.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>STRAFIFIED AIR DISTRIBUTION SYSTEMS (SECTION 403.2.2.1)</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor supply of cool air where the vertical throw is greater than or equal to 60 feet per minute (fpm) at a height of 4.5 feet above the floor and ceiling return at a height less than or equal to 18 feet above the floor.</td>
<td>1.05</td>
</tr>
<tr>
<td>Floor supply of cool air where the vertical throw is less than or equal to 60 feet per minute (fpm) at a height of 4.5 feet above the floor and ceiling return at a height less than or equal to 18 feet above the floor.</td>
<td>1.2</td>
</tr>
<tr>
<td>Floor supply of cool air where the vertical throw is less than or equal to 60 feet per minute (fpm) at a height of 4.5 feet above the floor and ceiling return at a height greater than 18 feet above the floor.</td>
<td>1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>PERSONALIZED VENTILATION SYSTEMS (SECTION 403.2.2.2)</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Personalized air at a height of 4.5 feet above the floor combined with ceiling supply of cool air and ceiling return.</td>
<td>1.40</td>
</tr>
<tr>
<td>Personalized air at a height of 4.5 feet above the floor combined with ceiling supply of warm air and ceiling return.</td>
<td>1.40</td>
</tr>
<tr>
<td>Personalized air at a height of 4.5 feet above the floor combined with a stratified air distribution system with nonaspirating floor supply devices and ceiling return.</td>
<td>1.20</td>
</tr>
<tr>
<td>Personalized air at a height of 4.5 feet above the floor combined with a stratified air distribution system with aspirating floor supply devices and ceiling return.</td>
<td>1.50</td>
</tr>
</tbody>
</table>

For SI units: °C = °F(5/9), 1 foot per minute = 0.005 m/s, 1 foot = 304.8 mm

**Notes:**

1 “Cool air” is air cooler than space temperature.
2 “Warm air” is air warmer than space temperature.
3 “Ceiling supply” includes any point above the breathing zone.
4 “Floor supply” includes any point below the breathing zone.
5 As an alternative to using the above values, $E_z$ shall be permitted to be regarded as equal to air change effectiveness determined in accordance with ASHRAE 129 for air distribution configurations except unidirectional flow.
6 For lower velocity supply air, $E_z = 0.8$
<table>
<thead>
<tr>
<th>OCCUPANCY CATEGORY</th>
<th>EXHAUST RATE (CFM/unit)</th>
<th>EXHAUST RATE (CFM/ft²)</th>
<th>AIR CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal imaging (MRI/CT/PET)</td>
<td>= 0.90</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Animal operating rooms</td>
<td>= 3.00</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Animal postoperative recovery room</td>
<td>= 1.50</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Animal preparation rooms</td>
<td>= 1.50</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Animal procedure room</td>
<td>= 2.25</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Animal surgery scrub</td>
<td>= 1.50</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Large-animal holding room</td>
<td>= 2.25</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Necropsy</td>
<td>= 2.25</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Small-animal-cage room (static cages)</td>
<td>= 2.25</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Small-animal-cage room (ventilated cages)</td>
<td>= 1.50</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Arenas</td>
<td>= 0.50</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Art classrooms</td>
<td>= 0.70</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Auto repair rooms</td>
<td>= 1.50</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Barber shops</td>
<td>= 0.50</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Beauty and nail salons</td>
<td>= 0.60</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cells with toilet</td>
<td>= 1.00</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Copy, printing rooms</td>
<td>= 0.50</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Darkrooms</td>
<td>= 1.00</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Educational science laboratories</td>
<td>= 1.00</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Janitor closets, trash rooms, recycling</td>
<td>= 1.00</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Kitchens – commercial</td>
<td>= 0.70</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Kitchenettes</td>
<td>= 0.30</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Kitchens – commercial</td>
<td>= 0.70</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Locker rooms for athletic, industrial and health care facilities</td>
<td>= 0.50</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>All other</td>
<td>= 0.25</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Other locker rooms</td>
<td>= 0.25</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Shower rooms</td>
<td>= 0.25</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Paint spray booths</td>
<td>= 0.25</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Parking garages</td>
<td>= 0.75</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Pet shops (animal areas)</td>
<td>= 0.90</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Refrigerating machinery rooms</td>
<td>= 1.00</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Residential – kitchens</td>
<td>= 50/100</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Soiled laundry storage rooms</td>
<td>= 1.00</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Storage rooms, chemical</td>
<td>= 1.50</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Toilets – private</td>
<td>= 25/50</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Toilets – public</td>
<td>= 50/70</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Woodwork shop/classrooms</td>
<td>= 0.50</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. Stands where engines are run shall have exhaust systems that directly connect to the engine exhaust and prevent escape of fumes.
2. Where combustion equipment is intended to be used on the playing surface, additional dilution ventilation, source control, or both shall be provided.
3. Exhaust shall not be required where two or more sides of a room are at least 50 percent open to the outside.
4. Rate is per water closet, urinal, or both. Provide the higher rate where periods of heavy use are expected to occur. The lower rate shall be permitted to be used otherwise.
5. Rate is for a toilet room intended to be occupied by one person at a time. For continuous system operation during normal hours of use, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.
6. For refrigeration machinery rooms, the exhaust rate shall comply with Chapter 11. See other applicable standards for exhaust rate.
7. For continuous system operation, the lower rates shall be permitted to be used. Otherwise the higher rate shall be used.
8. For unlisted occupancies for a proposed space not listed in the table, the requirements for the listed occupancy that is most similar in terms of occupant density and occupancy type shall be used.
9. Exhaust air that has been cleaned to meet Class 1 criteria from Section 403.9 shall be permitted to be recirculated.
10. Rate is per shower head.
CHAPTER 5
EXHAUST SYSTEMS

501.0 General.
501.1 Applicability. This chapter includes requirements for environmental air ducts, product-conveying systems, and commercial hoods and kitchen ventilation. Part I addresses environmental air ducts and product conveying systems. Part II addresses commercial hoods and kitchen ventilation.

502.0 Termination.
502.1 Exhaust Opening Protection. Exhaust openings terminating to the outdoors shall be covered with a corrosion-resistant screen having not less than ¼ of an inch (6.4 mm) openings, and shall have not more than ½ of an inch (12.7 mm) openings. Exception: Clothes dryers.

502.2 Termination of Exhaust Ducts. Exhaust ducts shall terminate in accordance with Section 502.2.1 through Section 502.2.3.

502.2.1 Environmental Air Ducts. Environmental air duct exhaust shall terminate not less than 3 feet (914 mm) from a property line, 10 feet (3048 mm) from a forced air inlet, 10 feet (3048 mm) above a public walkway, and 3 feet (914 mm) from openings into the building. The discharge of environmental exhaust ducts shall not be directed onto a public walkway.

502.2.2 Product Conveying Ducts. Ducts conveying explosive or flammable vapors, fumes, or dusts shall terminate not less than 30 feet (9144 mm) from a property line, 10 feet (3048 mm) from openings into the building, 6 feet (1829 mm) from exterior walls or roofs, 30 feet (9144 mm) from combustible walls or openings into the building that are in the direction of the exhaust discharge, and 10 feet (3048 mm) above adjoining grade.

Other product-conveying outlets shall terminate not less than 10 feet (3048 mm) from a property line, 3 feet (914 mm) from exterior walls or roofs, 10 feet (3048 mm) from openings into the building, and 10 feet (3048 mm) above adjoining grade.

502.2.3 Commercial Kitchen Ducts. Commercial kitchen exhaust ducts shall terminate in accordance with Section 510.9 for Type I exhaust systems or Section 519.5 for Type II exhaust systems.


503.0 Motors, Fans, and Filters.
503.1 General. Motors and fans shall be sized to provide the required air movement. Motors in areas that contain flammable vapors or dusts shall be of a type approved for such environments. A manually operated remote control installed at an approved location shall be provided to shut off fans or blowers in flammable vapor or dust systems. Equipment used in operations that generate explosive or flammable vapors, fumes, or dusts shall be interlocked with the ventilation system so that the equipment cannot be operated unless the ventilation fans are in operation. Motors for fans used to convey flammable vapors or dusts shall be located outside the duct or shall be protected with approved shields and dustproofing. Where belts are used, they shall not enter the duct unless the belt and pulley within the duct are enclosed. Motors and fans shall be accessible for servicing and maintenance.

503.2 Fans. Parts of fans in contact with explosive or flammable vapors, fumes, or dusts shall be of nonferrous or non-sparking materials, or their casing shall be lined or constructed of such material. Where the size and hardness of materials passing through a fan are capable of producing a spark, both the fan, and the casing shall be of nonsparking materials. Where fans are required to be spark-resistant, their bearings shall not be within the airstream, and parts of the fan shall be grounded. Fans in systems handling materials that are likely to clog the blades, and fans in buffing or woodworking exhaust systems, shall be of the radial-blade or tube-axial type.

Equipment used to exhaust explosive or flammable vapors, fumes, or dusts shall bear an identification plate stating the ventilation rate for which the system was designed.

Fans located in systems conveying corrosives shall be of materials that are resistant to the corrosive or shall be coated with corrosion-resistant materials.

504.0 Environmental Air Ducts.
504.1 General. Where not specified in this chapter, exhaust ducts shall be constructed and installed in accordance with Chapter 6 and shall be airtight as approved by the Authority Having Jurisdiction. Environmental air ducts that have an alternate function as a part of an approved smoke-control system do not require design as Class I product-conveying ducts.

Exceptions:
(1) Ductless range hoods where installed in accordance with the manufacturer’s installation instructions.
(2) Condensing clothes dryers where installed in accordance with the manufacturer’s installation instructions.

504.1.1 Backdraft Protection. Exhaust ducts shall terminate outside the building and shall be equipped with backdraft dampers or with motorized dampers that automatically shut where the systems or spaces served are not in use.

Exception: Where the exhaust duct does not discharge into a common exhaust plenum and one of the following:
(1) The exhaust fan runs continuously.
(2) The exhaust duct serves space(s) that are not mechanically heated or cooled.
(3) The space served is maintained at positive pressure.

### 504.2 Independent Exhaust Systems

Single or combined mechanical exhaust systems shall be independent of other exhaust systems.

### 504.3 Domestic Range Hoods

Ducts used for domestic kitchen range or cooktop ventilation shall be of metal and shall have smooth interior surfaces. All kitchen exhaust ducts used in domestic range hoods shall be constructed of metal and have a smooth surface, fastened and sealed with duct mastic or metal tapes that meet the requirements of UL 181. Range hoods shall discharge to the outdoors through a single wall duct and shall not terminate in an attic or crawl space.

A physical verification of air volume, operation, and design intent shall be performed by a certified Testing, Adjusting, and Balancing (TAB) technician. The TAB technician shall be certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), the Testing, Adjusting and Balancing Bureau (TABB), or other equivalent approved agencies.

#### Exception: Ducts for domestic kitchen downdraft grill-range ventilation installed under a concrete slab floor shall be permitted to be of approved Schedule 40 PVC provided:

1. The under-floor trench in which the duct is installed shall be completely backfilled with sand or gravel.
2. Not more than 1 inch (25.4 mm) of 6 inch diameter (152 mm) PVC coupling shall be permitted to protrude above the concrete floor surface.
3. PVC pipe joints shall be solvent cemented to provide an air and greasetight duct.
4. The duct shall terminate above grade outside the building and shall be equipped with a backdraft damper.

### 504.4 Clothes Dryers

A clothes dryer exhaust duct shall not be connected to a vent connector, gas vent, chimney, and shall not terminate into a crawl space, attic, or other concealed space. Exhaust ducts shall not be assembled with screws or other fastening means that extend into the duct and that are capable of catching lint, and that reduce the efficiency of the exhaust system. Exhaust ducts shall be constructed of rigid metallic material. Transition ducts used to connect the dryer to the exhaust duct shall be listed and labeled in accordance with UL 2158A, or installed in accordance with the clothes dryer manufacturer’s installation instructions. Clothes dryer exhaust ducts shall terminate to the outside of the building in accordance with Section 502.2.1 and shall be equipped with a backdraft damper. Screens shall not be installed at the duct termination. Devices, such as fire or smoke dampers that will obstruct the flow of the exhaust shall not be used. Where joining of ducts, the male end shall be inserted in the direction of airflow.

#### 504.4.1 Provisions for Makeup Air

Makeup air shall be provided in accordance with the following:

1. Makeup air shall be provided for Type 1 clothes dryers in accordance with the manufacturer’s installation instructions. [NFPA 54:4.4.3.1 10.4.4.1] Where a closet is designed for the installation of a clothes dryer, an opening of not less than 100 square inches (0.605 m²) for makeup air shall be provided in the door or by other approved means.
2. Provision for makeup air shall be provided for Type 2 clothes dryers, with a minimum free area of 1 square inch (0.006 m²) for each 1000 British thermal units per hour (Btu/h) (0.293 kW) total input rating of the dryer(s) installed. [NFPA 54:4.4.3.2 10.4.4.2]

### 504.4.2 Domestic Clothes Dryers

Where a compartment or space for a Type 1 clothes dryer is provided, not less than a 4 inch diameter (102 mm) exhaust duct of approved material shall be installed in accordance with Section 504.0.

Type 1 clothes dryer exhaust ducts shall be of rigid metal and shall have smooth interior surfaces. The diameter shall be not less than 4 inches nominal (100 mm), and the thickness shall be not less than 0.016 of an inch (0.406 mm).

#### 504.4.2.1 Length Limitation

Unless otherwise permitted or required by the dryer manufacturer’s instructions and approved by the Authority Having Jurisdiction, domestic dryer moisture exhaust ducts shall not exceed a total combined horizontal and vertical length of 14 feet (4267 mm), including two 90 degree (1.57 rad) elbows. A length of 2 feet (610 mm) shall be deducted for each 90 degree (1.57 rad) elbow in excess of two.

#### Exception: Where an exhaust duct power ventilator, in accordance with Section 504.4.2.3, is used, the maximum length of the dryer exhaust duct shall be permitted to be in accordance with the dryer exhaust duct power ventilator manufacturer’s installation instructions.

#### 504.4.2.2 Transition Ducts

Listed clothes dryer transition ducts not more than 6 feet (1829 mm) in length shall be permitted to be used to connect the Type 1 dryer to the exhaust ducts. Transition ducts and flexible clothes dryer transition ducts shall not be concealed within construction, and shall be installed in accordance with the manufacturer’s installation instructions.

#### 504.4.2.3 Exhaust Duct Power Ventilators

Dryer exhaust duct power ventilators for single residential clothes dryers shall be listed and labeled in accordance with UL 705 and installed in accordance with the manufacturer’s installation instructions.

### 504.4.3 Commercial Clothes Dryers

Commercial dryer exhaust ducts shall be installed in accordance with their listings. The installation of commercial clothes dryer exhaust ducts shall comply with the appliance manufacturer’s installation instructions.

#### 504.4.3.1 Exhaust Ducts for Type 2 Clothes Dryers

Exhaust ducts for Type 2 clothes dryers shall comply with the following:
504.4 Common Exhaust. Where permitted by the clothes dryer manufacturer’s installation instructions, multiple clothes dryers shall be permitted to be installed with a common exhaust. The common exhaust duct shall be constructed of rigid metal and shall be installed in a fire-resistant rated enclosure in accordance with the building code. The duct material shall be of rigid metal fire-resistant rated enclosure in accordance with NFPA 54:10.4.6.5. The exhaust fan shall operate continuously or shall be interlocked to exhaust air where a clothes dryer is in operation.

504.4.4 Common Exhaust. Where permitted by the clothes dryer manufacturer’s installation instructions, multiple clothes dryers shall be permitted to be installed with a common exhaust. The common exhaust duct shall be constructed of rigid metal and shall be installed in a fire-resistant rated enclosure in accordance with the building code. The duct material shall be of rigid metal with a thickness of not less than 0.020 of an inch (0.508 mm) thick. The duct enclosure shall be provided with a cleanout opening at the base of not less than 12 inches (305 mm) (24 gauge). The duct enclosure shall be provided with a cleanout opening at the base of not less than 12 inches by 12 inches (305 mm by 305 mm). The exhaust fan shall be located downstream of branch connections and operated continuously and shall be monitored by an approved means.

504.4.5 Duct Supports. Ducts shall be supported at intervals not to exceed 4 feet (1219 mm) and in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.

504.4.6 Multistory Exhausting of Dryers. Each vertical riser shall be provided with a means for cleanout or access door located at the bottom of the main exhaust shaft for lint removal.

504.5 Heat (Energy) Recovery Ventilator and Energy Recovery Ventilation (ERV) Systems. Heat (energy) recovery ventilators (HRV) and energy recovery ventilators (ERV) shall be installed in accordance with their listings and comply with the appliance manufacturer’s installation instructions. Non-ducted heat recovery ventilators shall comply with UL 1815. Ducted heat recovery ventilators shall comply with UL 1812. Heat recovery ventilator and energy recovery ventilator ducts shall comply with Chapter 6.

504.6 Gypsum Wallboard Ducts. Bathroom and laundry room exhaust ducts shall be permitted to be of gypsum wallboard subject to the limitations of Section 602.4.2.

505.0 Product-Conveying Systems.

505.1 General. A mechanical ventilation or exhaust system shall be installed to control, capture, and remove emissions generated from product use or handling where required in accordance with the building code or fire code and where such emissions result in a hazard to life or property. The design of the system shall be such that the emissions are confined to the area in which they are generated by air currents, hoods, or enclosures and shall be exhausted by a duct system to a safe location or treated by removing contaminants. Ducts conveying explosives or flammable vapors, fumes, or dusts shall extend directly to the exterior of the building without entering other spaces and shall not extend into or through ducts and plenums.

Exception: Ducts conveying vapor or fumes having flammable constituents less than 25 percent of their Lower Flammability Limit (LFL) shall be permitted to pass through other spaces.

505.1.1 Mechanical Ventilation. A mechanical ventilation system shall be interlocked to operate with the equipment used to produce vapors, fumes, or ducts that are flammable or hazardous.

505.2 Incompatible Materials. Incompatible materials shall not be conveyed in the same system. [NFPA 91:4.2.3.1]

505.3 Flammability Limit. Unless the circumstances stipulated in Section 505.3.1, Section 505.3.2, or Section 505.3.3 exist, in systems conveying flammable vapors, gases, or mists, the concentration shall not exceed 25 percent of the lower flammability limit (LFL). [NFPA 91:4.2.3.3]

505.3.1 Higher Concentrations. Higher concentrations shall be permitted if the exhaust system is designed and protected in accordance with NFPA 69, using one or more of the following techniques:

1. Combustible concentration reduction
2. Oxidant concentration reduction
3. Deflagration suppression
4. Deflagration pressure containment [NFPA 91:4.2.3.1]

Contaminated air shall not be recirculated to occupied areas unless contaminants have been removed. Air contaminated with explosive or flammable vapors, fumes, or dusts; flammable or toxic gases; or radioactive material shall not be recirculated.

505.3.2 Ovens and Furnaces. Higher concentrations shall be permitted for ovens and furnaces designed and protected in accordance with NFPA 86. [NFPA 91:4.2.3.2]
**EXHAUST SYSTEMS**

505.3.3 Deflagration. Higher concentrations shall be permitted where deflagration venting is provided in accordance with NFPA 68. [NFPA 91:4.2.3.3]

505.4 Air-Moving Devices. Air-moving devices shall be sized to establish the velocity required to capture, control, and convey materials through the exhaust system. [NFPA 91:4.2.5]

505.5 Generating Flames, Sparks, or Hot Materials. Operations generating flames, sparks, or hot material such as from grinding wheels and welding shall not be manifolded into any exhaust system that air conveys flammable or combustible materials. [NFPA 91:4.2.6]

505.6 Fire Dampers. Fire dampers shall be permitted to be installed in exhaust systems in accordance with the following:

1. Where ducts pass through fire barriers
2. Where a collection system installed on the end of the system is protected with an automatic extinguishing system
3. Where the duct system is protected with an automatic extinguishing system
4. Where ducts have been listed with interrupters
5. Where necessary to facilitate the control of smoke pursuant to the applicable NFPA standards [NFPA 91:4.2.9]

505.6.1 Prohibited. Fire dampers shall not be installed if the material being exhausted is toxic and if a risk evaluation indicates that the toxic hazard is greater than the fire hazard. [NFPA 91:4.2.10]

505.7 Fire Detection and Alarm Systems. Unless the circumstances stipulated in Section 505.7.1 or Section 505.7.2 exist, fire detection and alarm systems shall not be interlocked to shut down air-moving devices. [NFPA 91:4.2.14]

505.7.1 Automatic Extinguishing System. Where a documented risk analysis acceptable to the Authority Having Jurisdiction shows that the risk of damage from fire and the products of combustion would be higher with air-moving devices operating, it shall be permitted to interlock fire detection and alarm systems to shut down air-moving devices. [NFPA 91:4.2.14.2]

505.8 Product-Conveying Ducts Classification. Product-conveying ducts shall be classified according to their use, as follows:

- Class 1 - Ducts conveying nonabrasives, such as smoke, spray, mists, fog, noncorrosive fumes and gases, light fine dusts, or powders.
- Class 2 - Ducts conveying moderately abrasive particulate in light concentrations, such as sawdust and grain dust, and buffing and polishing dust.
- Class 3 - Ducts conveying Class 2 materials in high concentrations and highly abrasive materials in low concentrations, such as manganese, steel chips, and coke.
- Class 4 - Ducts conveying Class 3 materials in high concentrations and highly abrasive material in high concentrations, such as alumina, bauxite, iron silicate, sand, and slag.
- Class 5 - Ducts conveying corrosives, such as acid vapors.

505.9 Minimum Velocities and Circulation. The velocity and circulation of air in work areas shall be such that contaminant’s are captured by an airstream at the area where the emissions are generated and conveyed into a product-conveying duct system. Mixtures within work areas where contaminants are generated shall be diluted to be accordance with Section 505.3 with air that does not contain other contaminants. The velocity of air within the duct shall be not less than set forth in Table 505.9.

Systems conveying particulate matter shall be designed by employing the constant velocity method. Systems con-

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**TABLE 505.9**

<table>
<thead>
<tr>
<th>NATURE OF CONTAMINANTS</th>
<th>EXAMPLES</th>
<th>FEET PER MINUTE DESIGN VELOCITY (feet per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapors gases smoke</td>
<td>All vapors, gases, and smoke</td>
<td>1000 - 2000</td>
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<tr>
<td>Fumes</td>
<td>Welding</td>
<td>2000 - 2500</td>
</tr>
<tr>
<td>Very fine light dust</td>
<td>Cotton lint, wood flour, litho powder</td>
<td>2500 - 3000</td>
</tr>
<tr>
<td>Dry dusts and powders</td>
<td>Fine rubber dust, molding powder dust, jute lint, cotton dust, shavings</td>
<td>3000 - 4000</td>
</tr>
<tr>
<td></td>
<td>(light), soap dust, leather shavings</td>
<td></td>
</tr>
<tr>
<td>Average industrial dust</td>
<td>Grinding dust, buffing lint (dry), wool jute dust (shaker waste), coffee beans, shoe dust, granite dust, silica flour, general material handling, brick cutting, clay dust, foundry (general), limestone dust, packaging and weighing asbestos dust in textile industries</td>
<td>3500 - 4000</td>
</tr>
<tr>
<td>Heavy dusts</td>
<td>Sawdust (heavy and wet), metal turnings, foundry tumbling barrels and shake-out, sandblast dust, wood blocks, hog waste, brass turning, cast-iron boring dust, lead dust</td>
<td>4000 - 4500</td>
</tr>
<tr>
<td>Heavy or moist dust</td>
<td>Lead dust with chips, moist cement dust, asbestos chunks from transite pipe cutting machines, buffing lint (sticky), quick-lime dust</td>
<td>4500 and up</td>
</tr>
</tbody>
</table>

For SI units: 1 foot per minute = 0.005 m/s

1 Systems that are handling combustible particulate solids shall be in accordance with NFPA 654.
2 Any desired velocity (economic optimum velocity usually within this range).
veying explosive or radioactive materials shall be pre-balanced through duct sizing. Other systems shall be permitted to be designed with balancing devices such as dampers. Dampers provided to balance airflow shall be provided with securely fixed minimum-position blocking devices to prevent restricting flow below the required volume or velocity.

505.10 Makeup Air. Makeup air shall be provided to replenish air exhausted by the ventilation system. Makeup air intakes shall be located so as to avoid recirculation of contaminated air within enclosures.

505.11 Hoods and Enclosures. Hoods and enclosures shall be used where contaminants originate in a concentrated area. The design of the hood or enclosure shall be such that air currents created by the exhaust systems will capture the contaminants and transport them directly to the exhaust duct. The volume of air shall be sufficient to dilute explosive or flammable vapors, fumes, or dusts in accordance with Section 505.9. Hoods of steel shall have a base metal thickness not less than 0.027 of an inch (0.686 mm) (No. 22 gauge) for Class 1 and Class 5 metal duct systems; 0.033 of an inch (0.838 mm) (No. 20 gauge) for hoods serving a Class 2 duct system; 0.044 of an inch (1.118 mm) (No. 18 gauge) for hoods serving a Class 3 duct system; and 0.068 of an inch (1.727 mm) (No. 14 gauge) for hoods serving a Class 4 duct system.

Approved nonmetallic hoods and duct systems shall be permitted to be used for Class 5 corrosive systems where the corrosive mixture is nonflammable. Metal hoods used with Class 5 duct systems shall be protected with an approved corrosion-resistant material. Edges of hoods shall be rounded. The minimum clearance between hoods and combustible construction shall be the clearance required by the duct system.

506.0 Product-Conveying Ducts.

506.1 Materials. Materials used in product-conveying duct systems shall be suitable for the intended use and shall be of rigid sheet metal.

Exceptions:

1. Asbestos-cement, concrete, clay, or ceramic materials shall be permitted to be used where it is shown that these materials will be equivalent to metal ducts installed in accordance with this chapter.

2. Ducts serving a Class 5 system shall be permitted to be constructed of approved nonmetallic material where the corrosive mixture is nonflammable. Metal ducts used in such systems shall be protected with an approved corrosion-resistant material. Edges of ducts shall be rounded. The minimum clearance between ducts and combustible construction shall be the clearance required by the duct system.

506.2 Construction. Ducts used for conveying products shall be airtight construction as approved by the Authority Having Jurisdiction, and shall not have openings other than those required for operation and maintenance of the system.

Ducts constructed of steel shall comply with Table 506.2(1) or Table 506.2(2).

Exceptions:

1. Class 1 product-conveying ducts that operate at less than 4 inches water column (0.9 kPa) negative pressure and convey noncorrosive, nonflammable and nonexplosive materials at temperatures not exceeding 250°F (121°C) shall be permitted to be constructed in accordance with SMACNA HVAC Duct Construction Standards—Metal and Flexible.

2. Ducts used in central vacuuming systems within a dwelling unit shall be constructed of materials in accordance with ASTM F2158 or the applicable standards referenced in Chapter 17. Penetrations of fire-resistive walls or floor-ceiling or roof-ceiling assemblies shall be in accordance with the building code. Copper or ferrous pipes or conduit extending from within the separation between a garage and dwelling unit to the central vacuuming unit shall be permitted to be used.

The use of rectangular ducts conveying particulates shall be subject to approval of the Authority Having Jurisdiction. The design of rectangular ducts shall consider the adhesiveness and buildup of products being conveyed within the duct. Aluminum construction shall be permitted to be used in Class 1 duct systems. The thickness of aluminum ducts shall be not less than two Brown and Sharpe gauges thicker than the gauges required for steel ducts set forth in Table 506.2(1) and Table 506.2(2).

506.3 Penetrations. Exhaust ducts shall not pass through fire walls. [NFPA 91:4.2.11]

506.3.1 Fire Barriers. Exhaust ducts passing through a fire barrier having a fire resistance rating of 2 hours or greater shall meet one of the following specifications:

1. Wrapped or encased with listed or approved materials having a fire resistance rating equal to the fire barrier for 10 feet (3048 mm) of the duct on each side of the fire barrier including duct supports within this span.

2. Constructed of materials and supports having a minimum fire resistance rating equal to the fire barrier.
### TABLE 506.2(1)

**MINIMUM SHEET METAL THICKNESS FOR ROUND DUCTS**

<table>
<thead>
<tr>
<th>NEGATIVE PRESSURE (inches water column)</th>
<th>REINF. SPACING (inches)</th>
<th>CLASS 1 (inches)</th>
<th>CLASS 2 (inches)</th>
<th>CLASS 3 (inches)</th>
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<tbody>
<tr>
<td></td>
<td>Up to 7</td>
<td>8 to 11</td>
<td>12 to 15</td>
<td>16 to 20</td>
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<tr>
<td></td>
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<td>0.021 (24 ga.)</td>
<td>0.033 (20 ga.)</td>
<td>0.044 (18 ga.)</td>
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<tr>
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TABLE 506.2(1) (continued)
MINIMUM SHEET METAL THICKNESS FOR ROUND DUCTS

<table>
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<tr>
<th>NEGATIVE PRESSURE (inches water column)</th>
<th>REINF. SPACING (inches)</th>
<th>CLASS 3 (inches)</th>
<th>CLASS 4 (inches)</th>
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<tr>
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<td>8 to 11</td>
<td>12 to 15</td>
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<td>0.133 (20 ga.)</td>
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<td>0.155 (16 ga.)</td>
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<td>0.155 (16 ga.)</td>
<td>0.155 (16 ga.)</td>
<td>0.155 (16 ga.)</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm, 1 inch water column = 0.249 kPa

(3) Enclosed with a shaft that is constructed of material having a fire resistance rating equal to the fire barrier for 10 feet (3048 mm) of the duct on each side of the fire barrier with no inlets to the duct within this distance, and the duct entry into and exit from the shaft is protected in accordance with Section 506.3.2. [NFPA 91:4.2.12]

506.3.2 Protection. Exhaust ducts passing through fire barriers of any fire resistance rating shall be protected by sealing the space around the duct with listed or approved fire stopping having a fire resistance rating equal to the fire resistance rating of the fire barrier. [NFPA 91:4.2.13]

506.4 Condensate. Joints in duct construction shall be liquidtight when the conveying system contains condensable vapors or liquids in suspension. [NFPA 91:4.3.6.1]

506.4.1 Drainage. Provisions shall be made for drainage of condensate at low points in the duct. [NFPA 91:4.3.6.2]

506.5 Fittings. Fittings in Class 2, 3, and 4 systems shall be not less than two gauges thicker than the thickness required for straight runs. Flexible metallic duct shall be permitted to be used for connecting ductwork to vibrating equipment. Duct systems subject to wide temperature fluctuations shall be provided with expansion joints.

Branches shall connect to main ducts at the large end of transitions at an angle not exceeding 45 degrees (0.79 rad).

Except for ducts used to convey noncorrosive vapors with no particulate, accessible cleanouts shall be provided at 10 foot (3048 mm) intervals and at changes in direction. Access openings shall also be provided for access to sprinklers and other equipment within the duct that require servicing.
### TABLE 506.2(2)
MINIMUM SHEET METAL THICKNESS FOR RECTANGULAR DUCTS

<table>
<thead>
<tr>
<th>NEGATIVE PRESSURE (inches water column)</th>
<th>REINF. SPACING (inches)</th>
<th>CLASS 1 (inches)</th>
<th>CLASS 2 (inches)</th>
<th>CLASS 3 (inches)</th>
<th>CLASS 4 (inches)</th>
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<tr>
<td>Up to 12</td>
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</table>

For SI units: 1 inch = 25.4 mm, 1 inch water column = 0.249 kPa

### 506.6 Explosion Venting
Ducts conveying explosive dusts shall have explosion vents, openings protected by anti-flashback swing valves, or rupture diaphragms. Openings to relieve explosive forces shall be located outside the building. Where relief devices cannot provide sufficient pressure relief, ductwork shall be designed to withstand an internal pressure of not less than 100 pounds-force per square inch (psi) (689 kPa).

Where a room or building contains a dust explosion hazard that is external to protected equipment, as defined in NFPA 654, such areas shall be provided with deflagration venting to a safe outside location.

Systems exhausting explosive mixtures shall be protected by an approved explosion relief system in accordance with NFPA 69.

### 506.7 Supports
Supports shall be of noncombustible materials, and the spacing shall not exceed 12 feet (3658 mm) for 8 inch (203 mm) ducts and 20 feet (6096 mm) for larger ducts.

### 506.8 Fire Protection
Sprinklers or other fire-protection devices shall be installed within ducts having a cross-sectional dimension exceeding 10 inches (254 mm) where the duct conveys flammable vapors or fumes. Sprinklers shall be installed at 12 foot (3658 mm) intervals in horizontal ducts and at changes in direction. In vertical runs, sprinklers shall be installed at the top and at alternate floor levels.

### 506.8.1 Loads
Duct supports shall be designed to carry the weight of the duct half filled with material. Where sprinkler protection is provided or cleaning of the duct will be performed, the hanger’s design shall include...
the weight of any expected liquid accumulation. Duct supports shall be designed to prevent placing loads on connected equipment. [NFPA 91:4.6.1 – 4.6.3]

506.8.2 Corrosion. Hangers and supports exposed to corrosive atmospheres shall be resistant to the corrosive atmospheres. [NFPA 91:4.6.4]

506.8.3 Vibration and Stress. To avoid vibration and stress on the duct, hangers and supports shall be securely fastened to the building or structure. [NFPA 91:4.6.5]

506.8.4 Expansion and Contraction. Hangers and supports shall be designed to allow for expansion and contraction. [NFPA 91:4.6.6]

506.9 Protection from Physical Damage. Ducts and exhaust equipment installed in locations where they are subject to physical damage shall be protected by guards.

506.10 Duct Clearances. Unless the conditions stipulated in Section 506.10.1 or Section 506.10.2 exist, all duct systems and system components shall have a clearance of at least 6 inches (152 mm) from stored combustible materials, and not less than \( \frac{1}{2} \) of an inch (13 mm) clearance from combustible construction. [NFPA 91:4.7.1]

506.10.1 Protection Provided. Where stored combustible material or combustible construction is protected from ductwork by the use of materials or products listed for protection purposes, clearance shall be maintained in accordance with those listings. [NFPA 91:4.7.1.1]

506.10.2 Systems Conveying Combustible Materials. Unless the conditions stipulated in Section 506.10.3 exist, all duct systems and system components handling combustible materials shall have a clearance of not less than 18 inches (457 mm) from stored combustible materials or combustible construction. [NFPA 91:4.7.2]

506.10.3 Reduced Clearance Permitted. When the ductwork system is operating at 140°F (60°C) or below and is equipped with an approved automatic extinguishing system designed for the specific hazard, the clearance shall be permitted to be reduced to 6 inches (152 mm) from combustible materials and \( \frac{1}{2} \) of an inch (12.7 mm) from combustible construction. [NFPA 91:4.7.2.1]

506.10.4 Clearance Increases. All duct systems and system components operating at temperatures above 140°F (60°C) shall have clearances from stored combustible materials or combustible construction not less than those listed in Table 506.10.4. [NFPA 91:4.7.3]

506.10.4.1 Temperatures Over 900°F. Ducts handling materials at temperatures in excess of 900°F (482°C) shall be lined with refractory material or the equivalent. [NFPA 91:4.7.3.1]

506.10.4.2 Clearance Reduction. When stored combustible materials or combustible construction are protected from ductwork in accordance with Section 506.11, the clearance established in Table 506.10.4 shall be permitted to be reduced in accordance with Table 506.11, but not to less than specified in Section 506.10. [NFPA 91:4.7.3.2]

### Table 506.10.4

<table>
<thead>
<tr>
<th>DUCT GAS TEMPERATURE</th>
<th>LARGEST DUCT DIMENSION (inches)</th>
<th>CLEARANCE (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>140°F – 600°F incl.</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>&gt;600°F – 900°F incl.</td>
<td>&gt;8</td>
<td>12</td>
</tr>
<tr>
<td>&gt;900°F</td>
<td>All ducts lined with refractory</td>
<td>24</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm, °C=(°F-32)/1.8

506.11 Clearance Reduction Methods. It shall be permitted to protect stored combustible material or combustible construction from ductwork in accordance with Table 506.11 and Section 506.11.1 through Section 506.11.6. In no case shall the clearance between the duct and the combustible surface be reduced below that allowed in Table 506.11. [NFPA 91:4.7.4.1 – 4.7.4.7]

506.11.1 Spacers and Ties. Spacers and ties for protection materials shall be of noncombustible material and shall not be installed on the duct side of the protection system. [NFPA 91:4.7.4.2]

506.11.2 Wool Batts Insulation. Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per cubic feet (lb/ft³) (128 kg/m³) and have a minimum melting point of 1500°F (816°C). [NFPA 91:4.7.4.3]

506.11.3 Insulation Board. Insulation board used as a part of a clearance-reduction system shall meet the following criteria:

1. Have a thermal conductivity of 1 British thermal unit inch per hour square foot degree Fahrenheit [Btu•in/(h•ft²•°F)] [0.14 W/(m•K)] or less.
2. Be formed of noncombustible material. [NFPA 91:4.7.4.4]

506.11.4 Duct and Thermal Shield. With all clearance reduction systems, at least 1 inch (25.4 mm) clear space shall be provided between the duct and the thermal shield. [NFPA 91:4.7.4.5]

506.11.5 Thermal Shield and Combustible Surface. When using clearance reduction systems that include an air gap, at least 1 inch (25.4 mm) clear space shall be provided between the thermal shield and the combustible surface. [NFPA 91:4.7.4.6]

506.11.6 Reduced Clearance with Air Gaps. When using clearance reduction systems that include an air gap between the combustible surface and the selected means of protection, air circulation shall be provided by one of the methods in Section 506.11.6.1 through Section 506.11.6.3. [NFPA 91:4.7.4.7]

506.11.6.1 Air Circulation. Air circulation shall be permitted to be provided by leaving all edges of the protecting system open with at least a 1 inch (25.4 mm) air gap. [NFPA 91:4.7.4.7.1]
506.11.6.2 Single Flat Wall. If the means of protection is mounted on a single flat wall away from corners, air circulation shall be permitted to be provided by one of the following:

1. Leaving only the top and bottom edges open to circulation by maintaining the 1 inch (25.4 mm) air gap. [NFPA 91:4.7.4.7.2]

2. Leaving the top and both side edges open to circulation by maintaining the 1 inch (25.4 mm) air gap. [NFPA 91:4.7.4.7.2]

506.11.6.3 Thermal Shielding. Thermal shielding that covers two walls in a corner shall be permitted to be open at the top and bottom edges with at least 1 inch (25.4 mm) air gap. [NFPA 91:4.7.4.7.3]

Part II - Commercial Hoods and Kitchen Ventilation.

507.0 General Requirements.

507.1 Type I Hood Exhaust Systems. Exhaust systems serving Type I hoods shall comply with Section 507.0 through Section 518.0. Exhaust systems serving Type II hoods shall comply with Section 519.0.

507.2 Type I Hood Exhaust System Requirements. Cooking equipment used in processes producing smoke or grease-laden vapors shall be equipped with an exhaust system that complies with all the equipment and performance requirements of this chapter. [NFPA 96:4.1.1] All such equipment and its performance shall be maintained in accordance with the requirements of this chapter during all periods of operation of the cooking equipment. [NFPA 96:4.1.2] The following equipment shall be kept in working condition:

1. Cooking equipment
2. Hoods
3. Ducts (if applicable)
4. Fans
5. Fire-extinguishing equipment
6. Special effluent or energy control equipment [NFPA 96:4.1.3]

Maintenance and repairs shall be performed on all components at intervals necessary to maintain good working conditions. [NFPA 96:4.1.3.1]

507.2.1 Airflow. All airflow shall be maintained. [NFPA 96:4.1.4]

507.2.2 Responsibility. The responsibility for inspection, testing, maintenance, and cleanliness of the ventilation control and fire protection of the commercial cooking operations, including cooking appliances, shall ultimately be that of the owner of the system, provided that this responsibility has not been transferred in written form to a management company, tenant, or other party. [NFPA 96:4.1.5]
507.2.3 Solid-fuel Cooking Equipment. All solid-fuel cooking equipment shall comply with the requirements of Section 517.0. [NFPA 96:4.1.6]

507.2.4 Multitenant Applications. Multitenant applications shall require the concerted cooperation of design, installation, operation, and maintenance responsibilities by tenants and by the building owner. [NFPA 96:4.1.7]

507.2.5 Interior Surfaces. All interior surfaces of the exhaust system shall be accessible for cleaning and inspection purposes. [NFPA 96:4.1.8]

507.2.6 Used in Other Applications. Cooking equipment used in fixed, mobile, or temporary concessions, such as trucks, buses, trailers, pavilions, tents, or any form of roofed enclosure, shall comply with this chapter. [NFPA 96:4.1.9]

507.3 Listed Devices. Penetrations shall be sealed with listed devices in accordance with the requirements of Section 507.3.1.

507.3.1 Penetration. Devices that require penetration of a Type I hood or grease duct, such as pipe and conduit penetration fittings and fasteners, shall be listed in accordance with UL 710 or UL 1798. Seams, joints, and penetrations of the hood enclosure shall comply with Section 508.3.2. Seams, joints, and penetrations of the ductwork shall comply with Section 510.5.3.

507.4 Clearance. Where enclosures are not required, hoods, grease removal devices, exhaust fans, and ducts shall have a clearance of at least 18 inches (457 mm) to combustible material, 3 inches (76 mm) to limited-combustible material, and 0 inches (0 mm) to noncombustible material. [NFPA 96:4.2.1]

507.4.1 Listed. Where a hood, duct, or grease removal device is listed for clearances less than those required in Section 507.4, the listing requirements shall be permitted. [NFPA 96:4.2.2]

507.4.2 Clearance Reduction. Where a clearance reduction system consisting of 0.013 of an inch (0.33 mm) (28 gauge) sheet metal spaced out 1 inch (25.4 mm) on noncombustible spacers is provided, there shall be a minimum of 9 inches (229 mm) clearance to combustible material. [NFPA 96:4.2.3.1]

507.4.2.1 Mineral Wool Batts or Ceramic Fiber Blanket. Where a clearance reduction system consisting of 0.027 of an inch (0.686 mm) (22 gauge) sheet metal on 1 inch (25.4 mm) mineral wool batts or ceramic fiber blanket reinforced with wire mesh or equivalent spaced 1 inch (25.4 mm) on noncombustible spacers is provided, there shall be a minimum of 3 inches (76 mm) clearance to combustible material. [NFPA 96:4.2.3.2]

507.4.2.2 Field-Applied Grease Duct Enclosure. Where a clearance reduction system consisting of a listed and labeled field-applied grease duct enclosure material, system, product, or method of construction specifically evaluated for such purpose in accordance with ASTM E2336, the required clearance shall be in accordance with the listing. [NFPA 96:4.2.3.3]

507.4.2.3 Zero Clearance. Zero clearance to limited-combustible materials shall be permitted where protected by one of the following:

1. Metal lath and plaster.
2. Ceramic tile.
3. Quarry tile.
4. Other noncombustible materials or assembly of noncombustible materials that are listed for the purpose of reducing clearance.
5. Other materials and products that are listed for the purpose of reducing clearance. [NFPA 96:4.2.4.1]

507.4.3 Clearance Integrity. In the event of damage, the material or product shall be repaired and restored to meet its intended listing or clearance requirements and shall be acceptable to the Authority Having Jurisdiction. [NFPA 96:4.2.4.1]

507.4.3.1 Fire. In the event of a fire within a kitchen exhaust system, the duct and its enclosure (rated shaft, factory-built grease duct enclosure, or field-applied grease duct enclosure) shall be inspected by qualified personnel to determine whether the duct and protection method are structurally sound, capable of maintaining their fire protection function, and in compliance with this chapter for continued operation. [NFPA 96:4.2.4.2]

507.4.3.2 Required Protection. Protection shall be provided on the wall from the bottom of the hood to the floor, or to the top of the noncombustible material extending to the floor, to the same level as required in Section 507.4. [NFPA 96:4.2.4.3]

507.4.3.3 Protection Methods. The protection methods for ducts to reduce clearance shall be applied to the combustible or limited-combustible construction, not to the duct itself. [NFPA 96:4.2.4.4]

507.4.4 Factory Built. Factory-built grease duct enclosures shall be protected with a through-penetration firestop system classified in accordance with ASTM E814 or UL 1479 having an “F” and a “T” rating equal to the fire resistance rating of the assembly being penetrated from the point at which the duct penetrates a ceiling, wall, or floor to the outlet terminal. [NFPA 96:4.3.4.4]

507.4.4.1 Listing. The factory-built grease duct protection system shall be listed in accordance with UL 2221. [NFPA 96:4.3.4.4.4.1]

507.4.4.2 Single Wall. Listed single wall factory-built grease ducts shall be permitted to be enclosed with field-applied grease duct enclosure material where the material and the assembly of duct and material are listed for that application and installed in accordance with the grease duct manufacturer’s listing and their installation instructions. [NFPA 96:4.3.4.2.4.3.4.2]
**507.4.3 Installation.** The factory-built grease duct protection system shall be installed in accordance with the manufacturer’s instructions and the listing requirements. [NFPA 96:4.3.3.4, 3.4.3]

**507.4.5 Field Applied.** Field-applied grease duct enclosures shall be protected with a through penetration firestop system classified in accordance with ASTM E814 or UL 1479 having an “F” and a “T” rating equal to the fire resistance rating of the assembly being penetrated. The surface of the field fabricated grease duct shall be continuously covered on all sides from the point at which the duct enclosure penetrates a ceiling, wall, or floor to the outlet terminal. The field-applied grease duct shall be listed in accordance with ASTM E2336 and installed in accordance with the manufacturer’s instructions and the listing requirements. [NFPA 96:4.3.1 – 4.3.1.2]

**507.4.6 Both Field-Applied and Factory Built.** Field-applied grease duct enclosures and factory-built grease duct enclosures shall demonstrate that they provide mechanical and structural integrity, resiliency, and stability when subjected to expected building environmental conditions, duct movement under general operating conditions, and duct movement due to fire conditions. [NFPA 96:4.3.4.3.5]

**507.4.6.1 Physical Damage.** Measures shall be taken to prevent physical damage to a material or product used for the purpose of reducing clearances. **Exception:** Where the duct is protected with a field-applied grease duct enclosure or factory-built grease duct enclosure.

**507.4.6.2 Specification.** The specifications of material, gauge, and construction of the duct used in the testing and listing of field-applied grease duct enclosures and factory-built grease duct enclosures shall be included as minimum requirements in their listing and installation documentation. [NFPA 96:4.3.54.3.6]

**507.4.6.3 Clearance Options.** The following clearance options for which field-applied grease duct enclosures and factory-built grease duct enclosures have been successfully evaluated shall be clearly identified in their listing and installation documentation and on their labels:

1. Open combustible construction clearance at manufacturer’s requested dimensions.
2. Closed combustible construction clearance at manufacturer’s requested dimensions, with or without specified ventilation.
3. Rated shaft clearance at manufacturer’s requested dimensions, with or without specified ventilation. [NFPA 96:4.3.64.3.7]

**507.4.7 Building and Structural Contact.** A duct shall be permitted to contact noncombustible floors, interior walls, and other noncombustible structures or supports, but it shall not be in contact for more than 50 percent of its surface area for each linear foot of contact length. [NFPA 96:4.4.1]

**507.4.7.1 Corrosion Protection.** Where duct contact must exceed the requirements of Section 507.4.7, the duct shall be protected from corrosion. [NFPA 96:4.4.2]

**507.4.7.2 Zero Clearance.** Where the duct is listed for zero clearance to combustibles or is otherwise protected with a material or product listed for the purpose of reducing clearance to zero, the duct shall be permitted to exceed the contact limits of Section 507.4.7 without additional corrosion protection. [NFPA 96:4.4.3]

**507.4.8 Clearance Between Duct and Interior Surfaces.** Clearances between the duct and interior surfaces of enclosures shall meet the requirements of Section 507.4 through Section 507.4.3.3. [NFPA 96:4.5]

**507.5 Drawings.** For cooking operations in buildings, a drawing(s) of the exhaust system installation along with copies of operating instructions for subassemblies and components used in the exhaust system, including electrical schematics, shall be kept on the premises and made available on request to the Authority Having Jurisdiction and maintenance persons. [NFPA 96:4.6.4]

**507.6 Notification of Change.** If required by the Authority Having Jurisdiction, notification in writing shall be given of any alteration, replacement, or relocation of any exhaust or extinguishing system or part thereof or cooking equipment. [NFPA 96:4.7]

Satisfaction shall be provided to the Authority Having Jurisdiction that the complete exhaust system as addressed in this chapter is installed and operable in accordance with the approved design and the manufacturer’s installation instructions.

**508.0 Type I Hoods.**

**508.1 Where Required.** Type I hoods shall be installed at or above commercial-type deep-fat fryers, broilers, grills, hot-top ranges, ovens, barbecues, rotisseries, and similar equipment that emits comparable amounts of smoke or grease in a food-processing establishment. For the purpose of this section, a food-processing establishment shall include a building or portion thereof used for the processing of food, but shall not include a dwelling unit.

**Exceptions:**

1. A Type I hood shall not be required for cooking appliances that are in accordance with UL 710B UL 197 for reduced emissions where the grease discharge does not exceed 2.9 E-09 ounces per cubic inch (oz/in3) (5.0 E-06 kg/m3) where operated with a total airflow of 500 cubic feet per minute (CFM) (0.236 m3/s).
2. Recirculating systems listed in accordance with UL 710B and installed in accordance with Section 516.0.
3. Solid-fuel-fired ovens that comply with UL 2162 and that are vented in accordance with the manufacturer’s instructions with venting systems complying with UL 103 and UL 1978.
508.2 Listed Type I Hood Assemblies. Listed hood assemblies shall be installed in accordance with the terms of their listing and the manufacturer’s instructions. Listed hood assemblies shall be tested in accordance with UL 710 or equivalent. [NFPA 96:5.4.1, 5.4.2]

508.2.1 Listed Ultraviolet Hoods. Listed ultraviolet hoods shall be installed and maintained in accordance with the terms of their listing and the manufacturer’s instructions. Duct systems connected to ultraviolet hoods shall comply with Section 510.0. Ultraviolet hoods shall be tested and listed in accordance with UL 710 and UL 710C. [NFPA 96:5.5 – 5.5.2]

508.2.2 Listed Ventilated Ceiling Technology. Listed ventilated ceiling technology shall be installed and maintained in accordance with the terms of its listing and the manufacturer’s instructions. [NFPA 96:5.6]

508.2.3 Construction of Listed Exhaust Hoods. Listed exhaust hoods with or without exhaust dampers shall be permitted to be constructed of materials required by the listing. [NFPA 96:5.1.6]

508.2.4 Assembly of Listed Exhaust Hoods. Listed exhaust hoods with or without exhaust dampers shall be permitted to be assembled in accordance with the listing requirements. [NFPA 96:5.1.7]

508.3 Construction of Type I Hoods. The hood or that portion of a primary collection means designed for collecting cooking vapors and residues shall be constructed of and be supported by steel not less than 0.048 of an inch (1.219 mm) (No. 18 MSG), in thickness, stainless steel not less than 0.036 of an inch (0.914 mm) (No. 20 MSG) in thickness, or other approved material of equivalent strength and fire and corrosion resistance. [NFPA 96:5.1.11]

Exception: Listed exhaust hoods.

508.3.1 Grease Vapor. Wall-mounted exhaust hood assemblies shall be tight fitting against the back wall so as to not permit passage of grease vapor behind the hood, or between the back wall and the hood assembly. [NFPA 96:5.1.13]

508.3.2 Seams, Joints, and Penetrations. All seams, joints, and penetrations of the hood enclosure that direct and capture grease-laden vapors and exhaust gases shall have a liquid-tight continuous external weld to the hood’s lower outermost perimeter. [NFPA 96:5.1.2]

Exceptions:

(1) Seams, joints, and penetrations of the hood shall be permitted to be internally welded, provided that the weld is formed smooth or ground smooth, so as to not trap grease, and is cleanable. [NFPA 96:5.1.3]

(2) Penetrations shall be permitted to be sealed by devices that are listed for such use and whose presence does not detract from the hood’s or duct’s structural integrity. [NFPA 96:5.1.5]

508.3.3 Eyebrow-Type Hoods. Eyebrow-type hoods over gas or electric ovens shall be permitted to have a duct constructed as required in Section 510.0 from the oven flue(s) connected to the hood canopy upstream of the exhaust plenum, as shown in Figure 508.3.3. [NFPA 96:5.1.8.1]

508.3.4 Insulation. Insulation materials other than electrical insulation shall have a flame spread index of 25 or less, when tested in accordance with ASTM E84 or UL 723. Adhesives or cements used in the installation of insulating materials shall comply with the requirements of this section when tested with the specific insulating material. [NFPA 96:5.1.8.2]

508.3.5 Exhaust Hood Assemblies with Integrated Supply-Air Plenums. The construction and size of exhaust hood assemblies with integrated supply air plenums shall comply with the requirements of Section 508.2.3 through Section 508.3.4 and Section 508.5. [NFPA 96:5.3.1]
508.3.5.1 Outer Shell. The construction of the outer shell or the inner exhaust shell shall comply with Section 508.2.3 through Section 508.3.4. [NFPA 96:5.3.2]

508.3.5.2 Inner Shell. Where the outer shell is welded, the inner shell shall be of greasetight construction. [NFPA 96:5.3.3]

508.3.5.3 Fire Dampers. A fire-actuated damper shall be installed in the supply air plenum at each point where a supply air duct inlet or a supply air outlet penetrates the continuously welded shell of the assembly. [NFPA 96:5.3.4.1]

508.3.5.3.1 Listing. The fire damper shall be listed for such use or be part of a listed exhaust hood with or without exhaust damper. [NFPA 96:5.3.4.2]

508.3.5.3.2 Actuating Temperature. The actuation device shall have a maximum temperature rating of 286°F (141°C). [NFPA 96:5.3.4.3]

508.3.5.3.3 Exemption. Supply air plenums that discharge air from the face rather than from the bottom or into the exhaust hood and that are isolated from the exhaust hood by the continuously welded shell extending to the lower outermost perimeter of the entire hood assembly shall not require a fire-actuated damper. [NFPA 96:5.3.4.4]

508.4 Supports. Hoods shall be secured in place to resist lateral loads by noncombustible supports. The supports shall be capable of supporting the expected weight of the hood and plus 800 pounds (362.9 kg).

508.5 Hood Size. Hoods shall be sized in accordance with the airflow capacity in accordance with Section 508.5.1.1 and installed to provide for the removal of heat, and capture and removal of grease-laden vapors in accordance with Section 511.2.2.

508.5.1 Canopy Size and Location. For canopy type commercial cooking hoods, the inside edge thereof shall overhang or extend a horizontal distance of not less than 6 inches (152 mm) beyond the edge of the cooking surface on open sides, and the vertical distance between the lip of the hood and the cooking surface shall not exceed 4 feet (1219 mm).

Exception: Listed exhaust hoods are to be installed in accordance with the terms of their listings and the manufacturer’s installation instructions.

508.5.1.1 Capacity of Hoods. Canopy-type commercial cooking hoods shall exhaust through the hood with a quantity of air not less than determined by the application in accordance with Section 508.5.1.2 through Section 508.5.1.5. The exhaust quantity shall be the net exhaust from the hood determined in accordance with Equation 508.5.1.1. The duty level for the hood shall be the duty level of the appliance that has the highest (heaviest) duty level of appliances installed underneath the hood.

\[
E_{\text{NET}} = E_{\text{HOOD}} - MA_{\text{ID}} \quad \text{(Equation 508.5.1.1)}
\]

Where:

- \(E_{\text{NET}}\) = net hood exhaust
- \(E_{\text{HOOD}}\) = total hood exhaust
- \(MA_{\text{ID}}\) = makeup air, internal discharge

508.5.1.2 Extra-Heavy-Duty Cooking Appliances. The minimum net airflow for hoods used for solid fuel cooking appliances such as charcoal, briquette, and mesquite to provide the heat source for cooking shall be in accordance with Table 508.5.1.2.

<table>
<thead>
<tr>
<th>TYPE OF HOOD</th>
<th>AIRFLOW (cubic foot per minute per linear foot of hood)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backshelf/pass-over</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Double island canopy (per side)</td>
<td>550</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Single island canopy</td>
<td>700</td>
</tr>
<tr>
<td>Wall-mounted canopy</td>
<td>550</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 foot = 304.8 mm

508.5.1.3 Heavy-Duty Cooking Appliances. The minimum net airflow for hoods used for cooking appliances such as gas under-fired broilers, gas chain (conveyor) broilers, and electric and gas wok ranges, and electric and gas over-fired (upright) broilers shall be in accordance with Table 508.5.1.3.

<table>
<thead>
<tr>
<th>TYPE OF HOOD</th>
<th>AIRFLOW (cubic foot per minute per linear foot of hood)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backshelf/pass-over</td>
<td>400</td>
</tr>
<tr>
<td>Double island canopy (per side)</td>
<td>400</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Single island canopy</td>
<td>600</td>
</tr>
<tr>
<td>Wall-mounted canopy</td>
<td>400</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 foot = 304.8 mm

508.5.1.4 Medium-Duty Cooking Appliances. The minimum net airflow for hoods used for cooking appliances such as electric and gas hot-top ranges, gas open-burner ranges (with or without oven), electric and gas flat griddles, electric and gas double-sided griddles, electric and gas fryers (including open deep fat fryers, donut fryers, kettle fryers, tortilla chip...
EXHAUST SYSTEMS

508.5.15 Light-Duty Cooking Appliances. The minimum net airflow for hoods used for cooking appliances such as gas and electric ovens (including standard, bake, roasting, revolving, retherm, convection, combination convection/steamer, rotisserie, countertop conveyorized baking/finishing, deck, and pastry), discrete element ranges (with or without oven), electric and gas steam-jacketed kettles less than 20 gallons (76 L), electric and gas pasta cookers, electric and gas gas compartment steamers (both pressure and atmospheric), electric and gas cheese melters, electric and gas tilting skillets (braising pans) electric and gas rotisseries, and electric and gas salamanders shall be in accordance with Table 508.5.1.5.

<table>
<thead>
<tr>
<th>TYPE OF HOOD</th>
<th>AIRFLOW (cubic foot per minute per linear foot of hood)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backshelf/pass-over</td>
<td>300</td>
</tr>
<tr>
<td>Double island canopy (per side)</td>
<td>300</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>250</td>
</tr>
<tr>
<td>Single island canopy</td>
<td>500</td>
</tr>
<tr>
<td>Wall-mounted canopy</td>
<td>300</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 foot = 304.8 mm

508.5.2 Noncanopy-Type Hoods. Noncanopy-type commercial cooking hoods shall be installed and sized in accordance with the manufacturer’s installation instructions, and Section 508.5.2.1 and Section 508.5.2.2.

Exception: Listed hood assemblies designed and installed specifically for the intended use.

508.5.2.1 Installation. Noncanopy-type commercial cooking hoods shall be installed with the edge of the hood set back not more than 1 foot (305 mm) from the edge of the cooking surface, and the vertical distance between the lip of the hood and the cooking surface shall not exceed 3 feet (914 mm).

508.5.2.2 Capacity. In addition to other requirements for hoods specified in this section, the volume of air exhausting through a noncanopy-type hood to the duct system shall be not less than 300 cubic feet per minute per lineal foot [(ft³/min)/ft] [0.464 (m³/s)/m] of cooking equipment. Listed noncanopy exhaust hoods and filters shall be sized and installed in accordance with the terms of their listing and the manufacturer’s installation instructions.

508.5.3 Labeling. Type I hoods shall bear a label indicating the exhaust flow rate in cubic feet per minute per lineal foot [(m³/s)/m].

508.6 Solid-Fuel Hood Assemblies. Where solid-fuel cooking equipment is to be used, the solid-fuel hood assembly shall be in accordance with Section 517.0.

508.7 Exhaust Outlets. An exhaust outlet within an unlisted hood shall be located so as to optimize the capture of particulate matter. Each outlet shall serve not more than a 12 foot (3658 mm) section of an unlisted hood.

509.0 Grease Removal Devices in Hoods.

509.1 Grease Removal Devices. Listed grease filters or other listed grease removal devices intended for use with commercial cooking operations shall be provided. Listed grease filters and grease removal devices that are removable but not an integral component of a specific listed exhaust hood shall be listed in accordance with UL 1046 and shall be designated on the filter. [NFPA 96:6.1.1.6.1.241]

509.1.1 Grease Filters, Mesh-Type. Mesh filters shall not be used unless evaluated as an integral part of a listed exhaust hood or listed in conjunction with a primary filter in accordance with UL 1046. [NFPA 96:6.1.3]

509.2 Installation. The distance between the grease removal device and the cooking surface shall be as great as possible but not less than 18 inches (457 mm). [NFPA 96:6.2.1.1]

509.2.1 Vertical Distance. Where grease removal devices are used in conjunction with solid fuel or solid fuel-type broilers, including gas or electrically heated charbroilers, a minimum vertical distance of 4 feet (1219 mm) shall be maintained between the lower edge of the grease removal device and the cooking surface. [NFPA 96:6.2.1.2]

Exceptions:

1. For cooking equipment without exposed flame and where flue gases bypass grease removal devices, the minimum vertical distance shall be permitted to be reduced to not less than 6 inches (152 mm). [NFPA 96:6.2.1.3]

2. Where a grease removal device is listed for separation distances less than those required in Section 509.2 and Section 509.2.1, the listing requirements shall be permitted. [NFPA 96:6.2.1.4]

3. Grease removal devices supplied as part of listed hood assemblies shall be installed in accordance with the terms of the listing and the manufacturer’s instructions. [NFPA 96:6.2.1.5]
509.2.2 Grease Removal Device Protection. Where the distance between the grease removal device and the appliance flue outlet (heat source) is less than 18 inches (457 mm), grease removal devices shall be protected from combustion gas outlets and from direct flame impingement occurring during normal operation of cooking appliances producing high flue gas temperatures. [NFPA 96:6.2.2.1]

509.2.2.1 Installation. This protection shall be permitted to be accomplished by the installation of a steel or stainless steel baffle plate between the heat source and the grease removal device. [NFPA 96:6.2.2.2]

509.2.2.2 Size and Location. The baffle plate shall be sized and located so that flames or combustion gases travel a distance not less than 18 inches (457 mm) from the heat source to the grease removal device. [NFPA 96:6.2.2.3]

509.2.2.3 Clearance. The baffle shall be located not less than 6 inches (152 mm) from the grease removal device. [NFPA 96:6.2.2.4]

509.2.3 Grease Filters. Grease filters shall be listed and constructed of steel or other non-combustible material, and shall be of rigid construction that will not distort or crush under normal operation, handling, cleaning, or replacement.

509.2.3.1 Arrangement. Grease filters shall be arranged so that all exhaust air passes through the grease filters. [NFPA 96:6.2.3.4]

509.2.3.2 Accessibility. Grease filters shall be easily accessible for removal. [NFPA 96:6.2.3.5]

509.2.3.3 Angled Installation. Grease filters shall be installed at an angle not less than 45 degrees (0.79 rad) from the horizontal. [NFPA 96:6.2.3.6]

509.2.4 Grease Drip Trays. Grease filters shall be equipped with a grease drip tray beneath their lower edges. [NFPA 96:6.2.4.1]

509.2.4.1 Size and Pitch. Grease drip trays shall be kept to the minimum size needed to collect grease. Grease drip trays shall be pitched to drain into an enclosed metal container having a capacity not exceeding 1 gallon (4 L). [NFPA 96:6.2.4.2, 6.2.4.3]

509.2.5 Grease Filter Orientation. Grease filters that require a specific orientation to drain grease shall be clearly so designated on the face of the filter as to be visible with the filter installed, or the hood or filter shall be constructed so that filters cannot be installed in the wrong orientation. [NFPA 96:6.2.5]

509.3 Solid-Fuel Grease Removal Devices. Where solid-fuel cooking equipment is provided with grease removal devices, these devices shall be in accordance with Section 517.0.

510.0 Exhaust Duct Systems.

510.1 General. Ducts shall not pass through fire walls. [NFPA 96:7.1.1]
510.3.1 Access Panel. For hoods with dampers in the exhaust or supply collar, an access panel for cleaning and inspection shall be provided in the duct or the hood within 18 inches (457 mm) of the damper. [NFPA 96:7.3.4]  
Exception: Dampers that are accessible from under the hood.

510.3.2 Access for Cleaning and Inspection. Exhaust fans with ductwork connected to both sides shall have access for cleaning and inspection within 3 feet (914 mm) of each side of the fan. Wall-mounted exhaust fans shall have access for cleaning and inspection within 3 feet (914 mm) of the exhaust fan. [NFPA 96:7.3.7, 7.3.8, 7.3.9]  
510.3.3 Horizontal Ducts. On horizontal ducts, at least one 20 inch by 20 inch (508 mm by 508 mm) opening shall be provided for personnel entry. [NFPA 96:7.4.1.1]  
510.3.3.1 Cleaning. Where an opening of the size specified in Section 510.3.3 is not possible, openings large enough to permit thorough cleaning shall be provided at 12 feet (3658 mm) intervals. [NFPA 96:7.4.1.2]  
510.3.3.2 Safe Access and Work Platform. If not easily accessible from a 10 foot (3048 mm) stepladder, openings on horizontal grease duct systems shall be provided with safe access and a work platform. [NFPA 96:7.4.1.3]  
510.3.3.3 Support. Support systems for horizontal grease duct systems 24 inches (610 mm) and larger in any cross-sectional dimension shall be designed for the weight of the ductwork plus 800 pounds (362.9 kg) at any point in the duct systems. [NFPA 96:7.4.1.4]  
510.3.4 Vertical Ducts. On vertical ductwork where personnel entry is possible, access shall be provided at the top of the vertical riser to accommodate descent. [NFPA 96:7.4.2.1]  
510.3.4.1 Access. Where personnel entry is not possible, adequate access for cleaning shall be provided on each floor. [NFPA 96:7.4.2.2]  
510.3.4.2 Safe Access and Work Platform. If not easily accessible from the floor or a 10 foot (3048 mm) stepladder, openings on vertical grease ducts shall be provided with safe access and a work platform. [NFPA 96:7.4.2.3]  
510.3.5 Nonlisted Ductwork. On nonlisted ductwork, the edge of the opening shall not be less than 1/8 inches (38 mm) from all outside edges of the duct or welded seams. [NFPA 96:7.4.1.5]  
510.3.6 Access Panels. Access panels shall be of the same material and thickness as the duct. Access panels shall have a gasket or sealant that is rated for 1500°F (816°C) and shall be greasetight. Fasteners, such as bolts, weld studs, latches, or wing nuts, used to secure the access panels shall be carbon steel or stainless steel and shall not penetrate duct walls. [NFPA 96:7.4.3.1 – 7.4.3.3]  
510.3.6.1 Listed Grease Ducts. Listed grease duct access door assemblies (access panels) shall be installed in accordance with the terms of the listing and the manufacturer’s instructions. [NFPA 96:7.4.3.4]  
510.3.6.2 Within an Enclosure. Where openings are located in ducts within an enclosure, the access panel including its components shall be of the same fire rating as the enclosure.  
510.3.7 Fire Protection System Devices. Openings for installation, servicing, and inspection of listed fire protection system devices and for duct cleaning shall be provided in ducts and enclosures and shall be in accordance with the requirements of Section 510.3 through Section 510.3.2 and Section 510.7.7.  
Enclosure openings required to reach access panels in the ductwork shall be large enough for removal of the access panel through the enclosure opening. [NFPA 96:7.4.4.1 – 7.4.4.2]  
510.4 Listed Grease Ducts. Listed grease ducts shall be installed in accordance with the terms of the listing and the manufacturer’s instructions. [NFPA 96:7.4.7.1.8]  
510.4.1 Factory-Built Grease Ducts. Factory-built grease ducts in accordance with UL 1978 shall be permitted to incorporate non-welded joints in accordance with their listings.  
510.5 Other Grease Ducts. Other grease ducts shall comply with the requirements of Section 510.5.1 through Section 510.5.5. [NFPA 96:7.5]  
510.5.1 Materials. Ducts shall be constructed of and supported by carbon steel not less than 0.060 of an inch (1.524 mm) (No. 16 MSG) in thickness or stainless steel not less than 0.048 of an inch (1.219 mm) (No. 18 MSG) in thickness. [NFPA 96:7.5.1.1]  
510.5.2 Factory-Built Grease Ducts. Factory-built grease ducts listed in accordance with UL 1978 shall be permitted to use materials in accordance with their listing. [NFPA 96:7.5.1.2]  
510.5.3 Installation. All seams, joints, penetrations, and duct-to-hood collar connections shall have a liquidtight continuous external weld. [NFPA 96:7.5.2.1]  
Exceptions:  
(1) Factory-built grease ducts listed in accordance with UL 1978 shall be permitted to incorporate non-welded joint construction in accordance with their listings. [NFPA 96:7.5.2.1.1]  
(2) Duct-to-hood collar connections as shown in Figure 510.5.3 shall not require a liquidtight continuous external weld. [NFPA 96:7.5.2.2]  
(3) Penetrations shall be permitted to be sealed by other listed devices that are tested to be greasetight and are evaluated under the same conditions of fire severity as the hood or enclosure of listed grease extractors and whose presence does not detract from the hood’s or duct’s structural integrity. [NFPA 96:7.5.2.3]  
(4) Internal welding shall be permitted, provided the joint is formed or ground smooth and is readily accessible for inspection. [NFPA 96:7.5.2.4]
FIGURE 510.5.3
PERMITTED DUCT-TO HOOD COLLAR CONNECTION
[NFPA 96: FIGURE 7.5.2.2]

Notes:
1. Duct size decreases (going upward) with each telescope.
2. Smaller (inside) duct section shall be above or uphill (on sloped duct), to be self draining into larger (outside) duct.

FIGURE 510.5.3.2(1)
TELESCOPING -TYPE DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(a)]

FIGURE 510.5.3.2(2)
BELL-TYPE DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(b)]

For SI units: 1 inch = 25.4 mm

FIGURE 510.5.3.2(3)
FLANGE WITH EDGE WELD DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(c)]

FIGURE 510.5.3.2(4)
FLANGE WITH FILLED LAP JOINT WELD DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(d)]

Notes:
1. Duct size stays the same throughout the duct system.
2. Smaller (inside) male duct end is always above or uphill (on sloped duct), to be self draining into larger (outside) female duct end.

For SI units: 1 inch = 25.4 mm

Notes:
1. Duct size decreases (going upward) with each telescope.
2. Smaller (inside) duct section shall be above or uphill (on sloped duct), to be self draining into larger (outside) duct.
510.5.3.1 Duct Leakage Test. Prior to the use of or concealment of any portion of a grease duct system, a leakage test shall be performed to determine that all welded joints and seams are liquid tight. [NFPA 96:7.5.2.1.2]

510.5.3.2 Welded Duct Connection. Acceptable duct-to-duct connection shall be as follows:

(1) Telescoping joint, as shown in Figure 510.5.3.2(1).
(2) Bell-type joint, as shown in Figure 510.5.3.2(2).
(3) Flange with edge weld, as shown in Figure 510.5.3.2(3).
(4) Flange with filled lap joint weld, as shown in Figure 510.5.3.2(4). [NFPA 96:7.5.5.1]

510.5.4 Butt Welded Connections. Butt welded connections shall not be permitted. [NFPA 96:7.5.5.2]

510.5.5 Telescoping and Bell-Type Connections. For telescoping and bell-type connections, the inside duct section shall always be upfhh of the outside duct section. [NFPA 96:7.5.5.3] The overlap shall not exceed 2 inches (51 mm) as shown in Figure 510.5.3.2(1).

510.5.6 Duct Leakage Test. Prior to the use of or concealment of a grease duct system, a leakage test shall be performed to determine that welded joints and seams are liquid tight. The leakage test shall consist of a light test, water pressure test, or an approved equivalent test. The permit holder shall be responsible for providing the necessary equipment and for performing the test. Such test shall be conducted in accordance with ASHRAE 154.

510.6 Exterior Installations. For cooking operations in buildings. The the exterior portion of the ductwork shall be vertical wherever possible and shall be installed and supported on the exterior of a building. Bolts, screws, rivets, and other mechanical fasteners shall not penetrate duct walls. Clearance of ducts shall comply with Section 507.4 through Section 507.4.3.3. [NFPA 96:7.6.1 – 7.6.3, 7.6.4]

510.6.1 Weather Protection. All ducts shall be protected on the exterior by paint or other suitable weather-protective coating. Ducts constructed of stainless steel shall not be required to have additional paint or weather-protective coatings. Ductwork subject to corrosion shall not have minimal contact with the building surface. [[NFPA 96:7.6.4 – 7.6.6 7.6.5 – 7.6.7]]

Exception: Ducts constructed of stainless steel shall not be required to have additional paint or weather-protective coatings.

510.7 Interior Installations. In all buildings more than one story in height and in one-story buildings where the roof-ceiling assembly is required to have a fire resistance rating, the ducts shall be enclosed in a continuous enclosure extending from the lowest fire-rated ceiling or floor above the hood, through any concealed spaces, to or through the roof, to maintain the integrity of the fire separations required by the applicable building code provisions. The enclosure shall be sealed around the duct at the point of penetration of the first fire-rated barrier after the hood, to maintain the fire resistance rating of the enclosure. The enclosure shall be vented to the exterior of the building through weather-protected openings. [NFPA 96:7.7.1.2 – 7.7.1.4]

Exception: The continuous enclosure provisions shall not be required where a field-applied grease duct enclosure or a factory-built grease duct enclosure (see Section 507.4.4 through Section 507.4.6) is protected with a listed duct-through-penetration protection system equivalent to the fire resistance rating of the assembly being penetrated and where the materials are installed in accordance with the conditions of the listings and the manufacturer’s instructions and are acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.1.5]

510.7.1 Less than Four Stories. Buildings less than four stories in height shall have an enclosure with a fire resistance rating of not less than 1 hour. [NFPA 96:7.7.2.1.1]

510.7.2 Four Stories or More. Buildings four stories or more in height shall have an enclosure with a fire resistance rating of not less than 2 hours. [NFPA 96:7.7.2.1.2]

510.7.3 Clearance. Clearance from the duct or the exhaust fan to the interior surface of enclosures of combustible construction shall be not less than 18 inches (457 mm). Clearance from the duct to the interior surface of enclosures of noncombustible or limited-combustible construction shall be not less than 6 inches (152 mm). Provisions for reducing clearances as described in Section 507.4 through Section 507.4.3.3 shall not be applicable to enclosures. [NFPA 96:7.7.2.2.1 – 7.7.2.2.3]

Exception: Clearance from the outer surfaces of field-applied grease duct enclosures and factory-built grease duct enclosures to the interior surfaces of construction installed around them shall be permitted to be reduced where the field-applied grease duct enclosure materials and factory-built grease duct enclosures are installed in accordance with the conditions of the listing and the manufacturer’s instructions and are acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.2.2.4]

510.7.4 Mechanical and Structural Integrity. Field-applied grease duct enclosures and factory-built grease duct enclosures shall provide mechanical and structural integrity, resiliency, and stability when subjected to expected building environmental conditions, duct movement under general operating conditions, and duct movement as a result of interior and exterior fire conditions. [NFPA 96:7.7.2.2.5]

510.7.5 Materials. For field-applied grease duct enclosures and factory-built grease duct enclosures, the materials and products shall be provided in accordance with Section 510.7.5.1 and Section 510.7.5.2.

510.7.5.1 Protection from Physical Damage. Measures shall be taken to prevent physical damage to any covering or enclosure material. Any damage to the covering or enclosure shall be repaired, and the covering or enclosure shall be restored to meet its intended listing and fire resistance rating and to be acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.3.1, 7.7.3.2]
510.7.5.2 Inspection. In the event of a fire within a kitchen exhaust system, the duct, the enclosure, and the covering directly applied to the duct shall be inspected by qualified personnel to determine whether the duct, the enclosure, and the covering directly applied to the duct are structurally sound, capable of maintaining their fire protection functions, suitable for continued operation, and acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.3.3]

510.7.6 Listed. For listed grease ducts, see Section 510.4.

510.7.7 Fire Doors. Where openings in the enclosure walls are provided, they shall be protected by listed fire doors of proper rating. Fire doors shall be installed in accordance with NFPA 80. Openings on other listed materials or products shall be clearly identified and labeled according to the terms of the listing and the manufacturer’s instructions and shall be acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.4.1 – 7.7.4.3] The fire door shall be readily accessible, aligned, and of sufficient size to allow access to the rated access panels on the ductwork. [NFPA 96:7.7.4.4]

510.7.8 Ducts with Enclosure(s). Each duct system shall constitute an individual system serving only exhaust hoods in one fire zone on one floor. Multiple ducts shall not be permitted in a single enclosure unless acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.5.1 – 7.7.5.2]

510.8 Underground Installations. Grease ducts installed underground shall be approved for underground installation. The material of the grease duct shall be corrosion-resistant and shall comply with Section 510.5.1.

510.8.1 Grease Receptacle. The grease duct shall be sloped to drain the grease back to an approved grease collection device. A grease collection device shall be located at the base of the vertical riser.

510.8.2 Cleanouts. For horizontal installations, cleanouts for cleaning and maintenance shall be provided on the top portion of the grease duct in accordance with Section 510.3 and shall be labeled at the interior portion of the duct.

510.9 Termination of Type I Hood Exhaust System. The exhaust system shall terminate as follows:

1. Outside the building with a fan or duct.
2. Through the roof or to the roof from outside, as in Section 510.9.1, or through a wall, as in Section 510.9.2. [NFPA 96:7.8.1]

510.9.1 Rooftop Terminations. Rooftop terminations shall be arranged with or provided with the following:

1. A minimum of 10 feet (3048 mm) of horizontal clearance from the outlet to adjacent buildings, property lines, and air intakes.
2. A minimum of 5 feet (1524 mm) of horizontal clearance from the outlet (fan housing) to any combustible structure.
3. A vertical separation of 3 feet (914 mm) above any air intakes within 10 feet (3048 mm) of the exhaust outlet.
4. The ability to drain grease out of any traps or low points formed in the fan or duct near the termination of the system into a collection container that is non-combustible, closed, rainproof, and structurally sound for the service to which it is applied and that will not sustain combustion.
5. A grease collection device that is applied to exhaust systems that does not inhibit the performance of any fan.

6. Listed grease collection systems that meet the requirements of Section 510.9.1(4) and Section 510.9.1(5).
7. A listed grease duct complying with Section 507.4.7 or ductwork complying with Section 507.4.8.
8. A hinged upblast fan supplied with flexible weatherproof electrical cable and service hold-open retainer to permit inspection and cleaning that is listed for commercial cooking equipment with the following conditions:
   a. Where the fan attaches to the ductwork, the ductwork is a minimum of 18 inches (457 mm) away from any roof surface, as shown in Figure 510.9.1.
   b. The fan discharges a minimum of 40 inches (1016 mm) away from any roof surface, as shown in Figure 510.9.1.
9. Other approved fan, provided it meets all of the following criteria:
   a. The fan meets the requirements of Section 510.9.1(3) and Section 511.1.3.
   b. Its discharge or its extended duct discharge meets the requirements of Section 510.9.1(2). (See Section 511.1.3)
   c. Exhaust fan discharge is directed up and away from the roof surface. [NFPA 96:7.8.2.1]

![FIGURE 510.9.1 UPBLAST FAN CLEARANCES](NFPA 96: FIGURE 7.8.2.1)
510.9.1.1 Listed Vibration Isolation Connectors. Listed vibration isolation connectors shall be permitted to be used on exterior roof locations where required for proper equipment vibration isolation.

510.9.1.2 Inspection and Cleaning. Fans shall be provided with safe access and a work surface for inspection and cleaning. [NFPA 96:7.8.2.2]

510.9.2 Wall Terminations. Wall terminations shall be arranged with or provided with the following properties:

1. The termination shall be through a noncombustible wall with a minimum of 10 feet (3048 mm) of clearance from the outlet to adjacent buildings, property lines, grade level, combustible construction, electrical equipment or lines, and with the closest point of any air intake or operable door or window at or below the plane of the exhaust termination. The closest point of any air intake or operable door or window above the plane of the exhaust termination shall be a minimum of 10 feet (3048 mm) in distance, plus 3 inches (76 mm) for each 1 degree (0.017 rad) from horizontal, the angle of degree being measured from the center of the exhaust termination to the center of the air intake or operable door or window, as indicated in Figure 510.9.2.

Exception: A wall termination in a secured area shall be permitted to be at a lower height above grade if acceptable to the Authority Having Jurisdiction.

2. The exhaust flow shall be directed perpendicularly outward from the wall face or upward.

3. All the ductwork shall be pitched to drain the grease back into the hood(s) or with a drain provided to bring the grease back into a container within the building or into a remote grease trap.

4. A listed grease duct shall comply with Section 510.3.3 through Section 510.5.7; other ducts shall comply with Section 510.5.

5. An approved fan shall meet the requirements of Section 510.9.2(3), and Section 511.1.1 or Section 511.1.3. [NFPA 96:7.8.3]

510.10 Solid-Fuel Duct Systems. Where solid-fuel cooking equipment is to be vented, the duct system shall be in accordance with Section 517.0.

511.0 Air Movement.

511.1 Exhaust Fans for Commercial Cooking Operations. Exhaust fans shall be installed in accordance with Section 511.1 through Section 511.1.6. Exhaust fans shall comply with UL 762 and UL 705 and be installed in accordance with the manufacturer’s installation instructions.

511.1.1 Upblast Fans. Upblast fans with motors surrounded by the airstream shall be hinged and supplied with flexible weatherproof electrical cable, and service hold-open retainers. Installation shall conform to the requirements of Section 510.9. Upblast fans shall have a drain directed to a readily accessible and visible grease receptacle not to exceed 1 gallon (4 L). [NFPA 96:8.1.2.1 – 8.1.2.3]

511.1.2 In-Line Exhaust Fans. In-line fans shall be of the type with the motor located outside the airstream and with belts and pulleys protected from the airstream by a grease-tight housing. In-line fans shall be connected to the exhaust duct by flanges securely bolted as shown in Figure 511.1.2(1) through Figure 511.1.2(4), or by a system specifically listed for such use. Flexible connectors shall not be used. [NFPA 96:8.1.3.1 – 8.1.3.3]

511.1.2.1 Accessibility. If the design or positioning of the fan allows grease to be trapped, a drain directed to a readily accessible and visible grease receptacle not exceeding 1 gallon (4 L) shall be provided. In-line exhaust fans shall be located in easily accessible areas of adequate size to allow for service or removal. Where the duct system connected to the fan is in an enclosure, the space or room in which
the exhaust fan is located shall have the same fire resistance rating as the enclosure. [NFPA 96:8.1.3.4 – 8.1.3.6]

511.1.3 Utility Set Exhaust Fans. Utility set exhaust fans shall be installed in accordance with Section 511.1.3.1 through Section 511.1.3.3.

511.1.3.1 At the Rooftop. Fans installed at the rooftop termination point shall be in accordance with the following:
(1) Section 510.9.1 and Section 510.9.1.2.

(2) Vibration isolation connectors shall be permitted.
(3) A drain shall be directed to a readily accessible and visible grease receptacle not to exceed 1 gallon (4 L).

511.1.3.2 Within the Building. Fans installed within the building shall be in accordance with the following:
(1) Located in an accessible area of adequate size to allow for service or removal. [NFPA 96:8.1.4.2]
511.1.4 Construction. Exhaust fan housings shall be constructed of carbon steel not less than 0.060 inch (1.524 mm) (No. 16 MSG) in thickness, of stainless steel not less than 0.048 of an inch (1.219 mm) (No. 18 MSG) in thickness, or, if listed, in accordance with the terms of the listing. [NFPA 96:8.1.5]

511.1.5 Openings. Openings for cleaning, servicing, and inspection shall conform to the requirements of Section 510.3.2. Clearances shall conform to the requirements of Section 507.4 through 507.4.3.3, or Section 510.7.3 and Section 510.7.4 if installed within an enclosure. [NFPA 96:8.1.6.1, 8.1.6.2]

511.1.6 Standard. All wiring and electrical equipment shall comply with NFPA 70. [NFPA 96:8.1.7]

511.2 Airflow. The air velocity through a duct shall be not less than 500 feet per minute (ft/min) (2.54 m/s) and not exceed 2500 ft/min (12.7 m/s). [NFPA 96:8.1.4.6]

511.2.1 Exceptions. Transition duct sections that do not exceed 3 feet (914 mm) in length and do not contain grease traps shall be permitted to be connected to hoods and exhaust fans that do not meet this velocity. [NFPA 96:8.2.1.2]

511.2.2 Exhaust-Air Volumes. Exhaust air volumes for hoods shall be of sufficient level to provide for capture and removal of grease-laden cooking vapors. Test data, performance tests acceptable to the Authority Having Jurisdiction, or both shall be displayed, provided on request, or both. [NFPA 96:8.2.2.1, 8.2.2.2] Lower exhaust air volumes shall be permitted during no-load and partial load cooking conditions, provided they are sufficient to capture and remove flue gases and cooking effluent from cooking equipment.

511.2.2.1 Performance Test. A performance test shall be conducted upon completion and before final approval of the installation of a ventilation system serving commercial cooking appliances. The test shall verify the rate of exhaust airflow in accordance with Section 508.5.1.2 through Section 508.5.1.5. The permit holder shall furnish the necessary test equipment and devices required to perform the tests. [ASHRAE 154:4.7.1]

511.2.2.2 Capture and Containment Test. The permit holder shall verify the capture and containment performance of Type I hoods. A field test shall be conducted with all appliances under the hood at operating temperatures, all the hoods operating at design airflows, and with all sources of replacement air operating at design airflows for the restaurant. Capture and containment shall be verified visually by observing smoke or steam produced by actual cooking operation or by simulating cooking using devices such as smoke candles or smoke puffers. Smoke bombs shall not be used. [ASHRAE 154:4.7.2]

511.2.3 Exhaust Fan Operation. A hood exhaust fan(s) shall continue to operate after the extinguishing system has been activated unless fan shutdown is required by a listed component of the ventilation system or by the design of the extinguishing system. The hood exhaust fan shall start upon actuation of the extinguishing system if the exhaust fan and all cooking equipment served by the fan have been shut down, unless fan shutdown is required by a listed component of the ventilation system or by the listing of the extinguishing system. The exhaust fan shall be provided with a means so that the fan is activated when any heat-producing cooking appliance under the hood is turned on. [NFPA 96:8.2.3.1 – 8.2.3.3]

511.3 Makeup Air. The makeup air quantity shall prevent negative pressures in the commercial cooking area(s) from exceeding 0.02 inch water column (0.005 kPa). Where the fire-extinguishing system activates, makeup air supplied internally to a hood shall be shut off.

For compensating hoods, where a Type I or Type II hood has an internal discharge of makeup air, the makeup air flow shall not exceed 10 percent of the exhaust airflow, the exhaust airflow shall be the net exhaust from the hood in accordance with Section 508.5.1.2 through Section 508.5.1.5. The total hood exhaust shall be determined in accordance with Equation 511.3.

\[ E_{NET} = E_{HOOD} - MA_{ID} \]  
(Equation 511.3)

Where:
- \( E_{NET} \) = net hood exhaust
- \( E_{HOOD} \) = total hood exhaust
- \( MA_{ID} \) = makeup air, internal discharge

511.3.1 Air Balance. Design plans for a facility with a commercial kitchen ventilation system shall include a schedule or diagram indicating the design outdoor air balance. The design outdoor air balance shall indicate the exhaust and replacement air for the facility and the net exfiltration where applicable. The total replacement airflow rate shall equal the total exhaust airflow rate and the net exfiltration.

511.4 Common Duct (Manifold) Systems. Master kitchen exhaust ducts that serve multiple tenants shall include...
provision to bleed air from outdoors or from adjacent spaces into the master exhaust duct where required to maintain the necessary minimum air velocity in the master exhaust duct. [NFPA 96:8.4.1]

511.4.1 Connections. Bleed air ducts shall connect to the top or side of the master exhaust duct. [NFPA 96:8.4.2]

511.4.2 Fire Damper. The bleed-air duct shall have a fire damper at least 12 inches (305 mm) from the exhaust duct connection. [NFPA 96:8.4.3]

511.4.3 Construction and Clearance. The bleed-air duct shall have the same construction and clearance requirements as the main exhaust duct from the connection to the exhaust duct to at least 12 inches (305 mm) on both sides of the fire damper. [NFPA 96:8.4.4]

511.4.4 Adjustment. Each bleed air duct shall have a means of adjusting (e.g., by using volume dampers) the bleed air quantity. [NFPA 96:8.4.5]

511.4.5 Adjustment Location. Means to adjust the bleed air quantity shall be installed between the fire damper and the source of bleed air. [NFPA 96:8.4.6]

511.4.6 Bleed Air Duct. A bleed air duct shall not be used for the exhaust of grease-laden vapors and shall be so labeled. [NFPA 96:8.4.7]

511.4.7 Disconnect. Unused tenant exhaust connections to the master exhaust duct that are not used as bleed air connections shall be disconnected and sealed at the main duct. [NFPA 96:8.4.8]

511.5 Solid-Fuel Air Movement Requirements. Where solid-fuel cooking equipment is used, exhaust and replacement air also shall be in accordance with Section 517.0.

512.0 Auxiliary Equipment.

512.1 Dampers. Dampers shall not be installed in exhaust ducts or exhaust duct systems. [NFPA 96:9.1.1]

512.1.1 Use. Where specifically listed for such use or where required as part of a listed device or system, dampers in exhaust ducts or exhaust duct systems shall be permitted. [NFPA 96:9.1.2]

512.2 Electrical Equipment. Wiring systems of any type shall not be installed in ducts. [NFPA 96:9.2.1]

512.2.1 Device Installation in Ducts. Motors, lights, and other electrical devices shall be permitted to be installed in ducts or hoods or to be located in the path of travel of exhaust products only where specifically listed for such use. [NFPA 96:9.2.2]

512.2.2 Lighting Units. Lighting units on hoods shall not be located in concealed spaces except as permitted by Section 512.2.3 and Section 512.2.4. [NFPA 96:9.2.3.2]

512.2.3 Concealed Spaces. Lighting units shall be permitted in concealed spaces where such units are part of a listed exhaust hood. [NFPA 96:9.2.3.3]

512.2.4 Listed Lighting Units. Listed lighting units specifically listed for such use and installed in accordance with the terms of the listing shall be permitted to be installed in concealed spaces. [NFPA 96:9.2.3.4]

512.2.5 Standard. Electrical equipment shall be installed in accordance with NFPA 70, with due regard to the effects of heat, vapor, and grease on the equipment.

512.3 Other Equipment. Fume incinerators, thermal recovery units, air pollution control devices, or other devices shall be permitted to be installed in ducts or hoods or to be located in the path of travel of exhaust products where specifically listed for such use. [NFPA 96:9.3.1]

512.3.1 Access Required. Equipment shall have space provided to all access panels or doors for the safe removal and servicing of control devices, such as filters, electrostatic precipitator cells, and odor control media beds, and for cleaning of the equipment housing. [NFPA 96:9.3.1.3]

512.3.2 Downgrading. Downgrading other parts of the exhaust system due to the installation of approved devices, whether listed or not, shall not be allowed. [NFPA 96:9.3.2]

512.3.3 Fire-Extinguishing System. Any equipment installed in the path of exhaust products that provides secondary filtration or air pollution control shall be provided with an approved automatic fire-extinguishing system, installed in accordance with the fire-extinguishing system manufacturer’s instructions. [NFPA 96:9.3.3]

512.3.3.1 Protection. The fire-extinguishing system required by Section 512.3.3 shall provide protection for the component sections of the equipment, and ductwork downstream of the equipment. [NFPA 96:9.3.3.1]

512.3.3.2 Filter Media. Filter media used in secondary filtration or air pollution control units and not complying with Section 509.2.3 shall have fire protection that is adequate for the filter media being used in accordance with the fire-extinguishing system manufacturer’s instructions. [NFPA 96:9.3.3.2]

512.3.4 Source of Ignition. If the equipment provides a source of ignition, it shall be provided with detection to operate the fire-extinguishing system protecting the equipment. [NFPA 96:9.3.4]

512.3.5 Air Recirculation. Where a cooking exhaust system employs an air pollution control device that recirculates air into the building, the requirements of Section 516.0 shall apply. [NFPA 96:9.3.5]

512.3.6 Carbon Monoxide Detector Required. If the heat source is non-electric and open flames are used, a carbon monoxide detector shall be installed in both the kitchen and dining areas. [NFPA 96:9.3.7]

512.4 Solid-Fuel Auxiliary Equipment. Where solid fuel cooking comprises a part of a cooking operation, additional provisions, and equipment as described in Section 517.0 shall be used where required.

513.0 Fire-Extinguishing Equipment.

513.1 General. Fire-extinguishing equipment for the protection of grease removal devices, hood exhaust plenums, and exhaust duct systems shall be provided. [NFPA 96:10.1.1]
513.1.1 Devices in Exhaust Ducts. Fume incinerators, thermal recovery units, air pollution control devices, or other devices installed in the exhaust duct, shall be protected by an automatic fire-extinguishing system. [NFPA 96:10.1.3]

513.1.2 Protection. Cooking equipment that produces grease-laden vapors and that might be a source of ignition of grease in the hood, grease removal device, or duct shall be protected by fire-extinguishing equipment. [NFPA 96:10.1.2]

513.2 Types of Equipment. Fire-extinguishing equipment shall include both automatic fire-extinguishing systems as primary protection and portable fire extinguishers as secondary backup. [NFPA 96:10.2.1]

513.2.1 Identification. A placard shall be conspicuously placed near each Class K extinguisher that states that the fire protection system shall be activated prior to using the fire extinguisher. [NFPA 96:10.2.2]

513.2.2 Standard. Automatic fire-extinguishing systems shall comply with UL 300 or other equivalent standards and shall be installed in accordance with the requirements of the listing. In existing dry or wet chemical systems not in compliance with UL 300, the fire-extinguishing system shall be made to comply with this section when any of the following occurs:

1. The cooking medium is changed from animal oils and fats to vegetable oils.
2. The positioning of the cooking equipment is changed.
3. Cooking equipment is replaced.
4. The equipment is no longer supported by the manufacturer. [NFPA 96:10.2.3, 10.2.3.1]

Exception: Automatic fire-extinguishing equipment provided as part of listed recirculating systems shall comply with UL 710B. [NFPA 96:10.2.5]

513.2.3 Installation. Automatic fire-extinguishing systems shall be installed in accordance with the terms of their listing, the manufacturer’s installation instructions, and the following standards where applicable:

1. NFPA 12
2. NFPA 13
3. NFPA 17
4. NFPA 17A

513.2.4 Modification of Existing Hood Systems. Any abandoned pipe or conduit from a previous installation shall be removed from within the hood, plenum, and exhaust duct. [NFPA 96:10.2.7.1]

513.2.4.1 Sealing. Penetrations and holes resulting from the removal of conduit or piping shall be sealed with listed or equivalent liquid-tight sealing devices. [NFPA 96:10.2.7.2]

513.2.4.2 Obstructions. The addition of obstructions to spray patterns from the cooking appliance nozzle(s) such as baffle plates, shelves, or any modification shall not be permitted. [NFPA 96:10.2.7.3]

513.2.5 Baffle Hoods with Water Wash. Areas requiring protection in accordance with Section 513.1 shall be permitted to be protected by a water-wash system that is listed as a fire-extinguishing system in compliance with UL 300 or other equivalent standards and installed in accordance with the requirements of its listing. [NFPA 96:10.2.8.1]

513.2.5.1 Listed for the Purpose. Each such area not provided with a listed water-wash fire-extinguishing system shall be provided with a fire-extinguishing system listed for the purpose. [NFPA 96:10.2.8.2]

513.2.5.2 Domestic Water Supply. The water supply for water-wash fire-extinguishing systems shall be permitted to be supplied from the domestic water supply when the minimum water pressure and flow are provided in accordance with the terms of the listing. [NFPA 96:10.2.8.3]

513.2.5.3 Control Valve. The water supply for water-wash fire-extinguishing systems shall be controlled by a listed indicating valve. [NFPA 96:10.2.8.4]

513.2.5.4 Activation. Where a separate fire-extinguishing system is used for protection of cooking equipment only, a water-wash fire-extinguishing system listed for protection of the grease removal device(s), hood exhaust plenum(s), exhaust duct(s), or combination thereof shall be provided with instructions and appropriate means for electrical interface for simultaneous activation. [NFPA 96:10.2.8.5]

513.2.5.5 Water-Wash System. A water-wash system approved to be used for protection of the grease removal device(s), hood exhaust plenum(s), exhaust duct(s), or combination thereof include instructions and appropriate electrical interface for simultaneous activation of the water-wash system from an automatic fire-extinguishing system, where the automatic fire-extinguishing system is used for cooking equipment protection only. [NFPA 96:10.2.8.6]

513.2.5.6 Exception. Where the automatic fire-extinguishing system in accordance with NFPA 17A provides protection for the hood and duct in a fixed baffle hood containing a water-wash system, the water-wash system shall be made inoperable or delayed for a minimum of 60 seconds upon operation of the automatic fire-extinguishing system. [NFPA 96:10.2.8.7]

513.2.5.7 Water Supply. The water required for listed automatic fire-extinguishing systems shall be permitted to be supplied from the domestic water supply where the minimum water pressure and flow are provided in accordance with the terms of the listing.
The water supply shall be controlled by a supervised water supply control valve. Where the water supply is from a dedicated fire protection water supply in a building with one or more fire sprinkler systems, separate indicating control valves and drains shall be provided and arranged so that the hood system and sprinkler systems can be controlled individually. [NFPA 96:10.2.9.1, 10.2.9.2]

513.2.6 Water Valve Supervision. Valves controlling the water supply to listed water-wash fire-extinguishing systems, automatic fire-extinguishing systems, or both shall be listed indicating type of valve and shall be supervised open by one of the following methods:

(1) Central station, proprietary, or remote station alarm service.
(2) Local alarm service that will cause the sounding of an audible signal at a constantly attended point.
(3) Locking valves open.
(4) Sealing of valves and approved weekly recorded inspection. [NFPA 96:10.2.10]

513.3 Simultaneous Operation. Fixed pipe extinguishing systems in a single hazard area shall be arranged for simultaneous automatic operation upon actuation of any one of the systems. [NFPA 96:10.3.1]

513.3.1 Hoods. Hoods installed end to end, back to back, or both, or sharing a common ductwork, not exceeding 75 feet (22 860 mm) in distance from the farthest hood, and having a grease producing appliance(s) located under one or more of the hoods, shall be considered a single hazard area requiring simultaneous automatic fire protection in all hoods and ducts. [NFPA 96:10.3.1.1]

513.3.1.1 Common Ductwork. In hoods that are installed end to end, back to back, or both, and that share a common ductwork, the ductwork beyond 75 feet (22 860 mm) from the farthest hood shall be protected by an independent fire-extinguishing system with its own detection system or by a fire-extinguishing system that activates simultaneously with the fire-extinguishing system(s) protecting the hoods. [NFPA 96:10.3.1.1.1]

513.3.2 Independent Systems. Hoods installed end to end, back to back, or both that do not share a common exhaust duct and are separated by a wall(s) or other means to ensure that grease-laden vapors exhausted under one hood cannot propagate to the other hoods, the hoods’ fire-extinguishing system(s) shall be independent and shall not be required to simultaneously discharge. [NFPA 96:10.3.1.2]

513.3.3 Exempt Equipment. Fume incinerators, thermal recovery units, air pollution control devices, or other devices installed in the exhaust duct shall not be required to comply with Section 513.3.1. [NFPA 96:10.3.1.3]

513.3.4 Automatic Sprinkler System. Simultaneous operation shall not be required where the one fixed pipe extinguishing system is an automatic sprinkler system. Where an automatic sprinkler system is used in conjunction with a water-based fire-extinguishing system served by the same water supply, hydraulic calculations shall consider both systems operating simultaneously. [NFPA 96:10.3.2, 10.3.2.1]

513.3.5 Dry or Wet Chemical Systems. Simultaneous operation shall be required where a dry or wet chemical system is used to protect common exhaust ductwork by one of the methods specified in NFPA 17 or NFPA 17A. [NFPA 96:10.3.3]

513.4 Fuel and Electric Power Shutoff. Upon activation of any fire-extinguishing system for a cooking operation, all sources of fuel and electrical power that produce heat to all equipment requiring protection shall be automatically shut off. [NFPA 96:10.4.1]

Exception: Solid-fuel cooking operations.

513.4.1 Steam. Steam supplied from an external source shall not be required to automatically shut off. [NFPA 96:10.4.2]

513.4.2 Protection Not Required. Gas appliances not requiring protection but located under the same ventilation equipment where protected appliances are located, shall also be automatically shut off upon activation of the extinguishing system. [NFPA 96:10.4.3]

513.4.3 Manual Reset. Shutoff devices shall require manual reset before fuel or power being restored. [NFPA 96:10.4.4]

513.5 Manual Activation. All systems shall have both automatic and manual methods of actuation. At least one manual actuation device shall be located in a means of egress or at a location acceptable to the Authority Having Jurisdiction.

The manual actuation device shall clearly identify the hazard and be provided with instructions for its use. An automatic sprinkler system shall not require a method of manual actuation. [NFPA 96:10.5.1, 10.5.1.2, 10.5.2]

513.6 System Annunciation. Upon activation of an automatic fire-extinguishing system, an audible alarm or visual indicator shall be provided to show that the system has activated. [NFPA 96:10.6.1]

513.6.1 Signaling. Where a fire alarm signaling system is serving the occupancy where the extinguishing system is located, the activation of the automatic fire-extinguishing system shall activate the fire alarm signaling system in accordance with the requirements of NFPA 72. [NFPA 96:10.6.2]

513.7 Special Design and Application. Hoods containing automatic fire-extinguishing systems are protected areas; therefore, these hoods shall not be considered obstructions to overhead sprinkler systems and shall not require floor additional sprinkler coverage underneath. [NFPA 96:10.7.1]

513.8 Review and Certification. Where required, complete drawings of the system installation, including the hood(s), exhaust duct(s), and appliances, along with the interface of the fire-extinguishing system detectors, piping, nozzles, fuel and electric power shutoff devices, agent storage container(s), and manual actuation device(s), shall be submitted to the Authority Having Jurisdiction. [NFPA 96:10.8.1]
513.9 Installation Requirements. Installation of systems shall be performed only by persons properly trained and qualified to install the specific system being provided. The installer shall provide certification to the Authority Having Jurisdiction that the installation is in agreement with the terms of the listing and the manufacturer’s instructions and/or approved design. [NFPA 96:10.8.2.1, 10.8.2.2]

513.10 Portable Fire Extinguishers. Portable fire extinguishers shall be selected and installed in kitchen cooking areas in accordance with NFPA 10 and shall be specifically listed for such use. Class K fire extinguishers shall be provided for cooking appliance hazards that involve combustible cooking media (vegetable oils and animal oils and fats). [NFPA 96:10.9.1, 10.9.2]

513.10.1 Other Fire Extinguishers. Portable fire extinguishers shall be provided for other hazards in kitchen areas and shall be selected and installed in accordance with NFPA 10. [NFPA 96:10.9.3]

513.10.2 Carbon Dioxide-Type. Carbon dioxide-type extinguishers shall not be permitted. [NFPA 96:10.9.4]

513.11 Maintenance. Portable fire extinguishers shall be maintained in accordance with NFPA 10. [NFPA 96:10.9.5]

513.11.1 Permitted Use. Portable fire extinguishers listed specifically for use in the kitchen cooking areas shall also be permitted.

513.12 Solid-Fuel Fire-Extinguishing Equipment. Where solid-fuel cooking equipment is served by fire extinguishing equipment, the provisions of Section 517.0 shall apply.

514.0 Procedures for the Use, Inspection, Testing, and Maintenance of Equipment.

514.1 Operating Procedures. Exhaust systems shall be operated whenever cooking equipment is turned on. [NFPA 96:11.1.1]

514.1.1 Filters. Filter-equipped exhaust systems shall not be operated with filters removed. [NFPA 96:11.2.1]

514.1.2 Openings. Openings provided for replacing air exhausted through ventilating equipment shall not be restricted by covers, dampers, or any other means that would reduce the operating efficiency of the exhaust system. [NFPA 96:11.3]

514.1.3 Posting of Instructions. Instructions for manually operating the fire-extinguishing system shall be posted conspicuously in the kitchen and shall be reviewed with employees by the management. [NFPA 96:11.4.3]

514.1.4 Listing and Manufacturer’s Instructions. Listed exhaust hoods shall be operated in accordance with the terms of their listings and the manufacturer’s instructions. [NFPA 96:11.5.3]

514.1.5 Nonoperational. Cooking equipment shall not be operated while its fire-extinguishing system or exhaust system is nonoperational or impaired. [NFPA 96:11.6]

514.1.6 Secondary Control Equipment. Secondary filtration and pollution control equipment shall be operated in accordance with the terms of its listing and the manufacturer’s recommendations. [NFPA 96:11.7]

514.1.7 Inspection Frequency. Inspection and maintenance of “other equipment” as allowed in Section 512.3 shall be conducted by properly trained and qualified persons at a frequency determined by the manufacturer’s instructions or the equipment listing. [NFPA 96:11.8]

514.2 Inspection, Testing, and Maintenance. Maintenance of the fire-extinguishing systems and listed exhaust hoods containing a constant or fire-activated water system that is listed to extinguish a fire in the grease removal devices, hood exhaust plenums, and exhaust ducts shall be made by properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction at least every 6 months. [NFPA 96:12.1.1, 12.2.1]

514.2.1 Requirements. All actuation and control components, including remote manual pull stations, mechanical and electrical devices, detectors, and actuators, shall be tested for proper operation during the inspection in accordance with the manufacturer’s procedures. The specific inspection and maintenance requirements of the extinguishing system standards as well as the applicable installation and maintenance manuals for the listed system and service bulletins shall be followed. [NFPA 96:12.2.1, 12.2.2, 12.2.3]

514.2.2 Fusible Links and Sprinklers. Fusible links of the metal alloy type and automatic sprinklers of the metal alloy type shall be replaced at least semiannually. [NFPA 96:12.2.4]

514.2.3 Inspection Tag. The year of manufacture and the date of installation of the fusible links shall be marked on the system inspection tag. The tag shall be signed or initialed by the installer.

Detection devices that are bulb-type automatic sprinklers and fusible links other than the metal alloy type shall be examined and cleaned or replaced annually. [NFPA 96:12.2.5, 12.2.5.1, 12.2.6, 12.2.7, 12.2.8]

514.2.4 Temperature-Sensing Elements. Fixed temperature-sensing elements other than the fusible metal alloy type shall be permitted to remain continuously in service, provided they are inspected and cleaned, or replaced if necessary in accordance with the manufacturer’s instructions, every 12 months or more frequently to ensure proper operation of the system. [NFPA 96:12.2.7]

514.2.5 Certification. Where required, certificates of inspection and maintenance shall be forwarded to the Authority Having Jurisdiction. [NFPA 96:12.2.8]

514.3 Inspection for Grease Buildup. The entire exhaust system shall be inspected for grease buildup by a properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction and in accordance with Table 514.3. [NFPA 96:12.4]
TABLE 514.3
SCHEDULE OF INSPECTION FOR GREASE BUILDUP
[NFPA 96: TABLE 11.4]

<table>
<thead>
<tr>
<th>TYPE OR VOLUME OF COOKING</th>
<th>INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systems serving solid fuel cooking operations.</td>
<td>Monthly</td>
</tr>
<tr>
<td>Systems serving high-volume cooking operations.¹</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Systems serving moderate-volume cooking operations.</td>
<td>Semiannually</td>
</tr>
<tr>
<td>Systems serving low-volume cooking operations.²</td>
<td>Annually</td>
</tr>
</tbody>
</table>

Notes:
¹ High-volume cooking operations include 24-hour cooking, charbroiling, and wok cooking.
² Low-volume cooking operations include churches, day camps, seasonal businesses, and senior centers.

514.4 Cleaning of Exhaust Systems. If, upon inspection, the exhaust system is found to be contaminated with deposits from grease-laden vapors, the contaminated portions of the exhaust system shall be cleaned by a properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction. [NFPA 96:11.6.1.1.4]

514.4.1 Measurement System. A measurement system of deposition shall be established to trigger a need to clean when the exhaust system is inspected at the frequencies in Table 514.3. [NFPA 96:11.6.1.1.1]

514.4.1.1 Combustible Contaminants. Hoods, grease removal devices, fans, ducts, and other appurtenances shall be cleaned to remove combustible contaminants to a minimum of 0.002 of an inch (50 µm). [NFPA 96:11.6.1.1.1.1]

514.4.1.2 Gauge Comb. A grease depth gauge comb as shown in Figure 514.4.1.2 shall be placed upon the surface to measure grease depth. [NFPA 96:11.6.1.1.2]

514.4.1.3 Cleaning Method. Where a measured depth of 0.078 of an inch (2000 µm) is observed, the surfaces shall be cleaned in accordance with Section 514.4. [NFPA 96:11.6.1.1.3]

514.4.1.4 Combustible Contaminants. Where a measured depth of 0.125 of an inch (3175 µm) is observed in a fan housing, the surfaces shall be cleaned in accordance with Section 514.4. [NFPA 96:11.6.1.1.4]

514.4.2 Removal of Contaminants. Hoods, grease removal devices, fans, ducts, and other appurtenances shall be cleaned to remove combustible contaminants prior to surfaces becoming heavily contaminated with grease or oily sludge. [NFPA 96:11.6.2]

514.4.3 Electrical Switches. At the start of the cleaning process, electrical switches that could be activated accidentally shall be locked out. [NFPA 96:11.6.3]

514.4.4 Fire Suppression System. Components of the fire suppression system shall not be rendered inoperable during the cleaning process. [NFPA 96:11.6.4]

514.4.5 Inoperable. Fire-extinguishing systems shall be permitted to be rendered inoperable during the cleaning process where serviced by properly trained and qualified persons. [NFPA 96:11.6.5]

514.4.6 Solvents/Cleaning Aids. Flammable solvents or other flammable cleaning aids shall not be used. [NFPA 96:11.6.6]

514.4.7 Cleaning Chemicals. Cleaning chemicals shall not be applied on fusible links or other detection devices of the automatic extinguishing system. [NFPA 96:11.6.7]

514.4.8 Coating. After the exhaust system is cleaned, it shall not be coated with powder or other substance. [NFPA 96:11.6.8]

514.4.9 Access Panels and Cover Plates. When cleaning procedures are completed, all access panels (doors) and cover plates shall be restored to their normal operational condition. [NFPA 96:11.6.9]

514.4.10 Date of Inspection. When an access panel is removed, a service company label or tag preprinted with the name of the company and giving the date of inspection or cleaning shall be affixed near the affected access panels. [NFPA 96:11.6.10]

514.4.11 Airflow. Dampers and diffusers shall be positioned for proper airflow. [NFPA 96:11.6.11]

514.4.12 Operable State. When cleaning procedures are completed, all electrical switches and system components shall be returned to an operable state. [NFPA 96:11.6.12]

514.4.13 Certification of Service. When an exhaust system is inspected or cleaned, a certificate showing the name of the servicing company, the name of the person performing the work, and the date of inspection or cleaning shall be maintained on the premises. [NFPA 96:11.6.13]

514.4.14 Report Provided. After cleaning or inspection is completed, the exhaust cleaning company and the person performing the work at the location shall provide the owner of the system with a written report that also specifies areas that were inaccessible or not cleaned. [NFPA 96:11.6.14]
514.4.15 Unclean Area. Where required, certificates of inspection and cleaning and reports of areas not cleaned shall be submitted to the Authority Having Jurisdiction. [NFPA 96:14.6.14 12.6.15]

514.4.16 Metal Containers. Metal containers used to collect grease drippings shall be inspected or emptied at least weekly. [NFPA 96:14.6.14 12.6.16]

514.5 Cooking Equipment Maintenance. Inspection and servicing of the cooking equipment shall be made at least annually by properly trained and qualified persons. [NFPA 96:14.7.1 12.7.1]

514.5.1 Cleaning. Cooking equipment that collects grease below the surface, behind the equipment, or in cooking equipment flue gas exhaust, such as griddles, deep-fat fryers, or charbroilers, shall be inspected and, if found with grease accumulation, cleaned by a properly trained, qualified, and certified person(s) acceptable to the Authority Having Jurisdiction. [NFPA 96:14.7.2 12.7.2]

515.0 Minimum Safety Requirements for Cooking Equipment.

515.1 Cooking Equipment. Cooking equipment shall be approved based on one of the following criteria:

(1) Listings by a testing laboratory. [NFPA 96:13.1.1.1]

515.1.1 Installation. All listed appliances shall be installed in accordance with the terms of their listings and the manufacturer’s instructions. Solid fuel used for flavoring within a gas-operated appliance shall be in a solid fuel holder (smoker box) that is listed with the equipment. [NFPA 96:13.1.2.4 13.1.2.1.1 13.1.2.1.1]

515.1.1.1 Re-evaluation. Cooking appliances requiring protection shall not be moved, modified, or rearranged without prior re-evaluation of the fire-extinguishing system by the system installer or servicing agent, unless otherwise allowed by the design of the fire-extinguishing system. A solid fuel holder shall not be added to an existing appliance until the fire-extinguishing system has been evaluated by the fire-extinguishing system service provider. [NFPA 96:13.1.2.2.2 13.1.2.2 13.1.2.1.2.2 13.1.2.1.2.1.1]

515.1.1.2 Prior Location. The fire-extinguishing system shall not require re-evaluation where the cooking appliances are moved for the purposes of maintenance and cleaning, provided the appliances are returned to approved design location prior to cooking operations, and any disconnected fire-extinguishing system nozzles attached to the appliances are reconnected in accordance with the manufacturer’s listed design manual. [NFPA 96:13.1.2.3]

515.1.1.3 Minimum Space. All deep-fat fryers shall be installed with at least a 16 inch (406 mm) space between the fryer and surface flames from adjacent cooking equipment. [NFPA 96:13.1.2.4]

515.1.4 Space Not Required. Where a steel or tempered glass baffle plate is installed at a minimum 8 inches (203 mm) in height between the fryer and surface flames of the adjacent appliance, the requirement for a 16 inch (406 mm) space shall not apply. [NFPA 96:13.1.2.5 13.1.2.5.1]

515.1.5 Minimum Height. If the fryer and the surface flames are at different horizontal planes, the minimum height of 8 inches (203 mm) shall be measured from the higher of the two. [NFPA 96:13.1.2.5 13.1.2.5.1]

515.2 Operating Controls. Deep-fat fryers shall be equipped with a separate high-limit control in addition to the adjustable operating control (thermostat) to shut off fuel or energy when the fat temperature reaches 475°F (246°C) at 1 inch (25.4 mm) below the surface. [NFPA 96:13.2.1 13.2.2]

516.0 Recirculating Systems.

516.1 General Requirements. Recirculating systems containing or for use with appliances used in processes producing smoke or grease-laden vapors shall be equipped with components complying with the following:

(1) The clearance requirements of Section 507.4 through Section 507.4.3.3.
(2) A hood complying with the requirements of Section 508.0.
(3) Grease removal devices complying with Section 509.0.
(4) The air movement requirements of Section 511.2.1 and Section 511.2.2.
(5) Auxiliary equipment (such as particulate and odor removal devices) complying with Section 512.0.
(6) Fire-extinguishing equipment complying with the requirements of Section 513.0.

Exception: Fire-extinguishing equipment in accordance with Section 513.1 and Section 513.5.

(7) The use and maintenance requirements of Section 514.0.
(8) The minimum safety requirements of Section 515.0.
(9) All the requirements of Section 516.0. [NFPA 96:13.2.1 14.1]

516.2 Design Restrictions. All recirculating systems shall comply with the requirements of Section 516.2.1 through Section 516.2.9. [NFPA 96:13.2.1 14.2]

516.2.1 Gas/Electrically Fueled Cooking Appliances. Only gas-fueled or electrically fueled cooking appliances shall be used. Listed gas-fueled equipment designed for use with specific recirculating systems shall have the flue outlets connected in the intended manner. Gas-fueled appliances shall have a minimum 18 inches (457 mm) clearance from the flue outlet to the filter inlet in accordance with Section 509.2.2 through Section 509.2.2.3 and shall meet the installation requirements of this code, NFPA 54 or NFPA 58. [NFPA 96:13.2.1 14.2.3 14.2.1 – 14.2.3]

516.2.2 Recirculation. Recirculating systems shall be listed with a testing laboratory in accordance with UL 710B or equivalent. [NFPA 96:13.2.4 14.2.4]
516.2.3 Protection. Cooking appliances that require protection and that are under a recirculating hood shall be protected by either the integral fire protection system in accordance with UL 710B or a system in accordance with Section 513.0. [NFPA 96:13.2.4.2 14.2.4.2]

516.2.4 Maximum Limits. A recirculating system shall not use cooking equipment that exceeds that recirculating system’s labeled maximum limits for that type of equipment, stated in maximum energy input, maximum cooking temperature, and maximum square area of cooking surface or cubic volume of cooking cavity. [NFPA 96:14.2.4.1 14.2.7]

516.2.5 Label. The listing label shall show the type(s) of cooking equipment tested and the maximum limits specified in Section 516.2.4. [NFPA 96:14.2.4.1 14.2.7]

516.2.6 Fire Damper. A fire-actuated damper shall be installed at the exhaust outlet of the system. [NFPA 96:14.2.8 14.2.8] The actuation device for the fire damper shall have a maximum temperature rating of 375°F (191°C). [NFPA 96:14.2.4.1 14.2.10]

516.2.7 Installation of Electrical Wiring. No electrical wiring shall be installed in the interior sections of the hood plenum that is capable of becoming exposed to grease.

**Exception:** As permitted by NFPA 70.

516.2.8 Power Supply. The power supply of any electrostatic precipitator (ESP) shall be of the “cold spark,” ferroresonant type in which the voltage falls off as the current increases. [NFPA 96:14.2.8 14.2.11]

516.2.9 Listing Evaluation. Listing evaluation shall include the following:

1. Capture and containment of vapors at published and labeled airflow.
2. Grease discharge at the exhaust outlet of the system not to exceed an average of 2.9 E-09 (oz/in³) (5.0 E-06 kg/m³) of exhausted air sampled from that equipment at maximum amount of product that is capable of being processed over a continuous 8 hour test with the system operating at its minimum listed airflow.
3. Listing and labeling of clearance to combustibles from all sides, top, and bottom.
4. Electrical connection in the field in accordance with NFPA 70.
5. Interlocks on all removable components that lie in the path of airflow within the unit to ensure that they are in place during operation of the cooking appliance. [NFPA 96:14.2.4.1 14.2.12]

516.3 Interlocks. The recirculating system shall be provided with interlocks of all critical components and operations as indicated in Section 516.3.1 through Section 516.3.3.1 such that, if any of these interlocks are interrupted, the cooking appliance will not be able to operate. [NFPA 96:14.3.3.1 14.3.1]

516.3.1 Airflow Sections. All closure panels encompassing airflow sections shall have interlocks to ensure that the panels are in place and fully sealed. [NFPA 96:14.3.2 14.3.2]

516.3.2 Filter Component. Each filter component (grease and odor) shall have an interlock to prove the component is in place. [NFPA 96:14.3.3 14.3.3]

516.3.3 ESP Interlocks. Each ESP shall have a sensor to prove its performance is as designed, with no interruption of the power to exceed 2 minutes. [NFPA 96:14.3.4.1 14.3.4.1]

516.3.3.1 Manual Reset. The sensor shall be a manual reset device or circuit. [NFPA 96:14.3.4.2 14.3.4.2]

516.3.4 Airflow Switch or Transducer. An airflow switch or transducer shall be provided after the last filter component to ensure that a minimum airflow is maintained. The airflow switch or transducer shall open the interlock circuit when the airflow falls 25 percent below the system’s normal operating flow or 10 percent below its listed minimum rating, whichever is lower. The airflow switch or transducer shall be a manual reset device or circuit. [NFPA 96:14.3.5.1 14.3.5.1 14.3.5.1 14.3.5.3]

516.4 Location and Application Restrictions. The location of recirculating systems shall be approved by the Authority Having Jurisdiction. Items to be reviewed in the fire risk assessment shall include, but not be limited to, life safety, combustibility of surroundings, proximity to air vents, and total fuel load. [NFPA 96:14.4.1 14.4.1 14.4.2]

516.5 Additional Fire Safety Requirements. In addition to the appliance nozzle(s), a recirculating system shall be listed with the appropriate fire protection for grease filters, grease filtration, odor filtration units, and ductwork, where applicable. [NFPA 96:14.5.1 14.5.1]

516.5.1 Installation Downstream. In addition to any other fire-extinguishing system actuation device, there shall be a fire-extinguishing system actuation device installed downstream of any ESP. [NFPA 96:14.5.2 14.5.2]

516.5.2 Locations. The requirements of Section 513.6 shall also apply to recirculating system locations. [NFPA 96:14.5.3 14.5.3]

516.6 Use and Maintenance. Automatic or manual covers on cooking appliances, especially fryers, shall not interfere with the application of the fire suppression system. [NFPA 96:14.6.1 14.6.1]

516.6.1 Manufacturer’s Instructions. All filters shall be cleaned or replaced in accordance with the manufacturer’s instructions. [NFPA 96:14.6.2 14.6.2]

516.6.2 Cleaning Schedule. All ESPs shall be cleaned a minimum of once per week and according to the manufacturer’s cleaning instructions. [NFPA 96:14.6.3 14.6.3]

516.6.3 Hood Plenum and Blower Section Cleaning Schedule. The entire hood plenum and the blower section shall be cleaned a minimum of once every 3 months. [NFPA 96:14.6.4 14.6.4]

516.6.4 Inspection of Safety Interlocks. Inspection and testing of the total operation and all safety interlocks in accordance with the manufacturer’s instructions shall
be performed by qualified service personnel a minimum of once every 6 months or more frequently if required. [NFPA 96:14.6.5]

516.5 Inspection. Fire-extinguishing equipment shall be inspected in accordance with Section 514.2. [NFPA 96:14.6.6]

516.6 Maintenance Log. A signed and dated log of maintenance as performed in accordance with Section 516.3 and Section 516.4 shall be available on the premises for use by the Authority Having Jurisdiction. [NFPA 96:14.6.7]

5170 Solid-Fuel Cooking Operations.

517.1 Venting Application. Venting requirements of solid-fuel cooking operations shall be determined in accordance with Section 517.1.1 through Section 517.1.6. [NFPA 96:15.1]

517.1.1 Natural Draft. Where solid-fuel cooking equipment is required by the manufacturer to have a natural draft, the vent shall comply with Section 517.4. [NFPA 96:14.1.1]

517.1.2 System Compliance. Where the solid-fuel cooking equipment has a self-contained top, the appliance to be vented in an isolated space (except for a single water heater with its own separate vent), has a separate makeup air system, and is provided with supply and return air (not supplied or returned from other spaces), the system shall comply with Section 517.4 and Section 517.6. [NFPA 96:15.1.2]

517.1.3 Makeup Air System. Where the solid-fuel cooking equipment is located in a space with other vented equipment, all vented equipment shall have an exhaust system interlocked with a makeup air system for the space per Section 517.6. [NFPA 96:15.1.4]

517.1.4 Natural Draft Ventilation Systems. Natural draft ventilation systems and power-exhausted ventilation systems shall comply with Section 517.3, Section 517.4, and Section 517.6. [NFPA 96:15.1.5]

517.1.5 Opening Requirements. Where a solid-fuel cooking appliance allows effluent to escape from the appliance opening, this opening shall be covered by a hood and an exhaust system that meets the requirements of Section 517.3, Section 517.4, and Section 517.6. [NFPA 96:15.1.6]

517.1.6 Spark Arresters. Solid-fuel cooking operations shall have spark arresters to minimize the passage of airborne sparks and embers into plenums and ducts. Where the solid-fuel cooking operation is not located under a hood, a spark arrester shall be provided to minimize the passage of sparks and embers into flues and chimneys. [NFPA 96:15.1.7, 15.1.8]

517.2 Location of Appliances. For cooking operations in buildings, every appliance shall be located with respect to building construction and other equipment so as to permit access to the appliance. [NFPA 96:15.2.1]

5172.1 Prohibited Location. Solid-fuel cooking appliances shall not be installed in confined spaces. [NFPA 96:15.2.2]

Exception: Solid-fuel cooking appliances listed for installation in confined spaces such as alcoves shall be installed in accordance with the terms of the listing and the manufacturer’s instructions. [NFPA 96:15.2.3]

5172.2 Flammable Vapors. Solid-fuel cooking appliances shall not be installed in any location where gasoline or any other flammable vapors or gases are present. [NFPA 96:15.2.4]

5173 Hoods for Solid-Fuel Cooking. Hoods shall be sized and located in a manner capable of capturing and containing all the effluent discharging from the appliances. The hood and its exhaust system shall comply with the requirements of Section 508.0 through Section 513.0. [NFPA 96:15.3.1, 15.3.2]

5173.1 Separation. Except as permitted in Section 517.3.1.1, exhaust systems serving solid-fuel cooking equipment, in buildings, including gas or electrically operated equipment, shall be separate from all other exhaust systems. [NFPA 96:15.3.3]

Exception: Cooking equipment not requiring automatic fire-extinguishing equipment (per Section 513.0) shall be permitted to be installed under a common hood with solid-fuel cooking equipment that is served by a duct system separate from all other exhaust systems. [NFPA 96:15.3.5]

5173.1.1 Equipment with Solid Fuel for Flavoring. Gas-operated equipment utilizing solid fuel for flavoring that meets all the following conditions shall not be required to have a separate exhaust system:

1. The solid fuel holder (smoker box) shall be listed with the gas-operated equipment.
2. The solid fuel holder shall be located underneath the gas burners.
3. Spark arresters conforming with Section 517.1.6 shall be provided.
4. The maximum quantity of solid fuel consumed shall not exceed 1 pound (0.45 kg) per hour per 100 000 Btu/h (29 kW) of gas burner capacity.
5. The gas-operated equipment shall be protected by a fire suppression system listed for the equipment, including the solid fuel holder.
6. Gas-operated equipment with integral solid fuel holder(s) intended for flavoring, such as radiant charbroiler(s), shall comply simultaneously with the requirements of UL 300 that address the gas radiant charbroiler(s) and mesquite wood charbroiler(s).
7. A fire suppression system nozzle(s) shall be installed to protect the solid fuel holder.
8. The fire suppression system shall be designed and installed to protect the entire cooking operation.
(9) Each solid fuel holder shall be limited to a size of 150 cubic inches (2.5 L), with no dimension to exceed 20 inches (508 mm).

(10) A maximum of one solid fuel holder for each 100 000 Btu/h (29 kW), or portion thereof, of burner capacity shall be permitted.

(11) Solid fuel shall be immersed in water for a continuous period of at least 24 hours immediately prior to being placed in the cooking equipment.

(12) The inspection frequency shall be the same as for solid fuel cooking operations in Table 514.3. [NFPA 96:14.3.4 15.3.4]

517.4 Exhaust Systems for Solid-Fuel Cooking. Where a hood is not required, in buildings where the duct system is three stories or less in height, a duct complying with Section 510.0 shall be provided. [NFPA 96:14.4 15.4]

517.4.1 Hood. If a hood is used in buildings where the duct system is three stories or less in height, the duct system shall comply with Section 510.0. [NFPA 96:14.4 15.4.1]

517.4.2 Building Exceeding Four Stories. A listed or approved grease duct system that is four stories in height or greater shall be provided for solid-fuel cooking exhaust systems. [NFPA 96:14.4.2 15.4.2]

517.4.3 Prohibited. Wall terminations of solid-fuel exhaust systems shall be prohibited. [NFPA 96:14.4.4 15.4.4]

517.5 Grease Removal Devices for Solid-Fuel Cooking. Grease removal devices shall be constructed of steel or stainless steel or be approved for solid-fuel cooking. [NFPA 96:14.4.4 15.5.1]

517.5.1 Spark Arrester Devices. If airborne sparks and embers can be generated by the solid fuel cooking operation, spark arrester devices shall be used prior to using the grease removal device, to minimize the entrance of these sparks and embers into the grease removal device and into the hood and the duct system. [NFPA 96:14.5.2 15.5.2]

517.5.2 Filters. Filters shall be a minimum of 4 feet (1219 mm) above the appliance cooking surface. [NFPA 96:14.5.3 15.5.3]

517.6 Air Movement for Solid-Fuel Cooking. Exhaust system requirements shall comply with Section 511.0 for hooded operation or shall be installed in accordance with the manufacturer’s recommendations for unhooded applications. [NFPA 96:14.6.1 15.6.1]

517.6.1 Replacement Air. A replacement or makeup air system shall be provided to ensure a positive supply of replacement air at all times during cooking operations. [NFPA 96:14.6.2 15.6.2]

517.6.2 Operation. Makeup air systems serving solid-fuel cooking operations shall be interlocked with the exhaust air system and powered, if necessary, to prevent the space from attaining a negative pressure while the solid-fuel appliance is in operation. [NFPA 96:14.6.3 15.6.3]

517.7 Fire-Extinguishing Equipment for Solid-Fuel Cooking. Solid-fuel cooking appliances that produce grease-laden vapors shall be protected by listed fire-extinguishing equipment.

Exception: Where acceptable to the Authority Having Jurisdiction, solid-fuel cooking appliances constructed of solid masonry or reinforced Portland or refractory cement concrete and vented in accordance with NFPA 211 shall not require fixed automatic fire-extinguishing equipment. [NFPA 96:14.7.1, 14.7.2 15.7.1, 15.7.2]

517.7.1 Grease Removal Devices, Hoods, and Duct Systems. Listed fire-extinguishing equipment shall be provided for the protection of grease removal devices, hoods, and duct systems. [NFPA 96:14.7.3 15.7.3]

Exception: Where acceptable to the Authority Having Jurisdiction, solid-fuel cooking appliances constructed of solid masonry or reinforced Portland or refractory cement concrete and vented in accordance with NFPA 211 shall not require automatic fire-extinguishing equipment for the protection of grease removal devices, hoods, and duct systems. [NFPA 96:14.7.4 15.7.4]

517.7.2 Listed Fire-Extinguishing Equipment. Listed fire-extinguishing equipment for solid-fuel-burning cooking appliances, where required, shall comply with Section 513.0 and shall use water-based agents. [NFPA 96:14.7.5 15.7.5]

517.7.3 Rating and Design. Fire-extinguishing equipment shall be rated and designed to extinguish solid-fuel cooking fires. The fire-extinguishing equipment shall be of sufficient size to totally extinguish fire in the entire hazard area and prevent reignition of the fuel. [NFPA 96:14.7.6, 14.7.7 15.7.6, 15.7.7]

517.7.4 Listing/Class. All solid fuel appliances (whether under a hood or not) with fireboxes of 5 cubic feet (0.14 m³) volume or less shall have at least a listed 2-A rated water-spray fire extinguisher or a 1.6 gallon (6.1 L) wet chemical fire extinguisher listed for Class K fires in accordance with NFPA 10 with a maximum travel distance of 20 feet (6096 mm) to the appliance. [NFPA 96:14.7.8 15.7.8]

517.7.5 Fixed-Water Pipe System. Solid fuel appliances with fireboxes exceeding 5 cubic feet (0.14 m³) shall be provided with a fixed-water pipe system with a hose in the kitchen capable of reaching the firebox. The hose shall be equipped with an adjustable nozzle capable of producing a fine to medium spray or mist. The nozzle shall be of the type that cannot produce a straight stream. The system shall have a minimum operating pressure of 40 psi (276 kPa) and shall provide a minimum of 5 gallons per minute (gpm) (0.3 L/s). [NFPA 96:14.7.9.1 14.7.9.2 15.7.9.1 – 15.7.9.2]

517.7.6 Fuel Storage. All fuel storage areas for cooking operations in buildings shall be provided with a sprinkler system meeting the requirements of NFPA 13 except as permitted in accordance with the following:
(1) Where acceptable to the Authority Having Jurisdiction, fuel storage areas shall be permitted to be protected with a fixed water pipe system with a hose capable of reaching all parts of the area.

(2) In lieu of the sprinkler system outlined in Section 517.7.6, a listed 2-A rated water spray fire extinguisher or a 1.6 gallon (6.1 L) wet chemical fire extinguisher listed for Class K fires with a maximum travel distance of 20 feet (6096 mm) to the solid fuel piles shall be permitted to be used for a solid fuel pile, provided that the fuel pile does not exceed 5 cubic feet (0.14 m³) volume. [NFPA 96:15.7.11]

517.7.7 Auxiliary Fuel. In addition to the requirements of Section 517.7.4 through Section 517.8.3, any solid-fuel cooking appliance is also provided with auxiliary electric, gas, oil, or other fuel for ignition or supplemental heat and the appliance is also served by any portion of a fire-extinguishing system complying with Section 513.0, such auxiliary fuel shall be shut off on actuation of the fire-extinguishing system. [NFPA 96:15.1.2]

517.8 Other Safety Requirements. Metal-fabricated solid-fuel cooking appliances shall be listed for the application where produced in practical quantities or shall be approved by the Authority Having Jurisdiction. Where listed, metal-fabricated solid fuel cooking appliances shall be installed in accordance with terms of their listings and with the applicable requirements of this chapter. [NFPA 96:14.9.4.4–14.9.4.15.9.4.2]

517.8.1 Site-Built Solid Fuel Cooling Appliances. Site-built solid-fuel cooking appliances shall be submitted for approval to the Authority Having Jurisdiction before being considered for installation. All units submitted to the Authority Having Jurisdiction shall be installed, operated, and maintained in accordance with the approved terms of the manufacturer’s instructions and any additional requirements set forth by the Authority Having Jurisdiction. [NFPA 96:14.9.4.3.1–14.9.4.3.2, 15.9.4.3.1–15.9.4.3.2]

517.8.2 Additional Devices. Except for the spark arresters required in Section 517.1.6, there shall be no additional devices of any type in any portion of the appliance, flue pipe, and chimney of a natural draft solid-fuel operation. [NFPA 96:14.9.4.4, 15.9.4.4]

517.8.3 Prohibited. No solid fuel cooking device of any type shall be permitted for deep fat frying involving more than 1 quart (qt) (1 L) of liquid shortening, nor shall any solid fuel cooking device be permitted within 3 feet (914 mm) of any deep fat frying unit. [NFPA 96:14.9.4.5, 15.9.4.5]

518.0 Downdraft Appliances.

518.1 General. Downdraft appliance ventilation system containing or for use with appliances used in processes producing smoke or grease-laden vapors shall be equipped with components complying with the following:

(1) The clearance requirements of Section 507.4 through Section 507.4.3.3.

(2) The primary collection means designed for collecting cooking vapors and residues complying with the requirements of Section 508.0.

(3) Grease removal devices complying with Section 509.0.

(4) Special-purpose filters as listed in accordance with UL 1046.

(5) Exhaust ducts complying with Section 510.0.

(6) The air movement requirements of Section 511.2.1 and Section 511.2.2.

(7) Auxiliary equipment (such as particulate and odor removal devices) complying with Section 512.0.

(8) Fire-extinguishing equipment complying with the requirements of Section 513.0, and as specified in Section 518.3.

(9) The use and maintenance requirements of Section 514.0.

(10) The minimum safety requirements of Section 515.0. [NFPA 96:15.1.1–15.1.14]

518.2 Ventilation System. The downdraft appliance ventilation system shall be capable of capturing and containing all the effluent discharge from the appliance(s) it is serving. [NFPA 96:15.4.2, 16.1.2]

518.3 Fire-Extinguishing Equipment. For fire-extinguishing equipment on downdraft appliance ventilation systems, the following shall apply:

(1) Cooking surface, duct, and plenum protection shall be provided.

(2) At least one fusible link or heat detector shall be installed within each exhaust duct opening in accordance with the manufacturer’s listing.

(3) A fusible link or heat detector shall be provided for each protected cooking appliance located in the plenum area of that appliance or in accordance with the extinguishing system manufacturer’s listing.

(4) A manual activation device shall be provided as part of each appliance at a height acceptable to the Authority Having Jurisdiction.

(5) Portable fire extinguishers shall be provided in accordance with Section 513.10 through Section 513.11. [NFPA 96:15.2, 16.2.1]

518.3.1 Integral Fire-Extinguishing System. A listed downdraft appliance ventilation system employing an integral fire-extinguishing system including detection systems that has been evaluated for grease and smoke capture, fire extinguishing, and detection shall be considered as complying with Section 518.3. [NFPA 96:15.2.4, 16.2.1]

518.3.2 Interlocks. The downdraft appliance ventilation system shall be provided with interlocks such that the cooking fuel supply will not be activated unless the exhaust and supply air systems have been activated. [NFPA 96:15.2.2, 16.2.2]
518.4 Airflow Switch or Transducer. An airflow switch or transducer shall be provided after the last filter component to ensure that a minimum airflow is maintained. [NFPA 96:16.3.1]

518.4.1 Interlocks. The airflow switch or transducer shall open the interlock circuit when the airflow falls 25 percent below the system’s normal operating flow or less than 10 percent its listed minimum rating, whichever is lower. [NFPA 96:16.3.2]

518.4.2 Manual Reset. The airflow switch or transducer shall be a manual reset device or circuit. [NFPA 96:16.4]

518.5 Surface Materials. Any surface located directly above the cooking appliance shall be of noncombustible or limited-combustible materials. [NFPA 96:16.4]

519.0 Type II Hood Exhaust System Requirements.

519.1 Where Required. Type II hoods shall be installed above equipment and dishwashers that generate steam, heat, or products of combustion, and where grease or smoke is not present.

Exceptions:

1. Dishwashing machines connected to a Type II duct system and exhausted directly to the outdoors.

2. Dishwashing machines with a self-contained condensing system listed in accordance with UL 921 and installed in a space where the HVAC system has been engineered to accommodate the latent and sensible heat load emitted from such appliances as approved by the Authority Having Jurisdiction. Such equipment shall be provided with an interlocking device to prevent opening of the appliance prior to completion of its cycle.

519.2 Construction of Type II Hoods. Type II hoods constructed of steel shall be not less than 0.024 of an inch (0.61 mm) (No. 24 gauge). Hoods constructed of copper shall be of copper sheets weighing not less than 0.17 ounces per square inch (oz/in²) (7.47 kg/m²). Joints and seams shall be substantially tight. Solder shall not be used except for sealing a joint or seam.

519.3 Type II Hood Exhaust System Net Airflow. The net airflow for Type II hoods shall be in accordance with Section 508.5.1.5 for light-duty cooking appliances. The net airflow for Type II hoods serving dishwashing appliances shall comply with Section 519.3.1.

519.3.1 Dishwashing Appliances. The net airflow for Type II hoods used for dishwashing equipment shall be not less than 200 cubic feet per minute (0.094 m³/s) per linear foot (m) of hood length.

519.4 Type II Exhaust Duct Systems. Ducts and plenums serving Type II hoods shall be constructed of rigid metallic materials in accordance with Chapter 6. Duct bracing and supports shall comply with Chapter 6. Ducts subject to positive pressure shall be adequately sealed.

519.5 Termination of Type II Hood Exhaust System. The exhaust system shall terminate as follows:

1. Rooftop terminations shall terminate not less than 10 feet (3048 mm) from a property line, and the exhaust flow shall be directed away from the roof surface of the roof, not less than 40 inches (1016 mm).

2. Horizontal terminations shall terminate not less than 10 feet (3048 mm) from adjacent buildings, property lines, operable openings, and from grade level.

3. The discharge outlet shall not be directed onto a public walkway.

519.6 Makeup Air. Makeup air shall be provided in accordance with Section 511.3.

519.7 Independent Exhaust Duct System. Single or combined Type II exhaust systems shall be independent of all other exhaust systems.
CHAPTER 6
DUCT SYSTEMS

601.0 General.
601.1 Applicability. Ducts and plenums that are portions of a heating, cooling, ventilation, or exhaust system shall comply with the requirements of this chapter, and Chapter 5 for exhaust ducts, and Chapter 7 for combustion air ducts.

601.2 Sizing Requirements. Duct systems shall be sized in accordance with applicable standards in Chapter 17 or by other approved methods.

Exception: Residential duct systems shall be sized in accordance with ACCA Manual D, ACCA Manual Zr, as applicable, or by other approved methods.

602.0 Material.
602.1 General. Materials used for duct systems shall comply with Section 602.2 through Section 602.6 as applicable.

Concealed building spaces or independent construction within buildings shall be permitted to be used as ducts or plenums. Gypsum board shall not be used for positive pressure ducts.

Exception: In healthcare facilities, concealed spaces shall not be permitted to be used as ducts or plenums.

602.1.1 Duct Construction. All HVAC ducts and plenums conveying air shall be built to SMACNA standards recognized in the HVAC industry, ANSI, or organizational standards for construction and installation.

602.2 Combustibles Within Ducts or Plenums. Materials exposed within ducts or plenums shall be noncombustible or shall have a flame spread index not to exceed 25 and a smoke-developed index not to exceed 50, where tested as a composite product in accordance with ASTM E84 or UL 723. Plastic piping installed in plenums shall be tested in accordance with all requirements of ASTM E84 or UL 723. Mounting methods, supports and sample sizes of materials for testing that are not specified in ASTM E84 or UL 723 shall be prohibited.

Exceptions:
(1) Return-air and outside-air ducts, plenums, or concealed spaces that serve a dwelling unit.
(2) Air filters in accordance with the requirements of Section 311.2.
(3) Water evaporation media in an evaporative cooler.
(4) Charcoal evaporation media in an evaporative cooler.
(5) Products listed and labeled for installation within plenums in accordance with Section 602.2.1 through Section 602.2.3.
(6) Smoke detectors in accordance with the requirements of Section 609.0.
(7) Duct insulation, coverings, and linings and other supplementary materials installed in accordance with Section 605.0.
(8) Materials in a hazardous fabrication area including the areas above and below the fabrication area sharing a common air recirculation path with the fabrication area.

602.2.1 Electrical. Electrical wiring in plenums shall comply with NFPA 70. Electrical wires and cables and optical fiber cables shall be listed and labeled for use in plenums and shall have a flame spread distance not exceeding 5 feet (1524 mm), an average optical density not exceeding 0.15, and a peak optical density not exceeding 0.5, where tested in accordance with NFPA 262.

602.2.2 Fire Sprinkler Piping. Nonmetallic fire sprinkler piping in plenums shall be listed and labeled for use in plenums and shall have a flame spread distance not exceeding 5 feet (1524 mm), an average optical density not exceeding 0.15 and, a peak optical density not exceeding 0.5, where tested in accordance with UL 1887.

602.2.3 Pneumatic Tubing. Nonmetallic pneumatic tubing in plenums shall be listed and labeled for use in plenums and shall have a flame spread distance not exceeding 5 feet (1524 mm), an average optical density not exceeding 0.15, and a peak optical density not exceeding 0.5, where tested in accordance with UL 1820.

602.2.4 Discrete Products in Plenums. Discrete plumbing, mechanical, and electrical products that are located in a plenum and have exposed combustible material shall be listed and labeled in accordance with UL 2043.

602.3 Metallic. Ducts, plenums, or fittings of metal shall comply with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Flexible metallic ducts shall comply with UL 181.

602.4 Nonmetallic Ducts. Nonmetallic ducts shall comply with Section 602.4.1, Section 602.4.2, Section 602.4.3 or Section 602.4.4 through Section 602.4.5.

602.4.1 Phenolic. Phenolic duct, plenum, or fitting material shall comply with UL 181. Ducts, plenums, or fittings of phenolic shall be constructed in accordance with SMACNA Phenolic Duct Construction Standards or the conditions of its listing.

602.4.2 Gypsum. Where gypsum products are exposed in ducts or plenums, the air temperature shall be restricted to a range from 50°F (10°C) to 125°F (52°C), and moisture content shall be controlled so that the material is not adversely affected. All gypsum products shall have a mold or mildew resistant surface. For the purpose of this section, gypsum products shall not be exposed in supply ducts.
602.4.3 Air Dispersion Systems. Air dispersion systems shall be listed and labeled in accordance with UL 2518.

602.4.4 Fibrous Glass Duct. Fibrous glass ducts, plenums, or fittings shall be constructed in accordance with SMACNA Fibrous Glass Duct Construction Standards or NAIMA Fibrous Glass Duct Construction Standards.

602.4.4 602.4.5 Other Materials. Flexible and rigid ducts, plenums, or fittings for use in heating, ventilation, and air conditioning systems of other nonmetallic materials listed and labeled to UL 181 shall be permitted.

Exception: Plastic ducts shall comply with Section 603.5.

602.5 Vibration Isolators. Vibration isolation connectors installed between mechanical equipment and metal ducts (or casings) shall be made of an approved material and shall not exceed 10 inches (254 mm) in length.

602.6 Corridors. Corridors shall not be used to convey air to or from rooms where the corridor is required to be of fire-resistive construction in accordance with the building code except where permitted by the building code. Corridors shall not serve as supply, return, exhaust, relief, or ventilation air ducts.

603.0 Installation of Ducts.

603.1 General. Air ducts shall be installed in accordance with this chapter and the installation instructions.

603.1.1 Pressure Classification. The pressure classification of ducts shall not be less than the design operating pressure of the air distribution in which the duct is utilized. All ducts regardless of pressure classification shall be sealed to Seal Class A.

603.1.2 Air Temperature. The temperature of the air to be conveyed in a duct shall not exceed 250°F (121°C).

603.1.3 Protection. Air ducts, other than plastic ducts, shall be installed with not less than 4 inches (102 mm) of separation from earth, except where installed as a liner inside of concrete, tile, or metal pipe and shall be protected from physical damage.

603.1.4 Vertical Risers. Ducts listed and labeled to UL 181 shall not be used for vertical risers in air-duct systems serving more than two stories.

603.1.5 Penetrations. Ducts listed and labeled to UL 181 shall not penetrate a fire-resistance-rated assembly or construction.

603.2 Under Floor or Crawl Space. Air ducts installed under a floor in a crawl space shall be installed in accordance with the following:

1. Shall not prevent access to an area of the crawl space.
2. Where it is required to move under ducts for access to areas of the crawl space, a vertical clearance of not less than 18 inches (457 mm) shall be provided.

603.3 Metal Ducts. Ducts shall be supported at each change of direction and in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Riser ducts shall be held in place by means of metal straps or angles and channels to secure the riser to the structure.

Ducts shall be installed in a building with clearances that will retain the full thickness of fireproofing on structural members.

603.4 Flexible Air Ducts. Flexible air ducts shall comply with UL 181, and shall be installed in accordance with the manufacturer’s installation instructions and SMACNA HVAC Duct Construction Standards – Metal and Flexible. Flexible air duct installations shall comply with the following:

1. Ducts shall be installed using the minimum required length to make the connection.
2. Horizontal duct runs shall be supported at not more than 4 feet (1219 mm) intervals.
3. Vertical risers shall be supported at not more than 6 feet (1829 mm) intervals.
4. Sag between support hangers shall not exceed ½ inch (12.7 mm) per foot (305 mm) of support spacing.
5. Supports shall be rigid and shall be not less than 1½ inches (38 mm) wide at point of contact with the duct surface.
6. Duct bends shall be not less than one duct diameter bend radius.
7. Screws shall not penetrate the inner liner of non-metallic flexible ducts unless permitted in accordance with the manufacturer’s installation instructions.
8. Fittings for attaching non-metallic ducts shall be beaded and have a collar length of not less than 2 inches (51 mm) for attaching the duct. Metal worm-gear clamps shall be used.

Exception: Where attaching metallic ducts using screws in accordance with the manufacturer’s installation instructions.

9. Duct inner liner shall be installed at not less than 1 inch (25.4 mm) on the collar and past the bead prior to the application of the tape and mechanical fastener. Where mastic is used instead of tape, the mastic shall be applied in accordance with the manufacturer’s instructions.
10. Duct outer vapor barriers shall be secured using two wraps of approved tape. A mechanical fastener shall be permitted to be used in place of, or in combination with, the tape.
11. Flexible air ducts shall not penetrate a fire-resistance-rated assembly or construction.
12. The temperature of the air to be conveyed in a flexible air duct shall not exceed 250°F (121°C).
13. Flexible Air ducts shall be sealed in accordance with Section 603.9.
603.4.1 Length Limitation. Flexible air ducts shall be
not more than 5 feet (1524 mm) in length and shall not
be used in lieu of rigid elbows or fittings. Flexible air
ducts shall be permitted to be used as an elbow at a ter-
minal device.

Exception: Residential occupancies.

603.4.2 Flexible Air Connectors. Flexible air con-
nectors shall not be permitted.

603.5 Plastic Ducts. Plastic air ducts and fittings shall be
permitted where installed underground and listed for such
use.

603.6 Protection of Ducts. Ducts installed in locations
where they are exposed to mechanical damage by vehicles or
from other causes shall be protected by approved barriers.

603.6.1 Weather Protection. Ducts installed on the
exterior of the building shall be protected against the ele-
ments.

603.7 Support of Ducts. Ducts shall be supported in
accordance with the manufacturer’s installation instructions;
and Section 603.7.1, Section 603.7.2 or Section 603.7.3.

603.7.1 Metal Ducts. Ducts shall be supported at each
change of direction and in accordance with SMACNA
HVAC Duct Construction Standards – Metal and Flex-
ible. Riser ducts shall be held in place by means of metal
straps or angles and channels to secure the riser to the
structure.

603.7.1.1 Rectangular Ducts. Supports for rec-
tangular ducts shall be installed on two opposite
sides of each duct and shall be riveted, bolted, or
metal screwed to each side of the duct at intervals
specified.

603.7.1.2 Horizontal Round Ducts. Horizontal
round ducts not more than 40 inches (1016 mm) in
diameter where suspended from above shall be sup-
ported with one hanger per interval and in accordance
with Section 603.7.1.3 through Section 603.7.1.5.

603.7.1.3 Tight-Fitting Around the Perimeter.
Ducts shall be equipped with tight-fitting circular
bands extending around the entire perimeter of the
duct at each specified support interval.

603.7.1.4 Size of Circular Bands. Circular bands
shall be not less than 1 inch (25.4 mm) wide nor less
than equivalent to the gauge of the duct material it
supports.

Exception: Ducts not more than 10 inches (254
mm) in diameter shall be permitted to be supported
by No. 18 gauge galvanized steel wire.

603.7.1.5 Connection. Each circular band shall be
provided with means of connecting to the suspend-
ing support.

603.7.2 Flexible Air Ducts. Flexible air ducts shall be
supported in accordance with Section 603.4.

603.7.3 Other Ducts. Other approved ducts shall be
supported in accordance with the manufacturer’s installa-
tion instructions.

603.8 Protection Against Flood Damage. In flood haz-
ard areas, ducts shall be located above the elevation required
by the building code for utilities and attendant equipment or
the elevation of the lowest floor, whichever is higher, or shall
be designed and constructed to prevent water from entering or
accumulating within the ducts during floods up to such ele-
vation. Where the ducts are located below that elevation, the
ducts shall be capable of resisting hydrostatic and hydrody-
namic loads and stresses, including the effects of buoyancy,
during the occurrence of flooding to such elevation.

603.9 Joints and Seams of Ducts. Joints and seams for
duct systems shall comply with SMACNA HVAC Duct Con-
struction Standards – Metal and Flexible. Joints of duct sys-
tems shall be made substantially airtight by means of tapes,
mastics, gasketing, or other means. All ducts shall be sealed
to Seal Class A. Crimp joints for round ducts shall have a con-
tact lap of not less than ½ inches (38 mm) and shall be
mechanically fastened by means of not less than three sheet-
metal screws equally spaced around the joint, or an equivalent
fastening method.

603.9.1 Closure Systems. Joints and seams and rein-
forcements for air ducts and plenums listed and labeled
to UL 181, shall be in accordance with the manufac-
turer’s installation instructions. Closure systems for seal-
ing air ducts and plenums shall be listed and labeled in
accordance with UL 181A or UL 181B, and marked in
accordance with Table 603.9.1.

| TABLE 603.9.1 |
| CLOSURE MARKINGS |
| TYPE OF DUCTWORK | STANDARD | TYPE OF CLO-
| SURE SYSTEM | MARKING |
| Rigid Metallic or
Rigid Fiberglass | UL 181A | Pressure
Sensitive Tape |
| Rigid Metallic or
Rigid Fiberglass | UL 181A | Mastic Tape |
| Rigid Metallic or
Rigid Fiberglass | UL 181A | Heat
Sensitive Tape |
| Flexible Air Ducts | UL 181B | Pressure
Sensitive Tape |
| Flexible Air Ducts | UL 181B | Mastic |

* Mechanical fasteners shall be used in conjunction with a listed pressure
sensitive tape or mastic in accordance with UL 181. Nonmetallic mecha-
nical fasteners shall be listed and labeled in accordance with UL 181B and
labeled “181B-C.”

603.9.2 Duct Leakage Tests. Ductwork shall be leak-
tested in accordance with the SMACNA HVAC Air Duct
Leakage Test Manual. Duct leakage tests shall be per-
formed by a technician certified by the Associated Air
Balance Council (AABC), the National Environmental
Balancing Bureau (NEBB), the Testing, Adjusting and
Balancing Bureau (TABB), or other equivalent approved
agencies. Representative sections totaling not less than
10 percent of the total installed duct area shall be tested.
Where the tested 10 percent fail to comply with the
requirements of this section, then 40 percent of the total
installed duct area shall be tested. Where the tested 40 percent fail to comply with the requirements of this section, then 100 percent of the total installed duct area shall be tested. Sections shall be selected by the building owner or designated representative of the building owner. Positive pressure leakage testing shall be permitted for negative pressure ductwork. The permitted duct leakage shall not be more than the following:

\[ L_{\text{max}} = C_L P^{0.65} \]  

(Equation 603.9.2)

Where:

\[ L_{\text{max}} = \text{maximum permitted leakage, (ft}^3/\text{min)/100 square feet [0.0001 (m}^3/\text{s)/m}^2\text{) duct surface area.} \]

\[ C_L = \text{six, duct leakage class, (ft}^3/\text{min)/100 square feet [0.0001 (m}^3/\text{s)/m}^2\text{) duct surface area at 1 inch water column (0.2 kPa).} \]

\[ P = \text{test pressure, which shall be equal to the design duct pressure class rating, inch water column (kPa).} \]

**Exception:** Transfer air duct operating at less than 1 inch of water column (0.25 kPa).

**603.10 Cross Contamination.** Exhaust ducts that convey Class 4 air shall be negatively pressurized relative to ducts, plenums, or occupiable spaces through which the ducts pass. Exhaust ducts under positive pressure that convey Class 2 or Class 3 air shall not extend into or pass through ducts, plenums, or occupiable spaces other than the space from which the exhaust air is drawn.

**Exception:** Exhaust ducts conveying Class 2 air and exhaust ducts conveying air from residential kitchen hoods that are sealed in accordance with Seal Class A of the SMACNA HVAC Air Duct Leakage Test Method. [ASHRAE 62.1-5.2.1, 5.2.2]

**603.11 Underground Installation.** Ducts installed underground shall be approved for the installation and shall have a slope of not less than 1/4 inch per foot (10.4 mm/m) back to the main riser. Ducts, plenums, and fittings shall be permitted to be constructed of concrete, clay, or ceramics where installed in the ground or in a concrete slab, provided the joints are sealed and duct is secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Metal ducts where installed in or under a concrete slab shall be encased in not less than 2 inches (51 mm) of concrete, secured in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.

**603.12 Air Dispersion Systems.** Where installed, air dispersion systems shall be completely in exposed locations in duct systems under positive pressure, and not pass through or penetrate fire-resistant-rated construction. Air dispersion systems shall be listed and labeled in accordance with UL 2518.

**603.13 Clearances.** Duct clearances shall be in accordance with Section 603.13.1 through Section 603.13.6.

**603.13.1 General.** Duct clearances to combustible construction shall be in accordance with the listing and the manufacturer’s installation instructions.

**603.13.2 Supply Air Ducts to Listed Furnaces.** Supply air ducts connecting to listed central heating furnaces shall have the same minimum clearance to combustibles as required for the furnace supply plenum for a distance of not less than 3 feet (914 mm) from the supply plenum. Clearance shall not be required beyond the 3 feet (914 mm) distance. [NFPA 54:10.2.2.7 10.3.3.7]

**603.13.3 Supply Air Ducts to Unlisted Furnaces.** Supply air ducts connecting to unlisted central heating furnaces equipped with temperature limit controls with a maximum setting of 250°F (121°C) shall have a minimum clearance to combustibles of 6 inches (152 mm) for a distance of not less than 6 feet (1829 mm) from the furnace supply plenum. Clearance shall not be required beyond the 6 feet (1829 mm) distance. [NFPA 54:10.3.2.8 10.3.3.8]

**603.13.4 Furnace Plenums and Air Ducts.** A furnace plenum supplied as a part of the air-conditioning appliance shall be installed in accordance with the manufacturer’s instructions. Where a furnace plenum is not supplied with the appliance, any fabrication and installation instructions provided by the manufacturer shall be followed. The method of connecting supply and return ducts shall facilitate proper circulation of air. Where an air conditioner is installed within an enclosure, the installation shall comply with Section 604.4. [NFPA 54:10.2.2 10.2.6]

**603.13.5 Duct Furnaces.** Duct furnaces shall be installed in accordance with Section 905.0.

**603.13.6 Fuel-Burning Kilns.** A hood and duct serving a fuel-burning kiln shall have a clearance from combustible construction of not less than 18 inches (457 mm). This clearance shall be permitted to be reduced in accordance with Table 303.10.1.

**604.0 Furnace Plenums and Air Ducts Used in Fuel-Gas Appliances.**

**604.1 Furnace Plenums and Air Ducts.** Furnace plenums and air ducts shall be installed in accordance with this Chapter, and NFPA 90A or NFPA 90B. [NFPA 54:10.2.7.1 10.3.8.1]

**604.2 Supplied as a Part of Furnace.** A furnace plenum supplied as a part of a furnace shall be installed in accordance with the manufacturer’s instructions. [NFPA 54:10.3.7.2 10.3.8.2]

**604.3 Not Supplied with the Furnace.** Where a furnace plenum is not supplied with the furnace, any fabrication and installation instructions provided by the manufacturer shall be followed. The method of connecting supply and return ducts shall facilitate proper circulation of air. [NFPA 54:10.3.7.3 10.3.8.3]

**604.4 Return Air.** Where a furnace is installed so supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be han-
Smoke dampers shall be tested in accordance with NFPA 80 and NFPA 105. Fire dampers shall be tested in accordance with NFPA 54:10.3.8.4 (2) Ducts or plenums located in conditioned spaces where heat gain or heat loss will not increase energy use. Exceptions:

(1) Factory-installed plenums, casings, or ductwork furnished as a part of HVAC equipment tested and rated in accordance with approved energy efficiency standards.

(2) Ducts or plenums located in conditioned spaces where heat gain or heat loss will not increase energy use.

(3) For runouts less than 10 feet (3048 mm) in length to air terminals or air outlets, the rated R-value of insulation need not exceed R-3.5.

(4) Backs of air outlets and outlet plenums exposed to unconditioned or indirectly conditioned spaces with face areas exceeding 5 square feet (0.5 m²) need not exceed R-2; those 5 square feet (0.5 m²) or smaller need not be insulated.

(5) Ducts and plenums used exclusively for evaporative cooling systems.

605.1.1 Within Ducts or Plenums. Materials installed within ducts and plenums for insulating, sound deadening, or other purposes shall have a mold, humidity, and erosion-resistant surface where tested in accordance with UL 181. Duct liners in systems operating with air velocities exceeding 2000 feet per minute (10.16 m/s) shall be fastened with both adhesive and mechanical fasteners, and exposed edges shall have approved treatment to withstand the operating velocity. Where the internal insulation is capable of being in contact with condensates or other liquids, the material shall be water-resistant. Pipe and duct insulation shall not be used to reduce the maximum flame and smoke requirements in Section 602.2 unless listed for application in plenums and tested in accordance with ASTM E84 or UL 723 as a composite assembly of the duct or pipe and its associated insulation, coatings and adhesives.

605.1.2 Duct Coverings and Linings. Insulation applied to the surface of ducts, including duct coverings, linings, tapes, and adhesives, located in buildings shall have a flame-spread index not to exceed 25 and a smoke-developed index not to exceed 50, where tested in accordance with ASTM E84 or UL 723. The specimen preparation and mounting procedures of ASTM E2231 shall be used. Air duct coverings and linings shall not flame, glow, smolder, or smoke where tested in accordance with ASTM C411 at the temperature to which they are exposed in service. In no case shall the test temperature be less than 250°F (121°C). Coverings shall not penetrate a fire-resistance-rated assembly.

606.0 Smoke Dampers, Fire Dampers, and Ceiling Dampers.

606.0.1 Smoke Dampers. Smoke dampers shall comply with UL 555S, and shall be installed in accordance with the manufacturer’s installation instructions where required by the building code.

606.2 Fire Dampers. Fire dampers shall comply with UL 555, and shall be installed in accordance with the manufacturer’s installation instructions where required by the building code. Fire dampers shall have been tested for closure under airflow conditions and shall be labeled for both maximum airflow permitted and direction of flow. Where more than one damper is installed at a point in a single air path, the entire airflow shall be assumed to be passing through the smallest damper area.

Ductwork shall be connected to damper sleeves or assemblies in accordance with the fire damper manufacturer’s installation instructions.

606.3 Ceiling Radiation Dampers. Ceiling radiation dampers shall comply with UL 555C or shall be tested as part of a fire-resistance-rated floor-ceiling or roof-ceiling assembly in accordance with ASTM E119 or UL 263, and shall be installed in accordance with the manufacturer’s installation instructions in the fire-resistive ceiling membrane of floor-ceiling and roof-ceiling assemblies where required by the building code. Fire dampers not meeting the temperature limitation of ceiling radiation dampers shall not be used as a substitute.

606.4 Combination Fire/Smoke Dampers. Combination fire/smoke dampers shall comply with UL 555 and UL 555S and the requirements in Section 606.1 and Section 606.2.

606.5 Corridor Dampers. Corridor dampers shall comply with the requirements of combination fire/smoke dampers in Section 606.4.

606.6 Periodic Testing and Inspection. Testing and inspection of dampers shall be in accordance with the following:

(1) Smoke dampers shall be tested in accordance with NFPA 105.

(2) Fire dampers shall be tested in accordance with NFPA 80.

(3) Combination fire/smoke dampers shall be tested in accordance with NFPA 80 and NFPA 105.

606.6 Multiple Arrangements. Where size requires the use of multiple dampers, each damper shall be listed for use in multiple arrangements and installed in accordance with the manufacturer’s installation instructions.
606.5 606.8 Access and Identification. Fire and smoke dampers shall be provided with an approved means of access large enough to allow inspection and maintenance of the damper and its operating parts. The access shall not affect the integrity of the fire-resistance-rated assembly. The access openings shall not reduce the fire-resistance rating of the assembly.

Access shall not require the use of tools. Access doors in ducts shall be tight fitting and approved for the required duct construction. Access points shall be permanently identified on the exterior by a label with letters not less than ½ of an inch (12.7 mm) in height reading one of the following:

1. Smoke Damper
2. Fire Damper
3. Fire/Smoke Damper

606.6 606.9 Freedom from Interference. Dampers shall be installed in a manner to ensure positive closing or opening as required by function. Interior liniers or insulation shall be held back from portions of a damper, its sleeve, or adjoining duct that would interfere with the damper’s proper operation. Exterior materials shall be installed so as not to interfere with the operation or maintenance of external operating devices needed for the function of the damper.

606.7 606.10 Temperature Classification of Operating Elements. Fusible links, thermal sensors, and pneumatic or electric operators shall have a temperature rating or classification as in accordance with the building code.

607.0 Ventilating Ceilings.

607.1 General. Perforated ceilings shall be permitted to be used for air supply within the limitations of this section. Exit corridors, where required to be of fire-resistive construction by the building code, shall not have ventilating ceilings. Ventilating ceilings shall not be permitted in health care facilities.

607.2 Requirements. Ventilating ceilings shall comply with the following:

1. Suspended ventilating ceiling material shall have a Class 1 flame spread classification on both sides, determined in accordance with the building code. Suspended ventilating ceiling supports shall be of noncombustible materials.
2. Luminaires recessed into ventilating ceilings shall be of a type approved for that purpose.

608.0 Use of Under-Floor Space as Supply Plenum for Dwelling Units.

608.1 General. An under-floor space shall be permitted to be used as a supply plenum.

608.2 Dwelling Units. The use of under-floor space shall be limited to dwelling units not more than two stories in height. Except for the floor immediately above the under-floor plenum, supply ducts shall be provided extending from the plenum to registers on other floor levels.

Exception: In flood hazard areas, under-floor spaces shall not be used as supply plenums unless the flood opening requirements in the building code are met.

608.3 Enclosed. Such spaces shall be cleaned of all loose combustible scrap material and shall be tightly enclosed.

608.4 Flammable Materials. The enclosing material of the under-floor space, including the sidewall insulation, shall be not more flammable than 1 inch (25.4 mm) (nominal) wood boards (flame-spread index of 200). Installation of foam plastics is regulated by the building code.

608.5 Access. Access shall be through an opening in the floor and shall be not less than 24 inches by 24 inches (610 mm by 610 mm).

608.6 Automatic Control. A furnace supplying warm air to under-floor space shall be equipped with an automatic control that will start the air-circulating fan where the air in the furnace bonnet reaches a temperature not exceeding 150°F (66°C). Such control shall be one that cannot be set to exceed 150°F (66°C).

608.7 Temperature Limit. A furnace supplying warm air to such space shall be equipped with an approved temperature limit control that will limit outlet air temperature to 200°F (93°C).

608.8 Noncombustible Receptacle. A noncombustible receptacle shall be placed below each floor opening into the air chamber, and such receptacle shall comply with Section 608.8.1 through Section 608.8.3.

608.8.1 Location. The receptacle shall be securely suspended from the floor members and shall be not more than 18 inches (457 mm) below the floor opening.

608.8.2 Area. The area of the receptacle shall extend 3 inches (76 mm) beyond the opening on all sides.

608.8.3 Perimeter. The perimeter of the receptacle shall have a vertical lip not less than 1 inch (25.4 mm) high at the open sides where it is at the level of the bottom of the joists, or 3 inches (76 mm) high where the receptacle is suspended.

608.9 Floor Registers. Floor registers shall be designed for easy removal in order to give access for cleaning the receptacles.

608.10 Exterior Wall and Interior Stud Partitions. Exterior walls and interior stud partitions shall be fire blocked at the floor.

608.11 Wall Register. Each wall register shall be connected to the air chamber by a register box or boot.

608.12 Distance from Combustible. A duct complying with Section 602.0 shall extend from the furnace supply outlet not less than 6 inches (152 mm) below combustible framing.

608.13 Vapor Barrier. The entire ground surface of the under-floor space shall be covered with a vapor barrier having a thickness not less than 4 mils (0.1 mm) and a flame-spread index of not more than 200.

608.14 Prohibited. Fuel gas lines and plumbing waste cleanouts shall not be located within the space.
609.0 Automatic Shutoffs.

609.1 Air-Moving Systems and Smoke Detectors.
Air-moving systems supplying air in excess of 2000 cubic feet per minute (ft³/min) (0.9439 m³/s) to enclosed spaces within buildings shall be equipped with an automatic shutoff. Automatic shutoff shall be accomplished by interrupting the power source of the air-moving equipment upon detection of smoke in the main supply-air duct served by such equipment. Duct smoke detectors shall comply with UL 268A and shall be installed in accordance with the manufacturer's installation instructions. Such devices shall be compatible with the operating velocities, pressures, temperatures, and humidities of the system. Where fire-detection or alarm systems are provided for the building, the smoke detectors shall be supervised by such systems in an approved manner.

Exceptions:

(1) Where the space supplied by the air-moving equipment is served by a total coverage smoke-detection system in accordance with the fire code, interconnection to such system shall be permitted to be used to accomplish the required shutoff.
(2) Automatic shutoff is not required where occupied rooms served by the air-handling equipment have direct exit to the exterior, and the travel distance does not exceed 100 feet (30 480 mm).
(3) Automatic shutoff is not required for Group R, Division 3 and Group U Occupancies.
(4) Automatic shutoff is not required for approved smoke-control systems or where analysis demonstrates shutoff would create a greater hazard, such as shall be permitted to be encountered in air-moving equipment supplying specialized portions of Group H Occupancies. Such equipment shall be required to have smoke detection with remote indication and manual shutoff capability at an approved location.
(5) Smoke detectors that are factory installed in listed air-moving equipment shall be permitted to be used in lieu of smoke detectors installed in the main supply-air duct served by such equipment.
CHAPTER 7
COMBUSTION AIR

701.0 General.

701.1 Applicability. Air for combustion, ventilation, and dilution of flue gases for appliances installed in buildings shall be obtained by application of one of the methods covered in Section 701.4 through Section 701.9.3. Where the requirements of Section 701.4 are not met, outdoor air shall be introduced in accordance with methods covered in Section 701.6 through Section 701.9.3.

Exceptions:
(1) This provision shall not apply to direct vent appliances.
(2) Type 1 clothes dryers that are provided with makeup air in accordance with Section 504.4.1. [NFPA 54: 9.3.1.1]

701.1.1 Other Types of Appliances. Appliances other than natural draft design, appliances not designated as Category I vented appliances, and appliances equipped with power burners shall be provided with combustion, ventilation, and dilution air in accordance with the appliance manufacturer’s instructions. [NFPA 54: 9.3.1.2]

701.2 Pressure Difference. Where used, a draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the appliance served so as to prevent any difference in pressure between the hood or regulator and the combustion air supply. [NFPA 54: 9.3.1.4]

701.3 Makeup Air. Where exhaust fans, clothes dryers, and kitchen ventilation systems interfere with the operation of appliances, makeup air shall be provided. [NFPA 54: 9.3.1.5]

701.4 Indoor Combustion Air. The required volume of indoor air shall be determined in accordance with the method in Section 701.4.1 or Section 701.4.2 except that where the air infiltration rate is known to be less than 0.40 ACH (air change per hour), the method in Section 701.4.2 shall be used. The total required volume shall be the sum of the required volume calculated for appliances located within the space. Rooms communicating directly with the space in which the appliances are installed through openings not furnished with doors, and through combustion air openings sized and located in accordance with Section 701.5, are considered a part of the required volume. [NFPA 54: 9.3.2]

701.4.1 Standard Method. The minimum required volume shall be 50 cubic feet per 1000 British thermal units per hour (Btu/h) (4.83 m³/kW). [NFPA 54: 9.3.2.1]

701.4.2 Known Air Infiltration Rate Method. Where the air infiltration rate of a structure is known, the minimum required volume shall be determined as follows [NFPA 54: 9.3.2.2]:
(1) For appliances other than fan-assisted, calculate using the following Equation 701.4.2(1). [NFPA 54: 9.3.2.2(1)]

\[
\text{Required Volume}_{\text{other}} \geq \frac{21 \text{ ft}^3}{\text{ACH}} \left( \frac{I_{\text{other}}}{1000 \text{ Btu/h}} \right)
\]

(2) For fan-assisted appliances, calculate using the following Equation 701.4.2(2). [NFPA 54: 9.3.2.2(2)]

\[
\text{Required Volume}_{\text{fan}} \geq \frac{15 \text{ ft}^3}{\text{ACH}} \left( \frac{I_{\text{fan}}}{1000 \text{ Btu/h}} \right)
\]

Where:
\[I_{\text{other}} = \text{All appliances other than fan-assisted input (Btu/h)}\]
\[I_{\text{fan}} = \text{Fan-assisted appliance input (Btu/h)}\]
\[\text{ACH} = \text{Air change per hour (percent of volume of space exchanged per hour, expressed as a decimal)}\]

For SI units: 1 cubic foot = 0.0283 m³, 1000 British thermal units per hour = 0.293 kW

(3) For purposes of these calculations, an infiltration rate greater than 0.60 ACH shall not be used in the equations in Section Equation 701.4.2(1) and Section Equation 701.4.2(2). [NFPA 54: 9.3.2.2(3)]

701.5 Indoor Opening Size and Location. Openings used to connect indoor spaces shall be sized and located in accordance with the following:
(1) Combining spaces on the same story. Each opening shall have a minimum free area of 1 square inch per 1000 Btu/h (0.002 m²/kW) of the total input rating of all appliances in the space, but not less than 100 square inches (0.065 m²). One permanent opening shall commence within 12 inches (305 mm) of the top of the enclosure and one permanent opening shall commence within 12 inches (305 mm) of the bottom of the enclosure (see Figure 701.5). The minimum dimension of air openings shall not be less than 3 inches (76 mm).

(2) Combining spaces in different stories. The volumes of spaces in different stories shall be considered as communicating spaces where such spaces are connected by one or more permanent openings in doors or floors having a total minimum free area of 2 square inches per 1000 Btu/h (0.004 m²/kW) of total input rating of all appliances. [NFPA 54: 9.3.2.3]

701.6 Outdoor Combustion Air. Outdoor combustion air shall be provided through opening(s) to the outdoors in accor-
dance with the methods in Section 701.6.1 or Section 701.6.2. The minimum dimension of air openings shall not be less than 3 inches (76 mm). [NFPA 54:9.3.3]

701.6.1 Two Permanent Openings Method. Two permanent openings, one commencing within 12 inches (305 mm) of the top of the enclosure and one commencing within 12 inches (305 mm) of the bottom of the enclosure, shall be provided. The openings shall communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors as follows:

1. Where directly communicating with the outdoors or where communicating to the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4000 Btu/h (0.0005 m²/kW) of total input rating of all appliances in the enclosure. [See Figure 701.6.1(1) and Figure 701.6.1(2)]

2. Where communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of not less than 1 square inch per 2000 Btu/h (0.001 m²/kW) of total input rating of all appliances in the enclosure. [Yet Figure 701.6.1(3)] [NFPA 54:9.3.3.1]

701.6.2 One Permanent Opening Method. One permanent opening, commencing within 12 inches (305 mm) of the top of the enclosure, shall be provided. The appliance shall have clearances of at least 1 inch (25.4 mm) from the sides and back and 6 inches (152 mm) from the front of the appliance. The opening shall directly communicate with the outdoors or shall communicate through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors (see Figure 701.6.2) and shall have a minimum free area of the following:

1. One square inch per 3000 Btu/h (0.0007 m²/kW) of the total input rating of all appliances located in the enclosure.

2. Not less than the sum of the areas of all vent connectors in the space. [NFPA 54:9.3.3.2]

701.7 Combination Indoor and Outdoor Combustion Air. The use of a combination of indoor and outdoor combustion air shall be in accordance with Section 701.7.1 through Section 701.7.3. [NFPA 54:9.3.4] (see Appendix G for example calculations)
701.7.1 Indoor Openings. Where used, openings connecting the interior spaces shall comply with Section 701.5. [NFPA 54:9.3.4(1)]

701.7.2 Outdoor Opening(s) Location. Outdoor opening(s) shall be located in accordance with Section 701.6. [NFPA 54: 9.3.4(2)]

701.7.3 Outdoor Opening(s) Size. The outdoor opening(s) size shall be calculated in accordance with the following:

1. The ratio of the interior spaces shall be the available volume of all communicating spaces divided by the required volume.
2. The outdoor size reduction factor shall be 1 minus the ratio of interior spaces.
3. The minimum size of outdoor opening(s) shall be the full size of outdoor opening(s) calculated in accordance with Section 701.6, multiplied by the reduction factor. The minimum dimension of air openings shall not be less than 3 inches (76 mm). [NFPA 54:9.3.4(3)]

701.8 Engineered Installations. Engineered combustion air installations shall provide an adequate supply of combustion, ventilation, and dilution air and shall be approved by the Authority Having Jurisdiction determined using engineering methods. [NFPA 54:9.3.5]

701.9 Mechanical Combustion Air Supply. Where all combustion air is provided by a mechanical air supply system, the combustion air shall be supplied from outdoors at the minimum rate of not less than 0.35 cubic feet per minute per 1000 Btu/h [0.034 (m³/min)/kW] for all appliances located within the space. [NFPA 54:9.3.6]

701.9.1 Exhaust Fans. Where exhaust fans are installed, additional air shall be provided to replace the exhausted air. [NFPA 54:9.3.6.1]

701.9.2 Interlock. Each of the appliances served shall be interlocked to the mechanical air supply system to prevent main burner operation where the mechanical air supply system is not in operation. [NFPA 54:9.3.6.2]

701.9.3 Specified Combustion Air. Where combustion air is provided by the building’s mechanical ventilation system, the system shall provide the specified combustion air rate in addition to the required ventilation air. [NFPA 54:9.3.6.3]

701.10 Louvers, Grilles, and Screens. The required size of openings for combustion, ventilation, and dilution air shall be based on the net free area of each opening. Where the free area through a design of louver, grille, or screen is known, it shall be used in calculating the size opening required to provide the free area specified. Where the louver and grille design and free area are not known, it shall be assumed that wood louvers have 25 percent free area and metal louvers and grilles have 75 percent free area. Nonmotorized louvers and grilles shall be fixed in the open position. [NFPA 54:9.3.7.1]

701.10.1 Minimum Screen Mesh Size. Screens shall not be smaller than ¼ of an inch (6.4 mm) mesh. [NFPA 54:9.3.7.2]

701.10.2 Motorized Louvers. Motorized louvers shall be interlocked with the appliance so they are proven in the full open position prior to main burner ignition and during main burner operation. Means shall be provided to
prevent the main burner from igniting should the louver fail to open during burner startup and to shut down the main burner if the louver closes during burner operation. [NFPA 54:9.3.7.3]

701.11 Combustion Air Ducts. Combustion air ducts shall comply with the following [NFPA 54:9.3.8]:

1. Ducts shall be constructed of galvanized steel or a material having equivalent corrosion resistance, strength, and rigidity.

   **Exception:** Within dwellings units, unobstructed stud and joist spaces shall not be prohibited from conveying combustion air, provided that not more than one fire-block is removed. [NFPA 54:9.3.8.1]

2. Ducts shall terminate in an unobstructed space, allowing free movement of combustion air to the appliances. [NFPA 54:9.3.8.2]

3. Ducts shall serve a single space. [NFPA 54:9.3.8.3]

4. Ducts shall not serve both upper and lower combustion air openings where both such openings are used. The separation between ducts serving upper and lower combustion air openings shall be maintained to the source of combustion air. [NFPA 54:9.3.8.4]

5. Ducts shall not be screened where terminating in an attic space. [NFPA 54:9.3.8.5]

6. Combustion air intake openings located on the exterior of the building shall have the lowest side of the combustion air intake openings located at least 12 inches (305 mm) vertically from the adjoining finished ground level. [NFPA 54:9.3.8.8]

7. Horizontal upper combustion air ducts shall not slope downward toward the source of combustion air. [NFPA 54:9.3.8.6]

8. The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry, metal, or factory-built chimney shall not be used to supply combustion air.

   **Exception:** Direct vent appliances designed for installation in a solid fuel-burning fireplace where installed in accordance with the manufacturer’s installation instructions. [NFPA 54:9.3.8.7]

8. Combustion air intake openings located on the exterior of the building shall have the lowest side of the combustion air intake openings located at least 12 inches (305 mm) vertically from the adjoining finished ground level. [NFPA 54:9.3.8.8]

701.12 Dampers Prohibited. Combustion air ducts or plenums shall not be installed so as to require openings in or penetrations through construction where fire dampers are required. Manually operated dampers shall not be installed in combustion air openings. With prior approval, power-actuated movable louvers admitting combustion air shall be permitted to be used and, where installed, shall be electrically interlocked with the main burner fuel-supply valve so as to prevent fuel delivery unless the louvers are in the fully open position.

**702.0 Extra Device or Attachment.**

**702.1 General.** No device or attachment shall be installed on any appliance that could in any way impair the combustion of gas. [NFPA 54:9.1.15]
CHAPTER 8
CHIMNEYS AND VENTS

801.0 General.
801.1 Applicability. The requirements of this chapter shall govern the venting of fuel-burning appliances.

801.2 Venting of Gas Appliances. Low-heat and medium-heat gas appliances shall be vented in accordance with this chapter. Other gas appliances shall be vented in accordance with NFPA 211 or other applicable standards.

801.3 Appliances Fueled by Other Fuels. Appliances fueled by fuels other than gas shall be vented in accordance with NFPA 211 and the appliance manufacturer’s instructions.

802.0 Venting of Appliances.
802.1 Listing. Type B and Type B-W gas vents shall comply with UL 441, Type L gas vents shall comply with UL 641.

802.1.1 Installation. Listed chimneys and vents shall be installed in accordance with this chapter and the manufacturer’s installation instructions. [NFPA 54:12.2.1]

802.1.2 Prohibited Discharge. Appliance vents shall not discharge into a space enclosed by screens having openings less than $\frac{1}{4}$ of an inch (6.4 mm) mesh.

802.2 Connection to Venting Systems. Except as permitted in Section 802.2.1 through Section 802.2.7, all appliances shall be connected to venting systems. [NFPA 54:12.3.1]

802.2.1 Appliances Not Required to be Vented. The following appliances shall not be required to be vented:

(1) Listed ranges.
(2) Built-in domestic cooking units listed and marked for optional venting.
(3) Listed hot plates.
(4) Listed Type 1 clothes dryers exhausted in accordance with Section 504.4.
(5) A single listed booster-type (automatic instantaneous) water heater, when designed and used solely for the sanitizing rinse requirements of a dishwashing machine, provided that the appliance is installed with the draft hood in place and unaltered, if a draft hood is required, in a commercial kitchen having a mechanical exhaust system. [Where installed in this manner, the draft hood outlet shall not be less than 36 inches (914 mm) vertically and 6 inches (152 mm) horizontally from any surface other than the appliance.]
(6) Listed refrigerators.
(7) Counter appliances.
(8) Room heaters listed for unvented use.
(9) Direct gas-fired makeup-air heaters.
(10) Other appliances listed for unvented use and not provided with flue collars.
(11) Specialized appliances of limited input such as laboratory burners or gas lights. [NFPA 54:12.3.2]

802.2.2 Maximum Input Rating. Where any or all of the appliances in Section 802.2.1(5) through Section 802.2.1(11) are installed so the aggregate input rating exceeds 20 Btu/h/ft³ (207 W/m³) of room or space in which it is installed, one or more shall be provided with venting systems or other approved means for conveying the vent gases to the outdoors so that the aggregate input rating of the remaining unvented appliances does not exceed 20 Btu/h/ft³ (207 W/m³). [NFPA 54:12.3.2.1]

802.2.3 Adjacent Room or Space. Where the calculation includes the volume of an adjacent room or space, the room or space in which the appliances are installed shall be directly connected to the adjacent room or space by a doorway, archway, or other opening of comparable size that cannot be closed. [NFPA 54:12.3.2.2]

802.2.4 Ventilating Hoods. The use of ventilating hoods and exhaust systems to vent appliances shall be limited to industrial appliances and appliances installed in commercial applications. [NFPA 54:12.3.3]

802.2.5 Well-Ventilated Spaces. The flue gases from industrial-type appliances shall not be required to be vented to the outdoors where such gases are discharged into a large and well-ventilated industrial space. [NFPA 54:12.3.4]

802.2.6 Direct Vent Appliances. Listed direct vent appliances shall be installed in accordance with the manufacturer’s installation instructions and Section 802.8. [NFPA 54:12.3.5.1]

802.2.6.1 Through-the-Wall Vent Terminations. Through-the-wall vent terminations for listed direct vent appliances shall be in accordance with Section 802.8. [NFPA 54:12.3.5.2]

802.2.7 Appliances with Integral Vents. Appliances incorporating integral venting means shall be installed in accordance with the manufacturer’s installation instructions and Section 802.8 and Section 802.8.1. [NFPA 54:12.3.6]

802.2.8 Incinerators, Commercial–Industrial. Commercial industrial-type incinerators shall be vented in accordance with NFPA 82. [NFPA 54:12.3.7]

802.3 Minimum Safe Performance. Venting systems shall be designed and constructed to convey all flue and vent gases to the outdoors. [NFPA 54:12.1]

802.3.1 Appliance Draft Requirements. A venting system shall satisfy the draft requirements of the appliance in accordance with the manufacturer’s instructions. [NFPA 54:12.4.1]
802.3.2 Appliance Venting Requirements. Appliances required to be vented shall be connected to a venting system designed and installed in accordance with the provisions of Section 802.4 through Section 802.15.4. [NFPA 54:12.4.2]

802.3.3 Mechanical Draft Systems. Mechanical draft systems shall be listed in accordance with UL 378 and installed in accordance with both the appliance and the mechanical draft system manufacturer’s installation instructions. [NFPA 54:12.4.3.1]

802.3.3.1 Venting. Appliances requiring venting shall be permitted to be vented by means of mechanical draft systems of either forced or induced draft design. [NFPA 54:12.4.3.2]

802.3.3.2 Leakage. Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to prevent leakage of flue or vent gases into a building. [NFPA 54:12.4.3.3]

802.3.3.3 Vent Connectors. Vent connectors serving appliances vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure. [NFPA 54:12.4.3.4]

802.3.3.4 Operation. Where a mechanical draft system is employed, provision shall be made to prevent the flow of gas to the main burners when the draft system is not performing so as to satisfy the operating requirements of the appliance for safe performance. [NFPA 54:12.4.3.5]

802.3.3.5 Exit Terminals. The exit terminals of mechanical draft systems shall be not less than 7 feet (2134 mm) above finished ground level where located adjacent to public walkways and shall be located as specified in Section 802.8 and Section 802.8.1. [NFPA 54:12.4.3.6]

802.3.4 Ventilating Hoods and Exhaust Systems. Where automatically operated appliances, other than food service commercial cooking appliances, are vented through a ventilating hood or exhaust system equipped with a damper or with a power means of exhaust, provisions shall be made to allow the flow of gas to the main burners only when the damper is open to a position to properly vent the appliance and when the power means of exhaust is in operation. [NFPA 54:12.4.4.1]

802.3.5 Circulating Air Ducts, Above-Ceiling Air-Handling Spaces, and Furnace Plenums. Venting systems shall not extend into or pass through any fabricated air duct or furnace plenum. [NFPA 54:12.4.5.1]

802.3.6 Above-Ceiling or Nonducted Air Handling System. Where a venting system passes through an above-ceiling air space or other nonducted portion of an air-handling system, it shall conform to one of the following requirements:

1. The venting system shall be a listed special gas vent, other system serving a Category III or Category IV appliance, or other positive pressure vent, with joints sealed in accordance with the appliance or vent manufacturer’s instructions.

2. The vent system shall be installed such that no fittings or joints between sections are installed in the above-ceiling space.

3. The venting system shall be installed in a conduit or enclosure with joints between the interior of the enclosure and the ceiling space sealed. [NFPA 54:12.4.5.2]

802.4 Type of Venting System to be Used. The type of venting system to be used shall be in accordance with Table 802.4. [NFPA 54:12.5.1]

802.4.1 Plastic Piping. Where plastic piping is used to vent an appliance, the appliance shall be listed for use with such venting materials and the appliance manufacturer’s installation instructions shall identify the specific plastic piping material. The plastic pipe venting materials shall be labeled in accordance with the product standards specified by the appliance manufacturer or shall be listed and labeled in accordance with UL 1738. [NFPA 54:12.5.2]

802.4.2 Plastic Vent Joints. Plastic pipe and fittings used to vent appliances shall be installed in accordance with the appliance manufacturer’s installation instructions. Plastic pipe venting materials listed and labeled in accordance with UL 1738 shall be installed in accordance with the vent manufacturer’s installation instructions. Where primer is required, it shall be of a contrasting color. [NFPA 54:12.5.3]

802.4.3 Special Gas Vents. Special gas vents shall be listed and labeled in accordance with UL 1738 and installed in accordance with the special gas vent manufacturer’s installation instructions. [NFPA 54:12.5.4]

802.5 Masonry, Metal, and Factory-Built Chimneys. Chimneys shall be installed in accordance with Section 802.5.1 through Section 802.5.3.

802.5.1 Factory-Built Chimneys. Factory-built chimneys shall be listed in accordance with UL 103, UL 959, or UL 2561. Factory-built chimneys shall be installed in accordance with the manufacturer’s installation instructions. Factory-built chimneys used to vent appliances that operate at positive vent pressure shall be listed for such application. [NFPA 54:12.6.1.1]

802.5.1.1 Decorative Shrouds. Decorative shrouds addressed in Section 802.5.4.3 shall be listed or labeled in accordance with UL 103 for factory-built residential chimneys, UL 127 for factory-built fireplaces, or UL 1482 for solid-fuel room heaters.

802.5.2 Metal Chimneys. Metal chimneys shall be built and installed in accordance with NFPA 211. [NFPA 54:12.6.1.2]
802.5.3 Masonry Chimneys. Masonry chimneys shall be built and installed in accordance with NFPA 211 and lined with one of the following:

1. Approved clay flue lining.
2. A chimney lining system listed and labeled in accordance with UL 1777.
3. Other approved material that resists corrosion, erosion, softening, or cracking from vent gases at temperatures up to 1800°F (982°C).

Exception: Masonry chimney flues lined with a chimney lining system specifically listed for use with listed appliances with draft hoods, Category I appliances, and other appliances listed for use with Type B vents shall be permitted. The liner shall be installed in accordance with the liner manufacturer’s installation instructions. A permanent identifying label shall be attached at the point where the connection is to be made to the liner. The label shall read: “This chimney liner is for appliances that burn gas only. Do not connect to solid-or liquid-fuel-burning appliances or incinerators.” [NFPA 54:12.6.1.3]

802.5.4 Termination. A chimney for residential-type or low-heat appliances shall extend at least 3 feet (914 mm) above the highest point where it passes through a roof of a building and at least 2 feet (610 mm) higher than any portion of any building within a horizontal distance of 10 feet (3048 mm). [NFPA 54:12.6.2.1] (See Figure 802.5.4)

802.5.4.1 Medium-Heat Gas Appliances. A chimney for medium-heat gas appliances shall extend at least 10 feet (3048 mm) higher than any portion of any building within 25 feet (7620 mm). [NFPA 54:12.6.2.2]

802.5.4.2 Chimney Height. A chimney shall extend at least 5 feet (1524 mm) above the highest connected appliance draft hood outlet or flue collar. [NFPA 54:12.6.2.3]

802.5.4.3 Decorative Shrouds. Decorative shrouds shall not be installed at the termination of factory-built chimneys except where such shrouds are listed and labeled for use with the specific factory-built chimney system and are installed in accordance with the manufacturer’s installation instructions. [NFPA 54:12.6.2.4]

802.5.5 Size of Chimneys. The effective area of a chimney venting system serving listed appliances with draft hoods, Category I appliances, and other appliances listed for use with Type B vents shall be in accordance with one of the following methods:

1. Those listed in Section 803.0.
2. For sizing an individual chimney venting system for a single appliance with a draft hood, the effective areas of the vent connector and chimney flue of a venting system serving a single appliance with a...
draft hood shall be not less than the area of the appliance flue collar or draft hood outlet or greater than seven times the draft hood outlet area.

(3) For sizing, the effective area of the chimney flue of a chimney venting system connected to serving two appliances with draft hoods, the effective area of the chimney flue shall be not less than the area of the larger draft hood outlet plus 50 percent of the area of the smaller draft hood outlet or greater than seven times the smaller draft hood outlet area.

(4) Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods.

(5) Other approved engineering methods. [NFPA 54:12.6.3.1]

802.5.6 Inspection of Chimneys or Vents. This inspection shall be made after chimneys, vents, or parts thereof, authorized by the permit, have been installed and before such vent or part thereof has been covered or concealed.

802.5.7 Inspection of Chimneys. Before replacing an existing appliance or connecting a vent connector to a chimney, the chimney passageway shall be examined to ascertain that it is clear and free of obstructions and shall be cleaned if previously used for venting solid- or liquid-fuel-burning appliances or fireplaces. [NFPA 54:12.6.4.1]

802.5.7.1 Standard. Chimneys shall be lined in accordance with NFPA 211. Exception: Existing chimneys shall be permitted to have their use continued when an appliance is replaced by an appliance of similar type, input rating, and efficiency, where the chimney complies with Section 802.5.7 through Section 802.5.7.3 and the sizing of the chimney is in accordance with Section 802.5.5. [NFPA 54:12.6.4.2]

802.5.7.2 Cleanouts. Cleanouts shall be examined and where they do not remain tightly closed when not in use, they shall be repaired or replaced. [NFPA 54:12.6.4.3]

802.5.7.3 Existing Chimney. When inspection reveals that an existing chimney is not safe for the intended application, it shall be repaired, rebuilt, lined, relined, or replaced with a vent or chimney to conform to NFPA 211 and shall be suitable for the appliances to be attached. [NFPA 54:12.6.4.4]

802.5.8 Chimney Serving Appliances Burning Other Fuels. An appliance shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel. [NFPA 54:12.6.5.1]

802.5.8.1 Gas and Liquid Fuel-Burning Appliances. Where one chimney serves gas appliances and liquid fuel-burning appliances, the appliances shall be connected through separate openings or connected through a single opening where joined
by a suitable fitting located as close as practical to
the chimney. Where two or more openings are pro-
dvided into one chimney flue, they shall be at dif-
ferent levels. Where the gas appliance is automatically
controlled, it shall be equipped with a safety shutoff
device. [NFPA 54:12.6.5.2]

802.5.8.2 Gas and Solid Fuel-Burning Appliance.
A listed combination gas- and solid fuel-
burning appliance connected to a single chimney
flue shall be equipped with a manual reset device to
shut off gas to the main burner in the event of sus-
tained backdraft or flue gas spillage. The chimney
flue shall be sized to properly vent the appliance.
[NFPA 54:12.6.5.3]

802.5.8.3 Combination Gas- and Oil-Burning Appliance.
A single chimney flue serving a listed combina-
tion gas- and oil-burning appliance shall be
sized in accordance with the appliance manufacturer’s
instructions. [NFPA 54:12.6.5.4]

802.5.9 Support of Chimneys. All portions of chim-
neys shall be supported for the design and weight of
the materials employed. Listed factory-built chimneys shall be
supported and spaced in accordance with the manu-
facturer’s installation instructions. [NFPA 54:12.6.6]

802.5.10 Cleanouts. Where a chimney that formerly
carried flue products from liquid or solid fuel-burning
appliances is used with an appliance using fuel gas, an
accessible cleanout shall be provided. The cleanout shall
have a tight-fitting cover and be installed so its upper edge
is at least 6 inches (152 mm) below the lower edge of the
lowest chimney inlet opening. [NFPA 54:12.6.7]

802.5.11 Space Surrounding Lining or Vent. The remain-
ning space surrounding a chimney liner, gas vent,
special gas vent, or plastic piping installed within a
masonry chimney shall not be used to vent another appli-
cance. Exception: The insertion of another liner or vent within
the chimney as provided in this code and the liner or vent
manufacturer’s instructions. [NFPA 54:12.6.8.1]

802.5.11.1 Combustion Air. The remaining space
surrounding a chimney liner, gas vent, special gas vent,
or plastic piping installed within a masonry, metal or factory-built chimney flue shall not be used to
supply combustion air. Exception: Direct vent appliances designed for
installation in a solid-fuel-burning fireplace where
installed in accordance with the manufacturer’s installation instructions. [NFPA 54:12.6.8.2]

802.6 Gas Vents. The installation of gas vents shall meet
the following requirements:

(1) Gas vents shall be installed in accordance with the
manufacturer’s installation instructions.

(2) A Type B-W gas vent shall have a listed capacity not less
than that of the listed vented wall furnace to which it is
connected.

(3) Gas vents installed within masonry chimneys shall be
installed in accordance with the manufacturer’s installa-
tion instructions. Gas vents installed within masonry
chimneys shall be identified with a permanent label
installed at the point where the vent enters the chimney.
The label shall contain the following language: “This gas
vent is for appliances that burn gas. Do not connect to
solid or liquid fuel-burning appliances or incinerators.”

(4) Screws, rivets, and other fasteners shall not penetrate the
inner wall of double-wall gas vents, except at the transition
from the appliance draft hood outlet, flue collar, or
single-wall metal connector to a double-wall vent. [NFPA 54:12.7.2]

802.6.1 Gas Vent Termination. The termination of gas vents shall comply with the following requirements:

(1) A gas vent shall terminate in accordance with one of the following:

(a) Gas vents that are 12 inches (300 mm) or less in
size and located not less than 8 feet (2438 mm)
from a vertical wall or similar obstruction shall
terminate above the roof in accordance with
Figure 802.6.1 and Table 802.6.1.

(b) Gas vents that are over 12 inches (300 mm) in
size or are located less than 8 feet (2438 mm)
from a vertical wall or similar obstruction shall
terminate above the roof in accordance with
Figure 802.6.1 and Table 802.6.1.

(c) Industrial appliances as provided in Section
802.2.5.

(d) Direct vent systems as provided in Section
802.2.6.

(e) Appliances with integral vents as provided in
Section 802.2.7.

(f) Mechanical draft systems as provided in Sec-
Section 802.3.3.4.

(g) Ventilating hoods and exhaust systems as pro-
vided in Section 802.3.4.

(2) A Type B or a Type L gas vent shall terminate at
least 5 feet (1524 mm) in vertical height above the
highest connected appliance draft hood or flue col-

(3) A Type B-W gas vent shall terminate at least 12 feet
(3658 mm) in vertical height above the bottom of
the wall furnace.

(4) A gas vent extending through an exterior wall shall
not terminate adjacent to the wall or below eaves or
parapets, except as provided in Section 802.2.6 and
Section 802.3.3 through Section 802.3.3.4.

(5) Decorative shrouds shall not be installed at the termi-
nation of gas vents except where such shrouds are
listed for use with the specific gas venting system
and are installed in accordance with the manufac-
turer’s installation instructions.
(6) All gas vents shall extend through the roof flashing, roof jack, or roof thimble and terminate with a listed cap or listed roof assembly.

(7) A gas vent shall terminate at least 3 feet (914 mm) above a forced air inlet located within 10 feet (3048 mm). [NFPA 54:12.7.3]

802.6.2 Size of Gas Vents. Venting systems shall be sized and constructed in accordance with Section 802.6.2.1 through Section 802.6.2.3 and the appliance manufacturer’s instructions. [NFPA 54:12.7.4]

802.6.2.1 Category I Appliances. The sizing of natural draft venting systems serving one or more listed appliances equipped with a draft hood or appliances listed for use with a Type B gas vent, installed in a single story of a building, shall be in accordance with one of the following:

(1) The provisions of Section 803.0.

(2) Vents serving fan-assisted combustion system appliances, or combinations of fan-assisted combustion system and draft hood-equipped appliances, shall be sized in accordance with Section 803.0 or other approved engineering methods.

(3) For sizing an individual gas vent for a single, draft hood-equipped appliance, the effective area of the vent connector and the gas vent shall be not less than the area of the appliance draft hood outlet or greater than seven times the draft hood outlet area.

(4) For sizing a gas vent connected to two appliances with draft hoods, the effective area of the vent shall be not less than the area of the larger draft hood outlet plus 50 percent of the area of the smaller draft hood outlet or greater than seven times the smaller draft hood outlet area.

(5) Other approved engineering practices. Engineering methods. [NFPA 54:12.7.4.1]

802.6.2.2 Vent Offsets. Type B and Type L vents sized in accordance with Section 802.6.2.1(3) or Section 802.6.2.1(4) shall extend in a generally vertical direction with offsets not exceeding 45 degrees except that a vent system having not more than one 60 degree offset shall be permitted. Any angle greater than 45 degrees from the vertical is considered horizontal. The total horizontal distance of a vent plus the horizontal vent connector serving draft hood-equipped appliances shall not be greater than 75 percent of the vertical height of the vent. [NFPA 54:12.7.4.2]

802.6.2.3 Category II, Category III, and Category IV Appliances. The sizing of gas vents for Category II, Category III, and Category IV appliances shall be in accordance with the appliance manufacturer’s instructions. The sizing of plastic pipe specified by the appliance manufacturer as a venting material for Category II, III, and IV appliances shall be in accordance with the appliance manufacturers’ instructions. [NFPA 54:12.7.4.3]

802.6.2.4 Sizing. Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods. [NFPA 54:12.7.4.4]

802.6.3 Gas Vents Serving Appliances on More Than One Floor. Where a common vent shall be permitted is installed in a multistory installations installations to vent Category I appliances located on more than

802.6.1 Insulation Protection Shield. Where a vent passes through an insulated assembly, an approved metal shield constructed of steel having a thickness of not less than 26 gauge shall be installed between the vent and insulation. The shield shall extend not less than 2 inches (51 mm) above the insulation and be secured to the structure in accordance with the manufacturer’s installation instructions.
one floor level, provided the venting system is shall be
designed and installed in accordance with approved engi-
neering methods.

For the purpose of this section, crawl spaces, basements, and attics shall be considered as floor levels. [NFPA 54:12.7.5.1]

802.6.3.1 Occupiable Space. All appliances connected to the common vent shall be located in rooms separated from occupiable space. Each of these rooms shall have provisions for an adequate supply of combustion, ventilation, and dilution air that is not supplied from occupiable space. [NFPA 54:12.7.5.2] (See Figure 802.6.3.1)

![Plan View of Practical Separation Method for Multistory Gas Venting](image)

**FIGURE 802.6.3.1**
PLAN VIEW OF PRACTICAL SEPARATION METHOD FOR MULTISTORY GAS VENTING
[NFPA 54: FIGURE A.12.7.5.2]

802.6.3.2 Multistory Venting System. The size of the connectors and common segments of multistory venting systems for appliances listed for use with a Type B double-wall gas vent shall be in accordance with Table 803.2(1), provided all of the following apply:

1. The available total height \( H \) for each segment of a multistory venting system is the vertical distance between the level of the highest draft hood outlet or flue collar on that floor and the centerline of the next highest interconnection tee.

2. The size of the connector for a segment is determined from the appliance’s gas input rate and available connector rise and shall not be smaller than the draft hood outlet or flue collar size.

3. The size of the common vertical vent segment, and of the interconnection tee at the base of that segment, is based on the total appliance’s gas input rate entering that segment and its available total height. [NFPA 54:12.7.5.3]

802.6.4 Support of Gas Vents. Gas vents shall be supported and spaced in accordance with the manufacturer’s installation instructions. [NFPA 54:12.7.6]

802.6.5 Marking. In those localities where solid and liquid fuels are used extensively, gas vents shall be permanently identified by a label attached to the wall or ceil-
ing at a point where the vent connector enters the gas vent. The label shall read: “This gas vent is for appli-
cances that burn gas. Do not connect to solid or liquid fuel-burning appliances or incinerators.” The Authority Having Jurisdiction shall determine whether its area con-
stitutes such a locality. [NFPA 54:12.7.7]

802.7 Single-Wall Metal Pipe. Single-wall metal pipe shall be constructed of galvanized sheet steel not less than 0.0304 of an inch (0.7722 mm) thick or of other approved, noncom-
bustible, corrosion-resistant material. [NFPA 54:12.8.1]

802.7.1 Cold Climate. Uninsulated single-wall metal pipe shall not be used outdoors for venting appliances in regions where the 99 percent winter design temperature is below 32°F (0°C). [NFPA 54:12.8.2]

802.7.2 Termination. The termination of single-wall metal pipe shall meet the following requirements:

1. Single-wall metal pipe shall terminate at least 5 feet (1524 mm) in vertical height above the highest connected appliance draft hood outlet or flue collar.

2. Single-wall metal pipe shall extend at least 2 feet (610 mm) above the highest point where it passes through a roof of a building and at least 2 feet (610 mm) higher than any portion of a building within a horizontal distance of 10 feet (3048 mm). (See Figure 802.5.4)

3. An approved cap or roof assembly shall be attached to the terminus of a single-wall metal pipe. [NFPA 54:12.8.3]

802.7.3 Installation with Appliances Permitted by Section 802.4. Single-wall metal pipe shall not be used as a vent in dwellings and residential occupancies. [NFPA 54:12.8.4.1]

802.7.3.1 Limitations. Single-wall metal pipe shall be used only for runs directly from the space in which the appliance is located through the roof or exterior wall to the outer air. A pipe passing through a roof shall extend without interruption through the roof flashing, roof jacket, or roof thimble. [NFPA 54:12.8.4.2]

802.7.3.2 Attic or Concealed Space. Single-wall metal pipe shall not originate in any unoccupied attic or concealed space and shall not pass through any attic, inside wall, concealed space, or floor. [NFPA 54:12.8.4.3]

802.7.3.3 Clearances. Minimum clearances from single-wall metal pipe to combustible material shall be in accordance with Table 802.7.3.3. Reduced
clearances from single-wall metal pipe to combustible material shall be as specified for vent connectors. [NFPA 54:12.8.4.4]

802.7.3.4 Roof Thimble. Where a single-wall metal pipe passes through a roof constructed of combustible material, a noncombustible, nonventilating thimble shall be used at the point of passage. The thimble shall extend at least 18 inches (457 mm) above and 6 inches (152 mm) below the roof with the annular space open at the bottom and closed only at the top. The thimble shall be sized in accordance with Section 802.7.3.4 802.7.3.5. [NFPA 54:12.8.4.5]

802.7.3.5 Combustible Exterior Wall. Single-wall metal pipe shall not pass through a combustible exterior wall unless guarded at the point of passage by a ventilated metal thimble not smaller than the following:

1. For listed appliances with draft hoods and appliances listed for use with Type B gas vents, the thimble shall be a minimum of 4 inches (102 mm) larger in diameter than the metal pipe. Where there is a run of not less than 6 feet (1829 mm) of metal pipe in the opening between the draft hood outlet and the thimble, the thimble shall be a minimum of 2 inches (51 mm) larger in diameter than the metal pipe.

2. For unlisted appliances having draft hoods, the thimble shall be a minimum of 6 inches (152 mm) larger in diameter than the metal pipe.

3. For residential and low-heat appliances, the thimble shall be a minimum of 12 inches (305 mm) larger in diameter than the metal pipe.

Exception: In lieu of thimble protection, all combustible material in the wall shall be removed a sufficient distance from the metal pipe to provide the specified clearance from such metal pipe to combustible material. Any material used to close up such opening shall be noncombustible. [NFPA 54:12.8.4.6]

802.7.4 Size of Single-Wall Metal Pipe. Single-wall metal piping shall comply with the following requirements:

1. A venting system of a single-wall metal pipe shall be sized in accordance with one of the following methods and the appliance manufacturer’s instructions:
   a. For a draft hood-equipped appliance, in accordance with Section 803.0.
   b. For a venting system for a single appliance with a draft hood, the areas of the connector and the pipe each shall not be less than the area of the appliance flue collar or draft hood outlet, whichever is smaller. The vent area shall not be greater than seven times the draft hood outlet area.
   c. Other approved engineering methods.

2. Where a single-wall metal pipe is used and has a shape other than round, it shall have an equivalent effective area equal to the effective area of the round pipe for which it is substituted and the minimum internal dimension of the pipe shall be 2 inches (51 mm).

3. The vent cap or a roof assembly shall have a venting capacity not less than that of the pipe to which it is attached. [NFPA 54:12.8.5]

802.7.5 Support of Single-Wall Metal Pipe. All portions of single-wall metal pipe shall be supported for the design and weight of the material employed. [NFPA 54:12.8.6]

802.7.6 Marking. Single-wall metal pipe shall comply with the marking provisions of Section 802.6.5. [NFPA 54:12.8.7]

<table>
<thead>
<tr>
<th>TABLE 802.7.3.3</th>
<th>CLEARANCE FOR CONNECTORS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINIMUM DISTANCE FROM COMBUSTIBLE MATERIAL (inches)</td>
<td>LISTED TYPE B GAS VENT MATERIAL</td>
</tr>
<tr>
<td>Listed appliance with draft hoods and appliance listed for use with Type B gas vents</td>
<td>As listed</td>
</tr>
<tr>
<td>Residential boilers and furnaces with listed gas conversion burner and with draft hood</td>
<td>6</td>
</tr>
<tr>
<td>Residential appliances listed for use with Type L vents</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Listed gas-fired toilets</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Unlisted residential appliances with draft hood</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Residential and low-heat appliance other than those above</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Medium-heat appliance</td>
<td>Not permitted</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm

* These clearances shall apply unless the installation instructions of a listed appliance or connector specify different clearances, in which case the listed clearances shall apply.
802.8 Through-the-Wall Vent Termination. Through-the-wall vent termination shall be in accordance with Section 802.8.1 through Section 802.8.3. A mechanical draft venting system shall terminate at least 3 feet (914 mm) above any forced air inlet located within 10 feet (3048 mm). (See Figure 802.8)

Exceptions:
1. This provision shall not apply to the combustion air intake of a direct vent appliance.
2. This provision shall not apply to the separation of the integral outdoor air inlet and flue gas discharge of listed outdoor appliances. [NFPA 54:12.9.1]

802.8.1 Mechanical Draft Venting System. A mechanical draft venting system of other than direct vent type shall terminate not less than 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from, or 1 foot (305 mm) above any door, operable window, or gravity air inlet into any building. The bottom of the vent terminal shall be located at least 12 inches (305 mm) above finished ground level. [NFPA 54:12.9.2]

802.8.2 802.8.1 Direct Vent Appliance Clearance for Through-the-Wall Vent Termination. The clearances for through-the-wall direct vent and non-direct vent terminals shall be in accordance with Table 802.8.2 and Figure 802.8.1. The bottom of the vent terminal and the air intake shall be located not less than 12 inches (305 mm) above finished ground level.

Exception: The clearances in Table 802.8.1 shall not apply to the combustion air intake of a direct vent appliance. [NFPA 54:12.9.3]

802.8.3 Category I through Category IV and Non-categorized Appliances. Through-the-wall vents for Category II and Category IV appliances and noncategorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment. Where local experience indicates that condensate is a problem with Category I and Category III appliances, this provision shall also apply.

Drains for condensate shall be installed in accordance with the appliance and the vent manufacturer's installation instructions. [NFPA 54:12.9.4]

802.8.4 802.8.2 Annular Spaces. Where vents, including those for direct vent appliances or combustion air intake pipes, penetrate outside walls of buildings, the annular spaces around such penetrations shall be permanently sealed using approved materials to prevent entry of combustion products into the building. [NFPA 54:12.9.5]

802.8.5 802.8.3 Vent Terminals. Vent systems for Category IV appliances that terminate through an outside wall of a building and discharge flue gases perpendicular to the adjacent wall shall be located not less than 10 feet (3048 mm) horizontally from an operable opening in an adjacent building.

Exception: This shall not apply to vent terminals that are 2 feet (610 mm) or more above or 25 feet (7620 mm) or more below operable openings. [NFPA 54:12.9.6]

802.9 Condensation Drain. Provision shall be made to collect and dispose of condensate from venting systems serving Category II and Category IV appliances and noncategorized condensing appliances in accordance with Section 802.8.3. [NFPA 54:12.10.1]

802.9.1 Local Experience Installation. Where local experience indicates that condensate is a problem, provision shall be made to drain off and dispose of condensate from venting systems serving Category I and Category III appliances in accordance with Section 802.8.3. Drains for condensate shall be installed in accordance with the appliance and vent manufacturers' installation instructions. [NFPA 54:12.10.2]

802.10 Vent Connectors for Category I Appliances. A vent connector shall be used to connect an appliance to a gas vent, chimney, or single-wall metal pipe, except where the gas vent, chimney, or single-wall metal pipe is directly connected to the appliance. [NFPA 54:12.11.1]

802.10.1 Materials. A vent connector shall be made of noncombustible, corrosion-resistant material capable of withstanding the vent gas temperature produced by the appliance and of sufficient thickness to withstand physical damage. [NFPA 54:12.11.2]

802.10.1.1 Unconditioned Area Space. Where the vent connector used for an appliance having a draft hood or a Category I appliance is located in or passes through an unconditioned area space, attic, or crawl space, that portion of the vent connector shall be listed Type B, Type L, or listed vent material having equivalent insulation qualities.

Exception: Single-wall metal pipe located within the exterior walls of the building and located in an unconditioned space other than an attic or a crawl space having a local 99 percent winter design temperature of 5°F (-15°C) or higher. [NFPA 54:12.11.2.2]

802.10.1.2 Residential-Type Appliances. Vent connectors for residential-type appliances shall comply with the following:

1. Vent connectors for listed appliances having draft hoods, appliances having draft hoods and equipped with listed conversion burners, and Category I appliances that are not installed in attics, crawl spaces, or other unconditioned spaces shall be one of the following:
   a. Type B or Type L vent material.
   b. Galvanized sheet steel not less than 0.018 of an inch (0.457 mm) thick.
### TABLE 802.8-2802.8.1
**THROUGH-THE-WALL DIRECT VENT TERMINATION CLEARANCES**

<table>
<thead>
<tr>
<th>DIRECT VENT APPLIANCE INPUT RATING</th>
<th>THROUGH THE WALL VENT TERMINAL CLEARANCE FROM ANY AIR OPENING INTO A BUILDING (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000 Btu/hr and less</td>
<td>6</td>
</tr>
<tr>
<td>Greater than 10,000 Btu/hr and not exceeding 50,000 Btu/hr</td>
<td>9</td>
</tr>
<tr>
<td>Greater than 50,000 Btu/hr and not exceeding 150,000 Btu/hr</td>
<td>12</td>
</tr>
<tr>
<td>&gt; 150,000 Btu/hr</td>
<td>In accordance with the appliance manufacturer’s instructions and not less than the clearances specified in Section 802.8.1.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIGURE CLEARANCE</th>
<th>CLEARANCE LOCATION</th>
<th>MINIMUM CLEARANCES FOR DIRECT VENT TERMINALS</th>
<th>MINIMUM CLEARANCES FOR NON-DIRECT VENT TERMINALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Clearance above finished grade level, veranda, porch, deck, or balcony</td>
<td>12 inches</td>
<td>12 inches</td>
</tr>
<tr>
<td>B</td>
<td>Clearance to window or door that is openable</td>
<td>6 inches for Appliances ≤ 10,000 Btu/hr</td>
<td>4 feet below or to side of opening or 1 foot above opening</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 inches for Appliances &gt; 10,000 Btu/hr ≤ 50,000 Btu/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 inches for Appliances &gt; 50,000 Btu/hr ≤ 150,000 Btu/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appliance &gt; 150,000 Btu/hr in accordance with the appliance manufacturer’s instructions and not less than the clearances specified for non-direct vent terminals in row B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Clearance to non-openable window</td>
<td>None unless otherwise specified by the appliance manufacturer</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 feet from the center line of the terminal</td>
<td>None unless otherwise specified by the appliance manufacturer</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Clearance to unventilated soffit</td>
<td>None unless otherwise specified by the appliance manufacturer</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Clearance to outside corner of building</td>
<td>None unless otherwise specified by the appliance manufacturer</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Clearance to inside corner of building</td>
<td>None unless otherwise specified by the appliance manufacturer</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Clearance to non-mechanical air supply inlet to building and the combustion air inlet to any other appliance</td>
<td>Same clearance as specified for row B</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Clearance to a mechanical air supply inlet</td>
<td>10 feet horizontally from inlet or 3 feet above inlet</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>Clearance above paved sidewalk or paved driveway located on public property or other areas where condensate or vapor can cause a nuisance or hazard</td>
<td>7 feet and not located above public walkways or other areas where condensate or vapor can cause a nuisance or hazard</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Clearance to underside of veranda, porch, deck, or balcony</td>
<td>12 inches where the area beneath the veranda, porch, deck, or balcony is open on not less than two sides. The vent terminal is prohibited in this location where only one side is open</td>
<td></td>
</tr>
</tbody>
</table>

For SI Units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW
FIGURE 802.8.1
EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT VENT VENTING SYSTEMS
[NFPA 54: FIGURE A.12.9.9.1]
(c) Aluminum (1100 or 3003 alloy or equivalent) sheet not less than 0.027 of an inch (0.686 mm) thick.

(d) Stainless steel sheet not less than 0.012 of an inch (0.305 mm) thick.

(e) Smooth interior wall metal pipe having resistance to heat and corrosion equal to or greater than that of Section 802.10.1.2(1)(b), Section 802.10.1.2(1)(c), or Section 802.10.1.2(1)(d).

(f) A listed vent connector.

(2) Vent connectors shall not be covered with insulation.

Exception: Listed insulated vent connectors shall be installed in accordance with the manufacturer’s installation instructions. [NFPA 54:12.11.2.3]

802.10.1.3 Nonresidential Low-Heat Appliances. A vent connector for a nonresidential low-heat appliance shall be a factory-built chimney section or steel pipe having resistance to heat and corrosion equivalent to that for the appropriate galvanized pipe as specified in Table 802.10.1.3. Factory-built chimney sections shall be joined together in accordance with the chimney manufacturer’s instructions. [NFPA 54:12.11.2.4]

802.10.1.4 Medium-Heat Appliances. Vent connectors for medium-heat appliances shall be constructed of factory-built, medium-heat chimney sections or steel of a thickness not less than that specified in Table 802.10.1.4 and shall comply with the following:

1. A steel vent connector for an appliance with a vent gas temperature in excess of 1000°F (538°C) measured at the entrance to the connector shall be lined with medium-duty fire brick or the equivalent.

2. The lining shall be at least 2½ inches (64 mm) thick for a vent connector having a diameter or greatest cross-sectional dimension of 18 inches (457 mm) or less.

3. The lining shall be at least 4½ inches (114 mm) thick laid on the 4½ inches (114 mm) bed for a vent connector having a diameter or greatest cross-sectional dimension greater than 18 inches (457 mm).

4. Factory-built Where factory-built chimney sections, if employed, shall be joined together in accordance with the chimney manufacturer’s instructions. [NFPA 54:12.11.2.5]

<table>
<thead>
<tr>
<th>TABLE 802.10.1.4</th>
<th>MINIMUM THICKNESS FOR STEEL VENT CONNECTORS FOR MEDIUM-HEAT APPLIANCES [NFPA 54: TABLE 12.11.2.5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIAMETER (inches)</td>
<td>AREA (square inches)</td>
</tr>
<tr>
<td>Up to 14</td>
<td>Up to 154</td>
</tr>
<tr>
<td>Over 14 to 16</td>
<td>154 to 201</td>
</tr>
<tr>
<td>Over 16 to 18</td>
<td>201 to 254</td>
</tr>
<tr>
<td>Over 18</td>
<td>Larger than 254</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm, 1 square inch = 0.000645 m²

802.10.2 Size of Vent Connector. A vent connector for an appliance with a single draft hood or for a Category I fan-assisted combustion system appliance shall be sized and installed in accordance with Section 803.0 or other approved engineering methods. [NFPA 54:12.11.3.1]

802.10.2.1 Manifold. For a single appliance having more than one draft hood outlet or flue collar is installed, the manifold shall be constructed according to the instructions of the appliance manufacturer. Where there are no instructions, the manifold shall be designed and constructed in accordance with approved engineering practices. As an alternative method, the effective area of the manifold shall equal the combined area of the flue collars or draft hood outlets, and the vent connectors shall have a minimum 1 foot (305 mm) rise. [NFPA 54:12.11.3.2]

802.10.2.2 Size. Where two or more appliances are connected to a common vent or chimney, each vent connector shall be sized in accordance with Section 803.0 or other approved engineering methods. [NFPA 54:12.11.3.3]

As an alternative method applicable only where all of the appliances are draft hood-equipped, each vent connector shall have an effective area not less than the area of the draft hood outlet of the appliance to which it is connected. [NFPA 54:12.11.3.4]

802.10.2.3 Height. Where two or more appliances are vented through a common vent connector or vent manifold, the common vent connector or vent manifold shall be located at the highest level consistent with available headroom and clearance to com-
bustible material and sized in accordance with Section 803.0 or other approved engineering methods. [NFPA 54:12.11.3.5]

As an alternative method applicable only where there are two draft hood-equipped appliances, the effective area of the common vent connector or vent manifold and all junction fittings shall be not less than the area of the larger vent connector plus 50 percent of the area of the smaller flue collar outlet. [NFPA 54:12.11.3.6]

802.10.2.4 Size Increase. Where the size of a vent connector is increased to overcome installation limitations and obtain connector capacity equal to the appliance input, the size increase shall be made at the appliance draft hood outlet. [NFPA 54:12.11.3.7]

802.10.3 Two or More Appliances Connected to a Single Vent. Where two or more openings are provided into one chimney flue or vent, either of the following shall apply:

1. The openings shall be at different levels.
2. The connectors shall be attached to the vertical portion of the chimney or vent at an angle of 45 degrees or less relative to the vertical. [NFPA 54:12.11.4.1]

802.10.3.1 Height of Connector. Where two or more vent connectors enter a common vent, chimney flue, or single-wall metal pipe, the smaller connector shall enter at the highest level consistent with the available headroom or clearance to combustible material. [NFPA 54:12.11.4.2]

802.10.3.2 Pressure. Vent connectors serving Category I appliances shall not be connected to any portion of a mechanical draft system operating under positive static pressure, such as those serving Category III or Category IV appliances. [NFPA 54:12.11.4.3]

802.10.4 Clearance. Minimum clearances from vent connectors to combustible material shall be in accordance with Table 802.7.3.3.

Exception: The clearance between a vent connector and combustible material shall be permitted to be reduced where the combustible material is protected as specified for vent connectors in Table 303.10.1. [NFPA 54:12.11.5]

802.10.5 Joints. Joints between sections of connector piping and connections to flue collars or draft hood outlets shall be fastened in accordance with one of the following methods:

1. Mechanically fastened by means of not less than three sheet metal screws equally spaced around the joint.
2. Vent connectors of listed vent material assembled and connected to flue collars or draft hood outlets in accordance with the manufacturer’s instructions.
3. Other approved means. [NFPA 54:12.11.6]

802.10.6 Connector Junctions. Where vent connectors are joined together, the connection shall be made with a manufactured tee or wye fitting. [NFPA 54:12.11.7]

802.10.7 Slope. A vent connector shall be installed without any dips or sags and shall slope upward toward the vent or chimney at least ¼ inch per foot (20.8 mm/m).

Exception: Vent connectors attached to a mechanical draft system installed in accordance with appliance and the draft system manufacturers’ instructions. [NFPA 54:12.11.8]

802.10.8 Length of Vent Connector. The length of vent connectors shall comply with Section 802.10.7.4 or Section 802.10.7.2 802.10.8.2.

802.10.7.1 802.10.8.1 Single Wall Connector. The maximum horizontal length of a single-wall connector shall be 75 percent of the height of the chimney or vent, except for engineered systems. [NFPA 54:12.11.9.1]

802.10.7.2 802.10.8.2 Type B Double Wall Connector. The maximum horizontal length of a Type B double-wall connector shall be 100 percent of the height of the chimney or vent, except for engineered systems. The maximum length of an individual connector for a chimney or vent system serving multiple appliances, from the appliance outlet to the junction with the common vent or another connector, shall be 100 percent of the height of the chimney or vent. [NFPA 54:12.11.9.2]

802.10.9 Support. A vent connector shall be supported for the design and weight of the material employed to maintain clearances and prevent physical damage and separation of joints. [NFPA 54:12.11.10]

802.10.9 802.10.10 Chimney Connection. Where entering a flue in a masonry or metal chimney, the vent connector shall be installed above the extreme bottom to avoid stoppage. Where a thimble or slip joint is used to facilitate removal of the connector, the connector shall be firmly attached to or inserted into the thimble or slip joint to prevent the connector from falling out. Means shall be employed to prevent the connector from entering so far as to restrict the space between its end and the opposite wall of the chimney flue. [NFPA 54:12.11.11 – 12.11.13]

802.10.11 Inspection. The entire length of a vent connector shall be readily accessible for inspection, cleaning, and replacement. [NFPA 54:12.11.12]

802.10.11 802.10.12 Fireplaces. A vent connector shall not be connected to a chimney flue serving a fireplace unless the fireplace flue opening is permanently sealed. [NFPA 54:12.11.13]
802.10.12 802.10.13 Passage Through Ceilings, Floors, or Walls. A vent connector shall not pass through a ceiling, floor, or fire-resistance-rated wall. A single-wall metal pipe connector shall not pass through an interior wall.

Exceptions:

(1) Vent connectors made of listed Type B or Type L vent material and serving listed appliances with draft hoods and other appliances listed for use with Type B gas vents that pass through walls or partitions constructed of combustible material shall be installed with not less than the listed clearance to combustible material.

(2) Vent connectors shall be permitted to pass through ceilings, floors, or walls in accordance with Section 802.7.3.1 and Section 802.7.3.5.

802.10.12.1 802.10.13.1 Medium-Heat Appliances. Vent connectors for medium-heat appliances shall not pass through walls or partitions constructed of combustible material. [NFPA 54:12.13.2.2]

802.11 Vent Connectors for Category II, Category III, and Category IV Appliances. The vent connectors for Category II, Category III, and Category IV appliances shall be in accordance with Section 802.4 through Section 802.4.3. [NFPA 54:12.12]

802.12 Appliances Requiring Draft Hoods and Draft Controls. Vented appliances shall be installed with draft hoods.

Exception: Dual oven-type combination ranges; steam tables; direct vent appliances; fan-assisted combustion system appliances; appliances requiring chimney draft for operation; single-firebox boilers equipped with conversion burners with inputs greater than 400 000 Btu/h (117 kW); appliances equipped with blast, power, or pressure burners that are not listed for use with draft hoods; and appliances designed for forced venting. [NFPA 54:12.13.1]

802.12.1 Installation. A draft hood supplied with or forming a part of a listed vented appliance shall be installed without alteration, exactly as furnished and specified by the appliance manufacturer. [NFPA 54:12.13.2]

If a draft hood is not supplied by the appliance manufacturer where one is required, a draft hood shall be installed, be of a listed or approved type, and, in the absence of other instructions, be of the same size as the appliance flue collar. Where a draft hood is required with a conversion burner, it shall be of a listed or approved type. [NFPA 54:12.13.2.1]

Where a draft hood of special design is needed or preferable, the installation shall be approved and in accordance with the recommendations of the appliance manufacturer. [NFPA 54:12.13.2.2]

802.12.2 Draft Control Devices. Where a draft control device is part of the appliance or is supplied by the appliance manufacturer, it shall be installed in accordance with the manufacturer’s instructions. In the absence of manufacturer’s instructions, the device shall be attached to the flue collar of the appliance or as near to the appliance as practical. [NFPA 54:12.13.3]

802.12.3 Additional Devices. Appliances requiring controlled chimney draft shall be permitted to be equipped with listed double-acting barometric draft regulators installed and adjusted in accordance with the manufacturer’s instructions. [NFPA 54:12.13.4]

802.12.4 Location. Draft hoods and barometric draft regulators shall be installed in the same room or enclosure as the appliance in such a manner as to prevent any difference in pressure between the hood or regulator and the combustion air supply. [NFPA 54:12.13.5]

802.12.5 Positioning. Draft hoods and draft regulators shall be installed in the position for which they were designed with reference to the horizontal and vertical planes and shall be located so that the relief opening is not obstructed by any part of the appliance or adjacent construction. The appliance and its draft hood shall be located so that the relief opening is accessible for checking vent operation. [NFPA 54:12.13.6]

802.12.6 Clearance. A draft hood shall be located so that its relief opening is not less than 6 inches (152 mm) from any surface except that of the appliance it serves and the venting system to which the draft hood is connected. Where a greater or lesser clearance is indicated on the appliance label, the clearance shall not be less than that specified on the label. Such clearances shall not be reduced. [NFPA 54:12.13.7]

802.13 Manually Operated Dampers. A manually operated damper shall not be placed in any appliance vent connector. Fixed baffles and balancing baffles shall not be classified as manually operated dampers. [NFPA 54:12.14]


802.14 Automatically Operated Vent Dampers. An automatically operated vent damper shall be of a listed type. [NFPA 54:12.15]

802.15 Listing. Automatically operated vent dampers for oil-fired appliances shall comply with UL 17. The automatic damper control shall comply with UL 378.

802.14 Obstructions of Flow. Devices that retard the flow of vent gases shall not be installed in a vent connector, chimney, or vent. The following shall not be considered as obstructions:

(1) Draft regulators and safety controls specifically listed for installation in venting systems and installed in accordance with the manufacturer’s installation instructions.

(2) Approved draft regulators and safety controls designed and installed in accordance with approved engineering methods.
803.0 Sizing of Category I Venting Systems.

803.1 Single Appliance Vent Table 803.1.2(1) through Table 803.1.2(6). Venting Table 803.1.2(1) through Table 803.1.2(6) shall not be used where obstructions are installed in the venting system. The installation of vents serving listed appliances with vent dampers shall be in accordance with the appliance manufacturer’s instructions cover the installation of such a device in the venting system and performance in accordance with Section 802.3 and Section 802.3.1 is obtained. [NFPA 54:12.16]

803.1.1 Vent Downsizing. Where the vent size determined from the tables is smaller than the appliance draft hood outlet or flue collar, the use of the smaller size shall be permitted, provided that the installation complies with all of the following requirements:

(1) The total vent height (H) is at least 10 feet (3048 mm).
(2) Vents for appliance draft hood outlets or flue collars 12 inches (305 mm) in diameter or smaller are not reduced more than one table size.
(3) Vents for appliance draft hood outlets or flue collars larger than 12 inches (305 mm) in diameter are not reduced more than two table sizes.
(4) The maximum capacity listed in the tables for a fan-assisted appliance is reduced by 10 percent (0.90 x maximum table capacity).
(5) The draft hood outlet is greater than 4 inches (102 mm) in diameter. A 3 inch (76 mm) diameter vent shall not be connected to a 4 inch (102 mm) diameter draft hood outlet. This provision shall not apply to fan-assisted appliances. [NFPA 54:13.1.2]

803.1.2 Elbows. Single-appliance venting configurations with zero (0) lateral lengths in Table 803.1.2(1), Table 803.1.2(2), and Table 803.1.2(5) shall not have elbows in the venting system. Single-appliance venting with lateral lengths include two 90 degree elbows. For each additional elbow up to and including 45 degrees, the maximum capacity listed in the venting tables shall be reduced by 5 percent. For each additional elbow greater than 45 degrees up to and including 90 degrees, the maximum capacity listed in the venting tables shall be reduced by 10 percent. Where multiple offsets occur in a vent, the total lateral length of all offsets combined shall not exceed that specified in Table 803.1.2(1) through Table 803.1.2(5). [NFPA 54:13.1.3]

803.1.3 Zero Lateral. Zero (0) lateral (L) shall apply only to a straight vertical vent attached to a top outlet draft hood or flue collar. [NFPA 54:13.1.4]

803.1.4 High-Altitude Installations. Sea level input ratings shall be used when determining maximum capacity for high-altitude installation. Actual input (derated for altitude) shall be used for determining minimum capacity for high-altitude installation. [NFPA 54:13.1.5]

803.1.5 Multiple Input Ratings Two-Stage/Modulating Appliances. For appliances with more than one input rate, the minimum vent capacity (FAN Min) determined from Table 803.1.2(1) through Table 803.2(9) shall be less than the lowest appliance input rating, and the maximum vent capacity (FAN Max/NAT Max) determined from the tables shall be greater than the highest appliance rating input. [NFPA 54:13.1.6]

803.1.6 Corrugated Chimney Liners Reduction. Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table 803.1.2(1) or Table 803.1.2(2) for Type B vents, with the maximum capacity reduced by 20 percent (0.80 x maximum capacity) and the minimum capacity as shown in Table 803.1.2(1) or Table 803.1.2(2).

Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Section 803.1.2. The 20 percent reduction for corrugated metallic chimney liner systems includes an allowance for one long radius 90 degree (1.57 rad) turn at the bottom of the liner. [NFPA 54:13.1.7]

803.1.7 Connection to Chimney Liners. Connections between chimney liners and listed double-wall connectors shall be made with listed adapters designed for such purpose. [NFPA 54:13.1.8]

803.1.8 Vertical Vent Upsizing Using the 7 x Times Rule. Where the vertical vent has a larger diameter than the vent connector, the vertical vent diameter shall be used to determine the minimum vent capacity, and the connector diameter shall be used to determine the maximum vent capacity. The flow area of the vertical vent shall not exceed seven times the flow area of the listed appliance categorized vent area, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54:13.1.9]
803.1.9 Draft Hood Conversion Accessories. Draft hood conversion accessories for use with masonry chimneys venting listed Category I fan-assisted appliances shall be listed and installed in accordance with the listed accessory manufacturer’s installation instructions. [NFPA 54:13.1.10]

803.1.10 Chimney and Vent Locations. Table 803.1.2(1) through Table 803.1.2(5) shall be used only for chimneys and vents not exposed to the outdoors below the roof line. A Type B vent or listed chimney lining system passing through an unused masonry chimney flue shall not be considered to be exposed to the outdoors. Where vents extend outdoors above the roof more than 5 feet (1524 mm) higher than required by Table 802.6.1, and where vents terminate in accordance with Section 802.6.1(1)(b), the outdoor portion of the vent shall be enclosed as required by this paragraph for vents not considered to be exposed to the outdoors, or such venting system shall be engineered. A Type B vent passing through an unvented enclosure or chase insulated to a value of not less than R8 shall not be considered to be exposed to the outdoors. Table 803.1.2(3) in combination with Table 803.1.2(6) shall be used for clay tile-lined exterior masonry chimneys, provided all of the following requirements are met:

1. The vent connector is Type B double wall.
2. The vent connector length is limited to 18 in./in. (18 mm/mm) of vent connector diameter.
3. The appliance is draft hood equipped.
4. The input rating is less than the maximum capacity given in Table 803.1.2(3).
5. For a water heater, the outdoor design temperature shall not be less than 5°F (-15°C).
6. For a space-heating appliance, the input rating is greater than the minimum capacity given by Table 803.1.2(6). [NFPA 54:13.1.11]

803.1.11 Residential and Low-Heat Appliances. Flue lining system for residential and low heat appliances shall be in accordance with Section 803.1.11.1 and Section 803.1.11.2.

803.1.11.1 Clay Flue Lining. Clay flue lining shall be manufactured in accordance with ASTM C315 or other approved standard.

803.1.11.2 Chimney Lining. Chimney lining shall be listed in accordance with UL 1777.

803.1.12 Corrugated Vent Connector Size. Corrugated vent connectors shall not be smaller than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. [NFPA 54:13.1.12]

803.1.13 Upsizing. Vent connectors shall not be upsized more than two sizes greater than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. [NFPA 54:13.1.13]

803.1.14 Single Run of Vent Multiple Vertical Vent Sizes. In a single run of vent or vent connector, more than one diameter and type shall be permitted to be used, provided that all the sizes and types are permitted by the tables. [NFPA 54:13.1.14]

803.1.15 Interpolation. Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries. [NFPA 54:13.1.15]

803.1.16 Extrapolation. Extrapolation beyond the table entries shall not be permitted. [NFPA 54:13.1.16]

803.1.17 Engineering Methods. For Where a vent height is lower than 6 feet (1829 mm) and or higher than shown in Table 803.1.2(1) through Table 803.2(9), an engineering method shall be used to calculate the vent capacity. [NFPA 54:13.1.17]

803.1.18 Height Entries. Where the actual height of a vent falls between entries in the height column of the applicable table in Table 803.1.2(1) through Table 803.1.2(6), either of the following shall be used:

1. Interpolation.
2. The lower appliance input rating shown in the table entries for FAN MAX and NAT MAX column values, and the higher appliance input rating for the FAN MIN column values. [NFPA 54:13.1.18]

803.2 Multiple Appliance Vent Table 803.2(1) through Table 803.2(9) Obstructions and Vent Dampers. Venting Table 803.2(1) through Table 803.2(9) shall not be used where obstructions are installed in the venting system. The installation of vents serving listed appliances with vent dampers shall be in accordance with the appliance manufacturer’s instructions, or in accordance with the following:

1. The maximum capacity of the vent connector shall be determined using the NAT Max column.
2. The maximum capacity of the vertical vent or chimney shall be determined using the FAN + NAT column when the second appliance is a fan-assisted appliance, or the NAT + NAT column when the second appliance is equipped with a draft hood.
3. The minimum capacity shall be determined as if the appliance were a fan-assisted appliance, as follows:
   a. The minimum capacity of the vent connector shall be determined using the FAN Min column.
   b. The FAN + FAN column shall be used when the second appliance is a fan-assisted appliance, and the FAN + NAT column shall be used when the second appliance is equipped with a draft hood, to determine whether the vertical vent or chimney configuration is not permitted (NA). Where the vent configuration is NA, the vent configuration shall not be permitted and an alternative venting configuration shall be utilized. [NFPA 54:13.2.1]

803.2.1 Vent Connector Maximum Length. The maximum vent connector horizontal length shall be 18 inches per inch (18 mm/mm) of connector diameter as shown in Table 803.2.1, or as permitted by Section 803.2.2. [NFPA 54:13.2.2]
**803.2.2 Vent Connector Exceeding Maximum Length.** The vent connector shall be routed to the vent utilizing the shortest possible route. Connectors with longer horizontal lengths than those listed in Table 803.2.1 are permitted under the following conditions:

1. The maximum capacity (FAN Max or NAT Max) of the vent connector shall be reduced 10 percent for each additional multiple of the length listed in Table 803.2.1. For example, the maximum length listed for a 4 inch (100 mm) connector is 6 feet (1829 mm). With a connector length greater than 6 feet (1829 mm) but not exceeding 12 feet (3658 mm), the maximum capacity must be reduced by 10 percent (0.90 x maximum vent connector capacity). With a connector length greater than 12 feet (3658 mm) but not exceeding 18 feet (5486 mm), the maximum capacity must be reduced by 20 percent (0.80 x maximum vent capacity).

2. For a connector serving a fan-assisted appliance, the minimum capacity (FAN Min) of the connector shall be determined by referring to the corresponding single appliance table. For Type B double-wall connectors, Table 803.1.2(1) shall be used. For single-wall connectors, Table 803.1.2(2) shall be used. The height (H) and lateral (L) shall be measured according to the procedures for a single-appliance vent, as if the other appliances were not present. [NFPA 54:13.2.3]

**803.2.3 Vent Connector Manifolds.** Where the vent connectors are combined prior to entering the vertical portion of the common vent to form a common vent manifold, the size of the common vent manifold and the common vent shall be determined by applying a 10 percent reduction (0.90 x maximum common vent capacity) to the common vent capacity part of the common vent tables. The length of the common vent manifold (L_M) shall not exceed 18 inches per inch (18 mm/mm) of common vent diameter (D). [NFPA 54:13.2.4] (See Figure 802.6.3.2)

**TABLE 803.2.1 VENT CONNECTOR MAXIMUM LENGTH**

<table>
<thead>
<tr>
<th>CONNECTOR DIAMETER (inches)</th>
<th>MAXIMUM CONNECTOR HORIZONTAL LENGTH (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4½</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
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<tr>
<td>5</td>
<td>7½</td>
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<tr>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>24</td>
<td>36</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

**803.2.4 Vent Offsets.** Where the common vent is offset, the maximum capacity of the common vent shall be reduced in accordance with Section 803.2.5, and the horizontal length of the common vent offset shall not exceed 18 inches per inch (18 mm/mm) of common vent diameter (D). Where multiple offsets occur in a common vent, the total horizontal length of all offsets combined shall not exceed 18 inches per inch (18 mm/mm) of the common vent diameter. [NFPA 54:13.2.5]

**803.2.5 Elbows in Vents.** For each elbow up to and including 45 degrees (0.79 rad) in the common vent, the maximum common vent capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than 45 degrees (0.79 rad) up to and including 90 degrees (1.57 rad), the maximum common vent capacity listed in the venting tables shall be reduced by 10 percent. [NFPA 54:13.2.6]

**803.2.6 Elbows in Connectors.** The vent connector capacities listed in the common vent sizing tables include allowance for two 90 degree elbows. For each additional elbow up to and including 45 degrees (0.79 rad) in the common vent, the maximum vent connector capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than 45 degrees (0.79 rad) up to and including 90 degrees (1.57 rad), the maximum vent connector capacity listed in the venting tables shall be reduced by 10 percent. [NFPA 54:13.2.7]

**803.2.7 Common Vent Minimum Size.** The cross-sectional area of the common vent shall be equal to or greater than the cross-sectional area of the largest connector. [NFPA 54:13.2.8]
803.2.8 Tee and Wye Fittings. Tee and wye fittings connected to a common gas vent shall be considered as part of the common gas vent and constructed of materials consistent with that of the common gas vent. [NFPA 54:13.2.9]

803.2.9 Size of Fittings. At the point where tee or wye fittings connect to a common gas vent, the opening size of the fitting shall be equal to the size of the common vent. Such fittings shall not be prohibited from having reduced size openings at the point of connection of appliance gas vent connectors. [NFPA 54:13.2.10]

803.2.10 High-Altitude Installations. Sea level input ratings shall be used when determining maximum capacity for high-altitude installation. Actual input (derated for altitude) shall be used for determining minimum capacity for high-altitude installation. [NFPA 54:13.2.11]

803.2.11 Vent Connector Rise. The vent connector rise \((R)\) for each appliance connector shall be measured from the draft hood outlet or flue collar to the centerline where the vent gas streams come together. \([\text{NFPA 54:13.2.12}]\)

803.2.12 Vent Height. The available total height \((H)\) for multiple appliances all located on the same floor, available total height \((H)\) shall be measured from the highest draft hood outlet or flue collar up to the level of the outlet of the common vent. [NFPA 54:13.2.13]

803.2.13 Multistory Vent Height Installations. For multistory installations, Where appliances are located on more than one floor, the available total height \((H)\) for each segment of the system shall be the vertical distance between the highest draft hood outlet or flue collar up to the level of the outlet of the common vent. [NFPA 54:13.2.14]

803.2.14 Size of Vents for Multistory Installations. The size of the lowest connector and of the vertical vent leading to the lowest interconnection of a multistory system shall be in accordance with Table 803.1.2(1) or Table 803.1.2(2) for available total height \((H)\) up to the lowest interconnection. [NFPA 54:13.2.15]

803.2.15 Vent Type Multistory Type B Vents Required Installation. Where used in multistory systems, vertical common vents shall be Type B double wall and shall be installed with a listed vent cap. [NFPA 54:13.2.16]

803.2.16 Offsets in Multistory Vent Offsets and Capacity Installations. Offsets in multistory common vent systems shall be limited to a single offset in each system, and systems with an offset shall comply with all of the following:

1. The offset angle shall not exceed 45 degrees (0.79 rad) from vertical.
2. The horizontal length of the offset shall not exceed 18 inches per inch (18 mm/mm) of common vent diameter of the segment in which the offset is located.
3. For the segment of the common vertical vent containing the offset, the common vent capacity listed in the common venting tables shall be reduced by 20 percent (0.80 x maximum common vent capacity).
4. A multistory common vent shall not be reduced in size above the offset. [NFPA 54:13.2.17]

803.2.17 Vertical Vent Size Limitation. Where two or more appliances are connected to a vertical vent or chimney, the flow area of the largest section of vertical vent or chimney shall not exceed seven times the smallest listed appliance categorized vent areas, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54:13.2.18]

803.2.18 Multiple Input Ratings Two-Stage/Modulating Appliances. For appliances with more than one input rate, the minimum vent connector capacity \((\text{FAN Min})\) of appliances with more than one input rate shall be determined from the tables and shall be less than the lowest appliance input rating and the maximum vent connector capacity \((\text{FAN Max or NAT Max})\) shall be determined from the tables shall be greater than the highest appliance input rating. [NFPA 54:13.2.19]

803.2.19 Corrugated Metallic Chimney Liner Reduction. Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table 803.2(1) or Table 803.2(2) for Type B vents, with the maximum capacity reduced by 20 percent (0.80 x maximum capacity) and the minimum capacity as shown in Table 803.2(1) or Table 803.2(2). Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Section 803.2.4 and Section 803.2.5. The 20 percent reduction for corrugated metallic chimney liner systems includes an allowance for one long radius 90 degree (1.57 rad) turn at the bottom of the liner. [NFPA 54:13.2.20]

803.2.20 Chimneys and Vents. Table 803.2(1) through Table 803.2(5) shall be used only for chimneys and vents not exposed to the outdoors below the roof line. A Type B vent or listed chimney lining system passing through an unused masonry chimney flue shall not be considered to be exposed to the outdoors. A Type B vent passing through an unventilated enclosure or chase insulated to a value of not less than R8 shall not be considered to be exposed to the outdoors. Where vents extend outdoors above the roof more than 5 feet (1524 mm) higher than required by Table 802.6.1, and where vents terminate in accordance with Section 802.6.1(1)(b), the outdoor portion of the vent shall be enclosed as required by this section for vents not considered to be exposed to the outdoors, or such venting system shall be engineered. Table 803.2(6) through Table 803.2(9) shall be used for clay tile lined exterior masonry chimneys, provided all the following conditions are met:

1. The vent connector is Type B double wall.
2. At least one appliance is draft hood equipped.
The combined appliance input rating is less than the maximum capacity given by Table 803.2(6) (for NAT+NAT) or Table 803.2(8) (for FAN+NAT).

The input rating of each space-heating appliance is greater than the minimum input rating given by Table 803.2(7) (for NAT+NAT) or Table 803.2(9) (for FAN+NAT).

The vent connector sizing is in accordance with Table 803.2(3). [NFPA 54:13.2.22]

**803.2.21 Vent Connector Sizing.** Vent connectors shall not be increased more than two sizes greater than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. Vent connectors for draft hood-equipped appliances shall not be smaller than the draft hood outlet diameter. Where a vent connector size(s) determined from the tables for a fan-assisted appliance(s) is smaller than the flue collar diameter, the use of the smaller size(s) shall be permitted, provided that the installation complies with all of the following conditions:

1. Vent connectors for fan-assisted appliance flue collars 12 inches (300 mm) in diameter or smaller are not reduced by more than one table size [e.g., 12 inches to 10 inches (300 mm to 250 mm) is a one-size reduction] and those larger than 12 inches (300 mm) in diameter are not reduced more than two table sizes [e.g., 24 inches to 20 inches (600 mm to 500 mm) is a two-size reduction].

2. The fan-assisted appliance(s) is common vented with a draft hood-equipped appliance(s).

3. The vent connector has a smooth interior wall. [NFPA 54:13.2.24]

**803.2.22 Combination of Pipe Types and Multiple Vent and Connector Sizes.** All combinations of pipe sizes, single-wall metal pipe, and double-wall metal pipe shall be allowed within any connector run(s) or within the common vent, provided ALL of the appropriate tables permit ALL of the desired sizes and types of pipe, as if they were used for the entire length of the subject connector or vent. Where single-wall and Type B double-wall metal pipes are used for vent connectors within the same venting system, the common vent shall be sized using Table 803.2(2) or Table 803.2(4) as appropriate. [NFPA 54:13.2.25]

**803.2.23 Multiple Connector and Vent Sizes.** Where Table 803.1.2(1) through Table 803.2(9) permits more than one diameter of pipe to be used for a connector or vent, all the permitted sizes shall be permitted to be used. [NFPA 54:13.2.26]

**803.2.24 Interpolation.** Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries. [NFPA 54:13.2.27]

**803.2.25 Extrapolation.** Extrapolation beyond the table entries shall not be permitted. [NFPA 54:13.2.28]
99% Winter Design Temperatures for the Contiguous United States

This map is a necessarily generalized guide to temperatures in the contiguous United States. Temperatures shown for areas such as mountainous regions and large urban centers are not necessarily accurate. The climate data used to develop this map are from the ASHRAE Handbook – Fundamentals (Climate Conditions for the United States).

For 99% winter design temperatures in Alaska, consult the ASHRAE Handbook — Fundamentals.

99% winter design temperatures for Hawaii are greater than 37°F

For SI units: °C = (°F - 32) / 1.8

FIGURE 803.1.2(6)

RANGE OF WINTER DESIGN TEMPERATURES USED IN ANALYZING EXTERIOR MASONRY CHIMNEYS IN THE UNITED STATES

[NFPA 54: FIGURE F.2.4]
### TABLE 803.1.2(1)
**TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(a)]**

<table>
<thead>
<tr>
<th>Number of Appliances:</th>
<th>Single</th>
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<tbody>
<tr>
<td>Appliance Type:</td>
<td>Category I</td>
</tr>
<tr>
<td>Appliance Vent Connection:</td>
<td>Connected Directly to Vent</td>
</tr>
</tbody>
</table>

**Vent Diameter – \( D \) (inch):**

| Height \( H \) (feet) | Lateral \( L \) (feet) | Fan | Nat | Fan | Nat | Fan | Nat | Fan | Nat | Fan | Nat | Fan | Nat |
|------------------------|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                        |                        | Min | Max |     |     | Min | Max |     |     | Min | Max |     |     |     |     |
| 3                      | 4                      | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  |

*NA: Not applicable.*

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²
### TABLE 803.1.2(1)

**TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(a)] (continued)**

<table>
<thead>
<tr>
<th>HEIGHT H (feet)</th>
<th>LATERAL L (feet)</th>
<th>VENT DIAMETER – D (inch)</th>
<th>APPLIANCE VENT CONNECTION: CONNECTED DIRECTLY TO VENT</th>
<th>APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR</th>
<th>NUMBER OF APPLIANCES: SINGLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²
### TABLE 803.1.2(1)
**TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(a)] (continued)**

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**NUMBER OF APPLIANCES:**
- SINGLE

**APPLIANCE TYPE:**
- CATEGORY I

**APPLIANCE VENT CONNECTION:**
- CONNECTED DIRECTLY TO VENT

**VENT DIAMETER – $D$ (inch):**
- 16
- 18
- 20
- 22
- 24

**APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR**

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

**UNIFORM MECHANICAL CODE: PREPRINT**

123
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TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(b)]

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**Notes:**
- For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²
- * NA: Not applicable.
### TABLE 803.1.2(2)

**TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(b)] (continued)**

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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
### TABLE 803.1.2(3)

**MASONRY CHIMNEY** [NFPA 54: TABLE 13.1(c)]

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#### TYPE B DOUBLE-WALL CONNECTOR DIAMETER – D (inch)

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#### TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM

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<td></td>
</tr>
</tbody>
</table>

#### APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR

<table>
<thead>
<tr>
<th>HEIGHT \ LATERAL (feet)</th>
<th>APPLIANCE VENT CONNECTION</th>
<th>APPLIANCE TYPE: CATEGORY I</th>
<th>APPLIANCE TYPE: SINGLE</th>
<th>NUMBER OF APPLIANCES:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.

---

Minimum internal area of chimney (square inches): 12, 19, 28, 38, 50

Maximum internal area of chimney (square inches): Seven times the listed appliance categorized vent area, flue collar area, or draft hood outlet areas.
### TABLE 803.1.2(3)
MASONRY CHIMNEY [NFPA 54: TABLE 13.1(c)] (continued)*

<table>
<thead>
<tr>
<th>HEIGHT H (feet)</th>
<th>APPLIANCE VENT CONNECTION</th>
<th>APPLIANCE TYPE</th>
<th>APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SINGLE</td>
<td>CATEGORY I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TYPE B DOUBLE-WALL CONNECTOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>8</td>
<td>9</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>FAN</td>
<td>NAT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Max</td>
</tr>
<tr>
<td>6</td>
<td>NA</td>
<td>NA</td>
<td>247</td>
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<tr>
<td>8</td>
<td>NA</td>
<td>NA</td>
<td>266</td>
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<tr>
<td>10</td>
<td>68</td>
<td>519</td>
<td>298</td>
</tr>
<tr>
<td>15</td>
<td>64</td>
<td>613</td>
<td>336</td>
</tr>
<tr>
<td>20</td>
<td>61</td>
<td>678</td>
<td>375</td>
</tr>
<tr>
<td>30</td>
<td>57</td>
<td>762</td>
<td>421</td>
</tr>
<tr>
<td>50</td>
<td>51</td>
<td>840</td>
<td>477</td>
</tr>
</tbody>
</table>

**Minimum internal area of chimney (square inches):**

<table>
<thead>
<tr>
<th>Height H (feet)</th>
<th>63</th>
<th>78</th>
<th>95</th>
<th>132</th>
</tr>
</thead>
</table>

**Maximum internal area of chimney (square inches):**

Seven times the listed appliance categorized vent area, flue collar area, or draft hood outlet areas.

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
### TABLE 803.1.2(4)
MASONRY CHIMNEY [NFPA 54: TABLE 13.1(d)]

<table>
<thead>
<tr>
<th>Number of Appliances: SINGLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appliance Type: CATEGORY I</td>
</tr>
<tr>
<td>Appliance Vent Connection: SINGLE-WALL METAL CONNECTOR</td>
</tr>
</tbody>
</table>

#### Single-Wall Metal Connector Diameter — D (inch)

<table>
<thead>
<tr>
<th>Height H (feet)</th>
<th>Lateral L (feet)</th>
<th>Fan Input Rating in Thousands of BTU per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>48</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>81</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td>91</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>5</td>
</tr>
</tbody>
</table>

* NA: Not applicable.

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

---

**Minimum internal area of chimney (square inches):**

- 12
- 19
- 28
- 38
- 50

**Maximum internal area of chimney (square inches):**

Seven times the listed appliance categorized vent area, flue collar area, or draft hood outlet areas.
## TABLE 803.1.2(4)  
MASONRY CHIMNEY [NFPA 54: TABLE 13.1(d)] (continued)*

**TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM**  
**APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HEIGHT H (feet)</strong></td>
<td><strong>LATERAL L (feet)</strong></td>
<td><strong>FAN</strong></td>
<td><strong>FAN</strong></td>
</tr>
<tr>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>216</td>
<td>518</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>211</td>
<td>611</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>261</td>
<td>591</td>
</tr>
<tr>
<td>10</td>
<td>NA</td>
<td>NA</td>
<td>294</td>
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<td>NA</td>
<td>278</td>
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<tr>
<td>20</td>
<td>2</td>
<td>206</td>
<td>675</td>
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<tr>
<td></td>
<td>5</td>
<td>255</td>
<td>655</td>
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<tr>
<td>10</td>
<td>312</td>
<td>622</td>
<td>330</td>
</tr>
<tr>
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<td>NA</td>
<td>NA</td>
<td>294</td>
</tr>
<tr>
<td>20</td>
<td>NA</td>
<td>NA</td>
<td>292</td>
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<tr>
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<td>2</td>
<td>200</td>
<td>759</td>
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<td></td>
<td>5</td>
<td>245</td>
<td>737</td>
</tr>
<tr>
<td>10</td>
<td>300</td>
<td>703</td>
<td>370</td>
</tr>
<tr>
<td>15</td>
<td>NA</td>
<td>NA</td>
<td>349</td>
</tr>
<tr>
<td>20</td>
<td>NA</td>
<td>NA</td>
<td>327</td>
</tr>
<tr>
<td>30</td>
<td>NA</td>
<td>NA</td>
<td>281</td>
</tr>
<tr>
<td>50</td>
<td>2</td>
<td>191</td>
<td>837</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>10</td>
<td>NA</td>
<td>NA</td>
<td>420</td>
</tr>
<tr>
<td>15</td>
<td>NA</td>
<td>NA</td>
<td>395</td>
</tr>
<tr>
<td>20</td>
<td>NA</td>
<td>NA</td>
<td>370</td>
</tr>
<tr>
<td>30</td>
<td>NA</td>
<td>NA</td>
<td>318</td>
</tr>
</tbody>
</table>

Minimum internal area of chimney (square inches)  
63  
78  
95  
132

Maximum internal area of chimney (square inches)  
Seven times the listed appliance categorized vent area, flue collar area, or draft hood outlet areas.

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²  
* NA: Not applicable.
### Table 803.1.2(5)
SINGLE-WALL METAL PIPE OR TYPE B ASBESTOS-CEMENT VENT [NFPA 54: TABLE 13.1(e)]

<table>
<thead>
<tr>
<th>Height $H$ (feet)</th>
<th>Lateral $L$ (feet)</th>
<th>Appliance input rating in thousands of BTU per hour</th>
<th>Maximum appliance input rating in thousands of BTU per hour</th>
</tr>
</thead>
</table>

- **Diameter $D$ (inch)**
- **Appliance type:** Draft hood-equipped
- **Appliance vent connection:** Connected directly to pipe or vent
- **Number of appliances:** Single

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
### TABLE 803.1.2(6)
EXTERIOR MASONRY CHIMNEY [NFPA 54: TABLE 13.1(f)]\(^1,2\)

<table>
<thead>
<tr>
<th>VENT HEIGHT ( H ) (feet)</th>
<th>INTERNAL AREA OF CHIMNEY (square inches)</th>
<th>NUMBER OF APPLIANCES: SINGLE</th>
<th>APPLIANCE TYPE: NAT</th>
<th>APPLIANCE VENT CONNECTION: TYPE B DOUBLE-WALL CONNECTOR</th>
<th>MINIMUM ALLOWABLE INPUT RATING OF SPACE-HEATING APPLIANCE IN THOUSANDS OF BTU PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
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<td>8</td>
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<tr>
<td>20</td>
<td>NA</td>
<td>123</td>
<td>190</td>
<td>249</td>
<td>184</td>
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<tr>
<td>30</td>
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<td>NA</td>
<td>NA</td>
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<tr>
<td>50</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>334</td>
</tr>
<tr>
<td>6</td>
<td>Local 99% winter design temperature: 37°F or greater</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
<td>68</td>
<td>116</td>
<td>156</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
<td>82</td>
<td>127</td>
<td>167</td>
</tr>
<tr>
<td>15</td>
<td>NA</td>
<td>51</td>
<td>97</td>
<td>141</td>
<td>183</td>
</tr>
<tr>
<td>20</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>50</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>419</td>
</tr>
<tr>
<td>6</td>
<td>Local 99% winter design temperature: 27°F to 36°F</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
<td>68</td>
<td>116</td>
<td>156</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
<td>82</td>
<td>127</td>
<td>167</td>
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<tr>
<td>50</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>419</td>
</tr>
<tr>
<td>6</td>
<td>Local 99% winter design temperature: 17°F to 26°F</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>8</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>215</td>
</tr>
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<td>10</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>197</td>
</tr>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>352</td>
</tr>
<tr>
<td>6</td>
<td>Local 99% winter design temperature: 5°F to 16°F</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>8</td>
<td>NA</td>
<td>NA</td>
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<tr>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>6</td>
<td>Local 99% winter design temperature: -10°F to 4°F</td>
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<td></td>
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</tr>
<tr>
<td>8</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>20</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>30</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>50</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Local 99% winter design temperature: -11°F or lower
Not recommended for any vent configurations

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m², °C = (°F-32)/1.8

Notes:
1 See Figure 803.1.2(6) for a map showing local 99 percent winter design temperatures in the United States.
2 NA: Not applicable.
## TABLE 803.2(1)
### TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)]

| VENT HEIGHT H (feet) | CONNECTOR RISE R (feet) | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT |
|----------------------|-------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 3                    | 4                        | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  |
| 6                    | 1                        | 22  | 37  | 26  | 35  | 66  | 46  | 46  | 106 | 72  | 58  | 164 | 104 | 77  | 225 | 142 | 79  | 253 | 168 |
|                      | 2                        | 23  | 41  | 31  | 37  | 75  | 55  | 48  | 121 | 86  | 60  | 183 | 124 | 66  | 195 | 129 | 86  | 269 | 175 |
|                      | 3                        | 24  | 44  | 35  | 38  | 81  | 62  | 49  | 132 | 96  | 62  | 199 | 139 | 82  | 275 | 189 | 84  | 890 | 198 |
| 8                    | 1                        | 22  | 40  | 30  | 35  | 72  | 48  | 49  | 114 | 76  | 64  | 174 | 109 | 84  | 243 | 148 | 86  | 269 | 175 |
|                      | 2                        | 23  | 44  | 32  | 36  | 80  | 57  | 51  | 128 | 90  | 66  | 195 | 129 | 86  | 269 | 175 |
|                      | 3                        | 24  | 47  | 36  | 37  | 87  | 64  | 53  | 139 | 101 | 67  | 210 | 145 | 88  | 290 | 198 | 88  | 800 | 205 |
| 10                   | 1                        | 21  | 50  | 30  | 33  | 89  | 53  | 47  | 148 | 83  | 64  | 220 | 130 | 88  | 298 | 163 | 91  | 320 | 193 |
|                      | 2                        | 22  | 53  | 35  | 35  | 96  | 63  | 49  | 153 | 99  | 66  | 235 | 142 | 93  | 340 | 205 |
|                      | 3                        | 24  | 55  | 40  | 36  | 102 | 71  | 51  | 163 | 111 | 68  | 248 | 160 | 93  | 339 | 218 |
| 20                   | 1                        | 21  | 54  | 51  | 33  | 99  | 56  | 46  | 157 | 87  | 62  | 246 | 125 | 86  | 334 | 171 | 89  | 354 | 202 |
|                      | 2                        | 22  | 57  | 51  | 34  | 105 | 66  | 48  | 167 | 104 | 64  | 259 | 149 | 89  | 354 | 202 |
|                      | 3                        | 23  | 60  | 45  | 35  | 110 | 74  | 50  | 176 | 116 | 66  | 271 | 168 | 91  | 371 | 228 |
| 30                   | 1                        | 20  | 62  | 33  | 31  | 113 | 59  | 45  | 181 | 93  | 60  | 258 | 134 | 83  | 391 | 182 | 85  | 408 | 215 |
|                      | 2                        | 21  | 64  | 39  | 33  | 118 | 70  | 47  | 190 | 110 | 62  | 299 | 158 | 85  | 408 | 215 |
|                      | 3                        | 22  | 66  | 44  | 34  | 123 | 79  | 48  | 198 | 124 | 64  | 309 | 178 | 88  | 423 | 242 |
| 50                   | 1                        | 19  | 71  | 36  | 30  | 133 | 64  | 43  | 216 | 101 | 57  | 349 | 145 | 78  | 477 | 197 |
|                      | 2                        | 21  | 73  | 33  | 32  | 137 | 76  | 45  | 223 | 119 | 59  | 358 | 172 | 81  | 490 | 234 |
|                      | 3                        | 22  | 75  | 40  | 33  | 141 | 86  | 46  | 229 | 134 | 61  | 366 | 194 | 83  | 502 | 263 |
| 100                  | 1                        | 18  | 82  | 37  | 28  | 158 | 66  | 40  | 262 | 104 | 53  | 442 | 150 | 73  | 611 | 204 |
|                      | 2                        | 19  | 83  | 40  | 30  | 161 | 79  | 42  | 267 | 123 | 55  | 477 | 178 | 75  | 619 | 242 |
|                      | 3                        | 20  | 84  | 50  | 31  | 163 | 89  | 44  | 272 | 138 | 57  | 452 | 200 | 78  | 627 | 272 |

### COMMON VENT CAPACITY

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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
### TABLE 803.2(1)
**TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)] (continued)**

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<th>CONNECTOR RISE R (feet)</th>
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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²
### CHIMNEYS AND VENTS

#### TABLE 803.2(1)

**TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)]** (continued)*

| VENT HEIGHT H (feet) | CONNECTOR RISE R (feet) | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT |
|----------------------|-------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                      |                         | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| 6                    | 2                       | 174 | 764 | 496 | 223 | 1046 | 653 | 281 | 1371 | 853 | 346 | 1772 | 1080 |
|                      | 4                       | 180 | 897 | 616 | 230 | 1231 | 827 | 287 | 1617 | 1081 | 352 | 2069 | 1370 |
|                      | 6                       | NA  | NA  | NA  | NA  | NA  | NA  | NA  | NA  | NA  | NA  | NA  |
| 8                    | 2                       | 186 | 822 | 516 | 238 | 1126 | 696 | 298 | 1478 | 910 | 365 | 1920 | 1150 |
|                      | 4                       | 192 | 952 | 644 | 244 | 1307 | 884 | 305 | 1719 | 1150 | 372 | 2211 | 1460 |
|                      | 6                       | 198 | 1050 | 772 | 252 | 1445 | 1072 | 313 | 1902 | 1390 | 380 | 2434 | 1770 |
| 10                   | 2                       | 196 | 870 | 536 | 249 | 1195 | 730 | 311 | 1570 | 955 | 379 | 2049 | 1205 |
|                      | 4                       | 201 | 997 | 664 | 256 | 1371 | 924 | 318 | 1804 | 1205 | 387 | 2332 | 1535 |
|                      | 6                       | 207 | 1095 | 792 | 263 | 1509 | 1118 | 325 | 1989 | 1455 | 395 | 2556 | 1865 |
| 15                   | 2                       | 214 | 967 | 568 | 272 | 1334 | 790 | 336 | 1760 | 1030 | 408 | 2317 | 1305 |
|                      | 4                       | 221 | 1085 | 712 | 279 | 1499 | 1006 | 344 | 1978 | 1320 | 416 | 2579 | 1665 |
|                      | 6                       | 228 | 1181 | 856 | 286 | 1632 | 1222 | 351 | 2157 | 1610 | 424 | 2796 | 2025 |
| 20                   | 2                       | 223 | 1051 | 596 | 291 | 1443 | 840 | 357 | 1911 | 1095 | 430 | 2533 | 1385 |
|                      | 4                       | 230 | 1162 | 748 | 298 | 1597 | 1064 | 365 | 2116 | 1395 | 438 | 2778 | 1765 |
|                      | 6                       | 237 | 1253 | 900 | 307 | 1726 | 1288 | 373 | 2287 | 1695 | 450 | 2984 | 2145 |
| 30                   | 2                       | 216 | 1217 | 632 | 286 | 1664 | 910 | 367 | 2183 | 1190 | 461 | 2891 | 1540 |
|                      | 4                       | 223 | 1316 | 792 | 294 | 1802 | 1160 | 376 | 2366 | 1510 | 474 | 3110 | 1920 |
|                      | 6                       | 231 | 1400 | 952 | 303 | 1920 | 1410 | 384 | 2524 | 1830 | 485 | 3299 | 2340 |
| 50                   | 2                       | 206 | 1479 | 689 | 273 | 2023 | 1007 | 350 | 2659 | 1315 | 435 | 3548 | 1665 |
|                      | 4                       | 213 | 1561 | 860 | 281 | 2139 | 1291 | 359 | 2814 | 1685 | 447 | 3730 | 2135 |
|                      | 6                       | 221 | 1631 | 1031 | 290 | 2242 | 1575 | 369 | 2951 | 2055 | 461 | 3893 | 2605 |
| 100                  | 2                       | 192 | 1923 | 712 | 254 | 2644 | 1050 | 326 | 3490 | 1370 | 402 | 4707 | 1740 |
|                      | 4                       | 200 | 1984 | 885 | 263 | 2731 | 1346 | 336 | 3606 | 1760 | 414 | 4842 | 2220 |
|                      | 6                       | 208 | 2035 | 1064 | 272 | 2811 | 1642 | 346 | 3714 | 2150 | 426 | 4968 | 2700 |

* For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
### TABLE 803.2(1)

**TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)] (continued)**

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<th>VENT CONNECTOR CAPACITY</th>
<th>TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER – D (inch)</th>
<th>APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR</th>
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<td>VENT HEIGHT H (feet)</td>
<td>CONNECTOR RISE R (feet)</td>
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### COMMON VENT CAPACITY

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<th>VENT HEIGHT H (feet)</th>
<th>TYPE B DOUBLE-WALL COMMON VENT DIAMETER – D (inch)</th>
<th>COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR</th>
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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
### TABLE 803.2(2)
**TYPE B DOUBLE-WALL VENT (NFPA 54: TABLE 13.2(b))**

| VENT HEIGHT $H$ (feet) | CONNECTOR RISE $R$ (feet) | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT |
|-------------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 3                       |                          |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 4                       |                          |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 5                       |                          |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 6                       |                          |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 7                       |                          |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

**COMMON VENT CAPACITY**

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<th>FAN +NAT</th>
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<th>FAN +NAT</th>
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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
### TABLE 803.2(2)
TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(b)] (continued)

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<th>CONNECTOR RISE ( R ) (feet)</th>
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<th>FAN ( Max )</th>
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### COMMON VENT CAPACITY

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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²
### CHIMNEYS AND VENTS

#### TABLE 803.2(3)
**MASONRY CHIMNEY (NFPA 54: TABLE 13.2(c))**

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#### VENT CONNECTOR CAPACITY

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#### APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR

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#### COMMON VENT CAPACITY

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#### COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
## TABLE 803.2(3)
MASONRY CHIMNEY [NFPA 54: TABLE 13.2(c)] (continued)*

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### COMMON VENT CAPACITY

| VENT HEIGHT H (feet) | FAN | FAN | FAN | FAN | FAN | FAN | FAN | FAN | FAN | FAN | FAN | FAN | FAN |
|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 63                   | 63  | 63  | 63  | 63  | 63  | 63  | 63  | 63  | 63  | 63  | 63  | 63  | 63  |
| 78                   | 78  | 78  | 78  | 78  | 78  | 78  | 78  | 78  | 78  | 78  | 78  | 78  | 78  |
| 113                  | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²
* NA: Not applicable.
## CHIMNEYS AND VENTS

### TABLE 803.2(4)
Masonry Chimney (NFPA 54: Table 13.2(d))

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<td>APPLIANCE VENT CONNECTION:</td>
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### VENT CONNECTOR CAPACITY

| VENT HEIGHT H (feet) | CONNECTOR RISE R (feet) | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT | FAN | NAT |
|----------------------|-------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                      |                         | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| 3                    | 4                       | 5   | 6   | 7   |     |     |     |     |     |     |
| 6                    | 1                       | NA  | NA  | NA  | NA  | NA  | NA  | 21  | NA  | NA  | 39  | NA  |
|                      | 2                       | NA  | NA  | NA  | NA  | NA  | NA  | 28  | NA  | NA  | 52  | NA  |
|                      | 3                       | NA  | NA  | NA  | NA  | NA  | NA  | 34  | NA  | NA  | 61  | NA  |
| 8                    | 1                       | NA  | NA  | NA  | NA  | NA  | NA  | 21  | NA  | NA  | 40  | NA  |
|                      | 2                       | NA  | NA  | NA  | NA  | NA  | NA  | 28  | NA  | NA  | 52  | NA  |
|                      | 3                       | NA  | NA  | NA  | NA  | NA  | NA  | 34  | NA  | NA  | 62  | NA  |
| 10                   | 1                       | NA  | NA  | NA  | NA  | NA  | NA  | 22  | NA  | NA  | 41  | NA  |
|                      | 2                       | NA  | NA  | NA  | NA  | NA  | NA  | 29  | NA  | NA  | 53  | NA  |
|                      | 3                       | NA  | NA  | NA  | NA  | NA  | NA  | 34  | 97  | 102 | 62  | 143 |
| 15                   | 1                       | NA  | NA  | NA  | NA  | NA  | NA  | 23  | NA  | NA  | 43  | NA  |
|                      | 2                       | NA  | NA  | NA  | NA  | NA  | NA  | 30  | 92  | 103 | 54  | 135 |
|                      | 3                       | NA  | NA  | NA  | NA  | NA  | NA  | 34  | 96  | 112 | 63  | 141 |
| 20                   | 1                       | NA  | NA  | NA  | NA  | NA  | NA  | 23  | NA  | NA  | 45  | NA  |
|                      | 2                       | NA  | NA  | NA  | NA  | NA  | NA  | 30  | 91  | 111 | 55  | 134 |
|                      | 3                       | NA  | NA  | NA  | NA  | NA  | NA  | 35  | 96  | 119 | 64  | 140 |
| 30                   | 1                       | NA  | NA  | NA  | NA  | NA  | NA  | 24  | NA  | NA  | 47  | NA  |
|                      | 2                       | NA  | NA  | NA  | NA  | NA  | NA  | 31  | 91  | 119 | 57  | 132 |
|                      | 3                       | NA  | NA  | NA  | NA  | NA  | NA  | 35  | 95  | 127 | 65  | 138 |
| 50                   | 1                       | NA  | NA  | NA  | NA  | NA  | NA  | 24  | NA  | NA  | 50  | NA  |
|                      | 2                       | NA  | NA  | NA  | NA  | NA  | NA  | 31  | 89  | 123 | 60  | 130 |
|                      | 3                       | NA  | NA  | NA  | NA  | NA  | NA  | 35  | 94  | 131 | 68  | 136 |
| 100                  | 1                       | NA  | NA  | NA  | NA  | NA  | NA  | 23  | NA  | NA  | 49  | NA  |
|                      | 2                       | NA  | NA  | NA  | NA  | NA  | NA  | 30  | 88  | 115 | 59  | 127 |
|                      | 3                       | NA  | NA  | NA  | NA  | NA  | NA  | 34  | 93  | 124 | 67  | 133 |

### COMMON VENT CAPACITY

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<th>MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches)</th>
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### COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR

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<th>FAN +NAT</th>
<th>NAT +FAN</th>
<th>NAT +NAT</th>
<th>FAN +FAN</th>
<th>FAN +NAT</th>
<th>NAT +FAN</th>
<th>NAT +NAT</th>
<th>FAN +FAN</th>
<th>FAN +NAT</th>
<th>NAT +FAN</th>
<th>NAT +NAT</th>
<th>FAN +FAN</th>
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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
### TABLE 803.2(5)
**SINGLE-WALL METAL PIPE OR TYPE B ASBESTOS-CEMENT VENT [NFPA 54: TABLE 13.2(e)]***

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<th>NUMBER OF APPLIANCES:</th>
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<th>APPLIANCE TYPE:</th>
<th>DRAFT HOOD-EQUIPMENT</th>
<th>APPLIANCE VENT CONNECTION:</th>
<th>DIRECT TO PIPE OR VENT</th>
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</thead>
<tbody>
<tr>
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<td>VENT CONNECTOR DIAMETER – D (inch)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>CONNECTOR RISE (R) (feet)</td>
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<td>4</td>
<td>5</td>
<td>6</td>
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<td>34</td>
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<td>102</td>
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### COMMON VENT CAPACITY

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<th>7</th>
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<td>55</td>
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</table>

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.

### TABLE 803.2(6)
**EXTERIOR MASONRY CHIMNEY [NFPA 54: TABLE 13.2(f)]***

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<th>NUMBER OF APPLIANCES:</th>
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<th>APPLIANCE TYPE:</th>
<th>NAT + NAT</th>
<th>APPLIANCE VENT CONNECTION:</th>
<th>TYPE B DOUBLE-WALL CONNECTOR</th>
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<td></td>
<td></td>
<td></td>
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<td>VENT HEIGHT (H) (feet)</td>
<td>INTERNAL AREA OF CHIMNEY (square inches)</td>
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<td>25</td>
<td>46</td>
<td>71</td>
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<td>143</td>
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<td>8</td>
<td>28</td>
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<td>82</td>
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<td>31</td>
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<td>90</td>
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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
# CHIMNEYS AND VENTS

## TABLE 803.2(4) MASONRY CHIMNEY [NFPA 54: TABLE 13.2(d)] (continued)*

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<th>CONNECTOR RISE $R$ (feet)</th>
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<th>FAN</th>
<th>NAT</th>
<th>FAN</th>
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### COMMON VENT CAPACITY

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<th>NAT +FAN</th>
<th>FAN +FAN</th>
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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
### TABLE 803.2(8)
**EXTERIOR MASONRY CHIMNEY [NFPA 54: TABLE 13.2(h)]**

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<th>VENT HEIGHT ( H ) (feet)</th>
<th>12</th>
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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m²

* NA: Not applicable.
## External Masonry Chimney (NFPA 54: Table 13.2(g))

Table 803.2(7)  
**Exterior Masonry Chimney (NFPA 54: Table 13.2(g))**

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<th>63</th>
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For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m², °C = (°F-32)/1.8

Notes:

1. See Figure 803.1.2(6) for a map showing local 99 percent winter design temperatures in the United States.
2. NA: Not applicable.
**TABLE 803.2(9)**

**EXTERIOR MASONRY CHIMNEY [NFPA 54: TABLE 13.2(i)]**

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<th>APPLIANCE TYPE</th>
<th>APPLIANCE VENT CONNECTION</th>
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<td>NA</td>
</tr>
<tr>
<td>100</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Local 99% winter design temperature: 5°F to 16°F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>NA</td>
<td>78</td>
<td>121</td>
</tr>
<tr>
<td>8</td>
<td>NA</td>
<td>94</td>
<td>135</td>
</tr>
<tr>
<td>10</td>
<td>NA</td>
<td>111</td>
<td>149</td>
</tr>
<tr>
<td>15</td>
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<td>NA</td>
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</tr>
<tr>
<td>20</td>
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<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>30</td>
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<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>50</td>
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<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>100</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Local 99% winter design temperature: -10°F to 4°F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>NA</td>
<td>NA</td>
<td>145</td>
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<tr>
<td>8</td>
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<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>100</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m², °C = (°F-32)/1.8

**Notes:**

1. See Figure 803.1.2(6) for a map showing local 99 percent winter design temperatures in the United States.
2. NA: Not applicable.
CHAPTER 9
INSTALLATION OF SPECIFIC APPLIANCES

901.0 General.
901.1 Applicability. This chapter addresses requirements for the design, construction, and installation of specific appliances. In addition to the requirements of this chapter, appliances shall comply with the general requirements of Chapter 3.

902.0 General.
902.1 Nonindustrial Appliances. This chapter is applicable primarily to nonindustrial-type appliances and installations and, unless specifically indicated, does not apply to industrial-type appliances and installations. Listed appliances shall be installed in accordance with their listing and the manufacturer’s installation instructions or, as elsewhere specified in this chapter, as applicable to the appliance. Unlisted appliances shall be installed as specified in this part as applicable to the appliances.

902.2 Combustion Air from Bedroom or Bathroom. Appliances shall not be installed so their combustion, ventilation, and dilution air are obtained only from a bedroom or bathroom unless the bedroom or bathroom has the required volume in accordance with Section 701.4. [NFPA 54:10.1.2]

902.3 Added or Converted Appliances. When additional or replacement appliances or equipment is installed or an appliance is converted to gas from another fuel, the location in which the appliances or equipment is to be operated shall be checked to verify the following:

1. Air for combustion and ventilation is provided where required, in accordance with the provisions of Section 701.0. Where existing facilities are not adequate, they shall be upgraded to meet Section 701.0 specifications.

2. The installation components and appliances meet the clearances to combustible material provisions of Section 303.10. It shall be determined that the installation and operation of the additional or replacement appliances do not render the remaining appliances unsafe for continued operation.

3. The venting system is constructed and sized in accordance with the provisions of Section 802.0. Where the existing venting system is not adequate, it shall be upgraded to comply with Section 802.0. [NFPA 54:9.1.2]

902.4 Type of Gas(es). The appliance shall be connected to the fuel gas for which it was designed. No attempt shall be made to convert the appliance from the gas specified on the rating plate for use with a different gas without consulting the installation instructions, the serving gas supplier, or the appliance manufacturer for complete instructions. Listed appliances shall not be converted unless permitted by and in accordance with the manufacturer’s installation instructions. [NFPA 54:9.1.3]

902.5 Safety Shutoff Devices for Unlisted LP-Gas Appliances Used Indoors. Unlisted appliances for use with undiluted LP-Gases and installed indoors, except attended laboratory equipment, shall be equipped with safety shutoff devices of the complete shutoff type. [NFPA 54:9.1.4]

902.6 Fuel Input Rate. The fuel input rate to the appliance shall not be increased or decreased in violation of the approved rating at the altitude where it is being used.

902.7 Use of Air or Oxygen Under Pressure. Where air or oxygen under pressure is used in connection with the gas supply, effective means such as a back pressure regulator and relief valve shall be provided to prevent air or oxygen from passing back into the gas piping. Where oxygen is used, installation shall be in accordance with NFPA 51. [NFPA 54:9.1.5]

902.8 Building Structural Members Appliance Support. Appliances and equipment shall be furnished either with load-distributing bases or with a sufficient number of supports to prevent damage to either the building structure or the appliance and the equipment. [NFPA 54:9.1.8.1]

902.8.1 Structural Capacity. At the locations selected for installation of appliances and equipment, the dynamic and static load-carrying capacities of the building structure shall be checked to determine whether they are adequate to carry the additional loads. The appliances and equipment shall be supported and shall be connected to the piping so as not to exert undue stress on the connections. [NFPA 54:9.1.8.2]

902.9 Flammable Vapors. Appliances shall not be installed in areas where the open use, handling, or dispensing of flammable liquids occurs, unless the design, operation, or installation reduces the potential of ignition of the flammable vapors. Appliances installed in compliance with Section 305.1 through Section 305.1.2, Section 303.11, or Section 303.12 shall be considered to comply with the intent of this provision. [NFPA 54:9.1.9]

902.10 Solid-Fuel Burning Appliances. Unless otherwise specified, solid-fuel burning appliances shall be installed in accordance with NFPA 211 and the manufacturer’s installation instructions.

902.11 Combination of Appliances and Equipment. Any combination of appliances, equipment, attachments, or devices used together in any manner shall comply with the standards that apply to the individual appliance and equipment. [NFPA 54:9.1.21 9.1.19]

902.12 Protection of Gas Appliances from Fumes or Gases Other than Products of Combustion. Non-direct-vent appliances installed in beauty shops, barber shops, or other facilities where chemicals that generate corrosive or flammable products such as aerosol sprays are routinely used shall be located in a mechanical room separate or partitioned off from other areas with provisions for combustion and dilu-
In the case of vents entering the combustion chamber, conditioning appliances shall be Unlisted air-conditioning appliances shall be installed. In the case of vents leading outdoors, means shall be provided as required for cooling of appliances, equipment, or material; for controlling dew point, heating, drying, oxidation, dilution, safety exhaust, odor control, and air for compressors; and for comfort and proper working conditions for personnel. [NFPA 54:9.1.7]

902.14 Gas Appliance Pressure Regulators. Where the gas supply pressure is higher than that at which the appliance is designed to operate or varies beyond the design pressure limits of the appliance, a gas appliance pressure regulator shall comply with the following requirements:

1) Diaphragm-type valves shall be equipped to convey bleed gas to the outdoors or into the combustion chamber adjacent to a continuous pilot. Vent lines shall not terminate in the appliance flue or exhaust system.

2) Vent lines shall not terminate in combustible material or appliance is protected as required by the appliance manufacturer’s installation instructions. [NFPA 54:9.1.6.2]

3) Bleed lines shall not terminate in the appliance flue or exhaust system.

4) In the case of bleed lines entering the combustion chamber, the bleed line shall be located so the bleed gas is readily ignited by the pilot and the heat liberated thereby does not adversely affect the normal operation of the safety shutoff system. The terminus of the bleed line shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the bleed line piping shall be determined.

5) A bleed line(s) from a diaphragm-type valve and a vent line(s) from an appliance pressure regulator shall not be connected to a common manifold terminating in a combustion chamber. Bleed lines shall not terminate in positive-pressure-type combustion chambers. [NFPA 54:9.1.18 9.1.17]

903.1 Electric Air Conditioners. Electric air conditioning systems designed for permanent installation shall comply with UL 1995 or UL 60335-2-40.

903.2 Gas-Fired Air Conditioners and Heat Pumps. Gas-fired air conditioners shall comply with Section 903.2.1 through Section 903.2.6 903.2.7.

903.2.1 Application. Gas-fired air conditioners and heat pumps shall be listed in accordance with ANSI Z21.40.1/CSA 2.91 or ANSI Z21.40.2/CSA 2.92. [NFPA 54:10.2.1]

903.2.2 Independent Gas Piping. Gas piping serving heating appliances shall be permitted to also serve cooling appliances where heating and cooling appliances cannot be operated simultaneously. [NFPA 54:10.2.2]

903.2.3 Connection of Gas Engine-Powered Air Conditioners. To protect against the effects of normal vibration in service, gas engines shall not be rigidly connected to the gas supply piping. [NFPA 54:10.2.3]

903.2.4 Clearances for Indoor Installation. The installation of air-conditioning appliances shall comply with the following requirements:

1) Listed air-conditioning appliances shall be installed with clearances in accordance with the terms of their listing and the manufacturer’s installation instructions. [NFPA 54:10.2.4(1)]

2) Unlisted air-conditioning appliances shall be installed with clearances from combustible material of not less than 18 inches (457 mm) above the appliance and at the sides, front, and rear, and in accordance with the manufacturer’s installation instructions. [NFPA 54:10.2.3(2)]

(3) Listed and unlisted air-conditioning appliances shall be permitted to be installed with reduced clearances to combustible material, provided that the combustible material or appliance is protected as described in Table 303.10.1 and such reduction is
allowed by the manufacturer’s installation instructions. [NFPA 40.2.3(4) 10.2.4(2)]

(43) Where the furnace plenum is adjacent to plaster on metal lath or noncombustible material attached to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish where the clearance specified is 2 inches (51 mm) or less. [NFPA 40.2.4(3)]

(54) Listed air-conditioning appliances shall have the clearance from supply ducts within 3 feet (914 mm) of the furnace plenum be not less than that specified from the furnace plenum. No clearance is necessary beyond this distance. [NFPA 40.2.4(5) 10.2.4(4)]

903.2.4 903.2.5 Assembly and Installation. Air-conditioning appliances shall be installed in accordance with the manufacturer’s installation instructions. Unless the appliance is listed for installation on a combustible surface, such as a floor or roof, or unless the surface is protected in an approved manner, it shall be installed on a surface of noncombustible construction with noncombustible material and surface finish and with no combustible material against the underside thereof. [NFPA 40.2.4 10.2.5]

903.2.6 Refrigeration Coils. The installation of refrigeration coils shall be in accordance with Section 904.7 904.8 and Section 904.2.2 904.2.7. [NFPA 40.2.6 10.2.7]

903.2.7 Switches in Electrical Supply Line. Means for interrupting the electrical supply to the air-conditioning appliance and to its associated cooling tower (if supplied and installed in a location remote from the air conditioner) shall be provided within sight of and not over 50 feet (15 240 mm) from the air conditioner and the cooling tower shall be in accordance with NFPA 70. [NFPA 40.2.7 10.2.8]

903.3 Packaged Terminal Air Conditioners. Packaged terminal air conditioners and heat pumps shall comply with UL 484 or UL 60335-2-40, and shall be installed in accordance with the manufacturer’s installation instructions.

904.0 Central Heating Boilers and Furnaces.

904.1 Application. Central heating furnaces and boilers shall be listed in accordance with the following:

(1) Central heating furnaces and boilers having input ratings up to and including 400 000 Btu/hr (117 kW) shall be listed in accordance with the following as applicable:

(a) Furnaces listed in accordance with ANSI Z21.47/CSA 2.3.

(b) Low-pressure boilers listed in accordance with ANSI Z21.13/CSA 4.9. [NFPA 50.10.3.1.1]

(2) Furnaces and boilers having input ratings greater than 400 000 Btu/hr (117 kW) shall be listed or in accordance with Section 904.1.1(a) and Section 904.1.2(b). [NFPA 50.10.3.1.2]

(a) Acceptance of unlisted appliances, equipment, and accessories shall be on the basis of engineering methods. [NFPA54:9.1.1.2]

(b) The unlisted appliance, equipment, or accessory shall be safe and suitable for the proposed service and shall be recommended for the service by the manufacturer. [NFPA 50.10.3.1.3]

904.1 904.2 Location. Central heating furnace and low-pressure boiler installations in bedrooms or bathrooms shall comply with one of the following:

(1) Central heating furnaces and low-pressure boilers shall be permitted to be installed in a closet located in the bedroom or bathroom, provided the closet is equipped with a listed, gasketed door assembly, and a listed self-closing device. The self-closing door assembly shall comply with the requirements of Section 904.1.1 904.2.1. The door assembly shall be installed with a threshold and bottom door seal and shall comply with the requirements of Section 904.1.2 904.2.2. Combustion air for such installations shall be obtained from the outdoors. The closet shall be for the exclusive use of the central heating furnace or low-pressure boiler.

(2) Central heating furnaces and low-pressure boilers shall be of the direct vent type.

904.4.1 904.2.1 Self-Closing Doors. Self-closing doors shall swing easily and freely, and shall be equipped with a self-closing device to cause the door to close and latch each time it is opened. The closing mechanism shall not have a hold-open feature.

904.4.2 904.2.2 Gasketing. Gasketing on gasketed doors or frames shall be furnished in accordance with the published listings of the door, frame, or gasketing material制造商.

Exception: Where acceptable to the Authority Having Jurisdiction, gasketing of noncombustible or limited-combustible material shall be permitted to be applied to the frame, provided closing and latching of the door are not inhibited.

904.4.3 904.3 Clearance. Central heating furnaces and low-pressure boilers shall be provided with clearances in accordance with Section 904.2.1 904.3.1 through Section 904.2.7.

904.2.4 904.3.1 Listed Units. Listed central heating furnaces and low-pressure boilers shall be installed with clearances in accordance with the terms of their listings and the manufacturer’s installation instructions. [NFPA 50.10.3.1.1]

904.2.2 904.3.2 Unlisted Units. Unlisted central heating furnaces and low-pressure boilers shall be installed with clearances from combustible material not less than those specified in Table 904.2.2 904.3.2. [NFPA 50.10.3.1.2]

904.2.3 904.3.3 Listed and Unlisted Units. Listed and unlisted central heating furnaces and low-pressure boilers shall be permitted to be installed with reduced clearances to combustible material, provided
that the combustible material or appliance is protected as described in Table 303.10.1 and Figure 303.10.1(1) through Figure 303.10.1(3), and such reduction is allowed by the manufacturer's installation instructions. [NFPA 54:10.3.2.3 10.3.3.3]

904.2.4 904.3.4 Front Clearance. Front clearance shall be sufficient for servicing the burner and the furnace or boiler. [NFPA 54:10.3.2.4 10.3.3.4]

904.2.5 904.3.5 Adjacent to Plaster or Noncombustible Materials. Where the furnace plenum is adjacent to plaster on metal lath or noncombustible material attached to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish where the clearance specified is 2 inches (51 mm) or less. [NFPA 54:10.3.2.5 10.3.3.5]

904.2.6 904.3.6 Interference. The clearances to these appliances shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. [NFPA 54:10.3.2.6 10.3.3.6]

904.2.7 904.3.7 Central Heating Furnaces. Central heating furnaces other than those listed in Section 603.13.2 or Section 603.13.3 shall have clearances from the supply ducts of not less than 18 inches (457 mm) from the furnace plenum for the first 3 feet (914 mm), then 6 inches (152 mm) for the next 3 feet (914 mm) and 1 inch (25.4 mm) beyond 6 feet (1829 mm). [NFPA 54:10.3.2.7 10.3.3.7]

904.3 904.4 Assembly and Installation. A central heating boiler or furnace shall be installed in accordance with the manufacturer’s instructions in one of the following manners:

1. On a floor of noncombustible construction with noncombustible flooring and surface finish and with no combustible material against the underside thereof.

2. On fire-resistive slabs or arches having no combustible material against the underside thereof.

Exceptions:

1. Appliances listed for installation on a combustible floor.

2. Installation on a floor protected in an approved manner. [NFPA 54:10.3.3 10.3.4]

904.4.1 Under-Floor Installation. Furnaces installed in an under-floor area of the building shall be in accordance with Section 904.3.1 through Section 904.3.1.3.

904.4.1.1 Supported by Ground. Where a furnace is supported by the ground, it shall be installed on a concrete slab not less than 3 inches (76 mm) above the adjoining ground level.

904.4.1.2 Supported from Above. Where a furnace is supported from above, a clearance of not less than 6 inches (152 mm) shall be provided from finished grade.

904.4.1.3 Excavation. Where excavation is necessary to install a furnace, it shall be installed in accordance with Section 303.11.

904.4.5 Temperature or Pressure Limiting Devices. Steam and hot water boilers, respectively, shall be provided with approved automatic limiting devices for shutting down the burner(s) to prevent boiler steam pressure or boiler water temperature from exceeding the maximum allowable working pressure or temperature. Safety limit controls shall not be used as operating controls. [NFPA 54:10.3.5]

904.5 904.6 Low-Water Cutoff. All water boilers and steam boilers shall be provided with an automatic means to shut off the fuel supply to the burner(s) if the boiler water level drops below the lowest safe water line. In lieu of the low-water cutoff, water tube or coil-type boilers that require forced circulation to prevent overheating and failure shall have an approved flow sensing device arranged to shut down the boiler when the flow rate is inadequate to protect the boiler against overheating. [NFPA 54:10.3.5 10.3.6]

### TABLE 904.2.2 904.3.2 CLEARANCES TO COMBUSTIBLE MATERIAL FOR UNLISTED FURNACES AND BOILERS* [NFPA 54: TABLE 10.3.2 10.3.3.2]

<table>
<thead>
<tr>
<th>APPLIANCE</th>
<th>ABOVE AND SIDES OF FURNACE PLENUM</th>
<th>TOP OF BOILER</th>
<th>JACKET SIDES AND REAR</th>
<th>FRONT</th>
<th>DRAFT HOOD AND BAROMETRIC DRAFT REGULATOR</th>
<th>SINGLE-WALL VENT CONNECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Automatically fired, forced air or gravity system, equipped with temperature limit control that cannot be set higher than 250°F.</td>
<td>6</td>
<td>–</td>
<td>6</td>
<td>18</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>2. Automatically fired heating boilers – steam boilers operating at not over 15 pounds-force per square inch (psi) and hot water boilers operating at 250°F or less.</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>3. Central heating boilers and furnaces, other than in 1 or 2.</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm, °C = (°F-32)/1.8, 1 pound-force per square inch = 6.8947 kPa

* See Section 904.4.0 for additional requirements for central heating boilers and furnaces.
Steam and hot water boilers shall be equipped, respectively, with listed or approved steam safety or pressure relief valves of appropriate discharge capacity and conforming with ASME requirements. A shutoff valve shall not be placed between the relief valve and the boiler or on discharge pipes between such valves and the atmosphere. [NFPA 54:10.3.6 10.3.7]

Discharge. Relief valves shall be piped to discharge near the floor. [NFPA 54:10.3.6.1 10.3.7.1]

Size. The entire discharged piping shall be at least the same size as the relief valve discharge piping. [NFPA 54:10.3.6.2 10.3.7.2]

End Connections. Discharge piping shall not contain threaded end connection at its termination point. [NFPA 54:10.3.6.3 10.3.7.3]

Refrigeration Coils. The installation of refrigeration coils shall comply with the following requirements:

1. A refrigeration coil shall not be installed in conjunction with a forced air furnace where circulation of cooled air is provided by the furnace blower, unless the blower has sufficient capacity to overcome the external static pressure resistance imposed by the duct system and refrigeration coil at the air flow rate for heating or cooling, whichever is greater.

2. Furnaces shall not be located upstream from refrigeration coils, unless the refrigeration coil is designed or equipped so as not to develop excessive temperature or pressure.

3. Refrigeration coils shall be installed in parallel with or on the downstream side of central furnaces to avoid condensation in the heating element, unless the furnace has been specifically listed for downstream installation. With a parallel flow arrangement, the dampers or other means used to control flow of air shall be sufficiently tight to prevent any circulation of cooled air through the furnace.

4. Means shall be provided for disposal of condensate and to prevent dripping of condensate on the heating element. [NFPA 54:10.3.8 10.3.9]

Cooling Units Used with Heating Boilers. Boilers, where used in conjunction with refrigeration systems, shall be installed so that the chilled medium is piped in parallel with the heating boiler with appropriate valves to prevent the chilled medium from entering the heating boiler. [NFPA 54:10.3.10 10.3.10.1]

Exposed to Refrigerated Air Circulation. Where hot water heating boilers are connected to heating coils located in air-handling units where they can be exposed to refrigerated air circulation, such boiler piping systems shall be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle. [NFPA 54:10.3.9.2 10.3.10.2]

Furnace (Upright and Horizontal). Upright furnaces shall be permitted to be installed in an attic, furred, or under-floor space exceeding 5 feet (1524 mm) in height, provided the required listings and furnace and duct clearances are observed. Horizontal furnaces shall be permitted to be installed in an attic, furred, or under-floor space, provided the required listings and furnace and duct clearances are observed.

Solid-Fuel-Fired Furnaces. Factory-built solid-fuel-fired furnaces shall comply with UL 391 and shall be installed in accordance with the manufacturer’s installation instructions.

Oil-Fired Central Furnaces. Oil-fired central furnaces shall comply with UL 727 and shall be installed in accordance with the manufacturer’s installation instructions.

Commercial or Industrial Gas Heaters. Commercial or industrial gas-fired heaters shall comply with UL 795 and shall be installed in accordance with the manufacturer’s installation instructions.

Electric Central Furnaces. Electric central heating furnaces shall comply with UL 1995 or UL 60335-2-40 and shall be installed in accordance with the manufacturer’s installation instructions.

Duct Furnaces.

Application. Duct furnaces with inputs of 10 MBtu/hr (2931 kW) or less shall be listed in accordance with ANSI Z83.8/CSA 2.6. [NFPA 54:10.9.1]

Clearances. The installation of duct furnaces shall comply with the following clearance requirements:

1. Listed duct furnaces shall be installed with clearances of not less than 6 inches (152 mm) between adjacent walls, ceilings, and floors of combustible material and the furnace draft hood. Furnaces listed for installation at lesser clearances shall be installed in accordance with their listings and the manufacturer’s installation instructions. In no case shall the clearance be such as to interfere with combustion air and accessibility.

2. Unlisted duct furnaces shall be installed with clearances to combustible material in accordance with the clearances specified for unlisted furnaces and boilers in Table 904.2.2. Combustible floors under unlisted duct furnaces shall be protected in an approved manner.

Installation of Duct Furnaces. Duct furnaces shall be installed in accordance with the manufacturer’s instructions. [NFPA 54:10.10 10.9.3]

Access Panels. The ducts connected to duct furnaces shall have removable access panels on both the upstream and downstream sides of the furnace. [NFPA 54:10.10.4 10.9.4]

Location of Draft Hoods and Controls. The controls, combustion air inlet, and draft hoods for duct
furnaces shall be located outside the ducts. The draft hood shall be located in the same enclosure from which combustion air is taken. [NFPA 54:10.10.4 10.9.5]

**905.5 905.6 Circulating Air.** Where a duct furnace is installed so that supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace. The duct furnace shall be installed on the positive-pressure side of the circulating air blower. [NFPA 54:10.10.5 10.9.6]

**905.7 Duct Furnaces Used with Refrigeration Systems.** A duct furnace shall not be installed in conjunction with a refrigeration coil where circulation of cooled air is provided by the blower.

**Exception:** Where the blower has sufficient capacity to overcome the external static resistance imposed by the duct system, the furnace, and the cooling coil and the air throughput necessary for heating or cooling, whichever is greater. [NFPA 54:10.10.6.1 10.9.7.1]

**905.6.1 905.7.1 In Conjunction with Cooling Appliances.** Duct furnaces used in conjunction with cooling appliances shall be installed in parallel with or on the upstream side of cooling coils to avoid condensation within heating elements. With a parallel flow arrangement, the dampers or other means used to control the flow of air shall be sufficiently tight to prevent any circulation of cooled air through the unit.

**Exception:** Where the duct furnace has been specifically listed for downstream installation. [NFPA 54:10.10.6.2 10.9.7.2]

**905.6.2 Located Upstream from Cooling Coils.** Where duct furnaces are to be located upstream from cooling units, the cooling unit shall be so designed or equipped as to not develop excessive temperatures or pressures. [NFPA 54:10.10.6.3]

**905.6.3 905.7.2 Heat Exchangers.** Where a duct furnace is installed downstream of an evaporative cooler or air washer, the heat exchanger shall be constructed of corrosion-resistant materials. Stainless steel, ceramic-coated steel, and an aluminum-coated steel in which the bond between the steel and the aluminum is an iron-aluminum alloy are considered to be corrosion resistant. Air washers operating with chilled water that deliver air below the dew point of the ambient air at the duct furnace shall be considered as refrigeration systems. [NFPA 54:10.10.6.4 10.9.7.3]

**905.7 905.8 Installation in Commercial Garages and Aircraft Hangars.** Duct furnaces installed in garages for more than three motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with Section 303.11 and Section 303.12. [NFPA 54:10.10.7 10.9.8]

**905.9 Electric Duct Heaters.** Electric duct heaters installed within an air duct shall be listed and labeled in accordance with UL 1996 and designed for the maximum air temperature. The duct heater and fan shall be interlocked such that the electric duct heater operates when the fan is operating.

**905.8.1 905.9.1 Installation.** Duct heaters shall be installed in accordance with the manufacturer’s installation instructions, and shall not create a hazard to persons or property. Where installed 4 feet (1219 mm) or less from a heat pump or air conditioner, the duct heater shall be listed for such installation.

**905.8.2 905.9.2 Clearance.** A working space clearance shall be maintained to permit replacement of controls and heating elements and for adjusting and cleaning of controls. The working space for energized equipment shall comply with NFPA 70.

**906.0 Floor Furnaces.**

**906.1 Application.** Floor furnaces shall be listed in accordance with ANSI Z21.86/CSA 2.32. [NFPA 54:10.10.11]

**906.2 Installation.** The installation of floor furnaces shall comply with the following requirements:

1. Listed floor furnaces shall be installed in accordance with their listing and the manufacturer’s installation instructions.
2. Unlisted floor furnaces shall not be installed on combustible floors.
3. Thermostats controlling floor furnaces shall not be located in a room or space that is capable of being separated from the room or space in which the room or space in which the register of the floor furnace is located. [NFPA 54:10.10.11]

**906.3 Temperature Limit Controls.** Floor furnaces shall be provided with temperature limit controls in accordance with the following requirements:

1. Listed automatically. Automatically operated floor furnaces shall be equipped with temperature limit controls. [NFPA 54:10.11.2.1 10.9.10.3]
2. Unlisted automatically operated floor furnaces shall be equipped with a temperature-limit control arranged to shut off the flow of gas to the burner in the event the temperature at the warm air outlet register exceeds 250°F (121°C) above room temperature. [NFPA 54:10.11.2.2]

**906.4 Combustion and Circulating Air.** Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.11.3 10.10.4]

**906.5 Placement.** The following provisions apply to furnaces that serve one story:

1. Floors. Floor furnaces shall not be installed in the floor of any doorway, stairway landing, aisle, or passageway of any enclosure, public or private, or in an exitway from any such room or space.
2. Walls and Corners. The register of a floor furnace with a horizontal warm air outlet shall not be placed closer than 6 inches (152 mm) from the nearest wall. A distance of at least 18 inches (457 mm) from two adjoining sides of the
floor furnace register to walls shall be provided to eliminate the necessity of occupants walking over the warm air discharge. The remaining sides shall be a minimum of 6 inches (152 mm) from a wall. Wall register models shall not be placed closer than 6 inches (152 mm) to a corner.

3) Draperies. The furnace shall be placed so that a door, drapery, or similar object cannot be nearer than 12 inches (305 mm) to any portion of the register of the furnace. [NFPA 54:10.11.5 10.10.5]

906.5 906.6 Bracing. The space provided for the furnace shall be framed with doubled joists and with headers not lighter than the joists. [NFPA 54:10.11.6 10.10.6]

906.6 906.7 Support. Means shall be provided to support the furnace when the floor register is removed. [NFPA 54:10.11.6 10.10.7]

906.7 906.8 Clearance. The lowest portion of the floor furnace shall have at least a 6 inch (152 mm) clearance from the general ground level. A reduced clearance to a minimum of 2 inches (51 mm) shall be permitted, provided the lower 6 inches (152 mm) portion of the floor furnace is sealed by the manufacturer to prevent entrance of water. Where these clearances are not present, the ground below and to the sides shall be excavated to form a “basin-like” pit under the furnace so that the required clearance is provided beneath the lowest portion of the furnace. A 12 inch (305 mm) clearance shall be provided on all sides except the control side, which shall have an 18 inch (457 mm) clearance. [NFPA 54:10.11.5 10.10.8]

906.8 906.9 Access. The space in which any floor furnace is installed shall be accessible by an opening in the foundation not less than 24 inches by 18 inches (610 mm by 457 mm), or by a trapdoor not less than 24 inches by 24 inches (610 mm by 610 mm) in any cross-section thereof, and a passageway not less than 24 inches by 18 inches (610 mm by 457 mm) in any cross-section thereof. [NFPA 54:10.11.8 10.10.9]

906.9 906.10 Seepage Pan. Where the excavation exceeds 12 inches (305 mm) in depth or water seepage is likely to collect, a watertight copper pan, concrete pit, or other suitable material shall be used, unless adequate drainage is provided or the appliance is sealed by the manufacturer to meet this condition. A copper pan shall be made of not less than 16 ounces per square foot (oz/ft²) (4.9 kg/m²) sheet copper. The pan shall be anchored in place so as to prevent floating, and the walls shall extend at least 4 inches (102 mm) above the ground level with at least a 6 inches (152 mm) clearance on all sides, except on the control side, which shall have at least an 18 inch (457 mm) clearance. [NFPA 54:10.11.9 10.10.10]

906.10 906.11 Wind Protection. Floor furnaces shall be protected, where necessary, against severe wind conditions. [NFPA 54:10.11.10 10.10.11]

906.11 906.12 Upper Floor Installations. Listed floor furnaces shall be permitted to be installed in an upper floor, provided the furnace assembly projects below into a utility room, closet, garage, or similar nonhabitable space. In such installations, the floor furnace shall be enclosed completely (entirely separated from the nonhabitable space) with means for air intake to meet the provisions of Section 701.0, with access for servicing, minimum furnace clearances of 6 inches (152 mm) to all sides and bottom, and with the enclosure constructed of Portland cement plaster or metal lath or other noncombustible material. [NFPA 54:10.11.11 10.10.12]

906.12 906.13 First Floor Installation. Listed floor furnaces installed in the first or ground floors of buildings shall not be required to be enclosed unless the basements of these buildings have been converted to apartments or sleeping quarters, in which case the floor furnace shall be enclosed as specified for upper floor installations and shall project into a nonhabitable space. [NFPA 54:10.11.12 10.10.13]

906.13 906.14 Oil-Fired Floor Furnaces. Oil-fired floor furnaces shall comply with UL 729 and installed in accordance with the manufacturer’s installation instructions.

907.0 Wall Furnaces.

907.1 Application. Wall furnaces shall be listed in accordance with ANSI Z21.86/CSA 2.32. [NFPA 54:10.25.1]

907.2 Vented Wall Furnaces. Vented wall furnaces connected to a Type B-W gas vent system listed only for a single story shall be installed only in single-story buildings or the top story of multistory buildings. Vented wall furnaces connected to a Type B-W gas vent system listed for installation in multistory buildings shall be permitted to be installed in single-story or multistory buildings. Type B-W gas vents shall be attached directly to a solid header plate that serves as a firestop at that point and that shall be permitted to be an integral part of the vented wall furnace, as illustrated in Figure 907.2.1 907.2.1. The stud space in which the vented wall furnace is installed shall be ventilated at the first ceiling level by installation of the ceiling plate spacers furnished with the gas vent. Firestop spacers shall be installed at each subsequent ceiling or floor level penetrated by the vent. [NFPA 54:10.26.1.1 10.25.2.2]

907.3 Direct Vent Wall Furnaces. Direct vent wall furnaces shall be installed with the vent combustion air intake terminal outdoors. The thickness of the walls on which the furnace is mounted shall be within the range of wall thickness marked on the furnace and covered in the manufacturer’s installation instructions. [NFPA 54:10.26.1.1 10.25.2.3]

907.4 Panels, Grilles, and Access Doors. Panels, grilles, and access doors that are required to be removed for normal servicing operations shall not be
attached to the building. For additional information on the venting of wall furnaces, see Section 802.0. [NFPA 54:10.25.2.4]

For SI units: 1 inch = 25.4 mm

**FIGURE 907.2.1**
INSTALLATION OF TYPE B-W GAS VENTS FOR VENTED WALL FURNACES
[NFPA 54: FIGURE 10.26.1.3 10.25.2.2]

907.2 907.3 Location. Wall furnaces shall be located so as not to cause a hazard to walls, floors, curtains, furniture, or doors. Wall furnaces installed between bathrooms and adjoining rooms shall not circulate air from bathrooms to other parts of the building. [NFPA 54:10.25.3]

907.4 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.25.4]

907.5 Oil-Fired Wall Furnaces. Oil-fired wall furnaces shall comply with UL 730 and installed in accordance with the manufacturer’s installation instructions.

908.0 Clothes Dryers.

908.1 Application. Clothes dryers shall be listed in accordance with ANSI Z21.5.1/CSA 7.1 for Type I clothes dryers or ANSI Z21.5.2/CSA 7.2 for Type II clothes dryers. [NFPA 54:10.4.1]

908.2 908.3 Gas-Fired Clothes Dryers. Gas-fired clothes dryers shall comply with Section 908.2.1 through 908.3.3.

908.3.1 Clearance. The installation of clothes dryers shall comply with the following requirements:

1. Listed Type 1 clothes dryers shall be installed with a clearance of not less than 6 inches (152 mm) from adjacent combustible material. Clothes dryers listed for installation at reduced clearances shall be installed in accordance with their listing and the manufacturer’s installation instructions. Type 1 clothes dryers installed in closets shall be listed for such installation.

2. Listed Type 2 clothes dryers shall be installed with clearances of not less than those shown on the marking plate and in the manufacturer’s instructions. Type 2 clothes dryers designed and marked, “For use only in noncombustible locations,” shall not be installed elsewhere.

3. Unlisted clothes dryers shall be installed with clearances to combustible material of not less than 18 inches (457 mm). Combustible floors under unlisted clothes dryers shall be protected in an approved manner. [NFPA 54:10.4.2]

908.3.2 Exhausting to the Outdoors. Type 1 and Type 2 clothes dryers shall be exhausted to the outside air in accordance with Section 504.4. [NFPA 54:10.4.3]

908.3.3 Multiple-Family or Public Use. All clothes dryers installed for multiple-family or public use shall be equipped with approved safety shutoff devices and shall be installed as specified for a Type 2 clothes dryer under Section 504.4.3.1. [NFPA 54:10.4.6 10.4.7]

909.0 Conversion Burners.

909.1 General. Installation of conversion burners shall conform to CSA Z21.8. [NFPA 54:10.5]

910.0 Burner Assemblies.

910.1 Oil Burners. Oil burners shall comply with UL 296 and installed in accordance with the manufacturer’s installation instructions.

910.2 Gas Burners. Commercial gas burners shall comply with UL 295 and installed in accordance with the manufacturer’s installation instructions.

911.0 Decorative Appliances for Installation in Vented Fireplaces.

911.1 Application. Decorative appliances for installation in vented fireplaces shall be listed in accordance with ANSI Z21.60/CSA 2.26. [NFPA 54:10.6.1]
911.2 Prohibited Installations. Decorative appliances for installation in vented fireplaces shall not be installed in bathrooms or bedrooms unless the appliance is listed and the bedroom or bathroom has the required volume in accordance with Section 701.4. [NFPA 54:10.6.2 10.6.2]

911.2 Installation. A decorative appliance for installation in a vented fireplace shall be installed only in a vented fireplace having a working chimney flue and constructed of noncombustible materials. These appliances shall not be thermostatically controlled. [NFPA 54:10.6.2 10.6.3]

911.3 Listed Decorative Appliance. A listed decorative appliance for installation in a vented fireplace shall be installed in accordance with its listing and the manufacturer’s installation instructions. [NFPA 54:10.6.3.1]

911.3.2 In Manufactured Homes. A decorative appliance for installation in a vented fireplace, where installed in a manufactured home, shall be listed for installation in manufactured homes. [NFPA 54:10.6.2.2 10.6.3.2]

911.3.3 Unlisted Decorative Appliance. An unlisted decorative appliance for installation in a vented fireplace shall be installed in a fireplace having a permanent free opening, based on appliance input rating and chimney height, equal to or greater than that specified in Table 911.2. [NFPA 54:10.6.2.3]

911.4 Fireplace Screens. A fireplace screen shall be installed with a decorative appliance for installation in a vented fireplace. [NFPA 54:10.6.4]

912.0 Gas Fireplaces, Vented.

912.1 Application. Vented gas fireplaces shall be listed in accordance with ANSI Z21.50/CSA 2.32. [NFPA 54:10.7.1]

912.2 Prohibited Installations. Vented gas fireplaces shall not be installed in bathrooms or bedrooms unless the appliance is listed and the bedroom or bathroom has the required volume in accordance with Section 701.4.

Exception: Direct vent gas fireplaces. [NFPA 54:10.7.4 10.7.2]

912.3 Installation. The installation of vented gas fireplaces shall comply with the following requirements:

1) Listed vented Vented gas fireplaces shall be installed in accordance with their listing and the manufacturer’s installation instructions and where installed in or attached to combustible material shall be specifically listed for such installation.

2) Unlisted vented gas fireplaces shall not be installed in or attached to combustible material. They shall have a clearance at the sides and rear of not less than 18 inches (457 mm). Combustible floors under unlisted vented gas fireplaces shall be protected in an approved manner. Unlisted appliances of other than the direct vent type shall be equipped with a draft hood and shall be vented in accordance with Section 912.0. Appliances that use metal, asbestos, or ceramic material to direct radiation to the front of the appliance shall have a clearance of 36 inches (914 mm) in front and, where constructed with a double back of metal or ceramic, shall be installed with a clearance of not less than 18 inches (457 mm) at the sides and 12 inches (305 mm) at the rear.

3) Panels, grilles, and access doors that are required to be removed for normal servicing operations shall not be attached to the building.

4) Direct vent gas fireplaces shall be installed with the vent-air intake terminal in the outdoors and in accordance with the manufacturer’s installation instructions. [NFPA 54:10.7.3]

912.4 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.7.4]

913.0 Factory-Built Fireplaces and Fireplace Stoves. 913.1 Factory-Built Fireplaces. Factory-built fireplaces shall comply with UL 127 and installed in accordance with the manufacturer’s installation instructions. [NFPA 54:10.7.3]

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### TABLE 911.3

<table>
<thead>
<tr>
<th>CHIMNEY HEIGHT (feet)</th>
<th>APPLIANCE INPUT RATING (Btu/h)</th>
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<tbody>
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<td>51</td>
<td>56-2000</td>
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<tr>
<td>64</td>
<td>68-2000</td>
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</tbody>
</table>

Footnotes:
- For SI units: 1 foot = 0.3048 m, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m².
- The first six minimum permanent free openings [8 square inches (0.005 m²) to 51 square inches (0.32 m²)] correspond approximately to the cross-sectional areas of chimneys having diameters of 3 inches (76 mm) through 8 inches (203 mm), respectively. The 64 square inch (104 m²) opening corresponds to the cross-sectional area of a standard 8 inch (203 mm) by 8 inch (203 mm) chimney tile.
913.1.1 Gasketed Fireplace Doors. A gasketed fireplace door shall not be installed on a factory-built fireplace, except where the fireplace system has been tested in accordance with UL 127.

913.2 Fireplace Stoves. Fireplace stoves shall comply with UL 737 and installed in accordance with the manufacturer’s installation instructions.

913.3 Fireplace Accessories. Heat exchangers, glass doors assemblies, combustion air vents, and termination caps shall comply with UL 907 and installed in accordance with the manufacturer’s installation instructions.

914.0 Non-Recirculating Direct Gas-Fired Industrial Air Heaters.

914.1 Application. Direct gas-fired heating and forced ventilation appliances for commercial and industrial air heaters of the non-recirculating type shall be listed in accordance with CSA, the following standards as applicable:

1. ANSI Z83.4/CSA 3.7.
2. ANSI Z83.18. [NFPA 54:10.8.1]

914.2 Prohibited Installations. Non-recirculating direct gas-fired industrial air heaters shall not serve any area containing sleeping quarters. Non-recirculating direct gas-fired industrial air heaters shall not recirculate room air.

Recirculating direct gas-fired industrial air heaters shall not recirculate room air in buildings that contain flammable solids, liquids, or gases; explosive materials; or substances that can become toxic when exposed to flame or heat. [NFPA 54:10.8.2.1 – 10.8.2.3]

914.3 Installation. Non-recirculating direct gas-fired industrial air heaters shall be installed in accordance with the manufacturer’s instructions. [NFPA 54:10.8.3.1]

914.3.1 Fresh Air Ventilation. Non-recirculating direct gas-fired industrial air heaters shall be permitted to provide fresh air ventilation. [NFPA 54:10.8.3.2]

914.3.2 Access Required. Non-recirculating direct gas-fired industrial air heaters shall be provided with access for removal of burners; for replacement of motors, controls, filters, and other working parts; and for adjustment and lubrication of parts requiring maintenance. [NFPA 54:10.8.3.3]

914.4 Clearance from Combustible Materials. Non-recirculating direct gas-fired industrial air heaters shall be installed with a clearance from combustible materials of not less than that shown on the rating plate and the manufacturer’s instructions. [NFPA 54:10.8.4]

914.5 Air Supply. All the air supply to the recirculating direct gas-fired industrial air heater shall be ducted directly from outdoors.

Where outdoor air dampers or closing louvers are used, they shall be verified to be in the open position prior to main burner operation, in accordance with Section 914.5.1 through Section 914.5.3. [NFPA 54:10.8.5]

914.5.1 Non-Recirculating Systems. All air to the non-recirculating direct gas-fired heating and forced ventilation appliance shall be ducted directly from outdoors. [NFPA 54:10.8.5.1]

914.5.2 Recirculating Systems. Ventilation air to the recirculating direct gas-fired heating and forced ventilation appliance shall be ducted directly from outdoors. Air in excess of the minimum ventilation air specified on the heater’s rating plate shall be taken from the building, ducted directly from outdoors, or a combination of both. [NFPA 54:10.8.5.2]

914.5.3 Dampers or Louvers. Where outdoor air dampers or closing louvers are used, they shall be verified to be in the open position prior to main burner operation. [NFPA 54:10.8.5.3]

914.6 Atmospheric Vents, Gas Reliefs, or Bleeds. Non-recirculating direct gas-fired industrial air heaters shall be listed in accordance with CSA, the following standards as applicable:

1. CSA 84.1
2. CSA Z83.18. [NFPA 54:10.8.6]

914.7 Relief Openings. The design of the installation shall include adequate provisions to permit the non-recirculating direct gas-fired industrial air heater heating and forced ventilation appliances with valve train components equipped with atmospheric vents, gas reliefs, or bleeds to have their vent lines, gas reliefs, or bleeds lead to a safe point outdoors. Means shall be employed on these lines to prevent water from entering and to prevent blockage from insects and foreign matter. An atmospheric vent line shall not be required to be provided on a valve train component equipped with a listed vent limiter. [NFPA 54:10.8.6]

914.7.1 Infiltration Rate. The structure’s designed infiltration rate and the size of relief opening(s) shall be determined by approved engineering methods. [NFPA 54:10.8.7.1]

914.7.2 Louver or Gravity Dampers. Louver or counterbalanced gravity damper relief openings shall be permitted. Where motorized dampers or closeable louvers are used, they shall be proved to be in their open position prior to main burner operation. [NFPA 54:10.8.7.2]

914.8 Purging. Inlet ducting, when used, shall be purged with at least four air changes prior to an ignition attempt. [NFPA 54:10.8.8]

915.0 Recirculating Direct Gas-Fired Industrial Air Heaters.

915.1 Application. Direct gas-fired industrial air heaters of the recirculating type shall be listed in accordance with CSA Z83.18. [NFPA 54:10.9.1]
915.2 Prohibited Installations. Recirculating direct gas-fired industrial air heaters shall not serve any area containing sleeping quarters. Recirculating direct gas-fired industrial air heaters shall not recirculate room air in buildings that contain flammable solids, liquids, or gases, explosive materials, or substances that can become toxic when exposed to flame or heat. [NFPA 54:10.21.1, 10.21.2]

915.3 Installation. Recirculating direct gas-fired industrial air heaters shall be installed in accordance with the manufacturer’s instructions. [NFPA 54:10.9.3]

915.4 Clearance from Combustible Materials. Recirculating direct gas-fired industrial air heaters shall be installed with a clearance from combustible materials of not less than that shown on the rating plate and the manufacturer’s instructions. [NFPA 54:10.9.4]

915.5 Air Supply. Ventilation air to the recirculating direct gas-fired industrial air heater shall be ducted directly from outdoors. Air to the recirculating direct gas-fired industrial air heater in excess of the minimum ventilation air specified on the heater’s rating plate shall be taken from the building, ducted directly from outdoors, or a combination of both. Where outdoor air dampers or closing louvers are used, they shall be verified to be in the open position prior to main burner operation. [NFPA 54:10.9.5]

915.6 Atmospheric Vents, Gas Reliefs, or Bleeds. Recirculating direct gas-fired industrial air heaters with valve train components equipped with atmospheric vents, gas reliefs, or bleeds shall have their vent lines, gas reliefs, or bleeds lead to a safe point outdoors. Means shall be employed on these lines to prevent water from entering and to prevent blockage from insects and foreign matter. An atmospheric vent line shall not be required to be provided on a valve train component equipped with a listed vent limiter. [NFPA 54:10.9.6]

915.7 Relief Openings. The design of the installation shall include adequate provisions to permit the recirculating direct gas-fired industrial air heater to operate at its rated airflow without overpressurizing the space served by the heater by taking into account the structure’s designed infiltration rate, properly designed relief openings, or an interlocked powered exhaust system, or a combination of these methods. [NFPA 54:10.9.7]

915.7.1 Infiltration Rate. The structure’s designed infiltration rate and the size of relief opening(s) shall be determined by approved engineering methods. [NFPA 54:10.9.7.1]

915.7.2 Louver or Gravity Dampers. Louvers or counterbalanced gravity damper relief openings shall be permitted. Where motorized dampers or closeable louvers are used, they shall be proved to be in their open position prior to main burner operation. [NFPA 54:10.9.7.2]

915.8 Purging. Inlet ducting, when used, shall be purged with at least four air changes prior to an ignition attempt. [NFPA 54:10.9.8]
INSTALLATION OF SPECIFIC APPLIANCES

Unlisted unit heaters shall be installed with clearances to combustible material not less than 12 inches (305 mm).

(2) Unlisted unit heaters shall be installed with clearances to combustible material of not less than 18 inches (457 mm).

(3) Clearances for servicing shall be in accordance with the manufacturer’s installation instructions. [NFPA 54:10.24.3]

917.3 916.3.1 Floor-Mounted-Type Unit Heaters. Floor-mounted-type unit heaters shall comply with the following requirements:

(1) A listed unit heater shall be installed with clearances from combustible material at the back and one side of not less than 6 inches (152 mm). Where the flue gases are vented horizontally, the 6 inch (152 mm) clearance shall be measured from the draft hood or vent instead of the rear wall of the unit heater. A unit heater listed for reduced clearances shall be installed in accordance with its listing and the manufacturer’s installation instructions.

(2) Floor-mounted-type unit heaters installed on combustible floors shall be listed for such installation.

(3) Combustible floors under unlisted floor-mounted unit heaters shall be protected in an approved manner.

(4) Clearances for servicing shall be in accordance with the manufacturer’s instructions.

917.3 916.4 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.25.3 10.24.4]

917.4 916.5 Ductwork. A unit heater shall not be attached to a warm air duct system unless listed and marked for such installation. [NFPA 54:10.25.4 10.24.5]

917.5 916.6 Installation in Commercial Garages and Aircraft Hangars. Unit heaters installed in garages for more than three motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with Section 303.11 and Section 303.12. [NFPA 54:10.25.5 10.24.6]

917.6 916.7 Oil-Fired Unit Heaters. Oil-fired unit heaters shall comply with UL 731 and installed in accordance with the manufacturer’s installation instructions.

918.0 917.0 Food Service Appliance, Floor-Mounted. 917.1 Application. Floor-mounted food service appliances shall be listed in accordance with CSA Z83.11. [NFPA 54:10.11.1]

918.4 917.2 Clearance for Listed Appliances. Listed floor-mounted food service appliances, such as ranges for hotels and restaurants, deep fat fryers, unit broilers, kettles, steam cookers, steam generators, and baking and roasting ovens, shall be installed not less than 6 inches (152 mm) from combustible material except that at least a 2 inch (51
mm) clearance shall be maintained between a draft hood and combustible material. Floor-mounted food service appliances listed for installation at lesser clearances shall be installed in accordance with its listing and the manufacturer’s installation instructions. Appliances designed and marked, “For use only in noncombustible locations,” shall not be installed elsewhere. [NFPA 54:10.11.2]

918.2 Clearance for Unlisted Appliances. Unlisted floor mounted food service appliances shall be installed to provide a clearance to combustible material of not less than 18 inches (457 mm) from the sides and rear of the appliance and from the vent connector and not less than 18 inches (1219 mm) above cooking tops and at the front of the appliance.

Clearances for unlisted appliances installed in partially enclosed areas, such as alcoves, shall not be reduced. Reduced clearances for unlisted appliances installed in rooms that are not partially enclosed shall be in accordance with Table 303.10.1. [NFPA 54:10.12.2]

918.3 9173 Mounting on Combustible Floors. Listed floor mounted food service appliances that are listed specifically for installation on floors constructed of combustible material shall be permitted to be installed on combustible floors in accordance with its listing and the manufacturer’s installation instructions. [NFPA 54:10.11.3.1]

918.2.1 9173.1 Not Listed for Mounting on Combustible Floors. Floor-mounted food service appliances that are not listed for mounting on a combustible floor shall be mounted in accordance with Section 918.4 or be mounted in accordance with one of the following:

1) Where the appliance is set on legs that provide not less than 18 inches (457 mm) open space under the base of the appliance or where it has no burners and no portion of any oven or broiler within 18 inches (457 mm) of the floor, it shall be permitted to be mounted on a combustible floor without special floor protection, provided at least one sheet metal baffle is between the burner and the floor.

2) Where the appliance is set on legs that provide not less than 8 inches (203 mm) open space under the base of the appliance, it shall be permitted to be mounted on combustible floors, provided the floor under the appliance is protected with not less than \( \frac{1}{8} \) of an inch (9.5 mm) insulating millboard covered with sheet metal not less than 0.0195 of an inch (0.4953 mm) thick. Such masonry courses shall be laid with ends unsealed and joints matched in such a way as to provide for free circulation of air through the masonry.

3) Where the appliance is set on legs that provide not less than 4 inches (102 mm) under the base of the appliance, it shall be permitted to be mounted on combustible floors, provided the floor under the appliance is protected with hollow masonry not less than 4 inches (102 mm) in thickness covered with sheet metal not less than 0.0195 of an inch (0.4953 mm) thick. Such masonry courses shall be installed to permit proper combustion of the gas. [NFPA 54:10.12.5 10.11.4.2]

4) Where the appliance does not have legs at least 4 inches (102 mm) high, it shall be permitted to be mounted on combustible floors, provided the floor under the appliance is protected by two courses of 4 inch (102 mm) hollow clay tile, or equivalent, with courses laid at right angles and with ends unsealed and joints matched in such a way as to provide for free circulation of air through such masonry courses, and covered with steel plate not less than \( \frac{1}{8} \) of an inch (4.8 mm) in thickness. [NFPA 54:10.12.3.2 10.11.4.2]

918.4 9174 Installation on Noncombustible Floors. Listed floor installed food service appliances that are designed and marked “For use only in noncombustible locations” shall be installed on floors of noncombustible construction with noncombustible flooring and surface finish and with no combustible material against the underside thereof, or on noncombustible slabs or arches having no combustible material against the underside thereof. Such construction shall in all cases extend not less than 12 inches (305 mm) beyond the appliance on all sides. [NFPA 54:10.12.1.1, 10.12.1.2 10.11.4.1, 10.11.4.2]

918.5 9175 Combustible Material Adjacent to Cooking Top. Listed and unlisted food service ranges shall be installed to provide clearance to combustible material of not less than 18 inches (457 mm) horizontally for a distance of up to 2 feet (610 mm) above the surface of the cooking top where the combustible material is not completely shielded by high shelving, a warming closet, or other system. Reduced combustible material clearances are permitted where protected in accordance with Table 303.10.1. [NFPA 54:10.12.5 10.11.5]

918.6 9176 Use with Casters. Floor-mounted appliances with casters shall be mounted in accordance with the manufacturer’s installation instructions for limiting the movement of the appliance to prevent strain on the connection. [NFPA 54:10.12.6 10.11.6]

918.7 9177 Level Installation. Floor-mounted food service appliances shall be installed level on a firm foundation. [NFPA 54:10.12.7 10.11.7]

918.8 9178 Ventilation. Means shall be provided to properly ventilate the space in which a food service appliance is installed to permit proper combustion of the gas. [NFPA 54:10.12.8 10.11.8]

918.9 918.0 Food Service Appliances, Counter Appliances.

918.1 Application. Food service counter appliances shall be listed in accordance with ANSI Z83.11/CSA 1.8. [NFPA 54:10.12.1]

919.1 918.2 Vertical Clearance. A vertical distance of not less than 48 inches (1219 mm) shall be provided between the top of all food service hot plates and griddles and combustible material. [NFPA 54:10.13.1 10.12.2]
919.2 918.3 Clearance for Listed Appliances. Listed food service counter appliances such as hot plates and griddles, food and dish warmers, and coffee brewers and urns, where installed on combustible surfaces, shall be set on their own bases or legs and shall be installed with a horizontal clearance of not less than 6 inches (152 mm) from combustible material, except that not less than a 2 inches (51 mm) clearance shall be maintained between a draft hood and combustible material. Food service counter appliances listed for installation at lesser clearances shall be installed in accordance with their listing and the manufacturer’s installation instructions.

919.3 918.4 Clearance for Unlisted Appliances. Unlisted food service hot plates and griddles shall be installed with a horizontal clearance from combustible material of not less than 18 inches (457 mm). Unlisted gas food service counter appliances, including coffee brewers and urns, waffle makers, and hot water immersion sterilizers where installed on combustible surfaces, shall be installed with a minimum horizontal clearance of 6 inches (152 mm) from combustible material of not less than 12 inches (305 mm) or with a protective barrier made of a material approved in accordance with Table 203.10.1. Unlisted food and dish warmers installed on combustible floors, shall be set on their own bases or legs and shall be installed in accordance with the manufacturer’s installation instructions. [NFPA 54:10.13.1]

919.4 Mounting of Unlisted Appliances. Unlisted food service counter appliances shall not be set on combustible material unless they have legs that provide not less than 4 inches (102 mm) of open space below the burners and the combustible surface is protected with insulating millboard at least 0.0122 of an inch (0.3099 mm) thick, or with equivalent protection. [NFPA 54:10.13.4]

920.0 919.0 Household Cooking Appliances.

919.1 Application. Household cooking appliances shall be listed in accordance with ANSI Z21.1/CSA 1.1. [NFPA 54:10.13.1]

920.1 919.2 Electric Household Cooking Appliances. Electric household cooking appliances designed for permanent installations shall be installed in accordance with the manufacturer’s installation instructions. Household electric ranges shall comply with UL 858.

920.2 919.3 Gas-Fired Household Cooking Appliances. Gas-fired household cooking appliances shall comply with Section 920.3 though Section 920.5.3.

920.3 919.4 Floor-Mounted Units. Floor mounted units shall be installed in accordance with Section 920.3.4 919.4.1 and Section 920.3.2 919.4.2.

920.3.1 919.4.1 Clearances from Combustible Material. The clearances specified as follows: Floor-mounted household cooking appliances, where installed on combustible floors, shall be set on their own bases or legs and shall not interfere with combustion air, accessibility for operation, and servicing:

1. List floor mounted household cooking appliances, where installed on combustible floors, shall be set on their own bases or legs and shall be installed in accordance with their listing and the manufacturer’s installation instructions.

2. List household cooking appliances with listed gas room heater sections shall be installed so that the warm air discharge side shall have a clearance of not less than 18 inches (457 mm) from adjacent combustible material. A clearance of not less than 26 inches (660 mm) shall be provided between the top of the heater section and the bottom of cabinets.

3. List household cooking appliances that include a solid or liquid fuel burning section shall be spaced from combustible material and otherwise installed in accordance with the labeling and the manufacturer’s installation instructions for the supplementary fuel section of the appliance.

4. Unlisted floor mounted household cooking appliances shall be installed with not less than 6 inches (152 mm) clearance at the back and sides to combustible material. Combustible floors under unlisted appliances shall be protected in an approved manner. [NFPA 54:10.13.3]

920.2.2 919.4.2 Vertical Clearance Above Cooking Top. Household cooking appliances shall have a vertical clearance above the cooking top of not less than 30 inches (762 mm) to combustible material or metal cabinets. A minimum clearance of 24 inches (610 mm) shall be permitted where one of the following is installed:

1. The underside of the combustible material or metal cabinet above the cooking top is protected with not less than ¼ of an inch (6.4 mm) insulating millboard covered with sheet metal not less than 0.0122 of an inch (0.3099 mm) thick.

2. A metal ventilating hood of sheet metal not less than 0.0122 of an inch (0.3099 mm) thick is installed above the cooking top with a clearance of not less than ¼ of an inch (6.4 mm) below the hood and the underside of the combustible material or metal cabinet, and the hood is not less than the width of as wide as the appliance and is centered over the appliance.

3. A listed cooking appliance or microwave oven installed over a listed cooking appliance shall be in accordance with the terms of the upper appliance’s listing and the manufacturer’s installation instructions. [NFPA 54:10.13.3.1] Microwave ovens shall comply with UL 923.
920.4 919.5 Built-In Units. Built-in units shall be installed in accordance with Section 920.4.4 919.5.1 through Section 920.4.3 919.5.3.

920.4.1 919.5.1 Installation. Listed built-in household cooking appliances shall be installed in accordance with their listing and the manufacturer’s installation instructions. The installation shall not interfere with combustion air, accessibility for operation, and servicing. Unlisted built-in household cooking appliances shall not be installed in or adjacent to combustible material.

920.4.2 919.5.2 Vertical Clearance Above Cooking Top. Built-in top (or surface) cooking appliances shall have a vertical clearance above the cooking top of not less than 30 inches (762 mm) to combustible material or metal cabinets. A clearance of not less than 24 inches (610 mm) is permitted where one of the following is installed:

1. The underside of the combustible material or metal cabinet above the cooking top is protected with not less than ¼ of an inch (6.4 mm) insulating millboard covered with sheet metal not less than 0.0122 of an inch (0.3099 mm) thick.

2. A metal ventilating hood of sheet metal not less than 0.0122 of an inch (0.3099 mm) thick is installed above the cooking top with a clearance of not less than ¼ of an inch (6.4 mm) between the hood and the undersides of the combustible material or metal cabinet, and the hood not less than the width of the appliance and is centered over the appliance.

3. A listed cooking appliance or microwave oven installed over a listed cooking appliance shall be in accordance with the terms of the upper appliance’s listing and the manufacturer’s installation instructions. Microwave ovens shall comply with UL 923.

920.4.3 919.6 Level Installation. Cooking appliances shall be installed so that the cooking top, broiler pan, or oven racks are level. [NFPA 54:2018:10.14.3]

924.0 920.0 Cooking Appliances Listing.

924.1 920.1 Commercial Electric Ranges. Commercial electric ranges shall comply with UL 197 and installed in accordance with the manufacturer’s installation instructions.

924.2 920.2 Commercial Wood-Fired Baking Ovens. Commercial wood-fired baking ovens (refractory type) shall comply with UL 2162 and installed in accordance with the manufacturer’s installation instructions.

924.3 920.3 Oil-Burning Ranges. Oil-burning ranges shall comply with UL 896 and installed in accordance with the manufacturer’s installation instructions.

922.0 921.0 Open-Top Broiler Units.

922.1 921.1 Listed Units Application. Listed open top broiler units shall be listed in accordance with ANSI Z83.11/CSA 1.8 or ANSI Z21.1/CSA 1.1 and installed in accordance with the manufacturer’s installation instructions. [NFPA 54:10.18.4 10.17.1]

922.2 Unlisted Units. Unlisted open-top broiler units shall be installed in accordance with the manufacturer’s instructions but shall not be installed in combustible material. [NFPA 54:10.18.2]

922.2 921.2 Protection Above Domestic Units. Domestic open-top broiler units shall be provided with a metal ventilating hood not less than 0.0122 of an inch (0.3099 mm) thick with a clearance of not less than ⅛ of an inch (6.4 mm) between the hood and the underside of combustible material or metal cabinets. A clearance of at least 24 inches (610 mm) shall be maintained between the cooking top and the combustible material or metal cabinet, and the hood shall be at least as wide as the open-top broiler unit and centered over the unit. Listed domestic open-top broiler units incorporating an integral exhaust system and listed for use without a ventilating hood shall not be required to be provided with a ventilating hood if installed in accordance with Section 920.3.2(1) 919.4.2(1). [NFPA 54:10.18.2 10.17.2]

922.4 921.3 Commercial Units. Commercial open-top broiler units shall be provided with ventilation in accordance with Chapter 5, Part II. [NFPA 54:10.18.4 10.17.3]

922.0 922.0 Outdoor Cooking Appliances.

922.1 922.1 Listed Units Application. Listed outdoor cooking appliances shall be installed in accordance with their listing and the manufacturer’s installation instructions. Outdoor cooking appliances shall be listed in accordance with ANSI Z83.11/CSA 1.8, ANSI Z21.58/CSA 1.6, or ANSI Z21.89/CSA 1.18, and installed in accordance with the manufacturer’s installation instructions. [NFPA 54:10.18]

922.2 Unlisted Units. Unlisted outdoor cooking appliances shall be installed outdoors with clearances to combustible material of not less than 36 inches (914 mm) at the sides and back and not less than 48 inches (1219 mm) at the front. In no case shall the appliance be located under overhead combustible construction. [NFPA 54:10.19.2]

924.0 923.0 Illuminating Appliances.

924.1 923.1 Clearances for Listed Appliances. Listed illuminating appliances shall be installed in accordance with their listing and the manufacturer’s installation instructions. [NFPA 54:10.14.1]

924.2 923.2 Clearances for Unlisted Appliances. Clearances for unlisted illuminating appliances shall comply with the following:

1. Unlisted enclosed illuminating appliances installed outdoors shall be installed with clearances in any direction from combustible material of not less than 12 inches (305 mm). [NFPA 54:10.15.2.1(1) 10.14.2.1(1)]

2. Unlisted enclosed illuminating appliances installed indoors shall be installed with clearances in any direction from combustible material of not less than 18 inches (457 mm). [NFPA 54:10.15.2.1(2) 10.14.2.1(2)]
924.2.1 923.2.1 Open-Flame Type. Clearances Clearance shall comply with the following:

(1) Unlisted open-flame illuminating appliances installed outdoors shall have clearances from combustible material not less than that specified in Table 924.2.1 923.2.1. The distance from ground level to the base of the burner shall be a minimum of 7 feet (2134 mm) where installed within 2 feet (610 mm) of walkways. Lesser clearances shall be permitted to be used where acceptable to the Authority Having Jurisdiction.

(2) Unlisted open-flame illuminating appliances installed outdoors shall be equipped with a limiting orifice or other limiting devices that maintain a flame height consistent with the clearance from combustible material, as given in Table 924.2.1 923.2.1.

(3) Appliances designed for flame heights in excess of 30 inches (762 mm) shall be permitted to be installed if acceptable to the Authority Having Jurisdiction approved. Such appliances shall be equipped with a safety shutoff device or automatic ignition.

(4) Unlisted Clearances to combustible material from unlisted open-flame illuminating appliances installed indoors shall have clearances from combustible material acceptable to the Authority Having Jurisdiction shall be approved. [NFPA 54:10.14.2.2]

### TABLE 924.2.1 923.2.1 CLEARANCES FOR UNLISTED OUTDOOR OPEN-FLAME ILLUMINATING APPLIANCES [NFPA 54:TABLE 10.15.2.2 10.14.2.2]

<table>
<thead>
<tr>
<th>FLAME HEIGHT ABOVE BURNER HEAD (inches)</th>
<th>MINIMUM CLEARANCE FROM COMBUSTIBLE MATERIAL (feet)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HORIZONTAL</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
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<tr>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>4</td>
</tr>
</tbody>
</table>

* Measured from the nearest portion of the burner head.

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

924.3 923.3 Mounting on Buildings. Illuminating appliances designed for installation on a wall or ceiling mounting shall be securely attached to substantial structures in such a manner that they are not dependent on the gas piping for support. [NFPA 54:10.14.3 10.14.3]

924.4 923.4 Mounting on Posts. Illuminating appliances designed for installation on a post shall be securely and rigidly attached to a post. Posts shall be rigidly mounted installed. The strength and rigidity of posts greater than 3 feet (914 mm) in height shall be at least equivalent to that of a 2½ inch (64 mm) diameter post constructed of 0.064 of an inch (1.626 mm) thick steel or a 1 inch (25.4 mm) Schedule 40 steel pipe. Posts 3 feet (914 mm) or less in height shall not be smaller than a ⅝ of an inch (19.1 mm) Schedule 40 steel pipe. Drain openings shall be provided near the base of posts where water collecting inside the posts is possible. [NFPA 54:10.14.4 10.14.4]

924.5 923.5 Appliance Pressure Regulators. Where an appliance pressure regulator is not supplied with an illuminating appliance and the service line is not equipped with a service pressure regulator, an appliance pressure regulator shall be installed in the line serving one or more illuminating appliances. [NFPA 54:10.14.5 10.14.5]

925.0 924.0 Incinerators and Crematories.

925.1 924.1 Field Constructed Commercial-Industrial Incinerators. Field constructed commercial-industrial incinerators shall be constructed and installed in accordance with NFPA 82.

925.2 924.2 Factory-Built Commercial Crematories. Factory-built commercial incinerators and crematories shall comply with UL 2790 and installed in accordance with the manufacturer’s installation instructions.

925.3 924.3 Residential Incinerators. Residential incinerators shall comply with UL 791 and installed in accordance with the manufacturer’s installation instructions.

926.0 925.0 Infrared Heaters.

925.1 Application. Infrared heaters having an input rating of 400 000 Btu/hr (117 kW) or less shall be listed in accordance with ANSI Z83.19/CSA 2.35 or ANSI Z83.20/CSA 2.34. [NFPA 54:10.16.1]

925.2 Support. Suspended-type infrared heaters shall be fixed in position independent of gas and electric supply lines. Hangers and brackets shall be of noncombustible material. Heaters subject to vibration shall be provided with vibration-isolating hangers. [NFPA 54:10.16.2]

926.3 925.3 Clearance. The installation of infrared heaters shall comply with the following clearance requirements:

(1) Listed heaters shall be installed with clearances from combustible material in accordance with their listing and the manufacturer’s installation instructions.

(2) Unlisted heaters shall be installed in accordance with clearances from combustible material acceptable to the Authority Having Jurisdiction.

(3) In locations used for the storage of combustible materials, signs shall be posted to specify the maximum permissible stacking height to maintain required clearances from the heater to the combustibles. [NFPA 54:10.16.3]

926.3 925.4 Combustion and Ventilation Air. Where unvented infrared heaters are used, natural or mechanical means shall be provided to supply and exhaust at least 4 ft³/min/1000 Btu/h (0.38 m³/min/kW) input of installed heaters. [NFPA 54:10.16.4 10.16.4.1]

926.3.1 925.4.1 Exhaust Openings. Exhaust openings for removing flue products shall be above the level of the heaters. [NFPA 54:10.16.4 10.16.4.2]
926.4 925.5 Installation in Commercial Garages and Aircraft Hangars. Overhead heaters installed in garages for more than three motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with Section 303.11 and Section 303.12. [NFPA 54:10.16.5 10.17.4]

925.6 Electric Radiant Heaters. Electric radiant heaters shall be listed for outdoor installation in accordance with the manufacturer’s listing and the manufacturer’s installation instructions.

927.0 926.0 Pool Heaters.

926.1 Application. Pool heaters shall be listed in accordance with ANSI Z21.56/CSA 4.7. [NFPA 54:10.19.1]

927.4 926.2 Location. A pool heater shall be located or protected so as to minimize accidental contact of hot surfaces by persons. [NFPA 54:10.20.4 10.19.2]

927.2 926.3 Clearance. The installation of pool heaters shall comply with the following requirements:
1. In no case shall the clearances be such as to interfere with combustion air, draft hood, or vent terminal clearance and relief, and accessibility for servicing.
2. A listed pool heater shall be installed in accordance with the listing and the manufacturer’s installation instructions. [NFPA 54:10.19.3]
3. An unlisted pool heater shall be installed with a clearance of not less than 12 inches (305 mm) on the sides and the rear. A combustible floor under an unlisted pool heater shall be protected in an approved manner.

927.3 926.4 Temperature or Pressure-Limiting Devices. An unlisted pool heater shall be provided with overtemperature protection or overtemperature and overpressure protection by means of an approved device(s). Where a pool heater is provided with over-temperature protection only and is installed with any device in the discharge line of the heater that can restrict the flow of water from the heater to the pool (such as a check valve, shutoff valve, therapeutic pool valve, or flow nozzles), a pressure relief valve shall be installed either in the heater or between the heater and the restrictive device. [NFPA 54:10.19.4]

927.3.1 Pressure Relief Valve. Where a pool heater is provided with over-temperature protection only and is installed with any device in the discharge line of the heater that can restrict the flow of water from the heater to the pool (such as a check valve, shutoff valve, therapeutic pool valve, or flow nozzles), a pressure relief valve shall be installed either in the heater or between the heater and the restrictive device. [NFPA 54:10.20.3.2]

927.4 926.5 Bypass Valves. Where an integral bypass system is not provided as a part of the pool heater, a bypass line and valve shall be installed between the inlet and outlet piping for use in adjusting the flow of water through the heater. [NFPA 54:10.19.5]

927.5 926.6 Venting. A pool heater listed for outdoor installation shall be installed with the venting means supplied by the manufacturer and in accordance with the manufacturer’s installation instructions. [NFPA 54:10.19.6]

928.0 927.0 Refrigerators.

927.1 Application. Refrigerators shall be listed in accordance with ANSI Z21.19/CSA 1.4. [NFPA 54:10.20.1]

928.1 927.2 Clearance. Refrigerators shall be provided with clearances for ventilation at the top and back in accordance with the manufacturer’s instructions. Where such instructions are not available, at least 2 inches (51 mm) shall be provided between the back of the refrigerator and the wall at least 12 inches (305 mm) above the top. [NFPA 54:10.24.1 10.20.2]

928.2 927.3 Venting or Ventilating Kits Approved for Use with a Refrigerator. Where an accessory kit is used for conveying air for burner combustion or unit cooling to the refrigerator from areas outside the room in which it is located, or for conveying combustion products diluted with air containing waste heat from the refrigerator to areas outside the room in which it is located, the kit shall be installed in accordance with the refrigerator manufacturer’s instructions. [NFPA 54:10.24.3 10.20.3]

929.0 928.0 Gas-Fired Toilets.

928.1 929.1 Clearance. A listed gas-fired toilet shall be installed in accordance with its listing and the manufacturer’s installation instructions, provided that the clearance shall be such to afford ready accessibility for use, cleanout, and necessary servicing. [NFPA 54:10.23.1]

929.2 928.2 Installation on Combustible Floors. Listed gas-fired toilets installed on combustible floors shall be listed for such installation. [NFPA 54:10.24.2 10.23.2]

929.3 928.3 Vents. Vents or vent connectors that are capable of being contacted during casual use of the room in which the toilet is installed shall be protected or shielded to prevent such contact. [NFPA 54:10.24.3 10.23.3]

930.0 929.0 Appliances for Installation in Manufactured Housing.

930.1 929.1 General. Appliances installed in manufactured housing after the initial sale shall be listed for installation in manufactured housing, or approved, and shall be installed in accordance with the requirements of this code and the manufacturer’s installation instructions. Appliances installed in the living space of manufactured housing shall be in accordance with the requirements of Section 701.0. [NFPA 54:10.29 10.28]

931.0 930.0 Small Ceramic Kilns.

931.1 930.1 General. The provisions of this section apply to kilns used for ceramics that have a maximum interior volume of 20 cubic feet (0.57 m3) and are used for hobby or non-commercial purposes.

931.2 930.2 Installation. Kilns shall be installed in accordance with the manufacturer’s installation instructions and the provisions of this code.

931.3 930.3 Fuel-Gas Controls. Fuel-gas controls shall comply with Section 306.0 and Section 902.4. Standing pilots shall not be used with gas-fired kilns.
931.4 930.4 Electrical Equipment. All electrical equipment used as part of, or in connection with, the installation of a kiln shall be in accordance with the requirements in the electrical code. NFPA 70. Electric kilns shall be listed and labeled in accordance with UL 499.

931.5 930.5 Installations Inside Buildings. In addition to other requirements specified in this section, interior installations shall comply with the requirements of Section 603.13.6 and Section 931.5.4, through Section 931.5.4, 930.5.4.

931.5.1 930.5.1 Kiln Clearances. The sides and tops of kilns shall be located not less than 18 inches (457 mm) from a noncombustible wall surface and 3 feet (914 mm) from a combustible wall surface. Kilns shall be installed on noncombustible flooring consisting of not less than 2 inches (51 mm) of solid masonry or concrete extending not less than 12 inches (305 mm) beyond the base or supporting members of the kiln.

Exception: These clearances shall be permitted to be reduced, provided the kiln is installed in accordance with its listing.

In no case shall the clearance on the gas or electrical control side of a kiln be reduced to less than 30 inches (762 mm).

931.5.2 930.5.2 Hoods. A canopy-type hood shall be installed directly above each kiln. The face opening area of the hood shall be equal to or greater than the top horizontal surface area of the kiln. The hood shall be constructed of not less than 0.024 of an inch (0.61 mm) (No. 24 gauge) galvanized steel or equivalent and be supported at a height of between 12 inches (305 mm) and 30 inches (762 mm) above the kiln by noncombustible supports.

Exception: Electric kilns installed with listed exhaust blowers shall be permitted to be used where marked as being suitable for the kiln and installed in accordance with the manufacturer’s installation instructions.

931.5.3 930.5.3 Gravity Ventilation Ducts. Each hood shall be connected to a gravity ventilation duct extending in a vertical direction to outside the building. This duct shall be of the same construction as the hood and shall have a minimum cross-sectional area of not less than one-fifteenth of the face opening area of the hood. The duct shall terminate not less than 12 inches (305 mm) above a portion of a building within 4 feet (1219 mm) and terminate not less than 4 feet (1219 mm) from an openable window or other opening into the building or adjacent property line. The duct opening to the outside shall be shielded, without reduction of duct area, to prevent entrance of rain into the duct. The duct shall be supported at each section by noncombustible supports.

931.5.4 930.5.4 Makeup Air. Provisions shall be made for air to enter the room in which a kiln is installed at a rate not less than the air being removed through the kiln hood.

931.6 930.6 Exterior Installations. Kilns shall be installed with minimum clearances as specified in Section 931.5.4, 930.5.1. Wherever a kiln is located under a roofed area and is partially enclosed by more than two vertical wall surfaces, a hood and gravity ventilation duct shall be installed in accordance with Section 931.5.2, Section 931.5.3, and Section 603.13.6.

932.0 931.0 Outdoor Open Flame Decorative Appliances.

932.1 931.1 General. Permanently fixed in place outdoor open flame decorative appliances shall be installed in accordance with Section 932.1.1, through Section 932.1.3, 931.1.3. [NFPA 54:10.31.1]

932.1.1 931.1.1 Listed Units Application. Listed outdoor open flame decorative appliances shall be installed in accordance with the manufacturer’s installation instructions. [NFPA 54:10.31.1, 10.30.1]

932.1.2 931.1.2 Unlisted Units. Unlisted outdoor open flame decorative appliances shall be installed outdoors in accordance with the manufacturer’s installation instructions and with clearances to combustible material of not less than 36 inches (914 mm) from the sides. In no case shall the appliance be located under overhead combustible construction. [NFPA 54:10.31.2]

932.1.3 931.1.3 Connection to the Piping System. The connection to the gas piping system shall be in accordance with Section 1312.1(1), Section 1312.1(2), Section 1312.1(3), Section 1312.1(4), or Section 1312.1(5). [NFPA 54:10.31.2, 10.30.2]

933.0 932.0 Evaporative Cooling Systems.

933.1 932.1 General. Evaporative cooling systems, including air ducts and fire dampers that are a portion of an evaporative cooling system, shall be in accordance with Section 933.1 through Section 933.4.3, 932.4.3. Evaporative cooling systems shall be provided with outside air as specified for cooling systems in Section 403.0.

933.2 932.2 Location. Evaporative cooling systems shall be installed so as to minimize the probability of damage from an external source.

933.3 932.3 Access, Inspection, and Repair. Evaporative coolers shall be accessible for inspection, service, and replacement without removing permanent construction.

933.4 932.4 Installation. An evaporative cooler supported by the building structure shall be installed on a level base and shall be secured directly or indirectly to the building structure, to prevent displacement of the cooler.

933.4.1 932.4.1 Modifications to the Supporting Structure. Modifications made to the supporting framework of buildings as a result of the installation shall be in accordance with the requirements of the building code. Openings in exterior walls shall be flashed in an approved manner in accordance with the requirements of the building code.

933.4.2 932.4.2 On the Ground. An evaporative cooler supported directly by the ground shall be isolated...
from the ground by a level concrete slab extending not less than 3 inches (76 mm) above the adjoining ground level.

933.4.3 On a Platform. An evaporative cooler supported on an aboveground platform shall be elevated not less than 6 inches (152 mm) above adjoining ground level.

934.0 Refrigeration Appliances.
934.1 Self-Contained Refrigerators and Freezers. Factory-built commercial refrigerators and freezers shall comply with UL 471 or UL 60335-2-89 and shall be installed in accordance with the manufacturer’s installation instructions.

934.2 Unit Coolers. Factory-built unit coolers for use in refrigerators, freezers, refrigerated warehouses, and walk-in coolers shall comply with UL 412 or UL 60335-2-89 and shall be installed in accordance with the manufacturer’s installation instructions.

934.3 Self-Contained Mechanical Refrigeration Systems. Self-contained mechanical refrigeration systems for use in walk-in coolers shall comply with UL 427 or UL 60335-2-89 and shall be installed in accordance with the manufacturer’s installation instructions.

935.0 Ductless Mini-Split Systems Installation.
935.1 General. A ductless mini-split system installation shall be installed in accordance with the manufacturer’s installation instructions and Section 310.2 for condensate control.

936.0 Air Filter Appliances.
936.1 Electrostatic Air Cleaners. Electrostatic air cleaners shall comply with UL 867 and installed in accordance with the manufacturer’s installation instructions.

936.2 High-Efficiency Particulate Air Filter Units. High-efficiency particulate air filter units for use in industrial and laboratory exhaust and ventilation systems shall be installed in accordance with the manufacturer’s installation instructions.

937.0 Gaseous Hydrogen Systems.
937.1 General. Gaseous hydrogen systems shall be installed in accordance with NFPA 2.

938.0 Compressed Natural Gas (CNG) Vehicular Fuel Systems.
938.1 General. The installation of compressed natural gas (CNG) fueling (dispensing) systems shall conform to NFPA 52. Residential CNG fueling appliances shall be listed in accordance with ANSI/CSA NGV 5.2 and installed in accordance with the appliance manufacturer’s installation instructions. Non-residential CNG fuel-
CHAPTER 10
BOILERS AND PRESSURE VESSELS

1001.0 General.
1001.1 Applicability. The requirements of this chapter shall apply to the construction, installation, operation, repair, and alteration of boilers and pressure vessels. Low-pressure boilers shall comply with this chapter and Section 904.0.

Exceptions:
(1) Listed and approved potable water heaters with a nominal capacity not exceeding 120 gallons (454 L) and having a heat input not exceeding 200,000 British thermal units per hour (Btu/h) (58.6 kW) used for hot water supply at a pressure not exceeding 160 pounds-force per square inch (psi) (1103 kPa) and at temperatures not exceeding 210°F (99°C), in accordance with the plumbing code.
(2) Pressure vessels used for unheated water supply, including those containing air that serves as a cushion and is compressed by the introduction of water and tanks connected to sprinkler systems.
(3) Portable unfired pressure vessels and Interstate Commerce Commission (I.C.C.) containers.
(4) Containers for liquefied petroleum gases, bulk oxygen, and medical gas that are regulated by the fire code.
(5) Unfired pressure vessels in business, factory, hazardous, mercantile, residential, storage, and utility occupancies having a volume not exceeding 5 cubic feet (0.14 m³) and operating at pressures not exceeding 250 psi (1724 kPa).
(6) Pressure vessels used in refrigeration systems shall comply with Chapter 11.
(7) Pressure tanks used in conjunction with coaxial cables, telephone cables, power cables, and other similar humidity control systems.
(8) A boiler or pressure vessel subject to regular inspection by federal inspectors or licensed by federal authorities.
(9) Pressure vessels used in specific appliances shall comply with Chapter 9.
1001.2 Boiler Rooms and Enclosures. Boiler rooms and enclosures shall comply with the building code.
1001.3 Air for Combustion and Ventilation. Air for combustion and ventilation shall be provided in accordance with Chapter 7.
1001.4 Drainage. For heating or hot-water-supply boiler applications, the boiler room shall be equipped with a floor drain or other approved means for disposing of the accumulation of liquid wastes incident to cleaning, recharging, and routine maintenance. No steam pipe shall be directly connected to a part of a plumbing or drainage system, nor shall a water having a temperature above 140°F (60°C) be discharged under pressure directly into a part of a drainage system. Pipes from boilers shall discharge by means of indirect waste piping as determined by the Authority Having Jurisdiction or the boiler manufacturer’s instructions.
1001.5 Mounting. Equipment shall be set or mounted on a level base capable of supporting and distributing the weight contained thereon. Boilers, tanks, and equipment shall be securely anchored to the structure. Equipment requiring vibration isolation shall be installed as designed by a registered design professional and approved by the Authority Having Jurisdiction.
1001.5.1 Floors. Boilers shall be mounted on floors of noncombustible construction unless listed for mounting on combustible flooring.
1001.6 Chimneys or Vents. Boilers shall be connected to a chimney or vent, as provided for other fuel-burning equipment in Chapter 8 of this code.

1002.0 Standards.
1002.1 General. Pressure vessels shall be constructed and designed in accordance with the ASME Boiler & Pressure Vessel Code (BPVC) Section VIII. Boilers shall be constructed, designed, and installed in accordance with one of the following:
(1) ASME BPVC Section I
(2) ASME BPVC Section IV
(3) NFPA 85
1002.2 Oil-Burning Boilers. Oil-burning boilers shall comply with Section 1002.2.1 and Section 1002.2.2.
1002.2.1 Listing & Labeling. Oil-burning boilers shall be listed and labeled in accordance with UL 726.
1002.2.2 Installation. Tanks, piping, and valves for oil-burning boilers shall be installed in accordance with NFPA 31.
1002.3 Electric Boilers. Electric boilers shall be listed and labeled in accordance with UL 834.
1002.4 Solid-Fuel-Fired Boilers. Solid-fuel-fired boilers shall comply with UL 2523 and shall be installed in accordance with the manufacturer’s installation instructions.
1002.5 Dual Purpose Water Heaters. Water heaters utilized for combined space- and water-heating applications shall be listed or labeled in accordance with the standards referenced in Table 1203.2, and shall be installed in accordance with the manufacturer’s installation instructions.

1003.0 Detailed Requirements.
1003.1 Safety Requirements. The construction of boilers and pressure vessels and the installation thereof shall be
in accordance with minimum requirements for safety from structural and mechanical failure and excessive pressures as established by the Authority Having Jurisdiction in accordance with nationally recognized standards.

1003.2 Controls. Required electrical, mechanical, safety, and operating controls shall carry the approval of an approved testing agency or be accepted by the Authority Having Jurisdiction. Electrical controls shall be of such design and construction as to be suitable for installation in the environment in which they are located.

1003.2.1 Automatic Boilers. Automatic boilers shall be equipped with controls and limit devices in accordance with ASME CSD-1 or Table 1003.2.1.

The Authority Having Jurisdiction shall have the authority to approve solid-fuel-fired boilers that comply with the safety requirements for automatic gas fired boilers or oil fired boilers.

1003.3 Gauges. Steam boilers shall be provided with a pressure gauge and a water level glass. Water boilers shall be provided with a pressure gauge and a temperature gauge. Automatic boilers shall be equipped with the following gauges, as applicable:

- Oil temperature
- Oil suction pressure
- High and low gas pressure
- Stack temperature
- Windbox pressure

1003.4 Stack Dampers. Stack dampers on boilers fired with oil or solid fuel shall not close off more than 80 percent of the stack area where closed, except on automatic boilers with prepurge, automatic draft control, and interlock. Operative dampers shall not be placed within a stack, flue, or vent of a gas-fired boiler, except on automatic boilers with prepurge, automatic draft control, and interlock.

Exception: Automatic boilers with prepurge, automatic draft control, and interlock.

1003.5 Welding. Welding on pressure vessels shall be done by certified welders in accordance with nationally recognized standards.

1004.0 Expansion Tanks.

1004.1 General. An expansion tank shall be installed in a hot-water-heating system as a means for controlling increased pressure caused by thermal expansion. Expansion tanks shall be of the closed or open type and securely fastened to the structure. Tanks shall be rated for the pressure of the system. Supports shall be capable of carrying twice the weight of the tank filled with water without placing a strain on connecting piping.

Hot-water-heating systems incorporating hot water tanks or fluid relief columns shall be installed to prevent freezing under normal operating conditions.

1004.2 Open-Type Expansion Tanks. Open type expansion tanks shall be located not less than 3 feet (914 mm) above the highest point of the system. Such tanks shall be sized based on the capacity of the system. An overflow with a diameter of not less than one-half the size of the supply or not less than 1 inch (25 mm) in diameter shall be installed at the top of the tank. The overflow shall discharge through an air gap into the drainage system.

1004.3 Closed-Type Systems. Closed-type systems shall have an air tight tank or other approved air cushion that will be consistent with the volume and capacity of the system, and shall be designed for a hydrostatic test pressure of two and one-half times the allowable working pressure of the system. Expansion tanks for systems designed to operate at more than 30 pounds-force per square inch (psi) (207 kPa) shall comply with ASME BPVC Section VIII. Provisions shall be made for draining the tank without emptying the system.

1004.4 Minimum Capacity of Closed-Type Tank. The minimum capacity for a gravity-type hot water system expansion tank shall be in accordance with Table 1004.4(1). The minimum capacity for a forced-type hot water system expansion tank shall be in accordance with Table 1004.4(2), or Equation 1004.4(1). Equation 1004.4.1 shall not be used for diaphragm-type expansion tanks. The minimum capacity for a diaphragm-type hot water system expansion tank shall be in accordance with Table 1004.4(2) or Equation 1004.4(2).

\[ V_t (\text{forced-type}) = \frac{(0.00041 t - 0.0466) V_s}{(P_a / P_f - P_a / P_o)} \]

\[ V_t (\text{diaphragm-type}) = \frac{(0.00041 t - 0.0466) V_s}{l + \frac{P_f}{P_o}} \]

Where:
- \( V_t \) = Minimum volume of expansion tank, gallons (L).
- \( V_s \) = Volume of system, not including expansion tank, gallons (L).
- \( t \) = Average operating temperature, °F (°C).
- \( P_a \) = Atmospheric pressure, pounds per square inch (kPa).
- \( P_f \) = Fill pressure, pounds per square inch (kPa).
- \( P_o \) = Maximum operating pressure, pounds per square inch (kPa).

For SI units: 1 gallon = 3.785 L, °C = (°F-32)/1.8, 1 foot of water = 2.99 kPa; 1 psi = 6.89476 kPa
1005.0 Safety or Relief Valve Discharge.

1005.1 General. Pressurized vessels or boilers shall be provided with overpressure protection by means of a listed pressure relief valve installed in accordance with the manufacturer’s installation instructions.

1005.2 Discharge Piping. The discharge piping serving a temperature relief valve, pressure relief valve, or combination of both shall have no valves, obstructions, or means of isolation and provided with the following:

1. Equal to the size of the valve outlet and shall discharge full size to the flood level of the area receiving the discharge and pointing down.
2. Materials shall be rated at not less than the operating temperature of the system and approved for such use.
3. Discharge pipe shall discharge independently by gravity through an air gap into the drainage system or outside of the building with the end of the pipe not exceeding 2 feet (610 mm) and not less than 6 inches (152 mm) above the ground and pointing downwards.
4. Discharge in such a manner that does not cause personal injury or structural damage.
5. No part of such discharge pipe shall be trapped or subject to freezing.
6. The terminal end of the pipe shall not be threaded.
7. Discharge from a relief valve into a water heater pan shall be prohibited.
8. Discharge to a termination point that is readily visible.

1005.3 Splash Shield. Where the operating temperature exceeds 212°F (100°C), the discharge pipe shall be installed with a splash shield or centrifugal separator.

1005.4 Hazardous Discharge. Where the discharge from safety valves is capable of being hazardous, discharge of steam inside the boiler room, such discharge shall be discharged to the outside of the boiler room. Discharges from relief valves on industrial boilers shall be discharged to an approved location.

1005.5 Vacuum Relief Valve. Hot-water heating systems that are subjected to a vacuum while in operation or during shutdown shall be protected with a vacuum relief valve that complies with CSA Z21.22. Where the piping configuration, equipment location, and valve outlets are located below the boiler elevation, the system shall be equipped with a vacuum relief valve at the highest point.

1006.0 Shutoff Valves.

1006.1 General. An approved manual shutoff valve shall be installed upstream of all control devices on the main burner of a gas-fired boiler. The takeoff point for the gas supply to the pilot shall be upstream of the gas shutoff valve of the main burner and shall be valved separately. A union or other approved means of disconnect shall be provided immediately downstream of these shutoff valves.

1007.0 Gas-Pressure Regulators.

1007.1 General. An approved gas-pressure regulator shall be installed on gas-fired boilers where the gas supply pressure is exceeding that at which the main burner is designed to operate. A separate approved gas-pressure regulator shall be installed to regulate the gas pressure to the pilot or pilots.

1008.0 Low-Water Cutoff.

1008.1 General. Hot water boilers and steam boilers shall be installed with a low-water cutoff. A coil-type boiler or a
water-tube boiler that requires forced circulation to prevent overheating of the coils or tubes shall be installed with a flow-sensing device in the outlet piping in lieu of the low-water cutoff. The low-water cutoff or the flow sensing device shall be installed so as to prevent damage to the boiler and to permit testing of the fuel-supply cutoff without draining the heating system. The low-water cutoff shall shut off the combustion at a water level setpoint that is in accordance with the boiler manufacturer’s instructions.

1009.0 Combustion Regulators – Safety Valves.

1009.1 General. The following requirements shall be retroactive:

(1) Hot-water-heating boilers, other than manually fired, shall be equipped with two temperature combustion regulators in series. Steam-heating boilers, other than manually fired, shall be equipped with a pressure combustion regulator and a low-water cutoff. (See Section 1008.0)

(2) Boilers and pressure vessels shall be provided with the required number, size, and capacity of safety or relief valves to ensure positive relief of overpressure in accordance with nationally recognized standards, as applicable. Valves so employed shall be constructed, sealed, and installed in accordance with nationally recognized standards, as applicable.

1010.0 Clearance for Access.

1010.1 General. Where boilers are installed or replaced, clearance shall be provided to allow access for inspection, maintenance, and repair. Passageways around all sides of boilers shall have an unobstructed width of not less than 18 inches (457 mm). Clearance for repair and cleaning shall be permitted to be provided through a door or access panel into another area, provided the opening is of sufficient size.

Exception: Subject to the approval of the Authority Having Jurisdiction, boilers shall be permitted to be installed with a side clearance of less than 18 inches (457 mm), provided that the lesser clearance does not inhibit inspection, maintenance, or repair.

1010.2 Power Boilers. Power boilers having a steam-generating capacity in excess of 5000 pounds per hour (lb/h) (0.6299 kg/s) or having a heating surface in excess of 1000 square feet (92.9 m²) or input in excess of 5 000 000 Btu/h (1464 kW) shall have a clearance of not less than 7 feet (2134 mm) from the top of the boiler to the ceiling.

1010.3 Steam-Heating Boilers, Hot Water Boilers, and Power Boilers. Steam-heating boilers and hot-water-heating boilers that exceed one of the following limits:

(1) 5 000 000 Btu/h input (1464 kW)

(2) 5000 pounds steam per hour (0.6299 kg/s) capacity

(3) 1000 square foot (92.9 m²) heating surface

Power boilers that do not exceed one of the following limits:

(1) 5 000 000 Btu/h input (1464 kW)

Boilers with manholes on top of the boiler, except those described in Section 1010.2 and Section 1010.4, shall have a clearance of not less than 3 feet (914 mm) from the top of the boiler to the ceiling.

1010.4 Package Boilers, Steam-Heating Boilers, and Hot-Water-Heating Boilers. Package boilers, steam-heating boilers, and hot-water-heating boilers with no manhole on top of the shell and not exceeding one of the above limits shall have a clearance of not less than 2 feet (610 mm) from the ceiling.

1011.0 Boilers, Stokers, and Steam Generators.

1011.1 General. The design, installation, and operation of single burner boilers, multiple burner boilers, stokers, and atmospheric fluidized-bed boilers with not less than a fuel input rating of 12.5 E+06 Btu/h (3.663 MW) to pulverized fuel systems, fired or unfired steam generators used to recover heat from combustion turbines and to other combustion turbine exhaust systems shall be in accordance with NFPA 85. That portion of the oil-burning system supplied on boilers and covered within the scope of NFPA 85 shall be installed in accordance with NFPA 85.

1012.0 Operating Adjustments and Instructions.

1012.1 General. Hot water boiler installations, upon completion, shall have controls set, adjusted, and tested by the installing contractor. A complete control diagram of a permanent legible type, together with complete boiler operating instructions, shall be furnished by the installer for each installation.

1013.0 Inspections and Tests.

1013.1 General. An installation for which a permit is required shall not be put into service until it has been inspected and approved by the Authority Having Jurisdiction.

It shall be the duty of the owner or his authorized representative to notify the Authority Having Jurisdiction that the installation is ready for inspection and test. It also shall be the duty of the owner or his authorized representative to post in a conspicuous position on the installation a notice in substantially the following form: “WARNING! THIS INSTALLATION HAS NOT BEEN INSPECTED AND APPROVED BY THE AUTHORITY HAVING JURISDICTION AND SHALL NOT BE COVERED OR CONCEALED UNTIL SO INSPECTED AND APPROVED,” and it shall be unlawful for anyone other than the Authority Having Jurisdiction to remove such notice. The Authority Having Jurisdiction shall require such tests as it deems necessary to determine that the installation is in accordance with the provision of this section. Such tests shall be made by the owner or his authorized representative in the presence of the Authority Having Jurisdiction.

Exception: On installations designed and supervised by a registered design professional, the Authority Having Jurisdiction shall have the authority to permit inspection and testing by such registered design professional.
Where the owner or his authorized representative requests inspection of a boiler prior to its installation, the Authority Having Jurisdiction shall make such inspection.

1013.2 Operating Permit. It shall be unlawful to operate a boiler or pressure vessel without first obtaining a valid operating permit to do so from the Authority Having Jurisdiction. Such permit shall be displayed in a conspicuous place adjacent to the boiler or vessel. The operating permit shall not be issued until the equipment has been inspected and approved by the Authority Having Jurisdiction.

Exception: The operation of steam-heating boilers, low-pressure hot-water-heating boilers, hot water supply boilers, and pressure vessels in residential occupancies of less than six dwelling units and utility occupancies.

1013.3 Maintenance Inspection. The Authority Having Jurisdiction shall inspect boilers and pressure vessels operated under a permit in accordance with ASHRAE/ACCA 180 at such intervals as deemed necessary, but not less frequently than in accordance with Section 1013.4 through Section 1013.7.

1013.4 Power and Miniature Boilers. Power boilers and miniature boilers shall be inspected externally annually. Where construction and operating conditions permit, they shall be subject to inspection internally annually.

1013.5 Steam-Heating and Water-Heating Boilers. Steam-heating boilers and hot-water-heating boilers shall be inspected externally annually. Where construction and operating conditions permit, they shall also be subject to inspection internally annually.

1013.6 Automatic Steam-Heating Boilers. Automatic steam-heating boilers shall be inspected externally biennially. Where construction and operating conditions permit, they shall be subject to inspection internally biennially.

1013.7 Unfired Pressure Vessels. Unfired pressure vessels shall be inspected externally biennially. Where subject to corrosion and construction permits, they shall be subject to inspection internally biennially.

Inspection of boilers and pressure vessels covered by insurance shall be permitted to be made by employees of the insuring company holding commissions from the National Board of Boiler and Pressure Vessel Inspectors, subject to approval of the Authority Having Jurisdiction. Approved insuring company inspectors shall make reports on prescribed forms on inspections authorized by the Authority Having Jurisdiction. The reports shall be filed in the Authority Having Jurisdiction office. Company inspectors shall notify the Authority Having Jurisdiction of suspension of insurance because of dangerous conditions, new insurance in effect, and discontinuance of insurance coverage.

1014.0 Operation and Maintenance of Boilers and Pressure Vessels.

1014.1 General. Boilers and pressure vessels shall be operated and maintained in accordance with requirements for protection of the public established by the Authority Having Jurisdiction in accordance with nationally recognized standards.

The Authority Having Jurisdiction shall notify the owner or authorized representative of defects or deficiencies and properly corrected. Where such corrections are not made, or where the operation of the boiler or pressure vessel is deemed unsafe by the Authority Having Jurisdiction, they shall have the authority to revoke the permit to operate the boiler or pressure vessel. Where the operation of a boiler or pressure vessel is deemed by the Authority Having Jurisdiction to constitute an immediate danger, the pressure on such boiler or pressure vessel shall be permitted to be relieved at the owner’s cost and the boiler or pressure vessel shall not thereafter be operated without the approval of the Authority Having Jurisdiction.
TABLE 1003.2.1
CONTROLS AND LIMIT DEVICES FOR AUTOMATIC BOILERS

<table>
<thead>
<tr>
<th>BOILER GROUP</th>
<th>FUEL</th>
<th>FUEL INPUT RANGE (INCLUSIVE), BTU/H</th>
<th>TYPE OF PILOT</th>
<th>SAFETY CONTROL TIMING (NOMINAL MAXIMUM TIME IN SECONDS)</th>
<th>TRIAL FOR MAIN BURNER FRAME</th>
<th>DIRECT ELECTRIC IGNITION</th>
<th>FLAME PILOT</th>
<th>MAIN BURNER FLAME FAILURE</th>
<th>ASSURED FUEL SUPPLY CONTROL</th>
<th>ASSURED AIR SUPPLY CONTROL</th>
<th>LOW FIRE START UP CONTROL</th>
<th>PRE-PURGING CONTROL</th>
<th>HOT WATER TEMPERATURE AND LOW WATER LIMIT CONTROLS</th>
<th>STEAM PRESSURE AND LOW WATER LIMIT CONTROLS</th>
<th>APPROVED FUEL SHUT-OFF</th>
<th>CONTROL AND LIMIT DEVICE SYSTEM DESIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Gas</td>
<td>0 - 400 000</td>
<td>Any type</td>
<td>90</td>
<td>Not Required</td>
<td>90</td>
<td>90</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Required</td>
<td>Required</td>
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<td>Required</td>
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<td>Required</td>
</tr>
<tr>
<td>B</td>
<td>Gas</td>
<td>400 001 - 2 500 000</td>
<td>Interrupted or Intermittent</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>2-4</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Not Required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>C</td>
<td>Gas</td>
<td>2 500 001 - 5 000 000</td>
<td>Interrupted or Intermittent</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>2-4</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Not Required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>D</td>
<td>Gas</td>
<td>Over 5 000 000</td>
<td>Interrupted</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>2-4</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
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<td>Required</td>
<td>Required</td>
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<td>Required</td>
</tr>
<tr>
<td>E</td>
<td>Oil</td>
<td>0 - 400 000</td>
<td>Any type</td>
<td>Not Required</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Required</td>
<td>Required</td>
<td>Not Required</td>
<td>Required</td>
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</tr>
<tr>
<td>F</td>
<td>Oil</td>
<td>400 001 - 1 000 000</td>
<td>Interrupted</td>
<td>Not Required</td>
<td>30</td>
<td>30</td>
<td>2-4</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Not Required</td>
<td>Required</td>
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<tr>
<td>G</td>
<td>Oil</td>
<td>1 000 001 - 3 000 000</td>
<td>Interrupted</td>
<td>Not Required</td>
<td>15</td>
<td>15</td>
<td>2-4</td>
<td>Required</td>
<td>Required</td>
<td>Not Required</td>
<td>Required</td>
<td>Required</td>
<td>Not Required</td>
<td>Required</td>
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<tr>
<td>H</td>
<td>Oil</td>
<td>Over 3 000 000</td>
<td>Interrupted</td>
<td>15</td>
<td>15</td>
<td>60</td>
<td>2-4</td>
<td>Required</td>
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<td>Required</td>
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<td>Required</td>
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<td>Required</td>
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<td>Required</td>
</tr>
<tr>
<td>K</td>
<td>Electric</td>
<td>All</td>
<td>Not required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Required</td>
<td>Required</td>
<td>Not Required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>L</td>
<td>Gas, Oil and/or Coal</td>
<td>12 500 000 or more</td>
<td>Any</td>
<td>10 sec Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per ASME Power Boiler Code, Section 1 and NFPA 85</td>
<td>Per ASME Power Boiler Code, Section 1 and NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
</tr>
<tr>
<td>M</td>
<td>Heat Recovery Steam Generator</td>
<td>Any</td>
<td>None</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per ASME Boiler &amp; Pressure Code &amp; NFPA 85</td>
<td>Per ASME Boiler &amp; Pressure Code &amp; NFPA 85</td>
<td>Per NFPA 85</td>
<td>Per NFPA 85</td>
<td></td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW
FOOTNOTES FOR TABLE 1003.2.1 (continued)

1 Fuel input shall be determined by one of the following:
The burner input shall not exceed the input shown on the burner nameplate or as otherwise identified by the manufacturer.
The nominal boiler rating, as determined by the building official, plus 25 percent.

2 Automatic boilers shall have one flame failure device on each burner, which shall prove the presence of an ignition source at the point where it will ignite the main burner, except that boiler groups A, B, E, F, and G, which are equipped with direct electric ignition, shall monitor the main burner, and boiler groups using interrupted pilots shall monitor the main burner after the prescribed limited trial and ignition periods. Boiler group A, equipped with continuous pilot, shall accomplish 100 percent shutoff within 90 seconds upon pilot flame failure. The use of intermittent pilots in boiler group C is limited to approved burner units.

3 In boiler groups B, C, and D a 90 second main burner flame failure limit shall be permitted to be applied where continuous pilots are provided on manufacturer assembled boiler-burner units that have been approved by an approved testing agency in accordance with nationally recognized standards approved by the building official. Boiler groups F and G equipped to re-energize their ignition systems within 0.8 second after main burner flame failure will be permitted 30 seconds for group F or 15 seconds for group G to re-establish their main burner flames.

4 Boiler groups C and D shall have controls interlocked to accomplish a non-recycling fuel shutoff upon high or low gas pressure, and boiler groups F, G, and H using steam or air for fuel atomization shall have controls interlocked to accomplish a non-recycling fuel shutoff upon low atomizing steam or air pressure. Boiler groups F, G, and H equipped with a preheated oil system shall have controls interlocked to provide fuel shutoff upon low oil temperature.

5 Automatic boilers shall have controls interlocked to shut off the fuel supply in the event of draft failure where forced or induced draft fans are used or, in the event of low combustion airflow, where a gas water burner is used. Where a single motor directly driving both the fan and the oil pump is used, a separate control is not required.

6 Boiler groups C, D, and H, where firing in excess of 400 000 Btu/h (117 kW) per combustion chamber, shall be provided with low fire start of its main burner system to permit smooth light-off. This will normally be a rate of one-third of its maximum firing rate.

7 Boiler groups C, D, and H shall not permit pilot or main burner trial for ignition operation before a purging operation of sufficient duration to permit not less than four complete air changes through the furnace, including a combustion chamber and the boiler passes. Where this is not readily determinable, five complete air changes of the furnace, including combustion chamber up to the first pass, will be considered equivalent. An atmospheric gas burner with no mechanical means of creating air movement or an oil burner that obtains two-thirds or more of the air required for combustion without mechanical means of creating air movement shall not require purge by means of four air changes, so long as its secondary air openings are not provided with means of closing. Where such burners have means of closing secondary air openings, a time delay shall be provided that puts these closures in a normally open position for four minutes before an attempt for ignition. An installation with a trapped combustion chamber shall, in every case, be provided with a mechanical means of creating air movement for purging.

8 An automatic hot-water-heating boiler, low-pressure hot-water-heating boiler, and power hot water boiler shall be equipped with two high-temperature limit controls with a manual reset on the control, with the higher setting interlocked to shut off the main fuel supply, except that manual reset on the high-temperature limit control shall not be required on an automatic package boiler not exceeding 400 000 Btu/h (117 kW) input and that has been approved by an approved testing agency. An automatic hot-water heating, power boiler, and package hot-water supply boiler shall be equipped with one low-water level limit control with a manual reset interlocked to shut off the fuel supply, so installed as to prevent damage to the boiler and to permit testing of the control without draining the heating system, except on boilers used in Group R Occupancies of less than six units and in Group U Occupancies and further, except that the low-water level limit control is not required on package hot-water supply boilers approved by a nationally recognized testing agency. However, a low-water flow limit control installed in the circulating water line shall be permitted to be used instead of the low-water level limit control for the same purpose on coil-type boilers.

9 An automatic low-pressure steam-heating boiler, small power boiler, and power steam boiler shall be equipped with two high-temperature limit controls interlocked to shut off the fuel supply to the main burner with manual reset on the control, with the higher setting and two low-water-level limit controls, one of which shall be provided with a manual reset device and independent of the feed water controller. Coil-type flash steam boilers shall be permitted to use two high-temperature limit controls, one of which shall be manually reset in the hot water coil section of the boiler instead of the low-water level limit control for the same purpose on coil-type boilers.

10 Boiler groups C, D, and H shall use an approved automatic reset safety shutoff valve for the main burner fuel shutoff, which shall be interlocked to the programming control devices required. On oil burners where the safety shutoff valve will be subjected to pressures in excess of 10 psi (69 kPa) where the burner is not firing, a second safety shutoff valve shall be provided in series with the first. Boiler groups C and D using gas in excess of 1 psi (7 kPa) pressure or having a trapped combustion chamber or employing horizontal fire tubes shall be equipped with two approved safety shutoff valves, one of which shall be an automatic reset type, one of which shall be permitted to be used as an operating control, and both of which shall be interlocked to the limit-control devices required. Boiler groups C and D using gas in excess of 1 psi (7 kPa) pressure shall be provided with a permanent and ready means for making periodic tightness checks of the main fuel safety shutoff valves.

11 Control and limit device systems shall be grounded with operating voltage not to exceed 150 volts, except that, upon approval by the building official, existing control equipment to be reused in an altered boiler control system shall be permitted to use 220 volts single phase with one side grounded, provided such voltage is used for all controls. Control and limit devices shall interrupt the ungrounded side of the circuit. A readily accessible means of manually disconnecting the control circuit shall be provided with controls so arranged that where they are de-energized, the burner shall be inoperative.
CHAPTER 11
REFRIGERATION

1101.0 General.
1101.1 Applicability. Part I governs the design, installation, and construction of refrigeration systems, equipment, refrigerant piping, pressure vessels, safety devices, replacement of parts, alterations, and substitution of different refrigerants. Part II governs the installation and construction of cooling towers.

1101.2 Equipment. Equipment for refrigerant recovery, recycling, or both shall comply with UL 1963.


1102.0 Refrigeration Systems.
1102.1 General. Refrigeration systems using a refrigerant other than ammonia shall comply with this chapter and ASHRAE 15.

1102.2 Ammonia Refrigeration Systems. Refrigeration systems using ammonia as the refrigerant shall comply with IIAR 2, IIAR 3, IIAR 4, and IIAR 5, and IIAR 6 and shall not be required to comply with this chapter.

1102.3 Refrigerants. The refrigerant used shall be of a type listed in Table 1102.3 or in accordance with ASHRAE 34 where approved by the Authority Having Jurisdiction.

Exception: Lithium bromide absorption systems using water as the refrigerant.

1103.0 Classification.
1103.1 Classification of Refrigerants. Refrigerants shall be classified in accordance with Table 1102.3 or in accordance with ASHRAE 34 where approved by the Authority Having Jurisdiction.

1103.1.1 Safety Group. Table 1102.3 classifies refrigerants by toxicity and flammability, and assigns safety groups using combinations of toxicity class and flammability class. For the purposes of this chapter, the refrigerant Groups A1, A2L, A2, A3, B1, B2L, B2, and B3 shall be considered to be individual and distinct safety groups. Each refrigerant is assigned into not more than one group.

1103.2 Classification of Refrigeration Systems. Refrigeration systems shall be classified according to the degree of probability that a leakage of refrigerant will enter an occupancy-classified area in accordance with Section 1103.2.1 and Section 1103.2.2. [ASHRAE 15:5.2]

1103.2.1 High-Probability System. Systems in which the basic design, or the location of components, is such that a leakage of refrigerant from a failed connection, seal, or component will enter the occupied space shall be classified as high-probability systems. A typical high-probability system shall be one of the following:

1. A direct system
2. An indirect open spray system in which the refrigerant is capable of producing pressure that is more than the secondary coolant. [ASHRAE 15:5.2.1]

1103.2.2 Low-Probability System. Systems in which the basic design, or the location of the components, is such that a leakage of refrigerant from a failed connection, seal, or component is not capable of entering the occupied space shall be classified as low-probability systems. A typical low-probability system shall be one of the following:

1. An indirect closed system
2. A double indirect system
3. An indirect open spray system. In a low-probability indirect open spray system, the secondary coolant pressure remains more than the refrigerant pressure in operating and standby conditions. [ASHRAE 15:5.2.2]

1103.3 Higher Flammability Refrigerants. Group A3 and B3 refrigerants shall not be used except where approved by the Authority Having Jurisdiction.

Exceptions:
1. Laboratories with more than 100 square feet (9.29 m²) of space per person.
2. Industrial occupancies.
3. Listed self-contained systems containing not more than 0.331 pounds (0.150 kg) of Group A3 refrigerant, provided that the equipment is installed in accordance with the listing and the manufacturer’s installation instructions. [ASHRAE 15:7.5.3]

1104.0 Requirements for Refrigerant and Refrigeration System Use.
1104.1 System Selection. Refrigeration systems shall be limited in application in accordance with Table 1104.1, and the requirements of Section 1104.0.

1104.2 Refrigerant Concentration Limit (RCL). The concentration of refrigerant in a complete discharge of an independent circuit of high-probability systems shall not exceed the amounts shown in Table 1102.3, except as provided in Section 1104.3 and Section 1104.4. The volume of occupied space shall be determined in accordance with Section 1104.2.1 through Section 1104.2.3.

Exceptions:
1. Listed equipment containing not more than 6.6 pounds (2.99 kg) of refrigerant, regardless of the refrigerant safety classification, provided the equipment is installed in accordance with the listing and with the manufacturer’s installation instructions.
(2) Listed equipment for use in laboratories with more than 100 square feet (9.29 m<sup>2</sup>) of space per person, regardless of the refrigerant safety classification, provided that the equipment is installed in accordance with the listing and the manufacturer’s installation instructions. [ASHRAE 15:7.2]

**TABLE 1104.1 PERMISSIBLE REFRIGERATION SYSTEMS**

<table>
<thead>
<tr>
<th>OCCUPANCY GROUP&lt;sup&gt;3&lt;/sup&gt;</th>
<th>HIGH-PROBABILITY SYSTEM</th>
<th>LOW PROBABILITY SYSTEM</th>
<th>MACHINERY ROOM</th>
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</table>

Notes:
1 See Section 1104.0.
2 A refrigerant shall be permitted to be used within a high-probability system where the room or space is in accordance with Section 1104.4.
3 Occupancy classifications are defined in the building code.
4 See Section 1104.6 for requirements applicable to A2L equipment.

**1104.2.1 Volume Calculations.** The volume used to convert from refrigerant concentration limits to refrigerating system quantity limits for refrigerants in Section 1104.2 shall be based on the volume of space to which refrigerant disperses in the event of a refrigerant leak. [ASHRAE 15:7.3]

**1104.2.2 Nonconnecting Spaces.** Where a refrigerating system, or a part thereof, is located in one or more enclosed occupied spaces that do not connect through permanent openings or HVAC ducts, the volume of the smallest occupied space shall be used to determine the refrigerant quantity limit in the system. Where different stories and floor levels connect through an open atrium or mezzanine arrangement, the volume to be used in calculating the refrigerant quantity limit shall be determined by multiplying the floor area of the lowest space by 8.2 feet (2499 mm). [ASHRAE 15:7.3.1]

**1104.2.3 Ventilated Spaces.** Where a refrigerating system, or a part thereof, is located within an air handler, in an air distribution duct system, or in an occupied space served by a mechanical ventilation system, the entire air distribution system shall be analyzed to determine the worst-case distribution of leaked refrigerant. The worst case or the smallest volume in which the leaked refrigerant disperses shall be used to determine the refrigerant quantity limit in the system, subject to the criteria in accordance with Section 1104.2.3.1 through Section 1104.2.3.3. [ASHRAE 15:7.3.2]

**1104.2.3.1 Closures.** Closures in the air distribution system shall be considered. Where one or more
spaces of several arranged in parallel are capable of being closed off from the source of the refrigerant leak, their volume(s) shall not be used in the calculation.

Exceptions: The following closure devices are not considered:
(1) Smoke dampers, fire dampers, and combination smoke/fire dampers that close only in an emergency not associated with a refrigerant leak.
(2) Dampers, such as variable-air-volume (VAV) boxes, that provide limited closure where airflow is not reduced below 10 percent of its maximum (with the fan running). [ASHRAE 15:7.3.2.1]

1104.2.3.2 Plenums. The space above a suspended ceiling shall not be included in calculating the refrigerating system quantity limits unless such space is part of the air supply or return system. [ASHRAE 15:7.3.2.2]

1104.2.3.3 Supply and Return Ducts. The volume of the supply and return ducts and plenums shall be included when calculating the refrigerating system quantity limits. [ASHRAE 15:7.3.2.3]

1104.3 Institutional Occupancies. The RCL value required in Section 1104.2 shall be reduced by 50 percent for the areas of institutional occupancies. The total of Group A2, B2, A3, and B3 refrigerants shall not exceed 550 pounds (249.5 kg) in the occupied areas and machinery rooms of institutional occupancies.

Exception: The total of all Group A2L refrigerants shall not be limited in machinery rooms of institutional occupancies.

1104.4 Industrial Occupancies and Refrigerated Rooms. Section 1104.2 shall not apply in industrial occupancies and refrigerated rooms where in accordance with the following:
(1) The space(s) containing the machinery is (are) separated from other occupancies by tight construction with tight-fitting doors.
(2) Access is restricted to authorized personnel.
(3) Refrigerant detectors are installed with the sensing location and alarm level as required in refrigeration machinery rooms in accordance with Section 4.106.2.2.2
(4) Open flames and surfaces exceeding 800°F (427°C) shall not be permitted where a Group A2, B2, A3, or B3 refrigerant, is used.
(5) Electrical equipment that is in accordance with Class 1, Division 2, of NFPA 70 where the quantity of a Group A2, B2, A3, or B3 refrigerant in an independent circuit is capable of exceeding 25 percent of the lower flammability limit (LFL) upon release to the space based on the volume determined in accordance with Section 1104.2.1 through Section 1104.2.3.
(6) Refrigerant containing parts in systems exceeding 100 horsepower (74.6 kW) compressor drive power, except evaporators used for refrigeration or dehumidification, condensers used for heating, control and pressure-relief valves for either, low-probability pumps, and connecting piping, are located in a machinery room or outdoors. [ASHRAE 15:7.2.2]

1104.5 Flammable Refrigerants. The total of Group A2, B2, A3, and B3 refrigerants, other than Group A2L and B2L refrigerants shall not exceed 1100 pounds (498.9 kg) without approval by the Authority Having Jurisdiction. Institutional Occupancies shall comply with Section 1104.3. Machinery rooms required in accordance with Section 1106.0 based on flammability shall be constructed and maintained in accordance with Section 1106.2.1 through Section 1106.2.6 and Section 1106.13 for Group A2L and B2L refrigerants.

1104.6 Applications for Human Comfort and for Nonindustrial Occupancies. In nonindustrial occupancies, Group A2, A2L, A3, B1, B2L, B2, and B3 refrigerants shall not be used in high-probability systems for human comfort.

1104.7 Refrigerant Type and Purity. Refrigerants shall be of a type specified by the equipment manufacturer. Unless otherwise specified by the equipment manufacturer, refrigerants used in new equipment shall be of purity in accordance with AHRI 700.

1104.7.1 Recovered Refrigerants. Recovered refrigerants shall not be reused except in the system from which they were removed, or as provided in Section 1104.7.2 or Section 1104.7.3. When contamination is evident by discoloration, odor, acid test results, or system history, recovered refrigerants shall be reclaimed in accordance with Section 1104.7.3 before reuse. [ASHRAE 15:7.5.1.4]

1104.7.2 Recycled Refrigerants. Recycled refrigerants shall not be reused except in systems using the same refrigerant and lubricant designation and belonging to the same owner as the systems from which they were removed. Where contamination is evident by discoloration, odor, acid test results, or system history, recycled refrigerants shall be reclaimed in accordance with Section 1104.7.3.

Exception: Drying shall not be required in order to use recycled refrigerants where water is the refrigerant, is used as an absorbent or is a deliberate additive. [ASHRAE 15:7.5.1.5]

1104.7.3 Reclaimed Refrigerants. Used refrigerants shall not be reused in a different owner’s equipment unless tested and found to be in accordance with the requirements of AHRI 700. Contaminated refrigerants shall not be used unless reclaimed and is in accordance with AHRI 700. [ASHRAE 15:7.5.1.6]

1104.7.4 Mixing. Refrigerants, including refrigerant blends, with different refrigerant designations as in accordance with Table 1102.3 shall not only be mixed in a system, in accordance with the following:

Exception:
(1) The addition of a second refrigerant shall be permitted where specified is allowed by the equip-
1104.8 Changing Refrigerants. A change in the type of refrigerant in a system shall not be made without notifying the Authority Having Jurisdiction, the user, and due observance of safety requirements. The refrigerant being considered shall be evaluated for suitability. Changes of refrigerant in an existing system to a refrigerant with a different refrigerant designation shall only be allowed where in accordance with Sections 1104.8.1 through Section 1104.8.4. [ASHRAE 15:5.3]

1104.8.1 Approval. The change of refrigerant shall be approved by the owner. [ASHRAE 15:5.3.1]

1104.8.2 Procedures. The change of refrigerant shall be in accordance with one of the following:

(1) Written instructions of the original equipment manufacturer.

(2) An evaluation of the system by a registered design professional or by an approved nationally recognized testing laboratory that validates safety and suitability of the replacement refrigerant.

(3) Approval of the Authority Having Jurisdiction. [ASHRAE 15:5.3.2]

1104.8.3 Replacement Refrigerant of Same Classification. Where the replacement refrigerant is classified into the same safety group, requirements that were applicable to the existing system shall continue to apply. [ASHRAE 15:5.3.3]

1104.8.4 Replacement Refrigerant of Different Classification. Where the replacement refrigerant is classified into a different safety group, the system shall comply with the requirements of this chapter for a new installation, and the change of refrigerant shall require Authority Having Jurisdiction approval. [ASHRAE 15:5.3.4]

1105.0 General Requirements.

1105.1 Human Comfort. Cooling systems used for human comfort shall be in accordance with the return-air and outside-air provisions for furnaces in Section 604.1 and Section 904.7 904.8. Cooling equipment used for human comfort in residential buildings shall be selected in accordance with ACCA Manual S to satisfy the calculated loads determined in accordance with ACCA Manual J or other approved methods. Refrigerants used for human comfort shall be in accordance with Section 1104.6.

1105.2 Supports and Anchorage. Supports and anchorage for refrigeration equipment and piping shall be designed in accordance with the building code as Occupancy Category H (hazardous facilities). Supports shall be made of noncombustible materials.

Exceptions:

(1) Refrigerant evaporators, suspended overhead, shall be permitted to use portable means of access.

(2) Air filters, brine control or stop valves, fan motors or drives, and remotely de-energized electrical connections shall be permitted to be provided access to an obstructed space not less than 30 inches (762 mm) in depth, width, and height. Where an access opening is immediately adjacent to these items and the equipment is capable of being serviced, repaired, and replaced from this opening, the dimensions shall be permitted to be reduced to 22 inches (559 mm) by 30 inches (762 mm) provided the largest piece of equipment is removed through the opening.

(3) Cooling equipment, using Group A1 refrigerants or brine, located in an attic or furred space shall be permitted to be provided access by a minimum opening and passageway thereto of not less than 22 inches (559 mm) by 30 inches (762 mm).

(4) Cooling or refrigeration equipment, using Group A1 or B1 refrigerants or brine, located on a roof or on an exterior wall of a building, shall be permitted to be provided access as for furnaces in Section 304.3.

1105.4 Illumination and Service Receptacles. In addition to the requirements of Section 301.4, permanent luminaires shall be installed for equipment required by this code to be accessible or readily accessible. Such luminaires shall provide illumination to perform the required tasks for which access is provided. Control of the illumination source shall be provided at the access entrance.

Exceptions:

(1) Luminaires shall be permitted to be omitted where the fixed lighting of the building will provide the required illumination.

(2) Equipment located on the roof or on the exterior walls of a building.
1105.5 Ventilation of Rooms Containing Condensing Units. Where not in a refrigerant machinery room, rooms or spaces in which a refrigerant-containing portion of a condensing unit is installed shall be provided with ventilation in accordance with Section 1105.5.1 or Section 1105.5.2. Ventilation for machinery rooms shall comply with Section 1106.0.

1105.5.1 Permanent Gravity Ventilation Openings. Permanent gravity ventilation openings of not less than 2 square feet (0.2 m²) net free area opening shall be terminated directly to the outside of the building or extend to the outside of the building by continuous ducts.

1105.5.2 Mechanical Exhaust System. A mechanical exhaust system shall be designed to provide a complete change of air not less than every 20 minutes in such room or space and shall discharge to the outside of the building.

Exceptions:

(1) A condensing unit in a room or space where the cubic content exceeds 1000 cubic feet per horsepower (ft³/hp) (37.95 m³/kW) of the unit.

(2) A condensing unit in a room or space that has permanent gravity ventilation having an area of 2 square feet (0.2 m²) or more to other rooms or openings exceeding 1000 ft³/hp (37.95 m³/kW).

1105.6 Prohibited Locations. Refrigeration systems or portions thereof shall not be located within a required exit enclosure. Refrigeration compressors exceeding 5 horsepower (3.7 kW) rating shall be located not less than 10 feet (3048 mm) from an exit opening in a Group A; Group B; Group E; Group F; Group G; Group R, Division 1; or Group S Occupancy, unless separated by a one-hour fire-resistant occupancy separation.

1105.7 Condensate. Condensate from air-cooling coils shall be collected and drained to an approved location. Drain pans and coils shall be arranged to allow thorough drainage and access for cleaning. Where temperatures drop below freezing, heat tracing and insulation of condensate drains shall be installed.

1105.8 Defrost. Where defrost cycles are required for portions of the system, provisions shall be made for collection and disposal of the defrost liquid in a safe and sanitary manner.

1105.9 Overflows. Where condensate or defrost liquids are generated in an attic or furred space, and structural damage will result from overflow, provisions for overflow shall be provided.

1105.10 Condensate, Defrost, and Overflow Disposal. Disposal of condensate, defrost, or overflow discharges shall comply with Section 310.0.

1105.11 Refrigerant Port Protection. Air conditioning refrigerant circuit access ports located outdoors shall be protected from unauthorized access with locking-type tamper-resistant caps or in a manner approved by the Authority Having Jurisdiction.

Exception: Refrigerant ports in secure locations protected by walls or fencing and requiring key access.

1105.12 Storage. Refrigerants and refrigerant oils not charged within the refrigeration system shall be stored in accordance with Section 1105.12.1 and the fire code. Storage of materials in a refrigeration machinery room shall comply with the fire code.

1105.12.1 Quantity Storing Refrigerant. The total amount of refrigerant stored in a machinery room in all containers not provided with relief valves and piping in accordance with Section 1113.0 shall not exceed 350 pounds (149.7 kg). Refrigerant shall be stored in approved storage containers. Additional quantities of refrigerant shall be stored in an approved storage facility. [ASHRAE 15.11.5]

1106.0 Refrigeration Machinery Rooms.

1106.1 Where Required. Refrigeration systems shall be provided with a refrigeration machinery room where the conditions as outlined in Section 1106.1.1 through Section 1106.1.4 exist.

Exception: Refrigeration equipment shall be permitted to be located outdoors in accordance with ASHRAE 15.

1106.1.1 Quantity. The quantity of refrigerant in a single, independent refrigerant circuit of a system exceeds the amounts of Table 1102.3.

1106.1.2 Equipment. Direct- and indirect-fired absorption equipment is used.

Exception: Direct and indirect-fired lithium bromide absorption systems using water as the refrigerant.

1106.1.3 A1 System. An A1 system having an aggregate combined compressor horsepower of 100 (74.6 kW) or more is used.

1106.1.4 A1 Refrigerant. The system contains other than a Group A1 refrigerant.

Exceptions:

(1) Lithium bromide absorption systems using water as the refrigerant.

(2) Systems containing less than 300 pounds (136.1 kg) of refrigerant R-123 and located in an approved exterior location.

Refrigeration machinery rooms shall house refrigerant-containing portions of the system other than the piping and evaporators permitted by Section 1104.4, discharge piping required of this chapter, and cooling towers regulated by Part II of this chapter, and their essential piping.

1106.2 Refrigeration Machinery Room, General Requirements. Where a refrigeration system is located indoors and a machinery room is required in accordance with Section 1106.1, the machinery room shall be in accordance with Section 1106.2.1 through Section 1106.2.5.2 1106.2.9.1.

1106.2.1 Access. Machinery rooms shall not be prohibited from housing other mechanical equipment unless
specially prohibited elsewhere in this chapter. A machinery room shall be so dimensioned that parts are accessible with space for service, maintenance, and operations. There shall be clear head room of not less than 7.25 feet (2210 mm) below equipment situated over passageways. [ASHRAE 15:8.11.1]

1106.2.2 Openings. Each refrigeration machinery room shall have a tight-fitting door or doors opening outward, self-closing where they open into the building and adequate in number to ensure freedom for persons to escape in an emergency. With the exception of access doors and panels in air ducts and air-handling units in accordance with Section 1106.6 1106.2.3, there shall be no openings that will permit passage of escaping refrigerant to other parts of the building. [ASHRAE 15:8.11.2]

1106.6 1106.2.3 Airflow. There shall be no airflow to or from an occupied space through a machinery room unless the air is ducted and sealed in such a manner as to prevent a refrigerant leakage from entering the airstream. Access doors and panels in ductwork and air-handling units shall be gasketed and tight fitting. [ASHRAE 15:8.11.7 8.11.8]

1106.2.4 Restricted Access. Access to the refrigeration machinery room shall be restricted to authorized personnel. Doors shall be clearly marked or permanent signs shall be posted at each entrance to indicate this restriction. [ASHRAE 15:8.11.8 8.11.4]

1106.2.5.2 Detectors and Alarms. Each refrigeration machinery room shall contain one or more refrigerant detectors in accordance with Section 1106.2.2.2 1106.2.6, located in areas where refrigerant from a leak will concentrate, that actuate an alarm and mechanical ventilation in accordance with Section 1106.2.4 1106 2.8 at a set point not more than the corresponding Occupational Exposure Limit, OEL, in accordance with Table 1102.3, a set point determined in accordance with the OEL as defined in Chapter 2 shall be approved by the Authority Having Jurisdiction. The alarm shall annunciate visual and audible alarms inside the refrigeration machinery room and outside each entrance to the refrigeration machinery room. The alarms required in this section shall be of the manual reset type with the reset located inside the refrigeration machinery room. Alarms set at other levels, such as IDLH, and automatic reset alarms shall be permitted in addition to those required in accordance with this section. The meaning of each alarm shall be clearly marked by signage near the annunciator.

Exception: Refrigerant detectors are not required where only systems using R-718 (water) are located in the refrigeration machinery room. For Group A2L and B2L refrigerant detectors shall comply with Section 1106.13. 1106.2.2.2 1106.2.6. Refrigerant Detectors. Refrigerant detectors required in accordance with Section 1106.2.2.4 1106.2.5 or Section 1107.1.7 shall meet all of the following conditions:

1. The refrigerant detector shall perform automatic self-testing of sensors. Where a failure is detected, a trouble signal shall be activated.
2. The refrigerant detector shall have one or more set points to activate responses in accordance with Section 1106.2.2.4 1106.2.5 or Section 1107.1.7.
3. The refrigerant detector as installed, including any sampling tubes, shall activate responses within a time not to exceed 30 seconds after exposure to refrigerant concentration exceeding the set point value specified in Section 1106.2.2.4 1106.2.5 or Section 1107.1.7.

1106.2.3 1106.2.7 Mechanical Ventilation. Machinery rooms shall be vented to the outdoors, utilizing mechanical ventilation in accordance with Section 1106.2.4 1106.2.8 and Section 1106.2.5 1106.2.9.

1106.2.4 1106.2.6 Ventilation. Mechanical ventilation referred to in Section 1106.2.5 1106.2.7 shall be by one or more power-driven fans capable of exhausting air from the machinery room at not less than the amount shown in accordance with Section 1106.2.5 1106.2.9.

To obtain a reduced airflow for normal ventilation, multiple fans or multispeed fans shall be used. Provision shall be made to supply makeup air to replace that being exhausted. Ducts for supply and exhaust to the machinery room shall serve no other area. The makeup air supply locations shall be positioned relative to the exhaust air locations to avoid short-circuiting. Inlets to the exhaust ducts shall be located in an area where refrigerant from a leak will concentrate, in consideration of the location of the replacement supply air paths, refrigerating machines, and the density of the refrigerant relative to air.

Inlets to exhaust ducts shall be within 1 foot (305 mm) of the lowest point of the machinery room for refrigerants that are heavier than air, and shall be within 1 foot (305 mm) of the highest point of the machinery room for refrigerants that are lighter than air. The discharge of the exhaust air shall be to the outdoors in such a manner as not to cause a nuisance or danger.

1106.2.5.1 1106.2.9 Emergency Ventilation-Required Airflow. An emergency ventilation system shall be required to exhaust an accumulation of refrigerant due to leaks or a rupture of the system. The emergency ventilation required shall be capable of removing air from the machinery room in not less than the airflow quantity in Section 1106.2.5.1 1106.2.9.1 or Section 1106.2.5.2. Where multiple refrigerants are present, then the highest airflow quantity shall apply.

1106.2.5.1 1106.2.9.1 Ventilation - A1, A2, A3, B1, B2L, B2 and B3 Refrigerants. The emergency ventilation for A1, A2, A3, B1, B2L, B2 and B3 refrigerants shall have the capacity to provide mechanical exhaust at a rate as determined in accordance with Equation 1106.2.5.1 1106.2.9.1.
\[ Q = 100 \sqrt{G} \]  

(Equation 1106.2.5.1)  

Where:

- \( Q \) = Air flow rate, cubic feet per minute.
- \( G \) = Refrigerant mass in largest system, pounds.

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 pound = 0.453 kg

1106.2.5.2 Ventilation - Group A2L Refrigerants. The emergency ventilation for A2L refrigerants shall have the capacity to provide mechanical exhaust at a rate determined in accordance with Table 1106.2.5.2.

**TABLE 1106.2.5.2**  
REQUIRED AIRFLOW FOR GROUP A2L REFRIGERANTS

<table>
<thead>
<tr>
<th>REFRIGERANT</th>
<th>REQUIRED AIRFLOW (CFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-32</td>
<td>32,500</td>
</tr>
<tr>
<td>R-143a</td>
<td>29,600</td>
</tr>
<tr>
<td>R-444A</td>
<td>43,700</td>
</tr>
<tr>
<td>R-444B</td>
<td>22,400</td>
</tr>
<tr>
<td>R-445A</td>
<td>46,400</td>
</tr>
<tr>
<td>R-446A</td>
<td>30,500</td>
</tr>
<tr>
<td>R-447A</td>
<td>80,200</td>
</tr>
<tr>
<td>R-447B</td>
<td>29,600</td>
</tr>
<tr>
<td>R-451A</td>
<td>44,900</td>
</tr>
<tr>
<td>R-451B</td>
<td>44,900</td>
</tr>
<tr>
<td>R-452B</td>
<td>44,900</td>
</tr>
<tr>
<td>R-454A</td>
<td>42,900</td>
</tr>
<tr>
<td>R-454B</td>
<td>66,500</td>
</tr>
<tr>
<td>R-454C</td>
<td>82,800</td>
</tr>
<tr>
<td>R-455A</td>
<td>44,900</td>
</tr>
<tr>
<td>R-457A</td>
<td>31,400</td>
</tr>
<tr>
<td>R-1234yf</td>
<td>16,500</td>
</tr>
<tr>
<td>R-1234zeE</td>
<td>16,500</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 pound = 0.453 kg

* The values were tabulated from the following equation:

\[ Q_{A2L} = \frac{(\rho \cdot V \cdot A)}{LFL \cdot 0.50} \]  

(Equation 1106.2.5.2)

Where:

- \( \rho \) = Refrigerant density, pounds per cubic feet (kg/m³).
- \( V \) = Refrigerant velocity equal to the refrigerant acoustic velocity (speed of sound), feet per second (m/s).
- \( A \) = Cross-section flow area of refrigerant leak, square feet (m²).
- \( LFL \) = Lower Flammability Limit, or ETFL, where no LFL exist, published value in accordance with ASHRAE 34.

1106.3 Normal Operation. A part of the refrigeration machinery room mechanical ventilation shall be in accordance with the following:

1. Operated, where occupied, to supply not less than 0.5 CFM/ft² (2.54 L/s/m²) of machinery room area or 20 cubic feet per minute (9.44 L/s) per person.

2. Operable, where occupied at a volume required to not exceed the higher of a temperature rise of 18°F (10°C) above inlet air temperature or a maximum temperature of 122°F (50°C).

1106.4 Natural Ventilation. Where a refrigerating system is located outdoors more than 20 feet (6096 mm) from buildings openings and is enclosed by a penthouse, lean-to, or other open structure, natural or mechanical ventilation shall be provided. The requirements for such natural ventilation shall be in accordance with the following:

1. The free-aperture cross section for the ventilation of a machinery room shall be not less than as determined in accordance with Equation 1106.4.

\[ F = \sqrt{G} \]  

(Equation 1106.4)

Where:

- \( F \) = The free opening area, square feet.
- \( G \) = The mass of refrigerant in the largest system, any part of which is located in the machinery room, pounds.

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 pound = 0.453 kg

2. The location Locations of the gravity ventilation openings shall be based on the relative density of the refrigerant to air. [ASHRAE 15:8.11.5(a), (b) 8.14]

1106.5 Combustion Air. No open flames that use combustion air from the machinery room shall be installed where refrigerant is used. Combustion equipment shall not be installed in the same machinery room with refrigerant-containing equipment except under one of the following conditions:

1. Combustion air shall be ducted from outside the machinery room and sealed in such a manner as to prevent refrigerant leakage from entering the combustion chamber.

2. A refrigerant detector, that is in accordance with Section 1106.2.2.1, shall be installed to automatically shut down the combustion process in the event of refrigerant leakage.

Exception: Machinery rooms where carbon dioxide (R-744) or water (R-718) is the refrigerant.

1106.6 Ventilation Intake. Makeup air intakes to replace the exhaust air shall be provided to the refrigeration machinery room directly from outside the building. Intakes shall be located as required by other sections of the code and fitted with backdraft dampers or other approved flow-control means to prevent reverse flow. Distribution of makeup air
shall be arranged to provide thorough mixing within the refrigerator machinery room to prevent short circuiting of the makeup air directly to the exhaust.

1106.8 Maximum Temperature. Ventilation or mechanical cooling systems shall be provided to maintain a temperature of not more than 104°F (40°C) in the refrigerant machinery room under design load and weather conditions.

1106.9 Refrigerant Parts in Air Duct. Joints and refrigerant-containing parts of a refrigerating system located in an air duct carrying conditioned air to and from an occupied space shall be constructed to withstand a temperature of 700°F (371°C) without leakage into the airstream. [ASHRAE 15:8.8]

1106.10 Dimensions. Refrigeration machinery rooms shall be of such dimensions that system parts are readily accessible with approved space for maintenance and operations. An unobstructed walking space not less than 36 inches (914 mm) in width and 80 inches (2032 mm) in height shall be maintained throughout, allowing free access to not less than two sides of moving machinery and approaching each stop valve. Access to refrigeration machinery rooms shall be restricted to authorized personnel and posted with a permanent sign.

1106.11 Machinery Room, A2L and B2L. When required by Section 1106.1, machinery rooms shall comply with Section 1106.11.1 through Section 1106.11.6. [ASHRAE 15:8.13]

1106.11.1 Flame-Producing Device. There shall be no flame-producing device or hot surface over 1290°F (700°C) in the room, other than that used for maintenance or repair, unless installed in accordance with Section 1106.5. [ASHRAE 15:8.13.1]

1106.11.2 Communicating Spaces. Doors communicating with the building shall be approved, self-closing, tight-fitting fire doors. [ASHRAE 15:8.13.2]

1106.11.3 Noncombustible Construction. Walls, floor, and ceiling shall be tight and of noncombustible construction. Walls, floor, and ceiling separating the refrigerating machinery room from other occupied spaces shall be of at least one-hour fire-resistive construction. [ASHRAE 15:8.13.3]

1106.11.4 Exterior Openings. Exterior openings, if present, shall not be under any fire escape or any open stairway. [ASHRAE 15:8.13.4]

1106.11.5 Pipe Penetrations. All pipes piercing the interior walls, ceiling, or floor of such rooms shall be tightly sealed to the walls, ceiling, or floor through which they pass. [ASHRAE 15:8.13.5]

1106.11.6 Machinery Room Designation. When any refrigerant of Groups A2, A3, B2, or B3 are used, the machinery room shall be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with NFPA 70. When the only flammable refrigerants used are from Group A2L or B2L, the machinery room shall comply with both Section 1106.11.6.1 for ventilation and Section 1106.11.6.2 for refrigerant detection, or shall be designated as Class I, Division 2 hazardous (classified) electrical location in accordance with NFPA 70. [ASHRAE 15:8.13.6]

1106.11.6.1 Mechanical Ventilation. The machinery room shall have a mechanical ventilation system in accordance with Section 1106.11.11. The mechanical ventilation system shall:

1. Run continuously, and failure of the mechanical ventilation system actuates an alarm, or

2. Be activated by one or more refrigerant detectors, conforming to requirements of Section 1106.11.8. [ASHRAE 15:8.13.6.1]

1106.11.6.2 Detection System. Detection of refrigerant concentration that exceeds 25 percent of the LFL or the upper detection limit of the refrigerant detector, whichever is lower, shall automatically de-energize the following equipment in the machinery room:

1. Refrigerant compressors

2. Refrigerant pumps

3. Normally closed automatic refrigerant valves

4. Other unclassified electrical sources of ignition with apparent power rating greater than 1 kVA, where the apparent power is the product of the circuit voltage and current rating. [ASHRAE 15:8.13.6.2]

1106.11.7 Mechanical Equipment Control. Remote control of the mechanical equipment in the refrigerating machinery room shall be provided immediately outside the machinery room door solely for the purpose of shutting down the equipment in an emergency. Ventilation fans shall be on a separate electrical circuit and have a control switch located immediately outside the machinery room door. [ASHRAE 15:8.13.7]

1106.11.8 Refrigerant Detectors. Each refrigerating machinery room in accordance with Section 1106.11 shall contain one or more refrigerant detectors in accordance with Section 1106.11.9. The detector(s) sensing element shall be located in areas where refrigerant from a leak will concentrate, with one or more set points that activate responses in accordance with Section 1106.11.10 for alarms and Section 1106.11.11 for mechanical ventilation. Multiport-type devices shall be prohibited. [ASHRAE 15:8.13.8]

1106.11.9 Refrigerant Detectors Requirements. Refrigerant detectors required by Section 1106.11 shall meet all of the following conditions:

1. A refrigerant detector shall be capable of detecting each of the specific refrigerant designations in the machinery room.

2. The refrigerant detector shall activate responses within a time not to exceed a limit specified in Sec-
The refrigerant detector shall have a set point not greater than the applicable Occupational Exposure Limit (OEL) value in accordance with Table 1102.3. The applicable OEL value shall be the lowest OEL value for any refrigerant designation in the machinery room. For refrigerants that do not have an OEL value in Table 1102.3, use a value determined in accordance with the OEL as defined by ASHRAE 34 where approved by the Authority Having Jurisdiction.

(4) The refrigerant detector shall have a set point not more than the applicable Refrigerant Concentration Limit (RCL) value in accordance with Table 1102.3. The applicable RCL value shall be the lowest RCL value for any refrigerant designation in the machinery room. For refrigerants that do not have a RCL value in Table 1102.3, use a value determined in accordance with the RCL as defined by ASHRAE 34 where approved by the Authority Having Jurisdiction.

(5) The refrigerant detector shall provide a means for automatic self-testing and shall be in accordance with Section 1106.11.10.4. The refrigerant detector shall be tested during installation and annually thereafter in accordance with the fire code, or at an interval not exceeding the manufacturer’s installation instructions, whichever is less. Testing shall verify compliance with the alarm set points and response times per Section 1106.11.10 and Section 1106.11.11. [ASHRAE 15:8.13.9]

1106.11.10 Alarms. Alarms required by Section 1106.11.8 shall comply with Section 1106.11.10.1 through Section 1106.11.10.4.

1106.11.10.1 Visual and Audio. The alarm shall have visual and audible annunciation inside the refrigerating machinery room and outside each entrance to the refrigerating machinery room. [ASHRAE 15:8.13.10.1]

1106.11.10.2 Detector Activation. The refrigerant detector set points shall activate an alarm in accordance with the type of reset in Table 1106.11.10.2. Manual reset type alarms shall have the reset located inside the refrigerating machinery room. [ASHRAE 15:8.13.10.2]

1106.11.10.3 Alarm Levels. Alarms set at levels other than Table 1106.11.10.2 (such as IDLH) and automatic reset alarms are permitted in addition to those required by Section 1106.11.10. The meaning of each alarm shall be clearly marked by signage near the annunciators. [ASHRAE 15:8.13.10.3]

1106.11.10.4 Emergency. In the event of a failure during a refrigerant detector self-test in accordance with Section 1106.11.9(5), a trouble alarm signal shall be transmitted to an approved monitored location. [ASHRAE 15:8.13.10.4]

1106.11.11 Mechanical Ventilation. Machinery rooms, in accordance with Section 1106.11, shall be vented to the outdoors, using mechanical ventilation in accordance with Section 1106.11.11.1, Section 1106.11.11.2, and Section 1106.11.11.3. [ASHRAE 15:8.13.11]

1106.11.11.1 Mechanical Ventilation Requirements. Mechanical ventilation referred to in Section 1106.11.11 shall be in accordance with all of the following:

1. Include one or more power-driven fans capable of exhausting air from the machinery room; multispeed fans shall be permitted.

2. Electric motors driving fans shall not be placed inside ducts; fan rotating elements shall be nonferrous or non-sparking, or the casing shall consist of or be lined with such material.

3. Include provision to supply make-up air to replace that being exhausted; ducts for supply to and exhaust from the machinery room shall serve no other area; the makeup air supply locations shall be positioned relative to the exhaust air locations to avoid short circuiting.

4. Inlets to the exhaust ducts shall be located in an area where refrigerant from a leak will concentrate, in consideration of the location of the replacement supply air paths, refrigerating machines, and the density of the refrigerant relative to air.

5. Inlets to exhaust ducts shall be within 1 foot (0.3 m) of the lowest point of the machinery room for refrigerants that are heavier than air and shall be within 1 foot (0.3 m) of the highest point for refrigerants that are lighter than air.

6. The discharge of the exhaust air shall be to the outdoors in such a manner as not to cause a nuisance or danger. [ASHRAE 15:8.13.11.1]

TABLE 1106.11.10.2
REFRIGERANT DETECTOR SET POINTS, RESPONSE TIMES, ALARMS, AND VENTILATION LEVELS
[ASHRAE 15: TABLE 8-1]

<table>
<thead>
<tr>
<th>LIMIT VALUE</th>
<th>RESPONSE TIME (seconds)</th>
<th>ALARM TYPE</th>
<th>ALARM RESET TYPE</th>
<th>VENTILATION RATE</th>
<th>VENTILATION RESET TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set point &lt; OEL</td>
<td>≤150</td>
<td>Emergency Alarm</td>
<td>Manual</td>
<td>Level 2</td>
<td>Manual</td>
</tr>
<tr>
<td>Set point ≤ RCL</td>
<td>≤150</td>
<td>Trouble Alarm</td>
<td>Automatic</td>
<td>Level 1</td>
<td>Automatic</td>
</tr>
</tbody>
</table>
1106.11.11.2 Level 1 Ventilation Rate. The refrigerating machinery room mechanical ventilation in Section 1106.12.11.1 shall exhaust at an airflow rate not less than shown in Table 1106.12.11.2.

<table>
<thead>
<tr>
<th>STATUS</th>
<th>AIRFLOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operated when occupied and operated when activated in accordance with Section 1106.11.10.2 and Table 1106.11.10.2</td>
<td>The greater of the following: (1) 0.5 ft³/min per ft² of machinery room area, or (2) 20 ft³/min per person</td>
</tr>
<tr>
<td>Operable when occupied</td>
<td>With or without mechanical cooling of the machinery room, the greater of: (1) The airflow rate required to not exceed a temperature rise of 18°F above inlet air temperature or (2) The airflow rate required to not exceed a maximum air temperature of 122°F in the machinery room.</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m³/s. 1 cubic foot = 0.0283 m³. °C = °F(5/9).

1106.11.11.3 Level 2 Ventilation. A part of the refrigerating machinery room mechanical ventilation referred to in Section 1106.11.1 shall exhaust an accumulation of refrigerant due to leaks or a rupture of a refrigerating system, or portion thereof, in the machinery room. The refrigerant detectors required in accordance with Section 1106.11.8 shall activate ventilation at a set point and response time in accordance with Table 1106.11.10.2, at an airflow rate not less than the value determined in accordance with Section 1106.11.11.4.

When multiple refrigerant designations are in the machinery room, evaluate the required airflow according to each refrigerating system, and the highest airflow quantity shall apply.

Ventilation reset shall be in accordance with the type of reset in Table 1106.11.10.2. Manual-type ventilation reset shall have the reset located inside the refrigerating machinery room. [ASHRAE 15:8.13.11.3]

1106.11.11.4 Level 2 Ventilation Rate. When required by Section 1106.11.11.3, the total airflow for Level 2 ventilation shall be not less than the airflow rate determined by Figure 1106.11.11.4. [ASHRAE 15:8.13.11.4]

1107.0 Machinery Room, Special Requirements. 1107.1 General. In cases specified in the rules of Section 1106.1, a refrigeration machinery room shall comply with the special requirements in accordance with Section 1107.1.1 through Section 1107.1.10, in addition to Section 1106.2.

1107.1 Flame-Producing Devices. There shall be no flame-producing device or continuously operating hot surface over 800°F (427°C) permanently installed in the room.

1107.2 Doors. Doors communicating with the building shall be approved, self-closing, tight-fitting fire doors.

1107.3 Walls, Floors, and Ceilings. Walls, floor, and ceiling shall be tight and of noncombustible construction. Walls, floor, and ceiling separating the refrigeration machinery room from other occupied spaces shall be not less than one-hour fire-resistive construction.

1107.4 Machinery Rooms. The refrigeration machinery room shall have a door that opens directly to the outdoors or through a vestibule equipped with self-closing, tight-fitting doors.

1107.5 Exterior Openings. Exterior openings, where present, shall not be under a fire escape or an open stairway.

1107.6 Sealing. All pipes piercing the interior walls, ceiling, or floor of such rooms shall be tightly sealed to the walls, ceiling, or floor through which they pass.

1107.7 Group A2L and B2L Refrigerants. Where refrigerant of Groups A2L or B2L are used, the requirements of Class 1, Division 2, of NFPA 70, shall not apply to the machinery room provided that the conditions in Section 1107.7.1 through Section 1107.7.3 are met.

1107.7.1 Mechanical Ventilation. The mechanical ventilation system in the machinery room is run continuously in accordance with Section 1106.2.5 and failure of the mechanical ventilation system actuates an alarm, or the mechanical ventilation system in the machinery room is activated by one or more refrigerant detectors, in accordance with the requirements of Section 1106.2.2.1 and Section 1106.2.2.2.

1107.7.2 Refrigeration Detectors. For the refrigerant detection required in Section 1106.2.2.4 and failure of the mechanical ventilation system in the machinery room is run continuously in accordance with Section 1106.2.5, detection of refrigerant concentration that exceeds 25 percent of the LFL or the upper detection limit of the refrigerant detector, whichever is lower, shall automatically de-energize the following equipment in the machinery room:

(a) refrigerant compressors
(b) refrigerant pumps
(c) normally-closed automatic refrigerant valves

1107.7.3 Machinery Rooms. The machinery room shall comply with Section 1107.1.8 and 1106.11.

1107.8 Group A2, A3, B2, or B3 Refrigerants. Where any refrigerant of Groups A2, A3, B2, or B3 are used, the machinery room shall comply with Class 1, Division 2, of NFPA 70.
FIGURE 1106.11.4(1)
LEVEL 2 VENTILATION RATE FOR CLASS 2L REFRIGERANTS
[ASHRAE 15: FIGURE 8-1]
FIGURE 1106.11.14(2)
LEVEL 2 VENTILATION RATE FOR CLASS 2L REFRIGERANTS (SI)
[ASHRAE 15: FIGURE 8-2]
1107.1.9 Refrigeration Systems. As part of the mechanical ventilation system in accordance with Section 1106.2.4 1106.2.8, refrigeration systems that contain more than 110 pounds (50 kg) of any Group A2L, A2, A3, B2L, B2, or B3, refrigerant shall have not less than one exhaust air inlet located adjacent to each system not more than 9 feet (3 m) away.

1107.1.10 Remote Control. Remote control of the mechanical equipment in the refrigeration machinery room shall be provided immediately outside the machinery room solely for the purpose of shutting down the equipment in an emergency. Ventilation fans shall be on a separate electrical circuit and have a control switch located immediately outside the machinery room door.

1108.0 Refrigeration Machinery Room Equipment and Controls.

1108.1 General. Equipment, piping, ducts, vents, or similar devices that are not essential for the refrigeration process, maintenance of the equipment, or for the illumination, ventilation, or fire protection of the room shall not be placed in or pass through a refrigeration machinery room.

1108.2 Electrical. Electrical equipment and installations shall comply with the electrical code  NFPA 70. The refrigeration machinery room shall not be classified as a hazardous location except as provided in Section 1107.1.7 or Section 1107.1.8.

1108.3 Emergency Shut-off. A clearly identified emergency shut-off switch of the break-glass type or with an approved tamper-resistant cover shall be provided immediately adjacent to and outside of the principal refrigeration machinery room entrance. The switch shall provide off-only control of refrigerant compressors, refrigerant pumps, and normally-closed automatic refrigerant valves located in the machinery room. For other than A1 and B1 refrigerants, emergency shutoff shall be automatically activated by refrigerant Alarm 2 in accordance with Section 1106.2.4 1106.2.5.

1108.4 Installation, Maintenance, and Testing. Detection and alarm systems in accordance with Section 1106.2.2.4 1106.2.5 shall be installed, maintained, and tested in accordance with the fire code.

1108.5 Emergency Pressure Control System. Where required by the fire code, an emergency pressure control system shall be installed in accordance with applicable fire code requirements.

1109.0 Refrigeration Piping, Containers, and Valves.

1109.1 Materials. Materials used in the construction and installation of refrigerating systems shall be suitable for conveying the refrigerant used. Materials shall not be used that will deteriorate because of the refrigerant, the lubricant, or their combination in the presence of air or moisture to a degree that poses a safety hazard. [ASHRAE 15:9.1.1] Refrigerant piping shall be metallic. Materials for refrigerant piping, tubing, and fittings shall comply with the applicable standards in Table 1109.1.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>ASTM B210, ASTM B491</td>
</tr>
<tr>
<td>Steel</td>
<td>ASTM A105, ASTM A181, ASTM A193, ASTM A234, ASTM A420, ASTM A707</td>
</tr>
</tbody>
</table>

1109.1.1 Copper and Copper Alloy Pipe. Copper and copper alloy refrigeration piping, valves, fittings, and related parts used in the construction and installation of refrigeration systems shall be approved for the intended use. Refrigeration piping shall comply with ASME B31.5.

1109.1.2 Copper Linesets. Copper linesets shall comply with ASTM B280 or ASTM B1003.

1109.1.3 Iron and Steel. Iron and steel refrigeration piping, valves, fittings, and related parts shall be approved for the intended use. Pipe exceeding 2 inches (50 mm) iron pipe size shall be electric-resistance welded or seamless pipe. Refrigeration piping shall comply with ASME B31.5.

1109.1.4 Prohibited Contact. Aluminum, zinc, magnesium, or their alloys shall not be used in contact with methyl chloride. Magnesium alloys shall not be used in contact with any halogenated refrigerants. [ASHRAE 15:9.1.2]

1109.2 Joints. Iron or steel pipe joints shall be of approved threaded, flanged, or welded types. Exposed threads shall be tinned or coated with an approved corrosion inhibitor. Copper or copper alloy pipe joints of iron pipe size shall be of approved threaded, flanged, press-connect or brazed types. Copper tubing joints and connections shall be connected by approved flared, lapped, swaged, or brazed joints, soldered joints, or mechanical joints that comply with UL 207 either individually or as part of an assembly or a system by an approved nationally recognized laboratory. Piping and tubing shall be installed so as to prevent vibration and strains at joints and connections.

1109.3 Penetration of Piping. Refrigerant piping shall not penetrate floors, ceilings, or roofs.

Exceptions:

1. Penetrations connecting the basement and the first floor.
2. Penetrations connecting the top floor and a machinery penthouse or roof installation.
(3) Penetrations connecting adjacent floors served by the refrigeration system.

(4) Penetrations of a direct system where the refrigerant concentration does not exceed that listed in Table 1102.3 for the smallest occupied space through which the refrigerant piping passes.

(5) In other than industrial occupancies and where the refrigerant concentration exceeds that listed in Table 1102.3 for the smallest occupied space, penetrations that connect separate pieces of equipment that are in accordance with one of the following:

(a) Enclosed by an approved gastight, fire-resistant duct or shaft with openings to those floors served by the refrigerating system.

(b) Located on the exterior wall of a building where vented to the outdoors or to the space served by the system and not used as an air shaft, closed court, or similar space. [ASHRAE 15:8.10.3]

1109.4 Location of Refrigeration Piping. Refrigerant piping crossing an open space that affords passageway in any building shall be not less than 7.25 feet (2210 mm) above the floor unless the piping is located against the ceiling of such space and is permitted by the Authority Having Jurisdiction. [ASHRAE 15:8.10.1]

1109.4.1 Protection from Mechanical Damage. Passages shall not be obstructed by refrigerant piping. Refrigerant piping shall not be located in an any elevator, dumbwaiter, or other shaft containing a moving object, or in any shaft that has openings to living quarters or to means of egress. Refrigerant piping shall not be installed in an enclosed public stairway, stair landing, or means of egress. [ASHRAE 15:8.10.2]

1109.5 Underground Piping. Refrigerant piping placed underground shall be protected against corrosion.

1109.5.1 Piping in Concrete Floors. Refrigerant piping installed in concrete floors shall be encased in a pipe duct. Refrigerant piping shall be isolated and supported to prevent damaging vibration, stress, or corrosion. [ASHRAE 15:8.10.4]

1109.6 Support. In addition to the requirements of Section 1105.2, piping and tubing shall be securely fastened to a permanent support within 6 feet (1829 mm) following the first bend in such tubing from the compressor and within 2 feet (610 mm) of each subsequent bend or angle. Piping and tubing shall be supported at points not more than 15 feet (4572 mm) apart.

1109.7 Pipe Enclosure. Refrigerant piping and tubing shall be installed so that it is not subject to damage from an external source. Soft annealed copper tubing shall not exceed 3/8 inches (35 mm) nominal size. Mechanical joints, other than approved press-connect joints, shall not be made on tubing exceeding 3/4 of an inch (20 mm) nominal size. Soft annealed copper tubing conveying refrigerant shall be enclosed in iron or steel piping and fittings, or in conduit, molding, or raceway that will protect the tubing against mechanical injury from an exterior source.

Exceptions:

(1) Tubing entirely within or tubing within 5 feet (1524 mm) of a refrigerant compressor where so located that it is not subject to external injury.

(2) Copper tubing serving a dwelling unit, where such tubing contains Group A1 refrigerant and is placed in locations not subject to damage from an external source.

1109.8 Visual Inspection. Refrigerant piping and joints erected on the premises shall be exposed to view for visual inspection prior to being covered or enclosed.

Exception: Copper tubing enclosed in iron or steel piping conduit, molding, or raceway, provided there are no fittings or joints concealed therein.

1109.9 Condensation. Piping and fittings that convey brine, refrigerant, or coolants that during normal operation are capable of reaching a surface temperature below the dew point of the surrounding air and that are located in spaces or areas where condensation will cause a hazard to the building occupants or damage to the structure, electrical or other equipment shall be protected to prevent such damage.

1109.10 Identification. Piping shall be in accordance with the reference standard for identification. The type of refrigerant, function and pressure shall be indicated.

1110.0 Valves.

1110.1 More than 6.6 Pounds of Refrigerant. Systems containing more than 6.6 pounds (2.99 kg) of refrigerant shall have stop valves installed at the following locations:

(1) The suction inlet of each compressor, compressor unit, or condensing unit.

(2) The discharge of each compressor, compressor unit, or condensing unit.

(3) The outlet of each liquid receiver.

Exceptions:

(1) Systems that have a refrigerant pumpout function capable of storing the entire refrigerant charge.

(2) Systems that are equipped with the provisions for pumpout of the refrigerant.

(3) Self-contained systems. [ASHRAE 15:9.12.4]

1110.2 More than 110 Pounds of Refrigerant. Systems containing more than 110 pounds (49.9 kg) of refrigerant shall have stop valves installed at the following locations:

(1) The suction inlet of each compressor, compressor unit, or condensing unit.

(2) The discharge outlet of each compressor, compressor unit, or condensing unit.

(3) The inlet of each liquid receiver, except for self-contained systems or where the receiver is an integral part of the condenser or condensing unit.

(4) The outlet of each liquid receiver.

(5) The inlets and outlets of condensers where more than one condenser is used in parallel in the system.
1110.3 Support. Stop valves installed in copper refrigerant lines of ½ of an inch (20 mm) or less outside diameter shall be supported independently of the tubing or piping.

1110.4 Access. Stop valves required by Section 1110.0 shall be readily accessible from the refrigeration machinery room floor or a level platform.

1110.5 Identification. Stop valves shall be identified by tagging in accordance with the reference standard for identification. A valve chart shall be mounted under glass at an approved location near the principal entrance to a refrigeration machinery room.

1111.0 Pressure-Limiting Devices.

1111.1 Where Required. Pressure-limiting devices complying with Section 1111.2 through Section 1111.4 shall be provided for compressors on all systems operating above atmospheric pressure.

Exception: Pressure limiting devices are not required for listed factory-sealed systems containing less than 22 pounds (9.9 kg) of Group A1 refrigerant. [ASHRAE 15:9.9.1]

1111.2 Setting. Pressure limiting devices shall be set in accordance with one the following:

(1) For positive displacement compressors:
   (a) When systems are protected by a highside pressure relief device, the compressor’s pressure limiting device shall be set not more than 90 percent of the operating pressure for the highside pressure relief device.
   (b) When systems are not protected by a highside pressure relief device, the compressor’s pressure limiting device shall be set not more than the system’s highside design pressure.

(2) For nonpositive displacement compressors:
   (a) When systems are protected by a highside pressure relief device, the compressor’s pressure limiting device shall be set not more than 90 percent of the operating pressure for the highside pressure relief device.
   (b) When systems are protected by a lowside pressure relief device that is only subject to lowside pressure, and is provided with a permanent relief path between the systems’ highside and lowside, without intervening valves, the compressor’s pressure limiting device shall be set not more than the systems’ highside design pressure. [ASHRAE 15:9.9.2]

1111.3 Location. Stop valves shall not be installed between the pressure imposing element and pressure limiting devices serving compressors. [ASHRAE 15:9.9.3]

1111.4 Emergency Stop. Activation of a pressure-limiting device shall stop the action of the pressure-imposing element. [ASHRAE 15:9.9.4]

1112.0 Pressure-Relief Devices.

1112.1 General. Refrigeration systems shall be protected by a pressure-relief device or other approved means to safely relieve pressure due to fire or abnormal conditions. [ASHRAE 15:9.4.1]

1112.2 Positive Displacement Compressor. A positive displacement compressor with a stop valve in the discharge connection shall be equipped with a pressure-relief device that is sized, and with a pressure setting, in accordance with the compressor manufacturer to prevent rupture of the compressor or to prevent the pressure from increasing to more than 10 percent above the maximum allowable working pressure of components or any other component located in the discharge line between the compressor and the stop valve or in accordance with Section 1113.5, whichever is larger. The pressure-relief device shall discharge into the low-pressure side of the system or in accordance with Section 1112.11.

Exception: Hermetic refrigerant motor-compressors that are listed and have a displacement not more than 50 cubic feet per minute (1.42 m³/min).

The relief device(s) shall be sized based on compressor flow at the following conditions:

(1) For compressors in single-stage systems and high-stage compressors of other systems, the flow shall be calculated based on 50°F (10°C) saturated suction temperature at the compressor suction.

(2) For low-stage or booster compressors in compound refrigerating systems, the compressors that are capable of running only where discharging to the suction of a high-stage compressor, the flow shall be calculated based on the saturated suction temperature equal to the design operating intermediate temperature.

(3) For low-stage compressors in cascade systems, the compressors that are located in the lower-temperature stage(s) of cascade systems, the flow shall be calculated based on the suction pressure being equal to the pressure setpoint of the pressure-relieving devices that protect the lowside of the stage against overpressure.

Exceptions: For Section 1112.2(1), Section 1112.2(2), and Section 1112.2(3), the discharge capacity of the relief device shall be permitted to be the minimum regulated flow rate of the compressor where the following conditions are met:

(1) The compressor is equipped with capacity regulation.

(2) Capacity regulation actuates to a flow at not less than 90 percent of the pressure-relief device setting.

(3) A pressure-limiting device is installed and set in accordance with the requirements of Section 1111.0. [ASHRAE 15:9.8]

1112.3 Liquid-Containing Portions of Systems. Liquid-containing portions of systems, including piping, that is...
isolated from pressure-relief devices required elsewhere, and that develops pressures exceeding their working design pressures due to temperature rise, shall be protected by the installation of pressure-relief devices.

1112.4 Evaporators. Heat exchanger coils located downstream, or upstream within 18 inches (457 mm), of a heating source and capable of being isolated shall be fitted with a pressure-relief device that discharges to another part of the system in accordance with Section 1112.5 through Section 1112.5.2 or outside any enclosed space in accordance with Section 1112.11. The pressure relief device shall be connected at the highest possible location of the heat exchanger or piping between the heat exchanger and its manual isolation valves.

Exceptions:

(1) Relief valves shall not be required on heat exchanger coils that have a design pressure more than 110 percent of refrigerant saturation pressure when exposed to the maximum heating source temperature.

(2) A relief valve shall not be required on self-contained or unit systems where the volume of the lowside of the system, which is shut off by valves, is more than the specific volume of the refrigerant at critical conditions of temperature and pressure, as determined in accordance with Equation 1112.4.

\[
V_I / \left[ W_I - (V_2 - V_I) / V_{gt} \right] \quad \text{(Equation 1112.4)}
\]

Shall be more than \( V_{gc} \)

Where:
- \( V_I \) = Lowside volume, cubic foot (m³).
- \( V_2 \) = Total volume of system, cubic foot (m³).
- \( W_I \) = Total weight of refrigerant in system, pounds (kg).
- \( V_{gt} \) = Specific volume of refrigerant vapor at 110°F (43°C), cubic feet per pound (m³/kg).
- \( V_{gc} \) = Specific volume at critical temperature and pressure, cubic feet per pound (m³/kg). [ASHRAE 15:9.4.4]

1112.5 Hydrostatic Expansion. Pressure rise resulting from hydrostatic expansion due to temperature rise of liquid refrigerant trapped in or between closed valves shall be addressed in accordance with Section 1112.5.1 and Section 1112.5.2. [ASHRAE 15:9.4.3]

1112.5.1 Hydrostatic Expansion During Normal Operation. Where trapping of liquid with subsequent hydrostatic expansion is capable of occurring automatically during normal operation or during standby, shipping, or power failure, engineering controls shall be used that are capable of preventing the pressure from exceeding the design pressure. Acceptable engineering controls include but are not limited to the following:

(1) Pressure relief device to relieve hydrostatic pressure to another part of the system.

(2) Reseating pressure relief valve to relieve the hydrostatic pressure to an approved treatment system. [ASHRAE 15:9.4.3.1]

1112.5.2 Hydrostatic Expansion During Maintenance. Where trapping of liquid with subsequent hydrostatic expansion is capable of occurring only during maintenance—i.e., when personnel are performing maintenance tasks—either engineering or administrative controls shall be used to relieve or prevent the hydrostatic overpressure. [ASHRAE 15:9.4.3.2]

1112.6 Actuation. Pressure-relief devices shall be direct-pressure actuated or pilot operated. Pilot-operated pressure-relief valves shall be self-actuated, and the main valve shall open automatically at the set pressure and, where an essential part of the pilot fails, shall discharge its full rated capacity. [ASHRAE 15:9.4.5]

1112.7 Stop Valves Prohibited. Stop valves shall not be located between a pressure-relief device and parts of the system protected thereby. A three-way valve, used in conjunction with the dual relief valve in accordance with Section 1113.6, shall not be considered a stop valve. [ASHRAE 15:9.4.6]

1112.8 Location. Pressure-relief devices shall be connected directly to the pressure vessel or other parts of the system protected thereby. These devices shall be connected above the liquid refrigerant level and installed so that they are accessible for inspection and repair, and so that they are not capable of being readily rendered inoperative.

Exception: Where fusible plugs are used on the highside, they shall be located above or below the liquid refrigerant level. [ASHRAE 15:9.4.8]

1112.9 Materials. The seats and discs of pressure-relief devices shall be constructed of compatible material to resist refrigerant corrosion or other chemical action caused by the refrigerant. Seats or discs of cast iron shall not be used. Seats and discs shall be limited in distortion, by pressure or other cause, to a set pressure change of not more than 5 percent in a span of five years. [ASHRAE 15:9.4.9]

1112.10 Pressure-Relief Device-Settings Valve Setting. Pressure-relief valves shall start to function at a pressure not exceeding the design pressure of the parts of the system protected.

Exception: Relief valves that discharge into other parts of the system shall comply with Section 1112.11.3. [ASHRAE 15:9.5.1]

1112.10.1 Rupture Member Setting. Rupture members used in lieu of, or in series with, a relief valve shall have a nominal rated rupture pressure not exceeding the design pressure of the parts of the system protected. The conditions of application shall comply with ASME BPVC Section VIII. The size of rupture members installed ahead of relief valves shall not be less than the relief-valve inlet. [ASHRAE 15:9.5.2]

1112.11 Discharge from Pressure-Relief Devices. Pressure-relief systems designed for vapor shall comply with Section 1112.11.1 through Section 1112.11.4.1.
1112.11.1 Discharging Location Interior to Building. Pressure-relief devices, including fusible plugs, serving refrigeration systems shall be permitted to discharge to the interior of a building where in accordance with all of the following:

1. The system contains less than 110 pounds (49.9 kg) of a Group A1 or A2L refrigerant.
2. The system contains less than 6.6 pounds (2.99 kg) of a Group A2, B1, B2 or B2L refrigerant.
3. The system does not contain any quantity of a Group A3 or B3 refrigerant.
4. The system is not required to be installed in a machinery room in accordance with Section 1106.0.
5. The refrigerant concentration limits in Section 1104.2 are not exceeded. Refrigeration systems that do not comply with the above requirements shall comply with the requirements of Section 1112.11.2 through Section 1112.11.4. [ASHRAE 15:9.7.8.1]

1112.11.2 Discharging Location Exterior to Building. Pressure-relief devices designed to discharge external to the refrigeration system shall be arranged to discharge outside of a building and shall be in accordance with the following:

1. The point of vent discharge shall be located not less than 15 feet (4572 mm) above the adjoining ground level.

   Exception: Outdoor systems containing Group A1 refrigerant shall be permitted to discharge at any elevation where the point of discharge is located in an access-controlled area accessible to authorized personnel only.

2. The point of vent discharge shall be located not less than 20 feet (6096 mm) from windows, building ventilation openings, pedestrian walkways, or building exits.

3. For heavier-than-air refrigerants, the point of vent discharge shall be located not less than 20 feet (6096 mm) horizontally from below-grade walkways, entrances, pits, or ramps where a release of the entire system charge into such a space would yield a concentration of refrigerant in excess of the RCL. The direct discharge of a relief vent into enclosed outdoor spaces, such as a courtyard with walls on all sides, shall not be permitted where a release of the entire system charge into such a space would yield a concentration of refrigerant in excess of the RCL. The volume for the refrigerant concentration calculation shall be determined using the gross area of the space and a height of 8.2 feet (2499 mm), regardless of the actual height of the enclosed space.

4. The termination point of a vent discharge line shall be made in a manner that prevents discharged refrigerant from spraying directly onto personnel that are capable of being in the vicinity.

5. The termination point of vent discharge lines shall be made in a manner that prevents foreign material or debris from entering the discharge piping.

6. Relief vent lines that terminate vertically upward and are subject to moisture entry shall be provided with a drip pocket having a length of not less than 24 inches (610 mm) and having the size of the vent discharge pipe. The drip pocket shall be installed to extend below the first change in vent pipe direction and shall be fitted with a valve or drain plug to permit removal of accumulated moisture. [ASHRAE 15:9.7.8.2]

1112.11.3 Internal Relief. Pressure-relief valves designed to discharge from a higher-pressure vessel into a lower pressure vessel internal to the system shall comply with the following:

1. The pressure-relief valve that protects the higher-pressure vessel shall be selected to deliver capacity in accordance with Section 1113.5 without exceeding the maximum allowable working pressure of the higher-pressure vessel accounting for the change in mass flow capacity due to the elevated backpressure.

2. The capacity of the pressure-relief valve protecting the part of the system receiving a discharge from a pressure-relief valve protecting a higher-pressure vessel shall be not less than the sum of the capacity required in Section 1113.5 plus the mass flow capacity of the pressure-relief valve discharging into that part of the system.

3. The design pressure of the body of the relief valve used on the higher-pressure vessel shall be rated for operation at the design pressure of the higher-pressure vessel in both pressure-containing areas of the valve. [ASHRAE 15:9.7.8.3]

1112.11.4 Discharge Location, Special Requirements. Additional requirements for pressure relief device discharge location and allowances shall apply for specific refrigerants in accordance with Section 1112.11.4.1. [ASHRAE 15:9.7.8.4]

1112.11.4.1 Water (R-718). Where water is the only refrigerant, discharge to a floor drain shall be permitted where the all of the following conditions are met:

1. The pressure-relief device set pressure shall not exceed 15 psig (103 kPag).

2. The floor drain shall be sized to handle the flow rate from a single broken tube in a refrigerant-containing heat exchanger.

3. Either of the following:
   (a) The Authority Having Jurisdiction finds it acceptable that the working fluid, corrosion inhibitor, and other additives used in this type of refrigeration system are permitted

   (b) The entire refrigeration system is located in a space of not exceeding 2 1/2 times the cubic feet of the actual height of the enclosed space.
<table>
<thead>
<tr>
<th>REFRIGERANT</th>
<th>CHEMICAL FORMULA</th>
<th>CHEMICAL NAME1 (COMPOSITION FOR BLENDS)</th>
<th>SAFETY GROUP2</th>
<th>OEL2 (ppm)</th>
<th>RCL (lb/Mcf)</th>
<th>LFL (lb/Mcf)</th>
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<td>1, 1, 1, 2, 3, 3-heptafluoropropano</td>
<td>A1</td>
<td>1000</td>
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<td>R-245fa</td>
<td>CHF2CH2CF3</td>
<td>1, 1, 1, 3, 3-pentafluoropropano</td>
<td>B1</td>
<td>300</td>
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<td>R-290</td>
<td>CH2CH2CH3</td>
<td>Propane</td>
<td>A3</td>
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<tr>
<td>R-C318</td>
<td>-CF2-</td>
<td>Octafluorocyclobutane</td>
<td>A1</td>
<td>1000</td>
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<tr>
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<td>zeotrope</td>
<td>R-12/114 (50.0/50.0)</td>
<td>A1</td>
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<td>R-22/152a/124 (53.0/13.0/34.0)</td>
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**TABLE 1102.3**

REFRIGERANT GROUPS, PROPERTIES, AND ALLOWABLE QUANTITIES

[ASHRAE 34: TABLE 4-1, TABLE 4-2]
### Table 1102.3 (continued)

**Refrigerant Groups, Properties, and Allowable Quantities**

**[ASHRAE 34: Table 4-1, Table 4-2]**

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Chemical Formula</th>
<th>Chemical Name</th>
<th>(Composition for Blends)</th>
<th>Safety Group</th>
<th>OEL³ (ppm)</th>
<th>RCL (lb/Mcf)</th>
<th>LFL (lb/Mcf)</th>
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<td>zootrope</td>
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<td>1000</td>
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<td>R-125/290/22 (60.0/2.0/38.0)</td>
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<td>A2</td>
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<td>LFL (lb/Mcf)</td>
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<td>990</td>
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<td>4.7</td>
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<td>1.9</td>
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<td>zeotrope R-170/290/600a (600 (3.1/54.8/6.0/36.1)</td>
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<td>zeotrope R-32/125/134a/152a/227ea (31.0/31.0/30.0/3.0/5.0)</td>
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<td>R-443A</td>
<td>zeotrope R-1270/290/600a (55.0/40.0/5.0)</td>
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<td>9909.930</td>
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<td>960</td>
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<td>990960</td>
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<td>970</td>
<td>222.6</td>
<td>20.6</td>
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<td>zeotrope R-32/125/1234yf/134a/1234ze(E) (26.0/26.0/20.0/21/0.7.0)</td>
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<td>890860</td>
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<td>R-449A</td>
<td>zeotrope R-32/125/1234yf/134a/1234ze(E) (24.3/24.7/25.3/25.7)</td>
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<td>890840</td>
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<td>R-449B</td>
<td>zeotrope R-32/125/1234yf/134a (25.2/24.3/23.2/27.3)</td>
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<td>R-449C</td>
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<td>800</td>
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<td>R-450A</td>
<td>zeotrope R-134a/1234ze(E) (42.0/58.0)</td>
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<td>880</td>
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<td>R-451A</td>
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<td>530</td>
<td>54.50</td>
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### Table 1102.3 (continued)

**Refrigerant Groups, Properties, and Allowable Quantities**

**ASHRAE 34: TABLE 4-1, TABLE 4-2**

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<tr>
<th>Refrigerant</th>
<th>Chemical Formula</th>
<th>Chemical Name$^1$ (Composition for Blends)</th>
<th>Safety Group$^2$</th>
<th>OEL$^3$ (ppm)</th>
<th>RCL (lb/Mcf)</th>
<th>LFL (lb/Mcf)</th>
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<td>zeotrope</td>
<td>R-32/125/1234yf (11.0/59.0/30.0)</td>
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<td>zeotrope</td>
<td>R-32/125/1234yf (67.0/7.0/26.0)</td>
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<td>870</td>
<td>234.8</td>
<td>19.3</td>
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<td>R-32/125/134a/227ea/600/601a (20.0/20.0/53.8/5.0/0.6/0.6)</td>
<td>A1</td>
<td>1000</td>
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<td>R-125/143a/134a/227ea/600a (55.0/5.0/32.0/5.0/0.3.0)</td>
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<td>1000</td>
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<td>R-462A</td>
<td>zeotrope</td>
<td>R-32/125/143a/134a/600 (9.0/42.0/2.0/44.0/3.0)</td>
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<td>R-744/32/125/1234yf/134a (6.0/36.0/30.0/14.0/14.0)</td>
<td>A1</td>
<td>990</td>
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<td>R-464A</td>
<td>zeotrope</td>
<td>R-32/125/1234ze(E)/227ea (27.0/27.0/40.0/6.0)</td>
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<td>R-744/32/125/134a/1234ze(E)/227ea (10.0/17.0/19.0/7.0/44.0/3.0)</td>
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<td>1100</td>
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<td>R-22/12 (75.0/25.0)</td>
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<td>R-22/115 (48.8/51.2)</td>
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## TABLE 1102.3 (continued)
REFRIGERANT GROUPS, PROPERTIES, AND ALLOWABLE QUANTITIES

### [ASHRAE 34: TABLE 4-1, TABLE 4-2]

| REFRIGERANT | CHEMICAL FORMULA | CHEMICAL NAME\(^1\)  
(Composition for blends) | SAFETY GROUP\(^7\) | OEL\(^2\) (ppm) | RCL (lb/Mcf) POUNDS PER 1000 CUBIC FEET OF SPACE | LFL (lb/Mcf) |
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<td>R-503</td>
<td>azeotrope(^3)</td>
<td>R-23/13 (40.1/59.9)</td>
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<td>R-32/11S (48.2/51.8)</td>
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<td>R-22/218 (44.0/56.0)</td>
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<td>R-1234ze(E)/227ea (91.1/8.9)</td>
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<td>R-600a</td>
<td>CH(CH(_3))(_2)CH(_3) 2-methylpropane (isobutene)</td>
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<td>R-601</td>
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<td>R-611</td>
<td>HCOOCH(_3) Methyl formate</td>
<td>B2</td>
<td>100</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-620</td>
<td>— (Reserved for future assignment)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-630</td>
<td>CH(_3)NH(_2) Methanamine (methyl amine)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-631</td>
<td>CH(_3)CH(_2)(NH(_2)) Ethenamine (ethyl amine)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-702</td>
<td>H(_2) Hydrogen</td>
<td>A3</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-704</td>
<td>He Helium</td>
<td>A1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-717</td>
<td>NH(_3) Ammonia</td>
<td>B2L</td>
<td>25</td>
<td>0.014</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>R-718</td>
<td>H(_2)O Water</td>
<td>A1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-720</td>
<td>Ne Neon</td>
<td>A1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-728</td>
<td>N(_2) Nitrogen</td>
<td>A1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-732</td>
<td>O(_2) Oxygen</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-740</td>
<td>Ar Argon</td>
<td>A1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-744</td>
<td>CO(_2) Carbon dioxide</td>
<td>A1</td>
<td>5000</td>
<td>3.4</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-744A</td>
<td>N(_2)O Nitrous oxide</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-764</td>
<td>SO(_2) Sulfur dioxide</td>
<td>B1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-1130(E)</td>
<td>CHCl(_2)=CHCl Trans-1,2-dichloroethene</td>
<td>A2B2</td>
<td>200</td>
<td>0.25</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>R-1132a</td>
<td>CF(_3)=CH(_2) 1, 1-difluoroethylene</td>
<td>A2</td>
<td>500</td>
<td>2.0</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td>R-1150</td>
<td>CH(_2)=CH(_2) Ethene (ethylene)</td>
<td>A3</td>
<td>200</td>
<td>—</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>R-1224yd(Z)</td>
<td>CF(_3)CF=CHCl (Z)-1-chloro-2,3,3,3-tetrafluoropropane</td>
<td>A1</td>
<td>1000</td>
<td>23</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>R-1233zd(E)</td>
<td>CF(_3)CH=CHCl Trans-1-chloro-3,3,3-trifluoro-1-propane</td>
<td>A1</td>
<td>800</td>
<td>5.3</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>
to infrequently be discharged to the sewer system, or

(b) A catch tank that is sized to handle the expected discharge shall be installed and equipped with a normally closed drain valve and an overflow line to drain. [ASHRAE 15:9.7.8.4.1]

### 1112.12 Discharge Piping

The piping used for pressure-relief device discharge shall be in accordance with Section 1112.12.1 through Section 1112.12.5. [ASHRAE 15:9.7.9]

**1112.12.1 Piping Connection.** Piping connected to the discharge side of a fusible plug or rupture member shall have provisions to prevent plugging of the pipe upon operation of a fusible plug or rupture member. [ASHRAE 15:9.7.9.1]

**1112.12.2 Pipe Size.** The size of the discharge pipe from the pressure-relief device or fusible plug shall not be less than the outlet size of the pressure-relief device or fusible plug. [ASHRAE 15:9.7.9.2]

**1112.12.3 Maximum Length.** The maximum length of the discharge piping installed on the outlet of pressure-relief devices and fusible plugs discharging to the atmosphere shall be determined in accordance with Section 1112.12.4 and Section 1112.12.5. See Table 1112.12.3 for the allowable flow capacity of various equivalent lengths of single discharge piping vents for conventional pressure relief valves. [ASHRAE 15:9.7.9.3]

### 1112.12.4 Design Back Pressure

The design back pressure due to flow in the discharge piping at the outlet of pressure-relief devices and fusible plugs, discharging to the atmosphere, shall be limited by the allowable equivalent lengths of discharge piping vents for conventional pressure relief valves.
lent length of piping determined in accordance with Equation 1112.12.4(1).

\[
L = \frac{0.2146d^2 (P_0^2 - P_1^2)}{\ln (\frac{P_0}{P_1})} + \frac{6 \cdot f}{C_f}
\]  

[Equation 1112.12.4(1)]

Where:

- \( L \) = Equivalent length of discharge piping, feet.
- \( C_r \) = Rated capacity as stamped on the pressure relief device in pounds per minute (lb/min), or in standard cubic feet per minute (SCFM) multiplied by 0.0764, or as calculated in Section 1112.14 for a rupture member or fusible plug, or as adjusted for reduced capacity due to piping in accordance with the manufacturer of the device, or as adjusted for reduced capacity due to piping as estimated by an approved method.
- \( f \) = Moody friction factor in fully turbulent flow.
- \( d \) = Inside diameter of pipe or tube, inches.
- \( \ln \) = Natural logarithm.
- \( P_2 \) = Absolute pressure at outlet of discharge piping, psia.
- \( P_0 \) = Allowed back pressure (absolute) at the outlet of pressure relief device, (psia).

For SI units: 1 foot = 304.8 mm, 1 pound-force per square inch = 6.8947 kPa, 1 pound per minute = 0.00756 kg/s.

Unless the maximum allowable back pressure \( (P_0) \) is specified by the relief valve manufacturer, the following maximum allowable back pressure values shall be used for \( P_0 \), where \( P \) is the set pressure and \( P_a \) is atmospheric pressure at the nominal elevation of the installation (see Table 1112.14-1112.14.3):

1. For conventional relief valves: 15 percent of set pressure:
   \[
   P_0 = (0.15 \times P) + P_a
   \]  
   [Equation 1112.12.4(2)]

2. For balanced relief valves: 25 percent of set pressure:
   \[
   P_0 = (0.25 \times P) + P_a
   \]  
   [Equation 1112.12.4(3)]

3. For rupture disks, fusible plugs, and pilot-operated relief devices: 50 percent of set pressure:
   \[
   P_0 = (0.50 \times P) + P_a
   \]  
   [Equation 1112.12.4(4)]

For fusible plugs, \( P \) shall be the saturated absolute pressure for the stamped temperature melting point of the fusible plug or the critical pressure of the refrigerant used, whichever is smaller. [ASHRAE 15:9.7.9.3.1, 9.7.9.3.2]

1112.12.5 Simultaneous Operation. When outlets of two or more relief devices or fusible plugs, which are expected to operate simultaneously, connect to a common discharge pipe, the common pipe shall be sized large enough to prevent the back pressure at each pressure-relief device from exceeding the maximum allowable back pressure in accordance with Section 1112.12.4. [ASHRAE 15:9.7.9.3.3]

1112.13 Rating of Pressure-Relief Device. The rated discharge capacity of a pressure-relief device expressed in pounds of air per minute (kg/s), shall be determined in accordance with ASME BPVC Section VIII. Pipe and fittings between the pressure-relief valve and the parts of the system it protects shall have not less than the area of the pressure-relief valve inlet area. [ASHRAE 15:9.7.6]

1112.14 Rating of Rupture Members and Fusible Plugs. The rated discharge capacity of a rupture member or fusible plug discharging to the atmosphere under critical flow conditions, in pounds of air per minute (kg/s), shall be determined in accordance with the following formulas:

\[
C = 0.64P_0d^2
\]  

[Equation 1112.14(1)]

\[
d = 1.25 \sqrt{C/P_1}
\]  

[Equation 1112.14(2)]

Where:

- \( C \) = Rated discharge capacity expressed as mass flow of air, pounds per minute.
- \( d \) = Smallest of the internal diameter of the inlet pipe, retaining flanges, fusible plug, or rupture member, inches.

For rupture members:

\[
P_f = (\text{rated pressure in psig} \times 1.1) + 14.7
\]  

[Equation 1112.14(3)]

For fusible plugs:

\[
P_f = \text{Absolute saturation pressure, corresponding to the stamped temperature melting point of the fusible plug or the critical pressure of the refrigerant used, whichever is smaller, pound-force per square inch atmosphere, psia. [ASHRAE 15:9.7.7]}
\]

For SI units: 1 inch = 25.4 mm, 1 pound-force per square inch = 6.8947 kPa, 1 pound per minute = 0.00756 kg/s

1113.0 Overpressure Protection.

1113.1 General. Pressure vessels shall be provided with overpressure protection in accordance with ASME BPVC Section VIII. Pressure vessels containing liquid refrigerant that are capable of being isolated by stop valves from other parts of a refrigerating system shall be provided with over-pressure protection. Pressure relief devices or fusible plugs shall be sized in accordance with Section 1113.5. [ASHRAE 15:9.7.1, 9.7.2]

1113.2 Type of Protection. Pressure vessels with an internal gross volume of 3 cubic feet (0.1 m³) or less shall use one or more pressure relief devices or a fusible plug. Pressure vessels of more than 3 cubic feet (0.1 m³) but less than 10 cubic feet (0.28 m³) internal gross volume shall use one or more
pressure relief devices. Fusible plugs shall not be used. [ASHRAE 15:9.7.2.1, 9.7.2.2]

1113.3 Discharging into Lowside of System. For pressure-relief valves discharging into the lowside of the system, a single relief valve (not rupture member) of the required relieving capacity shall not be used on vessels of 10 cubic feet (0.28 m³) or more internal gross volume except under the conditions permitted in Section 1112.11.3. [ASHRAE 15:9.7.7.3]

1113.4 Parallel Pressure-Relief Devices. Two or more pressure-relief devices in parallel to obtain the required capacity shall be considered as one pressure-relief device. The discharge capacity shall be the sum of the capacities required for each pressure vessel being protected.

1113.5 Discharge Capacity. The minimum required discharge capacity of the pressure-relief device or fusible plug for a pressure vessel shall be determined in accordance with Equation 1113.5. [ASHRAE 15:TABLE 9.7.5]

\[ C = fDL \]  
(Equation 1113.5)

Where:
- \( C \) = Minimum required discharge capacity of the relief device expressed as mass flow of air, pounds per minute (kg/s).
- \( D \) = Outside diameter of vessel, feet (m).
- \( L \) = Length of vessel, feet (m).
- \( f \) = Factor dependent upon type of refrigerant from Table 1113.5.

Where combustible materials are used within 20 ft (6096 mm) of a pressure vessel, the value of \( f \) shall be multiplied by 2.5. [ASHRAE 15:TABLE 9.7.5]

1113.6 Three-Way Valve. Pressure vessels of 10 cubic feet (0.28 m³) or more internal gross volume shall use one or more rupture member(s) or dual pressure-relief valves where discharging to the atmosphere. Dual pressure-relief valves shall be installed with a three-way valve to allow testing or repair. Where dual relief valves are used, the valve shall comply with Section 1113.5.

Exception: A single relief valve shall be permitted on pressure vessels of 10 cubic feet (0.28 m³) or more internal gross volume where in accordance with the following conditions:

1. The relief valves are located on the lowside of the system.
2. The vessel is provided with shutoff valves designed to allow pumpdown of the refrigerant charge of the pressure vessel.

3. Other pressure vessels in the system are separately protected in accordance with Section 1113.1. [ASHRAE 15:9.7.7.3]

<table>
<thead>
<tr>
<th>REFRIGERANT</th>
<th>VALUE OF f</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-23, R-170, R-744, R-1150, R-508A, R-508B</td>
<td>1</td>
</tr>
<tr>
<td>R-13, R-13B1, R-503</td>
<td>2</td>
</tr>
<tr>
<td>R-14</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Other Applications:
- R-718 | 0.3 |
- R-212 | 0.5 |
- R-112, R-114A, R-414B, R-500R, R-509, R-600, R-600A, R-600B | 4 |
- R-141A, R-142B, R-403A, R-407A, R-408A, R-412A | 2.5 |

* In accordance with Section 1102.2, ammonia refrigeration systems are not regulated by this chapter. R-212 (ammonia) is included in this table because the table is extracted from ASHRAE 15 and is not capable of being modified.

1114.0 Special Discharge Requirements.

1114.1 General. Systems containing other than Group A1 or B1 refrigerants shall discharge to atmosphere through an approved flaring device.

Exceptions:

1. Where the Authority Having Jurisdiction determines upon review of a rational engineering analysis that fire, health, or environmental hazards will not result from the proposed atmospheric release.
2. Lithium bromide absorption system using water as the refrigerant.

1114.2 Design Requirements. Flaring devices shall be designed to incinerate the entire discharge. The products of refrigerant incineration shall not pose health or environmental hazards. Incineration shall be automatic upon initiation of discharge, shall be designed to prevent blow-back, and shall not expose structures or materials to the threat of fire. Standby fuel, such as LP-Gas, and standby power shall have the capacity to operate for one and a half times the required time for complete incineration of the charge.

1114.3 Testing. Flaring systems shall be tested to demonstrate their safety and effectiveness. A report from an approved agency shall be submitted detailing the emission products from the system as installed.
1115.0 Labeling and Identification.

1115.1 General. In addition to labels required elsewhere in this chapter, a refrigeration system shall be provided with identification labels in accordance with Section 1115.2 and Section 1115.3.

1115.2 Volume and Type. A condenser, receiver, absorber, accumulator and similar equipment having an internal volume of more than 3 cubic feet (0.1 m³) and containing refrigerant shall be equipped with a permanent label setting forth the type of refrigerant in such vessel.

1115.3 Permanent Sign. In a refrigeration machinery room and for a direct refrigerating system of more than 10 horsepower (7.5 kW), there shall be a permanent sign at an approved location giving the following information:

1. Name of contractor installing the equipment.
2. Name and number designation of refrigerant in system.
3. Pounds of refrigerant in system.

1115.4 Marking of Pressure-Relief Devices. Pressure-relief valves for refrigerant containing components shall be set and sealed by the manufacturer or assembler as defined in ASME BPVC Section VIII. Each pressure relief valve shall be marked by the manufacturer or assembler with the data required in ASME BPVC Section VIII.

Exception: Relief valves for systems with design pressures of 15 pounds-force per square inch gauge (psig) (103 kPa) or less shall be marked by the manufacturer with the pressure setting capacity. [ASHRAE 15:9.6.1]

1115.4.1 Rupture Members. Rupture members for refrigerant pressure vessels shall be marked with the data required in accordance with ASME BPVC Section VIII. [ASHRAE 15:9.6.2]

1115.4.2 Fusible Plugs. Fusible plugs shall be marked with the melting temperatures in °F (°C). [ASHRAE 15:9.6.3]

1115.5 Nameplate. Each self-contained system and each separate condensing unit, compressor, or compressor unit sold for field assembly in a refrigerating system shall carry a nameplate marked with the manufacturer’s name, nationally registered trademark or trade name, identification number, design pressures, and refrigerant for which it is designed. The refrigerant shall be designated by the refrigerant number “R-” number as shown in Table 1102.3. [ASHRAE 15:9.15]

Heat pumps and electric cooling appliances shall bear a factory-applied nameplate in accordance with Section 307.3.

1116.0 Testing of Refrigeration Equipment.

1116.1 Factory Tests. Refrigerant-containing parts of unit systems shall be tested and proved tight by the manufacturer at not less than the design pressure for which they are rated. Pressure vessels shall be tested in accordance with Section 1117.0. [ASHRAE 15:9.14.1]

1116.1.1 Testing Procedure. Tests shall be performed with dry nitrogen or another nonflammable, nonreactive, dried gas. Oxygen, air, or mixtures containing them shall not be used. The means used to build up the test pressure shall have either a pressure-reducing device or a pressure-limiting device and a gage on the outlet side. The pressure-limiting device shall be set above the test pressure but low enough to prevent permanent deformation of the system’s components.

Exceptions:

1. Mixtures of dry nitrogen, inert gases, and Class 1 nonflammable refrigerants shall be permitted for factory tests.
2. Mixtures of dry nitrogen, inert gases, or a combination thereof with flammable Class 2L, Class 2, or Class 3 refrigerants in concentrations not exceeding the lesser of a refrigerant weight fraction (mass fraction) of 5 percent or 25 percent of the LFL shall be permitted for factory tests.
3. Compressed air without added refrigerant shall be permitted for factory tests, provided the system is subsequently evacuated to less than 0.039 inch of mercury (0.132 kPa) before charging with refrigerant. The required evacuation level is atmospheric pressure for systems using R-718 (water) or R-744 (carbon dioxide) as the refrigerant. [ASHRAE 15:9.14.1.1]

1116.1.2 Applied Pressure. The test pressure applied to the highside of each factory-assembled refrigerating system shall be not less than the design pressure of the highside. The test pressure applied to the lowside of a factory assembled refrigerating system shall be not less than the design pressure of the lowside.

1116.1.3 Design Pressure of 15 psig or Less. Units with a design pressure of 15 psig (103 kPag) or less shall be tested at a pressure not less than 1.33 times the design pressure, and shall be proved leak-tight at not less than the lowside design pressure. [ASHRAE 15:9.14.3]

1116.2 Field Tests. Refrigerant-containing parts of a system that is field-erected shall be tested and proved tight after complete installation and before the operation. The high and low sides of each system shall be tested and proved tight at not less than the lower of the set pressure in Table 1116.2 or the setting of the pressure-relief device.

Exceptions:

1. Compressors, condensers, evaporators, coded pressure vessels, safety devices, pressure gauges, control mechanisms, and systems that are factory tested.
2. Refrigeration systems containing Group R-22, not exceeding 5 tons of refrigeration capacity (18 kW), and field-piped using approved, factory-charged line sets shall be permitted to be proved tight by observing retention of pressure on a set of charging gauges and soapting connections while the system is operating.
1116.3 Test Gases. Tests shall be performed with dry nitrogen or another nonflammable, nonreactive, dried gas. Oxygen, air, or mixtures containing them shall not be used. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gauge on the outlet side. The pressure-relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system’s components.

Exceptions:

1. Mixtures of dry nitrogen, inert gases, or a combination thereof with Class 1 nonflammable refrigerant refrigerants in concentrations of a refrigerant weight fraction (mass fraction) not exceeding 5 percent shall be permitted for tests.
2. Mixtures of dry nitrogen, inert gases, or a combination thereof with flammable Class 2L, Class 2, and Class 3 refrigerants in concentrations not exceeding the lower lesser of a refrigerant weight fraction (mass fraction) of 5 percent or 25 percent of the LFL shall be permitted for tests.
3. Compressed air without added refrigerants shall be permitted for tests, provided the system is subsequently evacuated to less than 1000 microns (0.1333 kPa) before charging with refrigerant. The required evacuation level is atmospheric pressure for systems using R-718 (water) or R-744 (carbon dioxide) as the refrigerant.
4. Systems erected on the premises using Group A1 refrigerant and with copper tubing not exceeding 0.62 of an inch (15.7 mm) outside diameter shall be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at not less than 68°F (20°C). [ASHRAE 15:10.1.2]

1116.4 Declaration. A dated declaration of test shall be provided for systems containing more than 55 pounds (24.9 kg) of refrigerant. The declaration shall give the name of the refrigerant and the field test pressure applied to the highside and the lowside of the system. The declaration of test shall be signed by the installer and, where an inspector is present at the tests, the inspector shall also sign the declaration. Where requested, copies of this declaration shall be furnished to the Authority Having Jurisdiction. [ASHRAE 15:10.2]

1116.5 Brine Systems. Brine-containing portions of a system shall be tested at one and a half times the design pressure of the system using brine as the test fluid.

1117.0 Refrigerant-Containing Pressure Vessels.

1117.1 Inside Dimensions 6 Inches or Less. Pressure vessels having inside dimensions of 6 inches (152 mm) or less shall:

1. Listed either individually or as part of an assembly by an approved, nationally recognized testing laboratory, or
2. Marked directly on the vessel or on a nameplate attached to the vessel with a “U” or “UM” symbol signifying compliance with ASME BPVC Section VIII, or
3. When requested by the Authority Having Jurisdiction, the manufacturer shall provide documentation to confirm that the vessel meets the design, fabrication, and testing requirements of ASME BPVC Section VIII.

Exception: Vessels having an internal or external design pressure of 15 psig (103 kPag) or less.

Pressure vessels having inside dimensions of 6 inches (152 mm) or less shall be protected by either a pressure-relief device or a fusible plug. [ASHRAE 15:9.3.1.1]

1117.1.1 Pressure-Relief Device. Where a pressure-relief device is used to protect a pressure vessel having an inside dimension of 6 inches (152 mm) or less, the ultimate strength of the pressure vessel so protected shall withstand a pressure of not less than 3.0 times the design pressure. [ASHRAE 15:9.3.1.2]

1117.1.2 Fusible Plug. Where a fusible plug is used to protect a pressure vessel having an inside diameter of 6 inches (152 mm) or less, the ultimate strength of the pressure vessel so protected shall withstand a pressure 2.5 times the saturation pressure of the refrigerant used at the temperature stamped on the fusible plug or 2.5 times the critical pressure of the refrigerant used, whichever is less. [ASHRAE 15:9.3.1.3]

1117.2 Inside Dimensions More than 6 Inches. Pressure vessels having an inside diameter exceeding 6 inches (152 mm) and having an internal or external design pressure greater than 15 psig (103 kPag) shall be directly marked, or marked on a nameplate, with a “U” or “UM” symbol signifying compliance with the rules of ASME BPVC Section VIII. [ASHRAE 15:9.3.2]

1117.3 Pressure Vessels for 15 psig or Less. Pressure vessels having an internal or external design pressure of 15 psig (103 kPag) or less shall have an ultimate strength to withstand not less than 3.0 times the design pressure and shall be tested with a pneumatic test pressure of not less than 1.25 times the design pressure or a hydrostatic test pressure of not less than 1.5 times the design pressure. [ASHRAE 15:9.3.3]
1118.0 Maintenance and Operation.
1118.1 General. Refrigeration systems shall be operated and maintained as required by the fire code.

Part II – Cooling Towers.

1119.0 General.
1119.1 Applicability. Cooling towers, evaporative condensers, and fluid coolers, and associated remote sump tanks shall be readily accessible. Where located on roofs, such equipment having combustible exterior surfaces shall be protected with an approved automatic fire-extinguishing system.

1120.0 Support and Anchorage.
1120.1 General. Cooling towers, evaporative condensers, and fluid coolers shall be supported on noncombustible grillage designed in accordance with the building code. Seismic restraints shall be as required by the building code.

1121.0 Drainage.
1121.1 General. Drains, overflows, and blow-down provisions shall have an indirect connection to an approved disposal location. Discharge of chemical waste shall be as approved by the regulatory authority Authority Having Jurisdiction.

1122.0 Chemical Treatment Systems.
1122.1 General. Chemical treatment systems shall comply with the fire code. Where chemicals used present a contact hazard to personnel, approved emergency eye-wash and shower facilities shall be installed.

1122.2 Automated Control of Cycles of Concentration. Cooling towers, evaporative condensers, and fluid coolers shall include controls that automate system bleed based on conductivity, fraction of metered makeup volume, metered bleed volume, recirculating pump run time, or bleed time.

1123.0 Location.
1123.1 General. Cooling towers, evaporative condensers, and fluid coolers shall be located such that their plumes cannot enter occupied spaces. Plume discharges shall be not less than 25 feet (7620 mm) away from a ventilation inlet to a building. Location on the property shall be as required for buildings by the building code.

1124.0 Electrical.
1124.1 General. Electrical systems shall be in accordance with the electrical code NFPA 70. Equipment shall be provided with a vibration switch to shut off fans operating with excessive vibration. In climates commonly subject to electrical storms, lightning protection shall be provided on roof-mounted equipment.

1125.0 Refrigerants and Hazardous Fluids.
1125.1 General. Equipment containing refrigerants as a part of a closed-cycle refrigeration system shall comply with Part I of this chapter. Equipment containing other fluids that are flammable, combustible, or hazardous shall be in accordance with this code and the fire code.

1126.0 Drift Eliminators.
1126.1 General. Cooling towers, evaporative condensers, and fluid coolers shall be equipped with drift eliminators that have a drift rate of not more than 0.005 percent of the circulated water flow rate in accordance with the equipment manufacturer’s instructions.

1127.0 Water Supply.
1127.1 General. Cooling towers, evaporative coolers and fluid coolers shall be provided with an approved water supply, sized for peak demand. The quality of water shall be provided in accordance with the equipment manufacturer’s recommendations. The piping system and protection of the potable water supply system shall be installed in accordance with the plumbing code.
CHAPTER 12
HYDRONICS

1201.0 General.
1201.1 Applicability. This chapter shall apply to hydronic piping systems that are part of heating, cooling, ventilation, refrigeration, and air conditioning systems. Such piping systems include steam, hot water, radiant heating and cooling, chilled water, steam condensate, condenser water, and ground source heat pump systems, and snow and ice melting systems. The regulations of this chapter shall govern the construction, location, and installation of hydronic piping systems.

1201.2 Insulation. Surfaces within reach of building occupants shall not exceed 140°F (60°C). Where sleeves are installed, the insulation shall continue full size through them.

Coverings and insulation used for piping shall be of material approved for the operating temperature of the system and the installation environment. Where installed in a plenum, the insulation, jackets, and lap-seal adhesives, including pipe coverings and linings, shall have a flame-spread index not to exceed 25 and a smoke-developed index not to exceed 50 where tested in accordance with ASTM E84 or UL 723.

1201.3 Water Hammer Protection. The piping system shall be designed to prevent water hammer.

1201.4 Terminal Units. Terminal units, valves, and flow control devices shall be installed in accordance with the manufacturer’s installation instructions.

1201.5 Return-Water Low-Temperature Protection. Where a minimum return-water temperature to the heat source is specified by the manufacturer, the heating system shall be designed and installed to meet or exceed the minimum return-water temperature during the normal operation of the heat source.

1201.6 Heat Emitters. Heat emitters shall be installed in accordance with the manufacturer’s installation instructions.

1201.7 Mechanical Devices. Where listed mechanical devices are used, the manufacturer’s installation instructions as to the location and method of installation shall be followed.

1201.8 Flexible Connectors. Listed flexible connectors shall be installed in readily accessible locations.

1201.9 Freeze Protection. Hydronic systems and components shall be designed, installed, and protected from freezing.

1202.0 Protection of Potable Water Supply.
1202.1 Prohibited Sources. Hydronic systems or parts thereof shall be constructed in such a manner that polluted, contaminated water or substances shall not enter a portion of the potable water system either during normal use or where the system is subject to pressure that exceeds the operating pressure in the potable water system. Piping, components and devices in contact with the potable water shall be approved for such use and where an additive is used it shall not affect the performance of the system.

1202.2 Chemical Injection. Where systems include an additive, chemical injection or provisions for such injection, the potable water supply shall be protected by a reduced-pressure principle backflow prevention assembly listed or labeled in accordance with ASSE 1013. Such additive or chemical shall be compatible with system components.

1202.3 Compatibility. Fluids used in hydronic systems shall be compatible with all components that will contact the fluid. Where a heat exchanger is installed with a dual purpose water heater, such application shall comply with the requirements for a single wall heat exchanger in Section 1218.1.

1203.0 Capacity of Heat Source.
1203.1 Heat Source. The heat source shall be sized to the design load.

1203.2 Dual Purpose Water Heaters. Water heaters utilized for combined space-heating and water-heating applications shall be listed or labeled in accordance with the standards referenced in Table 1203.2, and shall be installed in accordance with the manufacturer’s installation instructions. The total heating capacity of a dual purpose water heater shall be based on the sum of the potable hot water requirements and the space heating design requirements corrected for hot water first-hour draw recovery.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas-Fired, 75 000 Btu/h or less, Storage</td>
<td>CSA Z21.10.1</td>
</tr>
<tr>
<td>Gas-Fired, Above 75 000 Btu/h, Storage and Instantaneous</td>
<td>CSA Z21.10.3</td>
</tr>
<tr>
<td>Electric, Space Heating</td>
<td>UL 834</td>
</tr>
<tr>
<td>Solid Fuel-Fired</td>
<td>UL 2523</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

1203.3 Tankless Water Heaters. Tankless water heaters used in space-heating applications shall be rated by the manufacturer for space-heating applications, and the output performance shall be determined by the temperature rise and flow rate of water through the unit. The ratings shall be expressed by the water temperature rise at a given flow rate. Manufacturer’s flow rates shall not be exceeded.

1204.0 Identification of a Potable and Nonpotable Water Systems.
1204.1 General. In buildings where potable water and nonpotable water systems are installed, each system shall be clearly identified in accordance with Section 1204.2 through Section 1204.6.
1204.2 Color and Information. Each system shall be identified with a colored pipe or band and coded with paint, wraps, and materials compatible with the piping.

1204.3 Potable Water. Potable water systems shall be identified with a green background with white lettering. The minimum size of letters and length of the color field shall be in accordance with Table 1204.3.

1204.4 Nonpotable Water. Nonpotable water systems shall have a yellow background with black uppercase lettering, with the words: “CAUTION: NONPOTABLE WATER, DO NOT DRINK.” Each nonpotable system shall be identified to designate the liquid being conveyed, and the direction of normal flow shall be clearly shown. The minimum size of the letters and length of the color field shall comply with Table 1204.3.

<table>
<thead>
<tr>
<th>OUTSIDE DIAMETER OF PIPE OR COVERING (inches)</th>
<th>MINIMUM LENGTH OF COLOR FIELD (inches)</th>
<th>MINIMUM SIZE OF LETTERS (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ to 1¼</td>
<td>8</td>
<td>½</td>
</tr>
<tr>
<td>1½ to 2</td>
<td>8</td>
<td>½</td>
</tr>
<tr>
<td>2½ to 6</td>
<td>12</td>
<td>1½</td>
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<tr>
<td>8 to 10</td>
<td>24</td>
<td>2½</td>
</tr>
<tr>
<td>Over 10</td>
<td>32</td>
<td>3½</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm

1204.5 Location of Piping Identification. The background color and required information shall be indicated every 20 feet (6096 mm) but not less than once per room, and shall be visible from the floor level.

1204.6 Flow Directions. Flow directions shall be indicated on the system.

1204.7 Heat Transfer Fluid. Solar thermal piping shall be identified with an orange background with black uppercase lettering, with the words: “CAUTION: HEAT TRANSFER FLUID, DO NOT DRINK.” Each solar thermal system shall be identified to designate the fluid being conveyed. The minimum size of the letters and length of the color field shall comply with Table 1204.3.

Each outlet on the solar thermal piping system shall be posted with black uppercase lettering as follows: “CAUTION: HEAT TRANSFER FLUID, DO NOT DRINK.”

1205.0 Installation, Testing, and Inspection.

1205.1 Operating Instructions. Operating and maintenance information shall be provided to the building owner.

1205.2 Pressure Testing. System piping and components shall be tested with a pressure of not less than one and one-half times the operating pressure but not less than 100 psi (689 kPa). Piping shall be tested with water or air except that plastic pipe shall not be tested with air. Test pressures shall be held for a period of not less than 30 minutes with no perceptible drop in pressure. These tests shall be made in the presence of the Authority Having Jurisdiction.

Exceptions:

1. For PEX, PP-R, PP-RCT, PEX-AL-PEX, PE-RT, and PE-AL-PE piping systems, testing with air shall be permitted where authorized by the manufacturer’s instructions for the PEX, PP-R, PP-RCT, PEX-AL-PEX, PE-RT, and PE-AL-PE pipe and fittings products, and air testing is not prohibited by applicable codes, laws, or regulations outside this code.

2. Copper tubing shall be permitted to be tested at not less than 80 psi (552 kPa).

1205.3 Flushing. Heating and cooling sources, system piping and tubing shall be flushed after installation with water or a cleaning solution. Cleaning and flushing of the heating and cooling sources shall comply with the manufacturer’s instructions. The cleaning solution shall be compatible with all system components and shall be used in accordance with the manufacturer’s instructions.

1206.0 Pressure and Safety Devices.

1206.1 General. Each closed hydronic system shall be protected against pressures exceeding design limitations with not less than one pressure relief valve. Each closed section of the system containing a heat source shall have a relief valve located so that the heat source is not capable of being isolated from a relief device. Pressure relief valves shall be installed in accordance with their listing and the manufacturer’s installation instructions.

1206.2 Discharge Piping. The discharge piping serving a temperature relief valve, pressure relief valve, or combination of both shall have no valves, obstructions, or means of isolation and be provided with the following:

1. Except Not less than to the size of the valve outlet and shall discharge full size to the flood level of the area receiving the discharge and pointing down.

2. Materials shall be rated at not less than the operating temperature of the system and approved for such use or shall comply with ASME A112.4.1.

3. Discharge pipe shall discharge independently by gravity through an air gap into the drainage system or outside of the building with the end of the pipe not exceeding 2 feet (610 mm) and not less than 6 inches (152 mm) above the ground and pointing downwards.

4. Discharge in such a manner that does not cause personal injury or structural damage.

5. No part of such discharge pipe shall be trapped or subject to freezing.

6. The terminal end of the pipe shall not be threaded.

7. Discharge from a relief valve into a water heater pan shall be prohibited.

8. The discharge termination point shall be readily visible.

1207.0 Heating Appliances and Equipment.

1207.1 General. Heating appliances, equipment, safety and operational controls shall be listed for its intended use in a hydronic heating system and installed in accordance with the manufacturer’s installation instructions.
1207.2 Boilers. Boilers and their control systems shall comply with Section 1002.0.

1207.2.1 Condensing Boilers. A condensing boiler, in which the heat exchanger and venting system are designed to operate with condensing flue gases, shall be permitted to be connected directly to the panel heating system without a protective mixing device.

1207.2.2 Noncondensing Boilers. Where the heat exchanger and venting system are not designed to operate with condensed flue gases, the boiler shall be permitted to connect directly to the panel heating system where protected from flue gas condensation. The operating temperature of the boiler shall be more than the fluid temperature in accordance with the manufacturer’s instructions. The minimum return-water temperature to the heat source shall comply with Section 1201.5.

1207.3 Dual-Purpose Water Heaters. Water heaters used for combined space- and water-heating applications shall be in accordance with the standards referenced in Table 1203.2, and shall be installed in accordance with the manufacturer’s installation instructions. Water used as the heat transfer fluid in the hydronic heating system shall be isolated from the potable water supply and distribution in accordance with Section 312.1, Section 1202.0, and Section 1218.0.

1207.3.1 Temperature Limitations. Where a combined space- and water-heating application requires water for space heating at temperatures exceeding 140°F (60°C), a thermostatic mixing valve in accordance with ASSE 1017 shall be installed to temper the water supplied to the potable water distribution system to a temperature of 140°F (60°C) or less.

1207.4 Solar Heat Collector Systems. Solar water heating systems used in hydronic panel radiant heating systems shall be installed in accordance with the Uniform Solar, Hydronics and Geothermal Code (USHGC).

1208.0 Circulators and Pumps.

1208.1 General. Circulators and pumps shall be selected for their intended use based on the heat transfer fluid, intended operating temperature range and pressure. Circulators and pumps shall be installed to allow for service and maintenance. The manufacturer’s installation instructions shall be followed for correct orientation and installation. Motor Operated pumps rated 600V or less shall be listed and labeled in accordance with CSA C22.2 No. 108 or UL 778.

1208.2 Mounting. The circulator or pump shall be installed in such a way that strain from the piping is not transferred to the circulator or pump housing. The circulator or pump shall be permitted to be directly connected to the piping, provided the piping is supported on each side of the circulator or pump. Where the installation of a circulator or pump will cause strain on the piping, the circulator or pump shall be installed on a mounting bracket or base plate. Where means for controlling vibration of a circulator or pump is required, an approved means for support and restraint shall be provided.

1208.3 Sizing. The selection and sizing of a circulator or pump shall be based on all of the following:

1. Loop or system head pressure, feet of head (m)
2. Capacity, gallons per minute (L/s)
3. Maximum and minimum temperature, °F (°C)
4. Maximum working pressure, pounds per square inch (kPa)
5. Fluid type

1209.0 Expansion Tanks.

1209.1 General. An expansion tank shall be installed in each closed hydronic system to control system pressure due to thermal expansion and contraction. Expansion tanks shall be of the closed or open type. Expansion tanks shall be sized for the pressure of the system.

1209.2 Installation. Expansion tanks shall be accessible for maintenance and shall be installed in accordance with the manufacturer’s installation instructions. Each expansion tank shall be equipped with a shutoff device that will remain open during operation of the hydronic system. Valve handles shall be locked open or removed to prevent from being inadvertently shut off. Provisions shall be made for draining the tank without emptying the system. Expansion tanks shall be securely fastened to the structure. Supports shall be capable of carrying twice the weight of the tank filled with water without placing a strain on connecting piping. Hot-water-heating systems incorporating hot water tanks or fluid relief columns shall be installed to prevent freezing under normal operating conditions.

1209.3 Open-Type Expansion Tanks. Open type expansion tanks shall be located not less than 2 feet (0.61 m) above the highest point of the system. An overflow with a diameter of not less than one-half the size of the supply or not less than 1 inch (25 mm) in diameter shall be installed at the top of the tank. The overflow shall discharge through an air gap into the drainage system.

1209.4 1209.3 Closed-Type Tanks. Closed-type expansion tanks shall be sized for a hydrostatic test pressure of two and one-half times the allowable working pressure of the system. Expansion tanks for systems designed to operate at more than 30 pounds-force per square inch (psi) (207 kPa) shall comply with ASME BPVC Section VIII.

1209.5 1209.4 Sizing. Expansion tanks shall be sized to accept the full expansion volume of the fluid in the system. The minimum capacity of a closed-type expansion tank shall be sized in accordance with Section 1004.4.

1210.0 Materials.

1210.1 Piping, Tubing, and Fittings. Hydronic pipe and tubing shall comply with the applicable standards referenced in Table 1210.1 and shall be approved for use based on the intended purpose. Materials shall be rated for the operating temperature and pressure of the system and shall be compatible with the type of heat transfer fluid. Pipe fittings and valves shall be approved for the specific installation with the piping, materials to be installed and shall comply with the applicable standards referenced in Table 1210.1. Where required, exterior piping shall be protected against freezing, UV radiation, corrosion and degradation. Embedded pipe or tubing shall comply with Section 1221.2.
<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>PIPE/TUBING</th>
<th>STANDARDS</th>
<th>FITTINGS</th>
</tr>
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<tbody>
<tr>
<td>Ductile Iron</td>
<td>AWWA C115/A21.15, AWWA C151/A21.51</td>
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<td>PS 117</td>
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<td>Stainless Steel</td>
<td>ASTM A269, ASTM A312, ASTM A554, ASTM A778</td>
<td>ASME F1476, ASTM F1548, ASTM F3226, IAPMO PS 117</td>
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<td>Gray Iron</td>
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<td>ASME A126</td>
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<td>Malleable Iron</td>
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<td>Cross-Linked Polyethylene/</td>
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<td>ASTH F1281, ASTM F1974, ASTM F2165, ASTM F2434, CSA B137.10</td>
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<tr>
<td>Aluminum/Cross-Linked Polyethylene</td>
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<td>(PEX-AL-PE)</td>
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<td>(PE-AL-PE)</td>
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<tr>
<td>Chloride (CPVC/AL/CPVC)</td>
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</tbody>
</table>

**Notes:**

1. Ductile and gray iron.
2. Only type K, L, or M tubing allowed to be installed.
1210.2 Expansion and Contraction. Pipe and tubing shall be so installed that it will not be subject to undue strains or stresses, and provisions shall be made for expansion, contraction, and structural settlement.

1210.3 Hangers and Supports. Pipe and tubing shall be supported in accordance with Section 313.0. Equipment that is part of the piping system shall be provided with additional support in accordance with this code and manufacturer’s installation instructions.

1210.4 Oxygen Diffusion Corrosion. PEX and PE-RT tubing in closed hydronic systems shall contain an oxygen barrier. Exception: Closed hydronic systems without ferrous components in contact with the hydronic fluid.

1211.0 Joints and Connections.
1211.1 General. Joints and connections shall be of an approved type. Joints shall be gas and watertight and designed for the pressure of the hydronic system. Changes in direction shall be made by the use of fittings or with pipe bends. Pipe bends shall have a radius of not less than six times the outside diameter of the tubing or shall be in accordance with the manufacturer’s installation instructions. Joints between pipe and fittings shall be installed in accordance with the manufacturer’s installation instructions.

1211.2 Chlorinated Polyvinyl Chloride (CPVC) Pipe. Joints between chlorinated polyvinyl chloride (CPVC) pipe and fittings shall be installed in accordance with one of the following methods:

(1) Mechanical joints shall include flanged, grooved, and push-fit fittings. Removable and non-removable push fit fittings with an elastomeric o-ring that employ quick assembly push fit connectors shall be in accordance with ASSE 1061.

(2) Solvent cement joints for CPVC pipe and fittings shall be clean from dirt and moisture. Solvent cements in accordance with ASTM F493, requiring the use of a primer shall be orange in color. The primer shall be colored and be in accordance with ASTM F656. Listed solvent cement in accordance with ASTM F493 that does not require the use of primers, yellow in color, shall be permitted for pipe and fittings manufactured in accordance with ASTM D2846, 1/2 of an inch (15 mm) through 2 inches (50 mm) in diameter, 1/2 of an inch (15 mm) through 3 inches (80 mm) in diameter. Apply primer where required inside the fitting and to the depth of the fitting on pipe. Apply liberal coat of cement to the outside surface of pipe to depth of fitting and inside of fitting. Place pipe inside fitting to forcefully bottom the pipe in the socket and hold together until joint is set.

1211.3 CPVC/AL/CPVC Plastic Pipe and Joints. Joints between chlorinated polyvinyl chloride/aluminum/ chlorinated polyvinyl chloride (CPVC/AL/CPVC) pipe and fittings shall be installed in accordance with one of the following methods:

(1) Mechanical joints shall include flanged, grooved, and push-fit fittings.

(2) Solvent cement joints for CPVC/AL/CPVC pipe and fittings shall be clean from dirt and moisture. Solvent cements in accordance with ASTM F493, requiring the use of a primer shall be orange in color. The primer shall be colored and be in accordance with ASTM F656. Listed solvent cement in accordance with ASTM F493 that does not require the use of primers, yellow in color, shall be permitted for pipe and fittings manufactured in accordance with ASTM D2846, 1/2 of an inch (15 mm) through 2 inches (50 mm) in diameter, 1/2 of an inch (15 mm) through 3 inches (80 mm) in diameter. Apply primer where required inside the fitting and to the depth of the fitting on pipe. Apply liberal coat of cement to the outside surface of pipe to depth of fitting and inside of fitting. Place pipe inside fitting to forcefully bottom the pipe in the socket and hold together until joint is set.

1211.4 Copper or Copper Alloy Pipe and Tubing. Joints between copper or copper alloy pipe or tubing and fittings shall be installed in accordance with one of the following methods:

(1) Brazed joints between copper or copper alloy pipe or tubing and fittings shall be made with brazing alloys having a liquid temperature above 1000°F (538°C). The joint surfaces to be brazed shall be cleaned bright by either manual or mechanical means. Tubing shall be cut square and reamed to full inside diameter. Brazing flux shall be applied to the joint surfaces where required by manufacturer’s recommendation. Brazing filler metal in accordance with AWS A5.8 shall be applied at the point where the pipe or tubing enters the socket of the fitting.

(2) Flared joints for soft copper or copper alloy tubing shall be made with fittings that are in accordance with the applicable standards referenced in Table 1210.1. Pipe or tubing shall be cut square using an appropriate tubing cutter. The tubing shall be reamed to full inside diameter, resized to round, and expanded with a proper flaring tool.

(3) Mechanically formed tee fittings shall have extracted collars that shall be formed in a continuous operation consisting of drilling a pilot hole and drawing out the pipe or tube surface to form a collar having a height not less than...
three times the thickness of the branch tube wall. The branch pipe or tube shall be notched to conform to the inner curve of the run pipe or tube and shall have two dimple depth stops to ensure that penetration of the branch pipe or tube into the collar is of a depth for brazing and that the branch pipe or tube does not obstruct the flow in the main line pipe or tube. Dimple depth stops shall be in line with the run of the pipe or tube. The second dimple shall be \( \frac{1}{4} \) of an inch (6.4 mm) above the first and shall serve as a visual point of inspection. Fittings and joints shall be made by brazing. Soldered joints shall not be permitted.

(4) Pressed fittings for copper or copper alloy pipe or tubing shall have an elastomeric o-ring that forms the joint. The pipe or tubing shall be fully inserted into the fitting, and the pipe or tubing marked at the shoulder of the fitting. Pipe or tubing shall be cut square, chamfered, and reamed to full inside diameter. The fitting alignment shall be checked against the mark on the pipe or tubing to ensure the pipe or tubing is inserted into the fitting. The joint shall be pressed using the tool recommended by the manufacturer.

(5) Removable and nonremovable push fit fittings for copper or copper alloy tubing or pipe that employ quick assembly push fit connectors shall be in accordance with ASSE 1061. Push fit fittings for copper or copper alloy pipe or tubing shall have an approved elastomeric o-ring that forms the joint. Pipe or tubing shall be cut square, chamfered, and reamed to full inside diameter. The tubing shall be fully inserted into the fitting, and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing is inserted into the fitting and gripping mechanism has engaged on the pipe.

(6) Soldered joints between copper or copper alloy pipe or tubing and fittings shall be made in accordance with ASTM B828. Pipe or tubing shall be cut square and reamed to the full inside diameter including the removal of burrs on the outside of the pipe or tubing. Surfaces to be joined shall be cleaned bright by manual or mechanical means. Flux shall be applied to pipe or tubing and fittings and shall be in accordance with ASTM B813, and shall become noncorrosive and nontoxic after soldering. Insert pipe or tubing into the base of the fitting and remove excess flux. Pipe or tubing and fitting shall be supported to ensure a uniform capillary space around the joint. Solder in accordance with ASTM B32 shall be applied to the joint surfaces until capillary action draws the molten solder into the cup. Joint surfaces shall not be disturbed until cool, and any remaining flux residue shall be cleaned.

(7) Threaded joints for copper or copper alloy pipe shall be made with pipe threads in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

1211.5 Cross-Linked Polyethylene (PEX) Pipe. Joints between cross-linked polyethylene (PEX) pipe and fittings shall be installed with fittings for PEX tubing that comply with the applicable standards referenced in Table 1210.1. PEX tubing labeled in accordance with ASTM F876 or ASTM F3253 shall be marked with the applicable standard designation for the fittings specified for use with the tubing. Mechanical joints shall be installed in accordance with the manufacturer’s installation instructions.

1211.6 Cross-Linked Polyethylene/Aluminum/Cross-Linked Polyethylene (PEX-AL-PEX) Pipe. Joints between cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pipe and fittings shall be installed in accordance with one of the following methods:

(1) Mechanical joints between PEX-AL-PEX pipe and fittings shall include mechanical and compression type fittings and insert fittings with a crimping ring. Insert fittings utilizing a crimping ring shall be fit in accordance with ASTM F1974 or ASTM F2434. Crimp joints for crimp insert fittings shall be joined to PEX-AL-PEX pipe by the compression of a crimp ring around the outer circumference of the pipe, forcing the pipe material into annular spaces formed by ribs on the fitting.

(2) Compression joints shall include compression insert fittings and shall be joined to PEX-AL-PEX pipe through the compression of a split ring or compression nut around the outer circumference of the pipe, forcing the pipe material into the annular space formed by the ribs on the fitting.

1211.7 Ductile Iron Pipe. Joints between ductile iron pipe and fittings shall be installed in accordance with one of the following methods:

(1) Mechanical joints for ductile iron pipe and fittings shall consist of a bell that is cast integrally with the pipe or fitting and provided with an exterior flange having bolt holes and a socket with annular recesses for the sealing gasket and the plain end of the pipe or fitting. The elastomeric gasket shall comply with AWWA C111. Lubricant recommended for the application by the pipe manufacturer shall be applied to the gasket and plain end of the pipe.

(2) Push-on joints for ductile iron pipe and fittings shall consist of a single elastomeric gasket that shall be assembled by positioning the elastomeric gasket in an annular recess in the pipe or fitting socket and forcing the plain end of the pipe or fitting into the socket. The plain end shall compress the elastomeric gasket to form a positive seal and shall be designed so that the elastomeric gasket shall be locked in place against displacement. The elastomeric gasket shall comply with AWWA C111. Lubricant recommended for the application by the pipe manufacturer shall be applied to the gasket and plain end of the pipe.

1211.8 Polyethylene (PE) Plastic Pipe/Tubing. Joints between polyethylene (PE) plastic pipe or tubing and fittings shall be installed in accordance with one of the following methods:

(1) Butt-fusion joints shall be installed in accordance with ASTM F2620 and shall be made by heating the squared ends of two pipes, pipe and fitting, or two fittings by holding ends against a heated element. The heated element
shall be removed where the proper melt is obtained, and joined ends shall be placed together with applied force.

(2) Electro-fusion joints shall be heated internally by a conductor at the interface of the joint. Align and restrain fitting to pipe to prevent movement and apply electric current to the fitting. Turn off the current when the proper time has elapsed to heat the joint. The joint shall fuse together and remain undisturbed until cool.

(3) Socket-fusion joints shall be installed in accordance with one of the following methods:

- Electro-fusion joints shall be heated internally by a conductor at the interface of the joint. Align and restrain fitting to pipe to prevent movement and apply electric current to the fitting. Turn off the current when the proper time has elapsed to heat the joint. The joint shall fuse together and remain undisturbed until cool.

- Mechanical joints for PE-AL-PE pipe or tubing and fittings shall be installed with fittings for PE-RT tubing that comply with the applicable standards referenced in Table 1210.1. Metal insert fittings, metal compression fittings, and plastic fittings shall be manufactured to and marked in accordance with the standards for fittings in Table 1210.1.

1211.11 Polypropylene (PP) Pipe. Joints between polypropylene pipe and fittings shall be installed in accordance with one of the following methods:

(1) Heat fusion joints for polypropylene (PP) pipe shall be installed with socket-type heat-fused polypropylene fittings, butt-fusion polypropylene fittings or pipe, or electro-fusion polypropylene fittings. Joint surfaces shall be clean and free from moisture. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM F2389 or CSA B137.11.

(2) Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer’s installation instructions. Polypropylene pipe shall not be threaded. Polypropylene transition fittings for connection to other piping materials shall only be threaded by the use of copper alloy or stainless steel inserts molded in the fitting.

1211.12 Polyvinyl Chloride (PVC) Pipe. Joints between polyvinyl chloride pipe and fittings shall be installed in accordance with one of the following methods:

(1) Mechanical joints shall be designed to provide a permanent seal and shall be of the mechanical or push-on joint. The mechanical joint shall include a pipe spigot that has a wall thickness to withstand without deformation or collapse; the compressive force exerted where the fitting is tightened. The push-on joint shall have a minimum wall thickness of the bell at any point between the ring and the pipe barrel. The elastomeric gasket shall comply with ASTM D3139, and be of such size and shape as to provide a compressive force against the spigot and socket after assembly to provide a positive seal.

(2) Solvent cement joints for PVC pipe and fittings shall be clean from dirt and moisture. Pipe shall be cut square and pipe shall be deburred. Where surfaces to be joined are cleaned and free of dirt, moisture, oil, and other foreign material, apply primer purple in color in accordance with ASTM F656. Primer shall be applied until the surface of the pipe and fitting is softened. Solvent cements in accordance with ASTM D2564 shall be applied to all joint surfaces. Joints shall be made while both the inside socket surface and outside surface of pipe are wet with solvent cement. Hold joint in place and undisturbed for 1 minute after assembly.
(3) Threads shall comply with ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded; however, the pressure rating shall be reduced by 50 percent. The use of molded fittings shall not result in a 50 percent reduction in the pressure rating of the pipe provided that the molded fittings shall be fabricated so that the wall thickness of the material is maintained at the threads. Thread sealant compound that is compatible with the pipe and fitting, insoluble in water, and nontoxic shall be applied to male threads. Caution shall be used during assembly to prevent over-tightening of the PVC components once the thread sealant has been applied. Female PVC threaded fittings shall be used with plastic male threads only.

1211.13 Steel Pipe and Tubing. Joints between steel pipe or tubing and fittings shall be installed in accordance with one of the following methods:

(1) Mechanical joints shall be made with an approved and listed elastomeric gasket.

(2) Threaded joints shall be made with pipe threads that are in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

(3) Welded joints shall be made by electrical arc or oxygen/acetylene method. Joint surfaces shall be cleaned by an approved procedure. Joints shall be welded by an approved filler metal.

(4) Pressed joints shall have an elastomeric o-ring that forms the connection. The pipe or tubing shall be fully inserted into the fitting, and the pipe or tubing marked at the shoulder of the fittings. Pipe or tubing shall be cut square, chamfered, and reamed to full inside diameter. The fitting alignment shall be checked against the mark on the pipe or tubing to ensure the pipe or tubing is fully inserted into the fitting. The joint shall be pressed using the tool recommended by the manufacturer.

1211.14 Joints Between Various Materials. Joints between various materials shall be installed in accordance with the manufacturer’s installation instructions and shall comply with Section 1211.14.1 and Section 1211.14.2.

1211.14.1 Copper or Copper Alloy Pipe or Tubing to Threaded Pipe Joints. Joints from copper or copper alloy pipe or tubing to threaded pipe shall be made by the use of copper alloy adapter, copper alloy nipple [minimum 6 inches (152 mm)], dielectric fitting, or dielectric union in accordance with ASSE 1079. The joint between the copper or copper alloy pipe or tubing and the fitting shall be a soldered, brazed, flared, or pressed joint and the connection between the threaded pipe and the fitting shall be made with a standard pipe size threaded joint.

1211.14.2 Plastic Pipe to Other Materials. Where connecting plastic pipe to other types of plastic or other types of piping material; approved types of listed adapter or transition fittings designee for and listed for the specific transition intended shall be used. Except as provided in the plumbing code, PVC pipe and fittings shall not be solvent welded to any other unlike material.

1212.0 Valves.

1212.1 General. Valves shall be rated for the operating temperature and pressure of the system. Valves shall be compatible with the type of heat transfer medium and piping material.

1212.2 Where Required. Valves shall be installed in hydronic piping systems in accordance with Section 1212.3 through Section 1212.11.

1212.3 Heat Exchanger. Isolation valves shall be installed on the supply and return side of the heat exchanger.

1212.4 Pressure Vessels. Isolation valves shall be installed on connections to pressure vessels.

1212.5 Pressure Reducing Valves. Isolation valves shall be installed on both sides of a pressure reducing valve.

1212.6 Equipment, Components, and Appliances. Serviceable equipment, components, and appliances within the system shall have isolation valves installed upstream and downstream of such devices.

1212.7 Expansion Tank. Isolation valves shall be installed at connections to non-diaphragm-type expansion tanks.

1212.8 Flow Balancing Valves. Where flow balancing valves are installed, such valves shall be capable of increasing or decreasing the amount of flow by means of adjustment.

1212.9 Mixing or Temperature Control Valves. Where mixing or temperature control valves are installed, such valves shall be capable of obtaining the design water temperature and design flow requirements.

1212.10 Thermosiphoning. An approved type check valve shall be installed on liquid heat transfer piping to control thermosiphoning of heated liquids.

1212.11 Air Removal Device or Air Vents. Isolation valves shall be installed where air removal devices or automatic air vents are utilized to permit cleaning, inspection, or repair without shutting the system down.

1213.0 System Controls.

1213.1 Water Temperature Controls. A heat source or system of commonly connected heat sources shall be protected by a water-temperature-activated operating control to stop heat output of the heat source where the system water reaches a pre-set operating temperature.

1213.2 Operating Steam Controls. A steam heat source or system of commonly connected steam heat sources shall be protected by a pressure-actuated control to shut off the fuel supply where the system pressure reaches a pre-set operating pressure.

1213.2.1 Water-Level Controls. A primary water-level control shall be installed on a steam heat source to control the water level in the heat source. The control shall be installed in accordance with the manufacturer’s installation instructions.

1213.3 Occupied Spaces. A temperature-sensing device shall be installed in the occupied space to regulate the operation of the hydronic system.
1213.4 Simultaneous Operation. Radiant heating and cooling systems sharing a common space temperature control shall be configured to prevent simultaneous heating and cooling.

1213.5 Temperature Reading. A temperature gauge or transmitter shall be installed for reading the fluid temperatures in the panel system supply and heat source outlet. One temperature gauge or transmitter shall be permitted where the temperature between the heat source outlet and panel system supply are the same.

1214.0 Pressure and Flow Controls.
1214.1 Balancing. A means for balancing distribution loops, heat emitting devices, and multiple boiler installations shall be provided in accordance with the manufacturer’s instructions. A means for balancing and flow control shall include the piping design, pumping equipment, or balancing devices.

1214.2 Low-Water Control. Direct-fired heat sources within a closed heating system shall have a low-water fuel cut-off device, except as specified in Section 1214.3. Where a low-water control is integral with the heat source as part of the appliance’s integrated control and is listed for such use, a separate low-water control shall not be required. An external cut-off device shall be installed in accordance with the heat-source manufacturer’s installation instructions. No valve shall be located between the external low-water fuel cut-off and the heat-source unit. Where a pumped condensate return is installed, a second low-water cut-off shall be provided.

1214.3 Flow-Sensing Devices. A direct-fired heat source, requiring forced circulation to prevent overheating, shall have a flow-sensing device installed with the appliance, or such device shall be integral with the appliance. A low-water fuel cut-off device shall not be required.

1214.4 Automatic Makeup Fluid. Where an automatic makeup fluid supply fill device is used to maintain the fluid content of the heat-source unit, or any closed-loop in the system, the makeup supply shall be located at the expansion tank connection or other approved location. A pressure-reducing valve shall be installed on a makeup feed line. The pressure of the feed line shall be set in accordance with the design of the system, and connections to potable water shall be in accordance with Section 1202.0 to prevent contamination due to backflow.

1214.5 Differential Pressure Regulation. Provisions shall be made to bypass zone flows in excess of design velocity in a multi-zone hydronic system where the closing of some or all of the two-way zone valves causes excess flow through the open zones or deadheading of a fixed-speed circulator or pump.

1214.5.1 Differential Pressure Bypass Valve. Where a differential pressure bypass valve is used for the purpose specified in Section 1214.5, it shall be installed and adjusted to provide bypass of the distribution system when most or all of the zones are closed.

1214.6 Air-Removal Device. Provision shall be made for the removal of air from fluid in hydronic systems. Air-removal devices shall be located in the areas of the hydronic piping system where air is likely to accumulate. Air-removal devices shall be installed to facilitate their removal for examination, repair, or replacement.

1214.7 Air-Separation Device. To assist with the removal of entrained air, an air-separation device shall be installed in hydronic systems. The device shall be located in accordance with the manufacturer’s installation instructions or at the point of no mechanically-induced pressure change within the hydronic system.

1214.8 Secondary Loops. Secondary loops that are isolated from the primary heat-distribution loop by a heat exchanger are closed-loop hydronic systems and shall have an expansion tank in accordance with Section 1209.0, an air-removal device in accordance with Section 1214.6, and an air-separation device in accordance with Section 1214.7.

1215.0 Hydronic Space Heating.
1215.1 General. Based on the system design, the heat-distribution units shall be selected in accordance with the manufacturer’s specifications.

1215.2 Installation. Heat-distribution units shall be installed in accordance with the manufacturer’s installation instructions and this code.

1215.3 Balancing. System loops shall be installed so that the design flow rates are achieved within the system.

1215.4 Heat Transfer Fluid. The ignitable flash point of heat transfer fluid in a hydronic piping system shall be a minimum of 50°F (28°C) above the maximum system operating temperature. The heat transfer fluid shall be compatible with the makeup fluid supplied to the system.

1216.0 Steam Systems.
1216.1 Steam Traps. For other than one-pipe steam systems, each heat-distribution unit shall be supplied with a steam trap that is listed for the application.

1216.2 Sloping for Two-Pipe System. Two-pipe steam system piping and heat-distribution units shall be sloped down at not less than 1/8 inch per foot (10.4 mm/m) in the direction of the steam flow.

1216.3 Sloping for One-Pipe System. One-pipe steam system piping and heat-distribution units shall be sloped down at not less than 1/8 inch per foot (10.4 mm/m) towards the steam boiler, without trapping.

1216.4 Automatic Air Vents. Steam automatic air vents shall be installed to eliminate air pressure in heat-distribution units on gravity steam piping systems. Air vents shall not be used on a vacuum system.

1216.5 Condensate Flow. System piping shall be installed to allow condensate to flow to the condensate receiver or steam boiler either by gravity or pump-assisted.
1216.6 Steam-Distribution Piping. Where multi-row elements are installed in an enclosure, they shall be top fed and piped in parallel down to the steam trap. A single steam trap for each row of heating elements shall be installed. Where the size of the return header is increased by a minimum of one pipe size, a single steam trap shall be permitted to be installed for multiple rows. Where multiple steam unit heaters are installed, an individual steam trap for each unit shall be installed.

1217.0 Radiant Heating and Cooling. 1217.1 Installation. Radiant heating and cooling systems shall be installed in accordance with the system design.

1217.1.1 Manifolds. Manifolds shall be equipped with isolation valves on the supply and return lines. Manifolds shall be capable of withstanding the pressure and temperature of the system. The material of the manifold shall be compatible with the system fluid and shall be installed in accordance with the manufacturer’s installation instructions.

1217.2 Radiant Under-Floor Heating. Floor finished surface temperatures shall not exceed the following temperatures for space heating applications:

1. 85°F (29°C) in general occupied applications.
2. 90°F (32°C) in bathrooms, foyers, distribution areas such as hallways and indoor swimming pools.
3. 88°F (31°C) in industrial spaces.
4. 95°F (35°C) in radiant panel perimeter areas, i.e., up to 2.5 feet (762 mm) from outside walls.

The radiant heating system temperature shall not exceed the maximum temperature rating of the materials used in its construction.

1217.3 Radiant Cooling Systems. Radiant cooling systems shall be designed to minimize the potential for condensation. To prevent condensation on any cooled radiant surface, the supply water temperature for a radiant cooling system shall be not less than 3°F (2°C) above the anticipated space dewpoint temperature, or in accordance with the manufacturer’s recommendation.

1217.3.1 Minimum Floor Temperatures. The minimum floor surface temperature shall not be less than 66°F (19°C) in general occupied applications.

1217.4 Chilled Water Supply/Distribution Piping. Chilled water piping, valves, and fittings, and manifolds shall be insulated and vapor sealed to prevent surface condensation.

Exception: Piping, valves, fittings, and manifolds used to supply radiant cooling systems and where the water temperature is above the space dewpoint temperature shall not require insulation.

1217.5 Tube Placement. Hydronic radiant system tubing shall be installed in accordance with the manufacturer’s installation instructions and with the tube layout and spacing in accordance with the system design. Except for distribution mains, tube spacing and the individual loop lengths shall be installed with a variance of not more than ±10 percent from the design. The maximum loop length of continuous tubing from a supply-and-return manifold shall not exceed the lengths specified by the manufacturer or, in the absence of manufacturer’s specifications, the lengths specified in Table 1217.4 1217.5. Actual loop lengths shall be determined by spacing, flow rate, and pressure drop requirements as specified in the system design.

For the purpose of system balancing, each individual loop shall have a tag or label securely affixed to the manifold to indicate the length of the loop and the room(s) and area(s) served.

### Table 1217.4 1217.5

<table>
<thead>
<tr>
<th>Nominal Tube Size (inches)</th>
<th>Maximum Loop Length (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/32</td>
<td>125</td>
</tr>
<tr>
<td>1/8</td>
<td>200</td>
</tr>
<tr>
<td>5/32</td>
<td>250</td>
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<tr>
<td>1/4</td>
<td>300</td>
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<tr>
<td>3/32</td>
<td>400</td>
</tr>
<tr>
<td>1/2</td>
<td>500</td>
</tr>
<tr>
<td>3/16</td>
<td>750</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

1217.5.1 1217.5.2 Poured Floor Structural Concrete Slab Systems (Thermal Mass). Where tubing is embedded in a structural concrete slab such tubes shall not be larger in outside dimension than one-third of the overall thickness of the slab and shall be spaced not less than three diameters on center except within 10 feet (3048 mm) of the distribution manifold. The top of the tubing shall be embedded in the slab not less than 2 inches (51 mm) below the surface.

1217.5.3 1217.6.1 Slab Penetration Tube and Joint Protection. Where embedded in or installed under a concrete slab, tubing shall be protected from damage at penetrations of the slab with protective sleeving approved by the tubing manufacturer. The space between the tubing and sleeve shall be sealed with an approved sealant compatible with the tubing. The tubing at the location of an expansion joint in a concrete slab shall be encased in protective pipe sleeving that covers the tubing not less than 12 inches (305 mm) on either side of the expansion joint or the tubing shall be installed below the slab.

1217.6 Insulation. Where a poured concrete radiant floor system is installed in contact with the soil, insulation recommended by the manufacturer for such an application and with a minimum R-value of 5 shall be placed between the soil and the concrete; extend to the outside edges of the concrete; and be placed on all slab edges.

1217.6.2 1217.6.3 Types of Tube Fasteners. Tubing that is embedded within concrete shall be fastened according to manufacturer’s instructions. Unless prohibited by the manufacturer, tube fasteners include the following:
(1) Ties made of wire, typically fastened to anchors such as rebar or wire mesh.
(2) Plastic tube/cable ties, typically nylon, fastened to anchors such as rebar or wire mesh.
(3) Staples made of metal or plastic or combination thereof, without sharp edges that would harm tube, fastened to insulation or subfloor.
(4) Plastic rails with integrated tube holders intended for the specific type of tube.
(5) Insulation sheets with integrated knobs for holding the specific type of tube and intended for this application.
(6) Other fasteners recommended by the manufacturer.

1217.5.4 1217.6.4 Spacing of Tube Fasteners. The maximum spacing between tube fasteners within a concrete floor shall not exceed the spacing specified by the manufacturer or, in the absence of manufacturer’s specifications, 2.5 feet (762 mm).

1217.6.1 1217.7 Joist Systems and Subfloors. Where tubing is installed below a subfloor, the tube spacing shall be in accordance with the system design and joist space limitations.

Where tubing is installed above or in the subfloor, the tube spacing shall not exceed 12 inches (305 mm) center-to-center for living areas.

Where tubing is installed in the joist cavity, the cavity shall be insulated with not less than R-12 material below the heated space.

An air space of not less than 1 inch (25.4 mm) and not more than 3 inches (76 mm) shall be maintained between the top of the insulation and the underside of the floor unless a conductive plate is installed in accordance with manufacturer’s instructions.

Where tubing is installed in panels above or in the subfloor and not embedded in concrete, the floor assembly shall be insulated with not less than R-5 material below the tubing when installed over habitable space.

1217.6.4 1217.7.1 Tubing Fasteners. Tubing that is installed within joist spaces and subfloor panel systems shall be fastened according to manufacturer’s instructions. Unless prohibited by the manufacturer, tubing fasteners shall include the following:

(1) Heat transfer panel systems made of wood, aluminum or other thermally conductive materials intended for this application and the specific type of tube.
(2) Staples made of metal or plastic or combination thereof, without sharp edges that would harm tube, intended for this application and the specific type of tube fastened to subfloor.
(3) Plastic rails with integrated tube holders intended for the specific type of tube.
(4) Other fasteners recommended by the manufacturer.

1217.8 Wall and Ceiling Panels. Where piping is installed in the stud wall cavity or the ceiling joist cavity, the cavity shall be insulated with not less than R-12 material. The insulation shall be installed in such a manner as to prevent heating or cooling loss from the space intended to be controlled.

An air space of not less than 1 inch (25.4 mm) and not more than 3 inches (76 mm) shall be maintained between the insulation and the interior surface of the panel unless a conductive plate is installed.

1217.8 1217.9 Radiant Heating and Cooling Panels. Radiant heating and cooling panels shall be installed in accordance with the manufacturer’s installation instructions.

1217.8.4 1217.9.1 Electric Heating Panel Systems. Clearances for electric heating panels or between outlets, junction boxes, mounting luminaries, ventilating, or other openings shall comply with NFPA 70.

1217.8.2 1217.9.2 Radiant Wall and Ceiling Panels. Radiant panels attached to wood, steel, masonry, or concrete framing members shall be fastened by means of anchors, bolts, or approved screws of sufficient size and anchorage to support the loads applied. Panels shall be installed with corrosion-resistant fasteners. Piping systems shall be designed for thermal expansion to prevent the load being transmitted to the panel.

1218.0 Heat Exchangers.

1218.1 General. Systems utilizing heat exchangers shall protect the potable water system from being contaminated by the heat transfer medium. Systems that incorporate a single-wall heat exchanger to separate potable water from the heattransfer fluid shall meet the following requirements:

(1) Heat transfer medium is either potable water or contains fluids recognized as safe by the Food and Drug Administration (FDA) as food grade.
(2) A tag or label shall be securely affixed to the heat source with the word, “CAUTION” and the following statements:
   (a) The heat transfer medium shall be water or other nontoxic fluid recognized as safe by the FDA.
   (b) The maximum operating pressure of the heat exchanger shall not exceed the maximum operating pressure of the potable water supply.
(3) The word “CAUTION” and the statements listed above shall have an uppercase height of not less than 0.120 of an inch (3.048 mm). The vertical spacing between lines of type shall be not less than 0.046 of an inch (1.168 mm). Lowercase letters shall be not less than compatible with the uppercase letter size specification.

Systems that do not comply with the requirements for a single-wall heat exchanger shall install a double wall heat exchanger. Double-wall heat exchangers shall separate the potable water from the heat transfer medium by providing a space between the two walls that are vented to the atmosphere.

1219.0 Indirect-Fired Domestic Hot-Water Storage Tanks.

1219.1 General. Domestic hot-water heat exchangers, whether internal or external to the heating appliance, shall be permitted to be used to heat water in domestic hot-water stor-
1220.0 Snow and Ice Melt Systems.

1220.1 Use of Chemical Additives and Corrosive Fluids. Where auxiliary systems contain chemical additives, corrosive fluids, or both not intended or designed for use in the primary system, a double wall heat exchanger shall be used in accordance with Section 1218.1. The chemical additives in the auxiliary systems shall be compatible with auxiliary system components and accepted for use by the heat exchanger manufacturer.

1220.2 Types of Tube Fasteners. Tubing that is embedded within concrete shall be fastened according to manufacturer’s instructions. Unless prohibited by the manufacturer, tube fasteners include the following:

1. Ties made of wire, typically fastened to anchors such as rebar or wire mesh.
2. Plastic tube/cable ties, typically nylon, fastened to anchors such as rebar or wire mesh.
3. Staples made of metal or plastic or combination thereof, without sharp edges that would harm tube, fastened to insulation or subfloor.
4. Plastic rails with integrated tube holders intended for the specific type of tube.
5. Insulation sheets with integrated knobs for holding the specific type of tube and intended for this application.
6. Other fasteners recommended by the manufacturer.

1220.3 Spacing of Tube Fasteners. The maximum spacing between tube fasteners within a concrete area shall not exceed the spacing specified by the manufacturer or, in the absence of manufacturer’s specifications, 2.5 feet (762 mm).

1220.4 Snow and Ice Melt Controls. An automatic thermostatically operating control device that controls the supply hydronic solution temperature to the snow and ice melt area shall be installed in the system. Snow and ice melt systems shall be protected from freezing with a mixture of propylene glycol or ethylene glycol, and water or other approved fluid. Automotive antifreeze shall not be used.

1220.4.1 Tube Placement. Snow and ice melt tubing shall be installed in accordance with the manufacturer’s installation instructions and with the tube layout and spacing in accordance with the system design. Except for distribution mains, tube spacing and the individual loop lengths shall be installed with a variance of not more than ±10 percent from the design.

The maximum loop length of continuous tubing from a supply-and-return manifold arrangement shall not exceed the lengths specified by the manufacturer or, in the absence of manufacturer’s specifications, the lengths specified in Table 1220.4.1. Actual loop lengths shall be determined by spacing, flow rate, and pressure drop in accordance with the system design.

### Table 1220.4.1

<table>
<thead>
<tr>
<th>NOMINAL TUBE SIZE</th>
<th>MAXIMUM ACTIVE LOOP LENGTH (feet)</th>
<th>TOTAL LOOP LENGTH (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper Tubing³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>3/8</td>
<td>280</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. The total PE-RT and PEX loop lengths consist of two separate sections, the active loop, and the leader length. The active loop is installed within the heated slab. The leader length is the total distance to and from the manifold and heated slab, including any vertical distances.
2. The manifolds shall be installed as close to the snow melt area as possible.
3. In concrete use minimum Type L copper water tubing. In bituminous pavement use a Type K copper water tubing.

1220.4.2 Poured Structural Concrete Slab Systems. Where tubes are embedded in a structural concrete slab, such tubes shall not be larger in outside dimension than one-third of the overall thickness of the slab and shall be spaced not less than three diameters on center except within 10 feet (3048 mm) of the distribution manifold. The top of the tubing shall be embedded in the slab not less than 2 inches (51 mm) below the surface of the finished concrete slab.

1220.4.3 Slab Penetration Tube and Joint Protection. Where embedded in or installed under a concrete slab, tubing shall be protected from damage at penetrations of the slab with protective slewing approved by the tubing manufacturer. The space between the tubing and sleeve shall be sealed with an approved sealant compatible with the tubing. The tubing at the location of an expansion joint in a concrete slab shall be encased in a protective pipe sleeve that covers the tubing not less than 12 inches (305 mm) on either side of the joint or the tubing shall be installed below the slab.

1220.4.4 Concrete Slab Preparation. A solid foundation shall be prepared before the tubing is installed. Compaction shall be used for slabs, sidewalks, and driveways.

1220.4.5 Insulation. Where a poured concrete snow melt system is installed in contact with the soil, insulation...
recommended by the manufacturer for such application and with a minimum R-value of 5 shall be placed between the concrete and the compacted grade; and be extended as close as practicable to the outside edges of the concrete.

1220.4.6 Testing and Flushing. Testing of snow and ice melt systems shall be in accordance with Section 1205.2 and flushing shall be in accordance with Section 1205.3.

1220.5 Hydronic Makeup Air Units. Hydronic makeup air units that are affected by freezing shall be protected against freezing by a hydronic solution.

1221.0 Piping Installation.

1221.1 General. Piping, fittings, and connections shall be installed in accordance with the conditions of their approval and manufacturer’s installation instructions.

1221.2 Embedded Piping Materials and Joints. Piping embedded in concrete shall be steel pipe, Type L copper tubing or plastic pipe or tubing rated at not less than 80 psi at 180°F (552 kPa at 82°C). Joints of pipe or tubing that are embedded in a portion of the building, such as concrete or plaster shall be installed in accordance with the requirements of Section 1221.2.1 through Section 1221.2.3.

1221.2.1 Steel Pipe. Steel pipe shall be welded by electrical arc or oxygen/acetylene method.

1221.2.2 Copper Tubing. Copper tubing shall be joined by brazing with filler metals having a melting point not less than 1000°F (538°C).

1221.2.3 Plastics. Plastic pipe and tubing shall be installed in continuous lengths or shall be joined by heat fusion methods or other approved fittings in accordance with Table 1210.1 and the manufacturer’s installation instructions. Exception: Solvent cement joints shall not be used in embedded applications.

1221.3 Pressure Testing. Piping to be embedded in concrete shall be pressure-tested in accordance with Section 1205.2 prior to pouring concrete. During the pour, the pipe system shall maintain the test pressure of not less than one and one-half times the hydronic system operating pressure and not less than 100 psi (689 kPa). During freezing or the possibility of freezing conditions, testing shall be done with air where permitted by the manufacturer.

1221.4 System Drainage. Hydronic piping systems shall be installed to permit the system to be drained. The system shall drain by indirect waste in accordance with Section 1001.4. Embedded piping underground or under floors is not required to be designed for draining the system.

1221.5 Condensate Drainage. Condensate drains from dehumidifying coils shall be constructed and sloped for condensate removal. Such drains shall be installed in accordance with Section 310.0.

1221.6 Clearance to Combustibles. Hydronic piping where the exterior temperature exceeds 250°F (121°C) shall have a clearance of not less 1 inch (25.4 mm) to combustible materials.
CHAPTER 13
FUEL GAS PIPING

1301.0 Scope of Gas Piping.

1301.1 Applicability. The regulations of this chapter shall govern the installation of fuel gas piping in or in connection with a building, structure or within the property lines of premises up to 5 pounds-force per square inch (psi) (34 kPa) for natural gas and 10 psi (69 kPa) for undiluted propane, other than service pipe. Fuel oil piping systems shall be installed in accordance with NFPA 31.

1302.0 Coverage of Piping System.

1302.1 General. Coverage of piping systems shall extend from the point of delivery to the appliance connections. For other than undiluted liquefied petroleum gas (LP-Gas) systems, the point of delivery shall be the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where no meter is provided. For undiluted LP-Gas systems, the point of delivery shall be considered to be the outlet of the final pressure regulator, exclusive of line gas regulators where no meter is installed. Where a meter is installed, the point of delivery shall be the outlet of the meter. [NFPA 54:1.1.1.1(A)]

1302.2 Piping System Requirements. Requirements for piping systems shall include design, materials, components, fabrication, assembly, installation, testing, inspection, operation, and maintenance. [NFPA 54:1.1.1.1(E)]

1302.3 Applications. This code chapter shall not apply to the following items:

1. Portable LP-Gas appliances and equipment of all types that are not connected to a fixed fuel piping system.
2. Installation of appliances such as brooders, dehydrators, dryers, and irrigation equipment used for agricultural purposes.
3. Raw material (feedstock) applications except for piping to special atmosphere generators.
4. Oxygen-fuel gas cutting and welding systems.
5. Industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen, and nitrogen.
6. Petroleum refineries, pipeline compressor or pumping stations, loading terminals, compounding plants, refinery tank farms, and natural gas processing plants.
7. Large integrated chemical plants or portions of such plants where flammable or combustible liquids or gases are produced by chemical reactions or used in chemical reactions.
8. LP-Gas installations at utility gas plants.
10. Fuel gas piping in electric utility power plants.
11. Proprietary items of equipment, apparatus, or instruments such as gas-generating sets, compressors, and calorimeters.

12. LP-Gas equipment for vaporization, gas mixing, and gas manufacturing.
13. LP-Gas piping for buildings under construction or renovations that is not to become part of the permanent building piping system—that is, temporary fixed piping for building heat.
15. Installation of LP-Gas and compressed natural gas (CNG) systems on vehicles.
16. Gas piping, meters, gas pressure regulators, and other appurtenances used by the serving gas supplier in distribution of gas, other than undiluted LP-Gas.
17. Building design and construction, except as specified herein.
18. Fuel gas systems on recreational vehicles manufactured in accordance with NFPA 1192.
20. Construction of appliances. [NFPA 54:1.1.1.2]

1303.0 Inspection.

1303.1 Inspection Notification. Upon completion of the installation, alteration, or repair of gas piping, and prior to the use thereof, the Authority Having Jurisdiction shall be notified that such gas piping is ready for inspection.

1303.2 Excavation. Excavations required for the installation of underground piping shall be kept open until such time as the piping has been inspected and approved. Where such piping is covered or concealed before such approval, it shall be exposed upon the direction of the Authority Having Jurisdiction.

1303.3 Type of Inspections. The Authority Having Jurisdiction shall make the following inspections and either shall approve that portion of the work as completed or shall notify the permit holder wherein the same fails to be in accordance with this code.

1303.3.1 Rough Piping Inspection. This inspection shall be made after gas piping authorized by the permit has been installed before such piping has been covered or concealed, or before fixture or appliance has been attached thereto. This inspection shall include a determination that the gas piping size, material, and installation meet the requirements of this code.

1303.3.2 Final Piping Inspection. This inspection shall be made after piping authorized by the permit has been installed and after portions thereof that are to be covered or concealed are so concealed and before fixture, appliance, or shutoff valve has been attached thereto. This inspection shall comply with Section 1313.1. Test gauges used in conducting tests shall be in accordance with Section 1303.3.3 through Section 1303.3.3.4.
1303.3 Test Gauges. Tests required by this code, which are performed utilizing dial gauges, shall be limited to gauges having the following pressure graduations or increments.

1303.3.1 Pressure Tests (10 psi or less). Required pressure tests of 10 psi (69 kPa) or less shall be performed with gauges of 0.10 psi (0.69 kPa) increments or less.

1303.3.2 Pressure Tests (greater than 10 psi to 100 psi). Required pressure tests exceeding 10 psi (69 kPa) but less than or equal to 100 psi (689 kPa) shall be performed with gauges of 1 psi (7 kPa) increments or less.

1303.3.3 Pressure Tests (exceeding 100 psi). Required pressure tests exceeding 100 psi (689 kPa) shall be performed with gauges of 2 percent increments or less of the required test pressure.

1303.3.4 Pressure Range. Test gauges shall have a pressure range not exceeding twice the test pressure applied.

1303.4 Inspection Waived. In cases where the work authorized by the permit consists of a minor installation of additional piping to piping already connected to a gas meter, the foregoing inspections shall be permitted to be waived at the discretion of the Authority Having Jurisdiction. In this event, the Authority Having Jurisdiction shall make such inspection as deemed advisable in order to be assured that the work has been performed in accordance with the intent of this code.

1304.0 Certificate of Inspection.

1304.1 Issuance. Whereupon final piping inspection, the installation is found to be in accordance with the provisions of this code, a certificate of inspection shall be permitted to be issued by the Authority Having Jurisdiction.

1304.2 Gas Supplier. A copy of the certificate of such final piping inspection shall be issued to the serving gas supplier supplying gas to the premises.

1304.3 Unlawful. It shall be unlawful for a serving gas supplier or person furnishing gas, to turn on or cause to be turned on, fuel gas or a gas meter or meters until such certificate of final inspection, as herein provided, has been issued.

1305.0 Authority to Render Gas Service.

1305.1 Authorized Personnel. It shall be unlawful for a person, firm, or corporation, excepting an authorized agent or employee of a person, firm, or corporation engaged in the business of furnishing or supplying gas and whose service pipes supply or connect with the particular premises, to turn on or reconnect gas service in or on a premises where gas service is, at the time, not being rendered.

1305.2 Outlets. It shall be unlawful to turn on or connect gas in or on the premises unless outlets are securely connected to gas appliances or capped or plugged with screw joint fittings.

1306.0 Authority to Disconnect.

1306.1 Disconnection. The Authority Having Jurisdiction or the serving gas supplier is hereby authorized to disconnect gas piping or appliance or both that shall be found not to be in accordance with the requirements of this code or that are found defective and in such condition as to endanger life or property.

1306.2 Notice. Where such disconnection has been made, a notice shall be attached to such gas piping or appliance or both that shall state the same has been disconnected, together with the reasons thereof.

1306.3 Capped Outlets. It shall be unlawful to remove or disconnect gas piping or gas appliance without capping or plugging with a screw joint fitting, the outlet from which said pipe or appliance was removed. Outlets to which gas appliances are not connected shall be left capped and gastight on a piping system that has been installed, altered, or repaired.

Exception: Where an approved listed quick-disconnect device is used.

1307.0 Temporary Use of Gas.

1307.1 General. Where temporary use of gas is desired, and the Authority Having Jurisdiction deems the use necessary, a permit shall be issued for such use for a period of time not to exceed that designated by the Authority Having Jurisdiction, provided that such gas piping system otherwise is in accordance with the requirements of this code regarding material, sizing, and safety.

1308.0 Gas Piping System Design, Materials, and Components.

1308.1 Installation of Piping System. Where required by the Authority Having Jurisdiction, a piping sketch or plan shall be prepared before proceeding with the installation. The plan shall show the proposed location of piping, the size of different branches, the various load demands, and the location of the point of delivery. [NFPA 54:5.1.1]

1308.1.1 Addition to Existing System. When additional appliances are being connected to a gas piping system, the existing piping shall be checked to determine whether it has adequate capacity. If the capacity of the system is determined to be inadequate for the additional appliances, the existing system shall be enlarged as required, or separate gas piping of adequate capacity shall be provided. [NFPA 54:5.1.2]

1308.2 Provision for Location of Point of Delivery. The location of the point of delivery shall be acceptable to the serving gas supplier. [NFPA 54:5.2]

1308.3 Interconnections Between Gas Piping Systems Supplying Separate Users. Where two or more meters, or two or more service regulators where meters are not provided, are located on the same premises and supply separate users, the gas piping systems shall not be interconnected on the outlet side of the meters or service regulators. [NFPA 54:5.2.1]
1308.3.1 1308.3.2 Sizing of Gas Piping Systems. Gas piping systems shall be of such size and so installed as to provide a supply of gas sufficient to meet the maximum demand and supply gas to each appliance inlet at not less than the minimum supply pressure required by the appliance. [NFPA 54: A.5.3.3.1]

1308.4.1 1308.4.2 Sizing Methods. Gas piping shall be sized in accordance with one of the following:

1. Pipe sizing tables or sizing equations in this chapter.

2. Other approved engineering methods.

3. Sizing tables included in a listed piping system manufacturer’s installation instructions.

4. Engineering methods. [NFPA 54: A.5.3.3.3]

1308.4.3 Allowable Pressure Drop. The design pressure loss in any piping system under probable flow conditions, from the point of delivery to the inlet connection of the appliance, shall be such that the supply pressure at the inlet shall be greater than or equal to the minimum pressure required by the appliance. [NFPA 54: 5.3.4]

1308.5.1 1308.5.2 Acceptable Piping Materials and Joining Methods. Materials used for piping systems shall either comply with the requirements of this chapter Section 1308.4.1 through Section 1308.4.4.2.3 or be acceptable to the Authority Having Jurisdiction. [NFPA 54: 5.5.1.1]

1308.5.1.1 Other Materials. Material not covered by the standards specifications listed herein shall meet the following criteria:

1. Be investigated and tested to determine that it is safe and suitable for the proposed service.

2. Be recommended by the Authority Having Jurisdiction. [NFPA 54: A.5.6.1.3]

1308.6.1 Cast Iron. Cast-iron pipe shall not be used. [NFPA 54: A.5.6.2.1]

1308.6.2 Steel, Stainless Steel, and Wrought-Iron. Steel, stainless steel, and wrought-iron pipe shall be of Schedule 40 and shall comply with the dimensional standards of ASME B36.10M and one of the following:

### TABLE 1308.4.1 1308.4.2 APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES [NFPA 54: TABLE A.5.4.2.1 A.5.3.2.1]

<table>
<thead>
<tr>
<th>APPLIANCE</th>
<th>INPUT (Btu/h approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Heating Units</td>
<td></td>
</tr>
<tr>
<td>Warm air furnace</td>
<td>100 000</td>
</tr>
<tr>
<td>Single family</td>
<td>60 000</td>
</tr>
<tr>
<td>Multifamily, per unit</td>
<td>60 000</td>
</tr>
<tr>
<td>Hydronic boiler</td>
<td>100 000</td>
</tr>
<tr>
<td>Single family</td>
<td>60 000</td>
</tr>
<tr>
<td>Multifamily, per unit</td>
<td>60 000</td>
</tr>
<tr>
<td>Space and Water Heating Units</td>
<td></td>
</tr>
<tr>
<td>Hydronic boiler</td>
<td>120 000</td>
</tr>
<tr>
<td>Single family</td>
<td>75 000</td>
</tr>
<tr>
<td>Multifamily, per unit</td>
<td>75 000</td>
</tr>
<tr>
<td>Water Heating Appliances</td>
<td></td>
</tr>
<tr>
<td>Water heater, automatic storage</td>
<td>35 000</td>
</tr>
<tr>
<td>30 to 40 gallon tank</td>
<td>50 000</td>
</tr>
<tr>
<td>Water heater, automatic storage</td>
<td>142 800</td>
</tr>
<tr>
<td>50 gallon tank</td>
<td>285 000</td>
</tr>
<tr>
<td>Water heater, automatic instantaneous</td>
<td>428 400</td>
</tr>
<tr>
<td>Capacity at 2 gallons per minute</td>
<td>35 000</td>
</tr>
<tr>
<td>Capacity at 4 gallons per minute</td>
<td>50 000</td>
</tr>
<tr>
<td>Capacity at 6 gallons per minute</td>
<td>75 000</td>
</tr>
<tr>
<td>Water heater, domestic, circulating or side-arm</td>
<td>35 000</td>
</tr>
<tr>
<td>Cooking Appliances</td>
<td></td>
</tr>
<tr>
<td>Range, freestanding, domestic</td>
<td>65 000</td>
</tr>
<tr>
<td>Built-in oven or broiler unit, domestic</td>
<td>25 000</td>
</tr>
<tr>
<td>Built-in top unit, domestic</td>
<td>40 000</td>
</tr>
<tr>
<td>Other Appliances</td>
<td></td>
</tr>
<tr>
<td>Refrigerator</td>
<td>3000</td>
</tr>
<tr>
<td>Clothes dryer, Type 1 (domestic)</td>
<td>35 000</td>
</tr>
<tr>
<td>Gas fireplace direct vent</td>
<td>40 000</td>
</tr>
<tr>
<td>Gas log</td>
<td>80 000</td>
</tr>
<tr>
<td>Barbecue</td>
<td>40 000</td>
</tr>
<tr>
<td>Gaslight</td>
<td>2500</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

UNIFORM MECHANICAL CODE - PREPRINT 219
Copper and Copper Alloy Pipe. Copper and copper alloy pipe shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet (scf) of gas (0.7 mg/100 L). [NFPA 54:5.6.4.3(1) 5.5.3.3]

Threaded copper, copper alloy, or aluminum alloy pipe shall not be used with gases corrosive to such material. [NFPA 54:5.6.2.4 5.5.2.4]

Aluminum Alloy Pipe. Aluminum alloy pipe shall comply with ASTM B241 (except that the use of alloy 5456 is prohibited), and shall be marked at each end of each length indicating compliance. Aluminum alloy pipe shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergents, or sewage. [NFPA 54:5.6.2.5 5.5.2.5]

Aluminum alloy pipe shall not be used in exterior locations or underground. [NFPA 54:5.6.2.6 5.5.2.6]

Metallic Tubing. Tubing shall not be used with gases corrosive to the tubing material. [NFPA 54:5.6.2.7 5.5.3.1]

Steel Tubing. Steel tubing shall comply with ASTM A254. [NFPA 54:5.6.3.2 5.5.3.2]

Stainless Steel Tubing. Stainless steel tubing shall comply with one of the following:

1. ASTM A268
2. ASTM A269

Copper and Copper Alloy Tubing. Copper and copper alloy tubing shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 scf of gas (0.7 mg/100 L). Copper tubing shall comply with standard Type K or Type L of ASTM B88 or ASTM B280. [NFPA 54:5.5.3.4]

Aluminum Alloy Tubing. Aluminum alloy tubing shall comply with ASTM B210 or ASTM B241. Aluminum alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergent, or sewage. Aluminum alloy tubing shall not be used in exterior locations or underground. [NFPA 54:5.6.3.5 5.5.3.5]

Corrugated Stainless Steel Tubing. Corrugated stainless steel tubing shall be listed in accordance with CSA LC-1. [NFPA 54:5.6.3.6 5.5.3.6]
1308.5.6.2 1308.4.6.2 Number of Threads. Field threading of metallic pipe shall be in accordance with Table 1308.5.6.2. [NFPA 54:5.6.6.2 5.5.6.3]

TABLE 1308.5.6.2 1308.4.6.2 SPECIFICATIONS FOR THREADING METALLIC PIPE (NFPA 54: TABLE 5.6.6.2 5.5.6.3)

<table>
<thead>
<tr>
<th>IRON PIPE SIZE (inches)</th>
<th>APPROXIMATE LENGTH OF THREADED PORTION (inches)</th>
<th>APPROXIMATE NUMBER OF THREADS TO BE CUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>1/4</td>
<td>10</td>
</tr>
<tr>
<td>3/4</td>
<td>3/4</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>3/4</td>
<td>10</td>
</tr>
<tr>
<td>1 1/4</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>1 1/2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>2 1/2</td>
<td>1 1/2</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>1 1/2</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>1 1/4</td>
<td>13</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm

1308.5.6.3 1308.4.6.3 Thread Joint Compounds Sealing. Threaded joints shall be made using a thread joint sealing material. [NFPA 54:5.5.6.4.1] Thread joint sealing materials shall be compatible with the pipe and fitting material on which the compounds are used. [NFPA 54:5.5.6.4.2]

Thread joint compounds shall be resistant to the action of LP-Gas or to any other chemical constituents of the gases to be conducted through the piping. [NFPA 54:5.5.6.4.3]

1308.5.7 1308.4.7 Metallic Piping Joints and Fittings. The type of piping joint used shall be suitable for the pressure and temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, vibration, fatigue, or the weight of the pipe and its contents. [NFPA 54:5.5.7.1]

1308.5.7.1 1308.4.7.1 Pipe Joints. Schedule 40 and heavier pipe joints shall be threaded, flanged, brazed, welded, or assembled with press-connect fittings listed to CSA LC 4.

(1) Where nonferrous pipe is brazed, the brazing materials shall have a melting point in excess of 1000°F (538°C).

(2) Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.5.7.1]

1308.5.7.2 1308.4.7.2 Copper Tubing Joints. Copper tubing joints shall be assembled with approved gas tubing fittings, shall be brazed with a material having a melting point in excess of 1000°F (538°C), or shall be assembled with press-connect fittings listed to CSA LC 4. Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems. Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.5.7.2]

1308.5.7.3 1308.4.7.3 Stainless Steel Tubing Joints. Stainless steel joints shall be welded, assembled with approved tubing fittings, brazed with a material having a melting point in excess of 1000°F (538°C), or assembled with press-connect fittings listed to CSA LC 4. Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems. Brazing alloys and fluxes shall be recommended by the manufacturer for use on stainless steel alloys. [NFPA 54:5.5.7.3]

1308.5.7.4 1308.4.7.4 Flared Joints. Flared joints shall be used only in systems constructed from nonferrous pipe and tubing where experience or tests have demonstrated that the joint is suitable for the conditions and where provisions are made in the design to prevent separation of the joints. [NFPA 54:5.5.7.4]

1308.5.7.5 1308.4.7.5 Metallic Pipe Fittings. Metallic fittings shall comply with the following:

(1) Threaded fittings in sizes exceeding 4 inches (100 mm) shall not be used.

(2) Fittings used with steel, stainless steel, or wrought-iron pipe shall be steel, stainless steel, copper alloy, malleable iron, or cast-iron.

(3) Fittings used with copper or copper alloy pipe shall be copper or copper alloy.

(4) Fittings used with aluminum alloy pipe shall be aluminum alloy.

(5) Cast-iron fittings shall comply with the following:

(a) Flanges shall be permitted.

(b) Bushings shall not be used.

(c) Fittings shall not be used in systems containing flammable gas-air mixtures.

(d) Fittings in sizes 4 inches (100 mm) and larger shall not be used indoors unless approved by the Authority Having Jurisdiction.

(e) Fittings in sizes 6 inches (150 mm) and larger shall not be used unless approved by the Authority Having Jurisdiction.

(6) Aluminum alloy fitting threads shall not form the joint seal.

(7) Zinc-aluminum alloy fittings shall not be used in systems containing flammable gas-air mixtures.

(8) Special fittings such as couplings, proprietary-type joints, saddle tees, gland-type compression fittings, and flared, flareless, or compression-type tubing fittings shall be as follows:

(a) Used within the fitting manufacturer’s pressure-temperature recommendations.
(b) Used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion, or contraction.

(c) Acceptable to the Authority Having Jurisdiction.

(9) When pipe fittings are drilled and tapped in the field, the operation shall be in accordance with the following:

(a) The operation shall be performed on systems having operating pressures of 5 psi (34 kPa) or less.

(b) The operation shall be performed by the gas supplier or their designated representative.

(c) The drilling and tapping operation shall be performed in accordance with written procedures prepared by the gas supplier.

(d) The fittings shall be located outdoors.

(e) The tapped fitting assembly shall be inspected and proven to be free of leaks. [NFPA 54:5.6.7.5 5.5.7.5]

1308.5.8 1308.4.8 Plastic Piping, Joints, and Fittings. Plastic pipe, tubing, and fittings shall be joined in accordance with the manufacturer’s instructions. Section 1308.5.8.4 through Section 1308.5.8.4 shall be observed when making such joints. [NFPA 54:5.6.8(1) 5.5.8]

1308.5.8.1 1308.4.8.1 Joint Design. The joint shall be designed and installed so that the longitudinal pullout resistance of the joint will be at least equal to the tensile strength of the plastic piping material. [NFPA 54:5.6.8(1) 5.5.8(1)]

1308.5.8.2 1308.4.8.2 Heat Fusion Joint. Heat fusion joints shall be made in accordance with qualified procedures that have been established and proven by test to produce gastight joints at least as strong as the pipe or tubing being joined. Joints shall be made with the joining method recommended by the pipe manufacturer. Heat Polyethylene heat fusion fittings shall be marked “ASTM D2513.” Polyamide heat fusion fittings shall be marked "ASTM F2945." [NFPA 54:5.6.8(2) 5.5.8(2)]

1308.5.8.3 1308.4.8.3 Compression-Type Mechanical Joints. Where compression-type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting. The stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. Split tubular stiffeners shall not be used. [NFPA 54:5.6.8(2) 5.5.8(3)]

1308.5.8.4 1308.4.8.4 Liquefied Petroleum Gas Piping Systems. Plastic piping joints and fittings for use in LP-Gas piping systems shall be in accordance with NFPA 58. [NFPA 54:5.6.8(4) 5.5.8(4)]

1308.5.9 1308.4.9 Flange Specifications. Cast iron flanges shall be in accordance with ASME B16.1. [NFPA 54:5.6.9(1)] 5.5.9.1.1

1308.5.9.1 1308.4.9.1 Steel Flanges. Steel flanges shall be in accordance with the following:

1. ASME B16.5 or
2. ASME B16.47. [NFPA 54:5.6.10.1.2 5.5.9.1.2]

1308.5.9.2 1308.4.9.2 Non-Ferrous Flanges. Non-ferrous flanges shall be in accordance with ASME B16.24. [NFPA 54:5.6.9.1.3 5.5.9.1.3]

1308.5.9.3 1308.4.9.3 Ductile Iron Flanges. Ductile iron flanges shall be in accordance with ASME B16.42. [NFPA 54:5.6.9.1.4 5.5.9.1.4]

1308.5.9.4 1308.4.9.4 Dissimilar Flange Connections. Raised-face flanges shall not be joined to flat-faced cast iron, ductile iron or nonferrous material flanges. [NFPA 54:5.6.9.2 5.5.9.2]

1308.5.9.5 1308.4.9.5 Flange Facings. Standard facings shall be permitted for use under this code. Where 150 psi (1034 kPa) steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed. [NFPA 54:5.6.9.3 5.5.9.3]

1308.5.9.6 1308.4.9.6 Lapped Flanges. Lapped flanges shall be used only aboveground or in exposed locations accessible for inspection. [NFPA 54:5.6.9.4 5.5.9.4]

1308.5.10 1308.4.10 Flange Gaskets. The material for gaskets shall be capable of withstanding the design temperature and pressure of the piping system and the chemical constituents of the gas being conducted without change to its chemical and physical properties. The effects of fire exposure to the joint shall be considered in choosing the material. [NFPA 54:5.6.10 5.5.10]

1308.5.10.1 1308.4.10.1 Flange Gasket Materials. Acceptable materials shall include the following:

(a1) Metal (plain or corrugated)

(b2) Composition

(c3) Aluminum “O” rings

(d4) Spiral-wound metal gaskets

(e5) Rubber-faced phenolic

(f6) Elastomeric [NFPA 54:5.6.10.1 5.5.10.1]

1308.5.10.2 1308.4.10.2 Metallic Flange Gaskets. Metallic flange gaskets shall be in accordance with ASME B16.20. [NFPA 54:5.6.10.2.4 5.5.10.2.1]
1308.5 Non-Metallic Flange Gaskets. Non-metallic flange gaskets shall be in accordance with ASME B16.21. [NFPA 54:5.6.10.2.2 5.5.10.2.2]

1308.5.10.4 Full-Face Flange Gasket. Full-face flange gaskets shall be used with all non-steel flanges. [NFPA 54:5.6.10.3 5.5.10.3]

1308.5.10.5 Separated Flanges. When a flanged joint is separated, the gasket shall be replaced. [NFPA 54:5.6.10.4 5.5.10.4]

1308.6 Gas Meters. Gas meters shall be selected for the maximum expected pressure and permissible pressure drop. [NFPA 54:5.7.1 5.6.1]

1308.6.1 Location. Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement, or necessary maintenance. [NFPA 54:5.7.2.1 5.6.2.1]

1308.6.1.1 Subject to Protection from Damage. Gas meters shall not be placed where they will be subjected to damage, such as adjacent to a driveway, under a fire escape, in public passages, halls, or where they will be subject to excessive corrosion or vibration. [NFPA 54:5.7.2.2 5.6.2.2]

1308.6.1.2 Extreme Temperatures. Gas meters shall not be located where they will be subjected to extreme temperatures or sudden extreme changes in temperature or in areas where they are subjected to temperatures beyond those recommended by the manufacturer. [NFPA 54:5.7.2.3 5.6.2.3]

1308.6.2 Supports. Gas meters shall be supported or connected to rigid piping so as not to exert a strain on the meters. Where flexible connectors are used to connect a gas meter to downstream piping at mobile homes in mobile home parks, the meter shall be supported by a post or bracket placed in a firm footing or by other means providing equivalent support. [NFPA 54:5.7.3 5.6.3]

1308.6.3 Meter Protection. Meters shall be protected against overpressure, backpressure, and vacuum. [NFPA 54:5.7.4 5.6.4]

1308.6.4 Identification. Gas piping at multiple meter installations shall be marked by a metal tag or other permanent means designating the building or the part of the building being supplied and attached by the installing agency. [NFPA 54:5.7.5 5.6.5]

1308.7 Gas Pressure Regulators. A line pressure regulator shall be installed where the gas supply pressure exceeds the maximum allowable inlet pressure of the appliance served. [NFPA 54:5.8.1 5.7.1]

1308.7.1 Listing. Line pressure regulators shall be listed in accordance with CSA Z21.80 where the outlet pressure is set to 2 psi (14 kPa) or less. [NFPA 54:5.8.2 5.7.2]

1308.7.2 Location. The gas pressure regulator shall be accessible for servicing. [NFPA 54:5.8.3 5.7.3]

1308.7.3 Regulator Protection. Pressure regulators shall be protected against physical damage. [NFPA 54:5.8.4 5.7.4]

1308.7.4 Regulator Vents Venting of Line Pressure Regulators. Regulator vents shall be in accordance with Section 1308.14. Line pressure regulators shall comply with all of the following:

(1) An independent vent to the exterior of the building, sized in accordance with the regulator manufacturer’s instructions, shall be provided where the location of a regulator is such that a ruptured diaphragm will cause a hazard.

(a) Where more than one regulator is at a location, each regulator shall have a separate vent to the outdoors or, if approved by the Authority Having Jurisdiction, the vent lines shall be permitted to be manifolded in accordance with accepted engineering practices to minimize backpressure in the event of diaphragm failure.

(b) Materials for vent piping shall be in accordance with Section 1308.5 through Section 1308.5.10.5.

Exception: A regulator and vent limiting means combination listed as complying with CSA Z21.80 shall be permitted to be used without a vent to the outdoors.

(2) The vent shall be designed to prevent the entry of water, insects, or other foreign materials that could cause blockage.

(3) The regulator vent shall terminate at least 3 feet (914 mm) from a source of ignition.

(4) At locations where regulators might be submerged during floods, a special antiflood-type breather vent fitting shall be installed or the vent line shall be extended above the height of the expected flood waters.

(5) A regulator shall not be vented to the appliance flue or exhaust system. [NFPA 54:5.8.5.4 5.7.5]

1308.7.5 Venting of Gas Appliance Pressure Regulators. For venting of gas appliance pressure regulators, see Section 902.15. [NFPA 54:5.8.5.2]

1308.7.6 Bypass Piping. Valved and regulated bypasses shall be permitted to be placed around gas line pressure regulators where continuity of service is imperative. [NFPA 54:5.8.6]

1308.7.7 Identification. Line pressure regulators at multiple regulator installations shall be marked by a metal tag or other permanent means designating the building or the part of the building being supplied. [NFPA 54:5.8.7 5.7.6]
1308.8 1308.7 Overpressure Protection. Where the serving gas supplier delivers gas at a pressure greater than 2 psi for piping systems serving appliances designed to operate at a gas pressure of 14 inches water column or less, overpressure protection devices shall be installed. Piping systems serving equipment designed to operate at inlet pressures greater than 14 inches water column (3.5 kPa) shall be equipped with overpressure protection devices as required by the appliance manufacturer’s installation instructions. [NFPA 54:5.8.1]

1308.9 1308.8 Pressure Limitation Requirements. Where piping systems serving appliances designed to operate with a gas supply pressure of 14 inches water column (3.5 kPa) or less are required to be equipped with overpressure protection by Section 1308.8 1308.7, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance to 2 psi (14 kPa) or less upon a failure of the line pressure regulator. [NFPA 54:5.8.2.1]

1308.9.1 1308.8.1 Overpressure Protection Required. Where piping systems serving appliances designed to operate with a gas supply pressure greater than 14 inches water column (3.5 kPa) are required to be equipped with overpressure protection by Section 1308.8 1308.7, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance as required by the appliance manufacturer’s installation instructions. [NFPA 54:5.8.2.2]

1308.9.2 1308.8.2 Overpressure Protection Devices. Each overpressure protection device installed to meet the requirements of this section shall be capable of limiting the pressure to its connected appliance(s) as required by this section independently of any other pressure control equipment in the piping system. [NFPA 54:5.8.2.3]

1308.9.3 1308.8.3 Detection of Failure. Each gas piping system for which an overpressure protection device is required by this section shall be equipped with a pressure relief valve. Each overpressure protection device(s) is detectable. [NFPA 54:5.8.2.4]

1308.9.4 1308.8.4 Flow Capacity. If a pressure relief valve is used to meet the requirements of this section, it shall have a flow capacity such that the pressure in the protected system is maintained at or below the limits specified in Section 1308.9 1308.8 under the following conditions:

1. The line pressure regulator for which the relief valve is providing overpressure protection has failed wide open.

2. The gas pressure at the inlet of the line pressure regulator for which the relief valve is providing overpressure protection is not less than the regulator’s normal operating inlet pressure. [NFPA 54:5.8.2.5]

1308.10 1308.9 Overpressure Protection Devices. Overpressure protection devices shall be one of the following:

1. Pressure relief valve.


3. Series regulator installed upstream from the line regulator and set to continuously limit the pressure on the inlet of the line regulator to the maximum values specified by Section 1308.9 1308.8 or less.

4. Automatic shutoff device installed in series with the line pressure regulator and set to shut off when the pressure on the downstream piping system reaches the maximum values specified by Section 1308.8 1308.9 or less. This device shall be designed so that it will remain closed until manually reset. [NFPA 54:5.8.3.1]

1308.10.1 1308.9.1 Separate Devices. The devices in Section 1308.10 1308.9 shall be installed either as an integral part of the service or line pressure regulator or as separate units. Where separate overpressure protection devices are installed, they shall comply with Section 1308.10.2 1308.9.2 through Section 1308.10.7 1308.9.7. [NFPA 54:5.8.3.2]

1308.10.2 1308.9.2 Construction and Installation. All overpressure protection devices shall meet the following requirements:

1. Be constructed of materials so that the operation of the device is not impaired by corrosion of external parts by the atmosphere or of internal parts by the gas.

2. Be designed and installed so they can be operated to determine whether the valve is free. The devices shall also be designed and installed so they can be tested to determine the pressure at which they operate and be examined for leakage when in the closed position. [NFPA 54:5.8.4]

1308.10.3 1308.9.3 External Control Piping. External control piping shall be designed and installed so that damage to the control piping of one device does not render both the regulator and the overpressure protective device inoperative. [NFPA 54:5.8.5]

1308.10.4 1308.9.4 Setting. Each pressure limiting or pressure relieving device shall be set so that the gas pressure supplied to the connected appliance(s) does not exceed the limits specified in Section 1308.9 1308.8 and Section 1308.9.1 1308.8.1. [NFPA 54:5.8.6]

1308.10.5 1308.9.5 Unauthorized Operation. Where unauthorized operation of any shutoff valve could render a pressure relieving valve or pressure limiting device inoperative, one of the following shall be accomplished:

1. The valve shall be locked in the open position. Instruct authorized personnel in the importance of leaving the shutoff valve open and of being present while the shutoff valve is closed so that it can be locked in the open position before leaving the premises.
(2) Duplicate relief valves shall be installed, each having adequate capacity to protect the system, and arrange the isolating valves or three-way valve so that only one relief valve can be rendered inoperative at a time. [NFPA 54:5.9.7 5.8.7]

1308.10.6 1308.9.6 Discharge of Vents. The discharge stacks, vents, or outlet parts of all pressure relieving and pressure limiting devices shall be located so that gas is safely discharged to the outdoors. Discharge stacks or vents shall be designed to prevent the entry of water, insects, or other foreign material that could cause blockage. The discharge stack or vent line shall be at least the same size as the outlet of the pressure relieving device. [NFPA 54:5.9.8.1, 5.9.8.2 5.8.8.1 5.8.8.2]

1308.10.7 1308.9.7 Size of Fittings, Pipe, and Openings. The fittings, pipe, and openings located between the system to be protected and the pressure relieving device shall be sized to prevent hammering of the valve and to prevent impairment of relief capacity. [NFPA 54:5.9.9 5.8.9]

1308.11 1308.10 Backpressure Protection. Protective devices shall be installed as close to the equipment as practical where the design of equipment connected is such that air, oxygen, or standby gases could be forced into the gas supply system. Gas and air combustion mixers incorporating double diaphragm “zero” or “atmosphere” governors or regulators shall require no further protection unless connected directly to compressed air or oxygen at pressures of 5 psi (34 kPa) or more. [NFPA 54:5.10.1.1 5.10.1.2 5.9.1.1 5.9.1.2]

1308.11.1 1308.10.1 Protective Devices. Protective devices shall include but not be limited to the following:

(1) Check valves.

(2) Three-way valves (of the type that completely closes one side before starting to open the other side).

(3) Reverse flow indicators controlling positive shutoff valves.

(4) Normally closed air-actuated positive shutoff pressure regulators. [NFPA 54:5.10.2 5.9.2]

1308.12 1308.11 Low-Pressure Protection. A protective device shall be installed between the meter and the appliance or equipment if the operation of the appliance or equipment is such that it could produce a vacuum or a dangerous reduction in gas pressure at the meter. Such protective devices include, but are not limited to, mechanical, diaphragm-operated, or electrically operated low-pressure shutoff valves. [NFPA 54:5.11 5.10]

1308.13 1308.12 Shutoff Valves. Shutoff valves shall be approved and shall be selected giving consideration to pressure drop, service involved, emergency use, and reliability of operation in accordance with Table 1308.12. Shutoff valves of size 1 inch (25 mm) National Pipe Thread and smaller shall be listed and labeled. Where used outdoors, such use shall be in accordance with the manufacturer’s recommendation. [NFPA 54:5.12 5.11]

### Table 1308.12

<table>
<thead>
<tr>
<th>SHUTOFF VALVE APPLICATION</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appliance shutoff valve up to 1/2 psi</td>
<td>ANSI Z21.15/CSA 9.1</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.44</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32</td>
</tr>
<tr>
<td>Valve up to 1/2 psi</td>
<td>ANSI/ASME B16.44</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32</td>
</tr>
<tr>
<td>Valve up to 2 psi</td>
<td>ANSI/ASME B16.44 labeled 2 G</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.44 labeled 2 G or labeled 5 G</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33 marked 125 G</td>
</tr>
<tr>
<td>Valve up to 5 psi</td>
<td>ANSI/ASME B16.44 labeled 5 G</td>
</tr>
<tr>
<td></td>
<td>ANSI/ASME B16.33</td>
</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32</td>
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<tr>
<td></td>
<td>ANSI/ASME B16.44 marked 5 G</td>
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</tr>
<tr>
<td></td>
<td>ANSI LC 4/CSA 6.32</td>
</tr>
</tbody>
</table>

SI Units: 1 pound-force per square inch = 6.8947 kPa

1308.14 1308.13 Expansion and Flexibility. Piping systems shall be designed to prevent failure from thermal expansion or contraction. [NFPA 54:5.14.1 5.13.1]

1308.14.1 1308.13.1 Special Local Conditions. Where local conditions include earthquake, tornado, unstable ground, or flood hazards, special consideration shall be given to increased strength and flexibility of piping supports and connections. [NFPA 54:5.14.2 5.13.2]

1308.14.1 1308.13.1 Pressure Regulator and Pressure Control Venting. The venting of the atmospheric side of diaphragms in line pressure regulators, gas appliance regulators, and gas pressure limit controls shall be in accordance with all of the following:

(1) An independent vent pipe to the outdoors, sized in accordance with the device manufacturer’s instructions, shall be provided where the location of a device is such that a discharge of fuel gas will cause a hazard. For devices other than appliance regulators, vents are not required to be independent where the vents are connected to a common manifold designed in accordance with engineering methods to minimize backpressure in the event of diaphragm failure and such design is approved.

**Exceptions:**

(1) A regulator and vent limiting means combination listed as complying with ANSI Z21.80/CSA 6.22 shall not be required to be vented to the outdoors.
(2) A listed gas appliance regulator factory equipped with a vent limiting device is not required to be vented to the outdoors.

(2) Materials for vent piping shall be in accordance with Section 1308.4 through Section 1308.4.10.5.

(3) The vent terminus shall be designed to prevent the entry of water, insects, and other foreign matter that could cause blockage.

(4) Vent piping shall be installed to minimize static loads and bending moments placed on the regulators and gas pressure control devices.

(5) Vents shall terminate not less than 3 feet (914 mm) from a possible source of ignition.

(6) At locations where a vent termination could be submerged during floods or snow accumulations, an antiflood-type breather vent fitting shall be installed, or the vent terminal shall be located above the height of the expected floodwaters or snow.

(7) Vent piping from pressure regulators and gas pressure control devices shall not be connected to a common manifold that serves a bleed line from a diaphragm-type gas valve. [NFPA 54:5.14]

1309.0 Excess Flow Valve.

1309.1 General. Where automatic excess flow valves are installed, they shall be listed to CSA in accordance with ANSI Z21.93/CSA 6.30 and shall be sized and installed in accordance with the manufacturer’s instructions. [NFPA 54:5.13.5.12]

1310.0 Gas Piping Installation.

1310.1 Piping Underground. Underground gas piping shall be installed with sufficient clearance from any other underground structure to avoid contact therewith, to allow maintenance, and to protect against damage from proximity to other structures. In addition, underground plastic piping shall be installed with sufficient clearance or shall be insulated from any source of heat so as to prevent the heat from impairing the serviceability of the pipe. [NFPA 54:7.1.1.1, 7.1.1.2]

1310.1.1 Cover Requirements. Underground piping systems shall be installed with a minimum of 12 inches (305 mm) of cover. The minimum cover shall be increased to 18 inches (457 mm) if external damage to the pipe or tubing from external forces is likely to result. Where a minimum of 12 inches (305 mm) of cover cannot be provided, the piping shall be installed in conduit or bridge (shieded). [NFPA 54:7.1.2.1 – 7.1.2.1(B)]

1310.1.2 Trenches. The trench shall be graded so that the pipe has a firm, substantially continuous bearing on the bottom of the trench. [NFPA 54:7.1.2.2]

1310.1.2.1 Backfilling. Where flooding of the trench is done to consolidate the backfill, care shall be exercised to see that the pipe is not floated from its firm bearing on the trench bottom. [NFPA 54:7.1.2.3]

1310.1.3 Protection Against Corrosion. Steel pipe and steel tubing installed underground shall be installed in accordance with Section 1310.1.3.1 through Section 1310.1.3.9. [NFPA 54:7.1.3]

1310.1.3.1 Zinc Coating. Zinc coating (galvanizing) shall not be deemed adequate protection for underground gas piping. [NFPA 54:7.1.3.1]

1310.1.3.2 Underground Piping. Underground piping shall comply with one or more of the following unless approved technical justification is provided to demonstrate that protection is unnecessary:

1. The piping shall be made of corrosion-resistant material that is suitable for the environment in which it will be installed.

2. Pipe shall have a factory-applied, electrically insulating coating. Fittings and joints between sections of coated pipe shall be coated in accordance with the coating manufacturer’s instructions.

3. The piping shall have a cathodic protection system installed, and the system shall be maintained in accordance with Section 1310.1.3.3 or Section 1310.1.3.6. [NFPA 54:7.1.3.2]

1310.1.3.3 Cathodic Protection. Cathodic protection systems shall be monitored by testing and the results shall be documented. The test results shall demonstrate one of the following:

1. A pipe-to-soil voltage of –0.85 volts or more negative is produced, with reference to a saturated copper-copper sulfate half cell.

2. A pipe-to-soil voltage of –0.78 volts or more negative is produced, with reference to a saturated KCl calomel half cell.

3. A pipe-to-soil voltage of –0.80 volts or more negative is produced, with reference to a silver-silver chloride half cell.

4. Compliance with a method described in Appendix D of Title 49 of the Code of Federal Regulations, Part 192. [NFPA 54:7.1.3.3]

1310.1.3.4 Sacrificial Anodes. Sacrificial anodes shall be tested in accordance with the following:

1. Upon installation of the cathodic protection system, except where prohibited by climatic conditions, in which case the testing shall be performed not later than 180 days after the installation of the system.

2. 12 to 18 months after the initial test.

3. Upon successful verification testing in accordance with Section 1310.1.3.4(1) and Section 1310.1.3.4(2), periodic follow-up testing shall be performed at intervals not to exceed 36 months. [NFPA 54:7.1.3.4]

1310.1.3.5 System Failing Tests. Systems failing a test shall be repaired not more than 180 days after
the date of the failed testing. The testing schedule shall be restarted as required in Section 1310.1.3.4(1) and Section 1310.1.3.4(2), and the results shall comply with Section 1310.1.3.3. [NFPA 54:7.1.3.5]

1310.1.3.6 Impressed Current Cathodic Protection. Impressed current cathodic protection systems shall be inspected and tested in accordance with the following schedule:

1. The impressed current rectifier voltage output shall be checked at intervals not exceeding two months.
2. The pipe-to-soil voltage shall be tested at least annually. [NFPA 54:7.1.3.6]

1310.1.3.7 Documentation. Documentation of the results of the two most recent tests shall be retained. [NFPA 54:7.1.3.7]

1310.1.3.8 Dissimilar Metals. Where dissimilar metals are joined underground, an insulating coupling or fitting shall be used. [NFPA 54:7.1.3.8]

1310.1.3.9 Steel Risers. Steel risers, other than anodeless risers, connected to plastic piping shall be cathodically protected by means of a welded anode. [NFPA 54:7.1.3.9]

1310.1.4 Protection Against Freezing. Where the formation of hydrates or ice is known to occur, piping shall be protected against freezing. [NFPA 54:7.1.4]

1310.1.5 Piping Through Foundation Wall. Piping through a foundation wall shall comply with all of the following:

1. Underground piping, where installed through the outer foundation or basement wall of a building, shall be encased in a protective sleeve or protected by an approved device or method.
2. The space between the gas piping and the sleeve and between the sleeve and the wall shall be sealed to prevent entry of gas and water.
3. Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.1.5]

1310.1.6 Piping Underground Beneath Buildings. Where gas piping is installed underground beneath buildings, the piping shall be either of the following:

1. Encased in an approved conduit designed to withstand the imposed loads and installed in accordance with Section 1310.1.6.1 or Section 1310.1.6.2.
2. A piping/encasement system listed for installation beneath buildings. [NFPA 54:7.1.6]

1310.1.6.1 Conduit with One End Terminating Outdoors. The conduit shall extend into an accessible portion of the building and, at the point where the conduit terminates in the building, the space between the conduit and the gas piping shall be sealed to prevent the possible entrance of any gas leakage. Where the end sealing is of a type that retains the full pressure of the pipe, the conduit shall be designed for the same pressure as the pipe. The conduit shall extend at least 4 inches (102 mm) outside the building, be vented outdoors above finished ground level, and be installed so as to prevent the entrance of water and insects. [NFPA 54:7.1.6.1]

1310.1.6.2 Conduit with Both Ends Terminating Indoors. Where the conduit originates and terminates within the same building, the conduit shall originate and terminate in an accessible portion of the building and shall not be sealed. [NFPA 54:7.1.6.2]

1310.1.7 Connections of Plastic Piping. Plastic piping shall be installed outdoors, underground only.

Exceptions:

1. Plastic piping shall be permitted to terminate aboveground where an anodeless riser is used.
2. Plastic piping shall be permitted to terminate with a wall head adapter aboveground in buildings, including basements, where the plastic piping is inserted in a piping material permitted for use in buildings. [NFPA 54:7.1.7.1]

1310.1.7.1 Connections Between Metallic and Plastic Piping. Connections made between metallic and plastic piping shall be made with fittings conforming to one of the following:

1. ASTM D2513 Category I transition fittings
2. ASTM F1973
3. ASTM F2509 [NFPA 54:7.1.7.2]

1310.1.7.2 Tracer Wire. An electrically continuous corrosion-resistant tracer shall be buried with the plastic pipe to facilitate locating. The tracer shall be one of the following:

1. A product specifically designed for that purpose.
2. Insulated copper conductor not less than 14 AWG.

Where tracer wire is used, access shall be provided from aboveground or one end of the tracer wire or tape shall be brought aboveground at a building wall or riser. [NFPA 54:7.1.7.3.2]

1310.2 CSST Piping Systems. CSST piping systems shall be installed in accordance with this code and the manufacturer’s installation instructions. [NFPA 54:7.1.8]

1310.3 Installation of Aboveground Piping. Piping installed aboveground shall comply with all of the following:

1. Piping shall be securely supported and located where it will be protected from physical damage.
2. Where passing through an exterior wall, the piping shall also be protected from corrosion by coating or wrapping with an inert material approved for such applications.
3. The piping shall be sealed around its circumference at the point of the exterior penetration to prevent the entry of water, insects, and rodents.
Where piping is encased in a protective pipe sleeve, the annular spaces between the gas piping and the sleeve and between the sleeve and the wall opening shall be sealed.

Piping installed outdoors shall be elevated not less than 3½ inches (89 mm) above the ground.

Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.2.1]

1310.3.1 Protective Coating. Where piping is in contact with a material or an atmosphere corrosive to the piping system, the piping and fittings shall be coated with a corrosion-resistant material. Any such coating used on piping or components shall not be considered as adding strength to the system. [NFPA 54:7.2.2]

1310.3.2 Building Structure. The installation of gas piping shall not cause structural stresses within building components to exceed allowable design limits. Approval shall be obtained before any beams or joists are cut or notched. [NFPA 54:7.2.3.1 – 7.2.3.2]

1310.3.3 Gas Piping to be Sloped. Piping for other than dry gas conditions shall be sloped not less than ¼ inch in 15 feet (1.4 mm/m) to prevent traps. [NFPA 54:7.2.4]

1310.3.3.1 Ceiling Locations. Gas piping shall be permitted to be installed in accessible spaces between a fixed ceiling and a dropped ceiling, whether or not such spaces are used as a plenum. Valves shall not be located in such spaces.

Exception: Appliance or equipment shutoff valves required by this code shall be permitted to be installed in accessible spaces containing vented appliances.

1310.3.4 Prohibited Locations. Gas piping inside any building shall not be installed in or through a clothes chute, chimney or gas vent, dumbwaiter, elevator shaft, or air duct, other than combustion air ducts. [NFPA 54:7.2.5]

Exception: Ducts used to provide ventilation air in accordance with Section 701.0 or to above-ceiling spaces in accordance with Section 1310.3.3.1.

1310.3.5 Hangers, Supports, and Anchors. Piping shall be supported with metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers, or building structural components, suitable for the size of piping, of adequate strength and quality, and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected appliances and equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58 or IAPMO PS 95. [NFPA 54:7.2.6.1]

1310.3.5.1 Spacing. Spacing of supports in gas piping installations shall not be greater than shown in Table 1310.3.5.1. Spacing of supports of CSST shall be in accordance with the CSST manufacturer’s instructions. [NFPA 54:7.2.6.2]

### Table 1310.3.5.1 Support of Piping

<table>
<thead>
<tr>
<th>NOMINAL SIZE OF PIPE (inches)</th>
<th>SPACING OF SUPPORTS (feet)</th>
<th>SPACING OF TUBING SMOOTH WALL (inches O.D.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>6</td>
<td>1/2</td>
</tr>
<tr>
<td>¾ or 1</td>
<td>8</td>
<td>3/4 or ¾</td>
</tr>
<tr>
<td>1 1/2 or larger (horizontal)</td>
<td>10</td>
<td>1 1/2 or 1 (horizontal)</td>
</tr>
<tr>
<td>1 1/2 or larger (vertical)</td>
<td>Every floor</td>
<td>1 or larger (vertical)</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

1310.3.5.2 Expansion and Contraction. Supports, hangers, and anchors shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. All parts of the supporting system shall be designed and installed so they are not disengaged by movement of the supported piping. [NFPA 54:7.2.6.3]

1310.3.5.3 Piping on Roof-Tape Roofs. Gas piping installed on the roof surfaces shall be elevated above the roof surface and shall be supported in accordance with Table 1310.3.5.1. Gas piping shall be elevated not less than 3½ inches (89 mm) above the roof surface. [NFPA 54:7.2.6.4.1, 7.2.6.4.2]

1310.3.6 Removal of Piping. Where piping containing gas is to be removed, the line shall be first disconnected from sources of gas and then thoroughly purged with air, water, or inert gas before cutting or welding is done.

1310.4 Concealed Piping in Buildings. Gas piping in concealed locations shall be installed in accordance with this section. [NFPA 54:7.3.1]

1310.4.1 Connections. Where gas piping is to be concealed, connections shall be of the following type:

1. Pipe fittings, such as elbows, tees, couplings, and right/left nipple/couplings.
2. Joining tubing by brazing (see Section 1308.4.7.1).
4. CSST fittings listed to CSA LC 1.
5. Where necessary to insert fittings in gas pipe that has been installed in a concealed location, the pipe shall be reconnected by welding, flanges, or the use of a right/left nipple/coupling.

1310.4.2 Piping in Partitions. Concealed gas piping shall not be located in solid partitions. [NFPA 54:7.3.3]

1310.4.3 Tubing in Partitions. This provision shall not apply to tubing that pierces walls, floors, or partitions. Tubing installed vertically and horizontally inside hollow walls or partitions without protection along its entire concealed length shall meet the following requirements:

1. A steel striker barrier not less than 0.0508 of an inch (1.3 mm) thick, or equivalent, is installed between...
the tubing and the finished wall and extends at least 4 inches (102 mm) beyond concealed penetrations of plates, firestops, wall studs, and so on.

(2) The tubing is installed in single runs and is not rigidly secured. [NFPA 54:7.3.4.4]

1310.4.4 Piping in Floors Industrial Occupancies. In industrial occupancies, gas piping in solid floors such as concrete floor slabs constructed with Portland cement shall be surrounded with a minimum of 1 1/2 inches (38 mm) of concrete and shall not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. All piping, fittings, and risers shall be protected against corrosion in accordance with Section 1308.5.6. Piping shall not be embedded in concrete slabs containing quick-set additives or cinder aggregate. [NFPA 54:7.3.5.2]

1310.5 Piping in Vertical Chases. Where gas piping exceeding 5 psi (34 kPa) is located within vertical chases in accordance with Section 1310.6, the requirements of Section 1310.5.1 through Section 1310.5.3 shall apply. [NFPA 54:7.4]

1310.5.1 Pressure Reduction. Where pressure reduction is required in branch connections for compliance with Section 1310.6, such reduction shall take place either inside the chase or immediately adjacent to the outside wall of the chase. Regulator venting and downstream overpressure protection shall comply with Section 1308.4.1 through Section 1308.4.6. Piping shall not be embedded in concrete slabs containing quick-set additives or cinder aggregate. [NFPA 54:7.3.5.2]

1310.5.2 Chase Construction. Chase construction shall comply with local building codes with respect to fire resistance and protection of horizontal and vertical openings. [NFPA 54:7.4.2]

1310.5.3 Ventilation. A chase shall be ventilated to the outdoors and only at the top. The opening(s) shall have a minimum free area [in square inches (square meters)] equal to the product of one-half of the maximum pressure in the piping [in pounds per square inch (kilopascals)] times the largest nominal diameter of that piping [in inches (millimeters)], or the cross-sectional area of the chase, whichever is smaller. Where more than one fuel gas piping system is present, the free area for each system shall be calculated and the largest area used. [NFPA 54:7.4.3]

1310.6 Maximum Operating Pressure in Buildings. The maximum operating pressure for any piping systems located inside buildings shall not exceed 5 psi (34 kPa) unless one or more of the following conditions are met:

(1) The piping joints are welded or brazed.

(2) The piping is joined by fittings listed to ANSI LC 4/CSA 6.32 and installed according to the manufacturer’s installation instructions.

(3) The piping joints are flanged and all pipe-to-flange connections are made by welding or brazing.

(4) The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.

(5) The piping is located inside buildings or separate areas of buildings used exclusively for one of the following:

(a) Industrial processing or heating

(b) Research

(c) Warehousing

(d) Boiler or mechanical rooms

(6) The piping is a temporary installation for buildings under construction.

(7) The piping serves appliances or equipment used for agricultural purposes.

(8) The piping system is an LP-Gas piping system with an operating pressure greater than 20 psi (138 kPa) and complies with NFPA 58. [NFPA 54:5.4.4]

1310.6.1 LP-Gas Systems Operating Below -5°F (-21°C). LP-Gas systems designed to operate below -5°F (-21°C) or with butane or a propane-butane mix shall be designed to either accommodate liquid LP-Gas or to prevent LP-Gas vapor from condensing back into a liquid. [NFPA 54:5.4.5]

1310.7 Appliance Overpressure Protection. The maximum operating pressure for piping systems serving appliances designed to operate at 14 inches water column (3.5 kPa) inlet pressure or less shall be 2 pounds-force per square inch gauge (psig) (14 kPa) unless an over pressure protection device designed to limit pressure at the appliance to 2 psig (14 kPa) upon failure of the line gas pressure regulator is installed.

1310.8 Gas Pipe Turns. Changes in direction of gas pipe shall be made by the use of fittings, factory bends, or field bends. [NFPA 54:7.5]

1310.8.1 Metallic Pipe. Metallic pipe bends shall comply with the following:

(1) Bends shall be made only with bending tools and procedures intended for that purpose.

(2) All bends shall be smooth and free from buckling, cracks, or other evidence of mechanical damage.
(3) The longitudinal weld of the pipe shall be near the neutral axis of the bend.

(4) Pipe shall not be bent through an arc of more than 90 degrees.

(5) The inside radius of a bend shall be not less than 6 times the outside diameter of the pipe. [NFPA 54:7.5.1]

1310.8.2 Plastic Pipe. Plastic pipe bends shall comply with the following:

(1) The pipe shall not be damaged, and the internal diameter of the pipe shall not be effectively reduced.

(2) Joints shall not be located in pipe bends.

(3) The radius of the inner curve of such bends shall not be less than 25 times the inside diameter of the pipe.

(4) Where the piping manufacturer specifies the use of special bending tools or procedures, such tools or procedures shall be used. [NFPA 54:7.5.2]

1310.8.3 Elbows. Factory-made welding elbows or transverse segments cut therefrom shall have an arc length measured along the crotch of at least 1 inch (25 mm) for pipe sizes 2 inches (50 mm) and larger. [NFPA 54:7.5.3]

1310.9 Drips and Sediment Traps. For other than dry gas conditions, a drip shall be provided at any point in the line of pipe where condensate could collect. Where required by the Authority Having Jurisdiction or the serving gas supplier, a drip shall also be provided at the outlet of the meter. This drip shall be installed so as to constitute a trap wherein an accumulation of condensate shuts off the flow of gas before it runs back into the meter. [NFPA 54:7.6.1]

1310.9.1 Location of Drips. All drips shall be installed only in such locations that they are readily accessible to permit cleaning or emptying. A drip shall not be located where the condensate is likely to freeze. [NFPA 54:7.6.2]

1310.9.2 Sediment Traps. The installation of sediment traps shall be in accordance with Section 1312.9. [NFPA 54:7.6.3]

1310.10 Outlets. Outlets shall be located and installed in accordance with the following requirements:

(1) The outlet fittings or piping shall be securely fastened in place.

(2) Outlets shall not be located behind doors.

(3) Outlets shall be located far enough from floors, walls, patios, slabs, and ceilings to permit the use of wrenches without straining, bending, or damaging the piping.

(4) The unthreaded portion of gas piping outlets shall extend not less than 1 inch (25.4 mm) through finished ceilings or indoor or outdoor walls.

(5) The unthreaded portion of gas outlets shall extend not less than 2 inches (51 mm) above the surface of floors or outdoor patios or slabs.

(6) The provisions of Section 1310.10(4) and Section 1310.10(5) shall not apply to listed quick-disconnect devices of the flush-mounted type or listed gas convenience outlets. Such devices shall be installed in accordance with the manufacturer’s installation instructions. [NFPA 54:7.7.1.1 – 7.7.1.6]

1310.10.1 Cap Outlets. Each outlet, including a valve, shall be closed gastight with a threaded plug or cap immediately after installation and shall be left closed until the appliance or equipment is connected thereto. When an appliance or equipment is disconnected from an outlet and the outlet is not to be used again immediately, it shall be capped or plugged gastight.

Exceptions:

(1) Laboratory appliances installed in accordance with Section 1312.3.1 shall be permitted.

(2) The use of a listed quick-disconnect device with integral shutoff or listed gas convenience outlet shall be permitted. [NFPA 54:7.7.2.1]

1310.10.1.1 Appliance Shutoff Valves. Appliance shutoff valves installed in fireplaces shall be removed and the piping capped gastight where the fireplace is used for solid fuel burning. [NFPA 54:7.7.2.2]

1310.11 Manual Gas Shutoff Valves. An accessible gas shutoff valve shall be provided upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve shall not be required at the second regulator. [NFPA 54:7.8.4]

1310.11.1 Accessibility of Gas Valves Controlling Multiple Systems. Main gas System shutoff valves controlling several gas piping systems shall be readily accessible for operation and installed so as to be protected from physical damage. They System shutoff valves shall be marked with a metal tag or other permanent means attached by the installing agency so that the gas piping systems supplied through them can be readily identified. [NFPA 54:7.8.2.1, 7.8.2.2]

1310.11.1.1 Shutoff Valves for Multiple House Lines. In multiple-tenant buildings supplied through a master meter, through one service regulator where a meter is not provided, or where meters or service regulators are not readily accessible from the appliance or equipment location, an individual shutoff valve for each apartment or tenant line shall be provided at a convenient point of general accessibility. In a common system serving a number of individual buildings, shutoff valves shall be installed at each building. [NFPA 54:7.8.2.2, 7.8.3.1]

1310.11.2 Emergency Shutoff Valves. An exterior shutoff valve to permit turning off the gas supply to each building in an emergency shall be provided. The emergency shutoff valves shall be plainly marked as such and their locations posted as required by the Authority Having Jurisdiction. [NFPA 54:7.8.2.3, 7.8.3.2]

1310.11.3 Shutoff Valve for Laboratories. Each laboratory space containing two or more gas outlets installed on tables, benches, or in hoods in educational, research, commercial, and industrial occupancies shall have a sin-
1310.12 Prohibited Devices Obstruction of Flow. Devices shall not be placed within the interior of gas piping or fittings where such devices reduce the cross-sectional area or otherwise obstruct the free flow of gas, except where allowance in the piping system design has been made for such devices. [NFPA 54:7.9]

1310.13 Systems Containing Gas-Air Mixtures Outside the Flammable Range. Where gas-air mixing machines are employed to produce mixtures above or below the flammable range, they shall be provided with stops to prevent adjustment of the mixture to within or approaching the flammable range. [NFPA 54:7.10]


1310.14.1 Required Components. A central premix system with a flammable mixture in the blower or compressor shall consist of the following components:
1. Gas-mixing machine in the form of an automatic gas-air proportioning device combined with a downstream blower or compressor.
2. Flammable mixture piping, minimum Schedule 40.
3. Automatic firecheck(s).
4. Flowmeter(s) or backfire preventers for systems utilizing flammable mixture lines above 2 1⁄2 inches (64 mm) nominal pipe size or the equivalent. [NFPA 54:7.11.1]

1310.14.2 Optional Components. The following components shall also be permitted to be utilized in any type of central premix system:
1. Flowmeter(s)
2. Flame arrester(s) [NFPA 54:7.11.2]

1310.14.3 Additional Requirements. Gas-mixing machines shall have nonsparking blowers and shall be constructed so that a flashback does not rupture machine casings. [NFPA 54:7.11.3]

1310.14.4 Special Requirements for Mixing Blowers. A mixing blower system shall be limited to applications with minimum practical lengths of mixture piping, limited to a maximum mixture pressure of 10 inches water column (2.5 kPa) and limited to gases containing no more than 10 percent hydrogen. The blower shall be equipped with a gas control valve at its air entrance arranged so that gas is admitted to the airstream, entering the blower in proper proportions for correct combustion by the type of burners employed, the said gas control valve being of either the zero governor or mechanical ratio valve type that controls the gas and air adjustment simultaneously. No valves or other obstructions shall be installed between the blower discharge and the burner or burners. [NFPA 54:7.11.4]

1310.14.5 Installation of Gas-Mixing Machines. Installation of gas-mixing machines shall comply with the following:

1. Location. Gas-mixing machine shall be located in a well-ventilated area or in a detached building or cutoff room provided with room construction and explosion vents in accordance with sound engineering principles. Such rooms or below-grade installations shall have adequate positive ventilation. [NFPA 54:7.11.5.1]
2. Electrical Requirements. Where gas-mixing machines are installed in well-ventilated areas, the type of electrical equipment shall be in accordance with NFPA 70 for general service conditions unless other hazards in the area prevail. Where gas-mixing machines are installed in small detached buildings or cutoff rooms, the electrical equipment and wiring shall be installed in accordance with NFPA 70 for hazardous locations (Articles 500 and 501, Class I, Division 2). [NFPA 54:7.11.5.2]
3. Air Intakes. Air intakes for gas-mixing machines using compressors or blowers shall be taken from outdoors whenever practical. [NFPA 54:7.11.5.3]
4. Controls. Controls for gas-mixing machines shall include interlocks and a safety shut-off valve of the manual reset type in the gas supply connection to each machine arranged to automatically shut off the gas supply in the event of high or low gas pressure. Except for open burner installations only, the controls shall be interlocked so that the blower or compressor stops operating following a gas supply failure. Where a system employs pressurized air, means shall be provided to shut off the gas supply in the event of air failure. [NFPA 54:7.11.5.4]
5. Installation in Parallel. Centrifugal gas-mixing machines in parallel shall be reviewed by the user and equipment manufacturer before installation, and means or plans for minimizing the effects of downstream pulsation and equipment overload shall be prepared and utilized as needed. [NFPA 54:7.11.5.5]

1310.14.6 Use of Automatic Firechecks, Safety Blowouts, or Backfire Preventers. Automatic firechecks and safety blowouts or backfire preventers shall be provided in piping systems distributing flammable air-gas mixtures from gas-mixing machines to protect the piping and the machines in the event of flashback, in accordance with the following:
1. Approved automatic firechecks shall be installed upstream as close as practical to the burner inlets following the firecheck manufacturer’s instructions.
(2) A separate manually operated gas valve shall be provided at each automatic firecheck for shutting off the flow of the gas-air mixture through the firecheck after a flashback has occurred. The valve shall be located upstream as close as practical to the inlet of the automatic firecheck.

Caution: These valves shall not be reopened after a flashback has occurred until the firecheck has cooled sufficiently to prevent re-ignition of the flammable mixture and has been reset properly.

(3) A safety blowout or backfiring preventer shall be provided in the mixture line near the outlet of each gas-mixing machine where the size of the piping is larger than 2½ inches (65 mm) NPS, or equivalent, to protect the mixing equipment in the event of an explosion passing through an automatic firecheck. The manufacturers' instructions shall be followed when installing these devices, particularly after a disc has burst. The discharge from the safety blowout or backfire preventer shall be located or shielded so that particles from the ruptured disc cannot be directed toward personnel. Wherever there are interconnected installations of gas-mixing machines with safety blowouts or backfire preventers, provision shall be made to keep the mixture from other machines from reaching any ruptured disc opening. Check valves shall not be used for this purpose.

(4) Large-capacity premix systems provided with explosion heads (rupture discs) to relieve excessive pressure in pipelines shall be located at and vented to a safe outdoor location. Provisions shall be provided for automatically shutting off the supply of the gas-air mixture in the event of rupture. [NFPA 54:7.11.6]

1311.0 Electrical Bonding and Grounding.

1311.1 Pipe and Tubing Other than CSST. Each above-ground portion of a gas piping system, other than CSST, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than CSST, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance. [NFPA 54:7.12.1]

1311.2 Bonding of CSST Gas Piping. CSST gas piping systems, and gas piping systems containing one or more segments of CSST, shall be electrically continuous and bonded to the electrical service grounding electrode system or, where provided, lightning protection grounding electrode system. [NFPA 54:7.12.2]

1311.2.1 Bonding Jumper Connection. The bonding jumper shall connect to a metallic pipe, pipe fitting, or CSST fitting. [NFPA 54:7.12.2.1]

1311.2.2 Bonding Jumper Size. The bonding jumper shall not be smaller than 6 AWG copper wire or equivalent. [NFPA 54:7.12.2.2]

1311.2.3 Bonding Jumper Length. The length of the jumper between the connection to the gas piping system and the grounding electrode system shall not exceed 75 feet (22 860 mm). Any additional grounding electrodes installed to meet this requirement shall be bonded to the electrical service grounding electrode system or, where provided, lightning protection grounding electrode system. [NFPA 54:7.12.2.3]

1311.2.4 Bonding Connections. Bonding connections shall be in accordance with NFPA 70. [NFPA 54:7.12.2.4]

1311.2.5 Devices Used for Bonding. Devices used for the bonding connection shall be listed for the application in accordance with UL 467. [NFPA 54:7.12.2.5]

1311.3 Arc-Resistant Jacketed CSST. CSST listed with an arc-resistant jacket or coating system in accordance with CSA LC 1 shall be electrically continuous and bonded to an effective ground-fault current path. Where any CSST component of a piping system does not have an arc-resistant jacket or coating system, the bonding requirements of Section 1311.2 shall apply. Arc-resistant jacketed CSST shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance. [NFPA 54:7.12.3]

1311.4 Prohibited Use. Gas piping shall not be used as a grounding conductor or electrode. [NFPA 54:7.12.4.1]

1311.5 Lightning Protection System. Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780. [NFPA 54:7.12.5]

1311.6 Electrical Circuits. Electrical circuits shall not utilize gas piping or components as conductors. Exception: Low-voltage (50V or less) control circuits, ignition circuits, and electronic flame detection device circuits shall be permitted to make use of piping or components as a part of an electric circuit. [NFPA 54:7.13]

1311.7 Electrical Connections. All electrical connections between wiring and electrically operated control devices in a piping system shall conform to the requirements of NFPA 70. [NFPA 54:7.14.1]

1311.7.1 Safety Control. Any essential safety control depending on electric current as the operating medium shall be of a type that shuts off (fail safe) the flow of gas in the event of current failure. [NFPA 54:7.14.2]

1312.0 Appliance and Equipment Connections to Building Piping.

1312.1 Connecting Appliances and Equipment. Appliances and equipment shall be connected to the building piping in compliance with Section 1312.6 through Section 1312.8 by one of the following:

(1) Rigid metallic pipe and fittings.

(2) Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.

(3) A listed connector for gas appliances listed in compliance with CSA Z21.24ANSI Z21.24/CSA 6.27. The connector shall be used in accordance with the
manufacturer’s installation instructions and shall be in the same room as the appliance. Only one connector shall be used per appliance.

(4) A listed connector for outdoor gas appliances and manufactured homes listed in compliance with CSA-Z21.75, ANSI Z21.75/CSA 6.27. Only one connector shall be used per appliance.

(5) CSST where installed in accordance with the manufacturer’s installation instructions. CSST shall not be directly routed into a metallic appliance enclosure where the appliance is connected to a metallic vent that terminates above a roofline. CSST shall connect only to appliances that are fixed in place.

(6) Listed nonmetallic gas hose connectors in accordance with Section 1312.3.

(7) Unlisted gas hose connectors for use in laboratories and educational facilities in accordance with Section 1312.4. [NFPA 54:9.6.1]

1312.1.1 Commercial Cooking Appliances Food Service Appliance Connectors. Connectors used with commercial cooking food service appliances that are moved for cleaning and sanitation purposes shall be installed in accordance with the connector manufacturer’s installation instructions. Such connectors shall be listed in accordance with CSA Z21.69. [NFPA 54:9.6.1.3]

1312.1.2 Restraining Device. Movement of appliances with casters shall be by a restraining device installed in accordance with the connector and appliance manufacturer’s installation instructions. [NFPA 54:9.6.1.4]

1312.2 Suspended Low-Intensity Infrared Tube Heaters. Suspended low-intensity infrared tube heaters shall be connected to the building piping system with a connector listed for the application in accordance with CSA-Z21.24 ANSI Z21.24/CSA 6.27 as follows:

1. The connector shall be in accordance with the tube heater installation instructions, and shall be in the same room as the appliance.
2. Only one connector shall be used per appliance. [NFPA 54:9.6.1.5]

1312.3 Use of Nonmetallic Gas Hose Connectors. Listed gas hose connectors shall be used in accordance with the manufacturer’s installation instructions and in accordance with Section 1312.3.1 or Section 1312.3.2. [NFPA 54:9.6.2]

1312.3.1 Indoor. Indoor gas hose connectors shall be used only to connect laboratory, shop, and ironing appliances requiring mobility during operation and installed in accordance with the following:

1. An appliance shutoff valve shall be installed where the connector is attached to the building piping.
2. The connector shall be of minimum length and shall not exceed 6 feet (1829 mm).
3. The connector shall not be concealed and shall not extend from one room to another or pass through wall partitions, ceilings, or floors. [NFPA 54:9.6.2(1)]

1312.3.2 Outdoor. Where outdoor gas hose connectors are used to connect portable outdoor appliances, the connector shall be listed in accordance with CSA Z21.54 and installed in accordance with the following:

1. An appliance shutoff valve, a listed quick-disconnect device, or a listed gas convenience outlet shall be installed where the connector is attached to the building piping and in such a manner as to prevent the accumulation of water or foreign matter.
2. This connection shall be made only in the outdoor area where the appliance is to be used. [NFPA 54:9.6.2(2)]
3. The connector length shall not exceed 15 feet (4572 mm).

1312.4 Injection (Bunsen) Burners. Injection (Bunsen) burners used in laboratories and educational facilities shall be permitted to be connected to the gas supply by an unlisted hose. [NFPA 54:9.6.3]

1312.5 Connection of Portable and Mobile Industrial Appliances. Where portable industrial appliances or appliances requiring mobility or subject to vibration are connected to the building gas piping system by the use of a flexible hose, the hose shall be suitable and safe for the conditions under which it can be used. [NFPA 54:9.6.4.1]

1312.5.1 Swivel Joints or Couplings. Where industrial appliances requiring mobility are connected to rigid piping by the use of swivel joints or couplings, the swivel joints or couplings shall be suitable for the service required and only the minimum number required shall be installed. [NFPA 54:9.6.4.2]

1312.5.2 Metal Flexible Connectors. Where industrial appliances subject to vibration are connected to the building piping system by the use of all metal flexible connectors, the connectors shall be suitable for the service required. [NFPA 54:9.6.4.3]

1312.5.3 Flexible Connectors. Where flexible connections are used, they shall be of the minimum practical length and shall not extend from one room to another or pass through any walls, partitions, ceilings, or floors. Flexible connections shall not be used in any concealed location. They shall be protected against physical or thermal damage and shall be provided with gas shutoff valves in readily accessible locations in rigid piping upstream from the flexible connections. [NFPA 54:9.6.4.4]

1312.6 Appliance Shutoff Valves and Connections. Each appliance connected to a piping system shall have an accessible, approved manual shutoff valve with a nondisplaceable valve member, or a listed gas convenience outlet. Appliance shutoff valves and convenience outlets shall serve a single appliance only. [NFPA 54:9.6.5] The shutoff valve shall be located within 6 feet (1829 mm) of the appliance it serves. [NFPA 54:9.6.5.1] Where a connector is used, the valve shall be installed upstream of the connector. A union or flanged connection shall be provided downstream from the valve to permit removal of appliance controls. [NFPA 54:9.6.5.1(A)]
Exceptions:

(1) Shutoff valves serving decorative appliances in a fireplace shall not be located within the fireplace firebox except where the valve is listed for such use. [NFPA 54: 9.6.5.1(B)]

(2) Shutoff valves shall be permitted to be accessibly located inside wall heaters and wall furnaces listed for recessed installation where necessary maintenance is performed without removal of the shutoff valve.

1312.7 Quick-Disconnect Devices. Quick-disconnect devices used to connect appliances to the building piping shall be listed in accordance with CSA Z21.41. Where installed indoors, an approved manual shutoff valve with a nonreplaceable valve member shall be installed upstream of the quick-disconnect device. [NFPA 54: 9.6.6 – 9.6.6.2]

1312.8 Gas Convenience Outlets. Appliances shall be permitted to be connected to the building piping by means of a listed gas convenience outlet, in conjunction with a listed appliance connector, installed in accordance with the manufacturer’s installation instructions.

Gas convenience outlets shall be listed in accordance with CSA Z21.90 and installed in accordance with the manufacturer’s installation instructions. [NFPA 54:9.6.7]

1312.9 Sediment Trap. Where a sediment trap is not incorporated as a part of the appliance, a sediment trap shall be installed downstream of the appliance shutoff valve as close to the inlet of the appliance as practical at the time of appliance installation. The sediment trap shall be either a tee fitting with a capped nipple in the bottom outlet, as illustrated in Figure 1312.9, or another device recognized as an effective sediment trap. Illuminating appliances, gas ranges, clothes dryers, decorative appliances for installation in vented fireplaces, gas fireplaces, and outdoor cooking appliances shall not be required to be so equipped. [NFPA 54:9.6.8]

1312.10 Installation of Piping. Piping shall be installed in a manner not to interfere with inspection, maintenance, or servicing of the appliances. [NFPA 54:9.6.9]

1312.11 Liquefied Petroleum Gas (LP-Gas) Facilities and Piping. Liquefied petroleum gas (LP-Gas) facilities shall comply with NFPA 58.

1313.0 Pressure Testing, Inspection, and Purging.

1313.1 Piping Installations. Prior to acceptance and initial operation, all piping installations shall be visually inspected and pressure tested to determine that the materials, design, fabrication, and installation practices comply with the requirements of this code. [NFPA 54:8.1.1.1]

1313.1.1 Inspection Requirements. Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly, or pressure tests. [NFPA 54:8.1.1.2]

1313.1.2 Repairs and Additions. Where repairs or additions are made following the pressure test, the affected piping shall be tested. Minor repairs and additions are not required to be pressure tested, provided that the work is inspected and connections are tested with a noncorrosive leak-detecting fluid or other leak-detecting methods approved by the Authority Having Jurisdiction. [NFPA 54:8.1.1.3]

1313.1.3 New Branches. Where new branches are installed to new appliance(s), only the newly installed branch(es) shall be required to be pressure tested. Connections between the new piping and the existing piping shall be tested with a noncorrosive leak-detecting fluid or approved leak-detecting methods. [NFPA 54:8.1.1.4]

1313.1.4 Piping System. A piping system shall be tested as a complete unit or in sections. Under no circumstances shall a valve in a line be used as a bulkhead between gas in one section of the piping system and test medium in an adjacent section, unless a double block and bleed valve system is installed. A valve shall not be subjected to the test pressure unless it can be determined that the valve, including the valve-closing mechanism, is designed to safely withstand the pressure. [NFPA 54:8.1.1.5]

1313.1.5 Regulators and Valves. Regulator and valve assemblies fabricated independently of the piping system in which they are to be installed shall be permitted to be tested with inert gas or air at the time of fabrication. [NFPA 54:8.1.1.6]

1313.1.6 Test Medium. The test medium shall be air, nitrogen, carbon dioxide, or an inert gas. Oxygen shall not be used as a test medium. [NFPA 54:8.1.1.2]

1313.2 Test Preparation. Test preparation shall comply with Section 1313.2.1 through Section 1313.2.6.

1313.2.1 Pipe Joints. Pipe joints, including welds, shall be left exposed for examination during the test.

Exception: Covered or concealed pipe end joints that have been previously tested in accordance with this code. [NFPA 54:8.1.3.1]

1313.2.2 Expansion Joints. Expansion joints shall be provided with temporary restraints, if required, for the additional thrust load under test. [NFPA 54:8.1.3.2]
1313.2.3 Appliances and Equipment. Appliances and equipment that are not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges, or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test shall not be required to be tested. [NFPA 54:8.1.3.3]

1313.2.4 Designed for Operating Pressures Less than Test Pressure. Where the piping system is connected to appliances or equipment designed for operating pressures of less than the test pressure, such appliances or equipment shall be isolated from the piping system by disconnecting them and capping the outlet(s). [NFPA 54:8.1.3.4]

1313.2.5 Designed for Operating Pressures Equal to or Greater than Test Pressure. Where the piping system is connected to appliances or equipment designed for operating pressures equal to or greater than the test pressure, such appliances or equipment shall be isolated from the piping system by closing the individual appliance or equipment shutoff valve(s). [NFPA 54:8.1.3.5]

1313.2.6 Safety. All testing of piping systems shall be performed in a manner that protects the safety of employees and the public during the test. [NFPA 54:8.1.3.6]

1313.3 Test Pressure. This inspection shall include an air, CO₂, or nitrogen pressure test, at which time the gas piping shall stand a pressure of not less than 10 psi (69 kPa) gauge pressure. Test pressures shall be held for a length of time satisfactory to the Authority Having Jurisdiction but in no case less than 15 minutes with no perceptible drop in pressure. For welded piping, and for piping carrying gas at pressures in excess of 14 inches water column (3.5 kPa) pressure, the test pressure shall be not less than 60 psi (414 kPa) and shall be continued for a length of time satisfactory to the Authority Having Jurisdiction, but in no case for less than 30 minutes. For CSST carrying gas at pressures in excess of 14 inches water column (3.5 kPa) pressure, the test pressure shall be 30 psi (207 kPa) for 30 minutes. These tests shall be made using air, CO₂, or nitrogen pressure and shall be made in the presence of the Authority Having Jurisdiction. Necessary apparatus for conducting tests shall be furnished by the permit holder. Test gauges used in conducting test shall be in accordance with Section 1303.3.3.1 through Section 1303.3.3.4.

1313.4 Detection of Leaks and Defects. The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause. [NFPA 54:8.1.5.1]

1313.4.1 Detecting Leaks. The leakage shall be located by means of an approved gas detector, a noncorrosive leak detection fluid, or other approved leak detection methods. [NFPA 54:8.1.5.2]

1313.4.2 Repair or Replace. Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested. [NFPA 54:8.1.5.3]

1313.5 Piping System Leak Test. Leak checks using fuel gas shall be permitted in piping systems that have been pressure-tested in accordance with Section 1313.0 through Section 1313.4.2. [NFPA 54:8.2.1]

1313.5.1 Turning Gas On. During the process of turning gas on into a system of new gas piping, the entire system shall be inspected to determine that there are no open fittings or ends and that all valves at unused outlets are closed and plugged or capped. [NFPA 54:8.2.2]

1313.5.2 Leak Check. Immediately after the gas is turned on into a new system or into a system that has been initially restored after an interruption of service, the piping system shall be checked for leakage. Where leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made. [NFPA 54:8.2.3]

1313.5.3 Placing Appliances and Equipment in Operation. Appliances and equipment shall not be placed in operation until after the piping system has been checked for leakage in accordance with Section 1313.5.2, the piping system is purged in accordance with Section 1313.6, and connections to the appliance are checked for leakage. [NFPA 54:8.2.4]

1313.6 Purging Requirements. The purging of piping shall be in accordance with Section 1313.6.1 through Section 1313.6.3. [NFPA 54:8.3]

1313.6.1 Piping Systems Required to be Purged Outdoors. The purging of piping systems shall be in accordance with Section 1313.6.1.1 through Section 1313.6.1.4 where the piping system meets either of the following:

1. The design operating gas pressure is greater than 2 psig (14 kPag).
2. The piping being purged contains one or more sections of pipe or tubing meeting the size and length criteria of Table 1313.6.1. [NFPA 54:8.3.1]

**Table 1313.6.1**

<table>
<thead>
<tr>
<th>NOMINAL PIPING SIZE (inches)</th>
<th>LENGTH OF PIPING (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2½ &lt; 3</td>
<td>&gt; 50</td>
</tr>
<tr>
<td>≥ 3 &lt; 4</td>
<td>&gt; 30</td>
</tr>
<tr>
<td>≥ 4 &lt; 6</td>
<td>&gt; 15</td>
</tr>
<tr>
<td>≥ 6 &lt; 8</td>
<td>&gt; 10</td>
</tr>
<tr>
<td>≥ 8</td>
<td>Any length</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm; 1 foot = 304.8 mm

* CSST EHD size of 62 is equivalent to nominal size (50 mm) pipe or tubing.

1313.6.1.1 Removal from Service. Where existing gas piping is opened, the section that is opened shall be isolated from the gas supply and the line pressure vented in accordance with Section 1313.6.1.3. Where gas piping meeting the criteria of Table
1313.6.1 is removed from service, the residual fuel gas in the piping shall be displaced with an inert gas. [NFPA 54:8.3.1.1]

1313.6.1.2 Placing in Operation. Where gas piping containing air and meeting the criteria of Table 1313.6.1 is placed in operation, the air in the piping shall first be displaced with an inert gas. The inert gas shall then be displaced with fuel gas in accordance with Section 1313.6.1.3. [NFPA 54:8.3.1.2]

1313.6.1.3 Outdoor Discharge of Purged Gases. The open end of a piping system being pressure vented or purged shall discharge directly to an outdoor location. Purging operations shall comply with all of the following requirements:

1. The point of discharge shall be controlled with a shutoff valve.
2. The point of discharge shall be located at least 10 feet (3048 mm) from sources of ignition, at least 10 feet (3048 mm) from building openings and at least 25 feet (7620 mm) from mechanical air intake openings.
3. During discharge, the open point of discharge shall be continuously attended and monitored with a combustible gas indicator that complies with Section 1313.6.1.4.
4. Purging operations introducing fuel gas shall be stopped when 90 percent fuel gas by volume is detected within the pipe.
5. Persons not involved in the purging operations shall be evacuated from all areas within 10 feet (3048 mm) of the point of discharge. [NFPA 54:8.3.1.3]

1313.6.1.4 Combustible Gas Indicator. Combustible gas indicators shall be listed and calibrated in accordance with the manufacturer’s instructions. Combustible gas indicators shall numerically display a volume scale from 0 percent to 100 percent in 1 percent or smaller increments. [NFPA 54:8.3.1.4]

1313.6.2 Piping Systems Allowed to be Purged Indoors or Outdoors. The purging of piping systems shall be in accordance with the provisions of Section 1313.6.2.1 where the piping system meets both of the following:

1. The design operating pressure is 2 psig (14 kPag) or less.
2. The piping being purged is constructed entirely from pipe or tubing not meeting the size and length criteria of Table 1313.6.1. [NFPA 54:8.3.2]

1313.6.2.1 Purging Procedure. The piping system shall be purged in accordance with one or more of the following:

1. The piping shall be purged with fuel gas and shall discharge to the outdoors.
2. The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through an appliance burner not located in a combustion chamber. Such burner shall be provided with a continuous source of ignition.
3. The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through a burner that has a continuous source of ignition and that is designed for such purpose.
4. The piping shall be purged with fuel gas that is discharged to the indoors or outdoors, and the point of discharge shall be monitored with a listed combustible gas detector in accordance with Section 1313.6.2.2. Purging shall be stopped when fuel gas is detected.
5. The piping shall be purged by the gas supplier in accordance with written procedures. [NFPA 54:8.3.2.1]

1313.6.2.2 Combustible Gas Detector. Combustible gas detectors shall be listed and calibrated or tested in accordance with the manufacturer’s instructions. Combustible gas detectors shall be capable of indicating the presence of fuel gas. [NFPA 54:8.3.2.2]

1313.6.3 Purging Appliances and Equipment. After the piping system has been placed in operation, appliances and equipment shall be purged before being placed into operation. [NFPA 54:8.3.3]

1314.0 Required Gas Supply.

1314.1 General. The following regulations, shall comply with this section and Section 1315.0, shall be the standard for the installation of gas piping. Natural gas regulations and tables are based on the use of gas having a specific gravity of 0.60 and for undiluted liquefied petroleum gas having a specific gravity of 1.50.

Where gas of a different specific gravity is to be delivered, the serving gas supplier shall be permitted to be contacted for specific gravity conversion factors to use in sizing piping systems from the pipe sizing tables in this chapter.

1314.2 Volume. The hourly volume of gas required at each piping outlet shall be taken as not less than the maximum hourly rating as specified by the manufacturer of the appliance or appliances to be connected to each such outlet.

1314.3 Gas Appliances. Where the gas appliances to be installed have not been definitely specified, Table 1208.4-1 shall be permitted to be used as a reference to estimate requirements of typical appliances. To obtain the cubic feet per hour (m³/h) of gas required, divide the input of the appliances by the average Btu (kW•h) heating value per cubic foot (m³) of the gas. The average Btu (kW•h) per cubic foot (m³) of the gas in the area of the installation shall be permitted to be obtained from the serving gas supplier.

1314.4 Size of Piping Outlets. The size of the supply piping outlet for a gas appliance shall be not less than ⅜ of an inch (15 mm).

The size of a piping outlet for a mobile home shall be not less than ⅜ of an inch (20 mm).
1315.0 Required Gas Piping Size.

1315.1 Pipe Sizing Methods. Where the pipe size is to be determined using any of the methods in Section 1315.1.1 through Section 1315.1.3, the diameter of each pipe segment shall be obtained from the pipe sizing tables in Section 1315.2 or from the sizing equations in Section 1315.3. [NFPA 54:6.1]

1315.1.1 Longest Length Method. The pipe size of each section of gas piping shall be determined using the longest length of piping from the point of delivery to the most remote outlet and the load of the section. [NFPA 54:6.1.1]

1315.1.2 Branch Length Method. Pipe shall be sized as follows:

1. Pipe size of each section of the longest pipe run from the point of delivery to the most remote outlet shall be determined using the longest run of piping and the load of the section.

2. The pipe size of each section of branch piping not previously sized shall be determined using the length of piping from the point of delivery to the most remote outlet in each branch and the load of the section. [NFPA 54:6.1.2]

1315.1.3 Hybrid Pressure. The pipe size for each section of higher pressure gas piping shall be determined using the longest length of piping from the point of delivery to the most remote line pressure regulator. The pipe size from the line pressure regulator to each outlet shall be determined using the length of piping from the regulator to the most remote outlet served by the regulator. [NFPA 54:6.1.3]

1315.2 Sizing of Gas Piping Systems. Sizing of piping systems shall be in accordance with Section 1315.2.1 for natural gas piping systems and Section 1315.2.2 for propane piping systems.

1315.2.1 Natural Gas Piping Systems. Table 1315.2(1) through Table 1315.2(23) shall be used in conjunction with one of the methods described in Section 1315.1.1 through Section 1315.1.3 for piping materials other than non-corrugated stainless steel tubing. Section 1315.3 shall be used in conjunction with one of the methods described in Section 1315.1.1 through Section 1315.1.3 for non-corrugated stainless steel tubing. [NFPA 54:6.2.1, 6.2.2]

1315.2.2 Propane Piping Systems. Table 1315.2(24) through Table 1315.2(36) shall be used in conjunction with one of the methods described in Section 1315.1.1 through Section 1315.1.3 for piping materials other than non-corrugated stainless steel tubing. Section 1315.3 shall be used in conjunction with one of the methods described in Section 1315.1.1 through Section 1315.1.3 for non-corrugated stainless steel tubing. [NFPA 54:6.2.1, 6.2.2]

1315.3 Sizing Equations. The inside diameter of smooth wall pipe or tubing shall be determined by Equation 1315.3.1(1), Equation 1315.3.2 and Table 1315.3 using the equivalent pipe length determined by the methods in Section 1315.1.1 through Section 1315.1.3. [NFPA 54:6.4]

LOW-PRESSURE GAS FORMULA (LESS THAN 1.5 psi (10.3 kPa)) [NFPA 54:6.4.1]

\[ D = \frac{Q^{0.381}}{19.17 \left( \frac{AH}{Cr \times L} \right)^{0.206}} \]

Where:
- \( D \) = inside diameter of pipe, inches
- \( Q \) = input rate appliance(s), cubic feet per hour at 60°F and 30 inch mercury column
- \( L \) = equivalent length of pipe, feet
- \( \Delta H \) = pressure drop, inches of water column
- \( Cr \) = in accordance with Table 1315.3

HIGH-PRESSURE GAS FORMULA (1.5 psi (10.3 kPa) AND ABOVE) [NFPA 54:6.4.2]

\[ D = \frac{Q^{0.381}}{18.93 \left( \frac{(P_1^2 - P_2^2) \cdot Y}{Cr \times L} \right)^{0.206}} \]

Where:
- \( D \) = inside diameter of pipe, inches
- \( Q \) = input rate of appliance(s), cubic feet per hour at 60°F and 30 inch mercury column
- \( P_1 \) = upstream pressure, psia \((P_1 + 14.7)\)
- \( P_2 \) = downstream pressure, psia \((P_2 + 14.7)\)
- \( L \) = equivalent length of pipe, feet
- \( Cr \) = in accordance with Table 1315.3
- \( Y \) = in accordance with Table 1315.3

For SI units: 1 cubic foot = 0.0283 m³, 1000 British thermal units per hour = 0.293 kW, 1 inch = 25 mm, 1 pound-force per square inch = 6.8947 kPa, °C = (°F-32)/1.8, 1 inch mercury column = 3.39 kPa

1315.3.1 Formula Factors

<table>
<thead>
<tr>
<th>GAS</th>
<th>FORMULA FACTORS</th>
<th>Cr</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>0.6094</td>
<td>0.9992</td>
<td></td>
</tr>
<tr>
<td>Undiluted Propane</td>
<td>1.2462</td>
<td>0.9910</td>
<td></td>
</tr>
</tbody>
</table>

1315.4 Sizing of Piping Sections. To determine the size of each section of pipe in a system within the range of Table 1315.2(1) through Table 1315.2(36), proceed as follows:

1. Measure the length of the pipe from the gas meter location to the most remote outlet on the system.
(2) Select the length in feet column and row showing the distance, or the next longer distance where the table does not give the exact length.

(3) Starting at the most remote outlet, find in the just selected the gas demand for that outlet. Where the exact figure of demand is not shown, choose the next larger figure in the row.

(4) At the top of the column in the table will be found the correct size of pipe.

(5) Using this same row, proceed in a similar manner for each section of pipe serving this outlet. For each section of pipe, determine the total gas demand supplied by that section. Where gas piping sections serve both heating and cooling appliances and the installation prevents both units from operating simultaneously, the larger of the two demand loads needs to be used in sizing these sections.

(6) Size each section of branch piping not previously sized by measuring the distance from the gas meter location to the most remote outlet in that branch and follow the procedures of steps 2, 3, 4, and 5 above. Size branch piping in the order of their distance from the meter location, beginning with the most distant outlet not previously sized.

1315.5 Engineering Methods. For conditions other than those covered by Section 1315.1, such as longer runs or greater gas demands, the size of each gas piping system shall be determined by standard engineering methods acceptable to the Authority Having Jurisdiction, and each such system shall be so designed that the total pressure drop between the meter or other point of supply and an outlet where full demand is being supplied to outlets, shall be in accordance with the requirements of Section 1308.4.

1315.6 Variable Gas Pressures. Where the supply gas pressure exceeds 5 psi (34 kPa) for natural gas and 10 psi (69 kPa) for undiluted propane or is less than 6 inches (1.5 kPa) of water column, or where diversity demand factors are used, the design, pipe, sizing, materials, location, and use of such systems first shall be approved by the Authority Having Jurisdiction. Piping systems designed for pressures exceeding the serving gas supplier’s standard delivery pressure shall have prior verification from the gas supplier of the availability of the design pressure.
**FIGURE 1315.1.1**

**EXAMPLE ILLUSTRATING USE OF TABLE 1308.4.1 1308.3.1 AND TABLE 1315.2(1)**

**Problem:** Determine the required pipe size of each section and outlet of the piping system shown in Figure 1315.1.1. Gas to be used has a specific gravity of 0.60 and 1100 British thermal units (Btu) per cubic foot (0.0114 kW•h/L), delivered at 8 inch water column (1.9 kPa) pressure.

![Diagram of the piping system](image)

For SI units: 1 foot = 304.8 mm, 1 gallon = 3.785 L, 1000 British thermal units per hour = 0.293 kW, 1 cubic foot per hour = 0.0283 m³/h

**Solution:**

1. Maximum gas demand of Outlet A – 32 cubic feet per hour (0.91 m³/h) (from Table 1308.4.1 1308.3.1).
   - Maximum gas demand of Outlet B – 3 cubic feet per hour (0.08 m³/h) (from Table 1308.4.1 1308.3.1).
   - Maximum gas demand of Outlet C – 59 cubic feet per hour (1.67 m³/h) (from Table 1308.4.1 1308.3.1).
   - Maximum gas demand of Outlet D – 136 cubic feet per hour (3.85 m³/h) [150 000 Btu/hour (44 kW)] divided by 1100 Btu per cubic foot (0.0114 kW•h/L).

2. The length of pipe from the gas meter to the most remote outlet (Outlet A) is 60 feet (18 288 mm).

3. Using the length in feet column row marked 60 feet (18 288 mm) in Table 1315.2(1):
   - Outlet A, supplying 32 cubic feet per hour (0.91 m³/h), requires ½ of an inch (15 mm) pipe.
   - Section 1, supplying Outlets A and B, or 35 cubic feet per hour (0.99 m³/h) requires ½ of an inch (15 mm) pipe.
   - Section 2, supplying Outlets A, B, and C, or 94 cubic feet per hour (2.66 m³/h) requires ¾ of an inch (20 mm) pipe.
   - Section 3, supplying Outlets A, B, C, and D, or 230 cubic feet per hour (6.51 m³/h), requires 1 inch (25 mm) pipe.

4. Using the column marked 60 feet (18 288 mm) in Table 1315.2(1):
   - Outlet B supplying 3 cubic feet per hour (0.08 m³/h), requires ½ of an inch (15 mm) pipe.
   - Outlet C, supplying 59 cubic feet per hour (1.67 m³/h), requires ½ of an inch (15 mm) pipe.
   - Using the column marked 60 feet (18 288 mm) in Table 1315.2(1):
   - Outlet D, supplying 136 cubic feet per hour (3.85 m³/h), requires ¾ of an inch (20 mm) pipe.
<table>
<thead>
<tr>
<th>PIPE SIZE (inch)</th>
<th>CAPACITY IN CUBIC FEET OF GAS PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>LENGTH (feet)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.622</td>
</tr>
<tr>
<td>20</td>
<td>0.824</td>
</tr>
<tr>
<td>30</td>
<td>1.049</td>
</tr>
<tr>
<td>40</td>
<td>1.380</td>
</tr>
<tr>
<td>50</td>
<td>1.610</td>
</tr>
<tr>
<td>60</td>
<td>2.067</td>
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<td>70</td>
<td>2.469</td>
</tr>
<tr>
<td>80</td>
<td>3.068</td>
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<td>90</td>
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<td>100</td>
<td>5.047</td>
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<td>120</td>
<td>6.065</td>
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<tr>
<td>150</td>
<td>7.981</td>
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<tr>
<td>200</td>
<td>10.020</td>
</tr>
<tr>
<td>250</td>
<td>11.938</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

Notes:
1 Table entries are rounded to 3 significant digits.
2 NA means a flow of less than 10 ft³/h (0.283 m³/h).
### Table 1315.2(2)
**SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(c)]**

<table>
<thead>
<tr>
<th>NOMINAL:</th>
<th>½</th>
<th>¾</th>
<th>1</th>
<th>1¼</th>
<th>1½</th>
<th>2</th>
<th>2½</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>INLET PRESSURE:</td>
<td><strong>LESS THAN 2 psi</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRESSURE DROP:</td>
<td>3.0 in. w.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPECIFIC GRAVITY:</td>
<td>0.60</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INTENDED USE:** INITIAL SUPPLY PRESSURE OF 8.0 IN. W.C. OR GREATER

<table>
<thead>
<tr>
<th>PIPE SIZE (inch)</th>
<th>LENGTH (feet)</th>
<th>CAPACITY IN CUBIC FEET OF GAS PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>0.622</td>
<td>454, 949, 1790, 2120, 4160, 10 900, 60 800</td>
</tr>
<tr>
<td>3/4</td>
<td>0.824</td>
<td>652, 1230, 3720, 7280, 11 600, 20 500, 41 800</td>
</tr>
<tr>
<td>1</td>
<td>1.049</td>
<td>844, 1730, 4280, 8120, 14 100, 28 700</td>
</tr>
<tr>
<td>1¼</td>
<td>1.380</td>
<td>986, 2030, 4900, 10 000, 18 500, 36 000</td>
</tr>
<tr>
<td>1½</td>
<td>1.610</td>
<td>1120, 2100, 5000, 9000, 19 800, 39 600</td>
</tr>
<tr>
<td>2</td>
<td>2.067</td>
<td>1390, 2520, 6000, 10 500, 25 500, 51 000</td>
</tr>
<tr>
<td>2½</td>
<td>2.469</td>
<td>1790, 4540, 11 300, 21 000, 43 000, 8 600</td>
</tr>
<tr>
<td>3</td>
<td>3.068</td>
<td>1970, 5600, 13 500, 26 000, 52 000, 10 400</td>
</tr>
<tr>
<td>4</td>
<td>4.026</td>
<td>2270, 7800, 17 200, 34 000, 68 000, 14 400</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.
### TABLE 1315.2(3)
**SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(d)]**

**INTENDED USE:** INITIAL SUPPLY PRESSURE OF 11.0 IN. W.C. OR GREATER

<table>
<thead>
<tr>
<th>Pipe Size (inch)</th>
<th>Nominal</th>
<th>Actual ID</th>
<th>Capacity in Cubic Feet of Gas per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>½</td>
<td>0.622</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>¾</td>
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<td></td>
<td>1¼</td>
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<td>1.61</td>
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<td>70</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3.068</td>
<td>80</td>
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<tr>
<td></td>
<td>4</td>
<td>4.026</td>
<td>90</td>
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<td></td>
<td>100</td>
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<td>125</td>
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<td>150</td>
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For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

*Table entries are rounded to 3 significant digits.*
TABLE 1315.2(4)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(e)]

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For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa
* Table entries are rounded to 3 significant digits.
### TABLE 1315.2(5)
**SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(1)]**

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#### PIPE SIZE (inch)

**LENGTH (feet)**

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For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.
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</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.
### TABLE 1315.2(7)

**SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(h)]**

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<th>K &amp; L:</th>
<th>¼</th>
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<th>¾</th>
<th>1</th>
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<th>1½</th>
<th>2</th>
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<td>0.500</td>
<td>0.625</td>
<td>0.750</td>
<td>0.875</td>
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<td>1.375</td>
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<tr>
<td>INSIDE:</td>
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<td>0.402</td>
<td>0.527</td>
<td>0.652</td>
<td>0.745</td>
<td>0.995</td>
<td>1.245</td>
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</table>

<table>
<thead>
<tr>
<th>LENGTH (feet)</th>
<th>CAPACITY IN CUBIC FEET OF GAS PER HOUR</th>
</tr>
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<tbody>
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<tr>
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<td>10  20  40  70  99  211  381  600  1250</td>
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<td>NA  13  27  48  68  145  262  413  859</td>
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<tr>
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<td>NA  NA  NA  12  16  35  63  100  208</td>
</tr>
<tr>
<td>1200</td>
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<tr>
<td>1300</td>
<td>NA  NA  NA  11  15  32  58  91  190</td>
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<tr>
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<td>NA  NA  NA  10  14  31  56  88  183</td>
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<tr>
<td>1600</td>
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<td>1800</td>
<td>NA  NA  NA  NA  NA  13  27  49  77  159</td>
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<td>1900</td>
<td>NA  NA  NA  NA  NA  12  26  47  74  155</td>
</tr>
<tr>
<td>2000</td>
<td>NA  NA  NA  NA  NA  12  25  46  72  151</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**
1. Table entries are rounded to 3 significant digits.
2. NA means a flow of less than 10 ft³/h (0.283 m³/h).
3. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
TABLE 1315.2(8)
SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(i)]

<table>
<thead>
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<th>NOMINAL</th>
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<th>⅜</th>
<th>⅝</th>
<th>1</th>
<th>1¼</th>
<th>1½</th>
<th>2</th>
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</thead>
<tbody>
<tr>
<td>K &amp; L:</td>
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<td>1</td>
<td>1½</td>
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<td>ACR:</td>
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<td></td>
<td></td>
<td>⅝</td>
<td>1½</td>
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<tr>
<td>OUTSIDE</td>
<td>0.375</td>
<td>0.500</td>
<td>0.625</td>
<td>0.750</td>
<td>0.875</td>
<td>1.125</td>
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<td>INSIDE:</td>
<td>0.305</td>
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<td>0.652</td>
<td>0.745</td>
<td>0.995</td>
<td>1.245</td>
<td>1.481</td>
</tr>
</tbody>
</table>

| LENGTH (feet) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 | 175 | 200 | 250 |
|---------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|
| CAPACITY IN CUBIC FEET OF GAS PER HOUR | 27 | 38 | 50 | 63 | 77 | 92 | 107 | 123 | 139 | 156 | 175 | 195 | 216 | 237 | 260 |
|               | 55 | 77 | 107 | 139 | 175 | 216 | 251 | 292 | 337 | 383 | 432 | 483 | 536 | 591 | 648 |
|               | 111 | 134 | 166 | 200 | 243 | 288 | 336 | 386 | 440 | 497 | 558 | 623 | 691 | 761 | 834 |
|               | 195 | 236 | 288 | 348 | 416 | 495 | 581 | 676 | 780 | 894 | 1018 | 1157 | 1309 | 1475 | 1656 |
|               | 276 | 348 | 431 | 535 | 653 | 784 | 931 | 1093 | 1271 | 1465 | 1675 | 1903 | 2151 | 2425 | 2724 |
|               | 590 | 755 | 945 | 1159 | 1414 | 1699 | 2025 | 2389 | 2798 | 3253 | 3753 | 4303 | 4898 | 5542 | 6246 |
|               | 1060 | 1383 | 1759 | 2194 | 2705 | 3293 | 3976 | 4760 | 5653 | 6656 | 7770 | 9005 | 10351 | 11818 | 13406 |
|               | 1680 | 2222 | 2897 | 3612 | 4483 | 5434 | 6567 | 7893 | 9332 | 10905 | 12603 | 14435 | 16403 | 18508 | 20762 |
|               | 3490 | 4667 | 5997 | 7592 | 9539 | 11783 | 14340 | 17220 | 20434 | 23983 | 27967 | 32408 | 37319 | 42736 | 48674 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

Notes:
1. Table entries are rounded to 3 significant digits.
2. NA means a flow of less than 10 ft³/h (0.283 m³/h).
3. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
# FUEL GAS PIPING

## TABLE 1315.2(9)

**SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(j)]**

| INTENDED USE: TUBE SIZING BETWEEN HOUSE LINE REGULATOR AND THE APPLIANCE |
| TUBE SIZE (inch) |
| NOMINAL: | K & L: | % | % | % | % | % | % | 1 | 1¾ | 1½ | 2 |
| ACR: | % | % | % | % | % | % | % | 1 | 1¾ | 1½ | – | – |
| OUTSIDE: | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:³ | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR |
| 10 | 39 | 80 | 162 | 283 | 402 | 859 | 1550 | 2440 | 5080 |
| 20 | 27 | 55 | 111 | 195 | 276 | 590 | 1060 | 1680 | 3490 |
| 30 | 21 | 44 | 89 | 156 | 222 | 474 | 853 | 1350 | 2800 |
| 40 | 18 | 38 | 77 | 134 | 190 | 406 | 780 | 1190 | 2400 |
| 50 | 16 | 33 | 68 | 119 | 168 | 359 | 667 | 1020 | 2130 |
| 60 | 15 | 30 | 61 | 107 | 152 | 326 | 586 | 925 | 1930 |
| 70 | 13 | 28 | 57 | 99 | 140 | 300 | 539 | 851 | 1770 |
| 80 | 12 | 26 | 53 | 92 | 131 | 279 | 502 | 791 | 1650 |
| 90 | 12 | 24 | 49 | 86 | 122 | 262 | 471 | 742 | 1550 |
| 100 | 11 | 23 | 47 | 82 | 110 | 247 | 445 | 701 | 1460 |
| 125 | NA | 20 | 41 | 72 | 103 | 219 | 394 | 622 | 1290 |
| 150 | NA | 18 | 37 | 65 | 93 | 198 | 357 | 563 | 1170 |
| 175 | NA | 17 | 34 | 60 | 85 | 183 | 329 | 518 | 1080 |
| 200 | NA | 16 | 32 | 56 | 79 | 170 | 306 | 482 | 1000 |
| 250 | NA | 14 | 28 | 50 | 70 | 151 | 271 | 427 | 890 |
| 300 | NA | 13 | 26 | 45 | 64 | 136 | 245 | 387 | 806 |
| 350 | NA | 12 | 24 | 41 | 59 | 125 | 226 | 356 | 742 |
| 400 | NA | 11 | 22 | 39 | 55 | 117 | 210 | 331 | 690 |
| 450 | NA | 10 | 21 | 36 | 51 | 110 | 197 | 311 | 647 |
| 500 | NA | NA | 20 | 34 | 48 | 103 | 186 | 294 | 612 |
| 550 | NA | NA | 19 | 32 | 46 | 98 | 177 | 279 | 581 |
| 600 | NA | NA | 18 | 31 | 44 | 94 | 169 | 266 | 554 |
| 650 | NA | NA | 17 | 30 | 42 | 90 | 162 | 255 | 531 |
| 700 | NA | NA | 16 | 28 | 40 | 86 | 155 | 245 | 510 |
| 750 | NA | NA | 16 | 27 | 39 | 83 | 150 | 236 | 491 |
| 800 | NA | NA | 15 | 26 | 38 | 80 | 144 | 228 | 474 |
| 850 | NA | NA | 15 | 26 | 36 | 78 | 140 | 220 | 459 |
| 900 | NA | NA | 14 | 25 | 35 | 75 | 135 | 214 | 445 |
| 950 | NA | NA | 14 | 24 | 34 | 73 | 132 | 207 | 432 |
| 1000 | NA | NA | 13 | 23 | 33 | 71 | 128 | 202 | 420 |
| 1100 | NA | NA | 13 | 22 | 32 | 68 | 122 | 192 | 399 |
| 1200 | NA | NA | 12 | 21 | 30 | 64 | 116 | 183 | 381 |
| 1300 | NA | NA | 12 | 20 | 29 | 62 | 111 | 175 | 365 |
| 1400 | NA | NA | 11 | 20 | 28 | 59 | 107 | 168 | 350 |
| 1500 | NA | NA | 11 | 19 | 27 | 57 | 103 | 162 | 338 |
| 1600 | NA | NA | 10 | 18 | 26 | 55 | 99 | 156 | 326 |
| 1700 | NA | NA | 10 | 18 | 25 | 53 | 96 | 151 | 315 |
| 1800 | NA | NA | 10 | 17 | 24 | 52 | 93 | 147 | 306 |
| 1900 | NA | NA | 10 | 17 | 24 | 50 | 90 | 143 | 297 |
| 2000 | NA | NA | 10 | 16 | 23 | 49 | 88 | 139 | 289 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

1. Table entries are rounded to 3 significant digits.
2. NA means a flow of less than 10 ft³/h (0.283 m³/h).
3. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
### Table 1315.2(10)

**Semi-Rigid Copper Tubing [NFPA 54: Table 6.2.1(k)]²**

<table>
<thead>
<tr>
<th>NOMINAL:</th>
<th>K &amp; L:</th>
<th>¼</th>
<th>½</th>
<th>⅜</th>
<th>⅝</th>
<th>1</th>
<th>1¼</th>
<th>1½</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>OUTSIDE:</td>
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<td>0.375</td>
<td>0.500</td>
<td>0.625</td>
<td>0.750</td>
<td>0.875</td>
<td>1.125</td>
<td>1.375</td>
<td>1.625</td>
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<td></td>
<td>0.305</td>
<td>0.402</td>
<td>0.527</td>
<td>0.652</td>
<td>0.745</td>
<td>0.995</td>
<td>1.245</td>
<td>1.481</td>
</tr>
<tr>
<td>LENGTH (feet)</td>
<td>CAPACITY IN CUBIC FEET OF GAS PER HOUR</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</table>

<table>
<thead>
<tr>
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<th>⅜</th>
<th>⅝</th>
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<td>%</td>
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<td>OUTSIDE:</td>
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<td>0.500</td>
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<td>0.875</td>
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<td>0.402</td>
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<td>0.745</td>
<td>0.995</td>
<td>1.245</td>
<td>1.481</td>
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<tr>
<td>LENGTH (feet)</td>
<td>CAPACITY IN CUBIC FEET OF GAS PER HOUR</td>
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</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

Notes:

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. Table entries are rounded to 3 significant digits.

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### FUEL GAS PIPING

#### TABLE 1315.2(11)

**SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(l)]**

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<th>GAS: NATURAL</th>
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<tbody>
<tr>
<td>INLET PRESSURE: 2.0 psi</td>
</tr>
<tr>
<td>PRESSURE DROP: 1.0 psi</td>
</tr>
<tr>
<td>SPECIFIC GRAVITY: 0.60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TUBE SIZE (inch)</th>
<th>K &amp; L:</th>
<th>ACR:</th>
<th>OUTSIDE:</th>
<th>INSIDE:</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>¼  %</td>
<td>½  %</td>
<td>¾  %</td>
<td>1  %</td>
</tr>
<tr>
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<td>850</td>
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<td>1400</td>
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<tr>
<td>1500</td>
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<tr>
<td>2000</td>
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</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. Table entries are rounded to 3 significant digits.
TABLE 1315.2(12)
SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(m)]

<table>
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<tr>
<th>NOMINAL:</th>
<th>K &amp; L:</th>
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<th>¾</th>
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<th>1½</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ACR:</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>OUTSIDE:</td>
<td></td>
<td>0.375</td>
<td>0.500</td>
<td>0.625</td>
<td>0.750</td>
<td>0.875</td>
<td>1.125</td>
</tr>
<tr>
<td>INSIDE:</td>
<td>1</td>
<td>0.305</td>
<td>0.402</td>
<td>0.527</td>
<td>0.652</td>
<td>0.745</td>
<td>0.995</td>
</tr>
</tbody>
</table>

LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR
---|---
10 | 303 | 625 | 1270 | 2220 | 3150 | 6740 | 12 100 | 19 100 | 39 800 |
20 | 208 | 430 | 874 | 1530 | 2170 | 4630 | 8330 | 13 100 | 27 400 |
30 | 167 | 345 | 702 | 1230 | 1740 | 3720 | 6690 | 10 600 | 22 000 |
40 | 143 | 295 | 601 | 1050 | 1490 | 3180 | 5730 | 9030 | 18 800 |
50 | 127 | 262 | 532 | 931 | 1320 | 2820 | 5080 | 8000 | 16 700 |
60 | 115 | 237 | 482 | 843 | 1200 | 2560 | 4600 | 7250 | 15 100 |
70 | 106 | 218 | 444 | 776 | 1100 | 2350 | 4230 | 6670 | 13 900 |
80 | 98  | 203 | 413 | 722 | 1020 | 2190 | 3940 | 6210 | 12 900 |
90 | 92  | 190 | 387 | 677 | 961 | 2050 | 3690 | 5820 | 12 100 |
100 | 87 | 180 | 366 | 640 | 907 | 1940 | 3490 | 5500 | 11 500 |
125 | 77 | 159 | 324 | 567 | 804 | 1720 | 3090 | 4880 | 10 200 |
150 | 70 | 144 | 294 | 514 | 729 | 1560 | 2800 | 4420 | 9200 |
175 | 64 | 133 | 270 | 472 | 670 | 1430 | 2580 | 4060 | 8460 |
200 | 60 | 124 | 252 | 440 | 624 | 1330 | 2400 | 3780 | 7870 |
250 | 53 | 110 | 223 | 390 | 553 | 1180 | 2130 | 3350 | 6980 |
300 | 48 | 99 | 202 | 353 | 501 | 1070 | 1930 | 3040 | 6320 |
350 | 44 | 91 | 186 | 325 | 461 | 984 | 1770 | 2790 | 5820 |
400 | 41 | 85 | 173 | 302 | 429 | 916 | 1650 | 2600 | 5410 |
450 | 39 | 80 | 162 | 283 | 402 | 859 | 1550 | 2440 | 5080 |
500 | 36 | 75 | 153 | 268 | 380 | 811 | 1460 | 2300 | 4800 |
550 | 35 | 72 | 146 | 254 | 361 | 771 | 1390 | 2190 | 4560 |
600 | 33 | 68 | 139 | 243 | 344 | 735 | 1320 | 2090 | 4350 |
650 | 32 | 65 | 133 | 232 | 330 | 704 | 1270 | 2000 | 4160 |
700 | 30 | 63 | 128 | 223 | 317 | 676 | 1220 | 1920 | 4000 |
750 | 29 | 60 | 123 | 215 | 305 | 652 | 1170 | 1850 | 3850 |
800 | 28 | 58 | 119 | 208 | 295 | 629 | 1130 | 1790 | 3720 |
850 | 27 | 57 | 115 | 201 | 285 | 609 | 1100 | 1730 | 3600 |
900 | 27 | 55 | 111 | 195 | 276 | 590 | 1060 | 1680 | 3490 |
950 | 26 | 53 | 108 | 189 | 268 | 573 | 1030 | 1630 | 3390 |
1000 | 25 | 52 | 105 | 184 | 261 | 558 | 1000 | 1580 | 3300 |
1100 | 24 | 49 | 100 | 175 | 248 | 530 | 954 | 1500 | 3130 |
1200 | 23 | 47 | 95 | 167 | 237 | 505 | 910 | 1430 | 2990 |
1300 | 22 | 45 | 91 | 160 | 227 | 484 | 871 | 1370 | 2860 |
1400 | 21 | 43 | 88 | 153 | 218 | 465 | 837 | 1320 | 2750 |
1500 | 20 | 42 | 85 | 148 | 210 | 448 | 806 | 1270 | 2650 |
1600 | 19 | 40 | 82 | 143 | 202 | 432 | 779 | 1230 | 2560 |
1700 | 19 | 39 | 79 | 138 | 196 | 419 | 753 | 1190 | 2470 |
1800 | 18 | 37 | 77 | 134 | 190 | 406 | 731 | 1150 | 2400 |
1900 | 18 | 37 | 74 | 130 | 184 | 394 | 709 | 1120 | 2330 |
2000 | 17 | 36 | 72 | 126 | 179 | 383 | 690 | 1090 | 2270 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

Notes:
1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. Where this table is used to size the tubing upstream of a line pressure regulator, the pipe or tubing downstream of the line pressure regulator shall be sized using a pressure drop no greater than 1 inch water column (0.249 kPa).
3. Table entries are rounded to 3 significant digits.
**FUEL GAS PIPING**

**TABLE 1315.2(13)**

**SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(n)]**

<table>
<thead>
<tr>
<th>TABLE CAPACITIES</th>
<th>GAS: NATURAL</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>INLET PRESSURE: 5.0 psi</td>
</tr>
<tr>
<td></td>
<td>PRESSURE DROP: 3.5 psi</td>
</tr>
<tr>
<td></td>
<td>SPECIFIC GRAVITY: 0.60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TUBE SIZE (inch)</th>
<th>CAPACITY IN CUBIC FEET OF GAS PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/4</td>
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<tr>
<td>OUTSIDE:</td>
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For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. Table entries are rounded to 3 significant digits.
### TABLE 1315.2(14)
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.2.1(o)]

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

| Notes: | 1 Table entries are rounded to 3 significant digits.  
2 Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: \( L = 1.3 \times n \), where \( L \) is additional length (ft) of tubing and \( n \) is the number of additional fittings, bends, or both.  
3 EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing. |

| GAS: NATURAL |
| INLET PRESSURE: LESS THAN 2 psi |
| PRESSURE DROP: 0.5 in. w.c. |
| SPECIFIC GRAVITY: 0.60 |

| TUBE SIZE (EHD): |
| FLOW DESIGNATION: | 13 | 15 | 18 | 19 | 23 | 25 | 30 | 31 | 37 | 39 | 46 | 48 | 60 | 62 |
| LENGTH (feet): | | | | | | | | | | | | | | |
| 5 | 46 | 63 | 115 | 134 | 225 | 270 | 471 | 546 | 895 | 1037 | 1790 | 2070 | 3660 | 4140 |
| 10 | 32 | 44 | 82 | 95 | 161 | 192 | 330 | 383 | 639 | 746 | 1260 | 1470 | 2600 | 2930 |
| 15 | 25 | 35 | 66 | 77 | 132 | 157 | 267 | 310 | 524 | 615 | 1030 | 1200 | 2140 | 2400 |
| 20 | 22 | 31 | 58 | 67 | 116 | 137 | 231 | 269 | 456 | 536 | 888 | 1050 | 1850 | 2080 |
| 25 | 19 | 27 | 52 | 60 | 104 | 122 | 206 | 240 | 409 | 482 | 793 | 936 | 1660 | 1860 |
| 30 | 17 | 25 | 47 | 55 | 96 | 112 | 188 | 218 | 374 | 442 | 723 | 856 | 1520 | 1700 |
| 40 | 15 | 21 | 41 | 47 | 83 | 97 | 162 | 188 | 325 | 386 | 625 | 742 | 1320 | 1470 |
| 50 | 13 | 19 | 37 | 42 | 75 | 87 | 144 | 168 | 292 | 347 | 559 | 665 | 1180 | 1320 |
| 60 | 12 | 17 | 34 | 38 | 68 | 80 | 131 | 153 | 267 | 318 | 509 | 608 | 1080 | 1200 |
| 70 | 11 | 16 | 31 | 36 | 63 | 74 | 121 | 141 | 248 | 295 | 471 | 563 | 1000 | 1110 |
| 80 | 10 | 15 | 29 | 33 | 60 | 69 | 113 | 132 | 232 | 277 | 440 | 527 | 940 | 1040 |
| 90 | 10 | 14 | 28 | 32 | 57 | 65 | 107 | 125 | 219 | 262 | 415 | 498 | 887 | 983 |
| 100 | 9 | 13 | 26 | 30 | 54 | 62 | 101 | 118 | 208 | 249 | 393 | 472 | 843 | 933 |
| 150 | 7 | 10 | 20 | 23 | 42 | 48 | 78 | 91 | 171 | 205 | 320 | 387 | 691 | 762 |
| 200 | 6 | 9 | 18 | 21 | 38 | 44 | 71 | 82 | 148 | 179 | 277 | 336 | 600 | 661 |
| 250 | 5 | 8 | 16 | 19 | 34 | 39 | 63 | 74 | 133 | 161 | 247 | 301 | 538 | 591 |
| 300 | 5 | 7 | 15 | 17 | 32 | 36 | 57 | 67 | 95 | 148 | 226 | 275 | 492 | 540 |
# FUEL GAS PIPING

## TABLE 1315.2(15)
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.2.1(p)]

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</table>

For SI units: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**
1. Table entries are rounded to 3 significant digits.
2. Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: \( L = 1.3n \), where \( L \) is additional length (ft) of tubing and \( n \) is the number of additional fittings, bends, or both.
3. EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
**TABLE 1315.2(16)***
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.2.1(q)]

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<th>FLOW DESIGNATION: 13 15 18 20 25 30 31 35 40 46 48 60 62</th>
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<td>LENGTH (feet)</td>
<td>CAPACITY IN CUBIC FEET OF GAS PER HOUR</td>
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</table>

For SI units: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

Notes:
1 Table entries are rounded to 3 significant digits.
2 Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: \( L = 1.3n \), where \( L \) is additional length (ft) of tubing and \( n \) is the number of additional fittings, bends, or both.
3 EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
TABLE 1315.2(17)
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.2.1(r)]¹, ², ³, ⁴

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For SI units: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

Notes:
1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.75 psi (5.17 kPa), DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator are capable of varying with flow rate.
2. CAUTION: Capacities shown in table are capable of exceeding maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.
3. Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing according to the following equation: L = 1.3 n, where L is additional length (ft) of tubing and n is the number of additional fittings, bends, or both.
4. Table entries are rounded to 3 significant digits.
5. EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
TABLE 1315.2(18)  
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.2.1(s)]\(^1,2,3,4\)  

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<th>23</th>
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<td>300</td>
<td>400</td>
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For SI units: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m\(^3\)/h, 1 pound-force per square inch = 6.8947 kPa

Notes:
1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 1 psi (7 kPa), DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across regulator are capable of varying with the flow rate.
2. CAUTION: Capacities shown in table are capable of exceeding the maximum capacity of selected regulator. Consult tubing manufacturer for guidance.
3. Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: \(L = 1.3n\), where \(L\) is additional length (feet) of tubing and \(n\) is the number of additional fittings, bends, or both.
4. Table entries are rounded to 3 significant digits.
5. EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
## TABLE 1315.2(19)

**POLYETHYLENE PLASTIC PIPE [NFPA 54: TABLE 6.2.1(t)]***

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.

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**PIPE SIZE (inch)**

| LENGTH (feet) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 | 175 | 200 | 250 | 300 | 350 | 400 | 450 | 500 |
|---------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CAPACITY IN CUBIC FEET OF GAS PER HOUR | 201 | 138 | 111 | 95  | 84  | 76  | 70  | 65  | 61  | 58  | 51  | 46  | 43  | 40  | 35  | 32  | 29  | 27  | 26  | 24  |
| 403 | 499 | 401 | 343 | 304 | 276 | 254 | 236 | 221 | 209 | 193 | 168 | 154 | 144 | 127 | 115 | 106 | 99  | 93  | 88  |
| 726 | 865 | 695 | 594 | 527 | 477 | 439 | 409 | 383 | 362 | 321 | 291 | 268 | 249 | 221 | 214 | 184 | 165 | 146 | 128 |
| 1260 | 1310 | 1050 | 898 | 796 | 721 | 663 | 617 | 579 | 547 | 485 | 439 | 404 | 376 | 337 | 302 | 278 | 258 | 242 | 229 |
| 1900 | 2350 | 1880 | 1610 | 1430 | 1300 | 1190 | 1110 | 1040 | 983 | 871 | 789 | 726 | 675 | 617 | 598 | 542 | 499 | 464 | 435 |
| 3410 | 6490 | 5210 | 4460 | 3950 | 3580 | 3300 | 3070 | 2880 | 2720 | 2410 | 2180 | 2010 | 1870 | 1660 | 1500 | 1380 | 1280 | 1200 | 1140 |
| 9450 | 12 550 | 10 080 | 8630 | 7640 | 6930 | 6370 | 5930 | 5560 | 5250 | 4660 | 4220 | 3880 | 3610 | 3200 | 2900 | 2670 | 2480 | 2330 | 2200 |
TABLE 1315.2(21)
POLYETHYLENE PLASTIC PIPE [NFPA 54: TABLE 6.2.1(v)]*

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For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa
* Table entries are rounded to 3 significant digits.
### TABLE 1315.2(22)
**POLYETHYLENE PLASTIC TUBING [NFPA 54: TABLE 6.2.1(w)]**

<table>
<thead>
<tr>
<th>GAS: NATURAL</th>
<th>INLET PRESSURE: LESS THAN 2.0 psi</th>
<th>PRESSURE DROP: 0.3 in. w.c.</th>
<th>SPECIFIC GRAVITY: 0.60</th>
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<tbody>
<tr>
<td>PLASTIC TUBING SIZE (CTS)¹ (inch)</td>
<td>NOMINAL OD:</td>
<td>DESIGNATION:</td>
<td>ACTUAL ID:</td>
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<td>SDR 11</td>
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<td>0.927</td>
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</tbody>
</table>

<table>
<thead>
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<th>LENGTH (feet)</th>
<th>CAPACITY IN CUBIC FEET OF GAS PER HOUR</th>
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</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**
1 CTS = Copper tube size.
2 Table entries are rounded to 3 significant digits.
3 NA means a flow of less than 10 ft³/h (0.283 m³/h).

### TABLE 1315.2(23)
**POLYETHYLENE PLASTIC TUBING [NFPA 54: TABLE 6.2.1(x)]**

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<th>PRESSURE DROP: 0.5 in. w.c.</th>
<th>SPECIFIC GRAVITY: 0.60</th>
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<tbody>
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<td>NOMINAL OD:</td>
<td>DESIGNATION:</td>
<td>ACTUAL ID:</td>
</tr>
<tr>
<td>¹/₄</td>
<td>1/₂</td>
<td>SDR 7</td>
<td>SDR 11</td>
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<tr>
<td>0.445</td>
<td>0.927</td>
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</table>

<table>
<thead>
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<th>LENGTH (feet)</th>
<th>CAPACITY IN CUBIC FEET OF GAS PER HOUR</th>
</tr>
</thead>
<tbody>
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For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**
1 CTS = Copper tube size.
2 Table entries are rounded to 3 significant digits.
3 NA means a flow of less than 10 ft³/h (0.283 m³/h).
### TABLE 1315.2(24)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3.1(a)]

<table>
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<th>NOMINAL INSIDE:</th>
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<th>1¼</th>
<th>1½</th>
<th>2</th>
<th>2½</th>
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<th>4</th>
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<td>2.469</td>
<td>3.068</td>
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</table>

**Pipe size (inch) length (feet)**

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>CAPACITY IN THOUSANDS OF BTU PER HOUR</th>
</tr>
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</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.
### Table 1315.2(25)
**SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3.1(b)]**

**GAS:** UNDILUTED PROPANE  
**INLET PRESSURE:** 10.0 psi  
**PRESSURE DROP:** 3.0 psi  
**SPECIFIC GRAVITY:** 1.50

**INTENDED USE:** PIPE SIZING BETWEEN FIRST STAGE (HIGH PRESSURE) REGULATOR AND SECOND STAGE (LOW PRESSURE) REGULATOR

<table>
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<tr>
<th>PIPE SIZE (inch)</th>
<th>NOMINAL INSIDE:</th>
<th>ACTUAL:</th>
<th>LENGTH (feet)</th>
<th>CAPACITY IN THOUSANDS OF BTU PER HOUR</th>
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<td>⅞</td>
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<td>2000</td>
<td>335</td>
<td>700</td>
<td>1 320</td>
<td>2 710</td>
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</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa  
* Table entries are rounded to 3 significant digits.
# FUEL GAS PIPING

## TABLE 1315.2(26)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3.1(c)]*

<table>
<thead>
<tr>
<th>NOMINAL:</th>
<th>Actual ID</th>
<th>Length (feet)</th>
<th>Capacity in Thousands of BTU per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>0.622</td>
<td>10</td>
<td>2680</td>
</tr>
<tr>
<td>20%</td>
<td>0.824</td>
<td>20</td>
<td>1840</td>
</tr>
<tr>
<td>30%</td>
<td>1.049</td>
<td>30</td>
<td>1480</td>
</tr>
<tr>
<td>40%</td>
<td>1.380</td>
<td>40</td>
<td>1260</td>
</tr>
<tr>
<td>50%</td>
<td>1.610</td>
<td>50</td>
<td>1120</td>
</tr>
<tr>
<td>60%</td>
<td>2.067</td>
<td>60</td>
<td>1010</td>
</tr>
<tr>
<td>70%</td>
<td>2.469</td>
<td>70</td>
<td>934</td>
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<td>80%</td>
<td>3.068</td>
<td>80</td>
<td>869</td>
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<tr>
<td>90%</td>
<td>3.672</td>
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<tr>
<td>100%</td>
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</table>

**INLET PRESSURE:** 2.0 psi

**PRESSURE DROP:** 1.0 psi

**SPECIFIC GRAVITY:** 1.50

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.
### Table 1315.2(27)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3.1(d)]

**Intended Use:** Pipe sizing between single- or second-stage (low pressure) regulator and appliance.

<table>
<thead>
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<th>Pipe Size (inch)</th>
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<th>1⁄2</th>
<th>3⁄4</th>
<th>1</th>
<th>1 1⁄2</th>
<th>2</th>
<th>2 1⁄2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
<td><strong>Nominal Inside Diameter (inches)</strong></td>
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<td></td>
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<td></td>
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<tr>
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<td>291</td>
<td>608</td>
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<td>2350</td>
<td>3520</td>
<td>6790</td>
<td>10 800</td>
<td>19 100</td>
<td>39 000</td>
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</tr>
</tbody>
</table>

**Notes:**
- For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa
- Table entries are rounded to 3 significant digits.
## TABLE 1315.2(28)
**SEMI-RIGID COPPER TUBING (NFPA 54: TABLE 6.3.1(e))**

**INLET PRESSURE:** 10.0 psi  
**PRESSURE DROP:** 1.0 psi  
**SPECIFIC GRAVITY:** 1.50

<table>
<thead>
<tr>
<th>NOMINAL</th>
<th>K &amp; L:</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>1</th>
<th>1%</th>
<th>1%</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACR:</td>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LENGTH (feet)</th>
<th>CAPACITY IN THOUSANDS OF BTU PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>513 510 510 515 510 530 530 1140 2050 3230 6740</td>
</tr>
<tr>
<td>20</td>
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<tr>
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<td>283 302 302 305 302 320 320 6290 11300 17900 37200</td>
</tr>
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<tr>
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</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

**Notes:**
1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. Table entries are rounded to 3 significant digits.
## TABLE 1315.2(29)
SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.3.1(f)]², ³

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<th>TUBE SIZE (inch)</th>
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<tbody>
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<td>NA 16 28 40 85 153 241 502</td>
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<td>NA 15 26 37 78 141 223 464</td>
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<td>NA 14 25 35 75 135 212 442</td>
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</table>

### NOTES:
1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. Table entries are rounded to 3 significant digits.
3. NA means a flow of less than 10 000 Btu/h (2.93 kW).

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa.
### Table 1315.2(30)

**Semi-Rigid Copper Tubing (NFPA 54: Table 6.3.1(g))**

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<th>K &amp; L:</th>
<th>ACR:</th>
<th>LENGTH (feet)</th>
<th>OUTSIDE:</th>
<th>INSIDE:</th>
<th>CAPACITY IN THOUSANDS OF BTU PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>¼</td>
<td>½</td>
<td>¾</td>
<td>1</td>
<td>¼</td>
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<td></td>
<td>¼</td>
<td>½</td>
<td>¾</td>
<td>1</td>
<td>¼</td>
<td>1½</td>
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<td>0.305</td>
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<td>0.652</td>
<td>0.745</td>
<td>0.995</td>
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<tr>
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<td>0.268</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Inside:</td>
<td>0.350</td>
<td>0.402</td>
<td>0.527</td>
<td>0.652</td>
<td>0.745</td>
<td>0.995</td>
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<td>0.268</td>
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</table>

**Notes:**

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. Table entries are rounded to 3 significant digits.

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa
### Table 1315.2(31)
**Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.3.1(h)]**

<table>
<thead>
<tr>
<th>Flow Designation</th>
<th>Tube Size (EHD)</th>
<th>Length (feet)</th>
<th>Capacity in Thousands of BTU per Hour</th>
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<td>18</td>
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</tr>
<tr>
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<tr>
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<td>50</td>
<td>69</td>
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<tr>
<td>300</td>
<td>8</td>
<td>11</td>
<td>23</td>
</tr>
</tbody>
</table>

For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

**Notes:**

1. Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: \( L = 1.3n \), where \( L \) is additional length (ft) of tubing and \( n \) is the number of additional fittings, bends, or both.

2. Table entries are rounded to 3 significant digits.

3. EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
TABLE 1315.2(32)
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.3.1(i)]1, 2, 3, 4

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<th>46</th>
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<tbody>
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</table>

For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

Notes:

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.5 psi (3.4 kPa) [based on 13 inch water column (3.2 kPa) outlet pressure], DO NOT use THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator are capable of varying with flow rate.

2. CAUTION: Capacities shown in table are capable of exceeding the maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

3. Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: \( L = 1.3n \), where \( L \) is additional length (ft) of tubing and \( n \) is the number of additional fittings, bends, or both.

4. Table entries are rounded to 3 significant digits.

5. EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
### TABLE 1315.2(33)
**CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.3.1(j)]**\(^1, 2, 3, 4\)

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</thead>
<tbody>
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<td>CAPACITY IN THOUSANDS OF BTU PER HOUR</td>
<td></td>
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<td></td>
<td></td>
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<td>1210</td>
<td>1950</td>
<td>2247</td>
<td>3960</td>
<td>4540</td>
<td>8000</td>
<td>9110</td>
<td></td>
</tr>
</tbody>
</table>

For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.5 psi (3.4 kPa) [based on 13 inch water column (3.2 kPa) outlet pressure], DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator are capable of varying with flow rate.

2. CAUTION: Capacities shown in table are capable of exceeding the maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

3. Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: \( L = 1.3n \), where \( L \) is additional length (ft) of tubing and \( n \) is the number of additional fittings, bends, or both.

4. Table entries are rounded to 3 significant digits.

5. EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
### TABLE 1315.2(34)
POLYETHYLENE PLASTIC PIPE [NFPA 54: TABLE 6.3.1(k)]*

**GAS:** UNDILUTED PROPANE  
**INLET PRESSURE:** 11.0 in. w.c.  
**PRESSURE DROP:** 0.5 in. w.c.  
**SPECIFIC GRAVITY:** 1.50

**INTENDED USE:** PE PIPE SIZING BETWEEN INTEGRAL SECOND-STAGE REGULATOR AT TANK OR SECOND-STAGE (LOW PRESSURE) REGULATOR AND BUILDING

<table>
<thead>
<tr>
<th>NOMINAL OD</th>
<th>½</th>
<th>¾</th>
<th>1</th>
<th>1¼</th>
<th>1½</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>DESIGNATION</td>
<td>SDR 9.3</td>
<td>SDR 11</td>
<td>SDR 11</td>
<td>SDR 10</td>
<td>SDR 11</td>
<td>SDR 11</td>
<td>SDR 11</td>
<td>SDR 11</td>
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<tr>
<td>ACTUAL ID</td>
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<td>1.554</td>
<td>1.943</td>
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</table>

**LENGTH (feet)**

<table>
<thead>
<tr>
<th>CAPACITY IN THOUSANDS OF BTU PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
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<tr>
<td>400</td>
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<tr>
<td>450</td>
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<tr>
<td>500</td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.
### TABLE 1315.2(35)
**POLYETHYLENE PLASTIC PIPE [NFPA 54: TABLE 6.3.1(i)]**

<table>
<thead>
<tr>
<th>DESIGNATION: SDR 9.3</th>
<th>SDR 11</th>
<th>SDR 11</th>
<th>SDR 10</th>
<th>SDR 11</th>
<th>SDR 11</th>
<th>SDR 11</th>
<th>SDR 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOMINAL OD: 1/2</td>
<td>0.660</td>
<td>0.860</td>
<td>1.077</td>
<td>1.328</td>
<td>1.554</td>
<td>1.943</td>
<td>2.864</td>
</tr>
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<td></td>
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</tr>
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<td>CAPACITY IN THOUSANDS OF BTU PER HOUR</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
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<td>12400</td>
<td>11200</td>
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<td>22200</td>
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<td>69400</td>
<td>61500</td>
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<td>119000</td>
<td>108000</td>
<td>99100</td>
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</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.
### TABLE 1315.2(36)
POLYETHYLENE PLASTIC TUBING [NFPA 54: TABLE 6.3.1(m)]²

<table>
<thead>
<tr>
<th>GAS: UNDILUTED PROPANE</th>
<th>INLET PRESSURE: 11.0 in. w.c.</th>
<th>PRESSURE DROP: 0.5 in. w.c.</th>
<th>SPECIFIC GRAVITY: 1.50</th>
</tr>
</thead>
</table>

**INTENDED USE:** SIZING BETWEEN INTEGRAL 2-STAGE REGULATOR AT TANK OR SECOND-STAGE (LOW PRESSURE REGULATOR) AND THE BUILDING

<table>
<thead>
<tr>
<th>PLASTIC TUBING SIZE (CTS)¹ (inch)</th>
<th>NOMINAL OD: ¹⁄₂</th>
<th>NOMINAL OD: 1</th>
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<tr>
<td>DESIGNATION: SDR 7</td>
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</table>

<table>
<thead>
<tr>
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<th>30</th>
<th>40</th>
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<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPACITY IN THOUSANDS OF BTU PER HOUR</td>
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<td>121</td>
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<td></td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

**Notes:**

1. CTS = Copper tube size.
2. Table entries are rounded to 3 significant digits.
CHAPTER 14
PROCESS PIPING

1401.0 General.
1401.1 Applicability. Except as otherwise addressed in this code, this chapter shall govern the installation of process piping in or in conjunction with a building or structure located upon the premises.

1402.0 Permit.
1402.1 General. It shall be unlawful to install, alter, or repair or cause to be installed, altered, or repaired process material piping without first obtaining a permit.

Permits for process piping shall show the total number of outlets to be provided for on each system and such other information as required by the Authority Having Jurisdiction.

Fees for process piping permits are included in Table 104.5.

1403.0 Plans Required.
1403.1 General. Plans, engineering calculations, diagrams, and other data shall be submitted in one or more sets with each application for a permit. The Authority Having Jurisdiction shall be permitted to require plans, computations, and specifications to be prepared and designed by a registered design professional.

Where plans or other data are submitted for review, a plan review fee shall be paid, as provided in Section 104.3.2.

1404.0 Workmanship.
1404.1 General. Process piping shall not be strained or bent, nor shall tanks, vessels, vats, appliances, or cabinets be supported by or develop strain or stress on the piping.

1405.0 Inspections.
1405.1 General. Upon completion of the installation, alteration, or repair of process piping, and prior to the use thereof, the Authority Having Jurisdiction shall be notified that such piping is ready for inspection.

Excavations required for the installation of underground piping shall be kept open until such time as the piping has been inspected and approved. Where such piping is covered or concealed before such approval, it shall be exposed upon the direction of the Authority Having Jurisdiction.

1405.2 Required Inspections. The Authority Having Jurisdiction shall make the following inspections and shall either approve that portion of the work as completed or shall notify the permit holder wherein the same fails to be in accordance with this code.

1405.2.1 Rough Piping Inspection. This inspection shall be made after process piping authorized by the permit has been installed and before piping has been covered or concealed. This inspection shall include a determination that the piping size, material, and installation are in accordance with the requirements of this code.

1405.2.2 Final Piping Inspection. This inspection shall be made after piping authorized by the permit has been installed and after portions thereof that are to be covered or concealed are so concealed. This inspection shall include a pressure test, at which time the piping shall stand a pressure of not less than one-and-one-half times the maximum designed operating pressure where hydraulic testing is conducted or 110 percent where testing is conducted pneumatically. Test pressures shall be held for a length of time satisfactory to the Authority Having Jurisdiction, but in no case for less than 30 minutes with no perceptible drop in pressure. HPM drain, waste, and vent piping shall be tested in accordance with the plumbing code. Tests shall be made in the presence of the Authority Having Jurisdiction. Necessary apparatus for conducting tests shall be furnished by the permit holder.

1405.3 Other Inspections. In addition to the inspections required by this section, the Authority Having Jurisdiction shall be permitted to require a special inspector, as specified in the building code, during installation of piping systems. In cases where the work authorized was installed in accordance with plans and specifications prepared by a registered design professional, the Authority Having Jurisdiction shall be permitted to require a final signed report stating that the work was installed in accordance with approved plans and specifications and the applicable provisions of this chapter.

1406.0 Pipe, Tubing, and Fittings.
1406.1 General. Process pipe, tubing, and fittings shall comply with ASME B31.3 and shall be installed in accordance with the manufacturer’s installation instructions. Materials shall be rated for the operating temperatures and pressures of the system, and shall be compatible with the type of liquid.

1406.2 Hazardous Process Piping (HPP). HPP supply piping or tubing in service corridors shall be exposed to view. HPP piping shall be identified in accordance with nationally recognized standards to indicate the material being transported. Liquid HPP piping shall have an approved means for directing spilled materials to an approved containment or drainage system.

Liquid HPP waste or drainage systems shall be installed in accordance with the plumbing code.

1406.2.1 Installation in Exit Corridors and Above Other Occupancies. Hazardous process supply pipe shall not be located within exit corridors, within a portion of a means of egress required to be enclosed in fire-resistant construction, or in concealed spaces in or above
areas not classified as Group H Occupancies, except as permitted by this subsection.

Hazardous production material piping and tubing shall be permitted to be installed within the space defined by the walls of exit corridors and the floor or roof above, or in concealed spaces above other occupancies in accordance with Section 1406.2.1.1 through Section 1406.2.1.6.

1406.2.1.1 Automatic Sprinklers. Automatic sprinklers shall be installed within the space unless the space is less than 6 inches (152 mm) in the least dimension.

1406.2.1.2 Ventilation. Ventilation at not less than 6 air changes per hour (ACH) shall be provided. The space shall not be used to convey air from other areas.

1406.2.1.3 Receptor. Where the piping or tubing is used to transport HPP liquids, a receptor shall be installed below such piping or tubing. The receptor shall be designed to collect discharge or leakage and drain it to an approved location. The 1 hour enclosure shall not be used as part of the receptor.

1406.2.1.4 Separation. HPP supply piping and tubing and HPP nonmetallic waste lines shall be separated from the exit corridor and from an occupancy other than a semiconductor fabrication facility classified as a Group H Occupancy by construction, as required for walls or partitions that have a fire-protection rating of not less than 1 hour. Where gypsum wallboard is used, joints on the piping side of the enclosure need not be taped, provided the joints occur over framing members. Access openings into the enclosure shall be protected by approved fire assemblies.

1406.2.1.5 Emergency Shutoff Valves. Readily accessible manual or automatic remotely activated fail-safe emergency shutoff valves shall be installed on piping and tubing other than waste lines at the following locations:

1. At branch connections into the fabrication area.
2. At entries into exit corridors. Excess flow valves shall be installed as required by the fire code.

1406.2.1.6 Electrical Wiring. Electrical wiring and equipment located in the piping space shall be approved for Class I, Division 2, Hazardous Locations.

Exception: Occasional transverse crossing of the corridors by supply piping that is enclosed within the corridor need not comply with Section 1406.2.1.1 through Section 1406.2.1.6.

1406.3 Special Requirements for HPP Gases. In addition to other requirements of this section, HPP gases shall comply with this subsection and the fire code.

1406.3.1 Special Provisions. Where HPP supply gas is carried in pressurized piping, a fail-safe system shall shut off flow due to a rupture in the piping. Where the piping originates from outside the building, the valve shall be located outside the building as close to the bulk source as practical.

1406.3.2 Piping and Tubing Installation. Piping and tubing shall be installed in accordance with approved standards. Supply piping for hazardous production materials having a health hazard ranking of 3 or 4 shall have welded connections throughout, unless an exhausted enclosure is provided.

Exception: Material that is incompatible with ferrous piping shall be permitted to be installed in nonmetallic piping with approved connections.

1406.3.3 Gas-Detection System. Where hazardous production material gas is used or dispensed and the physiological warning properties of the gas are at a higher level than the accepted permissible exposure limit (PEL) of the gas, a continuous gas-monitoring system shall be provided to detect the presence of the short-term hazard condition. Where dispensing occurs and flammable gases or vapors are capable of being present in quantities in excess of 25 percent of the lower explosive limit (LEL), a continuous gas-monitoring system shall be connected to the emergency control station. The maximum permitted time-weighted average exposures to be utilized shall be as published in 29 CFR 1910.1000.
CHAPTER 15
SOLAR ENERGY SYSTEMS

1501.0 General.
1501.1 Applicability. See Section 1203.0 and the Uniform Solar, Hydronics and Geothermal Code (USHGC), published by the International Association of Plumbing and Mechanical Officials. The Uniform Solar, Hydronics and Geothermal Code (USHGC) provides requirements that shall be permitted to be adopted as part of the code by the Authority Having Jurisdiction.
CHAPTER 16
STATIONARY POWER PLANTS

1601.0 Stationary Fuel Cell Power Plants.
1601.1 General. Fuel cell power plants with a power output of less than 50 kW shall be listed in accordance with ANSI/CSA FC 1 and installed in accordance with the manufacturer’s instructions. Fuel cell power plants with a power output of greater than 50 kW shall be installed in accordance with NFPA 853. [NFPA 54:10.30 10.29] Stationary fuel cell power plants shall be tested in accordance with CSA FC 1.

1602.0 Stationary Gas Engines and Generators.
1602.1 General. The installation of gas engines shall conform to NFPA 37. [NFPA 54:10.23 10.22]
1602.2 Connection to the Gas Supply Piping. Stationary gas engines shall not be rigidly connected to the gas supply piping. [NFPA 54:10.23.1 10.22.1]
1602.3 Stationary Engine Generators. Stationary engine generators shall be tested in accordance with UL 2200, and shall be installed in accordance with NFPA 37 and the manufacturer’s installation instructions.
APPENDIX F CHAPTER 17
GEOTHERMAL ENERGY SYSTEMS AND DISTRICT AMBIENT TEMPERATURE LOOPS

Part I – General.

F.101.0 1701.0 General.

F.101.1 1701.1 Applicability. Part I of this appendix chapter shall apply to geothermal energy systems such as, but not limited to, building systems coupled with a ground-heat exchanger, submerged heat exchanger using water-based fluid as a heat transfer medium, or groundwater (well). The regulations of this appendix chapter shall govern the construction, location and installation of geothermal energy systems.

Indoor piping, fittings, and accessories that are part of the groundwater system shall be in accordance with Section F.101.4 and Chapter 12.

Part I through Part V of this chapter shall apply to geothermal energy systems and district thermal systems that circulate ground-ambient-temperature water to be used in end-use buildings as a thermal source or sink via water source heat pump or reversing chiller. The systems shall operate to permit independent and bi-directional heating and cooling for comfort and water heating such as, but not limited to, building systems coupled with ground ambient district loops, a ground-heat exchanger, submerged heat exchanger using water-based fluid as a heat transfer medium, or groundwater (well), or such local resources to the advantage of the district. Central district auxiliary components shall add or reject heat to benefit district ability to reduce both power consumption and demand combined with energy sharing. The regulations of this chapter shall govern the construction, location and installation of ground-ambient-temperature thermal distribution districts from 100 percent geothermal energy system to multiple hybrid district systems.

F.101.1.1 1701.1.1 Prior to Construction. Documents for permits shall be submitted prior to the construction of a building system, ground-heat exchanger, submerged heat exchanger, or water well. Permits shall be issued by the Authority Having Jurisdiction.

F.101.1.2 1701.1.2 Equipment, Accessories, Components, and Materials. The mechanical equipment, accessories, components, and materials used shall be of the type and rating approved for the specific use.

F.101.1.3 1701.1.3 Indoor Piping. Indoor piping, fittings, and accessories that are part of the groundwater system shall be in accordance with Section 1704.4 and Chapter 12.

F.101.2 1701.2 Construction Documents. The construction documents for the building system portion of the geothermal energy system shall be submitted to the Authority Having Jurisdiction.

F.101.3 1701.3 Site Survey. A site survey shall be conducted prior to designing the geothermal system. The requirements for construction documents shall be defined by the Authority Having Jurisdiction. Where no guidance is provided, the following information shall be provided:

1. Ground-heat exchanger dimensions.
2. Grout or sealing specifications, as applicable.
3. Dimensions from building to water well, ground-heat exchanger, or submerged heat exchanger.
4. Operating temperatures and pressures.

F.101.4 1701.4 Used Materials. The installation of used pipe, fittings, valves, and other materials shall not be permitted.

F.101.5 1701.5 Contact with Building Material. A ground source heat pump ground-loop piping system shall not be in direct contact with building materials that cause the piping or fitting material to degrade or corrode, or that interferes with the operation of the system.

F.101.6 1701.6 Strains and Stresses. Piping shall be installed so as to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction, and structural settlement. Piping shall be installed so as to avoid structural stresses or strains within building components.

F.101.7 1701.7 Flood Hazard. Piping located in a flood hazard area shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation.

F.101.8 1701.8 Pipe Support. Pipe shall be supported in accordance with Section 313.1.

F.101.9 1701.9 Velocities. Ground source heat pump ground-loop systems shall be designed so that the flow velocities do not exceed the maximum flow velocity recommended by the pipe and fittings manufacturer. Flow velocities shall be controlled to reduce the possibility of water hammer.

F.101.10 1701.10 Chemical Compatibility. Antifreeze and other materials used in the system shall be chemically compatible with the pipe, tubing, fittings, and mechanical systems.

F.101.11 1701.11 Transfer Fluid. The heat transfer fluid shall be compatible with the makeup water fluid supplied to the system.

F.101.2 Definitions.

Geothermal Energy System. A system that uses thermal energy for space heating and cooling, and water heating.

Ground-Heat Exchanger. An underground closed-loop heat exchanger through which a heat transfer medium passes to and from a heat pump or other rated mechanical equipment.
It includes the buried pipe and connecting main(s) up to and terminating with the building. Groundwater Source. A geothermal energy system that uses the groundwater as a heat source or sink. Water Well. An excavation that is drilled, cored, bored, washed, driven, dug, jetted, or otherwise constructed for the purpose of extracting groundwater, using the geothermal properties of the earth or injecting water into an aquifer or subsurface reservoir.

F-103.0 1702.0 Groundwater Systems.

F-103.1 1702.1 General. The potable water supply connected to a groundwater system shall be protected with an approved backflow prevention device. The connection of a discharge line to the sanitary or storm sewer system, or private sewage disposal system, shall be in accordance with the plumbing code or in accordance with the Authority Having Jurisdiction.

F-104.0 1703.0 Design of Systems.

F-104.1 1703.1 Ground-Heat Exchanger Design. The ground-heat exchanger design shall be provided by a licensed professional or a designer with the appropriate certifications or credentials as defined by the Authority Having Jurisdiction.

F-104.2 1703.2 Piping and Tubing Materials Standards. For water-based systems, ground source heat pump ground-loop pipe and tubing shall comply with the standards listed in Table F-104.2 1703.2. Piping and tubing used for DX systems shall be of copper in accordance with Section F-401.3 1715.3.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Density Polyethylene (HDPE)</td>
<td>ASTM D2683, ASTM D3261, ASTM F1055, CSA B137.1, CSA/IGSHPA C448, NSF 358-1</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>ASTM F2389, CSA B137.11, NSF 358-2</td>
</tr>
</tbody>
</table>

F-104.3 1703.3 Fittings. For water-based systems, fittings for ground source heat pump systems shall be approved for installation with the piping materials to be installed, and shall comply with the standards listed in Table F-104.3 1703.3. Fittings for use in DX systems shall comply with Section F-401.3 1715.3.
(2) Socket-fusion joints shall be made in accordance with ASTM F2620.
(3) Electrofusion joints shall be made in accordance with ASTM F1055.

**F 104.4.2 1703.4.2 Cross-Linked Polyethylene (PEX).** Cross-linked polyethylene pipe shall be manufactured in accordance with the standards listed in Table F 104.3 1703.3. PEX shall have a minimum tubing material designation code of PEX 1206 and shall have a minimum pressure rating of not less than 160 psi (1103 kPa) at 73°F (23°C).

**F 104.4.2.1 1703.4.2.1 Joining Methods for Cross-Linked Polyethylene Tubing.** Joints between cross-linked polyethylene (PEX) pipe or tubing and fittings shall be installed in accordance with the manufacturer’s installation instructions and the appropriate standards in accordance with Table F 104.3 1703.3.

**F 104.5 1703.5 Indoor Piping.** Indoor piping, fittings, and accessories that are part of the groundwater system shall be in accordance with Chapter 12. Such materials shall be rated for the operating temperature and pressures of the system and shall be compatible with the type of transfer medium.

**F 105.0 1704.0 Heat Pumps.**

**F 105.1 1704.1 Heat Pump Distribution System.** The heat pump distribution system shall be designed as follows:

1. Individual heat pumps shall have the capacity to handle the peak load for each zone at its peak hour.
2. Distribution piping and fittings shall be insulated to prevent condensation inside the building.
3. An isolation valve shall be installed on both supply and return of each unit.
4. Condensate drains on heat pumps shall be installed in accordance with the manufacturer’s installation instructions.
5. Air filters shall be installed for heat pump units.
6. Drain valves shall be installed at the base of each supply and return pipe riser for system flushing.
7. Piping shall be supported in accordance with Section 313.0 and provisions for vibration, expansion or contraction shall be provided.
8. Specifications for each heat pump, the heating and cooling capacity, the fluid flow rate, the airflow rate, and the external pressure or head shall be provided on the construction documents.
9. Manually controlled air vents shall be installed at the high points in the system and drains at the low points. Where the heat-transfer fluid is a salt or alcohol, automatic air vents shall not be installed.
10. Means for flow balancing for the building loop shall be provided.

(11) Supply and return header temperatures and pressures shall be marked.

**F 105.2 1704.2 Circulating Pumps.** The circulating pump shall be sized for the operating conditions and the heat transfer fluid properties.

**F 106.0 1705.0 Valves.**

**F 106.1 1705.1 Where Required.** Shutoff valves shall be installed in ground source-loop piping systems in the locations indicated in Section F 106.2 1705.2 through Section F 106.8 1705.8.

**F 106.2 1705.2 Heat Exchangers.** Shutoff valves shall be installed on the supply and return side of a heat exchanger except where the heat exchanger is integral with a boiler or is a component of a manufacturer’s boiler and heat exchanger packaged unit, and is capable of being isolated from the hydronic system by the supply and return valves.

**F 106.3 1705.3 Central Systems.** Shutoff valves shall be installed on the building supply and return of a central utility system.

**F 106.4 1705.4 Pressure Vessels.** Shutoff valves shall be installed on the connection to a pressure vessel.

**F 106.5 1705.5 Pressure-Reducing Valves.** Shutoff valves shall be installed on both sides of a pressure-reducing valve.

**F 106.6 1705.6 Equipment and Appliances.** Shutoff valves shall be installed on connections to mechanical equipment and appliances. This requirement does not apply to components of a ground source loop system such as pumps, air separators, metering devices, and similar equipment.

**F 106.7 1705.7 Expansion Tanks.** Shutoff valves shall be installed at connections to nondiaphragm-type expansion tanks.

**F 106.8 1705.8 Reduced Pressure.** A pressure relief valve shall be installed on the low-pressure side of a hydronic piping system that has been reduced in pressure. The relief valve shall be set at the maximum pressure of the system design.

**F 107.0 1706.0 Specific System Components Design.**

**F 107.1 1706.1 General.** Heat pumps shall be in compliance with Table 1706.1, as applicable. Heat pumps shall also be listed and labeled in accordance with UL 1995 or UL 60335-2-40. Ground coupled and water source heat pumps shall be certified in accordance with AHRI/ASHRAE/ISO 13256-1 for water-to-air heat pumps and AHRI/ASHRAE/ISO 13256-2 for water-to-water heat pumps. DX heat pumps shall be certified in accordance with ASHRAE 194. All heat pump equipment used in DX systems shall comply with AHRI 870. Heat pumps shall be fitted with a means to indicate that the compressor is locked out.
TABLE 1706.1
HEAT PUMPS

<table>
<thead>
<tr>
<th>TYPE OF HEAT PUMP</th>
<th>STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-to-Air</td>
<td>AHRI/ASHRAE/ISO 13256-1</td>
</tr>
<tr>
<td>Water-to-Water</td>
<td>AHRI/ASHRAE/ISO 13256-2</td>
</tr>
</tbody>
</table>

**F 107.2 1706.2** Heat Exchangers. Heat exchangers used for heat transfer or heat recovery shall protect the potable water system from being contaminated by the heat transfer medium. Single-wall heat exchangers shall comply with Section 1218.1. Double-wall heat exchangers shall separate the potable water from the heat transfer medium by providing a space between the two walls that are vented to the atmosphere.

**F 107.3 1706.3** Heat-Transfer Medium. The heat-transfer medium shall be compatible with components with which it comes into contact. Where antifreeze or corrosion inhibitors are used, such solutions shall be approved by the Authority Having Jurisdiction. The heat-transfer fluid flash point shall be not less than 50°F (27.8°C) above the maximum system operating temperature. For DX systems, the heat transfer medium shall be a refrigerant listed in ASHRAE 34 or this code.

**F 107.4 1706.4** Insulation. The temperature of surfaces within reach of building occupants shall not exceed 140°F (60°C) unless they are protected by insulation. Where sleeves are installed, the sleeve insulation shall retain its full size over the length of the material being protected.

**F 108.0 1707.0** Installation Practices.

**F 108.1 1707.1** Prior to Construction. Documents for permits shall be submitted prior to the construction of a building system, or water well. Permits shall be issued by the Authority Having Jurisdiction.

**F 108.2 1707.2** Equipment, Accessories, Components, and Materials. The mechanical equipment, accessories, components, and materials used shall be of the type and rating approved for the specific use.

**F 108.3 1707.3** Construction Documents. The construction documents for the building system portion of the geothermal energy system shall be submitted to the Authority Having Jurisdiction.

**F 108.4 1707.4** Site Survey Requirements. The site survey shall identify the physical limitations of the land area, including its extent, structures, existing wells of all types, proximity of other existing ground source heat pump systems, pavements, trees, grading, ponds, waterways, easements, overhead and underground services, septic systems, any identified septic repair areas, utility of rights-of-way, and any other elements that could affect an open-loop configuration.

Permission shall be obtained from any adjoining property owner(s), as evidenced by the registration and approval of a formal easement that meets requirements of the Authority Having Jurisdiction. It shall be received prior to the installation of any open-loop system that will extend into, cross, or interfere with the equipment or rights-of-way of utilities, jurisdictions, and other property owners.

The site survey shall include a subsurface investigation that meets the requirements for an open-loop heat exchanger.

**F 108.5 1707.5** Subsurface Investigation. A subsurface investigation shall be performed in accordance with Section F 108.6 1707.6 as determined by the registered design professional conducting the site survey.

**F 108.6 1707.6** Subsurface Conditions. The water well logs and other geological records shall be used to anticipate the subsurface conditions of the aquifer and its potential supply of fresh water, multiple aquifers, saltwater intrusions, contaminated soils and groundwater, hazardous gases, and any interference with neighboring water wells and ground source heat exchangers.

Geological issues such as permafrost conditions and building stability shall be considered when reviewing available records.

**F 108.7 1707.7** Ground-Heat Exchanger Installation Practices. A ground-heat exchanger system shall be installed as follows:

1. Outside piping or tubing located within 5 feet (1524 mm) of any wall or structure shall be continuously insulated with insulation that has a minimum R-5 value. Such pipe or tubing installed under the slab or basement floors shall be insulated within 5 feet (1524 mm) from the structure to the exterior point of exit from the slab.

2. Freeze protection shall be provided where the design of the ground-heat exchanger system would permit the heat-transfer medium to freeze.

3. Horizontal piping shall be installed not less than 12 inches (305 mm) below the frost line.

4. Submerged heat exchangers shall be protected from damage and shall be securely fastened to the bottom of the lake or pond, or other approved submerged structure.

5. A minimum separation distance shall be maintained between the potable water intake and the submerged heat exchanger system in accordance with the Authority Having Jurisdiction.

6. Vertical and horizontal ground-heat exchangers shall maintain the following setbacks:

   a. Ten feet (3048 mm) horizontally from a pressure-tested sewer lateral into a building.

   b. Twenty feet (6096 mm) horizontally from a non-pressure tested sewer lateral into a building.

   c. Three feet (914 mm) horizontally from buried utilities such as electrical, gas, or water.

   d. Fifty feet (15 240 mm) from a water well.

   e. Fifty feet (15 240 mm) from a septic tank and 100 feet (30 480 mm) from a subsurface sewage leaching field.

   f. One hundred feet (30 480 mm) from a spring; or at distances specified by the Authority Having Jurisdiction.
(7) Wells and boreholes shall be sealed in accordance with the Authority Having Jurisdiction. Where grout is required, it shall be applied in a single continuous operation from the bottom of the borehole by pumping through a tremie pipe.

F 108.8 1707.8 Trenching, Excavation, and Backfill. Prior to excavation, trenching, or drilling, buried utilities, drainage, water, and irrigation systems shall be located. Prior to excavation, trenching, or drilling, the contractor, and owner shall agree in writing to site restoration requirements and submit to the Authority Having Jurisdiction for approval. Prior to any excavation, trenching, or drilling, all buried utilities including drainage and irrigation systems shall be located and flagged by the appropriate utility and ground source heat pump system contractor representative.

F 108.9 1707.9 Trenches, Tunneling, and Driving. Trenches shall comply with Section 317.1. Tunneling and driving shall comply with Section 317.2.

F 108.10 1707.10 Excavations and Open Trenches. Excavations required to be made for the installation of piping or tubing shall be in accordance with Section 317.3. Piping or tubing shall be supported to maintain its alignment and prevent sagging. Piping in the ground shall be laid on a firm bed for its entire length; where other support is otherwise provided, it shall be approved in accordance with Section 302.0. Piping or tubing shall be backfilled after an inspection in accordance with Section 317.4.

F 108.11 1707.11 Protection of Piping, Materials, and Structures. Piping and tubing passing under or through walls shall be protected from breakage in accordance with Section 316.1. Piping and tubing shall be installed in accordance with Section 316.2 to provide for expansion, contraction, and structural settlement. An electrically continuous corrosion-resistant tracer wire (not less than AWG 14) or tape shall be buried with the plastic pipe to facilitate locating. One end shall be brought aboveground at a building wall or riser.

F 108.12 1707.12 Sleeves. In exterior walls, annular space between sleeves and pipes shall be sealed and made watertight and shall not be subject to a load from building construction in accordance with Section 316.7 through Section 316.7.2.

F 108.13 1707.13 Steel Nail Plates. Steel nail plates shall be installed for plastic and copper piping penetrating framing members to within 1 inch (25.4 mm) of the exposed framing in accordance with Section 316.6.

F 108.14 1707.14 Exterior Piping Protection. Exterior piping shall be fitted with end caps and protected from freezing, UV radiation, corrosion, and degradation.

F 108.15 1707.15 Heat Pump and Distribution System Installation. The heat pump and distribution system shall be installed in accordance with the system’s design, with this code, and the manufacturer’s installation instructions.

F 108.16 1707.16 Pressurizing During Installation. Ground source heat pump ground loop piping to be embedded in concrete shall be pressure tested prior to pouring concrete. During pouring, the pipe shall be maintained at the proposed operating pressure.

F 108.17 1707.17 Horizontal Geothermal Piping - Materials and Methods. Horizontal geothermal piping shall be in accordance with Section F 108.17.1 through Section F 108.18.8.

F 108.17.1 1707.17.1 Piping Material. Piping materials and joining methods for horizontal piping from the ground-heat exchanger shall be in accordance with Section F 104.1. Section F 104.2, Section F 104.3, Section F 104.4, Section F 401.2, Section F 401.3, Section F 401.4, Section F 401.5, Section 1703.2, Section 1703.3, Section 1703.4, Section 1703.5 and Section 1715.3.

F 108.17.2 1707.17.2 Dissimilar Materials. Transition fittings between dissimilar materials shall be inside or accessible.

F 108.17.3 1707.17.3 Protection of Piping. Pipes passing through walls shall be sleeved and sealed in accordance with Section 316.0.

F 108.18 1707.18 Trenches, Excavation, and Backfill. Excavation for horizontal piping shall comply with Section F 108.18.1 through Section F 108.18.8 and in accordance with the requirements of the Authority Having Jurisdiction. Prior to any excavation, trenching, or drilling, all buried utilities including drainage, and irrigation systems shall be located and flagged by the appropriate utility and ground source heat pump system contractor representative.

F 108.18.1 1707.18.1 Trenches. Trenches for underground piping or tubing shall be excavated in accordance with the setback requirements in Section F 104.1.1 through Section F 104.1.4.

F 108.18.2 1707.18.2 Buried Systems. Buried open-loop system piping, shall be installed not less than 3.3 feet (1006 mm) below the finished grade.

F 108.18.3 1707.18.3 Pipe Installation. Piping in horizontal trenches shall be embedded with not less than 6 inches (152 mm) of inert granular material above and below, or in accordance with the Authority Having Jurisdiction and project specifications.

Horizontal piping trenching shall be backfilled with approved material and shall be compacted.

F 108.18.4 1707.18.4 Separation. The horizontal piping shall be separated from fluid-based onsite service systems to prevent excessive short-circuiting heat transfer between such systems.

F 108.18.5 1707.18.5 Insulation. Insulation shall be provided on the piping where there is close proximity of all site services to prevent thermal interference between fluid-based onsite service systems.

F 108.18.6 1707.18.6 Pipe Bends. Sharp bending of pipe shall be prevented or approved elbow fitting shall be used with a bend-radius in accordance with the manufacturer’s installation instructions.

F 108.18.7 1707.18.7 Closed Cell Insulation. Buried horizontal open-loop system pipes passing parallel within 5 feet (1524 mm) of a wall, structure, or water pipe shall be insulated with R-2 minimum closed cell insulation.
**F-109.0 1708.0 System Start-Up.**

**F-109.1 1708.1 General.** The following requirements shall be verified prior to system start-up:

(1) Piping shall be cleaned, flushed, and purged.

(2) The ground-heat exchanger and building piping shall be cleaned, flushed, and, where required, shall be filled with the heat transfer fluid medium. The ground loop system shall be tested at the design flow rate(s) and differential pressure(s) recorded. Where the actual pressure change at design flow is more than +/- 10 percent of the design flow pressure drop, the cause shall be identified and corrective action taken.

(3) A method for the removal of air and a method for adding heat transfer fluid (where necessary) shall be provided.

(4) The heat pumps shall be operational and adjustments shall be made in accordance with the manufacturer’s installation instructions.

(5) All necessary additional flow tests of the ground-heat exchanger shall be completed prior to heat pump start-up.

(6) Ground-heat exchanger and building piping, valves, and operating controls, shall be set, adjusted, and operating as required.

(7) The system shall be labeled at the loop charging valves with a permanent-type label, indicating the type of heat transfer fluid used. Where antifreeze is used, the labels shall indicate the antifreeze type and concentration.

(8) Supply and return lines, as well as associated isolation valves from individual boreholes or water wells, shall be identified and tagged.

(9) Supply and return lines on submerged systems shall be identified in an approved manner, at the point of entry to a surface water resource.

**F-109.2 1708.2 Operation and Maintenance Manual.**

An operation and maintenance manual for the geothermal system shall be provided to the owner. The manual shall include information on required testing and maintenance of the system. Training shall be provided on the system’s operation, maintenance requirements, and on the content of the operation and maintenance manual. The operation and maintenance manual shall contain a layout of the ground-heat exchanger and building loop.

**F-109.3 1708.3 Labeling and Marking.** Ground source heat pump ground-loop system piping shall be marked with tape, metal tags, or other methods where it enters a building. The marking shall indicate the following words: “GROUND SOURCE HEAT PUMP LOOP SYSTEM.” The marking shall indicate antifreeze used in the system by name and concentration.

**F-109.4 1708.4 Documentation.** The ground source heat pump system as-built installation drawings and instructions shall be provided to the building owner or designated agent.

**F-109.5 1708.5 Maintenance.** The periodic maintenance required, in accordance with the design requirements, shall be provided and be made available to the owner or designated agent.

**F-109.6 1708.6 Records.** The ground source heat pump system construction documents shall be provided to the owner.

**F-109.7 1708.7 System Start-Up.** System start-up shall be in accordance with CSA C448.1, CSA C448.2, and Section F-109.0 1708.0.

**F-109.8 1708.8 Contaminants.** Particulate contaminants shall be removed from the indoor piping system prior to initial start-up.

**F-110.0 1709.0 Decommissioning and Abandonment.**

**F-110.1 1709.1 General.** Decommissioning of geothermal systems shall comply with CSA/IGSHPA C448. Prior to the abandonment or decommissioning of geothermal systems, the owner shall obtain the necessary permits from the Authority Having Jurisdiction.

### Part II – Closed-Loop Systems.

**F-201.0 1710.0 General.**

**F-201.3 1710.1 Applicability.** Part II of this chapter shall apply to geothermal energy systems such as, but not limited to, building systems coupled with a closed-loop system using water-based fluid as a heat transfer medium.

**F-201.2 1710.2 Piping and Tubing.** Piping and tubing for closed-loop systems shall be in accordance with Section F-104.2 1703.2 and Table F-104.2 1703.2.

**F-201.3 1710.3 Borehole Piping and Tubing.** Borehole piping or tubing for vertical and horizontally drilled closed-loop systems shall have a minimum wall thickness equal to SDR-11 and shall have a minimum pressure rating of not less than 160 psi (1103 kPa) at 73°F (23°C).

**F-201.4 1710.4 Underground Fittings.** Underground fittings for closed-loop systems shall be in accordance with Section F-104.3 1703.3 and Table F-104.3 1703.3.

**F-201.5 1710.5 Verification.** For closed-loop systems, the system shall be flushed of debris and purged of air after completion of the entire ground-heat exchanger. Flow rates and pressure drops shall be compared to calculated values to assure no blockage or kinking of the pipe. A report shall be submitted to the owner to confirm that the loop flow is in accordance with the construction documents.
**F 201.6 1710.6 Vertical Boreholes.** Vertical boreholes shall be drilled to a depth to provide complete insertion of the u-bend pipe to its specified depth. The borehole diameter shall be sized for the installation and placement of the heat exchange u-bend and the tremie used to place the grouting material. CSA/IGSHPA C448 shall be used for vertical loop depth and borehole diameter sizing guidance. The u-bend joint and pipe shall be visually inspected for integrity in accordance with the manufacturer’s installation instructions. The u-bend joint and pipe shall be pressurized to not less than 100 psi (689 kPa), not to exceed the pressure rating of the pipe at the test temperature, for 1 hour to check for leaks before insertion into the borehole.

**F 201.6.1 1710.6.1 Backfill.** Bentonite grout and thermally-enhanced bentonite grout, where used to seal and backfill each borehole, shall comply with NSF 60. Boreholes shall be backfilled in accordance with the Authority Having Jurisdiction.

**F 201.6.2 1710.6.2 U-Bends and Headers.** Headers, u-bends and ground loop pipes shall be pressure-tested in accordance with CSA/IGSHPA C448, or as required by the Authority Having Jurisdiction. Before testing, heat fusion joints shall be cooled to ambient temperature. Mechanical joints shall be completely assembled. Flushing and purging to remove air and debris shall be completed before testing. The assembly shall be filled with water (or water/antifreeze solution) and purged at a minimum flow rate of 2 feet per second (0.6 m/s) to remove air, but not more than the maximum flow velocity recommended by the pipe and fittings manufacturer to remove debris.

**F 201.6.2.1 1710.6.2.1 Test Pressure.** The maximum test pressure shall be 1.5 times the system design pressure, as determined by Section F 201.6.2.2, 1710.6.2.3, or Section F 201.6.2.4, 1710.6.2.4, not to exceed 100 psi (689 kPa). Components or devices with lower pressure-ratings than the pipe shall be protected from excessive pressure during testing by removing or isolating from the test section.

**Exception:** Where lower pressure-rated components or devices cannot be removed or isolated from the test section, the maximum test pressure shall not exceed the pressure rating of the component or device.

**F 201.6.2.2 1710.6.2.2 Testing Procedure.** The test section and the test liquid shall be at the same temperature. The test section shall be filled with liquid and purged of air. The test section shall be brought to the specified test pressure. Test pressure shall be maintained for 4 hours, with makeup additional fluid added as needed. The test pressure shall be reduced by 10 psi (69 kPa) and monitored for 1 hour with no addition of pressure or makeup additional fluid. A passing test is indicated where after a period of 1 hour no visual leakage is observed, and pressure remains equal to or greater than 95 percent of the original pressure.

**F 201.6.2.3 1710.6.2.3 Calculation of Static Pressure (Water).** For water, the static pressure applied shall be equivalent to 0.43 psig (2.96 kPa) per foot (305 mm) of elevation.

**F 201.6.2.4 1710.6.2.4 Calculation of Static Pressure (Other Fluids).** For fluids of different density, the static pressure shall be calculated using the density of the system fluid.

**F 202.0 1711.0 Ground-Heat Exchanger Testing.**

**F 202.1 1711.1 Testing.** Pressure-testing of the ground-heat exchanger shall be performed in accordance with the testing method in Section F 201.6.

**F 202.2 1711.2 Individual Loop Pressure Testing.** Individual loop testing shall be performed as required by the Authority Having Jurisdiction.

**F 202.3 1711.3 Field Pressure Testing – Final.** The ground-heat exchanger and building piping shall be cleaned, flushed, and, where required, shall be filled with the heat transfer fluid medium. The ground loop system shall be tested at the design flow rate(s) and differential pressure(s) recorded. Where the actual pressure change at design flow is more than +/- 10 percent of the design flow pressure drop, the cause shall be identified, and corrective action taken.

**F 202.4 1711.4 Field Flow Testing – Final.** Final field flow testing shall be performed as required by the Authority Having Jurisdiction.

**Part III – Open-Loop Systems.**

**F 304.0 1712.0 General.**

**F 304.1 1712.1 Applicability.** Part III of this appendix shall apply to geothermal energy systems such as, but not limited to, building systems coupled with a groundwater (well) or surface water open-loop using water-based fluid as a heat transfer medium. The regulations of this appendix shall govern the construction, location and installation of geothermal energy systems.

Indoor piping, fittings, and accessories that are part of the groundwater system shall be in accordance with Section F 104.4 1703.4 and Chapter 12.

**F 304.2 1712.2 Test Wells.** Test wells drilled to investigate subsurface conditions shall provide details of the groundwater location, chemical and physical characteristics, rock strata, and temperature profiles. The number of test wells shall be determined in accordance with the Authority Having Jurisdiction. Each test well shall be tested for flow rate for a period of not less than 24 hours. Water samples shall be collected in accordance with NGWA-01 from each well to establish existing water quality levels are approved for groundwater system use. Water samples shall be analyzed for standard drinking water, fecal and coliform content, bacterial iron, nitrate, dissolved minerals, pH, hardness, and other compounds in accordance with NGWA-01 or in accordance with the Authority.
Having Jurisdiction. Wells shall be tested for water production and recovery. Monitoring wells shall be protected, and marked to allow for monitoring of ground temperature, groundwater levels, and groundwater quality.

**F 301.3 1712.3 Installation of Water Wells.** Water supply, recharge wells, and pumping equipment shall be hydraulically tested, sealed, and grouted in accordance with approved well construction practices and submitted to the Authority Having Jurisdiction for approval. Wells shall be tested for water production and recovery, water quality before final system design. Wells shall be disinfected upon completion in accordance with NGWA-01 or in accordance with the Authority Having Jurisdiction. A copy of the water quality test results and the log of well construction in accordance with NGWA-01 shall be provided to the owner.

**F 301.4 1712.4 Setbacks.** Open-loop ground-heat exchangers shall maintain the following minimum setbacks or at distances specified by the Authority Having Jurisdiction:

1. Ten feet (3048 mm) horizontally from a pressure-tested sewer lateral into a building.
2. Twenty feet (6096 mm) horizontally from a non-pressure tested sewer lateral into a building.
3. Three feet (914 mm) horizontally from buried utilities such as electrical, gas, or water.
4. Fifty feet (15 240 mm) from a water well.
5. Fifty feet (15 240 mm) from a septic tank and 100 feet (30 480 mm) from a subsurface sewage leaching field.
6. One hundred feet (30 480 mm) from a spring.

**F 302.0 1713.0 Open Ground Water Systems.**

**F 302.4 1713.1 General.** The installation and use of water wells shall be in accordance with the Authority Having Jurisdiction. The water well records shall include well logs, pumping tests, and aquifer information.

**F 302.2 1713.2 Open-Loop Water Well Drilling Logs.** The water well drilling logs shall include the following:

1. The subsurface stratigraphy.
2. The aquifer type and conditions such as, but not limited to, confined, unconfined, flowing and depth.
3. The drilling method used and the penetration speed.
4. The presence of substances known to have a potential risk to health and safety shall be documented in the drill logs and the property owner shall be advised of the potential risk to health and safety.

**F 303.3 1713.3 Design Considerations.** A groundwater heat pump system shall be designed by a registered design professional. Due design consideration shall be given to the following:

1. Where multiple heat pumps or fan coils are connected to a common water loop, a diversified building design load shall be used to design a ground water heat pump.
2. The water supply well(s) and injection wells, or water discharge system, shall be capable of being operated at sustainable pumping rates that exceed the maximum daily requirements without causing an adverse impact to existing or future offsite uses of groundwater or surface water bodies.
3. The water temperature and the quality and chemical composition of the water resource are in accordance with the system manufacturer’s recommendations.
4. The groundwater and surface water resources shall be protected by returning water to the source aquifer or an aquifer with the same water quality, or a surface water body.
5. The return capacity of the injection, or surface water body discharge system, shall be suitable under winter conditions.
6. The temperature of the return water shall have no adverse thermal impacts on offsite existing or future uses of groundwater, or on surface water bodies, in accordance with the requirements of the Authority Having Jurisdiction.
7. Pressure gauges shall be provided to aid in start-up and monitoring of the system during operation.
8. The ability to switch over operation of supply and return wells for 100 percent of standby, redevelopment, cleaning of wells, and the thermal balancing of the ground and aquifer shall be provided.
9. There shall be no adverse effects on the quality and quantity of offsite existing or future users of groundwater, in accordance with the requirements of the Authority Having Jurisdiction.

**F 302.4 1714.4 Water Wells and Injection Wells.** Water wells and injection wells for groundwater heat pump systems shall be installed and tested by a registered design professional who is qualified to drill wells that comply with the requirements of the Authority Having Jurisdiction.

- Water supply wells and injection wells shall be disinfected upon completion in accordance with NGWA-01.
- The test result and the log of well construction in accordance with NGWA-01 shall be provided to the owner.
- The well logs and the property owner shall be advised of the potential risk to health and safety.
- The subsurface stratigraphy and the penetration speed shall be documented in the drill logs and the property owner shall be advised of the potential risk to health and safety.
- The presence of substances known to have a potential risk to health and safety shall be documented in the drill logs and the property owner shall be advised of the potential risk to health and safety.
- The operating conditions of the water supply wells and injection wells shall be evaluated and verified with a variable rate pumping.
on the groundwater flow requirements shall be confirmed with a constant rate-pumping test. The constant rate-pumping test shall be done on the water supply and injection wells at rates and durations as specified by the registered design professional.  

F 303.6 1714.5 Water Level Monitoring. Water levels shall be monitored in the pumping well and observation wells during pumping and recovery periods. The monitoring time intervals shall be as specified by the registered design professional.  

F 303.6 1714.6 Injection Wells. Injection testing shall be performed on water wells that are designated to be used as injection wells at rates specified by the registered design professional. The results of the drilling and pumping tests shall be provided to the owner or the owner’s representative and provided in accordance with requirements of the Authority Having Jurisdiction.  

F 303.7 1714.7 Re-Injected Water. The water quality of re-injected water into the earth shall comply with the requirements of the Authority Having Jurisdiction.  

Part IV – Direct Exchange (DX) Systems.  

F 401.0 1715.0 Direct Exchange (DX) Systems.  

F 401.4 1715.1 General. The installation and use of Direct Exchange (DX) wells shall be in accordance with the Authority Having Jurisdiction. The DX well records shall include well logs, pressure tests, and aquifer information.  

F 401.2 1715.2 Applicability. Part IV of this chapter shall apply to geothermal energy systems such as, but not limited to, building systems coupled with a DX closed-loop using refrigerant as a heat transfer medium. The regulations of this Chapter shall govern the construction, location and installation of geothermal energy systems.  

Indoor piping, fittings, and accessories that are part of the ground source system shall be in accordance with Section 1703.5 and Chapter 12.  

F 401.3 1715.3 DX Systems. Copper pipe and tubing installed for DX systems shall be manufactured in accordance with ASTM B280 and copper fittings in accordance with ASME B16.22. Joints shall be purged with an inert gas and brazed with a brazing alloy having 15 percent silver content in accordance with AWS A5.8. Underground piping and tubing shall have a cathodic protection system installed.  

F 401.4 1715.4 DX System Testing. For direct exchange (DX) systems, each refrigerant u-bend shall be tested and proved tight with an inert gas at not less than 315 psi (2172 kPa) and maintained for 15 minutes without pressure drop. The pressure reading after tremie grouting of the boreholes shall be maintained in the ground-heat exchanger for not less than 2 hours, in accordance with CSA/IGWHPA C448.  

F 401.5 1715.5 Indoor Piping. For DX systems, joints shall be purged with an inert gas and brazed with a brazing alloy having 15 percent silver content in accordance with AWS A5.8.  

F 401.6 1715.6 On Site Storage. For DX systems, copper piping and fittings shall be stored to prevent physical damage, contamination, and each pipe or tubing shall be pressurized with an inert gas and sealed with a cap.  

F 401.7 1715.7 System Start-Up. DX system start-up shall be in accordance with Section 1708.1 and the following:  

(1) DX systems shall be pressurized using nitrogen for not less than 1 hour. There shall be no allowable variance to the test pressure after being corrected for ambient temperature changes during the test. The test pressure shall not exceed 150 psig (1034 kPa) when pressure testing the compressor unit and indoor system components.  

(2) DX systems shall have permanent type labels installed and affixed on the compressor unit with the refrigerant type and quantity.  

(3) For DX systems, refrigerant liquid and vapor lines from the loop system shall be identified and tagged.  

F 401.8 1715.8 DX Piping. DX Piping should be installed in accordance with approved plans and specifications, including provisions for cathodic protection.  

Part V – District Ambient Temperature Loop (ATL) Geothermal.  

1716.0 Ambient Temperature Loop (ATL) Distributed Energy Systems.  

1716.1 General. An Ambient Temperature Loop (ATL) distributed energy system shall be installed in accordance with Section 1716.2 through Section 1716.6.2 and Section 1717.0. ATL systems shall comply with Part I through Part IV of this chapter, as applicable.  

1716.1.1 Fourth Generation (4G) System Configuration. A fourth-generation system configuration shall be a district geothermal energy system distributing hot water, cold water, or both to the conditioned space or building for a specific use. Where a geothermal energy source is used, such system shall comply with Part I through Part IV of this chapter, Chapter 11, and Chapter 12.  

1716.1.2 Fifth Generation (5G) System Configurations. An advanced Ambient Temperature Loop (ATL) System or fifth generation (5G) ATL system shall also be capable of interacting with the electric utility system as well as other utility systems and systems components.  

The system components shall include, but not limited to, the following:  

(1) Thermally diverse buildings with independent hydronic systems  

(2) Circulation loop  

(3) Global control system  

(4) Segment isolation capability
The system components may include, but not limited to, the following:
1. Electric grid-interactive enabled buildings
2. Hybrid components
3. Other renewable systems

1716.2 Permitting. Permits required for the installation and application of an ATL distributed energy system shall be obtained as required by the Authority Having Jurisdiction.

1716.3 Ambient Loop Temperature Range. The operating loop temperature range of an ambient temperature loop (ATL) system shall be not less than the freeze point of the circulating fluid and not more than the maximum temperature as required by the manufacturer’s installation instructions for the attached heat pump equipment in accordance with Section 1716.3.1 and Section 1716.3.2. The ATL system shall use treated water as the heat transfer medium.

1716.3.1 ATL Operating Temperature. For equipment listed to AHRI/ASHRAE/ISO 13256-1 and AHRI/ASHRAE/ISO 13256-2, the controlled temperature range of the ambient closed loop shall be not less than 7°F (4°C) above the freeze point of the transport fluid and 10°F (6°C) below the (collective) heat pump lowest minimum inlet supply temperature as recommended by the manufacturer’s instructions.

Exception: Equipment that is not listed to AHRI/ASHRAE/ISO 13256-1 and AHRI/ASHRAE/ISO 13256-2, the controlled temperature range of the ambient closed loop shall be in accordance with Section 1716.4 for minimum and maximum temperatures.

1716.3.2 ATL Operating Temperature Range for Mixed Equipment Certifications. The source inlet temperature range of any attached equipment shall govern the design operating temperature range. Such equipment shall be identified in the design documentation. In any case the most restrictive minimum and maximum inlet supply temperatures, as recommended by the manufacturer’s instructions, shall determine the system operating temperature range.

1716.4 Shutoff Valve. An automatic shutoff valve shall be provided for each individual building or facility transferring energy to or from an ATL distribution system. The automatic shutoff valve shall automatically shutoff upon operating command.

1716.4.1 Shutoff Valve Operation. The operation of the automatic shutoff valve shall be in accordance with the system operating procedures. Where the operation of a shutoff valve was due to an emergency response, an auxiliary hearing or cooling methodology shall be provided in accordance with Section 1717.1.2.

1716.5 Bypass. The ATL distributed energy system shall be provided with bypass path(s) to reroute the circulating fluid when necessary.

1716.6 Metering. Where meters are required by the system design, meter(s) shall be located as specified by the manufacturer on each consumptive or supply source and the range of the metering shall be appropriate to the thermal properties and flow rate(s) of the transport fluid.

1716.6.1 Sub-Metering System Specification. The entire energy measurement system shall be provided with a sub-metering system. The metering system shall be calibrated and shall consist of a flow meter, temperature sensors, temperature thermowells, or other required mechanical installation metering. The sub-meter traceable calibration shall comply with the National Institute of Standards Technology (NIST) traceable calibration program or in accordance with the Authority Having Jurisdiction and shall be provided with an ATL distributed energy system.

1716.6.2 BTU/Thermal Meters. Where used, the Btu/thermal meter shall be bidirectional and shall provide the following information via digital or analog display:
1. LCD, and via serial network communications.
2. Total energy.
3. Energy rate.
4. Total flow.
5. Flow rate.
7. Return temperature.

Each Btu/thermal meter shall be factory programmed for its specific application and shall be re-programmable to adjust for specific site conditions.

1716.6.3 Flow Meter. Where used, the flow meter shall be provided with the following information via digital or analog display:
1. LCD, and via serial network communications.
2. Instantaneous fluid rate.

1717.0 ATL Distributed Energy Systems Design Requirements.

1717.1 Thermal Resources. The ambient temperature loop shall be permitted to connect to a thermal resource(s). Such resources may be an alternative energy source and sink, such as but not limited to solar photovoltaic (PV), solar thermal, combined heat power (CHP), and phase change thermal storage. These systems shall be installed and comply with the respective system requirements. ATL distributed energy systems coupled with solar thermal systems shall comply with the Uniform, Solar, Hydrogenics and Geothermal Code (USHGC) or equivalent. ATL systems coupled with a solar PV system shall comply with the USHGC or NFPA 70, or equivalent. These systems shall optimize the use of the equipment and energy based on the system design intent.

1717.1.1 System Performance. The System Coefficient of Performance (SCOP) of the system shall take the net COP of each individual members in the district. The SCOP shall be provided by the designer and included in the system design documents.
1717.1.2 Emergency Response. An auxiliary heating or cooling methodology shall be provided with the ATL controls and shall be adequate to provide temporary service in the absence of an ATL energy transfer. Emergency source/sink measures such as but not limited to control subroutines that move energy between spaces in the building, use of locally connected ground source assets, combined heat and power (CHP), conventional equipment, other renewables systems may be used.

1717.2 District Load Profiles. The district load profile of an ambient temperature loop (ATL) distributed energy system shall be identified and shall be included in the basis-of-design (BOD).

1717.2.1 System Asset Identification. System assets shall be listed and included in the system design. The system asset shall include, but not be limited to, the following:

(1) Building type and quantity.
(2) Natural or constructed sources and sinks such as ground water, boreholes, etc.
(3) Other renewable assets.
(4) Wasted heat recovery.
(5) Potable and non-potable water or fluid sources.
(6) Conventional assets such as boilers and cooling towers.
(7) Other GeoMicroDistrict or thermal highway.

1717.2.2 Driver Building. The driver building profile shall be identified in an ATL distributed energy system and shall be reported in the design documents.

1717.2.3 Diversity Factor. The diversity factor and/or anticipated wasted energy recovery component of the GeoMicroDistrict shall be identified by the designer and this information shall be included in the drawings and specifications.
CHAPTER 1718
REFERENCED STANDARDS

4704.0 1801.0 General.
4701.1 1801.1 Standards. The standards listed in Table 1701.1 are referenced in various sections of this code and shall be considered part of the requirements of this document. The standards are listed herein by the standard number and effective date, the title, application and the section(s) of this code that reference the standard. The application of the referenced standard(s) shall be as specified in Section 302.1.2.

The promulgating agency acronym referred to in Table 1701.1 are defined in a list found at the end of the table.

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### Referenced Standards

#### 4701.2 Standards, Publications, Practices, and Guides

The standards, publications, practices and guides listed in Table 4701.2 are not referenced in other sections of this code. The application of the referenced standards, publications, practices and guides shall be as specified in Section 302.1.2. The promulgating agency acronyms are found at the end of the table.

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<td>Air Conditioning Contractors of America Association, Inc., 2800 S Shirlington Road, Suite 300, Arlington, VA 22206.</td>
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<td>AMCA</td>
<td>Air Movement and Control Association, 30 West University Drive, Arlington Heights, IL 60004-1806.</td>
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<tr>
<td>ANSI</td>
<td>American National Standards Institute, Inc., 25 W. 43rd Street, 4th Floor, New York, NY 10036.</td>
</tr>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.</td>
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<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.</td>
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<td>ASME</td>
<td>American Society of Mechanical Engineering, Two Park Avenue, New York, NY 10016-5990.</td>
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<tr>
<td>ASSE</td>
<td>American Society of Sanitary Engineering, 18927 Hickory Creek Drive, Suite 220, Mokena, IL 60448.</td>
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<td>ASSP</td>
<td>American Society of Safety Professionals, 520 N. Northwest Highway, Park Ridge, IL 60068.</td>
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<td>ASTM</td>
<td>ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.</td>
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<td>AWS</td>
<td>American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672.</td>
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<td>AWWA</td>
<td>American Water Works Association, 6666 W. Quincy Avenue, Denver, CO 80235.</td>
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<tr>
<td>CGA</td>
<td>Canadian Gas Association, 243 Consumers Road, Suite 1200, North York, Ontario, Canada M2J 5E3.</td>
</tr>
<tr>
<td>CGSB</td>
<td>Canadian General Standards Board, 140 O'Connor Street, L'Esplanade Laurier Building, 6th floor East Tower, Ottawa, Ontario, Canada K1A 0R5.</td>
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<tr>
<td>CSA</td>
<td>Canadian Standards Association, 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3.</td>
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<td>IAPMO</td>
<td>International Association of Plumbing and Mechanical Officials, 4755 E. Philadelphia Street, Ontario, CA 91761.</td>
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<td>IES</td>
<td>Illuminating Engineering Society, 120 Wall St. Fl 17, New York, NY 10005-4026.</td>
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<td>IIAR</td>
<td>International Institute of Ammonia Refrigeration, 1001 N. Fairfax Street, Suite 503, Alexandria, VA 22314.</td>
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<td>ISO</td>
<td>International Organization for Standardization, 1 ch. de la Voie-Creuse, Casa Postale 56, CH-1211 Geneva 20, Switzerland.</td>
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<td>MSS</td>
<td>Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park Street NE, Vienna, VA 22180.</td>
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<td>NEBB</td>
<td>National Environmental Balancing Bureau, 8575 Grovemont Circle, Gaithersburg, MD 20877.</td>
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<td>NFPA</td>
<td>National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.</td>
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<td>NGWA</td>
<td>National Ground Water Association, 601 Dempsey Road, Westerville, Ohio 43081-8978.</td>
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<td>NSF</td>
<td>NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105.</td>
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<td>SAE</td>
<td>Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.</td>
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<td>SMACNA</td>
<td>Sheet Metal and Air Conditioning Contractors National Association, 4201 Lafayette Center Drive, Chantilly, VA 20151-1219.</td>
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<td>UL</td>
<td>Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.</td>
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APPENDICES

The appendices are intended to supplement the provisions of the installation requirements of this code. The definitions in Chapter 2 are also applicable to the appendices.

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## APPENDIX A

### RESIDENTIAL PLANS EXAMINER REVIEW FORM FOR HVAC SYSTEM DESIGN

(Loads, Equipment, Ducts) [ACCA]

The following Residential Plans Examiner Review Form for HVAC System Design (Loads, Equipment, Ducts), Form RPER1, is included here for the convenience of the users of the Uniform Mechanical Code.

### HVAC LOAD CALCULATION (See Section 1105.1)

**Design Conditions**

<table>
<thead>
<tr>
<th>Winter Design Conditions</th>
<th>Building Construction Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor temperature °F</td>
<td>Building orientation (front door faces)</td>
</tr>
<tr>
<td>Indoor temperature °F</td>
<td>Number of bedrooms</td>
</tr>
<tr>
<td>Total heat loss Btu</td>
<td>Conditioned floor area Sq Ft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer Design Conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor temperature °F</td>
<td></td>
</tr>
<tr>
<td>Indoor temperature °F</td>
<td></td>
</tr>
<tr>
<td>Grains difference Δ Gr @ % Rh</td>
<td></td>
</tr>
<tr>
<td>Sensible heat gain Btu</td>
<td>Number of occupants</td>
</tr>
<tr>
<td>Latent heat gain Btu</td>
<td></td>
</tr>
<tr>
<td>Total heat gain Btu</td>
<td></td>
</tr>
</tbody>
</table>

### HVAC EQUIPMENT SELECTION

<table>
<thead>
<tr>
<th>Heating Equipment Data</th>
<th>Cooling Equipment Data</th>
<th>Blower Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment type</td>
<td>Equipment type</td>
<td>Heating CFM CFM</td>
</tr>
<tr>
<td>Furnace, Heat pump, Boiler, etc.</td>
<td>Air Conditioner, Heat pump, etc.</td>
<td>Cooling CFM</td>
</tr>
<tr>
<td>Model</td>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>Heating output capacity Btu</td>
<td>Sensible cooling capacity Btu</td>
<td>Static pressure IWC</td>
</tr>
<tr>
<td>Heat pumps - capacity at winter design outdoor conditions</td>
<td>Latent cooling capacity Btu</td>
<td></td>
</tr>
<tr>
<td>Auxiliary heat output capacity Btu</td>
<td>Total cooling capacity Btu</td>
<td></td>
</tr>
</tbody>
</table>

### HVAC DUCT DISTRIBUTION SYSTEM DESIGN (See Section 601.2)

<table>
<thead>
<tr>
<th>Design airflow CFM</th>
<th>Longest supply duct: Ft</th>
<th>Duct Materials Used (circle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Static Pressure (ESP) IWC</td>
<td>Longest return duct: Ft</td>
<td>Trunk Duct: Duct board, flex, Sheet metal, Lined sheet metal, Other (specify)</td>
</tr>
<tr>
<td>Component Pressure Losses (CPL) IWC</td>
<td>Total Effective Length (TEL) Ft</td>
<td></td>
</tr>
<tr>
<td>Available Static Pressure (ASP) IWC</td>
<td>Friction Rate: IWC</td>
<td>Branch Duct: Duct board, flex, Sheet metal, Lined sheet metal, Other (specify)</td>
</tr>
</tbody>
</table>

I declare the load calculation, equipment selection, and duct system design were rigorously performed based on the building plan listed above. I understand the claims made on these forms will be subject to review and verification.

Contractor’s Printed Name: _____________________________ Date: ____________

Contractor’s Signature: _____________________________

Reserved for County, Town, Municipality, or Authority having jurisdiction use.

* Home qualifies for MJFAE Forms based on Abridged Edition Checklist.
APPENDIX B
PROCEDURES TO BE FOLLOWED TO PLACE GAS EQUIPMENT IN OPERATION

B 101.0 Adjusting the Burner Input.
B 101.1 Adjusting Input. The input rate of the burner shall be adjusted to the proper value in accordance with the appliance manufacturer’s instructions. Firing at a rate in excess of the nameplate rating shall be prohibited. The input rate can be adjusted by either changing the size of a fixed orifice, changing the adjustment of an adjustable orifice, or readjusting the appliance’s gas pressure regulator outlet pressure (where a regulator is provided in the appliance). [NFPA 54:11.1.1, 11.1.1.1]

B 101.2 High Altitude. Gas input ratings of appliances shall be used for elevations up to 2000 feet (610 m). The input ratings of appliances operating at elevations above 2000 feet (610 m), shall be reduced in accordance with one of the following methods:
(1) At the rate of 4 percent for each 1000 feet (305 m) above sea level before selecting appropriately sized appliances.
(2) As permitted by the Authority Having Jurisdiction.
(3) In accordance with the manufacturer’s installation instructions. [NFPA 54:11.1.2]

B 102.0 Primary Air Adjustment.
B 102.1 General. The primary air for injection (Bunsen)-type burners shall be adjusted for proper flame characteristics in accordance with the appliance manufacturer’s instructions. After setting the primary air, the adjustment means shall be secured in position. [NFPA 54:11.1.2]

B 103.0 Safety Shutoff Devices.
B 103.1 General. Where a safety shutoff device is provided, it shall be checked for proper operation and adjustment in accordance with the appliance manufacturer’s instructions. Where the device does not function properly to turn off the gas supply in the event of pilot outage or other improper operation, the device shall be properly serviced or replaced with a new device. [NFPA 54:11.3]

B 104.0 Automatic Ignition.
B 104.1 General. Appliances supplied with means for automatic ignition shall be checked for operation within the parameters provided by the manufacturer. Any adjustments made shall be in accordance with the manufacturer’s installation instructions. [NFPA 54:11.4]

B 105.0 Protective Devices.
B 105.1 General. Where required by the manufacturer’s installation instructions, all protective devices furnished with the appliance such as a limit control, fan control to blower, temperature and pressure relief valve, low-water cutoff device, or manual operating features, shall be checked for operation within the parameters provided by the manufacturer. Any adjustments made shall be in accordance with the manufacturer’s installation instructions. [NFPA 54:11.5]

B 106.0 Checking the Draft.
B 106.1 General. Draft hood-equipped appliances shall be checked to verify that there is no draft hood spillage after 5 minutes of main burner operation. [NFPA 54:11.6]

B 107.0 Operating Instructions.
B 107.1 General. Operating instructions shall be furnished and shall be left in a prominent position near the appliance for use by the consumer. [NFPA 54:11.7]
APPENDIX C
INSTALLATION AND TESTING OF OIL (LIQUID) FUEL-FIRED EQUIPMENT

C 101.0 General.
C 101.1 Applicability. Appendix C governs the installation, testing, or repair of oil or liquid fuel burners, oil or liquid fuel-burning systems, oil or liquid fuel-burning equipment, and the oil or liquid fuel piping systems used in connection with buildings or structures and equipment within the property lines of the premises.

C 102.0 Definitions.
C 102.1 General. For the purpose of this appendix, the following definitions shall apply:

- **Anti-Flooding Device.** A primary safety control that causes the flow of oil or fuel to be shut off after a rise in oil or fuel level, or after receiving excess oil or fuel, and that operates before the hazardous discharge of oil or fuel can occur.

- **Burner, Automatically Ignited.** A burner equipped so that main burner fuel may be turned on and ignited automatically.

- **Burner, Manually Ignited.** A burner equipped, so that main burner fuel is turned on by hand and ignited under supervision.

- **Burner, Mechanical Draft Type.** A burner that includes a power-driven fan, blower, or other mechanism as the primary means for supplying the air for combustion.

- **Burner, Natural Draft Type.** A burner that depends primarily on the natural draft created in the chimney or venting system to induce air required for combustion into the burner.

- **Constant Level Valve.** A device for maintaining within a reservoir a constant level of oil or fuel for delivery to a burner.

- **Control Limit.** An automatic safety control that is responsive to changes in fluid flow or level, pressure, or temperature and that is normally set beyond the operating range for limiting the operation of the controlled equipment by shutting off the energy supply.

- **Control Safety.** Automatic interlock controls, including relays, switches, and other auxiliary equipment used in conjunction with them, to form a safety control system that is intended to prevent unsafe operation of the controlled equipment.

- **Draft Booster.** A power-operated fan, blower, or other device installed in the chimney connector to increase the natural draft developed in the connected chimney.

- **Draft Regulator, Barometric.** A device built into a fuel-burning appliance or made part of a chimney connector or vent connector that functions to reduce excessive draft through an appliance to a desired value by admitting ambient air into the appliance chimney, chimney connector, vent, or vent connector.

- **Fuel.** Natural, manufactured, or liquefied petroleum gas, or a mixture of these gases; all grades of fuel oil, wood, or any other combustible or flammable material or any mixture of combustible or flammable materials.

- **Fuel Burner.** A device used to convey the appropriate fuel into the combustion chamber zone in close proximity to its primary or secondary air supply to permit a stable controlled heat release compatible with the burner design, listing, and applicable approvals in a boiler, furnace, device or appliance. It includes but is not limited to burning oil or liquid fuel.

- **Fuel Burner System.** The fuel burner and a conveyance system or piping system for the purpose of introducing the appropriate fuel into the combustion chamber zone.

- **Fuel-Burning Equipment/Appliance.** An oil or fuel burner of any type including all oil or liquid fuel burners, oil or liquid fuel-fired units, dual, or multi-fuel burners and heating and cooking appliances with their fuel burner system and with their tank or fuel storage system, piping system, vent connectors, vent flues, fans, blowers, valves, control devices, combustion air, wiring, controls, and related devices including all accessories and appurtenances for safe and proper operation of the appliance.

- **Fuel Oil.** Hydrocarbon oil as specified by ASTM D396, or the Canadian Government Specification Board, 3-GP-28, and having a flashpoint of not less than 100°F (38°C).

- **Fuel-Piping System.** Method of conveying liquid, vapor, steam, gases, or slurry from one point to another, including accessories, appurtenances, and equipment necessary for its proper operation.

- **Indirect-Fired Appliance.** An oil or fuel-burning appliance in which products of combustion (flue gases) are not mixed in the appliance with the air or other medium being heated.

- **Labeled.** Having attached a label, symbol, or other identifying mark of an organization acceptable to the Authority Having Jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

- **Premixing.** A power burner in which all or nearly all of the air for combustion is mixed with the gas as primary air.

- **Pump, Oil or Fuel Transfer.** An oil or fuel pump, automatically or manually operated, that transfers oil or fuel through continuous piping from a supply tank to an oil or fuel-burning appliance or to an auxiliary tank, and that is designed to stop pumping automatically in case of total breakage of the oil or fuel supply line between the pump and the appliance.

- **Tank, Auxiliary.** A tank having a capacity of not over 60 gallons (227 L) listed for installation in the supply piping between a burner and its main fuel supply tank. It shall be permitted to be included as an integral part of an automatic pump or a transfer pump, or it shall be permitted to be a separate tank.
For conversion burners installed in steam boilers, the oil or liquid fuel input demand necessitated by an oversizing of the boiler shall be added to total input and shall be adjusted to within plus or minus 5 percent of the design load, not to exceed the design rate of the appliance.

(1) The appliance shall be allowed to operate until the stack temperature becomes stabilized, after which a sample of the undiluted flue products shall be taken from the appliance flue outlet. The sample taken shall be analyzed for carbon monoxide, carbon dioxide, and oxygen. Stack temperature shall be noted.

(2) Performance standards for atmospheric type shall be provided in accordance with the following:

(a) Shall be not less than 75 percent efficiency as determined by flue gas analysis method at the appliance flue outlet.

(b) Carbon monoxide concentration in flue gas shall not exceed 0.04 percent.

(c) Stack temperature shall not exceed 700°F (371°C) plus ambient.
(d) Carbon dioxide concentration shall be between 8 percent and 13 percent.
(e) Oxygen concentration shall be between 4 percent and 10 percent.
(f) Smoke test shall not exceed number 2 for light oils or number 4 for oils heavier than number 4.
(g) Draft shall comply with the burner manufacturer’s instructions.

(4) Performance standards for induced-draft or fan-assisted types shall comply with the following:
(a) Shall be not less than 80 percent efficiency, as determined by flue gas analysis method at appliance flue outlet.
(b) Carbon monoxide concentration in flue gas not exceeding 0.04 percent.
(c) Stack temperature shall not exceed 700°F (371°C) plus ambient.
(d) Carbon dioxide concentration shall be between 8 percent and 13 percent.
(e) Oxygen concentration shall be between 4 percent and 10 percent.
(f) Smoke test shall not exceed number 2 for light oils or number 4 for oils heavier than number 4.
(g) Draft shall comply with the burner manufacturer’s instructions.

Induced-draft and fan-assisted types of appliances require a sample be taken after the induced-draft fan that will cause oxygen figures in excess of the limits stated. In such cases, safe liquid fuel combustion ratios shall be maintained and be consistent with approvals and listings of the appliance.

(5) Method of test – power type.
(a) The appliance shall be allowed to operate until the stack temperature becomes stabilized; after that, a sample of the undiluted flue products shall be taken from the appliance flue outlet. The sample shall be analyzed for carbon monoxide, carbon dioxide, and oxygen. Stack temperature shall be noted.

(6) Performance standards for power type.
(a) Shall be not less than 80 percent efficiency as determined by flue gas analysis method at the appliance flue outlet.
(b) Carbon monoxide concentration in the flue gas shall not exceed 0.04 percent.
(c) Stack temperature shall not exceed 700°F (371°C) plus ambient.
(d) Carbon dioxide concentration shall be between 8 percent and 13 percent.
(e) Oxygen concentration shall be between 4 percent and 10 percent.
(f) Smoke test shall not exceed number 2 for light oils or number 4 for oils heavier than number 4.
(g) Draft shall comply with the burner manufacturer’s instructions.

(7) After completion of the test of newly installed oil or liquid fuel burner equipment as provided in this section, the installer shall file with the Authority Having Jurisdiction complete records of the test on a form approved by the Authority Having Jurisdiction. The tag stating the date of the test and the name of the installer shall be attached to the appliance at the main valve.

(8) Listing and approval.
(a) The concentration of oxygen in the undiluted flue products of oil or liquid fuel burners shall in no case be less than 3 percent nor exceed 10 percent and shall be in accordance with performance standards and shall be consistent with the listing and approval of the equipment.
(b) The allowable limit of carbon monoxide shall not exceed 0.04 percent.
(c) The flue gas temperature of an oil appliance, as taken on the appliance side of the draft regulator, shall not exceed applicable performance standards and shall be consistent with the listing and approvals of the equipment.

(9) The oxygen figures shall not apply where there is an approved oxygen trim system on the burner that is designed for that use, including a low oxygen interlock where approved by the Authority Having Jurisdiction.

(10) Supervision shall be as follows:
(a) Supervised startup shall be required to verify the safe operation of an oil or liquid fuel burner to provide documentation that operation is consistent with this code, listing, and approval. Supervised startup shall be required for liquid fuel burners in Section C 109.1(2), Section C 109.1(3), and Section C 109.1(4). Supervised startup requires that the liquid-fuel burner shall be tested in the presence of the mechanical official in a manner set forth by the Authority Having Jurisdiction before the installation is approved. Testing shall include safety and operating controls, input, flue gas analysis, and venting. Flue gas shall be tested at high, medium, and low fires. Provisions shall be made in the system to allow a firing test in warm weather. After completion of the test of newly installed oil or liquid fuel burner equipment, as provided in this section, the installer shall file with the Authority Having Jurisdiction complete records of the test on a form approved by the Authority Having Jurisdiction. The tag stating the date of the test and the name of the tester shall be attached to the appliance at the main valve.
(b) Oil and liquid fuel burners of 1 000 000 Btu/h (293 kW) input or more require a supervised startup in accordance with Section C 108.1(10)(a).
(c) Installation of oxygen trim systems, modulating dampers, or other draft control or combustion devices require a supervised startup in accordance with Section C 108.1(10)(a).
(d) Direct-fired heaters shall require a supervised startup in accordance with Section C 108.1(10)(a).

(11) The complete control diagram of the installation and operating instructions shall be supplied and posted by the installer of the appliance.

C 109.0 Special Requirements Based on Btu/h Input.

C 109.1 General.

(1) Zero to 400 000 Btu/h (0 kW to 117 kW) per burner.
   (a) One approved manual shutoff valve lever handle.
   (b) One approved fuel oil filter, installed on the supply piping.
   (c) Approved automatic safety shutoff valve to provide 100 percent shutoff of all oil.
   (d) A flame safeguard control capable of providing 100 percent shutoff in the event of flame failure. Flame failure response timing shall not exceed the control manufacturer’s instructions.
   (e) Two controls, one operating and one high limit, activated by temperature or pressure, as appropriate.
   (f) Burners relying on mechanical means to provide air for combustion shall have actual proof-of-air interlock device.
   (g) Installations with dampered combustion air openings shall prove damper open position before trial for burner ignition.
   (h) Vent dampers and flue dampers shall be properly interlocked to prevent burner ignition unless safely open.

(2) Four hundred thousand and one to 999 999 Btu/h (117.2 kW to 292.9 kW) per burner.
   (a) One approved manual shutoff valve lever handle.
   (b) One approved fuel-oil filter, installed on the supply piping.
   (c) Two safety shutoff valves in series with a combined flame failure response and valve closing time not to exceed 5 seconds with strainer directly before the valves.
   (d) One electronic flame safeguard pilot control providing a separately supervised and proven pilot, 100 percent shutoff manual reset. Flame failure response time shall not exceed the control manufacturer’s instructions.
   (e) Two controls, one operating and one high limit, activated by temperature or pressure.
   (f) Burners relying on mechanical means to provide air for combustion shall have actual proof-of-air interlock device.
   (g) Power burners shall include proven prepurge of not less than 60 seconds at high-fire damper settings. This prepurge shall occur before every burner cycle, regardless of reason.
   (h) Installations with dampered combustion air openings shall prove damper open position before trial for burner ignition.
   (i) Vent dampers and flue dampers shall be interlocked to prevent burner ignition unless safely open.
   (j) One high oil or liquid fuel-pressure interlock, reset from flame safeguard or manually.
   (k) Where hot water or steam, one low water cutoff.
   (l) An atomizing medium proving switch.
   (m) A low oil temperature switch for oil or liquid fuel requiring preheating.
   (n) A high oil temperature interlock for oil or liquid fuel requiring preheating.
   (o) The burner oil pump shall automatically not operate or rotate while the alternate fuel is firing.
   (p) A pressure-relief valve shall be provided between safety shutoff valves and between pump and safety valves where an integral valve is used with a pump.
   (q) A separate relief device is required on each transfer pump.

(3) One million to 2 499 999 Btu/h (293 kW to 732 kW) input per burner.
   (a) One approved manual shutoff valve lever handle.
   (b) One approved fuel-oil filter, installed on the supply piping.
   (c) Two safety shutoff valves in series with a combined flame failure response and valve closing time not to exceed 5 seconds with strainer directly before the valves.
   (d) Programmed electronic flame safeguard including proven low-fire start, manual reset lockout, 100 percent shutoff (both pilot and main burner), and a separately supervised and proven pilot.
   (e) Two controls, one operating and one high limit, activated by temperature or pressure.
   (f) Burners relying on mechanical means to provide air for combustion shall have actual proof-of-air interlock device.
   (g) Power burners shall include proven prepurge of not less than 60 seconds at high-fire damper settings. This prepurge shall occur before every burner cycle, regardless of reason.
   (h) Installations with dampered combustion air openings shall prove damper open position before trial for burner ignition.
   (i) Vent dampers and flue dampers shall be interlocked to prevent burner ignition unless safely open.
   (j) One high oil or liquid fuel-pressure interlock, reset from flame safeguard or manually.

Flame-sensing systems utilizing a UV scanner shall prove pilot and interrupt ignition spark prior to main burner valves being energized.

Direct-spark ignition shall be allowed where approved by the Authority Having Jurisdiction and where used on number 2 or lighter oil.

Two controls, one operating and one high limit, activated by temperature or pressure, as appropriate.

Burners relying on mechanical means to provide air for combustion shall have actual proof-of-air interlock device.

Power burners shall include proven prepurge of not less than 60 seconds at high-fire damper settings. This prepurge shall occur before every burner cycle, regardless of reason.

Installations with dampered combustion air openings shall prove damper open position before trial for burner ignition.

Vent dampers and flue dampers shall be interlocked to prevent burner ignition unless safely open.

One high oil or liquid fuel-pressure interlock, reset from flame safeguard or manually.
(k) Where hot water or steam, two low water cutoffs.
(l) An atomizing medium proving switch.
(m) A low oil temperature switch for oil or liquid fuel requiring preheating.
(n) A high oil temperature interlock for oil or liquid fuel requiring preheating.
(o) The burner oil pump shall automatically not operate or rotate while the alternate fuel is firing.
(p) A pressure-relief valve shall be provided between safety shutoff valves and between pump and safety valves where an integral valve is used with a pump.
(q) A separate relief device is required on each transfer pump.
(r) One low oil or liquid fuel-pressure interlock, reset from flame safeguard or manually.
(s) Burners with automatic controls, prepurge, proof-of-closure, modulation, or postpurge shall not use relays external to the flame safeguard to accomplish these functions.

(4) Two million five hundred thousand to 12,499,999 Btu/h (733 kW to 3663.3 kW) per burner.
(a) One approved manual shutoff valve lever handle.
(b) One approved fuel-oil filter, installed on the supply piping.
(c) Two safety shutoff valves in series, with a combined flame failure response and valve closing time not to exceed 5 seconds with strainer directly before the valves.
(d) Programmed electronic flame safeguard including proven low-fire start, manual reset lockout, 100 percent shutoff (both pilot and main burner), and a separately supervised and proven pilot.

Flame-sensing systems utilizing a UV scanner shall prove pilot and interrupt ignition spark prior to main burner valves being energized.
(e) Two controls, one operating and one high limit, activated by temperature or pressure.
(f) Burners relying on mechanical means to provide air for combustion shall have actual proof-of-air interlock device.
(g) Power burners shall include proven prepurge of not less than 60 seconds at high-fire damper settings. This prepurge shall occur before every burner cycle, regardless of reason.
(h) Installations with dampered combustion air openings shall prove damper open position before trial for burner ignition.
(i) Vent dampers and flue dampers shall be interlocked to prevent burner ignition unless safely open.
(j) One high oil or liquid fuel-pressure interlock, reset from flame safeguard or manually.
(k) Where hot water or steam, two low water cutoffs.

(5) More than 12,500,000 Btu/h (3663.4 kW) per burner input. These burners shall comply with the requirements of the appropriate standards listed in Chapter 17 and the following:
(a) One approved manual shutoff valve lever handle.
(b) One approved fuel-oil filter, installed on the supply piping.
(c) Two safety shutoff valves in series, one with proof of closure, with a combined flame failure response and valve closing time not to exceed 2 seconds with strainer directly before the valves.
(d) Programmed electronic flame safeguard including proven low-fire start, manual reset lockout, 100 percent shutoff (both pilot and main burner), and a separately supervised and proven pilot.

Flame-sensing systems utilizing a UV scanner shall prove pilot and interrupt ignition spark prior to main burner valves being energized.
(e) Two controls, one operating and one high limit, activated by temperature or pressure.
(f) Burners relying on mechanical means to provide air for combustion shall have actual proof-of-air interlock device.
(g) Power burners must include proven prepurge of not less than 60 seconds at high-fire damper settings. This prepurge shall occur before every burner cycle, regardless of reason.
(h) Installations with dampered combustion air openings shall prove damper open position before trial for burner ignition.
(i) Vent dampers and flue dampers shall be interlocked to prevent burner ignition unless safely open.
(j) One high oil or liquid fuel-pressure interlock; reset from flame safeguard or manually.
(k) A manual firing cock.
(l) Where hot water or steam, two low water cut-offs.
(m) An atomizing medium proving switch.
(n) A low oil temperature switch for oil or liquid fuel requiring preheating.
(o) A high oil temperature interlock for oil or liquid fuel requiring pre-heating.
(p) A separate firing rate control valve.
(q) The burner oil pump shall automatically not operate or rotate while the alternate fuel is firing.
(r) A pressure-relief valve shall be provided between safety shutoff valves and between pump and safety valves where an integral valve is used with a pump.
(s) A separate relief device is required on each transfer pump.
(t) One low oil or liquid fuel-pressure interlock, reset from flame safeguard or manually.
(u) Burners with automatic controls, prepurge, proof-of-closure, modulation, or postpurge shall not use relays external to the flame safeguard to accomplish these functions.

(6) Shutoff Valve.
(a) Oil or liquid fuel burner installations shall include a non-electric shutoff valve that is held open by a fusible link designed to close at 165°F (74°C), installed near the burner in the same room as the burner. This shall prevent the flow of oil or liquid fuel to the burner through the supply pipe. A check valve is required in the return line if the tank is higher than the burner.
APPENDIX D
FUEL SUPPLY: MANUFACTURED/MOBILE HOME PARKS AND RECREATIONAL VEHICLE PARKS

D 101.0 Fuel Gas Piping Systems.

D 101.1 General. All fuel gas piping systems serving manufactured homes, accessory buildings, or structures and communities shall be designed and constructed in accordance with any applicable provisions of Chapter 13 and NFPA 58. NFPA 31 shall apply to oil fuel-burning systems and shall conform to the criteria of the Authority Having Jurisdiction. [NFPA 501A:4.1.1.1 – 4.1.1.2]

D 101.2 Gas Supply Connections. Gas supply connections at sites, where provided from an underground gas supply piping system, shall be located and arranged to permit attachment to a manufactured home occupying the site. For the installation of liquefied petroleum gas (LP-Gas) storage systems, the provisions of NFPA 58 shall be followed. [NFPA 501A:4.1.2.1 – 4.1.2.2]

D 101.3 Location of Gas Supply Connection. The gas supply to the manufactured home shall be located within 4 feet (1219 mm) of the manufactured home stand.

Exception: The requirement of Section D 101.3 shall not apply to gas supply connections for manufactured homes located on all-weather wood, concrete, or concrete block foundation systems or on foundations constructed in accordance with the local building code or, in the absence of a local code, with a recognized model building code. [NFPA 501A:4.1.3]

D 101.4 Recreational Vehicle Park Fuel-Gas Equipment and Installations. Fuel gas equipment and installations shall comply with this appendix, except as otherwise permitted or required by this code.

D 102.0 Single and Multiple Manufactured Home Site Fuel Supply Systems.

D 102.1 Underground Installation. Underground gas piping system installations shall comply with any applicable building code and Section D 102.1.1 and Section D 102.1.2. [NFPA 501A:4.2.1]

D 102.1.1 Open-Ended Gastight Conduit. Underground gas piping shall not be installed beneath that portion of a manufactured home site reserved for the location of a manufactured home or manufactured home accessory building or structure unless installed in the open-ended gastight conduit of Section D 102.1.2. [NFPA 501A:4.2.1.1]

D 102.1.2 Requirements. The open-ended gastight conduit shall conform to the requirements in the following:

1. The conduit shall be not less than Schedule 40 pipe that is approved for underground installation beneath buildings.

2. The interior diameter of the conduit shall be not less than 1⁄2 of an inch (15 mm) larger than the outside diameter of the gas piping.

3. The conduit shall extend to a point not less than 4 inches (102 mm) beyond the outside wall of the manufactured home or accessory building or structure, and the outer ends shall not be sealed.

4. Where the conduit terminates within a manufactured home or accessory building or structure, it shall be accessible and the space between the conduit and the gas piping shall be sealed to prevent leakage of gas into the building. [NFPA 501A:4.2.1.2 – 4.2.1.2.4]

D 103.0 Manufactured Home Site Gas Shutoff Valve.

D 103.1 General. Each manufactured home site shall have a listed gas shutoff valve installed upstream of the manufactured home site gas outlet. The gas shutoff valve shall be located on the outlet riser at a height of not less than 6 inches (152 mm) above grade. A gas shutoff valve shall not be located under any manufactured home. The outlet shall be equipped with a cap or plug to prevent discharge of gas whenever the manufactured home site outlet is not connected to a manufactured home. [NFPA 501A:4.2.2.1 – 4.2.2.4]

Exception: Gas shutoff valves shall conform to Section D 103.1, except for manufactured homes located on foundations constructed in accordance with the local building code or, in the absence of a local code, with a recognized model building code. [NFPA 501A:4.2.2]

D 104.0 Gas Meters.

D 104.1 Support of Meters. Where installed, gas meters shall be supported by a post or bracket placed on a firm footing or other means providing equivalent support and shall not depend on the gas outlet riser for support. [NFPA 501A:4.2.3.1]

D 104.2 Location of Meters. Each gas meter shall be installed in an accessible location and shall be provided with unions or other fittings so that the meter can be removed easily and placed in an upright position. Meters shall not be installed in unventilated or inaccessible locations or closer than 3 feet (914 mm) to sources of ignition. [NFPA 501A:4.2.3.2.1 – 4.2.3.2.2]

D 104.3 Meter Shutoff Valve or Cock. All gas meter installations shall be provided with shutoff valves or cocks located adjacent to and on the inlet side of the meters. In the case of a single meter installation utilizing an LP-Gas container, the container service valve shall be permitted to be used in lieu of the shutoff valve or cock. All gas meter installations shall be provided with test tees located adjacent to and on the outlet side of the meters. [NFPA 501A:4.2.4.1 – 4.2.4.3]

D 105.0 Cathodic Protection Requirements.

D 105.1 General. Cathodic protection shall be installed for corrosion control of buried or submerged metallic gas piping in accordance with the following requirements:
(1) Where amphoteric metals are included in a buried or submerged pipeline containing a metal of different anodic potential the following protection shall be provided:
   
   (a) The buried or submerged pipeline shall be cathodically protected at a negative (cathodic) voltage of 0.85 volt, measured between the structure surface and a saturated copper-copper sulfate half cell contacting the electrolyte.

   (b) The amphoteric metals shall be electrically isolated from the remainder of the pipeline with insulating flanges, or equivalent, and cathodically protected.

(2) The amount of cathodic protection shall be such that the protective coating and the pipe are not damaged.

D 106.0 Manufactured Home Community LP-Gas Supply Systems.

D 106.1 General. Where 10 or more customers are served by one LP-Gas supply system, the installation of the gas supply system shall be in accordance with 49 CFR 192. Other types of liquefied petroleum gas supply systems and the storage and handling of LP-Gas shall be in accordance with NFPA 58 (see Section D 111.1). [NFPA 501A:4.3.2.1 – 4.3.2.2]

D 107.0 Required Gas Supply.

D 107.1 General. The minimum hourly volume of gas required at each manufactured home site outlet or any section of the manufactured home community gas piping system shall be calculated as shown in Table D 107.1. [NFPA 501A:4.3.4.1]

In extreme climate areas, additional capacities other than those shown in Table D 107.1 shall be considered. [NFPA 501A:4.3.4.1, 4.3.4.2]

### TABLE D 107.1
DEMAND FACTORS FOR USE IN CALCULATING GAS PIPING SYSTEMS IN MANUFACTURED HOME COMMUNITIES

<table>
<thead>
<tr>
<th>NUMBER OF MANUFACTURED HOME SITES</th>
<th>BTU/H PER MANUFACTURED HOME SITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>125 000</td>
</tr>
<tr>
<td>2</td>
<td>117 000</td>
</tr>
<tr>
<td>3</td>
<td>104 000</td>
</tr>
<tr>
<td>4</td>
<td>96 000</td>
</tr>
<tr>
<td>5</td>
<td>92 000</td>
</tr>
<tr>
<td>6</td>
<td>87 000</td>
</tr>
<tr>
<td>7</td>
<td>83 000</td>
</tr>
<tr>
<td>8</td>
<td>81 000</td>
</tr>
<tr>
<td>9</td>
<td>79 000</td>
</tr>
<tr>
<td>10</td>
<td>77 000</td>
</tr>
<tr>
<td>11–20</td>
<td>66 000</td>
</tr>
<tr>
<td>21–30</td>
<td>62 000</td>
</tr>
<tr>
<td>31–40</td>
<td>58 000</td>
</tr>
<tr>
<td>41–60</td>
<td>55 000</td>
</tr>
<tr>
<td>Over 60</td>
<td>50 000</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

D 108.0 Gas Pipe Sizing and Pressure.

D 108.1 Size. The size of each section of a gas piping system shall be determined in accordance with NFPA 54, or by other standard engineering methods acceptable to the Authority Having Jurisdiction. [NFPA 501A:4.3.5.1]

D 108.2 Pressure. Where all connected appliances are operated at their rated capacity, the gas supply pressure shall be not less than 7 inches water column (1.7 kPa). The gas supply pressure shall not exceed 14 inches water column (3.5 kPa). [NFPA 501A:4.3.5.2]

D 109.0 Gas Piping Materials.

D 109.1 Metal. Metal gas pipe shall be standard-weight wrought iron or steel (galvanized or black), yellow brass containing not more than 75 percent copper, or internally tinned or treated copper of iron pipe size. Galvanizing shall not be considered protection against corrosion.

Seamless copper or steel tubing shall be permitted to be used with gases not corrosive to such material. Steel tubing shall comply with ASTM A254. Copper tubing shall comply with ASTM B88 (Type K or Type L) or ASTM B280. Copper tubing (unless tin-lined) shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet (0.7 mg/100 L) of gas. [NFPA 501A:4.3.6.1 – 4.3.6.1.6]

D 109.2 Protection Coatings for Metal Gas Piping. All buried or submerged metallic gas piping shall be protected from corrosion by approved coatings or wrapping materials. All gas pipe protective coatings shall be approved types, shall be machine applied, and shall conform to recognized standards. Field wrapping shall provide equivalent protection and is restricted to those short sections and fittings that are necessarily stripped for threading or welding. Risers shall be coated or wrapped to a point at least 6 inches (152 mm) aboveground. [NFPA 501A:4.3.6.2 – 4.3.6.2.4]

D 109.3 Plastic. Plastic piping shall only be used underground and shall meet the requirements of ASTM D2513 or ASTM D2517, as well as the design pressure and design limitations of 49 CFR (Section 192.123), and shall otherwise conform to the installation requirements thereof. [NFPA 501A:4.3.6.3]

D 110.0 Gas Piping Installations.

D 110.1 Minimum Burial Below Ground Level and Clearances. All gas piping installed belowground level shall have a minimum earth cover of 18 inches (457 mm) and shall be installed with at least 12 inches (305 mm) of clearance in any direction from any other underground utility system. [NFPA 501A:4.3.7.1]

D 110.2 Metallic Gas Piping. All metallic gas piping systems shall be installed in accordance with approved plans and specifications, including provisions for cathodic protection. Each cathodic protection system shall be designed and installed to conform to the provisions of 49 CFR 192. [NFPA 501A:4.3.7.2.1, 4.3.7.2.2]
D 110.2.1 Cathodic Protection. Where the cathodic protection system is designed to protect only the gas piping system, the gas piping system shall be electrically isolated from all other underground metallic systems or installations. Where only the gas piping system is cathodically protected against corrosion, a dielectric fitting shall be used in the manufactured home gas connection to insulate the manufactured home from the underground gas piping system. [NFPA 501A:4.3.7.2.3, 4.3.7.2.4]

D 110.2.2 Underground Metallic Systems. Where a cathodic protection system is designed to provide all underground metallic systems and installations with protection against corrosion, all such systems and installations shall be electrically bonded together and protected as a whole. [NFPA 501A:4.3.7.2.5]

D 110.3 Plastic Gas Piping. Plastic gas piping shall be used underground and shall be installed with an electrically conductive wire for locating the pipe. The wire used to locate the plastic pipe shall be copper, not smaller in size than 18 AWG, with insulation approved for direct burial. Every portion of a plastic gas piping system consisting of metallic pipe shall be cathodically protected against corrosion. [NFPA 501A:4.3.7.3.1 – 4.3.7.3.3]

D 110.4 Gas Piping System Shutoff Valve. An accessible and identifiable shutoff valve controlling the flow of gas to the entire manufactured home community gas piping system shall be installed in a location acceptable to the Authority Having Jurisdiction and near the point of connection to the service piping or to the supply connection of an LP-Gas container. [NFPA 501A:4.3.7.4]

D 111.0 Liquefied Petroleum Gas Appliances.

D 111.1 General. LP-Gas equipment shall be installed in accordance with the applicable provisions of NFPA 58. [NFPA 501A:4.3.8]

D 112.0 Oil Supply.

D 112.1 General. The following three methods of supplying oil to an individual manufactured home site shall be permitted:

(1) Supply from an outside underground tank (see Section D 113.6).

(2) Supply from a centralized oil distribution system designed and installed in accordance with accepted engineering practices and in compliance with NFPA 31.

(3) Supply from an outside aboveground tank (see Section D 113.6). [NFPA 501A:4.3.9]

D 112.2 Minimum Oil Supply Tank Size. Oil supply tanks shall have a minimum capacity equal to 20 percent of the average annual oil consumption. [NFPA 501A:4.3.10]

D 112.3 Oil Supply Connections. Oil supply connections at manufactured home sites, where provided from a centralized oil distribution system, shall be located and arranged to permit attachment to a manufactured home utilizing the stand. [NFPA 501A:4.3.11.1] The installation of such facilities shall comply with the following requirements:

(1) The main distribution pipeline shall be permitted to be connected to a tank or tanks having an aggregate capacity not exceeding 20 000 gallons (75 708 L) at a point below the liquid level.

(2) Where this piping is so connected, a readily accessible internal or external shutoff valve shall be installed in the piping as close as practicable to the tank.

(3) If external and aboveground, the shutoff valve and its tank connections shall be made of steel.

(4) Connections between the tank(s) and the main pipeline shall be made with double swing joints or flexible connectors, or shall otherwise be arranged to permit the tank(s) to settle without damaging the system.

(5) If located aboveground, the connections specified in Section D 112.3(4) shall be located within the diked area.

(6) A readily accessible and identified manual shutoff valve shall be installed either inside or outside of the structure in each branch supply pipeline that enters a building, mobile home, travel trailer, or other structure. If outside, the valve shall be protected from weather and damage. If inside, the valve shall be located directly adjacent to the point at which the supply line enters the structure. If outside, the valve shall be protected from weather and damage.

(7) A device shall be provided in the supply line at or ahead of the point where it enters the interior of the structure that will automatically shut off the oil supply, if the supply line between this device and the appliance is broken. This device shall be located on the appliance side of the manual shutoff valve required in Section D 112.3(6) and shall be solidly supported and protected from damage.

(8) Means shall be provided to limit the oil pressure at the appliance inlet to a maximum gauge pressure of 3 pound-force per square inch gauge (psig) (21 kPa). If a pressure-reducing valve is used, it shall be a type approved for the service.

(9) A device shall be provided that will automatically shut off the oil supply to the appliance if the oil pressure at the appliance inlet exceeds a gauge pressure of 8 psig (55 kPa). The device shall not be required under either of the following conditions:

(a) Where the distribution system is supplied from a gravity tank and the maximum hydrostatic head of oil in the tank is such that the oil pressure at the appliance inlet will not exceed a gauge pressure of 8 psig (55 kPa).

(b) Where a means is provided to automatically shut off the oil supply if the pressure-regulating device provided in accordance with Section D 112.3(8) fails to regulate the pressure as required.

(10) Only appliances equipped with primary safety controls specifically listed for the appliance shall be connected to a centralized oil distribution system. [NFPA 31:9.2.10 – 9.2.15]
D 113.0 Fuel Supply Systems Installation.

D 113.1 Flexible Gas Connector. Except for manufactured homes located on an all-weather wood, concrete, or concrete block foundation system or on a foundation constructed in accordance with the local building code or, in the absence of a local code, with a recognized model building code, each gas supply connector shall be listed for outside manufactured home use, shall be not more than 6 feet (1829 mm) in length, and shall have a capacity rating to supply the connected load. [NFPA 501A:4.4.1]

D 113.2 Use of Approved Pipe and Fittings of Extension. Where it is necessary to extend a manufactured home inlet to permit connection of the 6 foot (1829 mm) listed connector to the site gas outlet, the extension shall be of approved materials of the same size as the manufactured home inlet and shall be adequately supported at no more than 4 foot (1219 mm) intervals to the manufactured home. [NFPA 501A:4.4.2]

D 113.3 Mechanical Protection. All gas outlet risers, regulators, meters, valves, and other exposed equipment shall be protected against accidental damage. [NFPA 501A:4.4.3]

D 113.4 Special Rules on Atmospherically Controlled Regulators. Atmospherically controlled regulators shall be installed in such a manner that moisture cannot enter the regulator vent and accumulate above the diaphragm. Where the regulator vent is obstructed due to snow and icing conditions, shields, hoods, or other suitable devices shall be provided to guard against closing of the vent opening. [NFPA 501A:4.4.4.1 – 4.4.4.2]

D 113.5 Fuel Gas Piping Test. The manufactured home fuel gas piping system shall be tested only with air before it is connected to the gas supply. The manufactured home fuel gas piping system shall be subjected to a pressure test with all appliance shutoff valves in their closed positions. [NFPA 501A:4.4.5]

D 113.5.1 Procedures. The fuel gas piping test shall consist of air pressure at not less than 10 inches water column or more than 14 inches water column (2.5 kPa to 3.5 kPa). The fuel gas piping system shall be isolated from the air pressure source and shall maintain this pressure for not less than 10 minutes without perceptible leakage. Upon satisfactory completion of the fuel gas piping test, the appliance valves shall be opened and the gas appliance connectors shall be tested with soapy water or bubble solution while under the pressure remaining in the piping system. Solutions used for testing for leakage shall not contain corrosive chemicals. Pressure shall be measured with a manometer, slope gauge, or gauge that is calibrated in either water inch (mm) or psi (kPa) with increments of either \( \frac{1}{10} \) of an inch (2.5 mm) or \( \frac{1}{10} \) psi (0.7 kPa) gauge, as applicable. Upon satisfactory completion of the fuel gas piping test, the manufactured home gas supply connector shall be installed and the connections shall be tested with soapy water or bubble solution. [NFPA 501A:4.4.5.1.1 – 4.4.5.1.6]

D 113.5.2 Warning. The following warning shall be supplied to the installer:

**WARNING:** Do not overpressurize the fuel gas piping system. Damage to valves, regulators, and appliances can occur due to pressurization beyond the maximums specified. [NFPA 501A:4.4.5.2]

D 113.5.3 Vents. Gas appliance vents shall be visually inspected to ensure that they have not been dislodged in transit and are connected securely to the appliance. [NFPA 501A:4.4.5.3]

D 113.6 Oil Tanks. Oil tank capacities shall comply with the following:

1. No more than one 660 gallon (2498 L) tank or two tanks with an aggregate capacity of 660 gallons (2498 L) or less shall be connected to one oil-burning appliance.

2. Two supply tanks, where used, shall be cross-connected and provided with a single fill and single vent, as described in NFPA 31 and shall be on a common slab and rigidly secured, one to the other.

3. Tanks having a capacity of 660 gallons (2498 L) or less shall be securely supported by rigid, noncombustible supports to prevent settling, sliding, or lifting. [NFPA 501A:4.4.6]

D 113.6.1 Installation. Oil supply tanks shall be installed in accordance with the applicable provisions of NFPA 31. [NFPA 501A:4.4.6.1]

D 113.6.2 Capacity. A tank with a capacity no larger than 60 gallons (227 L) shall be permitted to be a DOT-5 shipping container (drum), and so marked, or a tank meeting the provisions of UL 80. Tanks other than DOT-5 shipping containers having a capacity of not more than 660 gallons (2498 L) shall meet the provisions of UL 80. Pressure tanks shall be built in accordance with Section VIII, Pressure Vessels, of the ASME Boiler and Pressure Vessel Code. [NFPA 501A:4.4.6.2.1 – 4.4.6.2.2]

D 113.6.3 Location. Tanks, as described in Section D 113.6 and Section D 113.6.2, that are adjacent to buildings shall be located not less than 10 feet (3048 mm) from a property line that is permitted to be built upon. [NFPA 501A:4.4.6.3]

D 113.6.4 Vent. Tanks with a capacity no larger than 660 gallons (2498 L) shall be equipped with an open vent no smaller than 1½ inch (40 mm) iron pipe size; tanks with a 500 gallon (1892 L) or less capacity shall have a vent of 1 inch (32 mm) iron pipe size. [NFPA 501A:4.4.6.4]

D 113.6.5 Liquid Level. Tanks shall be provided with a means of determining the liquid level. [NFPA 501A:4.4.6.5]

D 113.6.6 Fill Opening. The fill opening shall be a size and in a location that permits filling without spillage. [NFPA 501A:4.4.6.6]

D 114.0 Manufactured Home Accessory Building Fuel Supply Systems.

D 114.1 General. Fuel gas supply systems installed in a manufactured home accessory building or structure shall
comply with the applicable provisions of NFPA 54 and NFPA 58. Fuel oil supply systems shall comply with the applicable provisions of NFPA 31. [NFPA 501A:4.5.1 – 4.5.2]

D 115.0 Community Building Fuel Supply Systems in Manufactured Home Communities.

D 115.1 Fuel Gas Piping and Equipment Installations. Fuel gas piping and equipment installed within a permanent building in a manufactured home community shall comply with nationally recognized appliance and fuel gas piping codes and standards adopted by the Authority Having Jurisdiction. Where the state or other political subdivision does not assume jurisdiction, such fuel gas piping and equipment installations shall be designed and installed in accordance with the applicable provisions of NFPA 54 or NFPA 58. [NFPA 501A:4.6.1.1 – 4.6.1.2]

D 115.2 Oil Supply Systems in Manufactured Home Communities. Oil-burning equipment and installation within a manufactured home community shall be designed and constructed in accordance with the applicable codes and standards adopted by the Authority Having Jurisdiction. Where the state or other political subdivision does not assume jurisdiction, such installations shall be designed and constructed in accordance with the applicable provisions of NFPA 31. [NFPA 501A:4.6.2.1 – 4.6.2.2]

D 115.3 Oil-Burning Equipment and Installation. Oil-burning equipment and installation within a building constructed in a manufactured home community in accordance with the local building code or a nationally recognized building code shall comply with nationally recognized codes and standards adopted by the Authority Having Jurisdiction. Where the state or other political subdivision does not assume jurisdiction, such oil-burning equipment and installations shall be designed and installed in accordance with the applicable provisions of NFPA 31. [NFPA 501A:4.6.3.1 – 4.6.3.2]

D 115.4 Inspection and Tests. Inspections and tests for fuel gas piping shall be made in accordance with Chapter 1 and Chapter 13 of this code.
APPENDIX E
SUSTAINABLE PRACTICES

E 101.0 General.

E 101.1 Applicability. The purpose of this appendix is to provide a comprehensive set of technically sound provisions that encourage sustainable practices and works towards enhancing the design and construction of mechanical systems that result in a positive long-term environmental impact. This appendix is not intended to circumvent the health, safety, and general welfare requirements of this code.

E 101.2 Definition of Terms. For the purposes of this code, the definitions shall apply to this appendix.

No attempt is made to define ordinary words, which are used in accordance with their established dictionary meanings, except where a word has been used loosely, and it is necessary to define its meaning as used in this appendix to avoid misunderstanding.

The definitions of terms are arranged alphabetically according to the first word of the term.

E 201.0 Definitions.

E 201.1 Definitions. For the purpose of this appendix, the following definitions shall apply:

Cycles of Concentration for Cooling Towers. Cycles of concentration equals the specific conductance of the water in the cooling tower basin divided by the combined flow-weighted average specific conductance of the makeup water(s) to the cooling tower.

Duct Wall Penetrations. Includes pipe, tubing, rods, and wire. Screws and other fasteners are not considered to be ductwork penetrations.

Energy Star. A joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. Energy Star is a voluntary program designed to identify and promote energy-efficient products and practices.

Fan, Embedded. A fan that is part of a manufactured assembly where the assembly includes functions other than air movement. [ASHRAE 90.1:3.2]

Fan Array. Multiple fans in parallel between two plenum sections in an air distribution system. [ASHRAE 90.1:3.2]

Fan Nameplate Electrical Input Power. The nominal electrical input power rating stamped on a fan assembly nameplate. [ASHRAE 90.1:3.2]

Fan Energy Index (FEI). The ratio of the electric input power of a reference fan to the electric input power of the actual fan as calculated per AMCA 208. [ASHRAE 90.1:3.2]

Fan System Electrical Input Power. The sum of the electrical input power of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the conditioned spaces and/or return it to the source or exhaust it to the outdoors. [ASHRAE 90.1:3.2]

Geothermal. Renewable energy generated by deep-earth.

Heating Seasonal Performance Factor (HSPF). The total heating output of a heat pump during its normal annual usage period for heating in British thermal units (Btu) (kW•h) divided by the total electric energy input during the same period. [ASHRAE 90.1:3.2]

Humidistatic Controls. Automatic controls used to maintain humidity at a fixed or adjustable set point. [ASHRAE 90.1:3.2]

Integrated Energy Efficiency Ratio (IEER). A single-number figure of merit expressing cooling part-load EER efficiency for commercial unitary air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment. [ASHRAE 90.1:3.2]

Integrated Part-Load Value (IPLV). A single-number figure of merit based on part-load EER, COPc, or kW/kW expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment. [ASHRAE 90.1:3.2]

Joint, Transverse. Connections of two duct sections oriented perpendicular to airflow.

Maintenance. The upkeep of property or equipment by the owner of the property in accordance with the requirements of this appendix.

Minimum Efficiency Reporting Value (MERV). Filter minimum efficiency reporting value, in accordance with ASHRAE 52.2.

Multi-Occupant Spaces. Indoor spaces used for presentations and training, including classrooms and conference rooms.

On-Site Renewable Energy. Energy generated from renewable energy resources produced harvested at the building site. [ASHRAE 90.1:3.2]

Parking Garage Section. A part of a parking garage where airflow is restricted from other parts of the garage by solid walls.

Process Application. A manufacturing, industrial, or commercial procedure or activity where the primary purpose is other than conditioning spaces and maintaining comfort and amenities for the occupants of a building. [ASHRAE 90.1:3.2]

Recirculation System. A system of hot water supply and return piping with shutoff valves, balancing valves, circulating pumps, and a method of controlling the circulating system.

Renewable Energy Resources. Energy from solar, wind, biomass or hydro, or extracted from hot fluid or steam heated within the earth. [ASHRAE 90.1:3.2]

Seasonal Energy Efficiency Ratio (SEER). The total cooling output of an air conditioner during its normal annual usage period for cooling in Btu (kW•h) divided by the total electric energy input during the same period in Btu (kW•h). [ASHRAE 90.1:3.2]

Site-Recycled Energy. Waste energy recovered at the building site that is used to offset consumption of purchased fuel or electrical energy supplies. [ASHRAE 90.1:3.2]

Stormwater. Natural precipitation that has contacted a surface at grade or below grade and has not been put to beneficial use.

Thermal Energy. The amount of sensible heat energy stored within a material or fluid. The product of the mass, specific thermal capacity and temperature increase/decrease of the material or fluid. Also known as sensible heat energy.

Thermal Storage. A tank or vessel used in a solar thermal, hydronic, or geothermal system, in which thermal energy is stored.

Total Dissolved Solids (TDS). A measure (by electrical conductivity) of the amount of soluble matter that is present in the water.

Whole House Fan. A fan used for ventilating a building or space primarily to exhaust air from the conditioned space typically through an attic.

E 301.0 General Regulations.
E 301.1 Installation. Mechanical systems covered by this appendix shall be installed in accordance with this code, other applicable codes, and the manufacturer’s installation and operating instructions.

E 301.2 Qualifications. Where permits are required, the Authority Having Jurisdiction shall have the authority to require contractors, installers, or service technicians to demonstrate competency. Where determined by the Authority Having Jurisdiction, the contractor, installer or service technician shall be licensed to perform such work.

E 302.0 Disposal of Liquid Waste.
E 302.1 Disposal. It shall be unlawful for a person to cause, suffer, or permit the disposal of liquid wastes, in a place or manner, except through and by means of an approved drainage system, installed and maintained in accordance with the provisions of the plumbing code.

E 302.2 Connections to Plumbing System Required. Equipment and appliances, used to receive or discharge liquid wastes or sewage, shall be connected to the drainage system of the building or premises in accordance with the requirements of the plumbing code and this appendix.

E 303.0 Abandonment.
E 303.1 General. An abandoned system or part thereof covered under the scope of this appendix shall be disconnected from remaining systems, drained, plugged, and capped in an approved manner.

E 401.0 Water Conservation and Efficiency.
E 401.1 General. The provisions of this section establish the means of conserving potable and nonpotable water used in and around a building.

E 402.0 Meters.
E 402.1 Required. A water meter shall be required for buildings connected to a public water system, including municipally supplied reclaimed (recycled) water. In other than single-family houses, multi-family structures not exceeding three stories above grade, and modular houses, a separate meter or submeter shall be installed in the following locations:

1. The makeup water supply to cooling towers, evaporative condensers, and fluid coolers.
2. The makeup water supply to one or more boilers collectively exceeding 1000 000 British thermal units per hour (Btu/h) (293 kW).
3. The water supply to a water-using process where the consumption exceeds 1000 gallons per day (gal/d) (0.0438 L/s), except for manufacturing processes.
4. The makeup water supply to an evaporative cooler having an air flow exceeding 30 000 cubic feet per minute (ft³/min) (14.1584 m³/s).

E 402.2 Consumption Data. A means of communicating water consumption data from submeters to the water consumer shall be provided.

E 402.3 Access. Meters and submeters shall be accessible.

E 403.0 HVAC Water Use.
E 403.1 Once-Through Cooling. Once-through cooling using potable water is prohibited.

E 403.2 Cooling Towers and Evaporative Coolers. Cooling towers and evaporative coolers shall be equipped with makeup water and blow down meters, conductivity controllers, and overflow alarms. Cooling towers shall be equipped with efficiency drift eliminators that achieve drift reduction to 0.002 percent of the circulated water volume for counterflow towers and 0.005 percent for cross-flow towers.

E 403.3 Cooling Tower Makeup Water. Not less than 5 cycles of concentration is required for air-conditioning cooling tower makeup water having a total hardness of less than 11 grains per gallon (gr/gal) (188 mg/L) expressed as calcium carbonate. Not less than 3.5 cycles of concentration is required for air-conditioning cooling tower makeup water having a total hardness equal to or exceeding 11 gr/gal (188 mg/L) expressed as calcium carbonate.

Exception: Air-conditioning cooling tower makeup water having discharge conductivity range not less than 7 gr/gal (120 mg/L) to 9 gr/gal (154 mg/L) of silica measured as silicon dioxide.

E 403.4 Evaporative Cooler Water Use. Evaporative cooling systems shall use 3.5 gallons (13.2 L) or less of water per ton-hour (kW•h) of cooling where system controls are set to maximum water use. Water use expressed in maximum
water use per ton-hour (kW•h) of cooling, shall be marked on
the device and included in the product user manual, product
information literature, and manufacturer’s installation instruc-
tions. Water use information shall be readily available at the
time of code compliance inspection.

E 403.4.1 Overflow Alarm. Cooling systems shall be
equipped with an overflow alarm to alert building owners,
tenants, or maintenance personnel where the water
refill valve continues to allow water to flow into the
reservoir where the reservoir is full. The alarm shall have
a sound pressure level rating of not less than 85 dBA
measured at a distance of 10 feet (3048 mm).

E 403.4.2 Automatic Pump Shut-Off. Cooling sys-
tems shall automatically cease pumping water to the
evaporation pads where airflow across evaporation pads
ceases.

E 403.4.3 Cooler Reservoir Discharge. A water
quality management system (either timer or water qual-
ity sensor) shall be provided. Where timers are used, the
time interval between discharge of reservoir water shall
be set to 6 or more hours of cooler operation. Where
water quality sensors are used, the discharge of reservoir
water shall be set for 800 ppm or more of total dissolved
solids (TDS). Continuous discharge or continuous bleed
systems shall not be installed.

E 403.4.4 Discharge Water Reuse. Discharge water
shall be reused where applications exist on site. Where a
nonpotable water source system exists on site, evapora-
tive cooler discharge water shall be collected and dis-
charged to the collection system.

Exception: Where the reservoir water affects the quality
of the nonpotable water supply making the nonpotable
water unusable for its intended purposes.

E 403.4.5 Discharge Water to Drain. Where dis-
charge water is not recovered for reuse, the sump over-
flow line shall not be directly connected to a drain.
Where the discharge water is discharged into a sanitary
drain, an air gap of not less than 6 inches (152 mm) shall
be provided between the termination of the discharge line
and the drain opening. The discharge line shall terminate
in a location that is visible to the building owner, tenants,
or maintenance personnel.

E 403.5 Use of Reclaimed (Recycled) and Onsite
Treated Nonpotable Water for Cooling. Where
approved for use by the water or wastewater utility and the
Authority Having Jurisdiction, reclaimed (recycled), or on-
site treated nonpotable water shall be permitted to be used for
industrial and commercial cooling or air-conditioning.

E 403.5.1 Drift Eliminator. A drift eliminator shall be
utilized in a cooling system, utilizing alternate sources
of water, where the aerosolized water is capable of com-
ing in contact with employees or members of the public.

E 403.5.2 Disinfection. A biocide shall be used to
treat the cooling system recirculation water where the
recycled water is capable of coming in contact with
employees or members of the public.

E 501.0 Heating, Ventilation, and Air-Conditioning
E 501.1 Scope. The provisions of this section shall establish
the means of enhancing energy efficiency associated with
mechanical systems in a building.

E 502.0 Heating, Ventilation, and Air-Conditioning
Low-Rise Residential Buildings.
E 502.1 General. The heating, ventilating, air-conditioning,
for single-family houses, multi-family structures not exceeding
three stories above grade, and modular houses shall be in
accordance with Section E 502.2 through Section E 502.12.
The heating, ventilation, and air-conditioning system of other
buildings shall be in accordance with Section E 503.0.

E 502.2 Heating, Ventilating, and Air-Conditioning
Systems and Equipment. This section shall regulate only
equipment using single-phase electric power, air condition-
ers, and heat pumps with rated cooling capacities less than 65
000 British thermal units per hour (Btu/h) (19 kW), warm air
furnaces with rated heating capacities less than 225 000 Btu/h
(66 kW), boilers less than 300 000 Btu/h (88 kW) input, and
heating-only heat pumps with rated heating capacities less
than 65 000 Btu/h (19 kW). [ASHRAE 90.2:6.2]

E 502.2.1 Nonresidential Type Systems and
Equipment. Heating, ventilating, and air-conditioning
systems and equipment that do not fall under the require-
ments of Section E 502.0 shall be in accordance with the
applicable requirements of Section E 503.0.

E 502.3 Balancing. The air distribution system design,
including outlet grilles, shall provide a means for balancing
the air distribution system unless the design procedure pro-
vides a system intended to operate within plus or minus 10
percent of design air quantities. [ASHRAE 90.2:6.3]

E 502.3.1 Balancing Dampers. Balancing dampers shall be
installed in branch ducts, and the axis of the
damper shall be installed parallel to the direction of air-
flow in the main duct.

E 502.4 Ducts. Ducts shall be sized, installed, and tested in
accordance with Section E 502.4.1 through Section E 502.4.4.
E 502.4.1 Insulation for Ducts. Portions of the air dis-
tribution system installed in or on buildings for heating
and cooling shall be R-8. Where the mean outdoor dew-
point temperature in a month exceeds 60°F (16°C), vapor
retarders shall be installed on conditioned-air supply ducts.
Vapor retarders shall have a water vapor permeance not
exceeding 0.5 perm [2.87 E-11 kg/(Pa•s•m2)] where tested
in accordance with Procedure A in ASTM E96.

Insulation shall not be required where the ducts are
within the conditioned space. [ASHRAE 90.2:6.4]

E 502.4.2 Ducts and Register Penetrations. Joints,
seams, and penetrations of duct systems shall be made
airtight by means of mastics, gasketing, or other means
in accordance with this code. Register penetrations shall
be sealed to the wall or floor assemblies. Where HVAC
duct penetrates a conditioned space, the duct penetration
shall be sealed to the wall or floor assembly to prevent
leakage into an unconditioned space.
E 502.4.3 Duct Leakage Test. For systems with a duct or air handler outside of the conditioned space, a duct leakage test shall be performed in accordance with Section E 502.4.3.1.

E 502.4.3.1 Duct Leakage Verification Test. Ductwork shall be tested to the maximum permitted leakage in 1 cubic foot per minute (ft³/min) per 100 square feet (0.0001 (m³/s)/m²) of duct surface area in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Register penetrations shall be sealed during the test. The test shall be conducted with a pressure differential of 0.1 inch water gauge (0.02 kPa) across the tested system.

E 502.4.4 Duct Sizing. Duct systems shall be sized in accordance with ACCA Manual D or other methods approved by the Authority Having Jurisdiction with the velocity in the main duct not to exceed 1000 feet per minute (ft/min) (5.08 m/s) and the velocity in the secondary branch duct not to exceed 600 ft/min (3.048 m/s).

E 502.5 Insulation for Piping. HVAC system piping installed to serve buildings and within buildings shall be thermally insulated in accordance with Table E 502.5. [ASHRAE 90.2:6.5]

E 502.6 Ventilation and Combustion Air. The building shall be designed to have the capability to provide the venti-

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### TABLE E 502.5

<table>
<thead>
<tr>
<th>NOMINAL PIPE DIAMETER (inches)</th>
<th>FLUID DESIGN OPERATING TEMPERATURE RANGE (°F)</th>
<th>Btu/in²/(h•ft²•°F)</th>
<th>MEAN RATING TEMPERATURE (°F)</th>
<th>&lt;1</th>
<th>1 TO 1¼</th>
<th>1¼ TO 3¼</th>
<th>4 TO 6</th>
<th>EQUAL TO OR GREATER THAN 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEATING SYSTEMS (STEAM, STEAM CONDENSATE, AND HOT WATER)²³</td>
<td>201–250</td>
<td>0.27–0.30</td>
<td>150</td>
<td>1.5</td>
<td>1.5</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>141–200</td>
<td>0.25–0.29</td>
<td>125</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>105–140</td>
<td>0.22–0.28</td>
<td>100</td>
<td>0.5</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>COOLING SYSTEMS (CHILLED WATER, BRINE, AND REFRIGERANT)⁴</td>
<td>40–55</td>
<td>0.22–0.28</td>
<td>100</td>
<td>0.5</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Below 40</td>
<td>0.22–0.28</td>
<td>100</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

For SI Units: °C = (°F-32)/1.8, 1 British thermal unit inch per hour square foot degree Fahrenheit = [0.1 W/(m•K)], 1 inch = 25 mm

Notes:
1 For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:

\[ T = r(1 + \frac{t}{r})K/k - 1 \]

Where:
- \( T \) = minimum insulation thickness (inches).
- \( r \) = actual outside radius of pipe (inches) (mm).
- \( t \) = insulation thickness listed in this table for applicable fluid temperature and pipe size.
- \( K \) = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature [Btu•in/(h•ft²•°F)] [W/(m•K)].
- \( k \) = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

2 These thicknesses are based on energy efficiency considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.

3 Piping insulation is not required between the control valve and coil on run-outs where the control valve is located within 4 feet (1219 mm) of the coil and the pipe size is 1 inch (25 mm) or less.

4 These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders, additional insulation or both.

5 For piping exposed to outdoor air, increase insulation thickness by ¼ of an inch (12.7 mm). The outdoor air is defined as any portion of insulation that is exposed to outdoor air. For example, attic spaces and crawl spaces are considered exposed to outdoor air.

### TABLE E 502.6

<table>
<thead>
<tr>
<th>VENTILATION AIR</th>
<th>MINIMUM REQUIREMENT</th>
<th>CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical ventilation¹</td>
<td>50 ft³/min outdoor air</td>
<td>Where summer design infiltration rate calculated in accordance with reference standard (a) or (b) is less than 0.35 ACH².</td>
</tr>
<tr>
<td>Kitchen exhaust</td>
<td>100 ft³/min intermittent</td>
<td>All conditions</td>
</tr>
<tr>
<td>Bath exhaust</td>
<td>intermittent</td>
<td>All conditions</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m³/s

Notes:
1 Calculate in accordance with Equation E 502.6.

2 Reference standards:
   a) ACCA Manual J
   b) ASHRAE GRP-158
Mechanical ventilation shall be calculated in accordance with Equation E 502.6. [ASHRAE 90.2:6.6.1]

\[
\text{Mechanical Ventilation} = \frac{(0.35 - \text{Summer}) \times \text{Volume}}{60}
\]

Where:

- **Mechanical Ventilation** = required mechanical ventilation rate to supplement summer infiltration, CFM (m³/s)
- **Summer** = summer design infiltration rate, ACH
- **Volume** = volume of conditioned space, ft³ (m³)

**E 502.6.1 Combustion Air.** Combustion air for fossil fuel heating equipment shall comply with this code or with one of the following:

1. Natural gas and propane heating equipment, NFPA 54
2. Oil heating equipment, NFPA 31
3. Solid fuel burning equipment, NFPA 211

**E 502.7 Electric Heating Systems.** Electric heating systems shall be installed in accordance with the following requirements. [ASHRAE 90.2:6.7]

**E 502.7.1 Wall, Floor, or Ceiling Electric-Resistance Heating.** Where wall, floor, or ceiling electric-resistance heating units are used, the structure shall be zoned and heaters installed in each zone in accordance with the heat loss of that zone. Where living and sleeping zones are separate, the number of zones shall be not less than two. Where two or more heaters are installed in one room, they shall be controlled by one thermostat. [ASHRAE 90.2:6.7.1]

**E 502.7.2 Electric Central Warm Air Heating.** Where electric central warm air heating is to be installed, an electric heat pump or an off-peak electric heating system with thermal storage shall be used.

**Exceptions:**

1. Electric resistance furnaces where the ducts are located inside the conditioned space, and not less than two zones are provided where the living and sleeping zones are separate.
2. Packaged air-conditioning units with supplemental electric heat. [ASHRAE 90.2:6.7.2]

**E 502.8 Bath Ceiling Units.** Bath ceiling units providing a combination of heat, light, or ventilation shall be provided with controls permitting separate operation of the heating function. [ASHRAE 90.2:6.8]

**E 502.9 HVAC Equipment, Rated Combinations.** HVAC system equipment and system components shall be furnished with the input(s), the output(s), and the value of the appropriate performance descriptor of HVAC products in accordance with federal law or in accordance with Table E 502.9, as applicable. These shall be based on newly produced equipment or components. Manufacturer’s instructions shall be furnished with and attached to the equipment. The manufacturer of electric-resistance heating equipment shall furnish full-load energy input over the range of voltages at which the equipment is intended to operate. [ASHRAE 90.2:6.9]

**E 502.10 Controls.** Each system or each zone within a system shall be provided with not less than one thermostat capable of being set from 55°F (13°C) to 85°F (29°C) and capable of operating the system’s heating and cooling. The thermostat or control system, or both, shall have an adjustable deadband, the range of which includes a setting of 10°F (6°C) between heating and cooling where automatic changeover is provided. Wall-mounted temperature controls shall be mounted on an inside wall. [ASHRAE 90.2:6.10.1]

**E 502.10.1 Initial Control Setting.** The control shall initially be set for a maximum heating temperature of 70°F (21°C) and a cooling temperature of not less than 78°F (26°C).

**E 502.10.2 Ventilation Control.** Each mechanical ventilation system (supply, exhaust, or both) shall be equipped with a readily accessible switch or other means for shutoff. Manual or automatic dampers installed for the purpose of isolating outside air intakes and exhausts from the air distribution system shall be designed for tight shutoff. [ASHRAE 90.2:6.10.2]

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**TABLE E 502.9**

**MINIMUM REQUIREMENTS FOR NON-FEDERALLY COVERED HVAC EQUIPMENT**

[ASHRAE 90.2: TABLE 6.9]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater source heat pump*</td>
<td>Cooling Mode</td>
<td>11.0 EER at 70°F Ent. Water</td>
<td>ARI 325</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.5 EER at 50°F Ent. Water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heating Mode</td>
<td>3.4 COP at 70°F Ent. Water</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0 COP at 50°F Ent. Water</td>
<td></td>
</tr>
<tr>
<td>Unitary A/C</td>
<td>Water cooled split system</td>
<td>9.3 EER at 85°F Ent. Water</td>
<td>ARI 210/240</td>
</tr>
<tr>
<td></td>
<td>Evaporatively cooled split system</td>
<td>8.3 IPLV at 75°F Ent. Water</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.3 EER at 95°F Out. Amb.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.5 IPLV at 80°F Out. Amb.</td>
<td></td>
</tr>
</tbody>
</table>

For SI units: °C = (°F-32)/1.8

* Performance for electrically powered equipment with capacity less than 65 000 Btu/h (19 kW) where rated in accordance with ARI 325.
E 502.10.3 Humidity Control. Where additional energy-consuming equipment is provided for adding moisture to maintain specific selected relative humidities in spaces or zones, a humidistat shall be provided. This device shall be capable of being set to prevent energy from being used to produce relative humidity within the space above 30 percent. [ASHRAE 90.2:6.10.3.1]

E 502.10.3.1 Cooling. Where additional energy-consuming equipment is provided for reducing humidity, it shall be equipped with controls capable of being set to prevent energy from being used to produce a relative humidity within the space below 50 percent during periods of human occupancy and below 60 percent during unoccupied periods. [ASHRAE 90.2:6.10.3.2]

E 502.10.4 Freeze Protection Systems. Freeze protection systems, such as heat tracing of outdoor piping and heat exchangers, including self-regulating heat tracing, shall include automatic controls capable of and configured to shut off the systems where outdoor air temperatures are above 40°F (4°C) or where the condition of the protected fluid will prevent freezing. Snow- and ice-melting systems shall include automatic controls capable of and configured to shut off the systems where the pavement temperature is above 50°F (10°C) and no precipitation is falling and an automatic or manual control that will allow shutoff where the outdoor temperature is above 40°F (4°C) so that the potential for snow or ice accumulation is negligible. [ASHRAE 90.1:6.4.3.7]

E 502.10.5 Other Controls. Where setback, zoned, humidity and cooling controls and equipment are provided, they shall be designed and installed in accordance with Section E 502.10 through Section E 502.10.3.1. [ASHRAE 90.2:6.10.3.3]

E 502.11 Whole House Fans. Whole house exhaust fans shall have insulated louvers or covers which close where the fan is off. Covers or louvers shall have an insulation value of not less than R-4.2, and shall be installed in accordance with the manufacturer’s installation instructions. The attic openings shall be sufficient to accommodate the ventilation capacity of the whole house fan. The operation of the whole house fan shall be considered in determining the adequacy of providing combustion air in accordance with this code.

E 502.12 Dampers. Dampers shall be installed to close off outdoor air inlets and exhaust outlets where the ventilation system is not operating.

E 503.0 Heating, Ventilation, and Air-Conditioning – Other than Low-Rise Residential Buildings.

E 503.1 General. The heating, ventilation, and air-conditioning in buildings, other than single-family houses, multi-family structures of not more than three stories above grade, and modular structures, shall be in accordance with Section E 503.0.

E 503.1.1 New Buildings. Mechanical equipment and systems serving the heating, cooling, ventilating, or refrigeration needs of new buildings shall be in accordance with the requirements of this section as described in Section E 503.2. [ASHRAE 90.1:6.1.1.1]

E 503.12 Additions to Existing Buildings. Mechanical equipment and systems serving the heating, cooling, ventilating, or refrigeration needs of additions to existing buildings shall be in accordance with the requirements of this section as described in Section E 503.2.

Exception: Where HVAC to an addition is provided by existing HVAC systems and equipment, such existing systems and equipment shall not be required to be in accordance with this appendix. A new system or equipment installed shall be in accordance with specific requirements applicable to those systems and equipment. [ASHRAE 90.1:6.1.1.1.2]

E 503.1.3 Alterations to Heating, Ventilating, Air-Conditioning, and Refrigeration in Existing Buildings. New HVAC equipment as a direct replacement of existing HVAC equipment shall be in accordance with the following sections as applicable for the equipment being replaced:

1. Section E 503.3 “Simplified Approach Option for HVAC Systems”
2. Section E 503.4 “Equipment Efficiencies, Verification, and Labeling Requirements”
3. Section E 503.4.6 “Zone Thermostatic Controls”
4. Section E 503.4.6.2 “Setpoint Overlap Restriction”
5. Section E 503.4.6.3 “Off-Hour Controls”
6. Section E 503.4.6.4 “Ventilation System Controls”
7. Section E 503.4.6.8 “Freeze Protection and Snow or Ice Melting Systems”
8. Section E 503.4.6.9 “Ventilation Controls for High-Occupancy Areas”
9. Section E 503.4.6.11 “Heated or Cooled Vestibules”
10. Section E 503.4.8 “Walk-In Coolers and Walk-In Freezers”
11. Section E 503.5.1 “Air Economizers, Design Capacity”
12. Section E 503.5.3 “Integrated Economizer Control”
13. Section E 503.5.4 “Economizer Heating System Impact”
14. Section E 503.5.6.1.2 “Fan Efficiency”
15. Section E 503.5.6.2 “Supply Fan Airflow Control”
16. Section E 503.5.6.5 “Fractional Horsepower Fan Motors”
17. Section E 503.5.7 “Boiler Turndown”
18. Section E 503.5.7.2 E 503.5.7.3 “Chiller and Boiler Isolation”
19. Section E 503.5.8.1 “Fan Speed Control”. [ASHRAE 90.1:6.1.1.3.1]

E 503.1.3.1 New Cooling Systems. New cooling systems installed to serve previously uncooled spaces shall be in accordance with this section as described in Section E 503.2. [ASHRAE 90.1:6.1.1.3.2]
E 503.1.3.2 Existing Cooling Systems. Alterations to existing cooling systems shall not decrease economizer capability unless the system is in accordance with Section E 503.5 through Section E 503.5.4.1. [ASHRAE 90.1:6.1.1.3.3]

E 503.1.3.3 Ductwork. New and replacement ductwork shall comply with Section E 503.4.7.1 through Section E 503.4.7.2.1. [ASHRAE 90.1:6.1.1.3.4]

E 503.1.3.4 Piping. New and replacement piping shall comply with Section E 503.4.7.1.

Exceptions:
1. For equipment that is being modified or repaired but not replaced, provided that such modifications or repairs will not result in an increase in the annual energy consumption of the equipment using the same energy type.
2. Where a replacement or alteration of equipment requires extensive revisions to other systems, equipment, or elements of a building, and such replaced or altered equipment is a like-for-like replacement.
3. For a refrigerant change of existing equipment.
4. For the relocation of existing equipment.
5. For ducts and piping where there is insufficient space or access to comply with these requirements. [ASHRAE 90.1:6.1.1.3.5]

E 503.2 Compliance Path(s). Mechanical equipment and systems providing heating, cooling, ventilating, or refrigeration shall comply with Section E 503.2.1 and Section E 503.2.2. Section E 503.0 shall be achieved in accordance with the requirements of Section E 503.1.1 through Section E 503.1.3.4, Section E 503.6, Section E 503.7, and one of the following:

1. Section E 503.3 and Section E 503.4 [ASHRAE 90.1:6.2.16.2]
2. Section E 503.4
3. Section E 503.4 and Section E 503.8 [ASHRAE 90.1:6.2.16.2]

E 503.2.1 Requirements for All Compliance Paths. Mechanical equipment and systems shall comply with the following:

1. Section E 503.0, “General”
2. Section E 503.4, “Equipment Efficiencies, Verification, and Labeling Requirements”
3. Section E 503.6, “Submittals”

E 503.2.2 Additional Requirements. Mechanical equipment and systems shall comply with one of the following:

   Exception: When compliance is shown using Section E 503.2.2(1), compliance with Section E 503.4 is not required.
2. Section E 503.5, “Prescriptive Compliance Path”
   Exception: HVAC systems only serving the heating, cooling, or ventilating needs of a computer room with IT equipment load greater than 10 kW (34,000 Btu/h) shall be permitted to comply with Section E 503.4, “Equipment Efficiencies, Verification, and Labeling Requirements” and Section E 503.8, “Alternative Compliance Path, Computer Room Systems.” [ASHRAE 90.1:6.2.2]

E 503.2.1 Projects Using Energy Cost Budget Method. Projects using the energy cost budget method in accordance with ASHRAE 90.1 shall comply with Section E 503.4, the mandatory provisions of this section, as a portion of that compliance path. [ASHRAE 90.1:6.2.2]

E 503.3 Simplified Approach Option Building Compliance Path for HVAC Systems. The simplified approach shall be an optional path for compliance where the following conditions are met:

1. The building is not more than two stories in height.
2. Gross floor area is less than 25,000 square feet (2,322.6 m²).
3. The HVAC system in the building is in accordance with the requirements listed in Section E 503.3.1. [ASHRAE 90.1:6.3.1]

E 503.3.1 Criteria. The HVAC system shall comply with all of the following criteria:

1. The system serves a single HVAC zone.
2. The equipment shall comply with the variable flow requirements of Section E 503.5.6.2.
3. Cooling (where any) shall be provided by a unitary packaged or split-system air conditioner that is either air-cooled or evaporatively cooled, with efficiency that is in accordance with the requirements shown in Table E 503.7.1(1) for air conditioners, Table E 503.7.1(2) for heat pumps, or Table E 503.7.1(4) for packaged terminal and room air conditioners and heat pumps for the applicable equipment category.
4. The system shall have an air economizer in accordance with Section E 503.5 and Section E 503.4.6.13.
5. Heating (where any) shall be provided by a unitary packaged or split-system heat pump that is in accordance with the applicable efficiency requirements shown in Table E 503.7.1(2) for heat pumps or Table E 503.7.1(4) for packaged terminal and room air conditioners and heat pumps, a fuel-fired furnace that is in accordance with the applicable efficiency requirements shown in Table E 503.7.1(5) for furnaces, duct furnaces, and unit heaters, an electric resistance heater, or a baseboard system connected to a boiler that is in accordance with the applicable efficiency requirements shown in Table E 503.7.1(6) for boilers.
6. The system shall comply with the exhaust air energy recovery requirements in accordance with Section E 503.8.10 E 503.5.10.1.2.
7. The system shall be controlled by a manual changeover or dual setpoint thermostat.
(8) Where a heat pump equipped with auxiliary internal electric resistance heaters is installed, controls shall be provided that prevent supplemental heater operation where the heating load is capable of being met by the heat pump alone during both steady-state operation and setback recovery. Supplemental heater operation shall be permitted during outdoor coil defrost cycles. The heat pump shall be controlled in accordance with one of the following:
   (a) A digital or electronic thermostat designed for heat pump use that energizes auxiliary heat where the heat pump has insufficient capacity to maintain setpoint or to warm up the space at a sufficient rate.
   (b) A multistage space thermostat and an outdoor air thermostat wired to energize auxiliary heat on the last stage of the space thermostat and where outdoor air temperature is less than 40°F (4°C).

**Exceptions:** Heat pumps that comply with the following:
   (1) Have a minimum efficiency regulated by NAECA.
   (2) In accordance with the requirements shown in Table E 503.7.1(2).
   (3) Include all usage of internal electric resistance heating.

(9) The system controls shall not permit reheat or other form of simultaneous heating and cooling for humidity control.

(10) Systems serving spaces other than hotel or motel guest rooms, and other than those requiring continuous operation, which have both a cooling or heating capacity more than 15 000 Btu/h (4.4 kW) and a supply fan motor power more than 0.75 horsepower (hp) (0.56 kW), shall be provided with a time clock that is in accordance with the following:
   (a) Can start and stop the system under different schedules for seven different day-types per week.
   (b) Is capable of retaining programming and time setting during a loss of power for a period of not less than 10 hours.
   (c) Includes an accessible manual override that allows temporary operation of the system for up to 2 hours.
   (d) Is capable of and configured with temperature setback down to 55°F (13°C) during off hours.
   (e) Is capable of and configured with temperature setup to 90°F (32°C) during off hours.

(11) Systems serving hotel/motel guest rooms shall comply with Section E 503.4.6.3.5.

(12) Except for piping within manufacturer’s units, HVAC piping shall be insulated in accordance with Table E 503.7.3(1) and Table E 503.7.3(2). Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation.

(13) Ductwork and plenums shall be insulated in accordance with Table E 503.7.2 and shall be sealed in accordance with Section E 503.4.7.2.

(14) Construction documents shall require a ducted system to be air balanced in accordance with industry-approved procedures.

(15) Outdoor air intake and exhaust systems shall comply with Section E 503.4.6.4 through Section E 503.4.6.5.

(16) Where separate heating and cooling equipment serves the same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling.

(17) Systems with a design supply air capacity more than 10 000 ft³/min (4.7195 m³/s) shall have optimum start controls.

(18) The system shall comply with the demand control ventilation requirements of Section E 503.4.6.9, occupied-standby controls in Section E 503.5.6.7, and the ventilation design requirements of Section E 503.5.6.6.

(19) The system shall comply with the door switch requirements of Section E 503.5.14. [ASHRAE 90.1:6.3.2]

**E 503.3.2 Climate Zone Determination.** Climate zones identified in this appendix shall be determined in accordance with ASHRAE 90.1. For locations in the United States and its territories, the assigned climate zone and, where required, the assigned climate zone letter shall be in accordance with ASHRAE 169.

**Exception:** Where recorded historical climatic data are available for a construction site, it is permitted to be used to determine compliance where approved by the Authority Having Jurisdiction. [ASHRAE 90.1:5.1.4.1]

**E 503.4 Mandatory Provisions Equipment Efficiencies, Verification, and Labeling Requirements.** Equipment shown in Table E 503.7.1(1) through Table E 503.7.1(16) and Table E 503.7.1(20) shall have a minimum performance at the specified rating conditions when tested in accordance with the specified test procedure. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy the all stated requirements unless otherwise exempted by footnotes in the table. Equipment covered under the Federal Energy Policy Act of 1992 (EPACT) shall have no minimum efficiency requirements for operation at minimum capacity or other than standard rating conditions. Equipment used to provide service water-heating functions as part of a combination system shall satisfy the all stated requirements for the appropriate space heating or cooling category.

Tables are as follows:
   (1) Table E 503.7.1(1), “Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements”
(2) Table E 503.7.1 (2), “Electrically Operated Air-Cooled Unitary and Applied Heat Pumps—Minimum Efficiency Requirements”

(3) Table E 503.7.1 (3), “Water-Chilling Packages—Minimum Efficiency Requirements” (See Section E 503.4.1 for water-cooled centrifugal water-chilling packages that are designed to operate at nonstandard conditions.)

(4) Table E 503.7.1 (4), “Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps—Minimum Efficiency Requirements”

(5) Table E 503.7.1 (5), “Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters—Minimum Efficiency Requirements”

(6) Table E 503.7.1 (6), “Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements”

(7) Table E 503.7.1 (7), “Performance Requirements for Heat-Rejection Equipment—Minimum Efficiency Requirements”

(8) Table E 503.7.1 (8), “Heat Transfer Equipment”

(9) Table E 503.7.1 (9), “Electrically Operated Variable-Refrigerant-Flow Air Conditioners—Minimum Efficiency Requirements”

(10) Table E 503.7.1 (10), “Electrically Operated Variable-Refrigerant-Flow and Applied Heat Pumps—Minimum Efficiency Requirements”

(11) Table E 503.7.1 (11), “Floor-Mounted Air Conditioners and Condensing Units Serving Computer Rooms”

(12) Table E 503.7.1 (12), “Commercial Refrigerators, Commercial Freezers, and Freezers and Refrigeration—Minimum Efficiency Requirements”

(13) Table E 503.7.1 (13), “Commercial Refrigeration—Minimum Efficiency Requirements”

(14) Table E 503.7.1 (14), “Vapor-Compression-Based Indoor Pool Dehumidifiers—Minimum Efficiency Requirements”


(17) Table E 503.7.1 (17), “Ceiling-Mounted Computer-Room Air Conditioners—Minimum Efficiency Requirements”

(18) Table E 503.7.1 (18), “Walk-In Cooler and Freezer Display Door Efficiency Requirements”

(19) Table E 503.7.1 (19), “Walk-In Cooler and Freezer Nondisplay Door Efficiency Requirements”

(20) Table E 503.7.1 (20), “Walk-In Cooler and Freezer Refrigeration System Efficiency Requirements”

All furnaces with input ratings of 225 000 Btu/h (66 kW) or more, including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75 percent of the input rating. Air conditioners primarily serving computer rooms and covered by ASHRAE 127 shall comply with the requirements in Table E 503.7.1(11). All other air conditioners shall meet the requirements in Table E 503.7.1(1). [ASHRAE 90.1:6.4.1.1]

### E 503.4.1 Water-Cooled Centrifugal Chilling Packages

Equipment not designed for operation in accordance with AHRI 550/590 test conditions of 44.00°F (6.67°C) leaving and 54.00°F (12.22°C) entering chilled-fluid temperatures, and with 85.00°F (29.44°C) entering and 94.30°F (34.61°C) leaving condenser-fluid temperatures, shall have maximum full-load kW/ton (FL) and part-load rating requirements adjusted in accordance with Equation E 503.4.1(1) through Equation E 503.4.1(3):

\[
FL_{adj} = \frac{FL}{K_{adj}} \quad \text{[Equation E 503.4.1(1)]}
\]

\[
PLV_{adj} = \frac{IPLV}{IP_{adj}} \quad \text{[Equation E 503.4.1(2)]}
\]

\[
K_{adj} = A \times B \quad \text{[Equation E 503.4.1(3)]}
\]

Where:

- \(FL\) = full-load kW/ton value from Table E 503.7.1(3)
- \(FL_{adj}\) = maximum full-load kW/ton rating, adjusted for nonstandard conditions
- \(IPLV\) = \(IPLV/IP\) value from Table E 503.7.1(3)

\[
PLV_{adj} = \text{maximum NPLV rating, adjusted for nonstandard conditions}
\]

\[
A = \frac{0.0000014592 \times (LIFT)^2 + 0.00314196 \times (LIFT)}{0.147199 \times (LIFT)}
\]

\[
B = 0.0015 \times LvgEvap + 0.934
\]

\[
LIFT = LvgCond - LvgEvap
\]

\[
LvgCond = \text{Full-load condenser leaving fluid temperature (°F)}
\]

\[
LvgEvap = \text{Full-load evaporator leaving temperature (°F)}
\]

The \(FL_{adj}\) and \(PLV_{adj}\) values shall only be applicable for centrifugal chillers meeting all of the following full-load design ranges:

1. 36.00°F (2.22°C) ≤ LvgEvap ≤ 60.00°F (15.56°C)
2. LvgCond ≤ 115.00°F (46.11°C)
3. 20.00°F (-6.67°C) ≤ LIFT ≤ 80.00°F (26.67°C)

Manufacturers shall calculate the \(FL_{adj}\) and \(PLV_{adj}\) before determining whether to label the chiller in accordance with Section E 503.4.4. Chillers that are in accordance with ASHRAE 90.1 shall be labeled on chillers in accordance with the scope of ASHRAE 90.1.
APPENDIX E

Centrifugal chillers designed to operate outside of these ranges shall not be covered under this appendix.

Example: Path A, 600 ton (600 000 kg) centrifugal chiller Table E 503.7.1(3) efficiencies.

\[
\begin{align*}
FL &= 0.5600 \text{ kW/ton} \\
IPLV_{IP} &= 0.5000 \text{ kW/ton} \\
LvgCond &= 91.16^\circ F \\
LvgEvap &= 42.00^\circ F \\
LIFT &= 91.16^\circ F - 42.00^\circ F = 49.16^\circ F \\
A &= 0.00000014592 \times (49.16)^3 + 0.00314196 \times (49.16)^2 - 0.147199 \times (49.16) + 3.93073 = 1.02331 \\
B &= 0.0015 \times 42.00 + 0.934 = 0.99700 \\
K_{adj} &= 0.0015 \times 42.00 + 0.934 = 0.99700 \\
PLV_{adj} &= 0.5600/1.02024 = 0.5489 \text{ kW/ton} \\
A_{PLVadj} &= 0.5600/1.02024 = 0.5489 \text{ kW/ton}
\end{align*}
\]

For SI units: 1 metric ton = 1000 kg, 1000 British thermal units per hour = 0.293 kW, 1 gallon per minute = 0.06 L/s, °C = °F - 32) / 1.8

E 503.4.1 Positive Displacement (air- and water-cooled) Chilling Packages. Equipment with an evaporator leaving fluid temperature higher than 32.00°F (0.00°C) and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 115.00°F (46.11°C) shall show compliance with Table E 503.7.1(3) when tested or certified with water at standard rating conditions, in accordance with the referenced test procedure. [ASHRAE 90.1:6.4.1.2.1]

E 503.4.2 Equipment not Listed. Equipment not listed in the tables referenced in Section E 503.4 and Section E 503.4.1 shall be permitted to be used. [ASHRAE 90.1:6.4.1.4]

E 503.4.3 Verification of Equipment Efficiencies. Equipment efficiency information supplied by manufacturers shall be verified in accordance with one of the following:

1. Equipment covered under EPACT shall be in accordance with U.S. Department of Energy certification requirements.
2. Where a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program.
3. Where a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, but the product is not listed in the existing certification program, the ratings shall be verified by an independent laboratory test report.
4. Where no certification program exists for a covered product, the equipment efficiency ratings shall be supported by data furnished by the manufacturer.
5. Where components such as indoor or outdoor coils from different manufacturers are used, the system designer shall specify component efficiencies whose combined efficiency is in accordance with the minimum efficiency requirements in Section E 503.4 through Section E 503.4.4.1.
6. Requirements for plate type liquid-to-liquid heat exchangers are listed in Table E 503.7.1(8). [ASHRAE 90.1:6.4.1.4]

E 503.4.4 Mechanical Equipment Labeling. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment is in accordance with the requirements of ASHRAE 90.1. [ASHRAE 90.1:6.4.1.5.1.6.4.1.6.1]

E 503.4.4.1 Packaged Terminal Air Conditioners. Nonstandard-size packaged terminal air conditioners and heat pumps with existing sleeves having an external wall opening of less than 16 inches (406 mm) high or less than 42 inches (1067 mm) wide and having a cross-sectional area less than 670 square inches (0.432 m²) shall be factory labeled as follows:

- Manufactured for nonstandard-size applications only: Not to be installed in new construction projects. [ASHRAE 90.1:6.4.1.5.1.26.4.1.6.2]

E 503.4.5 Load Calculations. Heating and cooling system design loads for the purpose of sizing systems and equipment shall be determined in accordance with ASHRAE/ACCA 183. [ASHRAE 90.1:6.4.1.2.1]

E 503.4.5.1 Pump Head. Pump differential pressure (head) for the purpose of sizing pumps shall be determined in accordance with generally accepted engineering standards and handbooks acceptable to the Authority Having Jurisdiction. The pressure drop through each device and pipe segment in the critical circuit at design conditions shall be calculated. [ASHRAE 90.1:6.4.2.2]

E 503.4.6 Zone Thermostatic Controls. The supply of heating and cooling energy to each zone shall be individually controlled by thermostatic controls responding to temperature within the zone. For the purposes of Section E 503.4.6, a dwelling unit shall be permitted to be considered a single zone.

Exceptions: Independent perimeter systems that are designed to offset only building envelope loads shall be permitted to serve one or more zones also served by an interior system, provided that:

1. the perimeter system includes not less than one thermostatic control zone for each building exposure having walls facing only one orientation for 50 contiguous feet (15 240 mm) or more and
2. the perimeter system heating and cooling supply is controlled by thermostatic controls located within the zones served by the system.
Extterior walls and semiexterior walls are considered to have different orientations where the exposures they face differ by more than 45 degrees (0.79 rad). [ASHRAE 90.1:6.4.3.1.1]

**E 503.4.6.1 Dead Band.** Where used to control both heating and cooling, zone thermostatic controls shall be capable of and configured to provide a temperature range or dead band of not less than 5°F (3°C) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

**Exceptions:**

(1) Thermostats that require manual changeover between heating and cooling modes.

(2) Special occupancy or special applications where wide temperature ranges are not acceptable (such as retirement homes, process applications, museums, some areas of hospitals) and are approved by the Authority Having Jurisdiction. [ASHRAE 90.1:6.4.3.1.2]

**E 503.4.6.2 Setpoint Overlap Restriction.** Where heating and cooling to a zone are controlled by separate zone thermostatic controls located within the zone, means (such as limit switches, mechanical stops, or, for DDC systems, software programming) shall be provided to prevent the heating setpoint from exceeding the cooling setpoint minus any applicable proportional band. [ASHRAE 90.1:6.4.3.2]

**E 503.4.6.3 Off-Hour Controls.** HVAC systems shall have the off-hour controls required by Section E 503.4.6.3.1 through Section E 503.4.6.3.4.

**Exceptions:**

(1) HVAC systems intended to operate continuously.

(2) HVAC systems having a design heating capacity and cooling capacity less than 15 000 Btu/h (4.4 kW) that are equipped with readily accessible manual ON/OFF controls. [ASHRAE 90.1:6.4.3.3]

**E 503.4.6.3.1 Automatic Shutdown.** HVAC systems shall be equipped with not less than one of the following:

(1) Controls that can start and stop the system under different time schedules for seven different day-types per week, are capable of retaining programming and time setting during loss of power for a period of not less than 10 hours, and include an accessible manual override, or equivalent function, that allows temporary operation of the system for up to 2 hours.

(2) An occupant sensor that is capable of shutting the system off where no occupant is sensed for a period of up to 30 minutes.

(3) A manually operated timer capable of being adjusted to operate the system for up to 2 hours.

(4) An interlock to a security system that shuts the system off where the security system is activated.

**Exception:** Residential occupancies shall be permitted to use controls that can start and stop the system under two different time schedules per week. [ASHRAE 90.1:6.4.3.3.1]

**E 503.4.6.3.2 Setback Controls.** Heating systems shall be equipped with controls capable of and configured to automatically restart and temporarily operate the system as required to maintain zone temperatures above an adjustable heating setpoint of not less than 10°F (6°C) below the occupied heating setpoint. Cooling systems shall be equipped with controls capable of and configured to automatically restart and temporarily operate the mechanical cooling system as required to maintain zone temperatures below an adjustable cooling setpoint of not less than 5°F (3°C) above the occupied cooling setpoint or to prevent high space humidity levels.

**Exception:** Radiant heating systems capable of and configured with a setback heating setpoint at not less than 4°F (2°C) below the occupied heating setpoint. [ASHRAE 90.1:6.4.3.3.2]

**E 503.4.6.3.3 Optimum Start Controls.** Individual heating and cooling systems with setback controls and DDC shall have optimum start controls. The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor temperature, and the amount of time prior to scheduled occupancy. Mass radiant floor slab systems shall incorporate floor temperature into the optimum start algorithm. [ASHRAE 90.1:6.4.3.3.3]

**E 503.4.6.3.4 Zone Isolation.** HVAC systems serving zones that are intended to operate or be occupied nonsimultaneously shall be divided into isolation areas. Zones shall be permitted to be grouped into a single isolation area provided it does not exceed 25 000 square feet (2322.6 m²) of conditioned floor area and does not include more than one floor. Each isolation area shall be equipped with isolation devices capable of and configured to automatically shut off the supply of conditioned air and outdoor air to and exhaust air from the area. Each isolation area shall be controlled independently by a device meeting the requirements of Section E 503.4.6.3.1. For central systems and plants, controls and devices shall be provided to allow stable system and equipment operation for any length of time while serving only the smallest isolation area served by the system or plant.
E 503.4.6.3.5 Automatic Control of HVAC in Hotel/Motel Guest Rooms. Hotels and motels with more than 50 guest rooms shall be provided with automatic controls for the HVAC equipment serving each guest room capable of and configured according to the requirements in Section E 503.4.6.3.1. [ASHRAE 90.1:6.4.3.3.5]

E 503.4.6.3.5.1 Guest Room HVAC Set-Point Control. Within 30 minutes of all occupants leaving the guest room, HVAC set points shall be automatically raised by not less than 4°F (2°C) from the occupant set point in the cooling mode and automatically lowered by at least 4°F (2°C) from the occupant set point in the heating mode. When the guest room is unrented and unoccupied, HVAC set points shall be automatically reset to 80°F (27°C) or higher in the cooling mode and to 60°F (16°C) or lower in the heating mode. Unrented and unoccupied guest rooms shall be determined by either of the following:

1. The guest room has been continuously unoccupied for up to 16 hours.
2. A networked guest room control system indicates the guest room is unrented and unoccupied for no more than 30 minutes.

Exceptions:
1. A networked guest room control system shall be permitted to return the thermostat set points to their default occupied set points 60 minutes prior to the time the room is scheduled to be occupied.
2. Cooling for humidity control shall be permitted during unoccupied periods.

E 503.4.6.4 Ventilation System Controls. Stair and shaft vents shall be equipped with motorized dampers that are capable of and configured to automatically close during normal building operation and are interlocked to open as required by fire and smoke detection systems. [ASHRAE 90.1:6.4.3.4.1]

E 503.4.6.4.1 Shutoff Damper Controls. Outdoor air intake and exhaust systems shall be equipped with motorized dampers that will automatically shut when the systems or spaces served are not in use. Ventilation outdoor air and exhaust or relief dampers shall be capable of and configured to automatically shut off during preoccupancy building warm-up, cooldown, and setback, except when ventilation outdoor air reduces energy costs or when ventilation outdoor air shall be supplied to comply with the code requirements.

Exceptions:
1. Back-draft Nonmotorized (gravity backdraft) dampers shall be permitted for exhaust and relief in buildings less than three stories in height and for ventilation outdoor air intakes and exhaust and relief dampers in buildings of any height located in Climate Zones 0, 1, 2 and 3. Back-draft Nonmotorized dampers for ventilation outdoor air intakes shall be protected from direct exposure to wind.
2. Back-draft gravity (nonmotorized) Nonmotorized dampers shall be permitted in systems with a design outdoor air intake or exhaust capacity of 300 ft³/min (0.142 m³/s) or less.
3. Dampers shall not be required in ventilation or exhaust systems serving unconditioned spaces.
4. Dampers shall not be required in exhaust systems serving Type 1 kitchen exhaust hoods.
5. Dampers are not required in systems intended to operate continuously. [ASHRAE 90.1:6.4.3.4.2]

E 503.4.6.4.2 Dampers Leakage. Where outdoor air supply, and exhaust or relief dampers are required in Section E 503.4.6.4, they shall have a maximum leakage rate in accordance with Table E 503.4.6.4.2 where tested in accordance with AMCA 500D. [ASHRAE 90.1:6.4.3.4.3]

E 503.4.6.4.3 Ventilation Fan Controls. Fans with motors more than 0.75 hp (0.56 kW) shall have automatic controls in accordance with Section E 503.4.6.3.1 that are capable of and configured to shut off fans when not required.

Exception: HVAC systems intended to operate continuously. [ASHRAE 90.1:6.4.3.4.4]

E 503.4.6.5 Enclosed Parking Garage Ventilation Systems. Enclosed parking garage ventilation systems shall automatically detect contaminant levels and stage fans or modulate fan airflow rates to 50 percent or less of design capacity, provided acceptable contaminant levels are maintained.
Parking garage ventilation systems shall meet all of the following:

(1) Separate ventilation systems and control systems shall be provided for each parking garage section.

(2) Control systems for each parking garage section shall automatically detect and control contaminant levels and shall be capable of and configured to reduce fan airflow to 20 percent or less of design capacity.

(3) The ventilation system for each parking garage section shall have controls and devices that result in fan motor demand of no more than 30 percent of design wattage at 50 percent of the design airflow.

Exceptions:

(1) Garages less than 30,000 square feet (2787.09 m²) with ventilation systems that do not utilize mechanical cooling or mechanical heating.

(2) Garages that have a garage area to ventilation system motor nameplate horsepower ratio that exceeds 1500 square feet per horsepower (ft²/hp) (186.8 m²/kW) and do not utilize mechanical cooling or mechanical heating.

(3) Where not permitted by the Authority Having Jurisdiction.

Exception: Garage ventilation systems serving a single parking garage section having a total ventilation system motor nameplate horsepower (kilowatts) not exceeding 5 hp (3.7 kW) at fan system design conditions and where the parking garage section has no mechanical cooling or mechanical heating. [ASHRAE 90.1:6.4.3.4.5]

E 503.4.6.6 Heat Pump Auxiliary Heat Control. Heat pumps equipped with internal electric resistance heaters shall have controls that prevent supplemental heater operation where the heating load is capable of being met by the heat pump alone during both steady-state operation and setback recovery. Supplemental heater operation shall be permitted during outdoor coil defrost cycles.

Exception: Heat pumps whose minimum efficiency is regulated by U.S. National Appliance Energy Conservation Act (NAECA) and whose ratings are in accordance with the requirements shown in Table E 503.7.1(2) and includes the use of an internal electric resistance heating. [ASHRAE 90.1:6.4.3.5]

E 503.4.6.7 Humidification and Dehumidification Control. Humidity control shall prevent the use of fossil fuel or electricity to produce relative humidity above 30 percent in the warmest zone served by the humidification system and to reduce relative humidity below 60 percent in the coldest zone served by the dehumidification system. Humidification and dehumidification control shall be in accordance with Section E 503.4.6.7.1 through Section E 503.4.6.7.3.

<table>
<thead>
<tr>
<th>TABLE E 503.4.6.4.2</th>
<th>MAXIMUM DAMPER LEAKAGE1,2 (cubic foot per minute per square foot) at 1.0 in.-wg inch water gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLIMATE ZONE</td>
<td>VENTILATION OUTDOOR AIR INTAKE (CFM²)</td>
</tr>
<tr>
<td></td>
<td>NONMOTORIZED1</td>
</tr>
<tr>
<td>0, 1, 2</td>
<td>20</td>
</tr>
<tr>
<td>any Any height</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>4, 5b, 5c</td>
<td></td>
</tr>
<tr>
<td>fewer than 3 stories</td>
<td>not allowed 20²</td>
</tr>
<tr>
<td>3 stories or more</td>
<td>not allowed 20²</td>
</tr>
<tr>
<td>5a, 6, 7, 8</td>
<td></td>
</tr>
<tr>
<td>fewer than 3 stories</td>
<td>not allowed 20²</td>
</tr>
<tr>
<td>3 stories or more</td>
<td>not allowed 20²</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 square foot = 0.0929 m², 1 inch water gauge = 0.249 kPa

1 Dampers smaller than 24 inches (610 mm) in either dimension shall be permitted to have leakage of 40 ft³/min per square foot (0.203 (m³/s)/m²).

2 When tested in accordance with AMCA 500D.

Notes:

1 When tested in accordance with AMCA 500D.

2 Dampers smaller than 12 inches (305 mm) in height, width, or diameter need not be tested but shall be of the same design and construction as the smallest tested damper meeting the listed leakage rate requirement.

3 Nonmotorized dampers smaller than 24 inches (610 mm) in height, width, or diameter shall be permitted to have a leakage rate of 40 CFM/ft² (0.203 (m³/s)/m²).

4 Where permitted by Section E 503.4.6.4.1, exception 2.
E 503.4.6.7.1 Dehumidification. Humidistatic controls shall not use mechanical cooling to reduce the humidity below the lower of a dew point of 55°F (12.8°C) or relative humidity of 60 percent in the coldest zone served by the system.

Exceptions:

(1) Lower humidity shall be permitted when operating mechanical cooling for temperature control.

(2) Systems serving zones where specific humidity levels are required, such as museums and hospitals, and approved by the Authority Having Jurisdiction or required by accreditation standards, and where humidistatic controls are capable of and configured to maintain a dead band of at least 10 percent relative humidity where no active humidification or dehumidification takes place.

(3) Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as approved by the Authority Having Jurisdiction. [ASHRAE 90.1:6.4.3.6.1]

E 503.4.6.7.2 Humidification. Humidistatic controls shall not use fossil fuel or electricity to produce relative humidity above 30 percent in the warmest zone served by the system.

Exceptions:

(1) Systems serving zones where specific humidity levels are required, such as museums and hospitals, and approved by the Authority Having Jurisdiction or required by accreditation standards, and where humidistatic controls are capable of and configured to maintain a dead band of at least 10 percent relative humidity where no active humidification or dehumidification takes place.

(2) Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as approved by the Authority Having Jurisdiction. [ASHRAE 90.1:6.4.3.6.1]

E 503.4.6.8 Freeze Protection and Snow or Ice Melting Systems. Freeze protection systems, such as heat tracing of outdoor piping and heat exchangers, including self-regulating heat tracing, shall include automatic controls capable of and configured to shut off the systems when outdoor air temperatures are more than 40°F (4°C) or when the conditions of the protected fluid will prevent freezing. Snow and ice melting systems shall include automatic controls capable of and configured to shut off the systems when the pavement temperature is more than 50°F (10°C) and no precipitation is falling, and an automatic or manual control that will allow shutoff when the outdoor temperature is more than 40°F (4°C) so that the potential for snow or ice accumulation is negligible. [ASHRAE 90.1:6.4.3.7]

E 503.4.6.9 Ventilation Controls for High-Occupancy Areas. Demand control ventilation (DCV) shall be required for spaces that are more than 500 square feet (46.45 m²) and with a design occupancy for ventilation of not less than 25 people per 1000 square feet (92.9 m²) of floor area and served by systems with one or more of the following:

(1) Air-economizer.

(2) Automatic modulating control of outdoor air damper.

(3) Design outdoor airflow more than 3000 ft³/min (1.4158 m³/s).

Exceptions:

(1) Systems with exhaust air energy recovery in accordance with Section E 503.5.10. E 503.5.10.1.2.

(2) Multiple-zone systems without DDC of individual zones communicating with a central control panel.

(3) Systems with a design outdoor airflow less than 750 ft³/min (0.3540 m³/s).

(4) Spaces where more than 75 percent of the space design outdoor airflow is required for makeup air that is exhausted from the space or transfer air.
that is required for makeup air that is exhausted from other spaces.

(5) Spaces with one of the following occupancy categories in accordance with Chapter 4 or ASHRAE 62.1: correctional cells, daycare sickrooms, science labs, barbers, beauty and nail salons, and bowling alley seating. [ASHRAE 90.1:6.4.3.8]

E 503.4.6.10 Outdoor Heating. Radiant heat systems shall be used to provide heat outdoors. Outdoor radiant heating systems shall be provided with controls that sense the presence of occupants or other device that automatically shuts down the system where no occupants are in the heating area.

E 503.4.6.11 Heated or Cooled Vestibules. Heating for vestibules and for air curtains with integral heating shall include automatic controls capable of and configured to shut off the heating system when outdoor air temperatures are more than 45°F (7.2°C). Vestibule heating and cooling systems shall be controlled by a thermostat in the vestibule capable of and configured to limit heating to a maximum of 60°F (15.5°C) and cooling to a minimum of 85°F (29.4°C).

Exception: Heating or cooling provided by site-recovered energy or by transfer air that would otherwise be exhausted. [ASHRAE 90.1:6.4.3.9]

E 503.4.6.12 Direct Digital Control (DDC) Requirements. Direct digital control shall be required in accordance with Section E 503.4.6.12.1 through Section E 503.4.6.12.3. [ASHRAE 90.1:6.4.3.10]

TABLE E 503.4.6.12.1
DDC APPLICATIONS AND QUALIFICATIONS
[ASHRAE 90.1:6.4.3.10.1]

<table>
<thead>
<tr>
<th>BUILDING STATUS</th>
<th>APPLICATION</th>
<th>QUALIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>New building</td>
<td>Air-handling system and all zones served by the system</td>
<td>Individual systems supplying more than three zones and with fan system bhp of 10 hp or more</td>
</tr>
<tr>
<td>New building</td>
<td>Chilled-water plant and all coils and terminal units served by the system</td>
<td>Individual plants supplying more than three zones and with design cooling capacity of 300 000 Btu/h or more</td>
</tr>
<tr>
<td>New building</td>
<td>Hot-water plant and all coils and terminal units served by the system</td>
<td>Individual plants supplying more than three zones and with design heating capacity of 300 000 Btu/h or more</td>
</tr>
<tr>
<td>Alteration or addition</td>
<td>Zone terminal unit such as VAV box</td>
<td>Where existing zones served by the same air-handling, chilled-water, or hot-water system have DDC</td>
</tr>
<tr>
<td>Alteration or addition</td>
<td>Air-handling system or fan coil</td>
<td>Where existing air-handling system(s) and fan-coil(s) served by the same chilled- or hot-water plant have DDC</td>
</tr>
<tr>
<td>Alteration or addition</td>
<td>New air-handling system and all new zones served by the system</td>
<td>Individual systems with fan system bhp of 10 hp or more and supplying more than three zones and more than 75 percent of zones are new</td>
</tr>
<tr>
<td>Alteration or addition</td>
<td>New or upgraded chilled-water plant</td>
<td>Where all chillers are new and plant design cooling capacity is 300 000 Btu/h or more</td>
</tr>
<tr>
<td>Alteration or addition</td>
<td>New or upgraded hot-water plant</td>
<td>Where all boilers are new and plant design heating capacity is 300 000 Btu/h or more</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units = 0.293 kW, 1 horsepower = 0.746 kW

E 503.4.6.12.1 DDC Applications. DDC shall be provided in the applications and qualifications in accordance with Table E 503.4.6.12.1.

Exception: DDC is not required for systems using the simplified approach to compliance in accordance with Section E 503.3. [ASHRAE 90.1:6.4.3.10.1]

E 503.4.6.12.2 DDC Controls. Where DDC is required by Section E 503.4.6.12.1, the DDC system shall be capable of and configured with all of the following, as required, to provide the control logic required in Section E 503.5:

(1) Monitoring zone and system demand for fan pressure, pump pressure, heating, and cooling.

(2) Transferring zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers.

(3) Automatically detecting those zones and systems that are capable of excessively driving the reset logic and generate an alarm or other indication to the system operator.

(4) Readily allowing operator removal of zone(s) from the reset algorithm. [ASHRAE 90.1:6.4.3.10.2]

E 503.4.6.12.3 DDC Display. Where DDC is required in accordance with Section E 503.4.6.12.1 for new buildings, the DDC system shall be capable of trending and graphically displaying input and output points. [ASHRAE 90.1:6.4.3.10.3]
E 503.4.6.13 Economizer Fault Detection and Diagnostics (FDD). Air-cooled direct-expansion cooling units listed in Tables E 503.7.1(1) and E 503.7.1(2), where an air economizer is installed in accordance with Section E 503.5, shall include a fault detection and diagnostics (FDD) system complying with the following:

1. The following temperature sensors shall be permanently installed to monitor system operation:
   - Outdoor air
   - Supply air
   - Return air, where required for economizer control

2. The system shall have the capability of displaying the value of each sensor.

3. The FDD system or unit controls shall be capable of and configured to provide system status by indicating the following:
   - Free cooling available
   - Economizer enabled
   - Compressor enabled
   - Heating enabled
   - Mixed-air low-limit cycle active

4. The FDD system or unit controls shall have provisions to manually initiate each operating mode so that the operation of compressors, economizers, fans, and the heating system can be independently tested and verified.

5. The FDD system shall be capable of and configured to detect the following faults:
   - Air temperature sensor failure/fault
   - Not economizing when the unit should be economizing
   - Economizing when the unit should not be economizing
   - Damper not modulating
   - Excess outdoor air

6. The FDD system shall be capable of and configured to report faults to a fault management application or DDC system accessible by operating or service personnel, or annunciated locally on zone thermostats. [ASHRAE 90.1:6.4.4.1.2]

E 503.4.7 HVAC System Construction and Insulation. HVAC Ducts shall be constructed in accordance with provisions contained in the SMACNA HVAC Duct Construction Standard. HVAC system construction and insulation shall comply with Section E 503.4.7.1 and Section E 503.4.7.2.

E 503.4.7.1 Insulation. Insulation required by this section shall be installed in accordance with industry-accepted standards. These requirements shall not apply to HVAC equipment. Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind, but not limited to the following:

1. Insulation exposed to weather shall be suitable for outdoor service (e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover). Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that is capable of causing degradation of the material.

2. Insulation covering chilled-water piping, refrigerant suction piping, or cooling ducts located outside the conditioned space shall include a vapor retardant located outside the insulation (unless the insulation is inherently vapor retardant), all penetrations and joints of which shall be sealed. [ASHRAE 90.1:6.4.4.1.1]

E 503.4.7.1.1 Duct and Plenum Insulation. Supply and return ducts and plenums installed as part of an HVAC air distribution system shall be thermally insulated in accordance with Table E 503.7.2.

Exceptions:

1. Factory-installed plenums, casings, or ductwork furnished as a part of HVAC equipment tested and rated in accordance with Section E 503.4 through Section E 503.4.4.1.

2. Ducts or plenums located in heated spaces, semi-heated spaces, or cooled spaces.

3. For runouts less than 10 feet (3048 mm) in length to air terminals or air outlets, the rated R-value of insulation shall not be required to exceed R-3.5.

4. Backs of air outlets and outlet plenums exposed to unconditioned space or indirectly conditioned spaces with face areas exceeding 5 square feet (0.5 m²) shall not be required to exceed R-2; those not exceeding 5 square feet (0.5 m²) shall not be required to be insulated. [ASHRAE 90.1:6.4.4.1.2]

E 503.4.7.1.2 Piping Insulation. Piping shall be thermally insulated in accordance with Table E 503.7.3(1) and Table E 503.7.3(2).

Exceptions:

1. Factory-installed piping within HVAC equipment tested and rated in accordance with Section E 503.4 through Section E 503.4.4.1.

2. Piping that conveys fluids having a design operating temperature range between 60°F (16°C) and 105°F (41°C), inclusive.

3. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electricity (such as roof and condensate drains, domestic cold water supply, and natural gas piping).
(4) Where heat gain or heat loss will not increase energy use (such as liquid refrigerant piping).

(5) In piping 1 inch (25.4 mm) or less, insulation is not required for strainers, control valves, and balancing valves. [ASHRAE 90.1:6.4.4.1.3]

E 503.4.7.1.3 Sensible Heating Panel Insulation. Thermally ineffective panel surfaces of sensible heating panels, including U-bends and headers, shall be insulated with a minimum of R-3.5. Adjacent building envelope insulation counts toward this requirement. [ASHRAE 90.1:6.4.4.1.4]

E 503.4.7.1.4 Radiant Floor Heating. The bottom surfaces of floor structures incorporating radiant heating shall be insulated with a minimum of R-3.5. Adjacent building envelope insulation counts toward this requirement.

Exception: Heated slab-on-grade floors incorporating radiant heating shall be in accordance with ASHRAE 90.1. [ASHRAE 90.1:6.4.4.1.5]

E 503.4.7.2 Ductwork and Plenum Leakage. Transverse joints, longitudinal seams, and duct wall penetrations shall be sealed. Pressure-sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL 181A or UL 181B by an independent testing laboratory and the tape is used in accordance with that certification. All other connections shall be considered transverse joints, including but not limited to spin-ins, taps, other branch connections, access door frames and jambs, and duct connections to equipment.

Exceptions:
(1) Rods that penetrate the duct wall that shall be permitted to move in order to function properly (control rod for volume damper) shall not be sealed in a fashion that prevents them from working properly.

(2) Spiral lock seams in a round or flat oval duct.

E 503.4.7.2.1 Duct Leakage Tests. Ductwork shall be leak-tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual. Representative sections totaling not less than 20 percent of the total installed duct area shall be tested. Where the tested 20 percent fail to comply with the requirements of this section, then 40 percent of the total installed duct area shall be tested. Where the tested 40 percent fail to comply with the requirements of this section, then 100 percent of the total installed duct area shall be tested. Sections shall be selected by the building owner or designated representative of the building owner. Positive pressure leakage testing shall be permitted for negative pressure ductwork. The permitted duct leakage shall be not more than the following:

\[
L_{\text{max}} = C_L P^{0.65} \quad (\text{Equation E 503.4.7.2.1})
\]

Where:
\[
L_{\text{max}} = \text{maximum permitted leakage, (ft}^3/\text{min})/100 \text{ square feet [0.0001 m}^3/\text{s/m}^2\text{] duct surface area.}
\]

\[
C_L = \text{Six, duct leakage class, (ft}^3/\text{min})/100 \text{ square feet [0.0001 m}^3/\text{s/m}^2\text{] duct surface area at 1 inch water column (0.2 kPa).}
\]

\[
P = \text{test pressure, which shall be equal to the design duct pressure class rating, inch water column (kPa).}
\]

E 503.4.8 Walk-In Coolers and Walk-In Freezers. Site-assembled or site-constructed walk-in coolers and walk-in freezers shall conform to the following requirements:

(1) Shall be equipped with automatic door closers that firmly close walk-in doors that have been closed to within 1 inch (25.4 mm) of full closure.

Exception: Doors wider than 3 feet 9 inches (1143 mm) or taller than 7 feet (2134 mm).

(2) Doorways shall have strip doors (curtains), spring-hinged doors, or other method of minimizing infiltration when doors are open.

(3) Walk-in coolers shall contain wall, ceiling, and door insulation of at least R-25 and at least R-32 for walk-in freezers.

Exception: Glazed portions of doors or structural members.

(4) Walk-in freezers shall contain floor insulation of at least R-28.

(5) Evaporator fan motors that are less than 1 hp (0.7 kW) and less than 460 V shall use electronically commutated motors (brushless direct-current motors) or three-phase motors.

(6) Lights shall use light sources with an efficacy of 40 lm/W or more, including ballast losses (if any). Light sources with lower may be used in conjunction with a timer or device that turns off the lights within 15 minutes of when the walk-in cooler or walk-in freezer is not occupied by people.

(7) Transparent reach-in doors for walk-in freezers, and windows in walk-in freezer doors, shall be of triple-pane glass, either filled with inert gas or with heat-reflective treated glass or vacuum insulating glazing.

(8) Transparent reach-in doors for walk-in coolers, and windows in walk-in cooler doors, shall be double-pane glass with heat-reflective treated glass and gas filled, or triple-pane glass, either filled with inert gas or with heat-reflective treated glass or vacuum insulating glazing.

(9) Antisweat heaters without antisweat heater controls shall have a total door rail, glass, and frame heater power draw of not more than 7.1 W/ft² (76 W/m²) of...
(10) Antisweat heater controls shall reduce the energy use of the antisweat heater as a function of the relative humidity in the air outside the door or to the condensation on the inner glass pane.

(11) Condenser fan motors that are less than 1 hp (0.7 kW) shall use electronically commutated motors, permanent split-capacitor-type motors, or three-phase motors.

(12) All walk-in freezers shall incorporate temperature-based defrost termination control with a time limit default. The defrost cycle shall terminate first on an upper temperature limit breach and second upon a time limit breach.

**Exception:** Walk-in coolers and walk-in freezers combined in a single enclosure greater than 3000 ft² (279 m²).

(13) Doors in walk-in coolers and walk-in freezers shall meet the requirements of ASHRAE 90.1. Walk-in cooler and walk-in freezer refrigeration systems, except for walk-in process cooling refrigeration systems as defined in 10 CFR 431.302, shall meet the requirements of ASHRAE 90.1. [ASHRAE 90.1:6.4.5]

**E 503.4.9 Liquid-to-Liquid Heat Exchangers.** Plate-type liquid-to-liquid heat exchangers shall be rated in accordance with AHRI 400. [ASHRAE 90.1:6.4.7]

**E 503.5 Prescriptive Compliance Path, Economizers.** Each Cooling systems shall include either an air economizer or fluid economizer in accordance with Section E 503.5.1 through Section E 503.5.4.1.

**Exceptions:** Economizers shall not be required for the following systems:

(1) Individual fan-cooling units with a supply capacity less than the minimum listed in Table E 503.5(1).

<table>
<thead>
<tr>
<th>CLIMATE ZONES</th>
<th>COOLING CAPACITY WHERE AN ECONOMIZER IS REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>0A, 0B, 1A, 1B</td>
<td>No economizer requirement</td>
</tr>
<tr>
<td>2A, 2B, 3A, 4A, 5A, 6A, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8</td>
<td>≥54 000 Btu/h</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

(2) Chilled-water cooling systems without a fan or that use induced airflow, where the total capacity of these systems is less than 1 000 000 Btu/h (293 kW) in Climate Zones 0, 1B, and 2 through 4; less than 1 400 000 Btu/h (410 kW) in Climate Zones 5 through 8; or any size in Climate Zone 1A.

<table>
<thead>
<tr>
<th>TABLE E 503.5(2)</th>
<th>ELIMINATE REQUIRED ECONOMIZER FOR COMFORT COOLING BY INCREASING COOLING EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLIMATE ZONES</td>
<td>EFFICIENCY IMPROVEMENT*</td>
</tr>
<tr>
<td>2A</td>
<td>17%</td>
</tr>
<tr>
<td>2B</td>
<td>21%</td>
</tr>
<tr>
<td>3A</td>
<td>27%</td>
</tr>
<tr>
<td>3B</td>
<td>32%</td>
</tr>
<tr>
<td>3C</td>
<td>65%</td>
</tr>
<tr>
<td>4A</td>
<td>42%</td>
</tr>
<tr>
<td>4B</td>
<td>49%</td>
</tr>
<tr>
<td>4C</td>
<td>64%</td>
</tr>
<tr>
<td>5A</td>
<td>49%</td>
</tr>
<tr>
<td>5B</td>
<td>59%</td>
</tr>
<tr>
<td>5C</td>
<td>74%</td>
</tr>
<tr>
<td>6A</td>
<td>56%</td>
</tr>
<tr>
<td>6B</td>
<td>65%</td>
</tr>
<tr>
<td>7</td>
<td>72%</td>
</tr>
<tr>
<td>8</td>
<td>77%</td>
</tr>
</tbody>
</table>

*Where a unit is rated with an IPLV, IEER or SEER, to eliminate the required economizer, the minimum cooling efficiency of the HVAC unit shall be increased by the percentage shown. Where the HVAC unit is rated with a full load metric like EER cooling, these shall be increased by the percentage shown.

(3) Systems that include nonparticulate air treatment in accordance with ASHRAE 62.1.

(4) In hospitals and ambulatory surgery centers, where more than 75 percent of the air designed to be supplied by the system is to spaces that are required to be humidified more than 35°F (2°C) dew-point temperature to comply with applicable codes or accreditation standards; in all other buildings, where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified more than 35°F (2°C) dew-point temperature to satisfy process application needs. This exception shall not apply to computer rooms.

(5) Systems that include a condenser heat recovery system with a minimum capacity in accordance with Section E 503.5.10.2.2

(6) Systems that serve residential spaces where the system capacity is less than five times the requirement listed in Table E 503.5(1).

(7) Systems that serve spaces whose sensible cooling load at design conditions, excluding transmission and infiltration loads, is less than or equal to transmission and infiltration losses at an outdoor temperature of 60°F (16°C).

(8) Systems expected to operate less than 20 hours per week.

(9) Where the use of outdoor air for cooling will affect supermarket open refrigerated casework systems.
(10) For comfort cooling where the cooling efficiency is not less than the efficiency improvement requirements in accordance with Table E 503.5(2).

(11) Systems primarily serving computer rooms where in accordance with one of the following:

(a) The total design cooling load of all computer rooms in the building is less than 3 000 000 Btu/h (879 kW) and the building in which they are located is not served by a centralized chilled water plant.

(b) The room total design cooling load is less than 600 000 Btu/h (176 kW) and the building in which they are located is served by a centralized chilled water plant.

(c) The local water authority does not permit cooling towers.

(d) Less than 600 000 Btu/h (176 kW) of computer room cooling equipment capacity is being added to an existing building.

(12) Dedicated systems for computer rooms where a minimum of 75 percent of the design load serves one of the following:

(a) Spaces classified as an essential facility.

(b) Spaces having a design of Tier IV in accordance with TIA 942.

(c) Spaces classified as Critical Operations Power Systems (COPS) in accordance with NFPA 70.

(d) Spaces where core clearing and settlement services are performed such that their failure to settle pending financial transactions is capable of systemic risk in accordance with “The Interagency Paper on Sound Practices to Strengthen the Resilience of the US Financial System” (April 7, 2003). [ASHRAE 90.1:6.5.1.1]

E 503.5.1 Air Economizers, Design Capacity. Air economizer systems shall be capable of and configured to modulate outdoor air and return air dampers to provide up to 100 percent of the design supply air quantity as outdoor air for cooling. [ASHRAE 90.1:6.5.1.1.1]

E 503.5.1.1 Control Signal. Economizer controls shall be capable of and configured to sequence the dampers with the mechanical cooling equipment and shall not be controlled by only mixed air temperature. Exception: The use of mixed air temperature limit control shall be permitted for systems controlled from space temperature (such as single-zone systems). [ASHRAE 90.1:6.5.1.1.2]

E 503.5.1.2 High-Limit Shutoff. Air economizers shall be capable of and configured to automatically reduce outdoor air intake to the design minimum outdoor air quantity where outdoor air intake will no longer reduce cooling energy use. High-limit shutoff control types and associated setpoints for specific climate zones shall be chosen from Table E 503.5.1.2. [ASHRAE 90.1:6.5.1.1.3]

E 503.5.1.3 Dampers. Return, exhaust or Relief or relief, and outdoor air dampers shall comply with the requirements of Section Table E 503.4.6.4.2. Return dampers shall meet the requirements of motorized exhaust or relief dampers in Table E 503.4.6.4.2.

TABLE E 503.5.1.2
HIGH-LIMIT SHUTOFF CONTROL SETTINGS FOR AIR ECONOMIZERS
[ASHRAE 90.1: TABLE 6.5.1.1.3]

<table>
<thead>
<tr>
<th>CONTROL TYPE</th>
<th>ALLOWED ONLY IN CLIMATE ZONE AT LISTED SETPOINT</th>
<th>REQUIRED HIGH LIMIT (ECONOMIZER OFF WHERE):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed dry-bulb temperature</td>
<td>0B, 1B, 2B, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8</td>
<td>( T_{\text{refOA}} &gt; 75^\circ F )</td>
</tr>
<tr>
<td></td>
<td>0A, 1A, 2A, 3A, 4A</td>
<td>( T_{\text{refOA}} &gt; 70^\circ F )</td>
</tr>
<tr>
<td></td>
<td>5A, 6A</td>
<td>( T_{\text{refOA}} &gt; 65^\circ F )</td>
</tr>
<tr>
<td>Differential dry-bulb temperature</td>
<td>0B, 1B, 2B, 3B, 3C, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8</td>
<td>( T_{\text{refOA}} &gt; T_{\text{refRA}} )</td>
</tr>
<tr>
<td>Fixed enthalpy with fixed dry-bulb temperature</td>
<td>All</td>
<td>( h_{\text{refOA}} &gt; 28 \text{ Btu/lb}^1 ) or ( T_{\text{refOA}} &gt; 75^\circ F )</td>
</tr>
<tr>
<td>Differential enthalpy with fixed dry-bulb temperature</td>
<td>All</td>
<td>( h_{\text{refOA}} &gt; h_{\text{refRA}} ) or ( T_{\text{refOA}} &gt; 75^\circ F )</td>
</tr>
</tbody>
</table>

For SI units: °C = (°F-32)/1.8, 1 British thermal unit per pound = 2326 J/kg

Notes:
1 At altitudes substantially different than sea level, the fixed enthalpy limit shall be set to the enthalpy value at 75°F (24°C) and 50 percent relative humidity. As an example, at approximately 6000 feet (1829 m) elevation, the fixed enthalpy limit shall be approximately 30.7 Btu/lb (71 408 J/kg).
2 Devices with selectable rather than adjustable setpoints shall be capable of being set to within 2°F (1°C) and 2 Btu/lb (4649 J/kg) of the setpoint listed.
**Exception:** Exhaust or relief and outdoor air intake dampers on systems intended to operate continuously. [ASHRAE 90.1:6.5.1.1.4]

E 503.5.1.4 Relief of Excess Outdoor Air. Systems shall provide a means to relieve excess outdoor air during air economizer operation to prevent overpressurizing the building. The relief air outlet shall be located so as to avoid recirculation into the building. [ASHRAE 90.1:6.5.1.1.5]

E 503.5.1.5 Sensor Accuracy. Outdoor air, return air, mixed air, and supply air sensors shall be calibrated within the following accuracies:

1. Dry-bulb and wet-bulb temperatures shall be accurate to ±2°F (1.1°C) over the range of 40°F (4.4°C) to 80°F (27°C).
2. Enthalpy and the value of a differential enthalpy sensor shall be accurate to ±3 Btu/lb (7 E+03 J/kg) over the range of 20 Btu/lb (4.6 E+04 J/kg) to 36 Btu/lb (8.4 E+04 J/kg).
3. Relative humidity shall be accurate to ±5 percent over the range of 20 percent to 80 percent relative humidity. [ASHRAE 90.1:6.5.1.1.6]

E 503.5.2 Fluid Economizers, Design Capacity. Fluid economizer systems shall be capable of providing up to 100 percent of the expected system cooling load at outdoor air temperatures of not more than 50°F (10°C) dry-bulb or 45°F (7°C) wet-bulb.

**Exceptions:**

1. Systems primarily serving computer rooms in which 100 percent of the expected system cooling load at the dry-bulb and wet-bulb temperatures in accordance with Table E 503.5.2 is met with water-cooled fluid economizers.
2. Systems primarily serving computer rooms in which 100 percent of the expected system cooling load at the dry-bulb temperatures listed in Table E 503.5.2 is met with air-cooled fluid economizers.
3. Systems where dehumidification requirements are not capable of being met using outdoor air temperatures of 50°F (10°C) dry-bulb or 45°F (7°C) wet-bulb and where 100 percent of the expected system cooling load at 45°F (7°C) dry-bulb or 40°F (4°C) wet-bulb is met with water-cooled fluid economizers. [ASHRAE 90.1:6.5.1.2.1]

E 503.5.2.1 Maximum Hydronic Pressure Drop. Precooling coils and fluid-to-water heat exchangers used as part of a fluid economizer system shall either have a water-side pressure drop of less than 15 feet of water (45 kPa), or a secondary loop pressure drop of less than 10 feet of water (30 kPa).

### TABLE E 503.5.2

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>WATER COOLED</th>
<th>AIR COOLED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DRY-BULB, °F</td>
<td>WET-BULB, °F</td>
</tr>
<tr>
<td>0</td>
<td>A</td>
<td>NR</td>
</tr>
<tr>
<td>0</td>
<td>B</td>
<td>NR</td>
</tr>
<tr>
<td>1</td>
<td>A</td>
<td>NR</td>
</tr>
<tr>
<td>1</td>
<td>B</td>
<td>NR</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>40.0</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>35.0</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>40.0</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>30.0</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>30.0</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>40.0</td>
</tr>
<tr>
<td>4</td>
<td>B</td>
<td>30.0</td>
</tr>
<tr>
<td>4</td>
<td>C</td>
<td>30.0</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>40.0</td>
</tr>
<tr>
<td>5</td>
<td>B</td>
<td>30.0</td>
</tr>
<tr>
<td>5</td>
<td>C</td>
<td>30.0</td>
</tr>
<tr>
<td>6</td>
<td>A</td>
<td>35.0</td>
</tr>
<tr>
<td>6</td>
<td>B</td>
<td>30.0</td>
</tr>
<tr>
<td>7</td>
<td>—</td>
<td>30.0</td>
</tr>
<tr>
<td>8</td>
<td>—</td>
<td>30.0</td>
</tr>
</tbody>
</table>

For SI units: °C = (°F-32)/1.8
NR = Not Required
shall be created so that the coil or heat exchanger pressure drop is not seen by the circulating pumps where the system is in the normal cooling (non-economizer) mode. [ASHRAE 90.1:6.5.1.2.2]

E 503.5.3 Integrated Economizer Control. Economizer systems shall be integrated with the mechanical cooling system and be capable of and configured to provide partial cooling even where additional mechanical cooling is required to be in accordance with the remainder of the cooling load. Controls shall not false load the mechanical cooling systems by limiting or disabling the economizer or by other means, such as hot gas bypass, except at the lowest stage of mechanical cooling.

Units that include an air economizer shall comply with the following:

(1) Unit controls shall have the mechanical cooling capacity control interlocked with the air economizer controls such that the outdoor air damper is at the 100 percent open position when mechanical cooling is on, and the outdoor air damper does not begin to close to prevent coil freezing due to minimum compressor run time until the leaving air temperature is less than 45°F (7°C).

(2) DX units with a rated capacity no less than 65,000 Btu/h (19 kW) that control the capacity of the mechanical cooling directly based on occupied space temperature shall have not less than two stages of mechanical cooling capacity.

(3) Other DX units, including those that control space temperature by modulating the airflow to the space, shall comply with the requirements of Table E 503.5.3. [ASHRAE 90.1:6.5.1.3]

TABLE E 503.5.3
DX COOLING STAGE REQUIREMENTS FOR MODULATING AIRFLOW UNITS
[ASHRAE 90.1: TABLE 6.5.1.3]

<table>
<thead>
<tr>
<th>RATING CAPACITY, Btu/h</th>
<th>MINIMUM NUMBER OF MECHANICAL COOLING STAGES</th>
<th>MINIMUM COMPRESSOR DISPLACEMENT*</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥65,000 and &lt;240,000</td>
<td>3</td>
<td>≤35% of full load</td>
</tr>
<tr>
<td>≥240,000</td>
<td>4</td>
<td>≤25% full load</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units = 0.293 kW

* For mechanical cooling stage control that does not use variable compressor displacement the percent displacement shall be equivalent to the mechanical cooling capacity reduction evaluated at the full load rating conditions for the compressor.

E 503.5.4 Economizer Heating System Impact. HVAC system design and economizer controls shall be such that economizer operation does not increase the building heating energy use during normal operation.

Exception: Economizers on variable air valve (VAV) systems that cause zone level heating to increase due to a reduction in supply air temperature. [ASHRAE 90.1:6.5.1.4]

E 503.5.5 Simultaneous Heating and Cooling Limitation, Zone Controls. Zone thermostatic controls shall prevent the following:

(1) Reheating.
(2) Recooling.
(3) Mixing or simultaneously supplying air that has been previously mechanically heated and air that has been previously cooled, either by mechanical cooling or by economizer systems.
(4) Other simultaneous operation of heating and cooling systems to the same zone.

Exceptions:

(1) Zones for which the volume of air that is reheated, recooled, or mixed is less than the larger of the following:
   (a) Twenty percent for systems without DDC. 30 percent of the zone design peak supply for systems with DDC and 30 percent for other systems.
   (b) The outdoor airflow rate required to be in accordance with the For systems with DDC, the minimum primary airflow rate required to meet the Simplified Procedure ventilation requirements of Chapter 4 or ASHRAE 62.1 for the zone permitted to be the average airflow rate as allowed by Chapter 4 or ASHRAE 62.1.
   (c) Any higher rate that can be demonstrated, to the satisfaction of the Authority Having Jurisdiction, to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system.
   (d) The airflow rate required to be in accordance with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.

(2) Zones with DDC that comply with the following:
   (a) The airflow rate in dead band between heating and cooling does not exceed the larger of the following:
      (1) Twenty percent of the zone design peak supply rate.
      (2) The outdoor airflow rate required to be in accordance with the The minimum primary airflow rate required to meet the Simplified Procedure ventilation
requirements of Chapter 4 or ASHRAE 62.1 for the zone, permitted to be the average airflow rate as allowed by Chapter 4 or ASHRAE 62.1.

(42) A higher rate that can be demonstrated, to the satisfaction of the Authority Having Jurisdiction, to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake.

(43) The airflow rate required with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.

(b) The airflow rate that is reheated, recooled, or mixed shall be less than 50 percent of the zone design peak supply rate.

c) The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the dead band flow rate.

d) The second stage of heating consists of modulating the airflow rate from the dead band flow rate up to the heating maximum flow rate.

(3) Laboratory exhaust systems that comply with Section E 503.5.11.3.

(4) Zones where at least 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from site-recovered energy (including condenser heat) or on-site renewable energy. [ASHRAE 90.1:6.5.2.1]

E 503.5.5.1 Supply Air Temperature Reheat Limit. Where reheating is permitted in accordance with this appendix, zones that have both supply and return or exhaust air openings more than 6 feet (1829 mm) above the floor shall not supply heating air more than 20°F (11°C) above the space temperature setpoint.

Exceptions:

(1) Laboratory exhaust systems in accordance with Section E 503.5.11.3.

(2) During preoccupancy building warm-up and setback. [ASHRAE 90.1:6.5.2.1.1]

E 503.5.5.2 Hydronic System Controls. The heating of fluids in hydronic systems that have been previously mechanically cooled and the cooling of fluids that have been previously mechanically heated shall be limited in accordance with Section E 503.5.5.2.1 through Section E 503.5.5.2.3. [ASHRAE 90.1:6.5.2.2]

E 503.5.5.2.1 Three-Pipe System. Hydronic systems that use a common return system for both hot water and chilled water shall not be used. [ASHRAE 90.1:6.5.2.2.1]

E 503.5.5.2.2 Two-Pipe Changeover System. Systems that use a common distribution system to supply both heated and chilled water are acceptable where in accordance with the following:

(1) The system is designed to allow a dead band between changeover from one mode to the other of not less than 15°F (8°C) outdoor air temperature.

(2) The system is designed to operate and is provided with controls that will allow operation in one mode for not less than 4 hours before changing over to the other mode.

(3) Reset controls are provided that allow heating and cooling supply temperatures at the changeover point to be not more than 30°F (17°C) apart. [ASHRAE 90.1:6.5.2.2.2]

E 503.5.5.2.3 Hydronic (Water Loop) Heat Pump Systems. Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection (e.g., cooling tower) and heat addition (e.g., boiler) shall have the following:

(1) Controls that are capable of and configured to provide a heat pump water supply temperature dead band of at least 20°F (11°C) between initiation of heat rejection and heat addition by the central devices (e.g., tower and boiler).

(2) For climate zone 3 through zone 8, where a closed-circuit cooling tower (fluid cooler) is used, either an automatic valve shall be installed to bypass all but a minimal flow of water around the tower (for freeze protection) or low-leakage positive closure dampers shall be provided. Where an open-circuit cooling tower is used directly in the heat pump loop, an automatic valve shall be installed to bypass all heat pump water flow around the tower. Where an open-circuit cooling tower is used in conjunction with a separate heat exchanger to isolate the tower from the heat pump loop then heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop.

Exception: Where a system loop temperature optimization controller is used to determine the most efficient operating temperature based on real-time conditions of demand and capacity, dead bands of less than 20°F (11°C) shall be permitted. [ASHRAE 90.1:6.5.2.2.3]

E 503.5.5.3 Dehumidification. Where humidity controls are provided, such controls shall prevent reheating, mixing of hot and cold airstreams, or other means of simultaneous heating and cooling of the same airstream.
Exceptions:

(1) The system is capable of and configured to reduce supply air volume to 50 percent or less of the design airflow rate or the minimum outdoor air ventilation rate in accordance with Chapter 4 or ASHRAE 62.1 or other applicable federal, state, or local code or recognized standard, whichever is larger before simultaneous heating and cooling takes place.

(2) The individual fan cooling unit has a design cooling capacity of not more than 65 000 Btu/h (19 kW) and is capable of and configured to unload to 50 percent capacity before simultaneous heating and cooling takes place.

(3) The individual mechanical cooling unit has a design cooling capacity of not more than 40 000 Btu/h (11.7 kW). An individual mechanical cooling unit is a single system composed of a fan or fans and a cooling coil capable of providing mechanical cooling.

(4) Systems serving spaces where specific humidity levels are required to satisfy process application needs, such as vivariums, museums, surgical suites, pharmacies, and buildings with refrigerating systems, such as supermarkets, refrigerated warehouses, and ice arenas, and where the building includes site-recovered energy or on-site renewable energy that provide energy equal to 75 percent or more of the annual energy for reheating or for providing warm air in mixing systems. This exception shall not apply to computer rooms.

(5) Not less than 90 percent of the annual energy for reheating or for providing warm air in mixing systems is provided from site-recovered energy (including condenser heat) or on-site renewable energy.

(6) Systems where the heat added to the airstream is the result of the use of a desiccant system and 75 percent of the heat added by the desiccant system is removed by a heat exchanger, either before or after the desiccant system with energy recovery. [ASHRAE 90.1:6.5.2.3]

E 503.5.5.4 Humidifier Preheat. Humidifiers with preheating jackets mounted in the airstream shall be provided with an automatic valve to shut off preheat where humidification is not required. [ASHRAE 90.1:6.5.2.4.1]

E 503.5.5.4.1 Insulation. Humidification system dispersion tube hot surfaces in the airstreams of ducts or air-handling units shall be insulated with a product with an insulating value of not less than R-0.5. Exception: Systems where mechanical cooling, including economizer operation, does not occur simultaneously with humidification. [ASHRAE 90.1:6.5.2.4.2]

E 503.5.5.5 Preheat Coils. Preheat coils shall have controls that stop their heat output where mechanical cooling, including economizer operation, is occurring. [ASHRAE 90.1:6.5.2.5]

E 503.5.6 Air System Design and Control. HVAC air system design and control shall be in accordance with the provisions of Section E 503.5.6.1 through Section E 503.5.6.6.

E 503.5.6.1 Fan System Power and Efficiency. Each HVAC system having a total fan system motor nameplate horsepower (kW) exceeding 5 hp (3.7 kW) at fan system design conditions shall not exceed the allowable fan system motor nameplate horsepower (kW) (Option 1) or fan system brake horsepower (kW) (Option 2) as shown in Table E 503.5.6.1(1). This shall include supply fans, return or relief fans, exhaust fans, and fan-powered terminal units associated with systems providing heating or cooling capacity that operate at fan system design conditions. Single-zone VAV systems shall comply with the constant-volume VAV systems power limitation.

**TABLE E 503.5.6.1(1)**

<table>
<thead>
<tr>
<th>LIMIT</th>
<th>CONSTANT VOLUME</th>
<th>VARIABLE VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Fan system motor nameplate (hp)</td>
<td>Allowable motor nameplate (hp)</td>
<td>hp ≤ CFMS * \ 0.0011</td>
</tr>
<tr>
<td>Option 2: Fan system (bhp)</td>
<td>Allowable fan system (bhp)</td>
<td>bhp ≤ CFMS * 0.00094 + A</td>
</tr>
</tbody>
</table>

* Where:
  - CFMS = the maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute (m³/s)
  - hp = the maximum combined motor nameplate horsepower (kW)
  - bhp = the maximum combined fan brake horsepower (kW)
  - A = sum of \( (PD \times CFMD) / 4131 \)
  - PD = each applicable pressure drop adjustment from Table E 503.5.6.1(2) in inch water column (kPa)
  - CFMD = the design airflow through each applicable device from Table E 503.5.6.1(2) in cubic feet per minute (m³/s)

For SI units: 1 horsepower = 0.746 kW, 1 cubic foot per minute = 0.00047 m³/s
### Exceptions:

1. Hospital, vivarium, and laboratory systems that utilize flow control devices on exhaust, return, or both to maintain space pressure differentials between adjacent rooms

2. Individual exhaust fans with a nameplate horsepower of 1 hp (0.7 kW) or less. [ASHRAE 90.1:6.5.3.1.1]

3. Systems that are in accordance with Section E 503.5.6.1, Option 1.

4. Fans with a motor nameplate horsepower of less than 1 hp (0.7 kW).

5. Fans with a motor nameplate horsepower of less than 6 hp (4.5 kW) and larger, where the first available motor larger than the bhp (kW) has a nameplate rating within 30 percent of the bhp (kW), the next larger nameplate motor size shall be permitted to be selected.

6. Systems with central electric resistance heat

7. Systems with central cooling device

8. Systems without central heating device

9. Systems without central cooling device

For SI units: 1 inch water column = 0.249 kPa, 1 foot = 304.8 mm

### E 503.5.6.1.1 Motor Nameplate Horsepower Fan Motor Selection

Fan motor selection shall be in accordance with the following:

1. For each fan less than 6 bhp (4.5 kW), the selected fan motor shall be no larger than the first available motor with a nameplate rating greater than 1.5 times the bhp.

2. The fan bhp shall be indicated on the design documents to allow for compliance verification by the Authority Having Jurisdiction. For each fan 6 bhp (4.5 kW) and larger, the selected fan motor shall be no larger than the first available motor with a nameplate rating greater than 1.3 times the bhp. The fan bhp must be indicated on the design documents to allow for compliance verification by the Authority Having Jurisdiction.

### E 503.5.6.1.2 Fan Efficiency

Fans shall have a fan efficiency grade (FEG) of 67 or more, based on manufacturers' specifications.
certified data in accordance with AMCA 205. The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan energy index (FEI) of 1.00 or higher. Each fan and fan array used for a variable-air-volume system that meets the requirements of Section E 503.5.6.2 shall have an FEI of 0.95 or higher. The FEI for fan arrays shall be calculated in accordance with AMCA 208.

Exceptions:

1. Individual fans that are not embedded fans with a motor nameplate horsepower of 5 hp (3.7 kW) or less that are part of a group operated as the functional equivalent of a single fan less than 1.0 hp (0.7 kW) or with a fan nameplate electrical input power of less than 0.89 kW (1.2 hp).

2. Multiple embedded fans in series or parallel (e.g., and fan arrays) that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less and are operated as the functional equivalent of a single fan or with a fan system electrical input power of 4.1 kW (5.5 hp) or less.

3. Fans that are part of equipment listed under Section E 503.4.

4. Fans included in equipment bearing a third-party-certified seal for air or energy performance of the equipment package.

5. Powered wall/roof ventilators (PRV) ceiling fans.

6. Fans used for moving gases at temperatures above 482°F (250°C).

7. Fans used for operation in explosive atmospheres.

8. Reversible fans used for tunnel ventilation.


10. Fans that are intended to only operate during emergency conditions. [ASHRAE 90.1:6.5.3.1.3]

E 503.5.6.2 Supply Fan Airflow Control. Each cooling system listed in Table E 503.5.6.2 shall be designed to vary the supply fan airflow as a function of load and shall comply with the following requirements:

1. DX and chilled-water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have a minimum of two stages of fan control. Low or minimum speed shall not exceed 66 percent of full speed. At low or minimum speed, the fan system shall draw no more than 40 percent of the fan power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

2. All other units, including DX cooling units and chilled-water units that control the space temperature by modulating the airflow to the space, shall have modulating fan control. Minimum speed shall not exceed 50 percent of full speed. At minimum speed, the fan system shall draw no more than 30 percent of the power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

3. Units that include an air economizer to meet the requirements of Section E 503.5 through Section E 503.5.4.1 shall have a minimum of two speeds of fan control during economizer operation.

Exceptions:

1. Modulating fan control shall not be required for chilled-water and evaporative cooling units with less than 1 hp (0.7 kW) fan motors where the units are not used to provide ventilation air and where the indoor fan cycles with the load.

2. Where the volume of outdoor air required to meet the ventilation requirements of Chapter 4 or ASHRAE 62.1 at low speed exceeds the air that would be delivered at the speed defined in Section E 503.5.6.2(1), or Section E 503.5.6.2(2), then the minimum speed shall be selected to provide the required ventilation air. [ASHRAE 90.1:6.5.3.2.1]

### TABLE E 503.5.6.2 FAN AIRFLOW CONTROL [ASHRAE 90.1: TABLE 6.5.3.2.1]

<table>
<thead>
<tr>
<th>COOLING SYSTEM TYPE</th>
<th>FAN MOTOR SIZE, (hp)</th>
<th>MECHANICAL COOLING CAPACITY, (Btu/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DX cooling</td>
<td>Any</td>
<td>≥65 000</td>
</tr>
<tr>
<td>Chilled-water and evaporative cooling</td>
<td>≥½</td>
<td>Any</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW, 1 horsepower = 0.746 kW, 1 cubic foot per minute = 0.00047 m³/s

E 503.5.6.2.1 VAV Static Pressure Sensor Location. Static pressure sensors used to control VAV fans shall be located such that the controller setpoint is not more than 1.2 inches water column (0.30 kPa). Where this results in the sensor being located downstream of major duct splits, sensors shall be installed in each major branch to ensure that static pressure is maintained in each.

Exception: Systems that are in accordance with Section E.503.5.6.2.2. [ASHRAE 90.1:6.5.3.2.2]
E 503.5.6.2.2 VAV Setpoint Reset. For multiple-zone VAV systems having a total fan system motor nameplate horsepower exceeding 5 hp (3.7 kW) with DDC of individual zones reporting to the central control panel, static pressure setpoint shall be reset based on the zone requiring the most pressure, such as the setpoint is reset lower until one zone damper is nearly wide open. Controls shall provide the following:

(1) Monitor zone damper positions or other indicator of need for static pressure.
(2) Automatically detect those zones that are capable of excessively driving the reset logic and generate an alarm to the system operator.
(3) Readily allow operator removal of zones from the reset algorithm. [ASHRAE 90.1:6.5.3.2.3]

E 503.5.6.3 Multiple-Zone VAV System Ventilation Optimization Control. Multiple-zone VAV systems with DDC of individual zone boxes reporting to a central control panel shall include means to automatically reduce outdoor air intake flow below design rates in response to changes in system ventilation efficiency in accordance with Section 404.0 or ASHRAE 62.1.

Exceptions:
(1) VAV systems with zonal transfer fans that recirculate air from other zones without directly mixing it with outdoor air, dual-duct dual-fan VAV systems, and VAV systems with fan-powered terminal units.
(2) Systems where total design exhaust airflow is more than 70 percent of total design outdoor air intake flow requirements. [ASHRAE 90.1:6.5.3.3]

E 503.5.6.4 Supply Air Temperature Reset Controls. Multiple zone HVAC systems shall include controls that are capable of and configured to automatically reset the supply air temperature in response to representative building loads, or to outdoor air temperature. The controls shall reset the supply air temperature to at least 25 percent of the difference between the design supply air temperature and the design room air temperature. Controls that adjust the reset based on zone humidity shall be permitted in Climate Zones 0B, 1B, 2B, 3B, 3C, and 4 through 8. HVAC Zone Zones that are expected to experience relatively constant loads, such as electronic equipment rooms, shall have maximum airflow designed for to accommodate the fully reset supply air temperature.

HVAC zones that are expected to experience relatively constant loads typically include electronic equipment rooms and interior zones.

Exceptions:
(1) Systems in Climate zones Zones 0A, 1A, 2A, and 3A with less than 3000 cubic feet per minute (1.4 m³/s) of design outdoor air.
(2) Systems in Climate Zone 2A with less than 10 000 cubic feet per minute (4.7 m³/s) of design outdoor air.
(3) Systems in Climate Zones 0A, 1A, 2A, and 3A with at least 80 percent outdoor air and employing exhaust air energy recovery complying with Section E 503.5.10.1.2.
(4) Systems that prevent reheating, recooling, or mixing of heated and cooled supply air.
(5) Systems where not less than in which at least 75 percent of the energy for reheating (on an annual basis) is from site recovered energy or on-site solar renewable energy. [ASHRAE 90.1:6.5.3.5]

E 503.5.6.5 Fractional Horsepower Fan Motors. Motors for fans that are 1/12 hp (62.1 W) or more and less than 1 hp (0.7 kW) shall be electronically-commutated motors or shall have a motor efficiency of not less than 70 percent where rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans shall be permitted to use sheave adjustments for airflow balancing in lieu of a varying motor speed.

Exceptions:
(1) Motors in the airstream within fan coils and terminal units that operate when providing heating to the space served.
(2) Motors installed in space conditioning equipment certified in accordance with Section E 503.4 through Section E 503.4.4.1.
(3) Motors shown in Table E 503.5.6.5(1) or Table E 503.5.6.5(2). [ASHRAE 90.1:6.5.3.6]

E 503.5.6.6 Low Power Fans. Fans that are not covered by Section E 503.5.6.5 and having a fan nameplate electrical input power of less than 180 W or having a motor nameplate horsepower less than 1/12 HP (62.1 W) shall meet the fan efficacy requirements specified in ASHRAE 90.1. [ASHRAE 90.1:6.5.3.7]

E 503.5.6.6 E 503.5.6.7 Ventilation Design. The required minimum outdoor air rate is the larger of the minimum outdoor air rate or the minimum exhaust air rate required by Chapter 4, ASHRAE 62.1, ASHRAE 62.2, ASHRAE 170, or applicable codes or accreditation standards. Outdoor air ventilation systems shall comply with one of the following:

(1) Design minimum system outdoor air provided shall not exceed 135 percent of the required minimum outdoor air rate.
Dampers, ductwork, and controls shall be provided that allow the system to supply no more than the required minimum outdoor air rate with a single setpoint adjustment.

The system includes exhaust air energy recovery complying with Section E 503.5.10.1.2. [ASHRAE 90.1:6.5.3.7

E 503.5.6.8 Occupied-Standby Controls. Zones serving only rooms that are required to have automatic partial OFF or automatic full OFF lighting controls in accordance with ASHRAE 90.1, where the Chapter 4 or ASHRAE 62.1 occupancy category permits ventilation air to be reduced to zero whenever the space is in occupied-stay mode, and when using the Ventilation Rate Procedure, shall meet the following within 5 minutes of all rooms in that zone entering occupied-stay mode.

1. Active heating set point shall be setback at least 1°F (0.6°C).
2. Active cooling set point shall be setup at least 1°F (0.6°C).
3. All airflow supplied to the zone shall be shut off whenever the space temperature is between the active heating and cooling set points.

Exception: Multiple zone systems without automatic zone flow control dampers.

E 503.5.7 Hydronic System Design and Control

Boiler Turndown. Hydronic system design and control shall be in accordance with Section E 503.5.7.1 and Section E 503.5.7.2.

E 503.5.7.1 Boiler Turndown. Boiler systems with design input of 1 000 000 Btu/h (293 kW) or

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**TABLE E 503.5.6.5(1)**
MINIMUM AVERAGE FULL-LOAD EFFICIENCY FOR POLYPHASE SMALL ELECTRIC MOTORS*
[ASHRAE 90.1: TABLE 10.8-3]

<table>
<thead>
<tr>
<th>NUMBER OF POLES</th>
<th>2</th>
<th>4</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYNCHRONOUS SPEED (RPM)</td>
<td>3600</td>
<td>1800</td>
<td>1200</td>
</tr>
<tr>
<td>MOTOR HORSEPOWER (hp)</td>
<td>EFFICIENCY, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td>65.6</td>
<td>69.5</td>
<td>67.5</td>
</tr>
<tr>
<td>0.33</td>
<td>69.5</td>
<td>73.4</td>
<td>71.4</td>
</tr>
<tr>
<td>0.50</td>
<td>73.4</td>
<td>78.2</td>
<td>75.3</td>
</tr>
<tr>
<td>0.75</td>
<td>76.8</td>
<td>81.1</td>
<td>81.7</td>
</tr>
<tr>
<td>1</td>
<td>77.0</td>
<td>83.5</td>
<td>82.5</td>
</tr>
<tr>
<td>1.5</td>
<td>84.0</td>
<td>86.5</td>
<td>83.8</td>
</tr>
<tr>
<td>2</td>
<td>85.5</td>
<td>86.5</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>85.5</td>
<td>86.9</td>
<td>N/A</td>
</tr>
</tbody>
</table>

For SI units: 1 horsepower = 0.746 kW

* Average full-load efficiencies shall be established in accordance with 10 CFR 431.

**TABLE E 503.5.6.5(2)**
MINIMUM AVERAGE FULL-LOAD EFFICIENCY FOR CAPACITOR-START CAPACITOR-RUN AND CAPACITOR-START INDUCTION-RUN SMALL ELECTRIC MOTORS*
[ASHRAE 90.1: TABLE 10.8-4]

<table>
<thead>
<tr>
<th>NUMBER OF POLES</th>
<th>2</th>
<th>4</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYNCHRONOUS SPEED (RPM)</td>
<td>3600</td>
<td>1800</td>
<td>1200</td>
</tr>
<tr>
<td>MOTOR HORSEPOWER (hp)</td>
<td>EFFICIENCY, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td>66.6</td>
<td>68.5</td>
<td>62.2</td>
</tr>
<tr>
<td>0.33</td>
<td>70.5</td>
<td>72.4</td>
<td>66.6</td>
</tr>
<tr>
<td>0.50</td>
<td>72.4</td>
<td>76.2</td>
<td>76.2</td>
</tr>
<tr>
<td>0.75</td>
<td>76.2</td>
<td>81.8</td>
<td>80.2</td>
</tr>
<tr>
<td>1</td>
<td>80.4</td>
<td>82.6</td>
<td>81.1</td>
</tr>
<tr>
<td>1.5</td>
<td>81.5</td>
<td>83.8</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>82.9</td>
<td>84.5</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>84.1</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

For SI units: 1 horsepower = 0.746 kW

* Average full-load efficiencies shall be established in accordance with 10 CFR 431.
more shall comply with the turndown ratio in accordance with Table E 503.5.7.

The system turndown requirement shall use multiple single-input boilers, one or more modulating boilers, or a combination of single-input and modulating boilers.

Boilers shall comply with the minimum efficiency requirements in Table E 503.7.1(6). [ASHRAE 90.1:6.5.4.1]

### Table E 503.5.7

<table>
<thead>
<tr>
<th>BOILER SYSTEM DESIGN INPUT, Btu/h</th>
<th>MINIMUM TURNDOWN RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥1 000 000 and ≤5 000 000</td>
<td>3 to 1</td>
</tr>
<tr>
<td>&gt;5 000 000 and ≤10 000 000</td>
<td>4 to 1</td>
</tr>
<tr>
<td>&gt;10 000 000</td>
<td>5 to 1</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

---

### E 503.5.7.1 E 503.5.7.2 Hydronic Variable Flow Systems

Chilled- and hot-water distribution systems that include three or more control valves designed to modulate or step open and close as a function of load shall be designed for variable fluid flow and shall be capable of and configured to reduce pump flow rates to not more than the larger of 25 percent of the design flow rate or the minimum flow required by the heating/cooling equipment manufacturer for the proper operation of equipment. Individual or parallel pumps serving variable-flow heating-water or chilled-water systems, where the nameplate horsepower of the motor or combined parallel motors is not less than the power shown in Table E 503.5.7.1 E 503.5.7.2, shall have controls or devices that will result in pump motor demand of not more than 30 percent of design wattage at 50 percent of design water flow. The controls or devices shall be controlled as a function of desired flow or to maintain a minimum required differential pressure. Differential pressure shall be measured at or near the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure. The differential pressure setpoint shall not exceed 110 percent of that required to achieve design flow through the heat exchanger. Where differential pressure control is used to comply with this section, and DDC systems are used, the setpoint shall be reset downward based on valve positions until one valve is nearly wide open.

**Exceptions:**

1. Differential pressure set point reset is not required where valve position is used to comply with Section E 503.5.7.3 E 503.5.7.4.
2. Variable-pump flow control is not required on heating-water pumps where more than 50 percent of annual heat is generated by an electric boiler.

---

### E 503.5.7.3 Chiller and Boiler Isolation

Where a chilled-water plant includes more than one chiller, provisions shall be made so that the fluid flow through the chiller is automatically shut off where the chiller is shut down. Chillers piped in series for the purpose of increased temperature differential, shall be considered as one chiller. Where constant-speed chilled-water or condenser water pumps are used to serve multiple chillers, the number of pumps shall be not less than the number of chillers and staged on and off with the chillers. [ASHRAE 90.1:6.5.4.3.1]

### E 503.5.7.2.1 E 503.5.7.3.1 Boiler Isolation

Where a boiler plant includes more than one boiler, provisions shall be made so that the flow through the boiler is automatically shut off where the boiler is shut down. Where constant-speed hot-water pumps are used to serve multiple boilers, the number of pumps shall be not less than the number of boilers and staged on and off with the boilers. [ASHRAE 90.1:6.5.4.3.2]

### E 503.5.7.4 Chilled- and Hot-Water Temperature Reset Controls

Chilled- and hot-water systems with a design capacity exceeding 300 000 Btu/h (88 kW) supplying chilled or heated water to comfort conditioning systems shall include controls that automatically reset supply water temperatures by representative building loads (including return water temperature) or by outdoor air temperature. Where DDC is used to control valves, the set point shall be reset based on valve positions until one valve is nearly wide open or setpoint limits of the system equipment or application have been reached.

---

For SI units: 1 horsepower = 0.746 kW

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For SI units: 1000 British thermal units per hour = 0.293 kW
Exceptions:

1. Where chilled-water supply is already cold, such as chilled water supplied from a district cooling or thermal energy storage system, such that blending would be required to achieve the reset chilled-water supply temperature.
2. Where a specific temperature is required for a process application.
3. Water temperature reset is not required where valve position is used to comply with Section E 503.5.7. [ASHRAE 90.1:6.5.4.4]

Hydronic (Water Loop) Heat Pump and Water-Cooled Unitary Air Conditioners. Hydronic heat pumps and water-cooled unitary air-conditioners shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.

Exception: Units employing water fluid economizers. [ASHRAE 90.1:6.5.4.5.1]

Controls. Hydronic heat pumps and water-cooled unitary air-conditioners having a total pump system power exceeding 5 hp (3.7 kW) shall have controls, devices, or both (such as variable speed control) that will result in pump motor demand of not more than 30 percent of design wattage at 50 percent of design water flow. [ASHRAE 90.1:6.5.4.5.2]

Pipe Sizing. Chilled-water and condenser-water piping shall be designed such that the design flow rate in each piping segment shall not exceed the values listed in Table E 503.5.7.5 for the appropriate total annual hours of operation. Piping size selections for systems that operate under variable flow conditions (e.g., modulating two-way control valves at coils) and that contain variable-speed pump motors shall be permitted to be made from the “Variable Flow/Variable Speed” columns. All others shall be made from the “Other” columns.

Exceptions:

1. Design flow rates exceeding the values in Table E 503.5.7.5 shall be permitted in specific sections of piping if the piping in question is not in the critical circuit at design conditions and is not predicted to be in the critical circuit during more than 30 percent of operating hours.
2. Piping systems that have equivalent or lower total pressure drop than the same system constructed with standard weight steel pipe with piping and fittings, sized in accordance with Table E 503.5.7.6. [ASHRAE 90.1:6.5.4.6]

Heat Rejection Equipment. Section E 503.5.8 through Section E 503.5.9 applies to heat-rejection equipment used in comfort cooling systems, such as air-cooled condensers, dry coolers, open-circuit cooling towers, closed-circuit cooling towers, and evaporative condensers.

Exception: Heat-rejection devices whose energy use is included in the equipment efficiency ratings listed in Table E 503.7.1(1) through Table E 503.7.1(4). [ASHRAE 90.1:6.5.5.1]

Fan Speed Control. The fan system on a heat-rejection device powered by an individual motor or an array of motors with a connected power, including the motor service factor, totaling 5 hp (3.7 kW) or more shall have controls and/or devices (such as variable-speed control) that shall result in fan motor demand of no more than 30 percent of design wattage at 50 percent of the design airflow and that shall automatically modulate the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat-rejection device.

### Table E 503.5.7.5

<table>
<thead>
<tr>
<th>OPERATING HOURS/YEAR</th>
<th>≤2000 HOURS/YEAR</th>
<th>&gt;2000 AND ≤4400 HOURS/YEAR</th>
<th>&gt;4400 HOURS/YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOMINAL PIPE SIZE, (inches)</td>
<td>OTHER</td>
<td>VARIABLE FLOW/ VARIABLE SPEED</td>
<td>OTHER</td>
</tr>
<tr>
<td>2 1/2</td>
<td>120</td>
<td>180</td>
<td>85</td>
</tr>
<tr>
<td>3</td>
<td>180</td>
<td>270</td>
<td>140</td>
</tr>
<tr>
<td>4</td>
<td>350</td>
<td>530</td>
<td>260</td>
</tr>
<tr>
<td>5</td>
<td>410</td>
<td>620</td>
<td>310</td>
</tr>
<tr>
<td>6</td>
<td>740</td>
<td>1100</td>
<td>570</td>
</tr>
<tr>
<td>8</td>
<td>1200</td>
<td>1800</td>
<td>900</td>
</tr>
<tr>
<td>10</td>
<td>1800</td>
<td>2700</td>
<td>1300</td>
</tr>
<tr>
<td>12</td>
<td>2500</td>
<td>3800</td>
<td>1900</td>
</tr>
<tr>
<td>Maximum velocity for pipes over 14-24 inches in size</td>
<td>8.5 ft/s</td>
<td>13.0 ft/s</td>
<td>6.5 ft/s</td>
</tr>
</tbody>
</table>

For SI units: 1 gallon per minute = 0.06 L/s, 1 foot per second = 0.3048 m/s, 1 inch = 25.4 mm
Exceptions:
(1) Condenser fans serving multiple refrigerant or fluid cooling circuits.
(2) Condenser fans serving flooded condensers. 
[ASHRAE 90.1:6.5.5.2.1]

E 503.5.8.2 Variable-Speed Fan Drives. Multi-cell heat rejection equipment with variable-speed fan drives shall:
(1) Operate the maximum number of fans allowed that comply with the manufacturer’s requirements for all system components.
(2) Control all fans to the same fan speed required for the instantaneous cooling duty, as opposed to staged (on/off) operation. Minimum fan speed shall comply with the minimum allowable speed of the fan drive system per the manufacturer’s recommendations. [ASHRAE 90.1:6.5.5.2.2]

E 503.5.9 Limitation on Centrifugal Fan Open-Circuit Cooling Towers. Centrifugal fan open-circuit cooling towers with a combined rated capacity of 1100 gallons per minute (gpm) (69.39 L/s) or greater at 95°F (35°C) condenser water return, 85°F (29°C) condenser water supply, and 75°F (24°C) outdoor air wet-bulb temperature shall comply with the energy efficiency requirement for axial fan open-circuit cooling towers in accordance with Table E 503.7.1(7).

Exception: Centrifugal open-circuit cooling towers that are ducted (inlet or discharge) or require external sound attenuation. [ASHRAE 90.1:6.5.5.3]

E 503.5.9.1 Tower Flow Turndown. Open-circuit cooling towers used on water-cooled chiller systems that are configured with multiple- or variable-speed condenser water pumps shall be designed so that all open-circuit cooling tower cells can be run in parallel with the larger of the following:
(1) The flow that is produced by the smallest pump at its minimum expected flow rate.
(2) Fifty percent of the design flow for the cell. [ASHRAE 90.1:6.5.5.4]

E 503.5.10 Energy Recovery. Energy recovery shall be in accordance with Section E 503.5.10.1 through Section E 503.5.10.3.

E 503.5.10.1 Exhaust Air Energy Recovery.

E 503.5.10.1.1 Exhaust Air Energy Recovery for Nontransient Dwelling Units. Nontransient dwelling units shall be provided with outdoor air energy recovery ventilation systems. For nontransient dwelling units, energy recovery systems shall result in an enthalpy recovery ratio of at least 50 percent at cooling design condition and at least 60 percent at heating design condition. The energy recovery system shall provide the required enthalpy recovery ratio at both heating and cooling design conditions, unless one mode is not required for the climate zone by the exceptions below.

Exceptions:
(1) Nontransient dwelling units in Climate Zone 3C.
(2) Nontransient dwelling units with no more than 500 ft$^2$ (46.45 m$^2$) of conditioned floor area in Climate Zone 0, 1, 2, 3, 4C, and 5C.
(3) Enthalpy recovery ratio requirements at heating design condition in Climate Zones 0, 1, and 2.
(4) Enthalpy recovery ratio requirements at cooling design condition in Climate Zones 4, 5, 6, 7, 8. [ASHRAE 90.1:6.5.6.1.1]

E 503.5.10.12 Exhaust Air Energy Recovery for Spaces Other than Nontransient Dwelling Units. Each fan system serving spaces other than nontransient dwelling units shall have an energy recovery sys-

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**TABLE E 503.5.10(1) E 503.5.10.12(1)**

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>PERCENT OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE</th>
<th>DESIGN SUPPLY FAN AIRFLOW RATE (cubic feet per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥10% and &lt;20%</td>
<td>≥20% and &lt;30%</td>
</tr>
<tr>
<td>3B, 3C, 4B, 4C, 5B</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>0B, 1B, 2B, 5C</td>
<td>26 000</td>
<td>26 500</td>
</tr>
<tr>
<td>6B</td>
<td>28 000</td>
<td>26 500</td>
</tr>
<tr>
<td>0A, 1A, 2A, 3A, 4A, 5A, 6A</td>
<td>≥26 000</td>
<td>≥16 000</td>
</tr>
<tr>
<td>7, 8</td>
<td>≥450</td>
<td>≥400</td>
</tr>
</tbody>
</table>

For SI units: 1 cubic foot per minute = 0.00047 m$^3$/s

* NR = Not Required
TABLE E-503.5.10(2) E 503.5.10.1.2(2)
EXHAUST AIR ENERGY RECOVERY REQUIREMENTS FOR VENTILATION
SYSTEMS OPERATING NOT LESS THAN OR EQUAL TO 8000 HOURS PER YEAR*
[ASHRAE 90.1: TABLE 6.5.6.1-1-6.5.6.1.2-2]

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>≥10% and &lt;20%</th>
<th>≥20% and &lt;30%</th>
<th>≥30% and &lt;40%</th>
<th>≥40% and &lt;50%</th>
<th>≥50% and &lt;60%</th>
<th>≥60% and &lt;70%</th>
<th>≥70% and &lt;80%</th>
<th>≥80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3C</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>0B, 1B, 2B, 3B, 4C, 5C</td>
<td>NR</td>
<td>≥19 500</td>
<td>≥9000</td>
<td>≥5000</td>
<td>≥4000</td>
<td>≥3000</td>
<td>≥1500</td>
<td>≥120</td>
</tr>
<tr>
<td>0A, 1A, 2A, 3A, 4B, 5B</td>
<td>≥2500</td>
<td>≥2000</td>
<td>≥1000</td>
<td>≥500</td>
<td>≥140</td>
<td>≥120</td>
<td>≥100</td>
<td>≥80</td>
</tr>
<tr>
<td>4A, 5A, 6A, 6B, 7, 8</td>
<td>≥200</td>
<td>≥130</td>
<td>≥100</td>
<td>≥80</td>
<td>≥70</td>
<td>≥60</td>
<td>≥50</td>
<td>≥40</td>
</tr>
</tbody>
</table>

* NR = Not Required

For SI units: 1 cubic foot per minute = 0.00047 m³/s

6. Energy For spaces other than nontransient dwelling units, energy recovery systems required by this section shall result in an enthalpy recovery ratio of not less than 50 percent. A fifty percent energy recovery system shall provide the required enthalpy recovery ratio shall mean a change in the enthalpy of the outdoor air supply equal to 50 percent of the difference between the outdoor air and entering exhaust air enthalpies at both heating and cooling design conditions, unless one mode is not required for the climate zone by the exceptions below. Provision shall be provided to bypass or control the energy recovery system to permit air economizer operation in accordance with Section E 503.5.1.

Exceptions:

1. Laboratory systems that are in accordance with Section E 503.5.11.3.

2. Systems serving spaces that are not cooled and that are heated to less than 60°F (16°C).

3. Heating energy recovery where more than 60 percent of the outdoor air heating energy is provided from site-recovered energy or on-site solar renewable energy.

4. Heating energy Enthalpy recovery ratio requirements at heating design condition in Climate Zones 0, 1, and 2.

5. Cooling energy recovery in climate zones 3C, 4C, 5C, 6B, 7, and 8.

(6) Where the sum of the airflow rates exhausted and relieved within 20 feet (6096 mm) of each other is less than 75 percent of the design outdoor airflow rate, excluding exhaust air that is:

(a) used for another energy recovery system,

(b) not allowed by ASHRAE 170 for use in energy recovery systems with leakage potential, or

(c) of Class 4 as defined in Chapter 2 or ASHRAE 62.1.

(7) Systems Heating energy recovery for systems in Climate Zones 0 through 4 requiring dehumidification during heating mode that employ energy recovery in series with the cooling coil and have a minimum SERR of 0.40.

(8) Systems expected to operate less than 20 hours per week at the outdoor air percentage in accordance with Table E 503.5.10(1) E 503.5.10.1.2(1).

(9) Indoor pool dehumidifiers meeting Section E 503.5.10.4. [ASHRAE 90.1:6.5.6.1 6.5.6.1.2]
The design service water heating load is more than 1,000,000 Btu/h (293 kW). [ASHRAE 90.1:6.5.6.2.1]

**E 503.5.10.1.2** Capacity. The required heat recovery system shall have the capacity to provide the smaller of:

1. Sixty percent of the peak heat-rejection load at design conditions or
2. Preheat of the peak service hot-water draw to 85°F (29°C).

**Exceptions:**

1. Facilities that employ condenser heat recovery for space heating with a heat recovery design exceeding 30 percent of the peak water-cooled condenser load at design conditions.
2. Facilities that provide 60 percent of their service water heating from on-site solar renewable energy or site-recovered energy or from other sources. [ASHRAE 90.1:6.5.6.2.2]

**E 503.5.10.3 Heat Recovery for Space Conditioning.** Where heating water is used for space heating, a condenser heat recovery system shall be installed, provided all of the following are true:

1. The building is an acute inpatient hospital, where the building or portion of a building is used on a 24-hour basis for the inpatient medical, obstetric, or surgical care for patients.
2. The total design chilled-water capacity for the acute inpatient hospital, either air cooled or water cooled, required at cooling design conditions exceeds 3,600,000 Btu/h (1055 kW) of cooling.
3. Simultaneous heating and cooling occurs above 60°F (16°C) outdoor air temperature. The required heat recovery system shall have a cooling capacity that is at least 7 percent of the total design chilled-water capacity of the acute inpatient hospital at peak design conditions. [ASHRAE 90.1:6.5.6.3]

**E 503.5.10.4 Indoor Pool Dehumidifier Energy Recovery.** An indoor pool dehumidifier serving a natatorium with a heated indoor pool over 500 ft² (46.45 m²) in size shall include one of the following:

1. An exhaust air sensible energy recovery system with a sensible energy recovery ratio of at least 50 percent.
2. A condenser heat recovery system capable of and configured to use 100 percent of the heat generated through dehumidification to heat the pool water when there is a pool water heating load.
3. An exhaust air energy recovery system that results in an enthalpy recovery ratio of at least 50 percent. [ASHRAE 90.1:6.5.6.4]

**E 503.5.11 Exhaust Systems.** Exhaust systems shall comply with Section E 503.5.11.1 through Section E 503.5.11.3.

**E 503.5.11.1 Transfer Air.** Conditioned supply air delivered to a space with a mechanical exhaust shall not exceed the greater of the following:

1. The supply flow required to be in accordance with the space heating or cooling load;
2. The ventilation rate required by the Authority Having Jurisdiction, the Facility Environmental Health and Safety department, Chapter 4 or ASHRAE 62.1; or
3. The mechanical exhaust flow minus the available transfer air from conditioned spaces or return air plenums on the same floor, not in different smoke or fire compartments, and that at their closest point are within 15 feet (4572 mm) of each other. Available transfer air is that portion of outdoor ventilation air that:
   a. is not required to satisfy other exhaust needs,
   b. is not required to maintain pressurization of other spaces, and
   c. is transferable according to applicable codes and standards and to the class of air recirculation limitations in Chapter 4 or ASHRAE 62.1.

**Exceptions:**

1. Biosafety level classified laboratories 3 or higher.
2. Vivarium spaces.
3. Spaces that are required by applicable codes and standards to be maintained at positive pressure relative to adjacent spaces. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy.
4. Spaces where the demand for transfer air may exceed the available transfer airflow rate and where the spaces have a required negative pressure relationship. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy. [ASHRAE 90.1:6.5.7.1]

**E 503.5.11.2 Kitchen Exhaust Systems.** Replacement air introduced directly into the hood cavity of kitchen exhaust hoods shall not exceed 10 percent of the hood exhaust airflow rate. [ASHRAE 90.1:6.5.7.2.1]

**E 503.5.11.2.1 Exhaust Flow Rate.** Where a kitchen or dining facility has a total kitchen hood exhaust airflow rate exceeding 5000 ft³/min (2.3597 m³/s), each hood shall have an exhaust rate in accordance with Table E 503.5.11.2.1.
Where a single hood, or hood section, is installed over appliances with different duty ratings, the maximum allowable flow rate for the hood or hood section shall not exceed the values in Table E 503.5.11.2.1 for the highest appliance duty rating under the hood or hood section. Refer to ASHRAE 154 for definitions of hood type, appliance duty, and net exhaust flow rate.

**Exception:** Seventy-five percent or more of the total replacement air is transfer air that would otherwise be exhausted. [ASHRAE 90.1:6.5.7.2.2]

### Table E 503.5.11.2.1

<table>
<thead>
<tr>
<th>TYPE OF HOOD</th>
<th>LIGHT DUTY EQUIPMENT</th>
<th>MEDIUM DUTY EQUIPMENT</th>
<th>HEAVY DUTY EQUIPMENT</th>
<th>EXTRA HEAVY DUTY EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted canopy</td>
<td>140</td>
<td>210</td>
<td>280</td>
<td>385</td>
</tr>
<tr>
<td>Single island</td>
<td>280</td>
<td>350</td>
<td>420</td>
<td>490</td>
</tr>
<tr>
<td>Double island (per side)</td>
<td>175</td>
<td>210</td>
<td>280</td>
<td>385</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>175</td>
<td>175</td>
<td>Not allowed</td>
<td>Not allowed</td>
</tr>
<tr>
<td>Backshelf/ Pass-over</td>
<td>210</td>
<td>210</td>
<td>280</td>
<td>Not allowed</td>
</tr>
</tbody>
</table>

For SI units: 1 foot = 304.8 mm, 1 cubic foot per minute = 0.00047 m³/s

E 503.5.11.2.2 Kitchen or Dining Facility.

Where a kitchen or dining facility has a total kitchen hood exhaust airflow rate more than 5000 ft³/min (2.3597 m³/s), then one of the following shall be provided:

1. Fifty percent or more of all replacement air is transfer air that would otherwise be exhausted.
2. Demand ventilation systems on 75 percent or more of the exhaust air. Such systems shall be capable of and configured to provide 50 percent or more reduction in exhaust and replacement air system airflow rates, including controls necessary to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent, and combustion products during cooking and idle.
3. Listed energy recovery devices that result in a sensible energy recovery ratio of 40 percent or more on 50 percent or more of the total exhaust airflow. A 40 percent sensible energy recovery ratio shall mean a change in the dry-bulb temperature of the outdoor air supply equal to 40 percent of the difference between the outdoor air and entering exhaust air dry-bulb temperatures at design conditions. [ASHRAE 90.1:6.5.7.2.3]

### E 503.5.11.3 Laboratory Exhaust Systems.

Buildings with laboratory exhaust systems having a total exhaust rate of more than 5000 ft³/min (2.3597 m³/s) shall include not less than one of the following features:

1. VAV laboratory exhaust and room supply systems capable of and configured to reduce exhaust and makeup airflow rates, incorporate a heat recovery system to precondition makeup air from laboratory exhaust, or both, and shall be in accordance with the following:

\[ A + B \times \left( \frac{E}{M} \right) \geq 50\% \]  

(Equation E 503.5.11.3)

Where:

- \( A \) = Percentage that the exhaust and makeup airflow rates are capable of being reduced from design conditions.
- \( B \) = Sensible energy recovery ratio.
- \( E \) = Exhaust airflow rate through the heat recovery device at design conditions.
- \( M \) = Makeup airflow rate of the system at design conditions.

2. VAV laboratory exhaust and room supply systems that are required to have minimum circulation rates to be in accordance with the codes or accreditation standards shall be capable of and configured to reduce zone exhaust and makeup airflow rates to the regulated minimum circulation values, or the minimum required to maintain pressurization relationship requirements. Systems serving nonregulated zones shall be capable of and configured to reduce exhaust and makeup airflow rates to 50 percent of the zone design values, or the minimum required to maintain pressurization relationship requirements.

3. Direct makeup (auxiliary) air supply of 75 percent or more of the exhaust airflow rate, heated not more than 2°F (1°C) below room setpoint, cooled to not less than 3°F (2°C) above room
setpoint, no humidification added, and no simultaneous heating and cooling are used for dehumidification control. [ASHRAE 90.1:6.5.7.3]

**E 503.5.12 Radiant Heating Systems.** Radiant heating systems shall be in accordance with Section E 503.5.12.1 through Section E 503.5.12.2.

**E 503.5.12.1 Heating Unenclosed Spaces.** Radiant heating shall be required when heating is required for unenclosed spaces.

**Exception:** Loading docks equipped with air curtains. [ASHRAE 90.1:6.5.8.1]

**E 503.5.12.2 Heating Enclosed Spaces.** Radiant heating systems that are used as primary or supplemental heating for enclosed spaces shall be in conformance with the governing provisions of the standard, including, but not limited to the following:

1. Radiant hydronic ceiling or floor panels (used for heating or cooling).
2. Combination or hybrid systems incorporating radiant heating (or cooling) panels.
3. Radiant heating (or cooling) panels used in conjunction with other systems such as VAV or thermal storage systems. [ASHRAE 90.1:6.5.8.2]

**E 503.5.13 Hot Gas Bypass Limitation.** Cooling systems shall not use hot gas bypass or other evaporator pressure control systems unless the system is designed with multiple steps of unloading or continuous capacity modulation. The capacity of the hot gas bypass shall be limited as indicated in Table E 503.5.13 for VAV units and single-zone VAV units. Hot-gas bypass shall not be used on constant-volume units. [ASHRAE 90.1:6.5.9]

<table>
<thead>
<tr>
<th>RATED CAPACITY</th>
<th>MAXIMUM HOT GAS BYPASS (PERCENT OF TOTAL CAPACITY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤240,000 Btu/h</td>
<td>15%</td>
</tr>
<tr>
<td>&gt;240,000 Btu/h</td>
<td>10%</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

**E 503.5.14 Door Switches.** Conditioned spaces with doors, including doors with more than one-half glass, opening to the outdoors shall be provided with controls that when any such door is open, the following shall occur:

1. Disable mechanical heating or reset the heating setpoint to 55°F (13°C) or lower within five minutes of the door opening.
2. Disable mechanical cooling or reset the cooling setpoint to 90°F (32°C) or more within five minutes of the door opening. Mechanical cooling shall be permitted to remain enabled where outdoor air temperature is less than the space temperature.

**Exceptions:**

1. Building entries with automatic closing devices.
2. Any space without a thermostat.

(3) Alterations to existing buildings.

(4) Loading docks. [ASHRAE 90.1:6.5.10]

**E 503.6 Submittals.** The Authority Having Jurisdiction shall require submittal of compliance documentation and supplemental information in accordance with Section E 503.6.1 through Section E 503.6.3.

**E 503.6.1 Construction Details.** Compliance documents shall show all the pertinent data and features of the building, equipment, and systems in sufficient detail to permit a determination of compliance by the building official and to indicate compliance with the requirements of this appendix. [ASHRAE 90.1:4.2.2.1]

**E 503.6.2 Supplemental Information.** Supplemental information necessary to verify compliance with this appendix, such as calculations, worksheets, compliance forms, vendor literature, or other data, shall be made available where required by the Authority Having Jurisdiction. [ASHRAE 90.1:4.2.2.2]

**E 503.6.3 Manuals.** Operating and maintenance information shall be provided to the building owner. This information shall include, but not be limited to, the information specified in Section E 503.6.3.1, Section E 503.6.3.2, and Section E 503.6.3.2. [ASHRAE 90.1:4.2.2.3]

**E 503.6.3.1 Required Information.** Construction documents shall require that an operating manual and maintenance manual be provided to the building owner. The manuals shall include, at a minimum, the following:

1. Submittal data stating equipment rating and selected options for each piece of equipment requiring maintenance.
2. Operation manuals and maintenance manuals for each piece of equipment requiring maintenance. Required routine maintenance actions shall be clearly identified.
3. Names and addresses of not less than one qualified service agency.
4. A complete narrative of how each system is intended to operate.

The Authority Having Jurisdiction shall only check to ensure that the construction documents require this information to be transmitted to the owner and should not expect copies of any of the materials. [ASHRAE 90.1:4.2.2.2]

**E 503.6.3.2 Lighting Manuals.** Construction documents shall require for all lighting equipment and lighting controls that an operating manual and maintenance manual be provided to the building owner or the designated representative of the building owner within 90 days after the date of system acceptance. These manuals shall include, at a minimum, the following:

1. Submittal data indicating all selected options for each piece of lighting equipment, including but not limited to lamps, ballasts, drivers, and lighting controls.
(2) Operation and maintenance manuals for each piece of lighting equipment and lighting controls with routine maintenance clearly identified including, as a minimum, a recommended relamping or cleaning program and a schedule for inspecting and recalibrating all lighting controls.

(3) A complete narrative of how each lighting control system is intended to operate including recommended settings. [ASHRAE 90.1:9.7.2.2 9.7.3.2]

**E 503.6.4 Labeling of Material and Equipment.** Materials and equipment shall be labeled in a manner that will allow for determination of their compliance with the applicable provisions of this appendix. [ASHRAE 90.1:4.2.3]

**E 503.6.5 Completion Requirements.** Section E 503.6.5.1 through Section E 503.6.5.4 are mandatory provisions and are necessary to comply with this appendix. [ASHRAE 90.1:6.7.2.3]

**E 503.6.5.1 Drawings.** Construction documents shall require that, within 90 days after the date of system acceptance, record drawings of the actual documents installation be provided to the building owner or the designated representative of the building owner. Record drawings shall include, as a minimum, the location and performance data on each piece of equipment, general configuration of the duct and pipe distribution system including sizes, and the terminal air or water design flow rates. [ASHRAE 90.1:6.7.2.1]

**E 503.6.5.2 Manuals.** Construction documents shall require that an operating manual and a maintenance manual be provided to the building owner or the designated representative of the building owner within 90 days after the date of system acceptance. These manuals shall be in accordance with industry-accepted standards and shall include, at a minimum, the following:

1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
2. Operation manuals and maintenance manuals for each piece of equipment and system requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
3. Names and addresses of not less than one service agency.
4. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in programming comments.
5. A complete narrative of how each system is intended to operate, including suggested setpoints. [ASHRAE 90.1:6.7.2.2 6.7.3.2]

**E 503.6.5.3 System Balancing.** Construction documents shall require that HVAC systems be balanced in accordance with generally accepted engineering standards. Construction documents shall require that a written balance report be provided to the building owner or the designated representative of the building owner for HVAC systems serving space or zone exceeding 5000 square feet (46.45 m²). [ASHRAE 90.1:6.7.2.3.1 6.7.3.2.1]

**E 503.6.5.3.1 Air System Balancing.** Air systems shall be balanced in a manner to first minimize throttling losses. Then, for fans with fan system power greater than 1 hp (0.7 kW), fan speed shall be adjusted to meet design flow conditions. [ASHRAE 90.1:6.7.2.3.2 6.7.3.2]

**E 503.6.5.3.2 Hydronic System Balancing.** Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses; then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions.

*Exceptions: Impellers need not be trimmed nor pump speed adjusted.*

1. For pumps with pump motors of 10 hp (7.5 kW) or less.
2. Where throttling results is not greater than 5 percent of the nameplate horsepower draw, or 3 hp (2.2 kW), whichever is greater, above that required where the impeller was trimmed. [ASHRAE 90.1:6.7.2.3.3]

**E 503.6.5.4 System Commissioning.** HVAC control systems shall be tested to ensure that control elements are calibrated, adjusted, and in proper working condition. For projects larger than 50 000 square feet (4645.15 m²) conditioned area, except warehouses and semiheated spaces, detailed instructions for commissioning HVAC systems shall be provided by the designer in plans and specifications. [ASHRAE 90.1:6.7.2.4]

**E 503.6.5.4.1 E 503.6.5.4 Minimum Level of Commission.** Commissioning shall be performed for HVAC systems in accordance with Level 1, Basic Commissioning of the SMACNA HVAC Systems Commissioning Manual. (See Section E 801.0 for additional information on HVAC system commissioning)

**E 503.7 Minimum Equipment Efficiency Tables.** The minimum efficiency requirements for equipment shall comply with Section E 503.7.1: duct insulation shall comply with Section E 503.7.2, and pipe insulation shall comply with Section E 503.7.3.

**E 503.7.1 Minimum Efficiency Requirement Listed Equipment – Standard Rating and Operating Conditions.** The minimum efficiency requirements for equipment shall comply with Table E 503.7.1(1) through Table E 503.7.1(16).
E 503.7.2 Duct Insulation Tables. Duct insulation shall comply with Table E 503.7.2.

E 503.7.3 Pipe Insulation Tables. Pipe insulation shall comply with Table E 503.7.3(1) through Table E 503.7.3(2).

E 503.8 Alternative Compliance Path, Computer Room Systems. HVAC systems only serving the heating, cooling, or ventilation needs of a computer room with IT equipment load greater than 13.4 hp (10 kW) shall be in accordance with Section E 503.1, Section E 503.4, Section E 503.8.1 or Section E 503.8.2, Section E 503.8.3, Section E 502.7 through Section E 502.7.2, and Section E 503.7.1 ASHRAE 90.4. [ASHRAE 90.1:6.6.1.1]

E 503.8.1 Computer Room (PUE1). The computer room PUE1 shall be not more than the values listed in Table E 503.8.1. Hourly simulation of the proposed design, for purposes of calculating PUE1, shall be in accordance with ASHRAE 90.1. Exception: The compliance path shall not be permitted for a proposed computer room design utilizing a combined heat and power system. [ASHRAE 90.1:6.6.1.1]

TABLE E 503.8.1
POWER USAGE EFFECTIVENESS (PUE) MAXIMUM [ASHRAE 90.1:TABLE 6.6.1]

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>PUE1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0A</td>
<td>1.64</td>
</tr>
<tr>
<td>0B</td>
<td>1.62</td>
</tr>
<tr>
<td>1A</td>
<td>1.64</td>
</tr>
<tr>
<td>1B</td>
<td>1.53</td>
</tr>
<tr>
<td>2A</td>
<td>1.49</td>
</tr>
<tr>
<td>2B</td>
<td>1.45</td>
</tr>
<tr>
<td>2C</td>
<td>1.44</td>
</tr>
<tr>
<td>3A</td>
<td>1.42</td>
</tr>
<tr>
<td>3B</td>
<td>1.39</td>
</tr>
<tr>
<td>3C</td>
<td>1.36</td>
</tr>
<tr>
<td>4A</td>
<td>1.38</td>
</tr>
<tr>
<td>4B</td>
<td>1.38</td>
</tr>
<tr>
<td>4C</td>
<td>1.38</td>
</tr>
<tr>
<td>5A</td>
<td>1.36</td>
</tr>
<tr>
<td>5B</td>
<td>1.33</td>
</tr>
<tr>
<td>5C</td>
<td>1.36</td>
</tr>
<tr>
<td>6A</td>
<td>1.34</td>
</tr>
<tr>
<td>6B</td>
<td>1.34</td>
</tr>
<tr>
<td>7</td>
<td>1.32</td>
</tr>
<tr>
<td>8</td>
<td>1.30</td>
</tr>
</tbody>
</table>

PUE1 and PUE0 shall not include energy for battery charging.

E 503.8.2 Computer Room (PUE0). The computer room PUE0 is less than or equal to the values listed in Table E 503.8.1. shall be the highest value determined at outdoor cooling design temperatures, and shall be limited to systems only using electricity for an energy source. PUE0 shall be calculated for two conditions:

1. One hundred percent design IT equipment energy and
2. Fifty percent design IT equipment energy. [ASHRAE 90.1:6.6.1.2]

E 503.8.3 Documentation. Documentation on the following components shall be provided, including a breakdown of energy consumption or demand:

1. IT equipment
2. Power distribution losses external to the IT equipment
3. HVAC systems
4. Lighting [ASHRAE 90.1:6.6.1.3]

E 504.0 Solar Energy Systems.

E 504.1 General. Solar energy systems shall be installed in accordance with the Uniform Solar, Hydronics and Geothermal Code (USHGC).
<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air conditioners, air cooled</td>
<td>&lt;65 000 Btu/h²</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>13.0 SEER before 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.4 SEER2 after 1/1/2023</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Single package, three phase and applications outside U.S. single phase</td>
<td>14.0 SEER before 1/1/2023</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.4 SEER2 after 1/1/2023</td>
<td></td>
</tr>
<tr>
<td>Through-the-wall</td>
<td>≤30 000 Btu/h²</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>12.0 SEER before 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td>Space constrained, air cooled</td>
<td></td>
<td></td>
<td></td>
<td>11.7 SEER2 after 1/1/2023</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Single package, three phase and applications outside U.S. single phase</td>
<td>12.0 SEER before 1/1/2023</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>11.7 SEER2 after 1/1/2023</td>
<td></td>
</tr>
<tr>
<td>Small duct, high velocity, air cooled</td>
<td>&lt;65 000 Btu/h²</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>11.0 SEER</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.0 SEER</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.0 SEER2</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td>Air conditioners, air cooled</td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>All other</td>
<td>Electric resistance (or none)</td>
<td>11.2 EER</td>
<td>11.0 EER before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.9 IEER</td>
<td>12.7 IEER before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.8 IEER</td>
<td>14.6 IEER after 1/1/2023</td>
</tr>
<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>All other</td>
<td>Electric resistance (or none)</td>
<td>11.0 EER</td>
<td>11.0 EER before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.4 IEER</td>
<td>12.4 IEER before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.2 IEER</td>
<td>14.2 IEER after 1/1/2023</td>
</tr>
<tr>
<td></td>
<td>≥240 000 Btu/h and &lt;760 000 Btu/h</td>
<td>All other</td>
<td>Electric resistance (or none)</td>
<td>10.8 EER</td>
<td>10.8 EER before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.2 IEER</td>
<td>12.2 IEER before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.0 IEER</td>
<td>14.0 IEER after 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10.0 EER</td>
<td>10.0 EER before 1/1/2023</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>11.6 IEER</td>
<td>11.6 IEER after 1/1/2023</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>13.2 IEER</td>
<td>13.2 IEER after 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.8 EER</td>
<td>10.0 EER before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.4 IEER</td>
<td>11.4 IEER before 1/1/2023</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>13.0 IEER</td>
<td>13.0 IEER after 1/1/2023</td>
</tr>
</tbody>
</table>
### TABLE E 503.7.1(1) (continued)
**ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS**
[ASHRAE 90.1: TABLE 6.8.1-1]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air conditioners, air cooled (continued)</strong></td>
<td>≥760 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>Split system and single package</td>
<td>11.2 IEER before 1/1/2023</td>
<td>9.5 EER 11.0 IEER before 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.5 IEER after 1/1/2023</td>
<td>12.3 IEER after 1/1/2023</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air conditioners, water cooled</strong></td>
<td>&lt;65 000 Btu/h</td>
<td>All</td>
<td></td>
<td>12.1 EER 12.3 IEER</td>
<td>AHRI 210/240</td>
</tr>
<tr>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td></td>
<td>12.1 EER 13.9 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.9 EER 13.7 IEER</td>
<td></td>
</tr>
<tr>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td></td>
<td>12.5 EER 13.9 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.3 EER 13.7 IEER</td>
<td>AHRI 340/360</td>
</tr>
<tr>
<td>≥240 000 Btu/h and &lt;760 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td></td>
<td>12.4 EER 13.6 IEER</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>12.2 EER 13.4 IEER</td>
<td></td>
</tr>
<tr>
<td>≥760 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td></td>
<td>12.2 EER 13.5 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.0 EER 13.3 IEER</td>
<td></td>
</tr>
<tr>
<td><strong>Air conditioners, evaporatively cooled</strong></td>
<td>&lt;65 000 Btu/h²</td>
<td>All</td>
<td></td>
<td>12.1 EER 12.3 IEER</td>
<td>AHRI 210/240</td>
</tr>
<tr>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td></td>
<td>12.1 EER 13.9 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.9 EER 12.1 IEER</td>
<td></td>
</tr>
<tr>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td></td>
<td>12.0 EER 12.2 IERR</td>
<td>AHRI 340/360</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.8 EER 12.0 IEER</td>
<td></td>
</tr>
<tr>
<td>≥240 000 Btu/h and &lt;760 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td></td>
<td>11.9 EER 12.1 IEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.7 EER 11.9 IEER</td>
<td></td>
</tr>
<tr>
<td>≥760 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>All other</td>
<td></td>
<td>11.7 EER 11.9 IEER</td>
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<td></td>
<td></td>
<td></td>
<td>11.5 EER 11.7 IEER</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE E 503.7.1(1) (continued)

**ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS**

[ASHRAE 90.1: TABLE 6.8.1-1]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensing units, air cooled</td>
<td>≥135 000 Btu/h</td>
<td>–</td>
<td>–</td>
<td>10.5 EER</td>
<td>AHRI 365</td>
</tr>
<tr>
<td>Condensing units, water cooled</td>
<td>≥135 000 Btu/h</td>
<td>–</td>
<td>–</td>
<td>13.5 EER</td>
<td>AHRI 365</td>
</tr>
<tr>
<td>Condensing units, evaporatively cooled</td>
<td>≥135 000 Btu/h</td>
<td>–</td>
<td>–</td>
<td>13.5 EER</td>
<td>AHRI 365</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

Notes:
1. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2. Single-phase, U.S. air-cooled air conditioners less than 65 000 Btu/h (19 kW) are regulated as consumer products by the U.S. Department of Energy Code of Federal Regulations 10 CFR 430. SEER and SEER2 values for single-phase products are set by the U.S. Department of Energy.

### TABLE E 503.7.1(2)

**ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS**

[ASHRAE 90.1: TABLE 6.8.1-2]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled (cooling mode)</td>
<td>&lt;65 000 Btu/h</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>14.0 SEER before 1/1/2023 14.3 SEER2 after 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td>Through the wall Space constrained, air cooled (cooling mode)</td>
<td>≤30 000 Btu/h</td>
<td>All</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td>Small duct, high velocity, air cooled (cooling mode)</td>
<td>&lt;65 000 Btu/h</td>
<td>All</td>
<td>Split System, three phase and applications outside U.S. single phase</td>
<td>11.0 SEER 12.0 SEER before 1/1/2023 12.0 SEER2 after 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
</tr>
<tr>
<td>Air cooled (cooling mode)</td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td></td>
<td>11.0 EER 12.2 IEER before 1/1/2023 14.1 IEER after 1/1/2023</td>
<td>AHRI 340/360</td>
</tr>
<tr>
<td>EQUIPMENT TYPE</td>
<td>SIZE CATEGORY</td>
<td>HEATING SECTION TYPE</td>
<td>SUBCATEGORY OR RATING CONDITION</td>
<td>MINIMUM EFFICIENCY</td>
<td>TEST PROCEDURE</td>
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<td>Air cooled (cooling mode) (continued)</td>
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<td>All other</td>
<td>10.8 EER 12.0 IEER before 1/1/2023 13.9 IEER after 1/1/2023</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>10.6 EER 11.6 IEER before 1/1/2023 13.5 IEER after 1/1/2023</td>
<td></td>
<td>AHRI 340/360</td>
</tr>
<tr>
<td></td>
<td>≥240 000 Btu/h</td>
<td>All other</td>
<td>10.4 EER 11.4 IEER before 1/1/2023 13.3 IEER after 1/1/2023</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water to air, water-loop (cooling mode)</td>
<td>&lt;17 000 Btu/h</td>
<td>All</td>
<td>10.8 EER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥17 000 Btu/h and ≤65 000 Btu/h</td>
<td>86°F entering water</td>
<td>10.6 EER</td>
<td>ISO 13256-1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>86°F entering water</td>
<td>10.4 EER</td>
<td>ISO 13256-1</td>
<td></td>
</tr>
<tr>
<td>Water to air, ground-water (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>10.7 EER</td>
<td>ISO 13256-1</td>
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</tr>
<tr>
<td>Brine to air, ground-loop (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>12.1 EER</td>
<td>ISO 13256-1</td>
<td></td>
</tr>
<tr>
<td>Water to water, water-loop (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>12.2 EER</td>
<td>ISO 13256-1</td>
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</tr>
<tr>
<td>Water to water, groundwater (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>12.3 EER</td>
<td>ISO 13256-1</td>
<td></td>
</tr>
<tr>
<td>Brine to water, ground-loop (cooling mode)</td>
<td>&lt;135 000 Btu/h</td>
<td>All</td>
<td>12.4 EER</td>
<td>ISO 13256-1</td>
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</tr>
<tr>
<td>Air cooled (heating mode)</td>
<td>&lt;65 000 Btu/h (cooling capacity)</td>
<td>Split system, three phase and applications outside U.S., single phase</td>
<td>8.2 HSPF before 1/1/2023 7.5 HSPF after 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single package, three phase and applications outside U.S., single phase</td>
<td>8.0 HSPF before 1/1/2023 6.7 HSPF after 1/1/2023</td>
<td>AHRI 210/240-2023 after 1/1/2023</td>
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</tbody>
</table>
### Table E 503.7.1(2) (continued)

**Electrically Operated Air-Cooled Unitary and Applied Heat Pumps—Minimum Efficiency Requirements**

**Notes:**
1. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2. Single-phase, U.S. air-cooled heat pumps less than 65,000 Btu/h (19 kW) are regulated as consumer products by the U.S. Department of Energy Code of Federal Regulations 10 CFR 430. SEER, SEER2, and HSPF values for single-phase products are set by the U.S. Department of Energy.

#### Table

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Size Category</th>
<th>Heating Section Type</th>
<th>Subcategory or Rating Condition</th>
<th>Minimum Efficiency</th>
<th>Test Procedure¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through-the-wall—Space constrained, air cooled (heating mode)</td>
<td>≤30,000 Btu/h (cooling capacity)</td>
<td>—</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>7.4 HSPF before 1/1/2023 6.3 HSPF2 after 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 Single package, three phase after 1/1/2023</td>
</tr>
<tr>
<td>—</td>
<td></td>
<td>Single package, three phase and applications outside U.S. single phase</td>
<td>7.4 HSPF before 1/1/2023 6.3 HSPF2 after 1/1/2023</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small duct high velocity, air cooled (heating mode)</td>
<td>&lt;65,000 Btu/h ²</td>
<td>—</td>
<td>Split system, three phase and applications outside U.S. single phase</td>
<td>6.8 HSPF 7.2 HSPF before 1/1/2023 6.1 HSPF2 after 1/1/2023</td>
<td>AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023</td>
</tr>
<tr>
<td>Air cooled (heating mode)</td>
<td>≥65,000 Btu/h² and &lt;135,000 Btu/h (cooling capacity)</td>
<td>—</td>
<td>47°F db/43°F wb outdoor air</td>
<td>3.3 COPH before 1/1/2023 3.40 COPH before 1/1/2023</td>
<td>AHRI 340/360</td>
</tr>
<tr>
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<td>17°F db/15°F wb outdoor air</td>
<td>2.25 COPH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>—</td>
<td></td>
<td>47°F db/43°F wb outdoor air</td>
<td>3.20 COPH</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>17°F db/15°F wb outdoor air</td>
<td>2.05 COPH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>—</td>
<td></td>
<td>47°F db/43°F wb outdoor air</td>
<td>3.20 COPH</td>
<td></td>
<td></td>
</tr>
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<td>—</td>
<td></td>
<td>17°F db/15°F wb outdoor air</td>
<td>2.05 COPH</td>
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<td></td>
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</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW, °C = (°F-32)/1.8

¹ ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
### APPENDIX E

#### TABLE E 503.7.1(3)

**WATER-CHILLING PACKAGES—MINIMUM EFFICIENCY REQUIREMENTS**<sup>1,2,5</sup>

[ASHRAE 90.1: TABLE 6.8.1-3]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>UNITS</th>
<th>PATH A</th>
<th>PATH B</th>
<th>TEST PROCEDURE&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air-cooled chillers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;150 tons</td>
<td>EER (Btu/Wh)</td>
<td>≥10.100 FL</td>
<td>≥9.700 FL</td>
<td>AHRI 550/590</td>
<td></td>
</tr>
<tr>
<td>≥150 tons</td>
<td></td>
<td>≥13.700 IPLV</td>
<td>≥15.800 IPLV</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥10.100 FL</td>
<td>≥9.700 FL</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥14.000 IPLV</td>
<td>≥16.100 IPLV</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air-cooled without condenser, electrically operated</strong></td>
<td>All capacities</td>
<td>EER (Btu/Wh)</td>
<td>Air-cooled chillers without condenser must be rated with matching condensers and comply with air-cooled chiller efficiency requirements</td>
<td>AHRI 550/590</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥0.600 FL</td>
<td>≥0.500 IPLV</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥0.540 IPLV</td>
<td>≥0.440 IPLV</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥0.500 IPLV</td>
<td>≤0.380 IPLV</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water-cooled, electrically operated positive displacement</strong></td>
<td></td>
<td>≤0.750 FL</td>
<td>≤0.780 FL</td>
<td>AHRI 550/590</td>
<td></td>
</tr>
<tr>
<td>&lt;75 tons</td>
<td>kW/ton</td>
<td>≤0.720 FL</td>
<td>≤0.750 FL</td>
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<td></td>
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<tr>
<td>≥75 tons and &lt;150 tons</td>
<td></td>
<td>≤0.560 IPLV</td>
<td>≤0.490 IPLV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥150 tons and &lt;300 tons</td>
<td></td>
<td>≤0.660 FL</td>
<td>≤0.680 FL</td>
<td></td>
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<tr>
<td>≥300 tons and &lt;600 tons</td>
<td></td>
<td>≤0.610 FL</td>
<td>≤0.625 FL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥600 tons</td>
<td></td>
<td>≤0.560 FL</td>
<td>≤0.585 FL</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water cooled, electrically operated centrifugal</strong></td>
<td></td>
<td>≤0.610 FL</td>
<td>≤0.695 FL</td>
<td>AHRI 550/590</td>
<td></td>
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<tr>
<td>&lt;150 tons</td>
<td>kW/ton</td>
<td>≤0.610 FL</td>
<td>≤0.550 IPLV</td>
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<tr>
<td>≥150 tons and &lt;300 tons</td>
<td></td>
<td>≤0.560 FL</td>
<td>≤0.595 FL</td>
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<td></td>
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<tr>
<td>≥300 tons and &lt;400 tons</td>
<td></td>
<td>≤0.560 FL</td>
<td>≤0.595 FL</td>
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<tr>
<td>≥400 tons and &lt;600 tons</td>
<td></td>
<td>≤0.560 FL</td>
<td>≤0.585 FL</td>
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<tr>
<td>≥600 tons</td>
<td></td>
<td>≤0.560 FL</td>
<td>≤0.585 FL</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air-cooled absorption, single effect</strong></td>
<td>All capacities</td>
<td>COP (W/W)</td>
<td>≥0.600 FL</td>
<td>NA&lt;sup&gt;4&lt;/sup&gt;</td>
<td>AHRI 560</td>
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<tr>
<td><strong>Water-cooled absorption, single effect</strong></td>
<td>All capacities</td>
<td>COP (W/W)</td>
<td>≥0.700 FL</td>
<td>NA&lt;sup&gt;4&lt;/sup&gt;</td>
<td>AHRI 560</td>
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<tr>
<td><strong>Absorption double effect, indirect fired</strong></td>
<td>All capacities</td>
<td>COP (W/W)</td>
<td>≥1.000 FL</td>
<td>NA&lt;sup&gt;4&lt;/sup&gt;</td>
<td>AHRI 560</td>
</tr>
<tr>
<td><strong>Absorption double effect, direct fired</strong></td>
<td>All capacities</td>
<td>COP (W/W)</td>
<td>≥1.000 IPLV</td>
<td>NA&lt;sup&gt;4&lt;/sup&gt;</td>
<td>AHRI 560</td>
</tr>
</tbody>
</table>

For SI units: 1 metric ton = 1000 kg, 1000 British thermal units per hour = 0.293 kW

**Notes:**

1. The requirements for centrifugal chillers shall be adjusted for nonstandard rating conditions per Section E 503.4.1 and are only applicable for the range of conditions listed there. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.

2. Both the full-load and IPLV requirements must be met or exceeded to comply with this appendix. When there is a Path B, compliance can be with either Path A or Path B for any application.

3. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

4. NA means the requirements are not applicable for Path B, and only Path A can be used for compliance.

5. FL is the full-load performance requirements, and IPLV is for the part-load performance requirements.
<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY (INPUT)</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY$^2$</th>
<th>TEST PROCEDURE$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTAC (cooling mode) standard size</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>95°F db/75°F wb outdoor air</td>
<td>13.8 – (0.300 × Cap/1000)$^2$ (as of 1/1/2015) 11.9 EER</td>
<td>AHRI 310/ 380</td>
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<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>14.0 – (0.300 × Cap/1000)$^2$ EER$^2$ (as of 1/1/2015)</td>
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</tr>
<tr>
<td></td>
<td>&gt;15 000Btu/h</td>
<td></td>
<td>9.5 EER</td>
<td></td>
</tr>
<tr>
<td>PTAC (cooling mode) nonstandard size$^1$</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>95°F db/75°F wb outdoor air</td>
<td>9.4 EER</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>10.9 – (0.213 × Cap/1000)$^2$ EER$^5$</td>
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</tr>
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<td>&gt;15 000Btu/h</td>
<td></td>
<td>7.7 EER</td>
<td></td>
</tr>
<tr>
<td>PTHP (cooling mode) standard size</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>95°F db/75°F wb outdoor air</td>
<td>11.9 EER</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>14.0 – (0.300 × Cap/1000)$^2$ EER$^5$</td>
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</tr>
<tr>
<td></td>
<td>&gt;15 000Btu/h</td>
<td></td>
<td>9.5 EER</td>
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</tr>
<tr>
<td>PTHP (cooling mode) nonstandard size$^2$</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>95°F db/75°F wb outdoor air</td>
<td>9.3 EER</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
<td></td>
<td>10.8 – (0.213 × Cap/1000)$^2$ EER$^5$</td>
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</tr>
<tr>
<td></td>
<td>&gt;15 000Btu/h</td>
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<td>7.6 EER</td>
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</tr>
<tr>
<td>PTHP (heating mode) standard size</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>47°F db/43°F wb outdoor air</td>
<td>3.3 COP$^H$</td>
<td>AHRI 310/ 380</td>
</tr>
<tr>
<td></td>
<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
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<td>3.7 – (0.052 × Cap/1000)$^2$ COP$^H$</td>
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<td></td>
<td>2.90 COP$^H$</td>
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<tr>
<td>PTHP (heating mode) nonstandard size$^2$</td>
<td>All capacities &lt;7000 Btu/h</td>
<td>47°F db/43°F wb outdoor air</td>
<td>2.7 COP$^H$</td>
<td>AHRI 310/ 380</td>
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<tr>
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<td>≥7000 Btu/h and ≤15 000 Btu/h</td>
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<td>2.9 – (0.026 × Cap/1000)$^2$ COP$^H$</td>
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<tr>
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<td>&gt;15 000Btu/h</td>
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<td>2.5 COP$^H$</td>
<td></td>
</tr>
<tr>
<td>SPVAC (cooling mode) single and three phase</td>
<td>&lt;65,000 Btu/h</td>
<td>95°F db/75°F wb outdoor air</td>
<td>10.0 EER</td>
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</tr>
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<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td></td>
<td>10.0 EER</td>
<td></td>
</tr>
<tr>
<td>SPVHP (cooling mode)</td>
<td>&lt;65 000 Btu/h</td>
<td>95°F db/75°F wb outdoor air</td>
<td>10.0 EER</td>
<td>AHRI 390</td>
</tr>
<tr>
<td></td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td></td>
<td>10.0 EER</td>
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</tr>
<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td></td>
<td>10.0 EER</td>
<td></td>
</tr>
<tr>
<td>SPVHP (heating mode)</td>
<td>&lt;65 000 Btu/h</td>
<td>47°F db/43°F wb outdoor air</td>
<td>3.0 COP$^H$</td>
<td>AHRI 390</td>
</tr>
<tr>
<td></td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td></td>
<td>3.0 COP$^H$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td></td>
<td>3.0 COP$^H$</td>
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</tr>
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</table>
## Table E 503.7.1(4) (continued)

**Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps—Minimum Efficiency Requirements**

[ASHRAE 90.1: Table 6.8.1-4]

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Size Category (Input)</th>
<th>Subcategory or Rating Condition</th>
<th>Minimum Efficiency$^4$</th>
<th>Test Procedure$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room air conditioners without reverse cycle with louvered sides for applications outside U.S.$^4$</td>
<td>&lt;6000 Btu/h</td>
<td>–</td>
<td>9.7 11.0 CSEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥6000 Btu/h and &lt;8000 Btu/h</td>
<td>–</td>
<td>9.7 11.0 CSEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥8000 Btu/h and &lt;14 000 Btu/h</td>
<td>–</td>
<td>9.7 10.7 CSEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥14 000 Btu/h and &lt;20 000 Btu/h</td>
<td>–</td>
<td>9.7 10.7 CSEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥20 000 Btu/h and &lt;28 000 Btu/h</td>
<td>–</td>
<td>8.5 9.4 CEEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥28 000 Btu/h</td>
<td>–</td>
<td>9.0 CEEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td>SPVAC (cooling mode), non-weatherized space constrained</td>
<td>&lt;30 000 Btu/h</td>
<td>95°F dry/75°F wet outdoor air</td>
<td>9.2 EER</td>
<td>AHRI 390</td>
</tr>
<tr>
<td></td>
<td>≥30 000 Btu/h and &lt;16 000 Btu/h</td>
<td>95°F dry/75°F wet outdoor air</td>
<td>9.0 EER</td>
<td>AHRI 390</td>
</tr>
<tr>
<td>SPVHP (cooling mode), non-weatherized space constrained</td>
<td>&lt;30 000 Btu/h</td>
<td>47°F dry/43°F wet outdoor air</td>
<td>3.0 COP$^4$</td>
<td>AHRI 390</td>
</tr>
<tr>
<td></td>
<td>≥30 000 Btu/h and &lt;16 000 Btu/h</td>
<td>47°F dry/43°F wet outdoor air</td>
<td>3.0 COP$^4$</td>
<td>AHRI 390</td>
</tr>
<tr>
<td>Room air conditioners without louvered sides</td>
<td>&lt;6000 Btu/h</td>
<td>–</td>
<td>9.0 EER 10.0 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥6000 Btu/h and &lt;8000 Btu/h</td>
<td>–</td>
<td>10.0 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥8000 Btu/h and &lt;14 000 Btu/h</td>
<td>–</td>
<td>8.5 EER 9.6 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥14 000 Btu/h and &lt;20 000 Btu/h</td>
<td>–</td>
<td>9.5 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥20 000 Btu/h</td>
<td>–</td>
<td>9.3 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td>Room air conditioners, heat pumps, with reverse cycle, with louvered sides for applications outside U.S.$^4$</td>
<td>&lt;20 000 Btu/h</td>
<td>–</td>
<td>9.0 EER 9.8 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥20 000 Btu/h</td>
<td>–</td>
<td>8.5 EER 9.3 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td>Room air conditioners, heat pumps, with reverse cycle without louvered sides for applications outside U.S.$^4$</td>
<td>&lt;14 000 Btu/h</td>
<td>–</td>
<td>8.5 EER 9.3 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td></td>
<td>≥14 000 Btu/h</td>
<td>–</td>
<td>8.0 EER 8.7 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td>Room air conditioners, casement only for applications outside U.S.$^4$</td>
<td>All capacities</td>
<td>–</td>
<td>8.7 EER 9.5 CEER</td>
<td>AHAM RAC-1</td>
</tr>
<tr>
<td>Room air conditioners, casement slider for applications outside U.S.$^4$</td>
<td>All capacities</td>
<td>–</td>
<td>9.5 EER 10.4 CEER</td>
<td>AHAM RAC-1</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW, °C = (°F-32)/1.8

**Notes:**

1. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2. Nonstandard size units must be factory labeled as follows: “MANUFACTURED FOR NONSTANDARD SIZE APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW STANDARD PROJECTS.” Nonstandard size efficiencies apply only to units being installed in existing sleeves having an external wall opening of less than 16 inch (406 mm) high or less than 42 inch (1067 mm) wide and having a cross-sectional area less than 670 square inches (0.432 m²).
3. “Cap” means the rated cooling capacity of the product in Btu/h (kW). If the unit’s capacity is less than 7000 Btu/h (2.05 kW), use 7000 Btu/h (2.05 kW) in the calculation. Where the unit’s capacity is more than 15 000 Btu/h (4.4 kW), use 15 000 Btu/h (4.4 kW) in the calculation.
4. The cooling-mode wet-bulb temperature requirement only applies for units that reject condensate to the condenser coil.
5. Room air conditioners are regulated as consumer products by 10 CFR 430. For U.S. applications of room air conditioners, refer to Informative Appendix F, Table F-3, of ASHRAE 90.1 for the USDOE minimum efficiency requirements for U.S. applications.

5. “Cap” in EER and COPH equations for PTACs and PTHPs means cooling capacity in Btu/h at 95°F outdoor dry-bulb temperature.
### APPENDIX E

**WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES, AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS**

[ASHRAE 90.1: TABLE 6.8.1-5]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY (INPUT)</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-air furnace, gas fired for application outside the U.S.²</td>
<td>&lt;225 000 Btu/h</td>
<td>Maximum capacity³</td>
<td>78% AFUE or 80% Et²⁴</td>
<td>DOE Appendix N of 10 CFR Part 430 or Section 2.39, Thermal Efficiency, CSA Z21.47</td>
</tr>
<tr>
<td></td>
<td>≥225 000 Btu/h</td>
<td>Maximum capacity³</td>
<td>80% Et²⁴ before 1/1/2023 81% Et² after 1/1/2023</td>
<td>Section 2.39, Thermal Efficiency, CSA Z21.47</td>
</tr>
<tr>
<td>Warm-air furnace, oil fired for application outside the U.S.²</td>
<td>&lt;225 000 Btu/h</td>
<td>Maximum capacity³</td>
<td>83% AFUE (nonweatherized) or 78% AFUE (weatherized) or 80% Et²⁴</td>
<td>Appendix N of 10 CFR 430 or Section 42, Combustion, UL 727</td>
</tr>
<tr>
<td></td>
<td>≥225 000 Btu/h</td>
<td>Maximum capacity³</td>
<td>81% Et² before 1/1/2023 82% Et² after 1/1/2023</td>
<td>Section 42, Combustion, UL 727</td>
</tr>
<tr>
<td>Electric furnaces for applications outside the U.S.²</td>
<td>&lt;225 000 Btu/h</td>
<td>All</td>
<td>96% AFUE</td>
<td>Appendix N of 10 CFR 430</td>
</tr>
<tr>
<td>Warm-air duct furnaces, gas fired</td>
<td>All capacities</td>
<td>Maximum capacity³</td>
<td>80% Et⁵</td>
<td>Section 2.10, Efficiency, CSA Z83.8</td>
</tr>
<tr>
<td>Warm-air unit heaters, gas fired</td>
<td>All capacities</td>
<td>Maximum capacity³</td>
<td>80% Et⁵⁶</td>
<td>Section 2.10, Efficiency, CSA Z83.8</td>
</tr>
<tr>
<td>Warm-air unit heaters, oil fired</td>
<td>All capacities</td>
<td>Maximum capacity³</td>
<td>80% Et⁵⁶</td>
<td>Section 40, Combustion, UL 731</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

**Notes:**

1. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2. Combination units (i.e., furnaces contained within the same cabinet as an air conditioner) not covered by the U.S. Department of Energy Code of Federal Regulations 10 CFR 430 [i.e., three-phase power or with cooling capacity greater than or equal to 65 000 Btu/h (19 kW)] may comply with either rating. All other units greater than 225 000 Btu/h (66 kW) sold in the U.S. must meet the AFUE standards for consumer products and test using USDOE’s AFUE test procedure at 10 CFR 430, Subpart B, Appendix N.
3. Compliance of multiple firing rate units shall be at the maximum firing rate.
4. Et = thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
5. Ec = combustion efficiency (100 percent less flue losses). See test procedure for detailed discussion.
6. As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.
7. For U.S. applications of federal covered greater than 225 000 Btu/h (66 kW) products, see Informative Appendix F, Table F-4 of ASHRAE 90.1.
TABLE E 503.7.1(6)
GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-6]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>SIZE CATEGORY (INPUT)</th>
<th>MINIMUM EFFICIENCY</th>
<th>EFFICIENCY AS OF</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boilers, hot water</td>
<td>Gas fired</td>
<td>&lt;300 000 Btu/h&lt;sup&gt;6&lt;/sup&gt; for applications outside U.S.&lt;sup&gt;2&lt;/sup&gt;</td>
<td>82% AFUE</td>
<td>82% AFUE</td>
<td>Appendix N of 10 CFR Part 430</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥300 000 Btu/h and ≤2 500 000 Btu/h&lt;sup&gt;4&lt;/sup&gt;</td>
<td>80% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>80% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;2 500 000 Btu/h&lt;sup&gt;1&lt;/sup&gt;</td>
<td>82% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>82% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
<tr>
<td></td>
<td>Oil fired</td>
<td>&lt;300 000 Btu/h&lt;sup&gt;5&lt;/sup&gt; for applications outside U.S.&lt;sup&gt;2&lt;/sup&gt;</td>
<td>84% AFUE</td>
<td>84% AFUE</td>
<td>Appendix N of 10 CFR Part 430</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥300 000 Btu/h and ≤2 500 000 Btu/h&lt;sup&gt;4&lt;/sup&gt;</td>
<td>82% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>82% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;2 500 000 Btu/h&lt;sup&gt;1&lt;/sup&gt;</td>
<td>84% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>84% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
<tr>
<td>Boilers, steam</td>
<td>Gas fired</td>
<td>&lt;300 000 Btu/h&lt;sup&gt;6&lt;/sup&gt; for applications outside U.S.&lt;sup&gt;2&lt;/sup&gt;</td>
<td>80% AFUE</td>
<td>80% AFUE</td>
<td>Appendix N of 10 CFR Part 430</td>
</tr>
<tr>
<td></td>
<td>Gas fired—all, except natural draft</td>
<td>≥300 000 Btu/h and ≤2 500 000 Btu/h&lt;sup&gt;4&lt;/sup&gt;</td>
<td>79% Et&lt;sup&gt;1&lt;/sup&gt;</td>
<td>79% Et&lt;sup&gt;1&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;2 500 000 Btu/h&lt;sup&gt;1&lt;/sup&gt;</td>
<td>79% Et&lt;sup&gt;1&lt;/sup&gt;</td>
<td>79% Et&lt;sup&gt;1&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
<tr>
<td></td>
<td>Gas fired—natural draft</td>
<td>≥300 000 Btu/h and ≤2 500 000 Btu/h&lt;sup&gt;4&lt;/sup&gt;</td>
<td>77% Et&lt;sup&gt;1&lt;/sup&gt;</td>
<td>77% Et&lt;sup&gt;1&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;2 500 000 Btu/h&lt;sup&gt;1&lt;/sup&gt;</td>
<td>77% Et&lt;sup&gt;1&lt;/sup&gt;</td>
<td>77% Et&lt;sup&gt;1&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
<tr>
<td></td>
<td>Oil fired</td>
<td>&lt;300 000 Btu/h&lt;sup&gt;5&lt;/sup&gt; for applications outside U.S.&lt;sup&gt;2&lt;/sup&gt;</td>
<td>82% AFUE</td>
<td>82% AFUE</td>
<td>Appendix N of 10 CFR Part 430</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥300 000 Btu/h and ≤2 500 000 Btu/h&lt;sup&gt;4&lt;/sup&gt;</td>
<td>81% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>81% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;2 500 000 Btu/h&lt;sup&gt;1&lt;/sup&gt;</td>
<td>81% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>81% Ec&lt;sup&gt;3&lt;/sup&gt;</td>
<td>10 CFR Part 431.86</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

Notes:
1 These requirements apply to boilers with rated input of 8 000 000 Btu/h (2343 kW) or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
2 Ec = combustion efficiency (100 percent less flue losses). See reference document for detailed information.
3 Ec = thermal efficiency. See reference document for detailed information.
4 Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit’s controls.
5 Includes oil-fired (residual).
6 Boilers shall not be equipped with a constant burning pilot light.
7 A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an automatic means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.
8 For new construction, refer to Section E 503.4 for additional system compliance requirements.
9 See Informative Appendix F, Table F-4 of ASHRAE 90.1, for U.S. minimum efficiencies for residential products covered by USDOE requirements for U.S. applications.
## Table E 503.7.1(7)
### Performance Requirements for Heat Rejection Equipment—Minimum Efficiency Requirements

[ASHRAE 90.1: Table 6.8.1-7]

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Subcategory or Rating Condition</th>
<th>Performance Required&lt;sup&gt;1,2,3,6,7&lt;/sup&gt;</th>
<th>Test Procedure&lt;sup&gt;4,5&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propeller or axial fan open-circuit cooling towers</td>
<td>All</td>
<td>≥40.2 gpm/hp</td>
<td>CTI ATC-105 and CTI STD-201 RS</td>
</tr>
<tr>
<td>Centrifugal fan open-circuit cooling towers</td>
<td>All</td>
<td>≥20.0 gpm/hp</td>
<td>CTI ATC-105 and CTI STD-201 RS</td>
</tr>
<tr>
<td>Propeller or axial fan closed-circuit cooling towers</td>
<td>All</td>
<td>≥16.1 gpm/hp</td>
<td>CTI ATC-105S and CTI STD-201 RS</td>
</tr>
<tr>
<td>Centrifugal closed-circuit cooling towers</td>
<td>All</td>
<td>≥7.0 gpm/hp</td>
<td>CTI ATC-105S and CTI STD-201 RS</td>
</tr>
<tr>
<td>Propeller or axial fan dry coolers (air-cooled fluid coolers)</td>
<td>All</td>
<td>≥15.5 gpm/hp</td>
<td>CTI ATC-105SDS</td>
</tr>
<tr>
<td>Propeller or axial fan evaporative condensers</td>
<td>R-507A, R-448A test fluid</td>
<td>≥157 000 Btu/h·hp</td>
<td>CTI ATC-106</td>
</tr>
<tr>
<td>Propeller or axial fan evaporative condensers</td>
<td>Ammonia test fluid</td>
<td>≥134 000 Btu/h·hp</td>
<td>CTI ATC-106</td>
</tr>
<tr>
<td>Centrifugal fan evaporative condensers</td>
<td>R-507A, R-448A test fluid</td>
<td>≥135 000 Btu/h·hp</td>
<td>CTI ATC-106</td>
</tr>
<tr>
<td>Centrifugal fan evaporative condensers</td>
<td>Ammonia test fluid</td>
<td>≥110 000 Btu/h·hp</td>
<td>CTI ATC-106</td>
</tr>
<tr>
<td>Air cooled condensers</td>
<td>All</td>
<td>≥176 000 Btu/h·hp</td>
<td>AHRI 460</td>
</tr>
</tbody>
</table>

For SI units: °C = (°F-32)/1.8, 1 gallon per minute per horsepower = 0.085 [(L/s)/kW], 1000 British thermal units per hour = 0.293 kW, 1 horsepower = 0.746 kW

Notes:

1. For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table E 503.7.1(7) divided by the fan motor nameplate power.
2. For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of the tower at the thermal rating condition listed in Table E 503.7.1(7) divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
3. For purposes of this table, dry-cooler performance is defined as the process water flow rating of the unit at the thermal rating condition listed in this table divided by the total fan motor nameplate power of the unit, and air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the total fan motor nameplate power of the unit.
4. ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
5. The efficiencies and test procedures for both open- and closed-circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field-erected cooling towers.
6. All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project-specific accessories and/or options included in the capacity of the cooling tower.
7. For purposes of this table, evaporative condenser performance is defined as the heat rejected at the specified rating condition in the table, divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.
8. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A, R-448A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A, R-448A must meet the minimum efficiency requirements listed above with R-507A, R-448A as the test fluid. For ammonia, the condensing temperature is defined as the saturation temperature corresponding to the refrigerant pressure at the condenser entrance. For R-448A, which is a zeotropic refrigerant, the condensing temperature is defined as the arithmetic average of the dew point and the bubble point temperatures corresponding to the refrigerant pressure at the condenser entrance.
### TABLE E 503.7.1(8)
HEAT TRANSFER EQUIPMENT — MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-8]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY</th>
<th>MINIMUM EFFICIENCY¹</th>
<th>TEST PROCEDURE²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid-to-liquid heat exchangers</td>
<td>Plate type</td>
<td>NR</td>
<td>AHRI 400</td>
</tr>
</tbody>
</table>

**Notes:**
¹ NR = No Requirement
² ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

### TABLE E 503.7.1(8) 503.7.1(8)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-9 6.8.1-8]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRF air conditioners, air cooled</td>
<td>&lt;65 000 Btu/h</td>
<td>All</td>
<td>VRF multisplit system</td>
<td>13.0 SEER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>VRF multisplit system</td>
<td>11.2 EER</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.1 IEER (as of 1/1/2017)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15.5 IEER (as of 1/1/2017)</td>
<td>AHRI 1230</td>
</tr>
<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>VRF multisplit system</td>
<td>11.0 EER</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.9 IEER (as of 1/1/2017)</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>14.9 IEER (as of 1/1/2017)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>VRF multisplit system</td>
<td>10.0 EER</td>
<td></td>
</tr>
<tr>
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<td></td>
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<td>11.6 IEER (as of 1/1/2017)</td>
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<td>13.9 IEER (as of 1/1/2017)</td>
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For SI units: 1000 British thermal units per hour = 0.293 kW
### ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
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<tbody>
<tr>
<td>VRF air cooled (cooling mode)</td>
<td>&lt;65 000 Btu/h</td>
<td>All</td>
<td>VRF multisplit system</td>
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</tr>
<tr>
<td></td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
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<td>VRF multisplit system with heat recovery</td>
<td>10.8 EER</td>
<td>AHRI 1230</td>
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<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
<td>VRF multisplit system with heat recovery</td>
<td>10.4 EER</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
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<tr>
<td>VRF water source (cooling mode)</td>
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<td>12.0 EER</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>VRF multisplit systems with heat recovery 86°F entering water</td>
<td>11.8 EER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>VRF multisplit system 86°F entering water</td>
<td>12.0 EER</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>≥240 000 Btu/h</td>
<td>VRF multisplit system 86°F entering water</td>
<td>10.0 EER</td>
<td>AHRI 1230</td>
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### TABLE E 503.7.1(10) 503.7.1(9)

| ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS |
| [ASHRAE 90.1: TABLE 6.8.1-10 6.8.1-9] |

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
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<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
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<tbody>
<tr>
<td>VRF air cooled (cooling mode)</td>
<td>&lt;65 000 Btu/h</td>
<td>All</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td></td>
<td>VRF multisplit system with heat recovery</td>
<td>10.8 EER</td>
<td>AHRI 1230</td>
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<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
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<tr>
<td></td>
<td>≥240 000 Btu/h</td>
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<td>10.4 EER</td>
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</tr>
<tr>
<td>VRF water source (cooling mode)</td>
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<td>12.0 EER</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>VRF multisplit systems with heat recovery 86°F entering water</td>
<td>11.8 EER</td>
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<td></td>
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<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
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<td></td>
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<tr>
<td></td>
<td>≥240 000 Btu/h</td>
<td>VRF multisplit system 86°F entering water</td>
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<td>AHRI 1230</td>
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### TABLE E 503.7.1(10) 503.7.1(9)

| ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS |
| [ASHRAE 90.1: TABLE 6.8.1-10 6.8.1-9] |

<table>
<thead>
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<th>EQUIPMENT TYPE</th>
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<th>SUBCATEGORY OR RATING CONDITION</th>
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<th>TEST PROCEDURE</th>
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<tr>
<td>VRF air cooled (cooling mode)</td>
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<tr>
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<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
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<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
<td>Electric resistance (or none)</td>
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<td>10.6 EER</td>
<td></td>
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<tr>
<td></td>
<td>≥240 000 Btu/h</td>
<td></td>
<td>VRF multisplit system with heat recovery</td>
<td>10.4 EER</td>
<td></td>
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<tr>
<td>VRF water source (cooling mode)</td>
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<tr>
<td></td>
<td>≥65 000 Btu/h and &lt;135 000 Btu/h</td>
<td>VRF multisplit systems with heat recovery 86°F entering water</td>
<td>11.8 EER</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
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### TABLE E 503.7.1(10) 503.7.1(9)

| ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS |
| [ASHRAE 90.1: TABLE 6.8.1-10 6.8.1-9] |

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
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<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
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<td>AHRI 1230</td>
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<tr>
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<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
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<td>10.6 EER</td>
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<td>VRF water source (cooling mode)</td>
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<td>≥135 000 Btu/h and &lt;240 000 Btu/h</td>
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<td>≥240 000 Btu/h</td>
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<td>AHRI 1230</td>
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<td>EQUIPMENT TYPE</td>
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<td>HEATING SECTION TYPE</td>
<td>SUBCATEGORY OR RATING CONDITION</td>
<td>MINIMUM EFFICIENCY</td>
<td>TEST PROCEDURE</td>
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<td>VRF groundwa-ter source (cooling mode)</td>
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<td>VRF multisplit system with heat recovery 59°F entering water</td>
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<tr>
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<td>≥135 000 Btu/h</td>
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<td>VRF multisplit system with heat recovery 59°F entering water</td>
<td>16.0 EER</td>
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<tr>
<td>VRF ground source (cooling mode)</td>
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<td>All</td>
<td>VRF multisplit system 77°F entering water</td>
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<td>All</td>
<td>VRF multisplit system 77°F entering water</td>
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<td>VRF Multi-split system</td>
<td>7.7 HSPF</td>
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<td>≥65 000 Btu/h and &lt;135 000 Btu/h (cooling capacity)</td>
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<td>≥135 000 Btu/h (cooling capacity)</td>
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<td>VRF Multi-split system 47°F db/43°F wb outdoor air</td>
<td>3.2 COPH</td>
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<td>17°F db/15°F wb outdoor air</td>
<td>2.05 COPH</td>
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<tr>
<td>VRF Water source (heating mode)</td>
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<td>—</td>
<td>VRF multisplit system 68°F entering water</td>
<td>4.2 COPH</td>
<td>AHRI 1230</td>
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<td></td>
<td></td>
<td>(as of 1/1/2018)</td>
<td>4.3 COPH</td>
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<tr>
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<td>≥65 000 Btu/h and &lt;135 000 Btu/h (cooling capacity)</td>
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<td>VRF multisplit system 68°F entering water</td>
<td>4.2 COPH</td>
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<td>(as of 1/1/2018)</td>
<td>4.3 COPH</td>
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<td>≥135 000 Btu/h and &lt;240 000 Btu/h (cooling capacity)</td>
<td>—</td>
<td>VRF multisplit system 68°F entering water</td>
<td>3.9 COPH</td>
<td>AHRI 1230</td>
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<td>(as of 1/1/2018)</td>
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<td>VRF multisplit system 68°F entering water</td>
<td>3.9 COPH</td>
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<tr>
<td>VRF Groundwater source (heating mode)</td>
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<td>VRF Multi-split system 50°F entering water</td>
<td>3.6 COPH</td>
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<td>VRF Multi-split system 50°F entering water</td>
<td>3.3 COPH</td>
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<tr>
<td>VRF Ground source (heating mode)</td>
<td>&lt;135 000 Btu/h (cooling capacity)</td>
<td>—</td>
<td>VRF Multi-split system 32°F entering water</td>
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<tr>
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<td>≥135 000 Btu/h (cooling capacity)</td>
<td>—</td>
<td>VRF Multi-split system 32°F entering water</td>
<td>2.8 COPH</td>
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For SI units: 1000 British thermal units per hour = 0.293 kW, °C=(°F-32)/1.8
### Table E 503.7.1(10)

**FLOOR-MOUNTED AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS—MINIMUM EFFICIENCY REQUIREMENTS**

**[ASHRAE 90.1: TABLE 6.8.1-10]**

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>STANDARD MODEL</th>
<th>NET SENSIBLE COOLING CAPACITY</th>
<th>MINIMUM NET SENSIBLE COP</th>
<th>RATING CONDITIONS RETURN S AIR (DRY-BULB/DEW POINT)</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled</td>
<td>Downflow</td>
<td>&lt;80,000 Btu/h</td>
<td>2.70</td>
<td>85°F/52°F (Class 2)</td>
<td>AHRI 1360</td>
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<tr>
<td></td>
<td></td>
<td>&gt;80,000 Btu/h and &lt;295,000 Btu/h</td>
<td>2.58</td>
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<tr>
<td></td>
<td></td>
<td>≥295,000 Btu/h</td>
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<td></td>
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<tr>
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<td>Upflow—ducted</td>
<td>&lt;80,000 Btu/h</td>
<td>2.67</td>
<td>85°F/52°F (Class 2)</td>
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<tr>
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<td></td>
<td>&gt;80,000 Btu/h and &lt;295,000 Btu/h</td>
<td>2.55</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>≥295,000 Btu/h</td>
<td>2.33</td>
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<tr>
<td></td>
<td>Upflow—nonducted</td>
<td>&lt;65,000 Btu/h</td>
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<td>75°F/52°F (Class 1)</td>
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<td>&lt;65,000 Btu/h</td>
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<td>95°F/52°F (Class 3)</td>
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<td></td>
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<td></td>
<td></td>
<td>≥240,000 Btu/h</td>
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<td>Air cooled with fluid economizer</td>
<td>Downflow</td>
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<td>&gt;80,000 Btu/h and &lt;295,000 Btu/h</td>
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<td></td>
<td>≥295,000 Btu/h</td>
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<tr>
<td></td>
<td>Upflow—ducted</td>
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<td>85°F/52°F (Class 1)</td>
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<td>&gt;80,000 Btu/h and &lt;295,000 Btu/h</td>
<td>2.55</td>
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<tr>
<td></td>
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<td>≥295,000 Btu/h</td>
<td>2.33</td>
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<td>Upflow—nonducted</td>
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<td>1.99</td>
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<td>≥240,000 Btu/h</td>
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<td>Horizontal</td>
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<td>95°F/52°F (Class 3)</td>
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<td></td>
<td></td>
<td>≥240,000 Btu/h</td>
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<td>Water cooled</td>
<td>Downflow</td>
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<td>≥295,000 Btu/h</td>
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<td>Upflow—ducted</td>
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## TABLE E 503.7.1(10) (continued)
### FLOOR-MOUNTED AIR CONDITIONERS AND CONDENSING UNITS
### SERVING COMPUTER ROOMS—MINIMUM EFFICIENCY REQUIREMENTS

[ASHRAE 90.1: TABLE 6.8.1-10]

<table>
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<tr>
<th>EQUIPMENT TYPE</th>
<th>STANDARD MODEL</th>
<th>NET SENSIBLE COOLING CAPACITY</th>
<th>MINIMUM NET SENSIBLE COP</th>
<th>RATING CONDITIONS</th>
<th>TEST PROCEDURE</th>
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<td>≥240,000 Btu/h</td>
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### TABLE E 503.7.1(10) (continued)
FLOOR-MOUNTED AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-10]

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<th>MINIMUM NET SENSIBLE COP</th>
<th>RATING CONDITIONS RETURNS AIR (DRY-BULB/DEW POINT)</th>
<th>TEST PROCEDURE</th>
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For SI units: 1000 British thermal units per hour = 0.293 kW, °C=(°F-32)/1.8
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<td>85°F/52°F</td>
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<td>Horizontal flow unit</td>
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<td>Air-cooled</td>
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Water-cooled

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<td>CLASS 2</td>
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<td>Horizontal flow unit</td>
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<td>Downflow unit</td>
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<td>Water-cooled</td>
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<tr>
<td></td>
<td>Horizontal flow unit</td>
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<tr>
<td>≥240,000 Btu/h</td>
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Water-cooled with fluid economizer

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<th>TEST PROCEDURE</th>
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<td>CLASS 2</td>
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<td>75°F/52°F</td>
<td>85°F/52°F</td>
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<td>Horizontal flow unit</td>
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### TABLE E 503.7(11) (continued)

**AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS**

**MINIMUM EFFICIENCY REQUIREMENTS**

*[ASHRAE 90.1: TABLE 6.8.1-11]*

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<th>EQUIPMENT TYPE</th>
<th>NET SENSIBLE COOLING CAPACITY</th>
<th>STANDARD MODEL</th>
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*For SI units: 1000 British thermal units per hour = 0.293 kW, °C = (°F - 32)/1.8

### TABLE E 503.7(12)

**COMMERCIAL REFRIGERATOR AND FREEZERS — MINIMUM EFFICIENCY REQUIREMENTS**

*[ASHRAE 90.1: TABLE 6.8.1-12]*

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<td>Refrigerator with solid doors</td>
<td>Holding temperature</td>
<td>0.10 × V + 2.04</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>Refrigerator with transparent doors</td>
<td>Holding temperature</td>
<td>0.12 × V + 3.74</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>Freezer with solid doors</td>
<td>Holding temperature</td>
<td>0.10 × V + 1.38</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>Freezer with transparent doors</td>
<td>Holding temperature</td>
<td>0.75 × V + 4.10</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>Refrigerators/freezers with solid doors</td>
<td>Holding temperature</td>
<td>the greater of 0.12 × V + 3.74 or 0.7</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>Commercial refrigerators</td>
<td>Pulldown</td>
<td>0.126 × V + 3.51</td>
<td>AHRI-1200</td>
</tr>
</tbody>
</table>

*V = the chiller or frozen compartment volume (ft³) as defined in Association of Home Appliance Manufacturers.*
## TABLE E 503.7.1(11)
COMMERCIAL REFRIGERATORS, COMMERCIAL FREEZERS, AND REFRIGERATION—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-11]

<table>
<thead>
<tr>
<th>EQUIPMENT CATEGORY</th>
<th>CONDENSING UNIT CONFIGURATION</th>
<th>EQUIPMENT FAMILY</th>
<th>RATING TEMP., °F</th>
<th>OPERATING TEMP., °F</th>
<th>EQUIPMENT CLASSIFICATION</th>
<th>MAXIMUM DAILY ENERGY CONSUMPTION, KWH/DAY</th>
<th>TEST STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote condensing commercial refrigerators and commercial freezers</td>
<td>Remote (RC)</td>
<td>Vertical Open (VOP)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>VOP.RC.M</td>
<td>0.64 × TDA + 4.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>VOP.RC.L</td>
<td>2.20 × TDA + 6.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semivertical Open (SVO)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>SVO.RC.M</td>
<td>0.66 × TDA + 3.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>SVO.RC.L</td>
<td>2.20 × TDA + 6.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Open (HZO)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>HZO.RC.M</td>
<td>0.35 × TDA + 2.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
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<td>HZO.RC.L</td>
<td>0.55 × TDA + 6.88</td>
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<td>Vertical Closed Transparent (VCT)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>VCT.RC.M</td>
<td>0.15 × TDA + 1.95</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>VCT.RC.L</td>
<td>0.49 × TDA + 2.61</td>
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<tr>
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<td>Horizontal Closed Transparent (HCT)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>HCT.RC.M</td>
<td>0.16 × TDA + 0.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>HCT.RC.L</td>
<td>0.34 × TDA + 0.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical Closed Solid (VCS)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>VCS.RC.M</td>
<td>0.10 × V + 0.26</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>VCS.RC.L</td>
<td>0.21 × V + 0.54</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Closed Solid (HCS)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>HCS.RC.M</td>
<td>0.10 × V + 0.26</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>HCS.RC.L</td>
<td>0.21 × V + 0.54</td>
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<tr>
<td></td>
<td></td>
<td>Service Over Counter (SOC)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>SOC.RC.M</td>
<td>0.44 × TDA + 0.11</td>
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<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>SOC.RC.L</td>
<td>0.93 × TDA + 0.22</td>
<td></td>
</tr>
<tr>
<td>Self-contained commercial refrigerators and commercial freezers with and with outdoors</td>
<td>Self-contained (SC)</td>
<td>Vertical Open (VOP)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>VOP.SC.M</td>
<td>1.69 × TDA + 4.71</td>
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</tr>
<tr>
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<td>0 (L)</td>
<td>&lt;32</td>
<td>VOP.SC.L</td>
<td>4.25 × TDA + 11.82</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Semivertical Open (SVO)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>SVO.SC.M</td>
<td>1.70 × TDA + 4.59</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>SVO.SC.L</td>
<td>4.26 × TDA + 11.51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Open (HZO)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>HZO.SC.M</td>
<td>0.72 × TDA + 5.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>HZO.RC.L</td>
<td>1.90 × TDA + 7.08</td>
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<td></td>
<td>Vertical Closed Transparent (VCT)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>VCT.SC.M</td>
<td>0.10 × V + 0.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>VCT.SC.L</td>
<td>0.29 × V + 2.95</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Vertical Closed Solid (VCS)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>VCS.SC.M</td>
<td>0.05 × V + 1.36</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>VCS.SC.L</td>
<td>0.22 × V + 1.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Closed Transparent (HCT)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>HCT.SC.M</td>
<td>0.06 × V + 0.37</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>HCT.SC.L</td>
<td>0.08 × V + 1.23</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Closed Solid (HCS)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>HCS.SC.M</td>
<td>0.05 × V + 0.91</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>HCS.SC.L</td>
<td>0.06 × V + 1.12</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Service Over Counter (SOC)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>SOC.SC.M</td>
<td>0.52 × TDA + 1.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 (L)</td>
<td>&lt;32</td>
<td>SOC.SC.L</td>
<td>1.10 × TDA + 2.10</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Equipment classification is based on the difference between condensing and operating temperatures.
- The energy consumption formula is given in the table.
- AHRI 1200 standard is referenced for certain categories.

**Self-contained commercial refrigerators with transparent doors for pull-down temperature applications**

<table>
<thead>
<tr>
<th>EQUIPMENT CATEGORY</th>
<th>EQUIPMENT FAMILY</th>
<th>RATING TEMP., °F</th>
<th>OPERATING TEMP., °F</th>
<th>EQUIPMENT CLASSIFICATION</th>
<th>MAXIMUM DAILY ENERGY CONSUMPTION, KWH/DAY</th>
<th>TEST STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull-Down (PD)</td>
<td>38 (M)</td>
<td>≥32</td>
<td>PD.SC.M</td>
<td>0.11 × V + 0.81</td>
<td>AHRI 1200</td>
<td></td>
</tr>
</tbody>
</table>
# APPENDIX E

**COMMERCIAL REFRIGERATORS, COMMERCIAL FREEZERS, AND REFRIGERATION—MINIMUM EFFICIENCY REQUIREMENTS**

**[ASHRAE 90.1: TABLE 6.8.1-11]**

<table>
<thead>
<tr>
<th>EQUIPMENT CATEGORY</th>
<th>CONDENSING UNIT CONFIGURATION</th>
<th>EQUIPMENT FAMILY</th>
<th>RATING TEMP., °F</th>
<th>OPERATING TEMP., °F</th>
<th>EQUIPMENT CLASSIFICATION</th>
<th>MAXIMUM DAILY ENERGY CONSUMPTION, KWH/DAY</th>
<th>TEST STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commercial ice-cream freezers</strong></td>
<td>Remote (RC)</td>
<td>Vertical Open (VOP)</td>
<td>-15 (I)</td>
<td>&lt;=15 (I)</td>
<td>VOP.RC.I</td>
<td>2.79 x TDA + 8.70</td>
<td>AHRI 1200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semivertical Open (SVO)</td>
<td></td>
<td></td>
<td>SVO.RC.I</td>
<td>2.79 x TDA + 8.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Open (HZO)</td>
<td></td>
<td></td>
<td>HZO.RC.I</td>
<td>0.70 x TDA + 8.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical Closed Transparent (VCT)</td>
<td></td>
<td></td>
<td>VCT.RC.I</td>
<td>0.58 x TDA + 3.05</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Closed Transparent (HCT)</td>
<td></td>
<td></td>
<td>HCT.RC.I</td>
<td>0.40 x TDA + 0.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical Closed Solid (VCS)</td>
<td></td>
<td></td>
<td>VCS.RC.I</td>
<td>0.25 x V + 0.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Closed Solid (HCS)</td>
<td></td>
<td></td>
<td>HCS.RC.I</td>
<td>0.25 x V + 0.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service Over Counter (SOC)</td>
<td></td>
<td></td>
<td>SOC.RC.I</td>
<td>1.09 x TDA + 0.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-contained (SC)</td>
<td>Vertical Open (VOP)</td>
<td></td>
<td>&lt;=15 (I)</td>
<td>VOP.SC.I</td>
<td>5.40 x TDA + 15.02</td>
<td>AHRI 1200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semivertical Open (SVO)</td>
<td></td>
<td></td>
<td>SVO.SC.I</td>
<td>5.41 x TDA + 14.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Open (HZO)</td>
<td></td>
<td></td>
<td>HZO.SC.I</td>
<td>2.42 x TDA + 9.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical Closed Transparent (VCT)</td>
<td></td>
<td></td>
<td>VCT.SC.I</td>
<td>0.62 x TDA + 3.29</td>
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</tr>
<tr>
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<td>Horizontal Closed Transparent (HCT)</td>
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<td></td>
<td>HCT.SC.I</td>
<td>0.56 x TDA + 0.43</td>
<td></td>
</tr>
<tr>
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<td></td>
<td>Vertical Closed Solid (VCS)</td>
<td></td>
<td></td>
<td>VCS.SC.I</td>
<td>0.34 x V + 0.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Closed Solid (HCS)</td>
<td></td>
<td></td>
<td>HCS.SC.I</td>
<td>0.34 x V + 0.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service Over Counter (SOC)</td>
<td></td>
<td></td>
<td>SOC.SC.I</td>
<td>1.53 x TDA + 0.36</td>
<td></td>
</tr>
</tbody>
</table>

For SI units: °C = (°F - 32)/1.8

**Notes:**

1. The meaning of the letters in this column is indicated in the columns to the left.
2. “Ice-cream freezer” is defined in 10 CFR 431.62 as a commercial freezer that is designed to operate at or below –5°F and that the manufacturer designs, markets, or intends for the storing, displaying, or dispensing of ice cream.
3. Equipment class designations consist of a combination (in sequential order separated by periods (AAA).(BB).(C)) of the following:
   a. (AAA)—An equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical closed transparent doors, VCS = vertical closed solid doors, HCT = horizontal closed transparent doors, HCS = horizontal closed solid doors, and SOC = service over counter);
   b. (BB)—An operating mode code (RC = remote condensing and SC = self-contained); and
   c. (C)—A rating temperature code (M = medium temperature (38°F), L = low temperature (0°F), or I = ice cream temperature (–15°F)). For example, “VOP.RC.M” refers to the “vertical open, remote condensing, medium temperature” equipment class.

4. V is the volume of the case (ft³) as measured in AHRI 1200, Appendix C.
5. TDA is the total display area of the case (ft²) as measured in AHRI 1200, Appendix D.
### Table E.503.7.1(13)
**Commercial Refrigeration—Minimum Efficiency Requirements**

[ASHRAE 90.1: Table 6.8.1-13]

<table>
<thead>
<tr>
<th>Equipment Class</th>
<th>Family Code</th>
<th>Operating Mode</th>
<th>Rating Temperature</th>
<th>Energy Use Limits(^{a,b}) kWh/day</th>
<th>Test Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOP.RC.M</td>
<td>Vertical-open</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>0.82 × TDA + 1.02</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SVO.RC.M</td>
<td>Semivertical-open</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>0.83 × TDA + 1.18</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.RC.M</td>
<td>Horizontal-open</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>0.35 × TDA + 2.88</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VOP.RC.L</td>
<td>Vertical-open</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>2.27 × TDA + 0.85</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.RC.L</td>
<td>Horizontal-open</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>0.57 × TDA + 0.68</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCT.RC.M</td>
<td>Vertical-transparent-door</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>0.32 × TDA + 1.05</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCT.RC.L</td>
<td>Vertical-transparent-door</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>0.56 × TDA + 2.64</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SOC.RC.M</td>
<td>Service-over-counter</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>0.51 × TDA + 0.14</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VOP.SC.M</td>
<td>Vertical-open</td>
<td>Self-contained</td>
<td>Medium-temperature</td>
<td>1.24 × TDA + 0.73</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SVO.SC.M</td>
<td>Semivertical-open</td>
<td>Self-contained</td>
<td>Medium-temperature</td>
<td>1.73 × TDA + 1.59</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.SC.M</td>
<td>Horizontal-open</td>
<td>Self-contained</td>
<td>Medium-temperature</td>
<td>0.72 × TDA + 0.51</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.SC.L</td>
<td>Horizontal-open</td>
<td>Self-contained</td>
<td>Low-temperature</td>
<td>0.92 × TDA + 2.08</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCT.SC.I</td>
<td>Vertical-transparent-door</td>
<td>Self-contained</td>
<td>Ice cream</td>
<td>0.67 × TDA + 3.29</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCS.SC.I</td>
<td>Vertical-solid-door</td>
<td>Self-contained</td>
<td>Ice cream</td>
<td>0.25 × T/Y + 0.58</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCT.SC.I</td>
<td>Horizontal-transparent-door</td>
<td>Self-contained</td>
<td>Ice cream</td>
<td>0.56 × TDA + 0.43</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VSO.RC.L</td>
<td>Vertical-open</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>2.27 × TDA + 0.85</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VSO.RC.I</td>
<td>Vertical-open</td>
<td>Remote-condensing</td>
<td>Ice cream</td>
<td>2.89 × TDA + 8.7</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.RC.I</td>
<td>Horizontal-open</td>
<td>Remote-condensing</td>
<td>Ice cream</td>
<td>0.72 × TDA + 8.74</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCT.RC.I</td>
<td>Vertical-transparent-door</td>
<td>Remote-condensing</td>
<td>Ice cream</td>
<td>0.66 × TDA + 7.05</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCT.RC.M</td>
<td>Horizontal-transparent-door</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>0.16 × TDA + 0.13</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCT.RC.L</td>
<td>Horizontal-transparent-door</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>0.34 × TDA + 0.26</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCS.RC.I</td>
<td>Horizontal-solid-door</td>
<td>Remote-condensing</td>
<td>Ice cream</td>
<td>0.14 × TDA + 0.31</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCS.RC.M</td>
<td>Vertical-solid-door</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>0.11 × T/Y + 0.26</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCS.RC.L</td>
<td>Vertical-solid-door</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>0.23 × T/Y + 0.54</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VCS.RC.I</td>
<td>Vertical-solid-door</td>
<td>Remote-condensing</td>
<td>Ice cream</td>
<td>0.27 × T/Y + 0.63</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCS.RC.M</td>
<td>Horizontal-solid-door</td>
<td>Remote-condensing</td>
<td>Medium-temperature</td>
<td>0.11 × T/Y + 0.26</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCS.RC.L</td>
<td>Horizontal-solid-door</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>0.27 × T/Y + 0.84</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCS.RC.I</td>
<td>Horizontal-solid-door</td>
<td>Remote-condensing</td>
<td>Ice cream</td>
<td>0.27 × T/Y + 0.63</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SOC.RC.L</td>
<td>Service-over-counter</td>
<td>Remote-condensing</td>
<td>Low-temperature</td>
<td>1.08 × TDA + 0.23</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SOC.RC.I</td>
<td>Service-over-counter</td>
<td>Remote-condensing</td>
<td>Ice cream</td>
<td>1.26 × TDA + 0.26</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VOP.SC.L</td>
<td>Vertical-open</td>
<td>Self-contained</td>
<td>Low-temperature</td>
<td>4.37 × TDA + 11.83</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>VOP.SC.I</td>
<td>Vertical-open</td>
<td>Self-contained</td>
<td>Ice cream</td>
<td>5.53 × TDA + 15.02</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SVO.SC.L</td>
<td>Semivertical-open</td>
<td>Self-contained</td>
<td>Low-temperature</td>
<td>4.34 × TDA + 11.54</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SVO.SC.I</td>
<td>Semivertical-open</td>
<td>Self-contained</td>
<td>Ice cream</td>
<td>5.52 × TDA + 11.63</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HZO.SC.I</td>
<td>Horizontal-open</td>
<td>Self-contained</td>
<td>Ice cream</td>
<td>2.44 × TDA + 9.00</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>SOC.SC.I</td>
<td>Service-over-counter</td>
<td>Self-contained</td>
<td>Ice cream</td>
<td>1.76 × TDA + 0.36</td>
<td>AHRI-1200</td>
</tr>
<tr>
<td>HCS.SC.I</td>
<td>Horizontal-solid-door</td>
<td>Self-contained</td>
<td>Ice cream</td>
<td>0.38 × T/Y + 0.88</td>
<td>AHRI-1200</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour per day = 0.293 kW/day, °C = (°F-32)/1.8

**Notes:**

- **a** Equipment class designations consist of a combination [in sequential order separated by periods (AAA) - (BB) - (C)] of the following:
  1. (AAA) — An equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical transparent doors, VCS = vertical solid doors, HCT = horizontal transparent doors, HCS = horizontal solid doors, and SOC = service over counter).
  2. (BB) — An operating mode code (RC = remote condensing and SC = self contained).
  3. (C) — A rating temperature code (M = medium temperature [38°F], L = low temperature [0°F], or I = ice cream temperature [15°F]). For example, “VOP.RC.M” refers to the “vertical open, remote condensing, medium temperature” equipment class.

- **b** TDA is the total display area of the case (ft) as measured in accordance with AHRI 1200.

- **c** V is the volume of the case (ft) as measured in accordance with AHRI 1200.

- **Energy Use Limits** are the values determined in Table 6.8.1-13 of ASHRAE 90.1.

- **Test Procedure** is the procedure used to determine the energy use limits.
### TABLE E 503.7.1(14) 503.7.1(12)
VAPOR COMPRESSION BASED INDOOR POOL DEHUMIDIFIERS—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-14 6.8.1-12]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single package indoor* (with or without economizer)</td>
<td>Rating Conditions: A or C</td>
<td>3.5 MRE</td>
<td></td>
</tr>
<tr>
<td>Single package indoor water-cooled (with or without economizer)</td>
<td></td>
<td>3.5 MRE</td>
<td>AHRI 910</td>
</tr>
<tr>
<td>Single package indoor air-cooled (with or without economizer)</td>
<td>Rating Conditions: A, B, or C</td>
<td>3.5 MRE</td>
<td></td>
</tr>
<tr>
<td>Split system indoor air-cooled (with or without economizer)</td>
<td></td>
<td>3.5 MRE</td>
<td></td>
</tr>
</tbody>
</table>

* Units without air-cooled condenser

### TABLE E 503.7.1(15) 503.7.1(13)
ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITHOUT ENERGY RECOVERY—MINIMUM EFFICIENCY REQUIREMENTS

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY OR CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled (dehumidification mode)</td>
<td></td>
<td>4.0 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Air source heat pumps (dehumidification mode)</td>
<td></td>
<td>4.0 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water cooled (dehumidification mode)</td>
<td>Cooling tower condenser water</td>
<td>4.9 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Chilled Water</td>
<td>6.0 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Air source heat pump (heating mode)</td>
<td></td>
<td>2.7 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water source heat pump (heating mode)</td>
<td>Ground source, closed loop</td>
<td>4.8 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Ground-water source</td>
<td>5.0 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Water source</td>
<td>4.0 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water source heat pump (heating mode)</td>
<td>Ground source, closed loop</td>
<td>2.0 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Ground-water source</td>
<td>3.2 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Water source</td>
<td>3.5 ISCOP</td>
<td>AHRI 920</td>
</tr>
</tbody>
</table>

### TABLE E 503.7.1(16) 503.7.1(14)
ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITH ENERGY RECOVERY—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-16 6.8.1-14]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled (dehumidification mode)</td>
<td></td>
<td>5.2 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Air source heat pumps (dehumidification mode)</td>
<td></td>
<td>5.2 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water cooled (dehumidification mode)</td>
<td>Cooling tower condenser water</td>
<td>5.3 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Chilled Water</td>
<td>6.6 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Air source heat pump (heating mode)</td>
<td></td>
<td>3.3 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water source heat pump (heating mode)</td>
<td>Ground source, closed loop</td>
<td>5.2 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Ground-water source</td>
<td>5.8 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Water source</td>
<td>4.8 ISMRE</td>
<td>AHRI 920</td>
</tr>
<tr>
<td>Water source heat pump (heating mode)</td>
<td>Ground source, closed loop</td>
<td>3.8 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Ground-water source</td>
<td>4.0 ISCOP</td>
<td>AHRI 920</td>
</tr>
<tr>
<td></td>
<td>Water source</td>
<td>4.8 ISCOP</td>
<td>AHRI 920</td>
</tr>
</tbody>
</table>
### TABLE E 503.7(15)

**ELECTRICALLY OPERATED WATER-SOURCE HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS**

[ASHRAE 90.1: TABLE 6.8.1-15]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-to-air, water loop (cooling mode)</td>
<td>&lt;17,000 Btu/h</td>
<td>All</td>
<td>86°F entering water</td>
<td>12.2 EER</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td></td>
<td>≥17,000 Btu/h and &lt;65,000 Btu/h</td>
<td>All</td>
<td></td>
<td>13.0 EER</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td></td>
<td>≥65,000 Btu/h and &lt;135,000 Btu/h</td>
<td>All</td>
<td></td>
<td>13.0 EER</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Water-to-air, groundwater (cooling mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>All</td>
<td>59°F entering water</td>
<td>18.0 EER</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Brine-to-air, ground loop (cooling mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>All</td>
<td>77°F entering water</td>
<td>14.1 EER</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Water-to-water, water loop (cooling mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>All</td>
<td>86°F entering water</td>
<td>10.6 EER</td>
<td>ISO 13256-2</td>
</tr>
<tr>
<td>Water-to-water, groundwater (cooling mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>All</td>
<td>59°F entering water</td>
<td>16.3 EER</td>
<td>ISO 13256-2</td>
</tr>
<tr>
<td>Brine-to-water, ground loop (cooling mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>All</td>
<td>77°F entering water</td>
<td>12.1 EER</td>
<td>ISO 13256-2</td>
</tr>
<tr>
<td>Water-to-water, water loop (heating mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>=</td>
<td>68°F entering water</td>
<td>4.3 COPH</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Water-to-air, groundwater (heating mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>=</td>
<td>80°F entering water</td>
<td>3.7 COPH</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Brine-to-air, ground loop (heating mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>=</td>
<td>32°F entering water</td>
<td>3.2 COPH</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Water-to-water, water loop (heating mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>=</td>
<td>68°F entering water</td>
<td>3.7 COPH</td>
<td>ISO 13256-1</td>
</tr>
<tr>
<td>Water-to-water, groundwater (heating mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>=</td>
<td>50°F entering water</td>
<td>3.1 COPH</td>
<td>ISO 13256-2</td>
</tr>
<tr>
<td>Brine-to-water, ground loop (heating mode)</td>
<td>&lt;135,000 Btu/h</td>
<td>=</td>
<td>32°F entering water</td>
<td>2.5 COPH</td>
<td>ISO 13256-2</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW, °C = (°F - 32)/1.8

**Notes:**
1. Section 12 of ASHRAE 90.1 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
2. Single-phase, U.S. air-cooled heat pumps less than 65,000 Btu/h (19 kW) are regulated as consumer products by 10 CFR 430. SCOPC, SCOP2C, SCOPH and SCOP2H values for single-phase products are set by the USDOE. See Informative Appendix F of ASHRAE 90.1 for the USDOE minimum.
<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY, ton</th>
<th>COOLING-ONLY OPERATION</th>
<th>HEATING OPERATION</th>
<th>HEAT RECOVERY CHILLER FULL-LOAD EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air source</td>
<td>All sizes</td>
<td>≥9.595 FL</td>
<td>≥9.215 FL</td>
<td>≥3.290 43 db/LF 2.770 ≥2.310 NA</td>
<td>AHRI 550/590</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥13.02 IPLV/JP</td>
<td>≥15.01 IPLV/JP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥9.595 FL</td>
<td>≥9.215 FL</td>
<td>≥2.230 15 db/LF 1.950 ≥1.630 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥13.30 IPLV/JP</td>
<td>≥15.30 IPLV/JP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water source</td>
<td>≤75</td>
<td>≤0.7885 FL</td>
<td>≤0.7875 FL</td>
<td>54/44 4.640 3.680 ≥2.680 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤0.6316 IPLV/JP</td>
<td>≤0.5145 IPLV/JP</td>
<td>75/65 NA NA NA ≥3.550 NA</td>
<td>AHRI 550/590</td>
</tr>
<tr>
<td>Electrically operated positive displacement</td>
<td>≥75 and &lt;150</td>
<td>≤0.7579 FL</td>
<td>≤0.7140 FL</td>
<td>54/44 4.640 3.680 ≥2.680 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤0.5895 IPLV/JP</td>
<td>≤0.4620 IPLV/JP</td>
<td>75/65 NA NA NA ≥3.550 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤0.6947 FL</td>
<td>≤0.7140 FL</td>
<td>54/44 4.640 3.680 ≥2.680 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤0.5684 IPLV/JP</td>
<td>≤0.4620 IPLV/JP</td>
<td>75/65 NA NA NA ≥3.550 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥150 and &lt;300</td>
<td>≤0.6424 FL</td>
<td>≤0.6563 FL</td>
<td>54/44 4.930 3.960 ≥2.970 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤0.5474 IPLV/JP</td>
<td>≤0.4305 IPLV/JP</td>
<td>75/65 NA NA NA ≥3.900 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥300 and &lt;600</td>
<td>≤0.5895 FL</td>
<td>≤0.6143 FL</td>
<td>54/44 4.930 3.960 ≥2.970 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤0.5263 IPLV/JP</td>
<td>≤0.3990 IPLV/JP</td>
<td>75/65 NA NA NA ≥3.900 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥600</td>
<td>≤0.5895 FL</td>
<td>≤0.6143 FL</td>
<td>54/44 4.930 3.960 ≥2.970 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤0.5263 IPLV/JP</td>
<td>≤0.3990 IPLV/JP</td>
<td>75/65 NA NA NA ≥3.900 NA</td>
<td></td>
</tr>
<tr>
<td>Water source</td>
<td>≤75</td>
<td>≤0.6421 FL</td>
<td>≤0.7316 FL</td>
<td>54/44 4.640 3.680 ≥2.680 NA</td>
<td></td>
</tr>
<tr>
<td>Electrically operated centrifugal</td>
<td>≥75 and 150</td>
<td>≤0.5895 FL</td>
<td>≤0.6684 FL</td>
<td>54/44 4.640 3.680 ≥2.680 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤0.5263 IPLV/JP</td>
<td>≤0.4211 IPLV/JP</td>
<td>75/65 NA NA NA ≥3.550 NA</td>
<td>AHRI 550/590</td>
</tr>
<tr>
<td></td>
<td>≥150 and &lt;300</td>
<td>≤0.5895 FL</td>
<td>≤0.6263 FL</td>
<td>54/44 4.640 3.680 ≥2.680 NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤0.5263 IPLV/JP</td>
<td>≤0.4105 IPLV/JP</td>
<td>75/65 NA NA NA ≥3.550 NA</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE E 503.7.1(16) (continued)
HEAT-PUMP AND HEAT RECOVERY CHILLER PACKAGES—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-16]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY (ton)</th>
<th>COOLING-ONLY OPERATION COOLING EFFICIENCY</th>
<th>WATER SOURCE POWER INPUT PER CAPACITY (FL/iplv), kW/ton°C</th>
<th>HEATING OPERATION</th>
<th>HEAT-PUMP HEATING FULL-LOAD EFFICIENCY (COPH₂) W/W</th>
<th>HEAT RECOVERY CHILLER FULL-LOAD EFFICIENCY (COPHR³) W/W</th>
<th>LEAVING HEATING WATER TEMPERATURE</th>
<th>LEAVING HEATING WATER TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PATH A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PATH B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water-source electrically operated centrifugal</td>
<td>≥300 and ≤600</td>
<td>≤0.5895 FL ≤0.6158 FL ≤0.6158 FL ≤0.5263 FL ≤0.5263 IPLV/IP ≤0.5263 IPLV/IP ≤0.5263 IPLV/IP ≤0.5263 IPLV/IP</td>
<td>54/44³</td>
<td>≥4.930 ≤2.960 ≥2.970 NA ≥8.900 ≥6.980 ≥5.000 NA</td>
<td>NA</td>
<td>NA</td>
<td>≥6.850</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;600</td>
<td>≤0.5895 FL ≤0.6158 FL ≤0.6158 FL ≤0.5263 FL ≤0.5263 IPLV/IP ≤0.5263 IPLV/IP ≤0.5263 IPLV/IP ≤0.5263 IPLV/IP</td>
<td>54/44³</td>
<td>≥4.930 ≤2.960 ≥2.970 NA ≥8.900 ≥6.980 ≥5.000 NA</td>
<td>NA</td>
<td>NA</td>
<td>≥6.850</td>
<td></td>
</tr>
</tbody>
</table>

For SI units: 1 metric ton = 1000 kg, 1000 British thermal units per hour = 0.293 kW, °C = (°F - 32)/1.8

Notes:
1. Cooling-only rating conditions are standard rating conditions defined in AHRI 550/590, Table 1.
2. Heating full-load rating conditions are at rating conditions defined in AHRI 550/590, Table 1.
3. For water-cooled heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser, the COPHR applies to operation at full load with 100 percent heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table E 503.7.1(3).
4. Outdoor air entering dry-bulb (db) temperature and wet-bulb (wb) temperature.
5. Source-water entering and leaving water temperature.

### TABLE E 503.7.1(17)
CEILING-MOUNTED COMPUTER-ROOM AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-17]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>STANDARD MODEL</th>
<th>NET SENSIBLE COOLING CAPACITY</th>
<th>MINIMUM NET SENSIBLE COP</th>
<th>RATING CONDITIONS RETURN AIR (DRY-BULB/DEW POINT)</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled with free air discharge condenser</td>
<td>Ducted</td>
<td>≤29 000 Btu/h</td>
<td>2.05</td>
<td>75°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
</tr>
<tr>
<td></td>
<td>Nonducted</td>
<td>≥29 000 Btu/h and ≤65 000 Btu/h</td>
<td>2.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65 000 Btu/h</td>
<td>1.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29 000 Btu/h and ≤65 000 Btu/h</td>
<td>2.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65 000 Btu/h</td>
<td>1.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air cooled with free air discharge condenser with fluid economizer</td>
<td>Ducted</td>
<td>≤29 000 Btu/h</td>
<td>2.01</td>
<td>75°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
</tr>
<tr>
<td></td>
<td>Nonducted</td>
<td>≥29 000 Btu/h and ≤65 000 Btu/h</td>
<td>1.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65 000 Btu/h</td>
<td>1.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤29 000 Btu/h</td>
<td>2.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29 000 Btu/h and ≤65 000 Btu/h</td>
<td>2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65 000 Btu/h</td>
<td>1.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air cooled with ducted condenser</td>
<td>Ducted</td>
<td>≥29 000 Btu/h and ≤65 000 Btu/h</td>
<td>1.83</td>
<td>75°F/52°F (Class 1)</td>
<td>AHRI 1360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65 000 Btu/h</td>
<td>1.73</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For SI units: 1 metric ton = 1000 kg, 1000 British thermal units per hour = 0.293 kW, °C = (°F - 32)/1.8

Notes:
1. Cooling-only rating conditions are standard rating conditions defined in AHRI 550/590, Table 1.
2. Heating full-load rating conditions are at rating conditions defined in AHRI 550/590, Table 1.
3. For water-cooled heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser, the COPHR applies to operation at full load with 100 percent heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table E 503.7.1(3).
4. Outdoor air entering dry-bulb (db) temperature and wet-bulb (wb) temperature.
5. Source-water entering and leaving water temperature.
TABLE E 503.7.1(17) (continued)
CEILING-MOUNTED COMPUTER-ROOM AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS
[ASHRAE 90.1: TABLE 6.8.1-17]

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>STANDARD MODEL</th>
<th>NET SENSIBLE COOLING CAPACITY</th>
<th>MINIMUM NET SENSIBLE COP</th>
<th>RATING CONDITIONS RETURN AIR (DRY-BULB/DEW POINT)</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled with ducted condenser</td>
<td>Nonducted</td>
<td>&lt;29,000 Btu/h</td>
<td>1.89</td>
<td>75°F/52°F (Class 1)</td>
<td>AHR1 1360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29,000 Btu/h and &lt;65,000 Btu/h</td>
<td>1.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65,000 Btu/h</td>
<td>1.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air cooled with fluid economizer and ducted condenser</td>
<td>Ducted</td>
<td>&lt;29,000 Btu/h</td>
<td>1.82</td>
<td>75°F/52°F (Class 1)</td>
<td>AHR1 1360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29,000 Btu/h and &lt;65,000 Btu/h</td>
<td>1.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65,000 Btu/h</td>
<td>1.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonducted</td>
<td>&lt;29,000 Btu/h</td>
<td>1.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29,000 Btu/h and &lt;65,000 Btu/h</td>
<td>1.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65,000 Btu/h</td>
<td>1.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water cooled</td>
<td>Ducted</td>
<td>&lt;29,000 Btu/h</td>
<td>1.89</td>
<td>75°F/52°F (Class 1)</td>
<td>AHR1 1360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29,000 Btu/h and &lt;65,000 Btu/h</td>
<td>1.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65,000 Btu/h</td>
<td>1.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonducted</td>
<td>&lt;29,000 Btu/h</td>
<td>1.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29,000 Btu/h and &lt;65,000 Btu/h</td>
<td>1.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65,000 Btu/h</td>
<td>1.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water cooled with fluid economizer</td>
<td>Ducted</td>
<td>&lt;29,000 Btu/h</td>
<td>1.97</td>
<td>75°F/52°F (Class 1)</td>
<td>AHR1 1360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29,000 Btu/h and &lt;65,000 Btu/h</td>
<td>1.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65,000 Btu/h</td>
<td>1.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonducted</td>
<td>&lt;29,000 Btu/h</td>
<td>1.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29,000 Btu/h and &lt;65,000 Btu/h</td>
<td>1.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65,000 Btu/h</td>
<td>1.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycol cooled</td>
<td>Ducted</td>
<td>&lt;29,000 Btu/h</td>
<td>1.92</td>
<td>75°F/52°F (Class 1)</td>
<td>AHR1 1360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29,000 Btu/h and &lt;65,000 Btu/h</td>
<td>1.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65,000 Btu/h</td>
<td>1.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonducted</td>
<td>&lt;29,000 Btu/h</td>
<td>1.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥29,000 Btu/h and &lt;65,000 Btu/h</td>
<td>1.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥65,000 Btu/h</td>
<td>1.76</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW, °C = °F - 32/1.8
### Table E 503.7.1(18)
**WALK-IN COOLER AND FREEZER DISPLAY DOOR EFFICIENCY REQUIREMENTS**

<table>
<thead>
<tr>
<th>CLASS DESCRIPTOR</th>
<th>CLASS</th>
<th>MAXIMUM ENERGY CONSUMPTION, kWh/day*</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display door, medium temperature</td>
<td>DD, M</td>
<td>0.04 × A&lt;sub&gt;dd&lt;/sub&gt; + 0.41</td>
<td>10 CFR 431</td>
</tr>
<tr>
<td>Display door, low temperature</td>
<td>DD, L</td>
<td>0.15 × A&lt;sub&gt;dd&lt;/sub&gt; + 0.29</td>
<td>10 CFR 431</td>
</tr>
</tbody>
</table>

* A<sub>dd</sub> is the surface area (ft<sup>2</sup>) of the display door.

### Table E 503.7.1(19)
**WALK-IN COOLER AND FREEZER NONDISPLAY DOOR EFFICIENCY REQUIREMENTS**

<table>
<thead>
<tr>
<th>CLASS DESCRIPTOR</th>
<th>CLASS</th>
<th>MAXIMUM ENERGY CONSUMPTION, kWh/day*</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage door, medium temperature</td>
<td>PD, M</td>
<td>0.05 × A&lt;sub&gt;nd&lt;/sub&gt; + 1.7</td>
<td>10 CFR 431</td>
</tr>
<tr>
<td>Passage door, low temperature</td>
<td>PD, L</td>
<td>0.14 × A&lt;sub&gt;nd&lt;/sub&gt; + 4.8</td>
<td>10 CFR 431</td>
</tr>
<tr>
<td>Freight door, medium temperature</td>
<td>FD, M</td>
<td>0.04 × A&lt;sub&gt;nd&lt;/sub&gt; + 1.9</td>
<td>10 CFR 431</td>
</tr>
<tr>
<td>Freight door, low temperature</td>
<td>FD, L</td>
<td>0.12 A&lt;sub&gt;nd&lt;/sub&gt; + 5.6</td>
<td>10 CFR 431</td>
</tr>
</tbody>
</table>

* A<sub>nd</sub> is the surface area (ft<sup>2</sup>) of the non-display door.

### Table E 503.7.1(20)
**WALK-IN COOLER AND FREEZER REFRIGERATION SYSTEM EFFICIENCY REQUIREMENTS**

<table>
<thead>
<tr>
<th>CLASS DESCRIPTOR</th>
<th>CLASS</th>
<th>MINIMUM ANNUAL WALK-IN ENERGY FACTOR, AWEF, Btu/W·h*</th>
<th>TEST PROCEDURE</th>
<th>COMPLIANCE DATE: EQUIPMENT MANUFACTURED STARTING ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedicated condensing, medium temperature, indoor system</td>
<td>DC.M.I</td>
<td>5.61</td>
<td>AHRI 1250</td>
<td>June 5, 2017</td>
</tr>
<tr>
<td>Dedicated condensing, medium temperature, outdoor system</td>
<td>DC.M.O</td>
<td>7.60</td>
<td>AHRI 1250</td>
<td>June 5, 2017</td>
</tr>
<tr>
<td>Dedicated condensing, low temperature, indoor system, net capacity (q&lt;sub&gt;net&lt;/sub&gt;) ≤ 6500 Btu/h</td>
<td>DC.L.I ≤ 6500 Btu/h</td>
<td>9.091 × 10&lt;sup&gt;−5&lt;/sup&gt; × q&lt;sub&gt;net&lt;/sub&gt; + 1.81</td>
<td>AHRI 1250</td>
<td>July 10, 2020</td>
</tr>
<tr>
<td></td>
<td>DC.L.I &gt; 6500 Btu/h</td>
<td>2.40</td>
<td>AHRI 1250</td>
<td>July 10, 2020</td>
</tr>
<tr>
<td>Dedicated condensing, low temperature, outdoor system, net capacity (q&lt;sub&gt;net&lt;/sub&gt;) ≤ 6500 Btu/h</td>
<td>DC.L.O ≤ 6500 Btu/h</td>
<td>6.522 × 10&lt;sup&gt;−5&lt;/sup&gt; × q&lt;sub&gt;net&lt;/sub&gt; + 2.73</td>
<td>AHRI 1250</td>
<td>July 10, 2020</td>
</tr>
<tr>
<td></td>
<td>DC.L.O &gt; 6500 Btu/h</td>
<td>3.15</td>
<td>AHRI 1250</td>
<td>July 10, 2020</td>
</tr>
<tr>
<td>Unit cooler, medium</td>
<td>UC.M</td>
<td>9.00</td>
<td>AHRI 1250</td>
<td>July 10, 2020</td>
</tr>
<tr>
<td>Unit cooler, low temperature, net capacity (q&lt;sub&gt;net&lt;/sub&gt;) ≤ 15 500 Btu/h</td>
<td>UC.L ≤ 15 500 Btu/h</td>
<td>1.575 × 10&lt;sup&gt;−5&lt;/sup&gt; × q&lt;sub&gt;net&lt;/sub&gt; + 3.91</td>
<td>AHRI 1250</td>
<td>July 10, 2020</td>
</tr>
<tr>
<td></td>
<td>UC.L &gt; 15 500 Btu/h</td>
<td>4.15</td>
<td>AHRI 1250</td>
<td>July 10, 2020</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW

* q<sub>net</sub> is net capacity (Btu/h) as determined in accordance with AHRI 1250.
### APPENDIX E

#### TABLE E 503.72
**MINIMUM DUCT INSULATION R-VALUE**
*ASHRAE 90.1: TABLE 6.8.2*

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>DUCT LOCATION</th>
<th>EXTERIOR²</th>
<th>UNCONDITIONED SPACE AND BURIED DUCTS</th>
<th>INDIRECTLY CONDITIONED SPACE³,⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SUPPLY AND RETURN DUCTS FOR HEATING AND COOLING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 to 4</td>
<td>R-8</td>
<td>R-6</td>
<td>R-1.9</td>
<td></td>
</tr>
<tr>
<td>5 to 8</td>
<td>R-12</td>
<td>R-6</td>
<td>R-1.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SUPPLY AND RETURN DUCTS FOR HEATING ONLY</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>0 to 1</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>2 to 4</td>
<td>R-6</td>
<td>R-6</td>
<td>R-1.9</td>
<td></td>
</tr>
<tr>
<td>5 to 8</td>
<td>R-12</td>
<td>R-6</td>
<td>R-1.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SUPPLY AND RETURN DUCTS FOR COOLING ONLY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 to 6</td>
<td>R-8</td>
<td>R-6</td>
<td>R-1.9</td>
<td></td>
</tr>
<tr>
<td>7 to 8</td>
<td>R-1.9</td>
<td>R-1.9</td>
<td>R-1.9</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. Insulation R-values, measured in [°F•h•ft²/(Btu•in)] [(m•K)/W], are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where portions of the building envelope are used as a plenum enclosure, building envelope insulation shall be as required by the most restrictive condition of Section E 503.4.7.1 or ASHRAE 90.1, depending on whether the plenum is located in the roof, wall, or floor. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F (24°C) at the installed thickness.
2. Includes attics above insulated ceilings, parking garages and crawl spaces.
3. Includes return air plenums, with or without exposed roofs above.
4. Return ducts in this duct location do not require insulation.

---

#### TABLE E 503.7.3(1)
**MINIMUM PIPE INSULATION THICKNESS FOR HEATING AND HOT WATER SYSTEMS**
*ASHRAE 90.1: TABLE 6.8.3-1*

<table>
<thead>
<tr>
<th>FLUID OPERATING TEMPERATURE RANGE (°F) AND USAGE</th>
<th>INSULATION CONDUCTIVITY</th>
<th>NOMINAL PIPE SIZE OR TUBE SIZE (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CONDUCTIVITY Btu•in/(h•ft²•°F)</td>
<td>MEAN RATING TEMPERATURE °F</td>
</tr>
<tr>
<td>INSULATION THICKNESS (inches)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;350</td>
<td>0.32 to 0.34</td>
<td>250</td>
</tr>
<tr>
<td>251 to 350</td>
<td>0.29 to 0.32</td>
<td>200</td>
</tr>
<tr>
<td>201 to 250</td>
<td>0.27 to 0.30</td>
<td>150</td>
</tr>
<tr>
<td>141 to 200</td>
<td>0.25 to 0.29</td>
<td>125</td>
</tr>
<tr>
<td>105 to 140</td>
<td>0.22 to 0.28</td>
<td>100</td>
</tr>
</tbody>
</table>

For SI units: °C=(°F-32)/1.8, 1 inch = 25 mm, 1 British thermal unit inch per hour square foot degree Fahrenheit = [0.1 W/(m•K)]

Notes:
1. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:

   \[
   T = \frac{r}{(1 + \frac{K}{k})^{0.5} - 1}
   \]

   Where:
   - \( T \) = minimum insulation thickness (inches).
   - \( r \) = actual outside radius of pipe (inches).
   - \( t \) = insulation thickness listed in this table for applicable fluid temperature and pipe size.
   - \( K \) = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature [Btu•in/(h•ft²•°F)] [W/(m•K)].
   - \( k \) = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

2. These thicknesses are for energy efficiency considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.
3. For piping smaller than ½ inches (40 mm) or less and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch (25.4 mm) shall be permitted (before thickness adjustment required in footnote 1) but not to thicknesses below 1 inch (25.4 mm).
4. For direct-buried heating and hot water system piping, reduction of these thicknesses by ½ inch (40 mm) shall be permitted (before thickness adjustment required in footnote 1) but not to thicknesses below 1 inch (25.4 mm).
5. Table E 503.7.3(1) is based on steel pipe. Nonmetallic pipes schedule 80 thickness or less shall use the table values. For other nonmetallic piping having thermal resistance more than that of steel pipe, reduced insulation thicknesses are permitted where documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot (mm) than a steel pipe of the same size with the insulation thickness shown in Table E 503.7.3(1).

---

**Notes:**

For SI units: °C=(°F-32)/1.8, 1 inch = 25 mm, 1 British thermal unit inch per hour square foot degree Fahrenheit = [0.1 W/(m•K)]
APPENDIX E

TABLE E 503.7.3(2)  
MINIMUM PIPE INSULATION THICKNESS FOR COOLING SYSTEMS (CHILLED WATER, BRINE, AND REFRIGERANT)¹,²,³,⁴  
[ASHRAE 90.1: TABLE 6.8.3-2]

<table>
<thead>
<tr>
<th>FLUID OPERATING TEMPERATURE RANGE ('F) AND USAGE</th>
<th>INSULATION CONDUCTIVITY</th>
<th>NOMINAL PIPE SIZE OR TUBE SIZE (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONDUCTIVITY Btu•inch/(h•f²•°F)</td>
<td>MEAN RATING TEMPERATURE °F</td>
<td>&lt;1</td>
</tr>
<tr>
<td>40 to 60</td>
<td>021 to 0.27</td>
<td>75</td>
</tr>
<tr>
<td>&lt;40</td>
<td>0.20 to 0.26</td>
<td>50</td>
</tr>
</tbody>
</table>

For SI units: °C = (°F-32)/1.8, 1 inch = 25 mm, 1 British thermal unit inch per hour square foot degree Fahrenheit = [0.1 W/(m•K)]

Notes:
1 For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:

\[ T = r(1 + b/K - 1) \]

Where:
- \( T \) = minimum insulation thickness (inches).
- \( r \) = actual outside radius of pipe (inches).
- \( t \) = insulation thickness listed in this table for applicable fluid temperature and pipe size.
- \( K \) = conductive alternate material at mean rating temperature indicated for the applicable fluid temperature [Btu•inch/(h•f²•°F) / W/(m•K)].
- \( k \) = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
2 These thicknesses are based on energy efficiency considerations only. Issues such as water, vapor permeability, or surface condensation require vapor retarders or additional insulation.
3 For direct-buried cooling system piping, insulation is not required.
4 Table E 503.7.3(2) is based on steel pipe. Nonmetallic pipes schedule 80 thickness or less shall use the table values. For other nonmetallic pipes having thermal resistance more than that of steel pipe, reduced insulation thicknesses are permitted where documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot (mm) than a steel pipe of the same size with the insulation thickness shown in Table E 503.7.3(2).

E 601.0 Indoor Environment.

E 601.1 Scope. The provisions of this section shall establish the means of reducing the quantity of air contaminants that are odorous, irritating, or harmful to the comfort and well-being of a building’s installers, occupants, and neighbors.

E 601.2 Prohibited. Continuous burning pilot lights and the use of indoor air for cooling a fireplace jacket, where the indoor air is vented to the outside of the building, are prohibited.

E 601.3 Pollutant Control.

E 603.1 Indoor Air Quality During Construction.

Indoor air quality of a building shall be maintained in accordance with Section E 603.1.1 through Section E 603.1.3.

E 603.1.1 Temporary Ventilation During Construction. Temporary ventilation during construction shall be provided in accordance with the following:

1. Ventilation during construction shall be achieved through openings in the building shell using fans to produce not less than three air changes per hour.

2. During dust-producing operations, the supply and return HVAC system openings shall be protected from dust in accordance with Section E 603.1.3.

3. Where the building is occupied during demolition or construction, ventilation shall be provided in accordance with the Control Measures of the SMACNA IAQ Guidelines for Occupied Buildings Under Construction.

4. The permanent HVAC system shall not be used during construction to condition and ventilate the building within the required temperature range for material and equipment installation. Where required, a supplemental HVAC system shall be used during construction, return air shall be equipped with filters with a minimum efficiency reporting value (MERV) of 8, in accordance with ASHRAE 52.2, or an average efficiency of 30 percent in accordance with
ASHRAE 52.2. Before occupancy, filters shall be replaced with filters having a MERV 13 rating in accordance with Section E 603.3.

Exception: Embedded hydronics system shall be permitted to be used to condition the building during construction.

E 603.1.2 Indoor Air Quality After Construction. After construction ends and interior finishes are installed, flush-out the building to reduce contaminant concentrations by supplying a total outdoor air volume of 14 000 cubic feet per square foot (ft³/ft²) (4267.2 m³/m²) of occupiable building area. An internal temperature of not less than 60°F (16°C) and relative humidity not higher than 60 percent shall be maintained during the flush-out process. Occupancy shall begin on condition of 3500 ft³/ft² (1066.8 m³/m²) of building area, with the remaining 10 500 ft³/ft² (3200.4 m³/m²) being accomplished as soon as possible.

Exception: Other means of reducing the contaminant concentration levels shall be permitted where approved by the Authority Having Jurisdiction.

E 603.1.3 Covering of Duct Openings and Protection of Mechanical Equipment During Construction. At the time of rough installation, or during storage on the construction site and until final startup of the heating and cooling equipment, duct and other related air distribution component openings shall be covered with tape, plastic, sheet metal, or other methods acceptable to the enforcing agency, Authority Having Jurisdiction to reduce the amount of dust or debris that collects in the system.

E 603.2 Isolation of Pollutant Sources. Rooms where activities produce hazardous fumes or chemicals, including commercial kitchens, garages, janitorial or laundry rooms, and copy or printing rooms, shall be exhausted and isolated from adjacent spaces in accordance with this code.

E 603.3 Filters. In mechanically ventilated buildings, particle filters, or air-cleaning devices shall be provided to clean outdoor and return air prior to its delivery to occupied spaces. The particle or air cleaner shall have a MERV of 13.

Exception: A filter or air cleaning device with a lower MERV value shall be permitted provided it is the highest value commercially available for the specific equipment that is installed.

E 603.4 Ozone Depletion and Global Warming Reductions. Installations of HVAC and refrigeration shall not contain CFCs and shall be in accordance with this code.

E 604.0 Indoor Moisture Control.

E 604.1 Rainwater Control. Roof drainage systems shall discharge to a place of disposal in accordance with the plumbing code. Storm water shall be directed away from the building.

E 605.0 Indoor Air Quality for Low-Rise Residential.

E 605.1 General. Rooms or occupied spaces within single-family homes and multifamily structures of three stories or less above grade shall be designed to have ventilation (outside) air for occupants in accordance with Section E 605.1.1 through Section E 605.1.3.2, or the applicable local code.

E 605.1.1 Natural Ventilation. Naturally ventilated spaces shall be permanently open to and within 20 feet (6096 mm) of operable wall or roof openings to the outdoors, the operable area of which is not less than 5 percent of the conditioned floor area of the naturally ventilated space. Where openings are covered with louver or otherwise obstructed, operable area shall be based on the free unobstructed area through the opening.

E 605.1.1.1 Access to Operable Openings. The means to open required operable openings shall be readily accessible to building occupants where the space is occupied.

E 605.1.2 Mechanical Ventilation. Each space that is not naturally ventilated in accordance with Section E 605.1.1 shall be ventilated with a mechanical system capable of providing an outdoor air rate not less than 15 ft³/min (0.007 m³/s) per person times the expected number of occupants. Mechanical ventilation shall comply with this code.

E 605.1.3 Dwelling Unit Ventilation. A Mechanical exhaust system, supply system, or combination thereof shall be installed, designed and provided with the capacity to operate for each deliver outdoor air ventilation to the whole dwelling unit to provide at a continuous dwelling unit ventilation with outdoor air at a rate not less than the rate that is specified in Section E 605.1.3.1 through Section E 605.1.3.5. [ASHRAE 62.2:4.1]

E 605.1.3.1 Total Ventilation Rate. The total required ventilation rate (Qtot) shall be as specified in Table E 605.1.3.1 or, alternatively, calculated using Equation E 605.1.3.1.

\[
Qtot = 0.03A_{floor} + 7.5(N_{br} + 1)
\]  

(Equation E 605.1.3.1)

Where:

\[
Qtot = \text{total required ventilation rate, cubic feet per minute (ft³/min)}
\]

\[
A_{floor} = \text{dwelling unit floor area, square foot (ft²)}
\]

\[
N_{br} = \text{number of bedrooms (not to be less than one)}
\]

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 square foot = 0.0929 m²

Exceptions: Dwelling-unit mechanical ventilation systems shall not be required where the Authority Having Jurisdiction determines that window operation is a locally permissible method of providing ventilation and provided one or more of the following conditions is met:

1. The building has no mechanical cooling and is in zone 1 or 2 of the climate zone map.
2. The building is thermally conditioned for human occupancy for less than 876 hours per year. [ASHRAE 62.2:4.1.1]
### TABLE E 605.1.3.1
VENTILATION AIR REQUIREMENTS, (cubic foot per minute)
[ASHRAE 62.2: TABLE 4-1a 4-1a]

<table>
<thead>
<tr>
<th>FLOOR AREA (ft²)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;500</td>
<td>30</td>
<td>38</td>
<td>45</td>
<td>53</td>
<td>60</td>
</tr>
<tr>
<td>501-1000</td>
<td>45</td>
<td>53</td>
<td>60</td>
<td>68</td>
<td>75</td>
</tr>
<tr>
<td>1001-1500</td>
<td>60</td>
<td>68</td>
<td>75</td>
<td>83</td>
<td>90</td>
</tr>
<tr>
<td>1501-2000</td>
<td>75</td>
<td>83</td>
<td>90</td>
<td>98</td>
<td>105</td>
</tr>
<tr>
<td>2001-2500</td>
<td>90</td>
<td>98</td>
<td>105</td>
<td>113</td>
<td>120</td>
</tr>
<tr>
<td>2501-3000</td>
<td>105</td>
<td>113</td>
<td>120</td>
<td>128</td>
<td>135</td>
</tr>
<tr>
<td>3001-3500</td>
<td>120</td>
<td>128</td>
<td>135</td>
<td>143</td>
<td>150</td>
</tr>
<tr>
<td>3501-4000</td>
<td>135</td>
<td>143</td>
<td>150</td>
<td>158</td>
<td>165</td>
</tr>
<tr>
<td>4001-4500</td>
<td>150</td>
<td>158</td>
<td>165</td>
<td>173</td>
<td>180</td>
</tr>
<tr>
<td>4501-5000</td>
<td>165</td>
<td>173</td>
<td>180</td>
<td>188</td>
<td>195</td>
</tr>
</tbody>
</table>

For SI units: 1 square foot = 0.0929 m², 1 cubic foot per minute = 0.00047 m³/s

---

**E 605.1.3.2 Effective Annual Average Infiltration Rate** (**Qinf**) Using a Single-Point Envelope Leakage Test. Effective Annual Average Infiltration Rate (**Qinf**) shall be calculated using Equation E 605.1.3.2: a single-point test at 50 Pa (0.007 psi). The Effective Annual Average Infiltration Rate (**Qinf**) shall be calculated using Equation 605.1.3.2:

\[
Q_{inf} (\text{CFM}) = \frac{(NL \times wsf \times A_{floor})}{(7.3)\star}
\]

Where:
- **NL** = normalized leakage
- **wsf** = weather and shielding factor from ASHRAE 62.2
- **A_{floor}** = floor area of residence, ft² (m²)

\* Replace 7.3 with 1.44 for metric units. [ASHRAE 62.2:4.1.2(e)]

\[
Q_{inf} = 0.052 \times Q_{50} \times wsf \times \left(\frac{H}{Hr}\right)\star
\]

Where:
- **Qinf** = estimated infiltration rate, cfm (L/s).
- **Q_{50}** = leakage rate at 50 Pa depressurization or pressurization, cfm (L/s).
- **wsf** = weather and shielding factor from ASHRAE 62.2.
- **H** = vertical distance between the lowest and highest above-grade points within the pressure boundary, ft (m).
- **Hr** = reference height, 8.2 ft (2.5 m).
- \(\star\) = 0.4 for the purpose of calculating the Effective Annual Average Infiltration Rate. [ASHRAE 62.2:4.1.2.1]

---

**E 605.1.3.3 Required Mechanical Ventilation Rate** (**Qfan**). If a blower door test has been performed, then a credit for estimated infiltration may be taken for detached dwelling units using either the procedure in Section E 605.1.3.2 or E 605.1.3.4. Attached dwelling units other than horizontally attached shall not be permitted to take an infiltration credit. Horizontally attached dwelling units shall be permitted to use a blower door test result to take this credit, subject to the duction factor A_{ext} in Equation E 605.1.3.3.

If this credit is taken, then the Required Mechanical Ventilation Rate (**Qfan**) shall be calculated using Equation E 605.1.3.3:

\[
Q_{fan} = Q_{tot} - \Phi \left(Q_{inf} \times A_{ext}\right)
\]

Where:
- **Qfan** = required mechanical ventilation rate, CFM (L/s)
- **Q_{tot}** = total required ventilation rate, CFM (L/s)
- **Q_{inf}** = may be not greater than \(\frac{2}{3}\times Q_{tot}\) infiltration, cfm (L/s)

(see ASHRAE 62.2 for exceptions for existing buildings)

\[
A_{ext} = 1 \text{ for single family detached homes,}
\]

<table>
<thead>
<tr>
<th>E 605.1.3.3</th>
<th>Required Mechanical Ventilation Rate (Qfan).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Qfan</strong></td>
<td><strong>Q_{tot}</strong> - \Phi \left(Q_{inf} \times A_{ext}\right)</td>
</tr>
<tr>
<td><strong>Q_{tot}</strong></td>
<td>total required ventilation rate, CFM (L/s)</td>
</tr>
<tr>
<td><strong>Q_{inf}</strong></td>
<td>may be not greater than (\frac{2}{3}\times Q_{tot}) infiltration, cfm (L/s)</td>
</tr>
</tbody>
</table>

(see ASHRAE 62.2 for exceptions for existing buildings)
Exception: Where \( Q_{fan} \), calculated for unbalanced ventilation, is less than or equal to 15 cfm (7 L/s), a dwelling-unit ventilation system is not required. [ASHRAE 62.2:4.1.2.1.2]

**E 605.1.3.4 Effective Annual Average Infiltration Rate (\( Q_{inf} \)) Using a Multipoint Envelope Leakage Test.** Effective Annual Average Infiltration Rate (\( Q_{inf} \)) shall be calculated using the normalized leakage calculated from measurements of envelope leakage using a multipoint test from either ASTM E779 in accordance with Section E 605.1.3.4(A) or CGSB 149.10 in accordance with Section E 605.1.3.4(B).

**E 605.1.3.4(A) ASTM Procedure.** To calculate the effective leak area (\( ELA \)) from ASTM E779, the leakage area for pressurization and depressurization (using a 4 Pa [0.0006 psi] reference pressure) shall be averaged using Equation E 605.1.3.4(A):

\[
ELA = \left( \frac{L_{press} + L_{depress}}{2} \right)
\]

Where:

- \( ELA \) = effective leakage area, ft\(^2\) (m\(^2\))
- \( L_{press} \) = leakage area from pressurization, ft\(^2\) (m\(^2\))
- \( L_{depress} \) = leakage area from depressurization, ft\(^2\) (m\(^2\))

**E 605.1.3.4(B) CGSB Procedure.** To calculate the \( ELA \) from CGSB 149.10, the following modifications to the test procedure must be made:

1. All vents and intentional openings must be in the same configuration as specified in ASTM E779 (i.e., HVAC dampers and registers should be in the normal operating position; fireplace and other dampers should be closed unless they are required for test operation).
2. Height and floor area must be reported consistently with the definitions of this standard.
3. The leakage area as calculated from the CGSB procedure must be converted using Equation E 605.1.3.4(B):

\[
ELA = 0.61 \times (0.4)^{n} - 0.5 \times L_{cgsb}
\]

Where:

- \( n \) = exponent measured from the CGSB 149.10
- \( L_{cgsb} \) = CGSB leakage area as modified above, ft\(^2\) (m\(^2\))

**E 605.1.3.4(C) Normalized Leakage.** Normalized leakage shall be calculated using Equation E 605.1.3.4(C):

\[
NL = 1000 \times ELA \times \left( \frac{H}{H_{r}} \right)^{\frac{n}{2}}
\]

Where:

- \( NL \) = normalized leakage
- \( ELA \) = effective leakage area, ft\(^2\) (m\(^2\))
- \( A_{floor} \) = floor area of residence, ft\(^2\) (m\(^2\))
- \( H \) = vertical distance between the lowest and highest above-grade points within the pressure boundary, ft (m)
- \( H_{r} \) = reference height, 8.2 ft (2.5 m)
- \( z \) = 0.4 for the purpose of calculating the Effective Annual Infiltration Rate

**E 605.1.3.4(D) Effective Annual Average Infiltration Rate.** Effective Annual Average Infiltration Rate (\( Q_{inf} \)) shall be calculated using Equation E 605.1.3.4(D):

\[
Q_{inf} (cfm) = \frac{NL \times wsf \times A_{floor}}{7.3}
\]

Where:

- \( NL \) = normalized leakage
- \( wsf \) = weather and shielding factor from ASHRAE 62.2
- \( A_{floor} \) = floor area of residence, ft\(^2\) (m\(^2\))

**E 605.1.3.5 Different Occupant Density.** Table E 605.1.3.1 and Equation E 605.1.3.1 assume two persons in a studio or one-bedroom dwelling unit and an additional person for each additional bedroom. Where higher occupant densities are known, the rate shall be increased by 7.5 ft\(^3\)/min (0.003 m\(^3\)/s) for each additional person. Where approved by the Authority Having Jurisdiction, lower occupant densities shall be permitted to be used. [ASHRAE 62.2:4.1.3]

**E 605.1.4 System Type.** The dwelling-unit mechanical ventilation system shall consist of one or more supply or exhaust fans and associated ducts and controls. Local exhaust fans shall be permitted to be part of a mechanical exhaust system. Where local exhaust fans are used to provide dwelling-unit ventilation, the local exhaust airflow shall be permitted to be credited toward the dwelling-unit ventilation airflow requirement. Outdoor air ducts connected to the return side of an air handler shall be permitted as supply ventilation where manufacturer’s requirements for return air temperature are met. See ASHRAE 62.3 Indoor Air Quality Guide for guidance on selection of methods. [ASHRAE 62.2:4.2]
E 605.1.5 Airflow Measurement. The airflow required by this section shall be the quantity of outdoor ventilation air supplied and/or indoor air exhausted by the mechanical ventilation system as installed and shall be measured according to the ventilation equipment manufacturer’s installation instructions, or by using a flow hood, flow grid, or other airflow measuring device at the mechanical ventilation fan’s inlet terminals/grilles, outlet terminals/grilles, or in the connected ventilation ducts. Balanced mechanical ventilation system airflow shall be the average of the supply fan and exhaust fan flows. Ventilation airflow of systems with multiple operating modes shall be tested in all modes designed to meet this section. [ASHRAE 62.2:4.3]

E 605.1.6 Control and Operation. An ON-OFF control readily accessible to the dwelling-unit occupant, including but not limited to a fan switch or a dedicated branch-circuit overcurrent device, shall be provided. Controls shall include text or an icon indicating the system’s function.

Exception: For multifamily dwelling units, the manual ON-OFF control shall not be required to be readily accessible to the dwelling-unit occupant. [ASHRAE 62.2:4.4.1]

E 605.1.6.1 Operation. The system shall be operated as designed. [ASHRAE 62.2:4.4.2]

E 605.1.7 Variable Mechanical Ventilation. Dwelling-unit mechanical ventilation systems designed to provide variable ventilation shall comply with Section E 605.1.7.1 or Section E 605.1.7.2 or Section E 605.1.7.3. Section E 605.1.7.2 and Section E 605.1.7.3 also require compliance with ASHRAE 62.2 and require verification with supporting documentation from the manufacturer, designer, or specifier of the ventilation control system that the system meets the requirements of these sections. Where the dwelling-unit ventilation rate varies based on occupancy, occupancy shall be determined by occupancy sensors or by an occupant-programmable schedule. Operation shall comply with Section E 605.1.6.1. [ASHRAE 62.2:4.4.5]

E 605.1.7.1 Short-Term Average Ventilation. To comply with this section, a variable ventilation system shall be installed to provide an average dwelling-unit ventilation rate over any three-hour period or less that is greater than or equal to \( \frac{Q_{\text{fan}}}{60} \) as calculated using Section E 605.1.3.3, and shall not provide a ventilation rate of zero over any three-hour interval. [ASHRAE 62.2:4.5.1]

E 605.1.7.2 Scheduled Ventilation. This section shall only be allowed to be used when one or more fixed patterns of designed ventilation are known at the time compliance to Section E 605.0 is being determined. Such patterns include those both clock-driven and driven by typical meteorological data. Compliance with this section shall be demonstrated with either Section E 605.1.7.2.1 or Section E 605.1.7.2.2. [ASHRAE 62.2:4.5.2]

E 605.1.7.2.1 Annual Average Schedule. An annual schedule of ventilation complies with this section when the annual average relative exposure during occupied periods is not more than one, and the peak relative exposure shall not exceed five for any time step as calculated in accordance with ASHRAE 62.2. [ASHRAE 62.2:4.5.2.1]
E 607.0 Environmental Comfort.
E 607.1 Thermal Comfort Controls. The mechanical systems and controls of building shall be designed to provide and maintain indoor comfort conditions in accordance with ASHRAE 55.
E 607.2 Heating and Air-Conditioning System Design. Heating and air-conditioning systems shall be sized, designed, and have their equipment selected in accordance with the following:
   (1) Heat loss and heat gain are established in accordance with ACCA Manual J, ASHRAE handbooks, or other equivalent methods.
   (2) Duct systems shall be sized in accordance with ACCA Manual D, ASHRAE handbooks, or other equivalent methods.
   (3) Heating and cooling equipment in accordance with ACCA Manual S or other equivalent methods.
E 608.0 Low VOC Solvent Cement and Primer.
E 608.1 General. Primers and solvent cements used to join plastic pipe, and fittings shall be in accordance with Section E 608.1.1 and Section E 608.1.2.
E 608.1.1 Solvent Cement. Solvent cement, including one-step solvent cement, shall have a volatile organic compound (VOC) content of less than or equal to 65 ounces per gallon (oz/gal) (487 g/L) for CPVC cement, 68 oz/gal (509 g/L) for PVC cement, and 43 oz/gal (322 g/L) for ABS cement, as determined by the South Coast Air Quality Management District’s Laboratory Methods of Analysis for Enforcement Samples, Method 316A.
E 608.1.2 Primer. Primer shall have a volatile organic compound (VOC) content of less than or equal to 73 oz/gal (546 g/L), as determined by the South Coast Air Quality Management District’s Laboratory Methods of Analysis for Enforcement Samples, Method 316A.
E 701.0 Installer Qualifications.
E 701.1 Scope. The provisions of this section address minimum qualifications of installers of mechanical systems covered within the scope of this appendix.
E 702.0 Qualifications.
E 702.1 General. Where permits are required, the Authority Having Jurisdiction shall have the authority to require contractors, installers, or service technicians to demonstrate competency. Where determined by the Authority Having Jurisdiction, the contractor, installer, or service technician shall be licensed to perform such work.

Part I

E 801.0 Heating, Ventilation, and Air Conditioning Systems Commissioning.
E 801.1 Applicability. The provisions of this section apply to the commissioning of commercial and institutional HVAC systems.

E 802.0 Commissioning.
E 802.1 Commissioning Requirements. HVAC commissioning shall be included in the design and construction processes of the project to verify that the HVAC systems and components meet the owner’s project requirements and in accordance with this appendix. Commissioning shall be performed in accordance with this appendix by personnel trained and certified in commissioning by a nationally recognized organization. Commissioning requirements shall include the following:
   (1) Owner’s project requirements
   (2) Basis of design
   (3) Commissioning measures shown in the construction documents
   (4) Commissioning plan
   (5) Functional performance
   (6) Testing
   (7) Post construction documentation and training
   (8) Commissioning report
HVAC systems and components covered by this appendix as well as process equipment and controls, and renewable energy systems shall be included in the scope of the commissioning requirements.
E 802.2 Owner’s Project Requirements (OPR). The performance goals and requirements of the HVAC system shall be documented before the design phase of the project begins. This documentation shall include not less than the following:
   (1) Environmental and sustainability goals
   (2) Energy efficiency goals
   (3) Indoor environmental quality requirements
   (4) Equipment and systems performance goals
   (5) Building occupant and O&M personnel expectations
E 802.3 Basis of Design (BOD). A written explanation of how the design of the HVAC system meets the owner’s project requirements shall be completed at the design phase of the building project, and updated as necessary during the design and construction phases. The basis of design document shall cover not less than the following systems:
   (1) Heating, ventilation, air conditioning (HVAC) systems and controls
   (2) Water heating systems
   (3) Renewable energy systems
E 802.4 Commissioning Plan. A commissioning plan shall be completed to document the approach to how the project will be commissioned, and shall be started during the design phase of the building project. The commissioning plan shall include not less than the following:
   (1) General project information
   (2) Commissioning goals
   (3) Systems to be commissioned. Plans to test systems and components shall include not less than the following:
APPENDIX E

(a) A detailed explanation of the original design intent.
(b) Equipment and systems to be tested, including the extent of tests.
(c) Functions to be tested.
(d) Conditions under which the test shall be performed.
(e) Measurable criteria for acceptable performance.

(4) Commissioning team information.
(5) Commissioning process activities, schedules, and responsibilities. Plans for the completion of commissioning requirements listed in Section E 802.5 through Section E 802.7 shall be included.

E 802.5 Functional Performance Testing. Functional performance tests shall demonstrate the correct installation and operation of each component, system, and system-to-system interface in accordance with the approved plans and specifications. Functional performance testing reports shall contain information addressing each of the building components tested, the testing methods utilized, and readings and adjustments made.

E 802.6 Post Construction Documentation and Training. A system manual and systems operations training are required.

E 802.6.1 Systems Manual. Documentation of the operational aspects of the HVAC system shall be completed within the systems manual and delivered to the building owner and facilities operator. The systems manual shall include not less than the following:
(1) Site information, including facility description, history, and current requirements.
(2) Site contact information.
(3) Basic O&M, including general site operating procedures, basic troubleshooting, recommended maintenance requirements, and site events log.
(4) Major systems.
(5) Site equipment inventory and maintenance notes.
(6) Equipment/system warranty documentation and information.
(7) “As-Built” design drawings.
(8) Other resources and documentation.

E 802.6.2 Systems Operations Training. The training of the appropriate maintenance staff for each equipment type or system shall include not less than the following:
(1) System/Equipment overview (what it is, what it does, and what other systems or equipment it interfaces with).
(2) Review of the information in the systems manual.
(3) Review of the record drawings on the system/equipment.

E 802.7 Commissioning Report. A complete report of commissioning process activities undertaken through the design, construction, and post-construction phases of the building project shall be completed and provided to the owner.

Part II

E 803.0 Commissioning Acceptance.
E 803.1 General. Part II of this appendix provides a means of verifying the commissioning requirements of Section E 802.1. The activities specified in Part II of this appendix includes three aspects, as described as follows:
(1) Visual inspection of the equipment and installation.
(2) Review of the certification requirements.
(3) Functional tests of the systems and controls.

E 803.2 Construction Documents. Details of commissioning acceptance requirements shall be incorporated into the construction documents, including information that describes the details of the functional tests to be performed. This information shall be permitted to be integrated into the specifications for testing and air balancing, energy management and control system, equipment startup procedures or commissioning. It is possible that the work will be performed by a combination of the test and balance (TAB) contractor, mechanical/electrical contractor, and the energy management control system (EMCS) contractor, so applicable roles and responsibilities shall be clearly called out.

E 803.2.1 Roles and Responsibilities. The roles and responsibilities of the persons involved in commissioning acceptance are included in Section E 803.2.1.1 through Section E 803.2.1.3.

E 803.2.1.1 Field Technician. The field technician shall be responsible for performing and documenting the results of the acceptance procedures on the certificate of acceptance forms. The field technician shall sign the certificate of acceptance to certify that the information he provides on the certificate of acceptance is true and correct.

E 803.2.1.2 Responsible Person. The responsible person shall be the contractor or registered design professional of record. A certificate of acceptance shall be signed by a responsible person to take responsibility for the scope of work specified by the certificate of acceptance document. The responsible person shall perform the field testing and verification work, and where this is the case, the responsible person shall complete and sign both the field technician’s signature block and the responsible person’s signature block on the certificate of acceptance form. The responsible person assumes responsibility for the acceptance testing work performed by the field technician agent or employee.

E 803.2.1.3 Certificate of Acceptance. The certificate of acceptance shall be submitted to the Authority Having Jurisdiction in order to receive the final certificate of occupancy. The Authority Having Jurisdiction shall not release a final certificate of occupancy unless the submitted certificate of acceptance demonstrates that the specified systems and equipment have been shown to be performing in
accordance with the applicable acceptance requirements. The Authority Having Jurisdiction has the authority to require the field technician and responsible person to demonstrate competence, to its satisfaction. Certificate of acceptance forms are located in Section E 806.0.

E 804.0 Commissioning Tests.
E 804.1 General. Functional tests shall be performed on new equipment and systems installed in either new construction or retrofit applications in accordance with this section. The appropriate certificate of acceptance form along with each specific test shall be completed and submitted to the Authority Having Jurisdiction before a final occupancy permit can be granted.

E 804.2 Tests. Functional testing shall be performed on the devices and systems listed in this section. The functional test results are documented using the applicable certificate of acceptance forms shown in parenthesis and located in Section E 806.0. The functional tests shall be performed in accordance with Section E 805.0 using the following forms:

1. Minimum ventilation controls for constant and variable air volume systems (Form MECH-2A).
2. Zone temperature and scheduling controls for constant volume, single-zone, unitary air conditioner and heat pump systems (Form MECH-3A).
3. Duct leakage on a subset of small single-zone systems depending on the ductwork location (Form MECH-4A).
4. Air economizer controls for economizers that are not factory installed and tested (Form MECH-5A).
5. Demand-controlled ventilation control systems (Form MECH-6A).
6. Supply fan variable flow controls (Form MECH-7A).
7. Valve leakage for hydronic variable flow systems and isolation valves on chillers and boilers in plants with more than one chiller or boiler being served by the same primary pumps through a common header (Form MECH-8A).
8. Supply water temperature reset control strategies programmed into the building automation system for water systems (e.g., chilled, hot, or condenser water) (Form MECH-9A).
9. Hydronic variable flow controls on a water system where the pumps are controlled by variable frequency drives (e.g., chilled and hot water systems; water-loop heat pump systems) (Form MECH-10A).
10. Automatic demand shed control (Form MECH-11A).
11. Fault detection and diagnostic for DX units (Form MECH-12A).
12. Automatic fault detection and diagnostic systems (AFDD) (Form MECH-13A).
13. Distributed energy storage DEC/DX AC systems (Form MECH-14A).
14. Thermal energy storage (TES) systems (Form MECH-15A).

E 804.3 Acceptance Process. The functional testing process shall comply with Section E 804.3.1 through Section E 804.3.4.

E 804.3.1 Plan Review. The installing contractor, registered design professional of record, owner’s agent, or the person responsible for certification of the acceptance testing on the certificate of acceptance (responsible person) shall review the plans and specifications to ensure that they are in accordance with the acceptance requirements. This is typically done prior to signing a certificate of compliance.

E 804.3.2 Construction Inspection. The installing contractor, registered design professional of record, owner’s agent, or the person responsible for certification of the acceptance testing on the certificate of acceptance (responsible person) shall perform a construction inspection prior to testing to ensure that the equipment that is installed is capable of complying with the requirements of this appendix and is calibrated. The installation of associated systems and equipment necessary for proper system operation is required to be completed prior to the testing.

E 804.3.3 Acceptance Testing. One or more field technicians shall perform the acceptance testing; identify performance deficiencies; ensure that they are corrected; and where necessary, repeat the acceptance procedures until the specified systems and equipment are performing in accordance with the acceptance requirements. The field technician who performs the testing shall sign the certificate of acceptance to certify that the information has been provided to document the results of the acceptance procedures is true and correct.

The responsible person shall review the test results from the acceptance requirement procedures provided by the field technician and sign the certificate of acceptance to certify compliance with the acceptance requirements. The responsible person shall be permitted to perform the field technician’s responsibilities, and shall then sign the field technician declaration on the certificate of acceptance to certify that the information on the form is true and correct.

E 804.3.4 Certificate of Occupancy. The Authority Having Jurisdiction shall not issue the final certificate of occupancy until required certificates of acceptance are submitted. Copies of completed, signed certificates of acceptance are required to be posted, or made available with the permit(s), and shall be made available to the Authority Having Jurisdiction.

E 805.0 HVAC System Tests.
E 805.1 Variable Air Volume Systems (Form MECH-2A). This test ensures that adequate outdoor air ventilation is provided through the variable air volume air handling unit at two representative operating conditions. The test consists of measuring outdoor air values at maximum flow and at or near minimum flow. The test verifies that the minimum volume
of outdoor air is introduced to the air handling unit where the system is in occupied mode at these two conditions of supply airflow. This test shall be performed in conjunction with supply fan variable flow controls test procedures to reduce the overall system testing time as both tests use the same two conditions of airflow for their measurements.

**E 805.1 Test Procedure.** The procedure for performing a functional test for variable air volume systems shall be in accordance with Section E 805.1.1.1 and Section E 805.1.1.2.

**E 805.1.1 Construction Inspection.** Prior to functional testing, verify and document that the system controlling outside airflow is calibrated either in the field or factory.

**E 805.1.1.2 Functional Testing.** The functional testing shall be in accordance with the following steps:

1. Where the system has an outdoor air economizer, force the economizer high limit to disable economizer control (e.g., for a fixed dry-bulb high limit, lower the setpoint below the current outdoor air temperature).
2. Adjust supply airflow to either the sum of the minimum zone airflows or 30 percent of the total design airflow. Verify and document the following:
   1. Measured outside airflow reading is within 10 percent of the total ventilation air called for in the certificate of compliance.
   2. OSA controls stabilize within 5 minutes.
3. Adjust supply airflow to achieve design airflow. Verify and document the following:
   1. Measured outside airflow reading is within 10 percent of the total ventilation air called for in the certificate of compliance.
   2. OSA controls stabilize within 5 minutes.
4. Restore system to “as-found” operating conditions.

**E 805.2 Acceptance Criteria.** System controlling outdoor air flow shall be calibrated in the field or at the factory.

1. Measured outdoor airflow reading shall be within 10 percent of the total value found on the certificate of compliance under the following conditions:
   1. Minimum system airflow.
   2. Thirty percent of total design flow design supply airflow.

**E 805.2 Constant Volume Systems (Form MECH-2A).** The purpose of this test is to ensure that adequate outdoor air ventilation is provided through the constant volume air handling unit to the spaces served under operating conditions. The intent of this test is to verify that the minimum volume of outdoor air is introduced to the air handling unit during typical space occupancy.

**E 805.2.1 Test Procedure.** The procedure for performing a functional test for constant air volume systems shall be in accordance with Section E 805.2.1.1 and Section E 805.2.1.2.

**E 805.2.1.1 Construction Inspection.** Prior to functional testing, verify and document the following:

1. Minimum position is marked on the outside air damper.
2. The system has means of maintaining the minimum outdoor air damper position.

**E 805.2.1.2 Functional Testing.** Where the system has an outdoor air economizer, force the economizer to the minimum position and stop outside air damper modulation (e.g., for a fixed dry-bulb high limit, lower the setpoint below the current outdoor air temperature).

**E 805.2.2 Acceptance Criteria.** The system has a means of maintaining the minimum outdoor air damper position. The minimum damper position is marked on the outdoor air damper. The measured outside airflow reading shall be within 10 percent of the total ventilation air called for in the certificate of compliance.

**E 805.3 Constant Volume, Single-Zone, Unitary Air Conditioner and Heat Pumps Systems Acceptance (Form MECH-3A).** The purpose of this test is to verify the individual components of a constant volume, single-zone, unitary air conditioner and heat pump system function correctly; including: thermostat installation and programming, supply fan, heating, cooling, and damper operation.

**E 805.3.1 Test Procedure.** The procedure for performing a functional test for constant volume, single-zone, unitary air conditioner and heat pump systems shall be in accordance with Section E 805.3.1.1 and Section E 805.3.1.2.

**E 805.3.1.1 Construction Inspection.** Prior to functional testing, verify and document the following:

1. Thermostat is located within the space-conditioning zone that is served by the HVAC system.
2. Thermostat shall be in accordance with temperature adjustment and dead band requirements.
3. Occupied, unoccupied, and holiday schedules shall be programmed per the facility’s schedule.
4. Preoccupancy purge is programmed.

**E 805.3.1.2 Functional Testing.** The functional testing shall be in accordance with the following steps:

1. Disable economizer and demand control ventilation systems (where applicable).
2. Simulate a heating demand during the occupied condition. Verify and document the following:
Step 3: Simulate operation in the dead band during occupied condition. Verify and document the following:
(1) Supply fan operates continually.
(2) The unit provides heating.
(3) No cooling is provided by the unit.
(4) Outside air damper is at minimum position.

Step 4: Simulate cooling demand during occupied condition. Lock out economizer (where applicable). Verify and document the following:
(1) Supply fan operates continually.
(2) Neither heating nor cooling is provided by the unit.
(3) Outside air damper is at minimum position.

Step 5: Simulate operation in the dead band during unoccupied mode. Verify and document the following:
(1) Supply fan is off.
(2) Outside air damper is fully closed.
(3) Neither heating nor cooling is provided by the unit.
(4) Outside air damper is at minimum position.

Step 6: Simulate heating demand during unoccupied conditions. Verify and document the following:
(1) Supply fan is on (either continuously or cycling).
(2) Heating is provided by the unit.
(3) No cooling is provided by the unit.
(4) Outside air damper is either closed or at minimum position.

Step 7: Simulate cooling demand during unoccupied condition. Lock out economizer (where applicable). Verify and document the following:
(1) Supply fan is on (either continuously or cycling).
(2) Cooling is provided by the unit.
(3) No heating is provided by the unit.
(4) Outside air damper is either closed or at minimum position.

Step 8: Simulate manual override during unoccupied condition. Verify and document the following:
(1) System operates in “occupied” mode.
(2) System reverts to “unoccupied” mode where manual override time period expires.

E 805.3.2 Acceptance Criteria. Thermostat is located within the space-conditioning zone that is served by the respective HVAC system. The thermostat shall comply with temperature adjustment and dead band requirements. Occupied, unoccupied, and holiday schedules shall be programmed per the facility’s schedule. Premature purge is programmed in accordance with the requirements.

E 805.4 Air Distribution Systems (Form MECH-4A).
The purpose of this test is to verify duct work associated with non-exempt constant volume, single-zone, HVAC units (e.g., air conditioners, heat pumps, and furnaces) meet the material, installation, and insulation R-values and leakage requirements outlined in this appendix. This test is required for single-zone units serving less than 5000 square feet (464.52 m²) of floor area where 25 percent or more of the duct surface area is in one of the following spaces:
(1) Outdoors.
(2) In a space directly under a roof where the U-factor of the roof is greater than the U-factor of the ceiling.
(3) In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces.
(4) In an unconditioned crawl space.
(5) In other unconditioned spaces.

This test applies to both new duct systems and to existing duct systems being extended or the space conditioning system is altered by the installation or replacement of space conditioning equipment, including: replacement of the air handler; outdoor condensing unit of a split system air conditioner or heat pump; cooling or heating coil; or the furnace heat exchanger. Existing duct systems do not have to be tested where they are insulated or sealed with asbestos.

E 805.4.1 Test Procedure. The procedure for performing a functional test for air distribution systems shall be in accordance with Section E 805.4.1.1 and Section E 805.4.1.2.

E 805.4.1.1 Construction Inspection. Prior to functional testing, verify and document the following:
(1) Duct connections shall comply with the requirements of this appendix and this code.
(2) Flexible ducts are not compressed.
(3) Ducts are fully accessible for testing.
(4) Joints and seams are properly sealed in accordance with the requirements of this appendix.
(5) Insulation R-Values shall comply with the minimum requirements of this appendix.

E 805.4.1.2 Functional Testing. Perform duct leakage test in accordance with Section E 503.4.7.2.1.

E 805.4.2 Acceptance Criteria. Flexible ducts are not compressed or constricted. Duct connections shall comply with the requirements of this appendix and this code (new ducts only). Joints and seams are properly sealed in accordance with the requirements of this appendix and this code (new ducts only). Duct R-values shall comply with the minimum requirements of this appendix (new ducts only). Insulation is protected from damage and
suitable for outdoor usage where applicable (new ducts only). The leakage shall not exceed the rate in accordance with Section E 503.4.7.2.

E 805.5 Air Economizer Controls Acceptance (Form MECH-5A). The purpose of functionally testing an air economizer cycle is to verify that an HVAC system uses outdoor air to satisfy space cooling loads where outdoor air conditions are acceptable. There are two types of economizer controls: stand-alone packages and DDC controls. The stand-alone packages are commonly associated with small unitary rooftop HVAC equipment, and DDC controls are typically associated with built-up or large packaged air handling systems. Test procedures for both economizer control types are provided.

For units with economizers that are factory installed and certified operational by the manufacturer to economizer quality control requirements, the in-field economizer functional tests do not have to be conducted. A copy of the manufacturer’s certificate shall be attached to the Form MECH-5A. However, the construction inspection, including compliance with high-temperature lockout temperature setpoint, shall be completed regardless of whether the economizer is field or factory installed.

E 805.5.1 Test Procedure. The procedure for performing a functional test for air economizer controls shall comply with Section E 805.5.1.1 and Section E 805.5.1.2.

E 805.5.1.1 Construction Inspection. Prior to functional testing, verify and document the following:

1. Economizer lockout setpoint is in accordance with this appendix.
2. Economizer lockout control sensor is located to prevent false readings.
3. System is designed to provide up to 100 percent outside air without over-pressurizing the building.
4. For systems with DDC controls lockout sensor(s) are either factory calibrated or field calibrated.
5. For systems with non-DDC controls, manufacturer’s startup and testing procedures are applied.

E 805.5.1.2 Functional Testing. The functional testing shall be in accordance with the following steps:

Step 1: Disable demand control ventilation systems (where applicable).

Step 2: Enable the economizer, and simulate a cooling demand large enough to drive the economizer fully open. Verify and document the following:

1. Economizer damper is 100 percent opened and return air damper is 100 percent closed.
2. Where applicable, verify that the economizer remains 100 percent open where the cooling demand can no longer be met by the economizer alone.

Step 3: Disable the economizer and simulate a cooling demand. Verify and document the following:

1. Economizer damper shall close to its minimum position.
2. Applicable fans and dampers shall operate as intended to maintain building pressure.
3. The unit heating is disabled.

Step 4: Simulate a heating demand, and set the economizer so that it is capable of operating (e.g., actual outdoor air conditions are below lockout setpoint). Verify the economizer is at minimum position.

Step 5: Restore demand control ventilation systems (where applicable) and remove system overrides initiated during the test.

E 805.5.2 Acceptance Criteria. Air economizer controls acceptance criteria shall be as follows:

1. Where the economizer is factory installed and certified, a valid factory certificate is required for acceptance. No additional equipment tests are necessary.
2. Air economizer lockout setpoint is in accordance with this appendix. Outside sensor location accurately reads true outdoor air temperature and is not affected by exhaust air or other heat sources.
3. Sensors are located to achieve the desired control.
4. During economizer mode, the outdoor air damper shall modulate open to a maximum position and return air damper to 100 percent closed.
5. The outdoor air damper is 100 percent open before mechanical cooling is enabled and for units 75 000 Btu/h (22 kw) and larger remains at 100 percent open while mechanical cooling is enabled (economizer integration where used for compliance).
6. Where the economizer is disabled, the outdoor air damper closes to a minimum position; the return damper modulates 100 percent open, and mechanical cooling remains enabled.

E 805.6 Demand-Controlled Ventilation Systems Acceptance (Form MECH-6A). The purpose of this test is to verify that systems required to employ demand-controlled ventilation shall be permitted to vary outside ventilation flow rates based on maintaining interior carbon dioxide (CO₂) concentration setpoints. Demand-controlled ventilation refers to an HVAC system’s ability to reduce outdoor air ventilation flow below design values where the space served is at less than design occupancy. Carbon dioxide is a good indicator of occupancy load and is the basis used for modulating ventilation flow rates.

E 805.6.1 Test Procedure. The procedure for performing a functional test for demand-control ventilation (DVC) systems shall be in accordance with Section E 805.6.1.1 and Section E 805.6.1.2.
E 805.6.1.1 Construction Inspection. Prior to functional testing, verify and document the following:

(1) Carbon dioxide control sensor is factory calibrated or field-calibrated in accordance with this appendix.

(2) The sensor is located in the high-density space between 3 feet (914 mm) and 6 feet (1829 mm) above the floor or at the anticipated level of the occupants’ heads.

(3) DCV control setpoint is at or below the carbon dioxide concentration permitted by this appendix.

E 805.6.1.2 Functional Testing. The functional testing shall be in accordance with the following steps:

Step 1: Disable economizer controls.

Step 2: Simulate a signal at or slightly above the carbon dioxide concentration setpoint required by this appendix. Verify and document the following:

(1) For single zone units, outdoor air damper modulates open to satisfy the total ventilation air called for in the certificate of compliance.

(2) For multiple zone units, either outdoor air damper or zone damper modulate open to satisfy the zone ventilation requirements.

Step 3: Simulate signal well below the carbon dioxide setpoint. Verify and document the following:

(1) For single zone units, outdoor air damper modulates to the design minimum value.

(2) For multiple zone units, either outdoor air damper or zone damper modulate to satisfy the reduced zone ventilation requirements.

Step 4: Restore economizer controls and remove system overrides initiated during the test.

Step 5: With controls restored, apply carbon dioxide calibration gas at a concentration slightly above the setpoint to the sensor. Verify that the outdoor air damper modulates open to satisfy the total ventilation air called for in the certificate of compliance.

E 805.6.2 Acceptance Criteria. Demand-controlled ventilation systems acceptance criteria shall be as follows:

(1) Each carbon dioxide sensor is factory calibrated (with calibration certificate) or field calibrated.

(2) Each carbon dioxide sensor is wired correctly to the controls to ensure proper control of the outdoor air damper.

(3) Each carbon dioxide sensor is located correctly within the space 1 foot (305 mm) to 6 feet (1829 mm) above the floor.

(4) Interior carbon dioxide concentration setpoint is not more than 600 parts per million (ppm) plus outdoor air carbon dioxide value where dynamically measured or not more than 1000 ppm where no OSA sensor is provided.

(5) A minimum OSA setting is provided where the system is in occupied mode in accordance with this appendix regardless of space carbon dioxide readings.

(6) A maximum OSA damper position for DCV control shall be established in accordance with this appendix, regardless of space carbon dioxide readings.

(7) The outdoor air damper shall modulate open where the carbon dioxide concentration within the space exceeds setpoint.

(8) The outdoor air damper modulates closed (toward minimum position) where the carbon dioxide concentration within the space is below setpoint.

E 805.7 Supply Fan Variable Flow Controls (Form MECH-7A). The purpose of this test is to ensure that the supply fan in a variable air volume application modulates to meet system airflow demand. In most applications, the individual VAV boxes serving each space will modulate the amount of air delivered to the space based on heating and cooling requirements. As a result, the total supply airflow provided by the central air handling unit shall vary to maintain sufficient airflow through each VAV box. Airflow shall be controlled using a variable frequency drive (VFD) to modulate supply fan speed and vary system airflow. The most common strategy for controlling the VFD is to measure and maintain static pressure within the duct.

E 805.7.1 Test Procedure. The procedure for performing a functional test for supply fan variable controls shall be in accordance with Section E 805.7.1.1 and Section E 805.7.1.2.

E 805.7.1.1 Construction Inspection. Prior to functional testing, verify and document the following:

(1) Supply fan controls modulate to increase capacity.

(2) Supply fan maintains discharge static pressure within plus or minus 10 percent of the current operating set point.

(3) Supply fan controls stabilize within a 5 minute period.

E 805.7.1.2 Functional Testing. The functional testing shall be in accordance with the following steps:

Step 1: Simulate demand for design airflow. Verify and document the following:

(1) Supply fan controls modulate to increase capacity.

(2) Supply fan maintains discharge static pressure within plus or minus 10 percent of the current operating set point.

(3) Supply fan controls stabilize within a 5 minute period.
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Step 2: Simulate demand for minimum airflow. Verify and document the following:

1. Supply fan controls modulate to decrease capacity.
2. Current operating setpoint has decreased (for systems with DDC to the zone level).
3. Supply fan maintains discharge static pressure within plus or minus 10 percent of the current operating setpoint.
4. Supply fan controls stabilize within a 5 minute period.

Step 3: Restore system to correct operating conditions.

E 805.7.2 Acceptance Criteria. Supply fan variable flow controls acceptance criteria shall be as follows:

1. Static pressure sensor(s) is factory calibrated (with calibration certificate) or field calibrated.
2. For systems without DDC controls to the zone level, the pressure sensor setpoint is less than one-third of the supply fan design static pressure.
3. For systems with DDC controls with VAV boxes reporting to the central control panel, the pressure setpoint is reset by zone demand (box damper position or a trim and respond algorithm).

At full flow:

1. Supply fan maintains discharge static pressure within plus or minus 10 percent of the current operating control static pressure setpoint.
2. Supply fan controls stabilizes within a 5 minute period.
3. At minimum flow (not less than 30 percent of total design flow).
4. Supply fan controls modulate to decrease capacity.
5. Current operating setpoint has decreased (for systems with DDC to the zone level).
6. Supply fan maintains discharge static pressure within plus or minus 10 percent of the current operating setpoint.

E 805.8 Valve Leakage (Form MECH-8A). The purpose of this test is to ensure that control valves serving variable flow systems are designed to withstand the pump pressure over the full range of operation. Valves with insufficient actuators will lift under certain conditions causing water to leak through and loss of control. This test applies to the variable flow systems, chilled and hot-water variable flow systems, chiller isolation valves, boiler isolation valves, and water-cooled air conditioner and hydronic heat pump systems.

E 805.8.1 Test Procedure. The procedure for performing a functional test for valve leakage shall be in accordance with Section E 805.8.1.1 and Section E 805.8.1.2.

E 805.8.1.1 Construction Inspection. Prior to functional testing, verify and document the valve and piping arrangements were installed in accordance with the design drawings.

E 805.8.1.2 Functional Testing. The functional testing shall be in accordance with the following steps:

1. Record the differential pressure across the pumps.
2. Verify that this is within 5 percent of the submittal data for the pump.

Step 2: Reopen the pump discharge isolation valves. Automatically close valves on the systems being tested. Where three-way valves are present, close off the bypass line. Verify and document the following:

1. The valves automatically close.
2. Record the pressure differential across the pump.
3. Verify that the pressure differential is within 5 percent of the reading from Step 1 for the pump that is operating during the valve test.

Step 3: Restore system to correct operating conditions.

E 805.8.2 Acceptance Criteria. System has no flow where coils are closed and the pump is turned on.

E 805.9 Supply Water Temperature Reset Controls (Form MECH-9A). The purpose of this test is to ensure that both the chilled water and hot water supply temperatures are automatically reset based on either building loads or outdoor air temperature, as indicated in the control sequences. Many HVAC systems are served by central chilled and heating hot water plants. The supply water operating temperatures shall meet peak loads where the system is operating at design conditions. As the loads vary, the supply water temperatures shall be permitted to be adjusted to satisfy the new operating conditions. The chilled water supply temperature shall be permitted to be raised as the cooling load decreases, and heating hot water supply temperature shall be permitted to be lowered as the heating load decreases.

This requirement applies to chilled and hot water systems that are not designed for variable flow, and that have a design capacity greater than or equal to 500 000 Btu/h (147 kW).

E 805.9.1 Test Procedure. The procedure for performing a functional test for supply water temperature reset controls shall be in accordance with Section E 805.9.1.1 and Section E 805.9.1.2.

E 805.9.1.1 Construction Inspection. Prior to functional testing, verify and document the supply water temperature sensors shall be either factory or field calibrated.

E 805.9.1.2 Functional Testing. The functional testing shall be in accordance with the following steps:

1. Change reset control variable to its maximum value. Verify and document the following:
E 805.9.2 Acceptance Criteria. The supply water temperature sensors are either factory calibrated (with calibration certificates) or field calibrated. Sensor performance shall comply with the specifications. The supply water reset is operational.

E 805.10 Hydronic System Variable Flow Controls (Form MECH-10A). The purpose of this test is to ensure that hydronic variable flow chilled water and water-loop heat pump systems with circulating pumps larger than 5 hp (3.7 kW) vary system flow rate by modulating pump speed using a variable frequency drive (VFD) or equivalent. As the loads within the building fluctuate, control valves modulate the amount of water passing through each coil and add or remove the desired amount of energy from the air stream to satisfy the load. In the case of water-loop heat pumps, each two-way control valve associated with a heat pump will be closed where that unit is not operating. As each control valve modulates, the pump variable frequency drive (VFD) responds accordingly to meet system water flow requirements. This is not required on heating hot water systems with variable flow designs or for condensing water serving water cooled chillers.

E 805.10.1 Test Procedure. The procedure for performing a functional test for hydronic system variable flow controls shall be in accordance with Section E 805.10.1.1 and Section E 805.10.1.2.

E 805.10.1.1 Construction Inspection. Prior to functional testing, verify and document the pressure sensors are either factory or field calibrated.

E 805.10.1.2 Functional Testing. The functional testing shall comply with the following steps:
Step 1: Open control valves to increase water flow to not less than 90 percent design flow. Verify and document the following:
(1) Chilled or hot water temperature setpoint is reset to appropriate value.
(2) Actual supply temperature changes to meet setpoint.
(3) Verify that supply temperature is within 2 percent of the control setpoint.

Step 2: Change reset control variable to its minimum value. Verify and document the following:
(1) Chilled or hot water temperature setpoint is reset to appropriate value.
(2) Actual supply temperature changes to meet setpoint.
(3) Verify that supply temperature is within 2 percent of the control setpoint.

Step 3: Restore reset control variable to automatic control. Verify and document the following:
(1) Chilled or hot water temperature setpoint is reset to appropriate value.
(2) Actual supply temperature changes to meet setpoint.
(3) Verify that supply temperature is within 2 percent of the control setpoint.

E 805.10.2 Acceptance Criteria. The differential pressure sensor is either factory calibrated (with calibration certificates) or field calibrated. The pressure sensor shall be located at or near the most remote HX or control valve. The setpoint system controls shall stabilize.

E 805.11 Automatic Demand Shed Control (Form MECH-11A). The purpose of this test is to ensure that the central demand shed sequences have been properly programmed into the DDC system.

E 805.11.1 Test Procedure. The procedure for performing a functional test for automatic demand shed controls shall be in accordance with Section E 805.11.1.1 and Section E 805.11.1.2.

E 805.11.1.1 Construction Inspection. Prior to functional testing, verify and document that the EMCS interface enables activation of the central demand shed controls.

E 805.11.1.2 Functional Testing. The functional testing shall comply with the following steps:
Step 1: Engage the global demand shed system. Verify and document the following:
(1) That the cooling setpoint in noncritical spaces increases by the proper amount.
(2) That the cooling setpoint in critical spaces do not change.

Step 2: Disengage the global demand shed system. Verify and document the following:
(1) That the cooling setpoint in noncritical spaces return to their original values.
(2) That the cooling setpoint in critical spaces do not change.

E 805.11.2 Acceptance Criteria. The control system changes the setpoints of noncritical zones on activation of a single central hardware or software point then restores the initial setpoints where the point is released.
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**E 805.12 Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion (DX) Units (Form MECH-12A).** The purpose of this test is to verify proper fault detection and reporting for automated fault detection and diagnostics systems for packaged units. Automated FDD systems ensure proper equipment operation by identifying and diagnosing common equipment problems such as improper refrigerant charge, low airflow, or faulty economizer operation. Qualifying FDD systems receive a compliance credit where using the performance approach. A system that does not meet the eligibility requirements shall be permitted to be installed, but no compliance credit will be given.

**E 805.12.1 Test Procedure.** The procedure for performing a functional test for fault detection and diagnostics (FDD) for packaged direct-expansion (DX) units shall be in accordance with Section E 805.12.1.1 and Section E 805.12.1.2.

**E 805.12.1.1 Construction Inspection.** Prior to functional testing, verify and document that the FDD hardware is installed on equipment by the manufacturer, and that equipment make and model include factory-installed FDD hardware that match the information indicated on copies of the manufacturer’s cut sheets and on the plans and specifications.

This procedure applies to fault detection and diagnostics (FDD) system for direct-expansion packaged units containing the following features:

1. The unit shall include a factory-installed economizer and shall limit the economizer dead band to not more than 2°F (-17°C).
2. The unit shall include direct-drive actuators on outside air and return air dampers.
3. The unit shall include an integrated economizer with either differential dry-bulb or differential enthalpy control.
4. The unit shall include a low temperature lock-out on the compressor to prevent coil freeze-up or comfort problems.
5. Outside air and return air dampers shall have maximum leakage rates in accordance to this appendix.
6. The unit shall have an adjustable expansion control device such as a thermostatic expansion valve (TXV).
7. To improve the ability to troubleshoot charge and compressor operation, a high-pressure refrigerant port will be located on the liquid line. A low-pressure refrigerant port will be located on the suction line.
8. The following sensors shall be permanently installed to monitor system operation, and the controller shall have the capability of displaying the value of each parameter:
   (a) Refrigerant suction pressure
   (b) Refrigerant suction temperature
   (c) Liquid line pressure
   (d) Liquid line temperature
   (e) Outside air temperature
   (f) Outside air relative humidity
   (g) Return air temperature
   (h) Return air relative humidity
   (i) Supply air temperature
   (j) Supply air relative humidity

The controller will provide system status by indicating the following conditions:

1. Compressor enabled
2. Economizer enabled
3. Free cooling available
4. Mixed air low limit cycle active
5. Heating enabled

The unit controller shall have the capability to manually initiate each operating mode so that the operation of compressors, economizers, fans, and heating system can be independently tested and verified.

**E 805.12.2 Acceptance Criteria.** The system is able to detect a low airflow condition and report the fault. The system is able to detect where refrigerant charge is low or high and the fault is reported.

**E 805.13 Automatic Fault Detection Diagnostics (FDD) for Air Handling Units (AHU) and Zone Terminal Units (Form MECH-13A).** The purpose of this test is to verify that the system detects common faults in air handling units and terminal units. FDD systems for air handling units and zone terminal units require DDC controls to the zone level. Successful completion of this test provides a compliance credit where using the performance approach. An FDD system that does not pass this test shall be permitted to be installed, but no compliance credit will be given.

**E 805.13.1 Test Procedure.** The procedure for performing a functional test for automatic fault detection diagnostics (FDD) for Air Handling Units and Zone Terminal Units shall be in accordance with Section E 805.13.1.1.
**E 805.13.1.1 Functional Testing**. The functional testing shall be in accordance with Section E 805.13.1.1.1 and Section E 805.13.1.1.2.

**E 805.13.1.1.1 Functional Testing for Air Handling Units.** The functional testing of AHU with FDD controls shall be in accordance with the following steps:

Step 1: Sensor drift/failure:
1. Disconnect outside air temperature sensor from unit controller.
2. Verify that the FDD system reports a fault.
3. Connect OAT sensor to the unit controller.
4. Verify that FDD indicates normal system operation.

Step 2: Damper/actuator fault:
1. From the control system workstation, command the mixing box dampers to full open (100 percent outdoor air).
2. Disconnect power to the actuator and verify that a fault is reported at the control workstation.
3. Reconnect power to the actuator and command the mixing box dampers to full open.
4. Verify that the control system does not report a fault.
5. From the control system workstation, command the mixing box dampers to a full-closed position (0 percent outdoor air).
6. Disconnect power to the actuator and verify that a fault is reported at the control workstation.
7. Reconnect power to the actuator and command the dampers closed.
8. Verify that the control system does not report a fault during normal operation.

Step 3: Valve/actuator fault:
1. From the control system workstation, command the heating and cooling coil valves to full open or closed, then disconnect power to the actuator and verify that a fault is reported at the control workstation.

Step 4: Inappropriate simultaneous heating, mechanical cooling, and economizing or all functions:
1. From the control system workstation, override the heating coil valve and verify that a fault is reported at the control workstation.
2. From the control system workstation, override the cooling coil valve and verify that a fault is reported at the control workstation.
3. From the control system workstation, override the mixing box dampers and verify that a fault is reported at the control workstation.

**E 805.13.1.1.2 Functional Testing for Zone Terminal Units.** The functional testing of one of each type of terminal unit (VAV box) in the project not less than 5 percent of the terminal boxes shall be in accordance with the following steps:

Step 1: Sensor drift/failure:
1. Disconnect the tubing to the differential pressure sensor of the VAV box.
2. Verify that control system detects and reports the fault.
3. Reconnect the sensor and verify proper sensor operation.
4. Verify that the control system does not report a fault.

Step 2: Damper/actuator fault:
1. Damper stuck open.
   - (a) Command the damper to full open (room temperature above setpoint).
   - (b) Disconnect the actuator to the damper.
   - (c) Adjust the cooling setpoint so that the room temperature is below the cooling setpoint to command the damper to the minimum position. Verify that the control system reports a fault.
   - (d) Reconnect the actuator and restore to normal operation.
2. Damper stuck closed.
   - (a) Set the damper to the minimum position.
   - (b) Disconnect the actuator to the damper.
   - (c) Set the cooling setpoint below the room temperature to simulate a call for cooling. Verify that the control system reports a fault.
   - (d) Reconnect the actuator and restore to normal operation.

Step 3: Valve/actuator fault (for systems with hydronic reheat):
1. Command the reheat coil valve to full open.
2. Disconnect power to the actuator. Set the heating setpoint temperature to be lower than the current space temperature, to command the valve closed. Verify that the fault is reported at the control workstation.
3. Reconnect the actuator and restore normal operation.

Step 4: Feedback loop tuning fault (unstable airflow):
1. Set the integral coefficient of the box controller to a value 50 times the current value.
(2) The damper cycles continuously and airflow is unstable. Verify that the control system detects and reports the fault.

(3) Reset the integral coefficient of the controller to the original value to restore normal operation.

Step 5: Disconnected inlet duct:
(1) From the control system workstation, command the damper to full closed; then disconnect power to the actuator, and verify that a fault is reported at the control workstation.

E 805.13.2 Acceptance Criteria. The system is able to detect common faults with air-handling units, such as a sensor failure, a failed damper, an actuator, or an improper operating mode.

The system is able to detect and report common faults with zone terminal units, such as a failed damper, an actuator, or a control tuning issue.

E 805.14 Distributed Energy Storage DX AC System (Form MECH-14A). The purpose of this test is to verify the proper operation of distributed energy storage DX systems. Distributed energy systems (DES) reduce peak demand by operating during off-peak hours and storing cooling, usually in the form of ice. During peak cooling hours the ice is melted to avoid compressor operation. The system typically consists of a water tank containing refrigerant coils that cool the water and convert it to ice. As with a standard direction expansion (DX) air conditioner, the refrigerant is compressed in a compressor and then cooled in an air-cooled condenser. The liquid refrigerant then is directed through the coils in the water tank to make ice or to air handler coils to cool the building. This applies to constant or variable volume, direct expansion (DX) systems with distributed energy storage (DES/DXAC).

E 805.14.1 Test Procedure. The procedure for performing a functional test for distributed energy storage DX AC systems shall be in accordance with Section E 805.14.1.1 through Section E 805.14.1.3.

E 805.14.1.1 Construction Inspection. Prior to functional testing, verify and document the following:
(1) The water tank is filled to the proper level.
(2) The water tank is sitting on a foundation with adequate structural strength.
(3) The water tank is insulated and the top cover is in place.
(4) The DES/DXAC is installed correctly (e.g., refrigerant piping, etc.).
(5) Verify that the correct model number is installed and configured.

E 805.14.1.2 Functional Testing. The functional testing shall be in accordance with the following steps:
Step 1: Simulate cooling load during daytime period (e.g., by setting time schedule to include actual time and placing thermostat cooling setpoint below actual temperature). Verify and document the following:
(1) Supply fan operates continually.
(2) Where the DES/DXAC has cooling capacity, DES/DXAC shall run to meet the cooling demand (in ice melt mode).
(3) Where the DES/DXAC has no ice and there is a call for cooling, the DES/DXAC shall run in direct cooling mode.

Step 2: Simulate no cooling load during daytime condition. Verify and document the following:
(1) Supply fan operates in accordance with the facility thermostat or control system.
(2) The DES/DXAC and the condensing unit do not run.

Step 3: Simulate no cooling load during morning shoulder time period. Verify and document the following:
(1) The DES/DXAC is idle.

Step 4: Simulate a cooling load during morning shoulder time period. Verify and document the following:
(1) The DES/DXAC runs in direct cooling mode.

E 805.14.2 Acceptance Criteria. Distributed energy storage DXAC system acceptance criteria shall be as follows:
(1) Verify night time ice making operation.
(2) Verify that tank discharges during on-peak cooling periods.
(3) Verify that the compressor does not run and the tank does not discharge where there is no cooling demand during on-peak periods.
(4) Verify that the system does not operate during a morning shoulder period where there is no cooling demand.
(5) Verify that the system operates in direct mode (with compressor running) during the morning shoulder time period.

E 805.15 Thermal Energy Storage (TES) System (Form MECH-15A). The purpose of this test is to verify the proper operation of thermal energy storage (TES) systems. TES systems reduce energy consumption during peak demand periods by shifting energy consumption to nighttime. Operation of the thermal energy storage compressor during the night produces cooling energy which is stored in the form of cooled fluid or ice in tanks. During peak cooling hours the
thermal storage is used for cooling to prevent the need for chiller operation. This section is limited to the following types of TES systems:

1. Chilled water storage
2. Ice-on-coil
3. Ice harvester
4. Brine
5. Ice-slurry
6. Eutectic salt
7. Clathrate hydrate slurry (CHS)

**E 805.15.1 Test Procedure.** The procedure for performing a functional test for thermal energy storage (TES) system shall be in accordance with Section E 805.15.1.1 and Section E 805.15.1.2.

**E 805.15.1.1 Construction Inspection.** Prior to functional testing, verify and document the following for the chiller and storage tank:

1. **Chiller:**
   a. Brand and Model
   b. Type (centrifugal, reciprocating, other)
   c. Capacity (tons) (SIZE)
   d. Starting efficiency (kW/ton) at beginning of ice production (COMP - kW/TON - START)
   e. Ending efficiency (kW/ton) at end of ice production (COMP - kW/TON/END)
   f. Capacity reduction (percent/°F) (PER – COMP - REDUCT/F)
   g. Verify that the efficiency of the chiller meets or exceeds the requirements of Section E 501.0.

2. **Storage Tank:**
   a. Storage type (TES-TYPE)
   b. Number of tanks (SIZE)
   c. Storage capacity per tank (ton-hours) (SIZE)
   d. Storage rate (tons) (COOL – STORE - RATE)
   e. Discharge rate (tons) (COOL – SUPPLY - RATE)
   f. Auxiliary power (watts) (PUMPS + AUX - kW)
   g. Tank area (CTANK – LOSS - COEFF)
   h. Tank insulation (R-Value) (CTANK – LOSS – COEFF)

3. **TES System:**
   a. The TES system is one of the above eligible systems.
   b. Initial charge rate of the storage tanks (tons).
   c. Final charge rate of the storage tank (tons).
   d. Initial discharge rate of the storage tanks (tons).
   e. Final discharge rate of the storage tank (tons).
   f. Charge test time (hrs).
   g. Discharge test time (hrs).
   h. Tank storage capacity after charge (ton-hrs).
   i. Tank storage capacity after discharge (ton-hrs).
   j. Tank standby storage losses (UA).
   k. Initial chiller efficiency (kW/ton) during charging.
   l. Final chiller efficiency (kW/ton) during charging.

**E 805.15.1.2 Functional Testing.** The functional testing shall be in accordance with the following steps:

Step 1: Verify that the TES system and the chilled water plant is controlled and monitored by an energy management system (EMS).

Step 2: Force the time to be between 9:00 p.m. and 9:00 a.m., and simulate a partial or no charge of the tank. Simulate no cooling load by setting the indoor temperature setpoint(s) higher than the ambient temperature.

Where the tank is full or nearly full of ice, it shall be permitted to adjust the control settings for this test. In some cases, the control system will not permit the chiller to start the ice-making process unless a portion of the ice has been melted. The controls designer shall be permitted to use an inventory meter (a 4-20 mA sensor that indicates water level) to determine whether or not ice-making can commence (e.g., not allow ice-making unless the inventory meter signal is less than 17 mA). Where this is the case, this limit can be reset to 20 mA during testing to allow ice making to occur.

Verify that the TES system starts charging (storing energy). This shall be checked by verifying flow and inlet and outlet temperatures of the storage tank, or directly by reading an inventory meter where the system has one.

Step 3: Force the time to be between 6:00 p.m. and 9:00 p.m., and simulate a partial charge on the tank. Simulate a cooling load by setting the indoor temperature setpoint lower than the ambient temperature. Verify that the TES system starts discharging. This shall be checked by observing tank inlet and outlet temperatures and system flow, or directly by reading an inventory meter where the system has one. Where the system has no charge, verify that the system will still attempt to meet the load through storage.
Step 4: Force the time to be between noon and 6:00 p.m., and simulate a cooling load by lowering the indoor air temperature setpoint below the ambient temperature. Verify that the tank starts discharging and the compressor is off.

Step 5: Force the time to be between 9:00 a.m. to noon, and simulate a cooling load by lowering the indoor air temperature setpoint below the ambient temperature. Verify that the tank does not discharge and the cooling load is met by the compressor.

Step 6: Force the time to be between 9:00 p.m. and 9:00 a.m. and simulate a full tank charge. This can be done in a couple of ways:

1. By changing the inventory sensor limit that indicates tank capacity to the energy management system so that it indicates a full tank.

2. By resetting the coolant temperature that indicates a full charge to a higher temperature than the current tank leaving temperature. Verify that the tank charging is stopped.

Step 7: Force the time to be between noon and 6:00 p.m. and simulate no cooling load by setting the indoor temperature setpoint above the ambient temperature. Verify that the tank does not discharge and the compressor is off.

E 805.15.2 Acceptance Criteria. Thermal energy storage (TES) system acceptance criteria shall be as follows:

1. Verify that the system is able to charge the storage tank during off-peak periods where there is no cooling load.

2. Verify that tank discharges during on-peak cooling periods.

3. Verify that the compressor does not run and the tank does not discharge where there is no cooling demand during on-peak periods.

4. Verify that the system does not operate during a morning shoulder period where there is no cooling demand.

5. Verify that the system operates in direct mode (with compressor running) during the morning shoulder time period.

E 806.0 Certificate of Acceptance Forms.

E 806.1 General. This section includes the certificate of acceptance forms referenced in Section E 804.0 and Section E 805.0.
# APPENDIX E

## UNIFORM MECHANICAL CODE - PREPRINT

### CERTIFICATE OF ACCEPTANCE

<table>
<thead>
<tr>
<th>Outdoor Air Acceptance</th>
<th>MECH-2A</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Page 1 of 3)</td>
<td></td>
</tr>
</tbody>
</table>

**Project Name/Address:**

**System Name or Identification/Tag:**

**System Location or Area Served:**

**Enforcement Agency:**

**Permit Number:**

*Note: Submit one Certificate of Acceptance for each system that must demonstrate compliance.*

**Enforcement Agency Use:**

**Checked by/Date**

### FIELD TECHNICIAN’S DECLARATION STATEMENT

- I certify under penalty of perjury the information provided on this form is true and correct.
- I am the person who performed the acceptance requirements verification reported on this Certificate of Acceptance (Field Technician).
- I certify that the construction/installation identified on this form complies with the acceptance requirements indicated in the plans and specifications approved by the enforcement agency, and conforms to the applicable acceptance requirements and procedures specified in Section E 801.0 through Section E 806.0.
- I have confirmed that the Installation Certificate(s) for the construction/installation identified on this form has been completed and is posted or made available with the building permit(s) issued for the building.

**Company Name:**

**Field Technician’s Name:**

**Field Technician’s Signature:**

**Date Signed:**

**Position with Company (Title):**

### RESPONSIBLE PERSON’S DECLARATION STATEMENT

- I certify under penalty of perjury that I am the Field Technician, or the Field Technician is acting on my behalf as my employee or my agent and I have reviewed the information provided on this form.
- I am a licensed contractor or registered design professional who is eligible per the requirements of the Authority Having Jurisdiction to take responsibility for the scope of work specified on this document and attest to the declarations in this statement (responsible person).
- I certify that the information provided on this form substantiates that the construction/installation identified on this form complies with the acceptance requirements indicated in the plans and specifications approved by the enforcement agency, and conforms to the applicable acceptance requirements and procedures specified in Section E 801.0 through Section E 806.0.
- I have confirmed that the Installation Certificate(s) for the construction/installation identified on this form has been completed and is posted or made available with the permit(s) issued for the building.
- I will ensure that a completed, signed copy of this Certificate of Acceptance shall be posted, or made available with the building permit(s) issued for the building, and made available to the enforcement agency for all applicable inspections. I understand that a signed copy of this Certificate of Acceptance is required to be included with the documentation the builder provides to the building owner at occupancy.

**Company Name:**

**Phone:**

**Responsible Person’s Name:**

**Responsible Person’s Signature:**

**License:**

**Date Signed:**

**Position With Company (Title):**
### Outdoor Air Acceptance

#### Project Name/Address:

#### System Name or Identification/Tag:

#### System Location or Area Served:

#### Intent:
Verify measured outside airflow reading is within ±10% of the total required outside airflow value found in Section E 805.1 through Section E 805.2.2

#### Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   a. Watch.
   b. Calibrated means to measure airflow.
2. Check one of the following:
   - Variable Air Volume (VAV) - Check as appropriate:
     a. Sensor used to control outdoor air flow must have calibration certificate or be field calibrated.
     - Calibration certificate (attach calibration certification).
     - Field calibration (attach results).
   - Constant Air Volume (CAV) - Check as appropriate:
     - System is designed to provide a fixed minimum OSA when the unit is on.

#### Outdoor Air Acceptance

<table>
<thead>
<tr>
<th>A. Functional Testing</th>
<th>CAV</th>
<th>VAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Verify unit is not in economizer mode during test - check appropriate column.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Step 1: CAV and VAV testing at full supply airflow.

| a. | Adjust supply to achieve design airflow. |
| b. | Measured outdoor airflow reading (ft³/min). |
| c. | Required outdoor airflow (ft³/min). |
| d. | Time for outside air damper to stabilize after VAV boxes open (minutes). |
| e. | Return to initial conditions (check). |

#### Step 2: VAV testing at reduced supply airflow.

| a. | Adjust supply airflow to either the sum of the minimum zone airflows or 30% of the total design airflow. |
| b. | Measured outdoor airflow reading (ft³/min). |
| c. | Required outdoor airflow (ft³/min). |
| d. | Time for outside air damper to stabilize after VAV boxes open and minimum airflow achieved (minutes). |
| e. | Return to initial conditions (check). |

#### B. Testing Calculations and Results.

<table>
<thead>
<tr>
<th>CAV</th>
<th>VAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent OSA at full supply airflow (% OAFA for Step 1).</td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>% OAFA = Measured outside air reading / Required outside air (Step 1b / Step 1c)</td>
</tr>
<tr>
<td>b.</td>
<td>90% ≤ % OAFA ≤ 110%</td>
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<tr>
<td>c.</td>
<td>Outside air damper position stabilizes within 15 minutes (Step 1d &lt; 15 minutes)</td>
</tr>
</tbody>
</table>

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<tr>
<th>Y / N</th>
<th>Y / N</th>
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</thead>
</table>

| Percent OSA at reduced supply airflow (% OA RA for Step 2). |
| a. | % OA RA = Measured outside air reading / Required outside air (Step 2b / Step 2c). |
| b. | 90% ≤ % OA RA ≤ 110% |
| c. | Outside air damper position stabilizes within 15 minutes (Step 2d < 15 minutes). |

<table>
<thead>
<tr>
<th>Y / N</th>
<th>Y / N</th>
</tr>
</thead>
</table>

Note: Shaded boxes do not apply for CAV systems.

For SI units: 1 cubic foot per minute = 0.00047 m³/s
### CERTIFICATE OF ACCEPTANCE

**Outdoor Air Acceptance**  
(Page 3 of 3)

<table>
<thead>
<tr>
<th>Project Name/Address:</th>
<th>System Name or Identification/Tag:</th>
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</tr>
</thead>
</table>

#### C. PASS/FAIL Evaluation  
(check one):

- [ ] PASS: All Construction Inspection responses are complete and Testing Calculations & Results responses are positive (Y – yes).
- [ ] FAIL: Any Construction Inspection responses are incomplete OR there is one or more negative (N – no) responses in Testing Calculations & Results section. Provide explanation below. Use and attach additional pages if necessary.

---

PREPRINT
### CERTIFICATE OF ACCEPTANCE

**MECH-3A**

**Constant Volume Single Zone Unitary Air Conditioner and Heat Pump Systems**

<table>
<thead>
<tr>
<th>Project Name/Address:</th>
<th>System Name or Identification/Tag:</th>
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<tbody>
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<th>Permit Number:</th>
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</table>

**Note:** Submit one Certificate of Acceptance for each system that must demonstrate compliance.

**Enforcement Agency Use:** Checked by/Date

---

### FIELD TECHNICIAN’S DECLARATION STATEMENT

- I certify under penalty of perjury the information provided on this form is true and correct.
- I am the person who performed the acceptance requirements verification reported on this Certificate of Acceptance (Field Technician).
- I certify that the construction/installation identified on this form complies with the acceptance requirements indicated in the plans and specifications approved by the enforcement agency, and conforms to the applicable acceptance requirements and procedures specified in Section E 801.0 through Section E 806.0.
- I have confirmed that the Installation Certificate(s) for the construction/installation identified on this form has been completed and is posted or made available with the building permit(s) issued for the building.

<table>
<thead>
<tr>
<th>Company Name:</th>
<th>Field Technician’s Name:</th>
<th>Field Technician’s Signature:</th>
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</table>

**Date Signed:** **Position with Company (Title):**

---

### RESPONSIBLE PERSON’S DECLARATION STATEMENT

- I certify under penalty of perjury that I am the Field Technician, or the Field Technician is acting on my behalf as my employee or my agent and I have reviewed the information provided on this form.
- I am a licensed contractor or registered design professional who is eligible per the requirements of the Authority Having Jurisdiction to take responsibility for the scope of work specified on this document and attest to the declarations in this statement (responsible person).
- I certify that the information provided on this form substantiates that the construction/installation identified on this form complies with the acceptance requirements indicated in the plans and specifications approved by the enforcement agency, and conforms to the applicable acceptance requirements and procedures specified in Section E 801.0 through Section E 806.0.
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- I will ensure that a completed, signed copy of this Certificate of Acceptance shall be posted, or made available with the building permit(s) issued for the building, and made available to the enforcement agency for all applicable inspections. I understand that a signed copy of this Certificate of Acceptance is required to be included with the documentation the builder provides to the building owner at occupancy.

<table>
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<tr>
<th>Company Name:</th>
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<th>Responsible Person’s Name:</th>
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<thead>
<tr>
<th>License:</th>
<th>Date Signed:</th>
<th>Position With Company (Title):</th>
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</table>
### Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   a. None required
2. Installation
   - Thermostat is located within the space-conditioning zone that is served by the HVAC system.
3. Programming (check all of the following):
   - Thermostat meets the temperature adjustment and dead band requirements.
   - Occupied, unoccupied, and holiday schedules have been programmed per the facility’s schedule.
   - Preoccupancy purge has been programmed to meet the requirements of Section E 805.3 through Section E 805.3.2.

### A. Functional Testing Requirements.

<table>
<thead>
<tr>
<th>Operating Modes</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling load during unoccupied condition</td>
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<tr>
<td>Cooling load during occupied condition</td>
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<tr>
<td>Manual override</td>
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<td>No-load during unoccupied condition</td>
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<tr>
<td>Heating load during unoccupied condition</td>
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<td>No-load during occupied condition</td>
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<td>Heating load during occupied condition</td>
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</table>

**Step 1: Check and verify the following for each simulation mode required.**

a. Supply fan operates continually.
b. Supply fan turns off.
c. Supply fan cycles on and off.
d. System reverts to “occupied” mode to satisfy any condition.
e. System turns off when manual override time period expires.
f. Gas-fired furnace, heat pump, or electric heater stages on.
g. Neither heating or cooling is provided by the unit.
h. No heating is provided by the unit.
i. No cooling is provided by the unit.
j. Compressor stages on.
k. Outside air damper is open to minimum position.
l. Outside air damper closes completely.
m. System returned to initial operating conditions after all tests have been completed: **Y/N**

---

### B. Testing Results

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
</table>

Indicate if Passed (P), Failed (F), or N/A (X), fill in appropriate letter.
CERTIFICATE OF ACCEPTANCE

Constant Volume Single Zone Unitary Air Conditioner and Heat Pump Systems

Project Name/Address:
System Name or Identification/Tag: System Location or Area Served:

C. PASS/FAIL Evaluation. (check one):

- [ ] PASS: All Construction Inspection responses are complete and Testing Results responses are “Pass” (P).
- [ ] FAIL: Any Construction Inspection responses are incomplete OR there is one or more “Fail” (F) responses in Testing Results section. Provide explanation below. Use and attach additional pages if necessary.
## CERTIFICATE OF ACCEPTANCE

Air Distribution Systems Acceptance

<table>
<thead>
<tr>
<th>Project Name/Address:</th>
<th>System Name or Identification/Tag:</th>
<th>System Location or Area Served:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Enforcement Agency:</th>
<th>Permit Number:</th>
</tr>
</thead>
</table>

**Note:** Submit one Certificate of Acceptance for each system that must demonstrate compliance.

### FIELD TECHNICIAN'S DECLARATION STATEMENT

- I certify under penalty of perjury the information provided on this form is true and correct.
- I am the person who performed the acceptance requirements verification reported on this Certificate of Acceptance (Field Technician).
- I certify that the construction/installation identified on this form complies with the acceptance requirements indicated in the plans and specifications approved by the enforcement agency, and conforms to the applicable acceptance requirements and procedures specified in Section E 801.0 through Section E 806.0.
- I have confirmed that the Installation Certificate(s) for the construction/installation identified on this form has been completed and is posted or made available with the building permit(s) issued for the building.

<table>
<thead>
<tr>
<th>Company Name:</th>
<th>Field Technician’s Name:</th>
<th>Field Technician’s Signature:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Date Signed:</th>
<th>Position with Company (Title):</th>
</tr>
</thead>
</table>

### RESPONSIBLE PERSON'S DECLARATION STATEMENT

- I certify under penalty of perjury that I am the Field Technician, or the Field Technician is acting on my behalf as my employee or my agent and I have reviewed the information provided on this form.
- I am a licensed contractor or registered design professional who is eligible per the requirements of the Authority Having Jurisdiction to take responsibility for the scope of work specified on this document and attest to the declarations in this statement (responsible person).
- I certify that the information provided on this form substantiates that the construction/installation identified on this form complies with the acceptance requirements indicated in the plans and specifications approved by the enforcement agency, and conforms to the applicable acceptance requirements and procedures specified in Section E 801.0 through Section E 806.0.
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<table>
<thead>
<tr>
<th>Responsible Person’s Name:</th>
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</table>

<table>
<thead>
<tr>
<th>License:</th>
<th>Date Signed:</th>
<th>Position With Company (Title):</th>
</tr>
</thead>
</table>

UNIFORM MECHANICAL CODE - PREPRINT

427
### CERTIFICATE OF ACCEPTANCE

**Air Distribution Systems Acceptance**

**Project Name/Address:**

**System Name or Identification/Tag:**

**System Location or Area Served:**

**Intent:**
- New single zone supply ductwork must be less than 6% leakage rate per Section E 805.4 through Section E 805.4.2.
- Existing single zone ductwork must be less than 15% leakage or other compliance path per Section E 805.4 through Section E 805.4.2.

### Construction Inspection

1. **Scope of test – New Buildings –** this test required on New Buildings only if all check boxes 1(a) through 1(c) are checked.
   - Existing Buildings – this test required if 1(a) through 1(d) are checked.
   - Ductwork conforms to the following (note if any of these are not checked, then this test is not required):
     - 1(a) Connected to a constant volume, single zone air conditioners, heat pumps, or furnaces.
     - 1(b) Serves less than 5000 square feet of floor area.
     - 1(c) Has more than 25% duct surface area located in one or more of the following spaces.
       - Outdoors.
       - A space directly under a roof where the U-factor of the roof is greater than U-factor of the ceiling.
       - A space directly under a roof with fixed vents or openings to the outside or unconditioned spaces.
       - An unconditioned crawl space.
       - Other unconditioned spaces.
     - 1(d) A duct is extended or any of the following replaced: air handler, outdoor condensing unit of a split system, cooling or heating coil, or the furnace heat exchanger.

2. **Instrumentation to perform test includes:**
   - a. Duct Pressure Test.

3. **Material and Installation.** Complying new duct systems shall have a checked box for all of the following categories (a) through (g):
   - a. Choice of drawbands. (check one of the following)
     - Stainless steel worm-drive hose clamps.
     - UV-resistant nylon duct ties.
   - b. Flexible ducts are not constricted in any way.
   - c. Duct leakage tests performed before access to ductwork and connections are blocked.
   - d. Joints and seams are not sealed with cloth back rubber adhesive tape unless used in combination with mastic and drawbands.
   - e. Duct R-values are verified R-8 per Section E 805.4 through Section E 805.4.2.
   - f. Ductwork located outdoors has insulation that is protected from damage and suitable for outdoor service.
   - g. A sticker has been affixed to the exterior surface of the air handler access door per Section E 805.4 through Section E 805.4.2.

For SI units: 1 square foot = 0.0929 m²
# CERTIFICATE OF ACCEPTANCE

**MECH-4A**

## Air Distribution Systems Acceptance

### Project Name/Address:

<table>
<thead>
<tr>
<th>System Name or Identification/Tag:</th>
<th>System Location or Area Served:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Air Distribution System Leakage Diagnostic.

The installing contractor must pressure test every new HVAC systems that meet the requirements of Section E 805.4 through Section E 805.4.2 and every retrofit to existing HVAC systems that meet the requirements of Section E 805.4 through Section E 805.4.2.

### RATED FAN FLOW (applies to all systems)

<table>
<thead>
<tr>
<th>Measured Values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Cooling capacity or for heating only units heating capacity.</td>
</tr>
<tr>
<td>(a) Cooling capacity (for all units but heating only units) in tons.</td>
</tr>
<tr>
<td>(b) Heating capacity (for heating only units) kBTU/h.</td>
</tr>
<tr>
<td><strong>2.</strong> Fan flow calculation</td>
</tr>
<tr>
<td>(a) Cooling capacity in tons [\text{Line # 1a}] \times 400 \text{ft}^3/\text{min/ton}.</td>
</tr>
<tr>
<td>(b) Heating only cap. kBTU/h [\text{Line # 1b}] \times 21.7 \text{ft}^3/\text{min/kBTU/h}.</td>
</tr>
<tr>
<td><strong>3.</strong> Total calculated supply fan flow (2(\text{a})) or (2(\text{b})) \text{ft}^3/\text{min}.</td>
</tr>
</tbody>
</table>

### NEW CONSTRUCTION OR ENTIRE NEW DUCT SYSTEM ALTERATION:

Duct pressurization test results (\text{ft}^3/\text{min} @ 25 \text{Pa}).

| Enter tested leakage flow in \text{ft}^3/\text{min}: | \checkmark | \checkmark |
|--------------------------------------------------|-------------|
| **4.** Pass if leakage percentage \(\leq 6\%\): \[[\text{Line #4}] / \text{Line #3}] \times 100 \% | \square Pass \square Fail |

### ALTERATIONS: Pre-existing duct system with duct alteration and/or HVAC equipment change-out.

6. Enter tested leakage flow (cubic feet per minute): Pre-test of existing duct system prior to duct system alteration, equipment change-out, or both.

7. Enter tested leakage flow (cubic feet per minute): Final test of new duct system or altered duct system for duct system alteration, equipment change-out, or both.

### TEST OR VERIFICATION STANDARDS: For altered duct system and/or HVAC equipment change-out use one of the following three tests or verification standards for compliance:

8. Pass if leakage percentage <15\% \[\text{Line #7}] / \text{Line #3}] \times 100 \% | \square Pass \square Fail |

9. Pass if leakage reduction percentage >60\%  
   Leakage reduction = \[1 - \left[\text{Line#7}] / \text{Line#6}\right]\] \times 100 \% | \square Pass \square Fail |

10. Pass if all accessible leaks are sealed as confirmed by visual inspection and verification by HERS rater (sampling rate 100\%). | \square Pass \square Fail |

**Pass if One of Lines #8 through #10 pass** | \square Pass \square Fail |

---

For SI units: 1000 British thermal units per hour = 0.293 kW, 1 cubic foot per minute = 0.00047 m$^3$/s, 1 metric ton = 1000 kg
### Certificate of Acceptance

**Project Name/Address:**

**System Name or Identification/Tag:**

**System Location or Area Served:**

**Enforcement Agency:**

**Permit Number:**

**Note:** Submit one Certificate of Acceptance for each system that must demonstrate compliance.

**Enforcement Agency Use:** Checked by/Date

---

### Field Technician’s Declaration Statement

- I certify under penalty of perjury the information provided on this form is true and correct.
- I am the person who performed the acceptance requirements verification reported on this Certificate of Acceptance (Field Technician).
- I certify that the construction/installation identified on this form complies with the acceptance requirements indicated in the plans and specifications approved by the enforcement agency, and conforms to the applicable acceptance requirements and procedures specified in Section E 801.0 through Section E 806.0.
- I have confirmed that the Installation Certificate(s) for the construction/installation identified on this form has been completed and is posted or made available with the building permit(s) issued for the building.

**Company Name:**

**Field Technician’s Name:**

**Field Technician’s Signature:**

**Date Signed:**

**Position with Company (Title):**

---

### Responsible Person’s Declaration Statement

- I certify under penalty of perjury that I am the Field Technician, or the Field Technician is acting on my behalf as my employee or my agent and I have reviewed the information provided on this form.
- I am a licensed contractor or registered design professional who is eligible per the requirements of the Authority Having Jurisdiction to take responsibility for the scope of work specified on this document and attest to the declarations in this statement (responsible person).
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**Company Name:**

**Responsible Person’s Name:**

**Responsible Person’s Signature:**

**License:**

**Date Signed:**

**Position With Company (Title):**

---

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UNIFORM MECHANICAL CODE - PREPRINT
## CERTIFICATE OF ACCEPTANCE

### Air Economizer Controls Acceptance

**Project Name/Address:**

**System Name or Identification/Tag:**

**System Location or Area Served:**

### Intent:

**Verify that airside economizers function properly.**

### Construction Inspection

1. **Instrumentation to perform test includes, but not limited to:**
   - Handheld temperature probes calibration.
     - Date: (must be within last year).
   - Multimeter capable of measuring ohms and milliamps.

2. **Test method (check one of the following):**
   - [ ] Economizer comes from HVAC system manufacturer installed by and has been factory calibrated and tested. Attach documentation and complete certification statement. No functional testing required.
   - [ ] Economizer field installed and field tested or factory installed and field tested.

3. **Installation (check all of the following first level boxes):**
   - [ ] Economizer lockout setpoint complies with Section E 805.5 through Section E 805.5.2.
   - [ ] Economizer lockout control sensor is located to prevent false readings.
   - [ ] System is designed to provide up to 100% outside air without over-pressurizing the building.
   - [ ] For systems with DDC controls lockout sensor(s) are either factory calibrated or field calibrated.
   - [ ] For systems with non-DDC controls, manufacturer’s startup and testing procedures have been applied.

### A. Functional Testing.

#### Step 1: Disable demand control ventilation systems (if applicable).

#### Step 2: Enable the economizer and simulate a cooling demand large enough to drive the economizer fully open (check and verify the following).

- [ ] Economizer damper modulates 100% open.
- [ ] Return air damper modulates 100% closed.
- [ ] Where applicable, verify that the economizer remains 100% open when the cooling demand can no longer be met by the economizer alone.
- [ ] All applicable fans and dampers operate as intended to maintain building pressure.
- [ ] The unit heating is disabled.

#### Step 3: Simulate a cooling load and disable the economizer (check and verify the following).

- [ ] Economizer damper closes to its minimum position.
- [ ] All applicable fans and dampers operate as intended to maintain building pressure.
- [ ] The unit heating is disabled.

#### Step 4: Simulate a heating demand and enable the economizer (check and verify the following).

- [ ] Economizer damper closes to its minimum position.

#### Step 5: System returned to initial operating conditions.

**Y/N**

### B. Testing Results.

**PASS / FAIL**

**Step 1:** Simulate cooling load and enable the economizer (all check boxes are complete).

**Step 2:** Simulate cooling load and disable the economizer (all check boxes are complete).

**Step 3:** Simulate heating demand and enable the economizer (all check boxes are complete).
C. PASS/FAIL Evaluation (check one):

☐ PASS: All Construction Inspection responses are complete and Testing Results responses are “Pass.”

☐ FAIL: Any Construction Inspection responses are incomplete OR there is one or more “Fail” responses in Testing Results section. Provide explanation below. Use and attach additional pages if necessary.
# CERTIFICATE OF ACCEPTANCE

**Demand Control Ventilation Systems Acceptance**

**MECH-6A**

**Project Name/Address:**

**System Name or Identification/Tag:**

**System Location or Area Served:**

**Enforcement Agency:**

**Permit Number:**

*Note: Submit one Certificate of Acceptance for each system that must demonstrate compliance.*

**Enforcement Agency Use:** Checked by/Date

---

### FIELD TECHNICIAN’S DECLARATION STATEMENT

- I certify under penalty of perjury the information provided on this form is true and correct.
- I am the person who performed the acceptance requirements verification reported on this Certificate of Acceptance (Field Technician).
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**Company Name:**

**Field Technician’s Name:**

**Field Technician’s Signature:**

**Date Signed:**

**Position with Company (Title):**

---

### RESPONSIBLE PERSON’S DECLARATION STATEMENT

- I certify under penalty of perjury that I am the Field Technician, or the Field Technician is acting on my behalf as my employee or my agent and I have reviewed the information provided on this form.
- I am a licensed contractor or registered design professional who is eligible per the requirements of the Authority Having Jurisdiction to take responsibility for the scope of work specified on this document and attest to the declarations in this statement (responsible person).
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**Company Name:**

**Responsible Person’s Name:**

**Responsible Person’s Signature:**

**License:**

**Date Signed:**

**Position With Company (Title):**
### Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   - Calibrated handheld CO₂ analyzer.
   - Manufacturer’s calibration kit.
   - Calibrated CO₂/air mixtures.

2. Installation.
   - The sensor is located in the high density space between 3 feet and 6 feet above the floor or at the anticipated level of the occupants heads.

3. Documentation of all carbon dioxide control sensors includes (check one of the following):
   - Calibration method.
     - Factory-calibration certificate (certificate must be attached).
     - Field calibrated.
   - Sensor accuracy.
     - Certified by manufacturer to be no more than +/- 75 ppm calibration certificate must be attached.

### A. Functional Testing.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Disable economizer controls.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Outside air CO₂ concentration (select one of the following):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measured dynamically using CO₂ sensor.</td>
<td>ppm</td>
</tr>
<tr>
<td>c.</td>
<td>Interior CO₂ concentration setpoint (Outside CO₂ concentration + 600 ppm).</td>
<td>ppm</td>
</tr>
</tbody>
</table>

**Step 1:** Simulate a signal at or slightly above the CO₂ setpoint or follow manufacturers recommended testing procedures.

- For single zone units, outdoor air damper modulates opens to satisfy the total ventilation air called for in the certificate of compliance.
- For multiple zone units, either outdoor air damper or zone damper modulate open to satisfy the zone ventilation requirements.

**Step 2:** Simulate signal well below the CO₂ setpoint or follow manufacturers recommended procedures.

- For single zone units, outdoor air damper modulates to the design minimum value.
- For multiple zone units, either outdoor air damper or zone damper modulate to satisfy the reduced zone ventilation requirements.

**Step 3:** System returned to initial operating conditions.

Y/N

### B. Testing Results.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>PASS / FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1:</td>
<td>Simulate a high CO₂ load (check box complete).</td>
<td></td>
</tr>
<tr>
<td>Step 2:</td>
<td>Simulate a low CO₂ load (check box complete).</td>
<td></td>
</tr>
</tbody>
</table>

For SI units: 1 inch = 25.4 mm
C. PASS/FAIL Evaluation (check one):

- **PASS:** All Construction Inspection responses are complete and Testing Results responses are “Pass.”

- **FAIL:** Any Construction Inspection responses are incomplete OR there is one or more “Fail” responses in Testing Results section. Provide explanation below. Use and attach additional pages if necessary.

<table>
<thead>
<tr>
<th>System Name or Identification/Tag:</th>
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---
# CERTIFICATE OF ACCEPTANCE

## Supply Fan VFD Acceptance

### Project Name/Address:

<table>
<thead>
<tr>
<th>System Name or Identification/Tag:</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
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### Enforcement Agency:

<table>
<thead>
<tr>
<th>Permit Number:</th>
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<tbody>
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**Note:** Submit one Certificate of Acceptance for each system that must demonstrate compliance.

### Enforcement Agency Use: Checked by/Date

<table>
<thead>
<tr>
<th>Checked by/Date</th>
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### Field Technician’s Name:

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<th>Field Technician’s Signature:</th>
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<tr>
<td></td>
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</table>

### Date Signed:

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<tr>
<th>Position with Company (Title):</th>
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## RESPONSIBLE PERSON’S DECLARATION STATEMENT

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### Responsible Person’s Name:

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### License:

<table>
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<tr>
<th>Date Signed:</th>
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### Position With Company (Title):

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</table>
CERTIFICATE OF ACCEPTANCE

MECH-7A

Supplement VFD Acceptance

Project Name/Address:

System Name or Identification/Tag:  
System Location or Area Served:  

Intent:  
Verify that the supply fan in a variable air volume application modulates to meet system airflow demand.

Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   a. Calibrated differential pressure gauge.

2. Installation:
   - Discharge static pressure sensors are either factory calibrated or field-calibrated.
   - The static pressure location, setpoint, and reset control meets the requirements of Section E 805.7 through Section E 805.7.2.

3. Documentation of all discharge static pressure sensors including (check one of the following):
   - Field-calibrated.
   - Calibration complete, all pressure sensors within 10% of calibrated reference sensor.

A. Functional Testing.

<table>
<thead>
<tr>
<th>Step 1: Drive all VAV boxes to achieve design airflow.</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Supply fan controls modulate to increase capacity.</td>
<td>Y / N</td>
</tr>
<tr>
<td>b. Supply fan maintains discharge static pressure within +/-10% of the current operating setpoint.</td>
<td>Y / N</td>
</tr>
<tr>
<td>c. Supply fan controls stabilize within a 5 minute period.</td>
<td>Y / N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2: Drive all VAV boxes to minimum flow.</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Supply fan controls modulate to decrease capacity.</td>
<td>Y / N</td>
</tr>
<tr>
<td>b. Current operating setpoint has decreased (for systems with DDC to the zone level).</td>
<td>Y / N</td>
</tr>
<tr>
<td>c. Supply fan maintains discharge static pressure within +/-10% of the current operating setpoint.</td>
<td>Y / N</td>
</tr>
<tr>
<td>d. Supply fan controls stabilize within a 5 minute period.</td>
<td>Y / N</td>
</tr>
</tbody>
</table>

Step 3: System returned to initial operating conditions.  
Y / N

B. Testing Results.  
PASS / FAIL

Step 1: Drive all VAV boxes to achieve design airflow.
Step 2: Drive all VAV boxes to minimum flow.

C. PASS / FAIL Evaluation (check one):
- PASS: All Construction Inspection responses are complete and all Testing Results responses are “Pass.”
- FAIL: Any Construction Inspection responses are incomplete OR there is one or more “Fail” responses in Testing Results section. Provide explanation below. Use and attach additional pages if necessary.
# APPENDIX E

## CERTIFICATE OF ACCEPTANCE

**Valve Leakage Test**

<table>
<thead>
<tr>
<th>Project Name/Address:</th>
<th>System Location or Area Served:</th>
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### RESPONSIBLE PERSON’S DECLARATION STATEMENT

- I certify under penalty of perjury that I am the Field Technician, or the Field Technician is acting on my behalf as my employee or my agent and I have reviewed the information provided on this form.
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APPENDIX E

CERTIFICATE OF ACCEPTANCE

Valve Leakage Test

Project Name/Address: ____________________________

System Name or Identification/Tag: ____________________________

System Location or Area Served: ____________________________

Intent: Ensure that control valves serving variable flow systems are designed to withstand the pump pressure over the full range of operation.

Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   a. Calibrated differential pressure gauge.
   b. Pump curve submittals showing the shutoff head.

2. Installation.
   □ Valve and piping arrangements were installed per the design drawings.

A. Functional Testing.

<table>
<thead>
<tr>
<th>Pump Tag (Id)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Step 1: Determine pump dead head pressure.

a. Close pump discharge isolation valve. Y / N

b. Measure and record the differential pump pressure. Feet Water Column =

c. Record the shutoff head from the submittal. Feet Water Column =

d. The measurement across the pump in step 1b is within 5% of the pump submittal in step 1c. Y / N

e. Open pump discharge isolation valve. Y / N

Step 2: Automatically close all valves on the systems being tested. If three-way valves are present, close off the bypass line(s).

a. The 2-way valves automatically close. Y / N

b. Measure and record the differential pump pressure in feet of water column. Feet Water Column =

c. The measurement across the pump in step 2b is within 5% of the measurement in step 1b. Y / N

Step 3: System returned to initial operating conditions. Y / N

B. Testing Results.

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

Step 1: Pressure measurement is within 5% of submittal data for all pumps. □ □

Step 2: Pressure measurements are within 5%. □ □

C. PASS / FAIL Evaluation (check one):

□ PASS: All Construction Inspection responses are complete and all Testing Results responses are “Pass.”

□ FAIL: Any Construction Inspection responses are incomplete OR there is one or more “Fail” responses in Testing Results section. Provide explanation below. Use and attach additional pages if necessary.

For SI units: 1 inch water column = 0.249 kPa

UNIFORM MECHANICAL CODE - PREPRINT

439
<table>
<thead>
<tr>
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</table>
CERTIFICATE OF ACCEPTANCE

Supply Water Temperature Reset Controls Acceptance

Project Name/Address:

System Name or Identification/Tag: System Location or Area Served:

Intent: Ensure that both the chilled water and hot water supply temperatures are automatically reset based on either building loads or outdoor air temperature, as indicated in the control sequences.

Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   a. Calibrated reference temperature sensor or drywell bath.

2. Installation
   □ Supply water temperature sensors have been either factory or field calibrated.

3. Documentation of hydronic system supply temperature sensors including (check one of the following):
   □ Field-calibrated
   □ Calibration complete, hydronic system supply temperature sensors within 1% of calibrated reference sensor or drywell bath.

A. Functional Testing.

Step 1: Test maximum reset value.
   a. Change reset control variable to its maximum value. Y / N
   b. Verify that chilled or hot water temperature setpoint is reset to appropriate value. Y / N
   c. Verify that actual system temperature changes to within 2% of the new setpoint. Y / N

Step 2: Test minimum reset value.
   a. Change reset control variable to its minimum value. Y / N
   b. Verify that chilled or hot water temperature setpoint is reset to appropriate value. Y / N
   c. Verify that actual system temperature changes to within 2% of the new setpoint. Y / N

Step 3: Test maximum reset value.
   a. Restore reset control variable to automatic control. Y / N
   b. Verify that chilled or hot water temperature setpoint is reset to appropriate value. Y / N
   c. Verify that actual supply temperature changes to meet setpoint. Y / N
   d. Verify that actual supply temperature changes to within 2% of the new setpoint. Y / N

B. Testing Results.

System passes criteria in 1c, 2c, and 3d. PASS / FAIL

C. PASS / FAIL Evaluation (check one):

□ PASS: All Construction Inspection responses are complete and all Testing Results responses are “Pass.”

□ FAIL: Any Construction Inspection responses are incomplete OR there is one or more “Fail” responses in Testing Results section. Provide explanation below. Use and attach additional pages if necessary.
CERTIFICATE OF ACCEPTANCE

Hydronic System Variable Flow Control Acceptance

Project Name/Address:

System Name or Identification/Tag:

System Location or Area Served:

Enforcement Agency:

Permit Number:

Note: Submit one Certificate of Acceptance for each system that must demonstrate compliance.

Enforcement Agency Use: Checked by/Date

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Company Name:

Field Technician’s Name:

Field Technician’s Signature:

Date Signed:

Position with Company (Title):

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Company Name:

Responsible Person’s Name:

Responsible Person’s Signature:

License:

Date Signed:

Position With Company (Title):
CERTIFICATE OF ACCEPTANCE

Hydronic System Variable Flow Control Acceptance

Project Name/Address: ____________________________
System Name or Identification/Tag: ____________________________
System Location or Area Served: ____________________________

Intent: Ensure that when loads within the building fluctuate, control valves modulate the amount of water passing through each coil and add or remove the desired amount of energy from the air stream to satisfy the load.

Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   a. Calibrated differential pressure gauge.

2. Installation
   - Pressure sensors are either factory calibrated or field-calibrated.
   - Pressure sensor location, setpoint, and reset control meets the requirements of Section E 805.8 through Section E 805.8.2.

3. Documentation of all control pressure sensors including (check one of the following):
   - Factory-calibrated (proof required).
     - Factory-calibration certificate.
   - Field-calibrated.
     - Calibration complete, all pressure sensors within 10% of calibrated reference sensor.

A. Functional Testing.

Step 1: Design flow test.
- a. Open control valves to achieve a minimum of 90% of design flow. Y / N
- b. Verify that the pump speed increases. Y / N
- c. Are the pumps operating at 100% speed? Y / N
- d. Record the system pressure as measured at the control sensor. (Feet Water Column) = ____________
- e. Record the system pressure setpoint. (Feet Water Column) = ____________
- f. Is the pressure reading 1d within 5% of pressure setpoint 1e? Y / N
- g. Did the system operation stabilize within 5 minutes after completion of step 1a? Y / N

Step 2: Low flow test
- a. Close coil control valves to achieve a maximum of 50% of design flow. Y / N
- b. Verify that the current operating speed decreases (for systems with DDC to the zone level). Y / N
- c. Verify that the current operating speed has not increased (for all other systems that are not DDC). Y / N
- d. Record the system pressure as measured at the control sensor. (Feet Water Column) = ____________
- e. Record the system pressure setpoint. (Feet Water Column) = ____________
- f. Is the setpoint in 2e less than the setpoint in 1d? Y / N
- g. Is the pressure reading 2d within 5% of pressure setpoint 2e? Y / N
- h. Did the system operation stabilize within 5 minutes after completion of step 2a? Y / N

Step 3: System returned to initial operating conditions.
Y / N

B. Testing Results

PASS / FAIL

Step 1: Select pass if either 1c or 1f are true. □ □
Step 2: Select pass if 2b, 2e, 2f and 2g are true. □ □

For SI units: 1 inch water column = 0.249 kPa
C. PASS / FAIL Evaluation (check one):

- [ ] PASS: All **Construction Inspection** responses are complete and all **Testing Results** responses are “Pass.”
- [x] FAIL: Any **Construction Inspection** responses are incomplete OR there is one or more “Fail” responses in **Testing Results** section. Provide explanation below. Use and attach additional pages if necessary.
# CERTIFICATE OF ACCEPTANCE

### Automatic Demand Shed Control Acceptance

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| License: | Date Signed: |
| Position With Company (Title): |  |
**CERTIFICATE OF ACCEPTANCE**

**Automatic Demand Shed Control Acceptance**

**Intent:** Ensure that the central demand shed sequences have been properly programmed into the DDC system.

**Construction Inspection**

1. Instrumentation to perform test includes, but not limited to:
   a. None.
2. Installation.
   - The EMCS front end interface enables activation of the central demand shed controls.

### A. Functional Testing.

<table>
<thead>
<tr>
<th>Step 1: Engage the demand shed controls.</th>
<th>Pump Tag (Id)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Engage the central demand shed control signal.</td>
<td>Y / N</td>
</tr>
<tr>
<td>b. Verify that the current operating temperature setpoint in a sample of noncritical spaces increases by the proper amount.</td>
<td>Y / N</td>
</tr>
<tr>
<td>c. Verify that the current operating temperature setpoint in a sample of critical spaces does not change.</td>
<td>Y / N</td>
</tr>
</tbody>
</table>

| Step 2: Disengage the demand shed controls. | |
|-----------------------------------------| |
| a. Disengage the central demand shed control signal. | Y / N |
| b. Verify that the current operating temperature setpoint in the sample of noncritical spaces returns to their original value. | Y / N |
| c. Verify that the current operating temperature setpoint in the sample of critical spaces does not change. | Y / N |

### B. Testing Results.

Test passes if all answers are yes in Step 1 and Step 2.

| PASS / FAIL | |

### C. PASS / FAIL Evaluation (check one):

- **PASS:** All Construction Inspection responses are complete and all Testing Results responses are “Pass.”
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CERTIFICATE OF ACCEPTANCE  
MECH-12A

Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units  

Project Name/Address:  
System Name or Identification/Tag:  
System Location or Area Served:  

Enforcement Agency:  
Permit Number:  

Note: Submit one Certificate of Acceptance for each system that must demonstrate compliance.  
Enforcement Agency Use: Checked by/Date  

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Date Signed:  
Position With Company (Title):  

Phone:
### Intent:
The purpose of this test is to verify proper fault detection and reporting for automated fault detection and diagnostics systems for packaged units.

### Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   a. List of instrumentation may be needed or included.

2. Installation.
   - Verify that FDD hardware is installed on equipment by the manufacturer and that equipment make and model include factory-installed FDD hardware that matches the information indicated on copies of the manufacturer’s cut sheets and on the plans and specifications.

### A. Eligibility Criteria Results.

<table>
<thead>
<tr>
<th>A. Eligibility Criteria Results</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. A fault detection and diagnostics (FDD) system for direct-expansion packaged units shall contain the following features to be eligible for credit in the performance calculation method:</td>
<td>Y / N</td>
</tr>
<tr>
<td>b. The unit shall include a factory-installed economizer and shall limit the economizer dead band to no more than 2°F.</td>
<td>Y / N</td>
</tr>
<tr>
<td>c. The unit shall include direct-drive actuators on outside air and return air dampers.</td>
<td>Y / N</td>
</tr>
<tr>
<td>d. The unit shall include an integrated economizer with either differential dry-bulb or differential enthalpy control.</td>
<td>Y / N</td>
</tr>
<tr>
<td>e. The unit shall include a low temperature lockout on the compressor to prevent coil freeze-up or comfort problems.</td>
<td>Y / N</td>
</tr>
<tr>
<td>f. Outside air and return air dampers shall have maximum leakage rates conforming to Section E 805.12 through Section E 805.12.2.</td>
<td>Y / N</td>
</tr>
<tr>
<td>g. The unit shall have an adjustable expansion control device such as a thermostatic expansion valve (TXV).</td>
<td>Y / N</td>
</tr>
<tr>
<td>h. To improve the ability to troubleshoot charge and compressor operation, a high-pressure refrigerant port will be located on the liquid line. A low-pressure refrigerant port will be located on the suction line.</td>
<td>Y / N</td>
</tr>
<tr>
<td>i. The following sensors should be permanently installed to monitor system operation and the controller should have the capability of displaying the value of each parameter:</td>
<td>Y / N</td>
</tr>
<tr>
<td>- Refrigerant suction pressure</td>
<td></td>
</tr>
<tr>
<td>- Refrigerant suction temp</td>
<td></td>
</tr>
<tr>
<td>- Liquid line pressure</td>
<td></td>
</tr>
<tr>
<td>- Supply air relative humidity</td>
<td></td>
</tr>
<tr>
<td>- Outside air relative humidity</td>
<td></td>
</tr>
<tr>
<td>- Return air temp</td>
<td></td>
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<td>- Supply air temp</td>
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<td>- Return air relative humidity</td>
<td></td>
</tr>
<tr>
<td>- Outside air temp</td>
<td></td>
</tr>
<tr>
<td>j. The controller will provide system status by indicating the following conditions:</td>
<td>Y / N</td>
</tr>
<tr>
<td>- Compressor enabled</td>
<td></td>
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<tr>
<td>- Economizer enabled</td>
<td></td>
</tr>
<tr>
<td>- Free cooling available</td>
<td></td>
</tr>
<tr>
<td>- Heating enabled</td>
<td></td>
</tr>
<tr>
<td>- Mixed air low limit cycle active</td>
<td></td>
</tr>
<tr>
<td>k. The unit controller shall have the capability to manually initiate each operating mode so that the operation of compressors, economizers, fans, and heating system can be independently tested and verified.</td>
<td>Y / N</td>
</tr>
</tbody>
</table>

For SI units: °C = (°F-32)/1.8
B. Functional Testing.

<table>
<thead>
<tr>
<th>Step 1: Low airflow test.</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Test low airflow condition by replacing the existing filter with a dirty filter or appropriate obstruction.</td>
<td>Y / N</td>
</tr>
<tr>
<td>b. Verify that the fault detection and diagnostics system reports the fault.</td>
<td>Y / N</td>
</tr>
<tr>
<td>c. Verify that the system is able to verify the correct refrigerant charge.</td>
<td>Y / N</td>
</tr>
<tr>
<td>d. Verify that you are able to calibrate the following:</td>
<td>Y / N</td>
</tr>
</tbody>
</table>

C. Testing Results

<table>
<thead>
<tr>
<th>PASS / FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
</tr>
<tr>
<td>☐</td>
</tr>
</tbody>
</table>

Test passes if all answers are yes under Eligibility Criteria and Functional Testing.

☐ PASS: All Construction Inspection responses are complete and all Testing Results responses are “Pass.”

☐ FAIL: Any Construction Inspection responses are incomplete OR there is one or more “Fail” responses in Testing Results section. Provide explanation below. Use and attach additional pages if necessary.
## Certificate of Acceptance

### Automatic Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units and Zone Terminal Units Acceptance

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**Note:** Submit one Certificate of Acceptance for each system that must demonstrate compliance.

### Field Technician’s Declaration Statement

- I certify under penalty of perjury the information provided on this form is true and correct.
- I am the person who performed the acceptance requirements verification reported on this Certificate of Acceptance (Field Technician).
- I certify that the construction/installation identified on this form complies with the acceptance requirements indicated in the plans and specifications approved by the enforcement agency, and conforms to the applicable acceptance requirements and procedures specified in Section E 801.0 through Section E 806.0.
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### Responsible Person’s Declaration Statement

- I certify under penalty of perjury that I am the Field Technician, or the Field Technician is acting on my behalf as my employee or my agent and I have reviewed the information provided on this form.
- I am a licensed contractor or registered design professional who is eligible per the requirements of the Authority Having Jurisdiction to take responsibility for the scope of work specified on this document and attest to the declarations in this statement (responsible person).
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CERTIFICATE OF ACCEPTANCE

Automatic Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units and Zone Terminal Units Acceptance

Project Name/Address:

System Name or Identification/Tag: System Location or Area Served:

Intent: Verify that the system detects common faults in air handling units and zone terminal units.

Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   a. No instrumentation is required – changes are implemented at the building automation system control station.
2. Installation.
   a. The functional testing verifies proper installation of the controls for FDD for air handling units and zone terminal units. No additional installation checks are required.

A. Eligibility Criteria Results.

<table>
<thead>
<tr>
<th>Testing of each AHU with FDD controls shall include the following tests:</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1: Sensor Drift/Failure:</strong></td>
<td></td>
</tr>
<tr>
<td>a. Disconnect outside air temperature sensor from unit controller.</td>
<td>Y / N</td>
</tr>
<tr>
<td>b. Verify that the FDD system reports a fault.</td>
<td>Y / N</td>
</tr>
<tr>
<td>c. Connect OAT sensor to the unit controller.</td>
<td>Y / N</td>
</tr>
<tr>
<td>d. Verify that FDD indicates normal system operation.</td>
<td>Y / N</td>
</tr>
<tr>
<td><strong>Step 2: Damper/actuator fault.</strong></td>
<td></td>
</tr>
<tr>
<td>a. From the control system workstation, command the mixing box dampers to full open (100% outdoor air).</td>
<td>Y / N</td>
</tr>
<tr>
<td>b. Disconnect power to the actuator and verify that a fault is reported at the control workstation.</td>
<td>Y / N</td>
</tr>
<tr>
<td>c. Reconnect power to the actuator and command the mixing box dampers to full open.</td>
<td>Y / N</td>
</tr>
<tr>
<td>d. Verify that the control system does not report a fault.</td>
<td>Y / N</td>
</tr>
<tr>
<td>e. From the control system workstation, command the mixing box dampers to a full-closed position (0% outdoor air).</td>
<td>Y / N</td>
</tr>
<tr>
<td>f. Disconnect power to the actuator and verify that a fault is reported at the control workstation.</td>
<td>Y / N</td>
</tr>
<tr>
<td>g. Reconnect power to the actuator and command the dampers closed.</td>
<td>Y / N</td>
</tr>
<tr>
<td>h. Verify that the control system does not report a fault during normal operation.</td>
<td>Y / N</td>
</tr>
<tr>
<td><strong>Step 3: Valve/actuator fault.</strong></td>
<td></td>
</tr>
<tr>
<td>a. From the control system workstation, command the heating and cooling coil valves to full open or closed, then disconnect power to the actuator and verify that a fault is reported at the control workstation.</td>
<td>Y / N</td>
</tr>
<tr>
<td><strong>Step 4: Inappropriate simultaneous heating, mechanical cooling, and/or economizing.</strong></td>
<td></td>
</tr>
<tr>
<td>a. From the control system workstation, override the heating coil valve and verify that a fault is reported at the control workstation.</td>
<td>Y / N</td>
</tr>
<tr>
<td>b. From the control system workstation, override the cooling coil valve and verify that a fault is reported at the control workstation.</td>
<td>Y / N</td>
</tr>
<tr>
<td>c. From the control system workstation, override the mixing box dampers and verify that a fault is reported at the control workstation.</td>
<td>Y / N</td>
</tr>
</tbody>
</table>
B. Functional Testing for Zone Terminal Units.

Testing shall be performed on one of each type of terminal unit (VAV box) in the project. A minimum of 5% of results the terminal boxes shall be tested.

<table>
<thead>
<tr>
<th>Step 1: Sensor Drift/Failure:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Disconnect the tubing to the differential pressure sensor of the VAV box.</td>
</tr>
<tr>
<td>b. Verify that control system detects and reports the fault.</td>
</tr>
<tr>
<td>c. Reconnect the sensor and verify proper sensor operation.</td>
</tr>
<tr>
<td>d. Verify that the control system does not report a fault.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2: Damper/actuator fault.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>If the damper is stuck open:</strong></td>
</tr>
<tr>
<td>a. Command the damper to be fully open (room temperature above setpoint).</td>
</tr>
<tr>
<td>b. Disconnect the actuator to the damper.</td>
</tr>
<tr>
<td>c. Adjust the cooling setpoint so that the room temperature is below the cooling setpoint to command the damper to the minimum position. Verify that the control system reports a fault.</td>
</tr>
<tr>
<td>d. Reconnect the actuator and restore to normal operation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>If the damper is stuck closed:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Set the damper to the minimum position.</td>
</tr>
<tr>
<td>b. Disconnect the actuator to the damper.</td>
</tr>
<tr>
<td>c. Set the cooling setpoint below the room temperature to simulate a call for cooling. Verify that the control system reports a fault.</td>
</tr>
<tr>
<td>d. Reconnect the actuator and restore to normal operation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3: Valve/actuator fault (for systems with hydronic reheat).</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Command the reheat coil valve to full open.</td>
</tr>
<tr>
<td>b. Disconnect power to the actuator. Set the heating setpoint temperature to be lower than the current space temperature, to command the valve closed. Verify that the fault is reported at the control workstation.</td>
</tr>
<tr>
<td>c. Reconnect the actuator and restore to normal operation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4: Feedback loop tuning fault (unstable airflow).</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Set the integral coefficient of the box controller to a value 50 times the current value. Lower the space cooling setpoint to simulate a call for cooling.</td>
</tr>
<tr>
<td>b. The damper cycles continuously and airflow is unstable. Verify that the control system detects and reports the fault.</td>
</tr>
<tr>
<td>c. Reset the integral coefficient of the controller to the original value to restore normal operation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5: Disconnected inlet duct.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. From the control system workstation, command the damper to full closed, then disconnect power to the actuator and verify that a fault is reported at the control workstation.</td>
</tr>
</tbody>
</table>
## CERTIFICATE OF ACCEPTANCE

**MECH-13A**

**Automatic Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units and Zone Terminal Units Acceptance**

**Project Name/Address:**

**System Name or Identification/Tag:**

**System Location or Area Served:**

### C. Testing Results

<table>
<thead>
<tr>
<th>Test passes if all answers are yes under <strong>Functional Testing Sections.</strong></th>
<th>PASS / FAIL</th>
</tr>
</thead>
</table>

### D. PASS / FAIL Evaluation (check one):

- **PASS:** All **Construction Inspection** responses are complete and all **Testing Results** responses are “Pass.”
- **FAIL:** Any **Construction Inspection** responses are incomplete **OR** there is one or more “Fail” responses in **Testing Results** section. Provide explanation below. Use and attach additional pages if necessary.
## CERTIFICATE OF ACCEPTANCE

**Distributed Energy Storage DX AC Systems Acceptance**

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<thead>
<tr>
<th>Project Name/Address:</th>
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**Note:** Submit one Certificate of Acceptance for each system that must demonstrate compliance.

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- I certify under penalty of perjury the information provided on this form is true and correct.
- I am the person who performed the acceptance requirements verification reported on this Certificate of Acceptance (Field Technician).
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<th>Field Technician’s Signature:</th>
<th>Date Signed:</th>
<th>Position with Company (Title):</th>
</tr>
</thead>
</table>

### RESPONSIBLE PERSON’S DECLARATION STATEMENT

- I certify under penalty of perjury that I am the Field Technician, or the Field Technician is acting on my behalf as my employee or my agent and I have reviewed the information provided on this form.
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### CERTIFICATE OF ACCEPTANCE

Distributed Energy Storage DX AC Systems Acceptance

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</thead>
</table>

### Intent:
Verify that the system detects common faults in air handling units and zone terminal units.

### Construction Inspection

1. Instrumentation to perform test includes, but not limited to:
   a. No special instrumentation is required to perform these tests.

2. Installation.
   Prior to Performance Testing, verify and document the following:
   - The water tank is filled to the proper level.
   - The water tank is sitting on a foundation with adequate structural strength.
   - The water tank is insulated and the top cover is in place.
   - The DES/DXAC is installed correctly (refrigerant piping, etc.).
   - Verify that the correct model number is installed and configured.

### A. Functional Testing

<table>
<thead>
<tr>
<th>Step 1: Simulate no cooling load during a nighttime period by setting system time to between 9:00 p.m. and 6:00 a.m. Raise the space temperature setpoint above the current space temperature. Verify and document the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The system charges the tank.</td>
</tr>
<tr>
<td>b. The system does not provide cooling to the building.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2: Simulate cooling load during daytime period (e.g., by setting time schedule to include actual time and placing thermostat cooling set-point below actual temperature). Verify and document the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Supply fan operates continually during occupied hours.</td>
</tr>
<tr>
<td>b. If the DES/DXAC has cooling capacity, DES/DXAC runs to meet the cooling demand (in ice melt mode).</td>
</tr>
<tr>
<td>c. If the DES/DXAC has no ice and there is a call for cooling, the DES/DXAC runs in direct cooling mode.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3: Simulate no cooling load during daytime condition. Verify and document the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Supply fan operates as per the facility thermostat or control system.</td>
</tr>
<tr>
<td>b. The DES/DXAC and the condensing unit do not run.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4: Simulate no cooling load during morning shoulder time period. Verify and document the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The DES/DXAC is idle (the condensing unit and the refrigerant pumps remain off).</td>
</tr>
</tbody>
</table>

### B. Calibrating Controls

| a. Verify that you are able to set the proper time and date, as per manufacturer’s installation manual for approved installers. | Y / N |

### C. Testing Results

PASS / FAIL

Test passes if all answers are yes under **Functional Testing** and **Calibrating Controls**.

For SI units: 1 metric ton = 1000 kg, 1000 British thermal units per hour = 0.293 kW
| PASS: All Construction Inspection responses are complete and all Testing Results responses are “Pass.” |
|FAIL: Any Construction Inspection responses are incomplete OR there is one or more “Fail” responses in Testing Results section. Provide explanation below. Use and attach additional pages if necessary. |
### FIELD TECHNICIAN’S DECLARATION STATEMENT

- I certify under penalty of perjury the information provided on this form is true and correct.
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<tr>
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<th>Position With Company (Title):</th>
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</table>
**CERTIFICATE OF ACCEPTANCE**

**Thermal Energy Storage (TES) System Acceptance**

<table>
<thead>
<tr>
<th>Project Name/Address:</th>
<th>System Name or Identification/Tag:</th>
<th>System Location or Area Served:</th>
</tr>
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</table>

**Intent:** Verify proper operation of distributed energy storage DX systems.

**Construction Inspection**

1. Instrumentation to perform test includes, but not limited to:
   a. No special instrumentation is required for the acceptance tests.

**A. Certificate of Compliance Information**

The following Certificate of Compliance information for both the chiller and the storage tank shall be provided on the plans to document the key TES System parameters and allow plan check comparison to the inputs used in the DOE-2 simulation. DOE-2 keywords are shown in ALL CAPITALS in parentheses.

<table>
<thead>
<tr>
<th>a. Chiller</th>
<th>Brand and Model:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type (centrifugal, reciprocating, etc):</td>
<td></td>
</tr>
<tr>
<td>Capacity (tons): (Size)</td>
<td></td>
</tr>
<tr>
<td>Starting Efficiency (kW/ton): (at beginning of ice production) (COMP-kW/TON-START)</td>
<td></td>
</tr>
<tr>
<td>Ending Efficiency (kW/ton): (at end of ice production) (COMP-kW/TON-END)</td>
<td></td>
</tr>
<tr>
<td>Capacity Reduction (% / F): (PER-COMP-REDUCT/F)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b. Storage Tank</th>
<th>Storage Type (Check): (TES-TYPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Chilled Water Storage</td>
<td>□ Ice-on-Coil</td>
</tr>
<tr>
<td>□ Ice Harvester</td>
<td>□ Brine</td>
</tr>
<tr>
<td>□ Ice-Slurry</td>
<td>□ Eutectic Salt</td>
</tr>
</tbody>
</table>

- **Number of tanks (SIZE)**
- **Storage Capacity per Tank (ton-hours)**
- **Storage Rate (tons): (COOL-STORE-RATE)**
- **Discharge Rate (tons): (COOL-SUPPLY-RATE)**
- **Auxiliary Power (watts): (PUMP+ AUX-kW)**
- **Tank Area (square feet): (CTANK-LOSS-COEFF)**
- **Tank Insulation (R-Value): (CTANK-LOSS-COEFF)**

For SI units: 1 metric ton = 1000 kg, 1000 British thermal units per hour = 0.293 kW
**CERTIFICATE OF ACCEPTANCE**

**Thermal Energy Storage (TES) System Acceptance**

<table>
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<tr>
<th>Project Name/Address:</th>
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</table>

### B. Functional Testing

#### Step 1: TES System Design Verification

- **a.** In the TES System Design Verification part, the installing contractor shall certify the following information, which verifies proper installation of the TES System consistent with system design expectations:
  - ☐ The TES system is one of the above eligible systems
  - ☐ Initial charge rate of the storage tanks (tons)
  - ☐ Final charge rate of the storage tank (tons)
  - ☐ Final charge rate of the storage tank (tons)
  - ☐ Tank standby storage losses (UA)
  - ☐ Initial discharge rate of the storage tanks (tons)
  - ☐ Final discharge rate of the storage tank (tons)
  - ☐ Charge test time (hours)
  - ☐ Initial chiller efficiency (kW/ton) during charging
  - ☐ Discharge test time (hours)
  - ☐ Tank storage capacity after charge (ton-hours)
  - ☐ Tank storage capacity after discharge (ton-hours)
  - ☐ Final chiller efficiency (kW/ton) during charging

#### Results

- ☐ Y / N

#### Step 2: TES System Controls and Operation Verification

- **a.** The TES system and the chilled water plant is controlled and monitored by an EMS.
- **b.** Force the time between 9:00 p.m. and 9:00 a.m. and simulate a partial or no charge of the tank and simulate no cooling load by setting the indoor temperature setpoint higher than the ambient temperature. Verify that the TES system starts charging (storing energy).
  - ☐ Pass
  - ☐ Fail
- **c.** Force the time to be between 6:00 p.m. and 9:00 p.m. and simulate a partial charge on the tank and simulate a cooling load by setting the indoor temperature setpoint lower than the ambient temperature. Verify that the TES system starts discharging.
  - ☐ Pass
  - ☐ Fail
- **d.** Force the time to be between noon and 6:00 p.m. and simulate a cooling load by lowering the indoor air temperature setpoint below the ambient temperature. Verify that the tank starts discharging and the compressor is off. For systems designed to meet partial loads the system should be run until the TES storage is fully depleted. The number of hours of operation must meet or exceed the designed operational hours for the system.
  - ☐ Pass
  - ☐ Fail
- **e.** Force the time to be between 9:00 a.m. to noon, and simulate a cooling load by lowering the indoor air temperature setpoint below the ambient temperature. Verify that the tank does not discharge and the cooling load is met by the compressor only.
  - ☐ Pass
  - ☐ Fail
- **f.** Force the time to be between 9:00 p.m. and 9:00 a.m. and simulate a full tank charge by changing the output of the sensor to the EMS. Verify that the tank charging is stopped.
  - ☐ Pass
  - ☐ Fail
- **g.** Force the time to be between noon and 6:00 p.m. and simulate no cooling load by setting the indoor temperature setpoint above the ambient temperature. Verify that the tank does not discharge and the compressor is off.
  - ☐ Pass
  - ☐ Fail

#### C. PASS / FAIL Evaluation (check one):

- ☐ PASS: All Construction Inspection responses are complete and all Testing Results responses are “Pass.”
- ☐ FAIL: Any Construction Inspection responses are incomplete OR there is one or more “Fail” responses in Testing Results section. Provide explanation below. Use and attach additional pages if necessary.

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For SI units: 1 metric ton = 1000 kg, 1000 British thermal units per hour = 0.293 kW
APPENDIX F
THE SAFE OPERATION, CLOSURE, AND RESTARTING OF COOLING TOWERS

F 101.0 General.

F 101.1 Applicability. The provisions of this appendix address risk management practices of mechanical systems for safe operation during normal operation, interruption to normal operation (system shutdown), and restarting of cooling towers.

F 101.2 Building Water Systems. This appendix shall be applicable to building water systems for cooling towers.

F 101.3 Building Types. This appendix shall be applicable to the following building types:

(1) Non-residential (low- and high-rise)
   (a) Office buildings
   (b) Mercantile (seasonal retail)
   (c) Schools/dormitories
   (d) Hotels/motels
   (e) Assemblies
   (f) Healthcare facilities

(2) Residential
   (a) All except single and double family residence

F 201.0 Definitions.

F 201.1 General. For the purpose of this appendix, the following definitions shall apply:

Building Water. Water collected, conveyed, circulated, stored, drained, or discharged by building plumbing systems for use in and around buildings.

Building Water Systems. Potable and non-potable water systems in the building, or on-site.

Disinfectant. Chemical agent or physical treatments used to kill or inactivate pathogens.

Disinfection. The process of killing or inactivating pathogens.

Legionella. The name of the genus of bacteria that can cause a pneumonia called Legionnaires’ disease or a flu-like illness called Pontiac fever when inhaled, aspirated or directly introduced into the lungs of susceptible individuals. It is a common aquatic bacteria found in natural and building water systems, as well as in some soils.

Legionellosis. The term used to describe Legionnaires’ disease, Pontiac fever, and any illness caused by exposure to Legionella bacteria.

Monitoring. Conducting a planned sequence of observations or measurements of the physical and chemical characteristics of control measures.

Normal Operation. The state of a building water system when the building is open and being used as intended. This includes the normal hours of operation and the number of people that occupy the building.

Risk. The potential for harm to humans resulting from exposure to Legionella.

Risk Management. Systematic activities to reduce risk.

System Management. The set of actions that should be taken to ready a building for normal operations after an extended period of no or limited operations.

System Restarting. The set of actions that should be taken to ready a mechanical system for normal operations after an extended period of no or limited operations.

Water Management Program (WMP). A risk management plan to help building managers identify risks to water quality and establish clear guidelines for managing these risks at various points in the building lifecycle, including start-up, normal operation, under occupancy, water system shutdown, and water system restart. Such programs are often focused on Legionella risk prevention and are required in some states for certain building types to combat waterborne pathogens such as Legionellosis.

F 301.0 Normal Operation, Cooling Towers.

F 301.1 Legionella. Section F 301.2 through Section F 301.4.1.1 shall apply to cooling towers under normal operation.

Note: Water based mechanical system are generally closed and pressurized and have no potential to affect the health of occupants, except at the cooling tower. Cooling towers can carry Legionella on aerosolized water droplets and infect occupants in and outside of the building.

F 301.2 Water Management Program, Cooling Towers. For each cooling tower system, the owner shall have a maintenance program and plan prepared by a qualified person in accordance with ASHRAE 188, the manufacturer’s instructions, and the requirements of this section.

The plan shall be kept current and amended by a qualified person or building owner designee as needed to reflect any changes in the management and maintenance team, system design, operation or system control requirements for the cooling tower system. The plan shall be kept in the building where a cooling tower or cooling tower system is located, or in an adjacent building or structure on the same location and shall be made available to the Authority Having Jurisdiction for inspection.

The water management program shall include, but not be limited to, the following:

(1) Management and maintenance team. Identification, including names and contact information (such as mail, email addresses and telephone numbers) and description of the function of each person on the cooling tower system management and maintenance team, including:

   (a) The owner of the building where each cooling tower system is located, and any manager or other person
designated by the owner as responsible for compliance with the requirements of the Authority Having Jurisdiction.

(b) Person designated by the owner as a responsible person, as defined by the Authority Having Jurisdiction.

(c) Consultants, service company and qualified person who cleans, disinfects, delivers chemicals or services the cooling tower system.

(2) Cooling tower system. Identification, specifications and description of each cooling tower system and all components located at a specific address, including:

(a) The number of cooling towers in the cooling tower system.

(b) The location of each cooling tower in relation to the building and the building address, block and lot number.

(c) The dimensions and characteristics of the cooling tower system including total recirculating water volume, cooling tower tonnage, biocide delivery method, flow rate and other key characteristics.

(d) The purpose of the cooling tower system and seasonal or year-round operation including start and end date, if applicable. For systems with multiple cooling towers, conditional operation, such as cycling or scaling related to cooling demand, shall also be noted.

(e) The identification and/or registration number for each cooling tower where required by the Authority Having Jurisdiction.

(f) The cooling tower manufacturer, model number and serial number, if applicable.

(g) Flow diagram or schematic of the cooling tower system, identifying all of the principal components and appurtenances of the cooling tower system including makeup water and waste stream plumbing locations.

(3) Risk management assessment. The assessment shall identify risk factors for Legionella proliferation and specify risk management procedures for all or parts of each cooling tower system, and anticipated conditions including:

(a) Any dead legs or stagnant water in the recirculation system.

(b) Operating configurations and conditions that may occur after periods of extended inactivity lasting more than three days, including idling or low circulation while not being fully drained.

(c) System parts that require continual operation throughout the year making regular, periodic offline cleaning and disinfection difficult.

(d) Any components that may add additional risk factors for organic material buildup and microbial growth such as strainers and out-of-use filters.

(e) Sources of elevated organic contamination, including, but not limited to windblown debris, bird waste and plant material.

(f) Design configurations that present risk of direct sun exposure on basin, deck or fill.

(g) Ventilation intakes or other routes for human exposure to cooling tower aerosols.

(h) System components adversely affecting water quality management procedures.

(i) Other risks or limiting factors or constraints in the cooling tower system’s design and functioning.

(4) Cooling tower operation:

(a) Control measures, corrective actions, documentation, including a written checklist for routine monitoring and reporting as required by the Authority Having Jurisdiction, and any routine maintenance activities recommended by the manufacturer’s instructions, including performance measures, which may sufficiently demonstrate adequate implementation of the operation requirements described in the maintenance program and plan. Where there is a conflict between the requirements of this section and the manufacturer’s instructions, the maintenance program and plan shall reflect the most stringent requirement.

(b) Specific, detailed seasonal and temporary shutdown and start-up procedures.

(c) Notification and communication strategies among management and maintenance team members regarding the required corrective actions in response to process control activities, monitoring, sampling results and other actions taken to maintain the cooling tower system.

F 301.3 Water Treatment and Filtration Equipment. Water treatment and filtration of cooling towers shall be in accordance with Section F 301.3.1 through Section F 301.4.1.

F 301.3.1 Water Treatment. Water treatment shall be provided to control microbiological activity, scale, corrosion, sediment and solids in the system, and shall be in accordance with the following:

(1) Equipment and chemicals used shall be specified for the purpose of treating the open recirculating loop.

(2) The required schedule for inspection, maintenance, cleaning, and monitoring, and a corrective action plan.

(3) The requirements for documenting system water treatment.

F 301.3.2 Disinfection. The responsible person for initiating disinfection shall be identified in the water management program documents and the disinfection process shall include the following:

(1) Online disinfection.

(2) Emergency disinfection.
F 301.3.3 Water Treatment Chemicals. Water treatment chemicals, such as biocides, shall be applied using an automated dosing system, where possible, at regular intervals. The frequency and quantity of chemical dosing shall be defined in the water management program, and performed accordingly, based on the microbial activity of the system and the chemical parameters of the circulating water.

Prior to changing an existing chemical treatment system or introducing a new chemical treatment agent, cooling tower design, installation, operation, and maintenance shall be evaluated by a qualified person or building owner designee to ensure compatibility between the chemicals and the cooling tower system’s materials, and to minimize microbial growth and the release of aerosols.

The evaluation shall describe the optimum level of chemicals required to achieve the desired result in a manner which can be used as a system performance measure.

(1) Daily automatic treatment while in operation. Water in a cooling tower system shall be treated at least once a day when the system is in operation and such treatment shall be automated, unless the water management program and plan explicitly state how manual or less frequent biocide additions will provide effective control of Legionella growth.

(2) Recirculating system. A cooling tower system shall be operated and programmed to continually recirculate the water, irrespective of the building’s cooling demand of the system.

Exception: Where the water management program specifies in detail how the intended water treatment schedule will be carried out, and how effective biofilm and microorganism control will be achieved when the whole or a part of the system is idle during the scheduled chemical injection.

(3) Chemicals and biocides. Chemicals and biocides shall be used in quantities and combinations sufficient to control the presence of Legionella, minimize biofilms, and prevent scaling and corrosion that may facilitate microbial growth. It is recommended that oxidizing chemicals be used as the primary biocide control. For systems where oxidizing chemicals cannot be used as the primary biocide to control the presence of Legionella, building owners shall submit an alternative plan for effective bacteriological control for approval by the Authority Having Jurisdiction.

(a) Biocide applications. Any person who performs cleaning and disinfection or applies biocides in a cooling tower system shall be a certified person as required by the Authority Having Jurisdiction.

(b) Registered biocides. Only biocide products registered with the Authority Having Jurisdiction may be used to meet the disinfection requirements of this Appendix.

(c) Records. Water treatment records shall be kept for all chemicals and biocides added, noting the purpose of their use, the manufacturer’s name, the brand name, the safety data sheet, the date and time of each addition, and the amount added each week.

(d) Chemical and biocide additions. Chemicals and biocides shall be added in accordance with this appendix and the procedures described in the water management program addressing, as applicable, feeding mechanism, feeding location, frequency, set timer, duration, triggering events, control procedures, and target biocide residuals. Water treatment chemicals and biocides shall be used in accordance with the product label and manufacturer’s instructions.

F 301.4 Water Quality Monitoring. Water quality in the cooling tower shall be monitored as follows:

(1) Water quality parameters, including but not limited to pH, temperature, conductivity and biocidal indicators, shall be measured and recorded as specified in the water management program and plan as follows:

(a) Manual measurements as required by the manufacturer’s recommendation and the Authority Having Jurisdiction.

(b) When continuous, automated and/or remote measurements and recordings are used, the water management program and plan shall show how effective measurements of system process control are being monitored.

(2) A bacteriological indicator to estimate microbial content of recirculating water shall be collected and interpreted in accordance with Table F 301.4(2) at least once each week while the cooling tower system is operating. Indicators shall be taken at times and from water sampling points, as detailed in the water management program, that will be representative of water microbial content. Indicators may be taken at any time from constant chemical treatment systems. Indicators from systems that use intermittent biocide applications shall be taken before biocide application and reflect normal cooling tower operating conditions.

(3) Legionella culture testing shall be conducted not less than every 90 days during cooling tower system operation. A Legionella sample shall be analyzed by an accredited laboratory where Legionella appears on the laboratory’s scope of accreditation, or other laboratory approved by the Authority Having Jurisdiction. When required, the test results of all Legionella bacteria at or above the magnitude of (1000 CFU/mL) as indicated in Table F 301.4(1) shall be reported to the Authority Having Jurisdiction within 24 hours of receiving the test results.

Additional emergency Legionella sampling shall be conducted if any of the following occur:

(a) Power failure, system shutdown, or equipment failure of sufficient duration to allow for growth of bacteria.
(b) Loss of biocide treatment sufficient to allow for growth of bacteria.
(c) Failure of conductivity controls to maintain proper cycles of concentration.
(d) At the request of the Authority Having Jurisdiction upon a determination that one or more cases of legionellosis is or may be associated with the cooling tower, based on epidemiological data or laboratory testing.
(e) Any time two consecutive bacteriological indicator sample results are above 1000 CFU/mL as indicated in Table J301.4(1).
(f) Any other conditions specified by the Authority Having Jurisdiction.

(4) System monitoring and sampling locations shall be representative of the entire cooling tower system. The system shall be operating with water circulating in the system for at least one hour prior to water quality measurements or collection of samples.

(5) The maintenance program and plan shall identify the procedures, responsible parties, required response time(s) and notification protocol for corrective actions and shall include, at a minimum, corrective actions that shall be implemented according to the result levels in Table F 301.4(1).

F 301.4.1 Water Sampling. An analysis of water samples from a location capable of being contaminated with Legionella bacteria shall be performed as required by the Authority Having Jurisdiction to determine the number of organisms present in Colony Forming Units per milliliter (CFU/mL) of Legionella in the sample. The minimum remediation action shall be in accordance with Table F 301.4(1).

F 301.4.1.1 Legionella Test Levels. A means of controlling Legionella shall be established in accordance with applicable levels in accordance with the following:

(1) Levels Less than 10 CFU/mL. Water samples containing Legionella levels less than 10 CFU/mL shall be permitted to maintain the established water treatment program in accordance with Table F 301.4(1).
(2) Levels Between 10 CFU/mL and 1000 CFU/mL. Water samples containing Legionella levels greater than 10 CFU/mL, but less than 1000 CFU/mL shall require the water treatment program to be reviewed, instituted immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table F 301.4(1).
(3) Levels Greater than 1000 CFU/mL. Water samples containing Legionella levels greater than 1000 CFU/mL shall require the water treatment program to be reviewed, notify Authority Having Jurisdiction, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table F 301.4(1).

F 401.0 Interruption to Normal Operation.
F 401.1 Shutdown Date. When an interruption to normal operation occurs (system shutdown), a shutdown date shall be established prior to shutting down a cooling tower. A shutdown date of a cooling tower shall be a date after which the cooling tower is unlikely to be restarted for the season. Where shutdown of the cooling tower is required, a shutdown date shall be determined, and the requirements of Section F 401.1.1 through Section F 401.4 shall be completed.

F 401.1.1 Reduce Solids and Sterilize the System. The cooling tower shall be drained prior to system shut down. Biocide shall be applied in accordance with the manufacturer’s instructions to kill any bacteria or contaminants.

F 401.1.2 Drain, Inspect and Clean the System. Where an interruption to normal operation occurs, the following actions shall be performed:

(1) The cooling tower fill, sump, heat exchangers, chillers, and piping shall be drained.
(2) The system shall be cleaned as required by the manufacturer’s instructions.
(3) The system shall be inspected, and maintenance shall be performed as required by the manufacturer.
(4) The controllers shall be taken offline.
(5) The protective probes shall be removed.
(6) The tower fill and sump shall be drained.
(7) The heat exchangers, chillers and piping shall be drained and protected in accordance with the manufacturer’s instructions.

F 401.1.3 Refill, Flush and Drain the Cooling Tower System. Where an interruption to normal operation occurs, the following additional actions shall be performed:

(1) The system shall be refilled.
(2) A nonoxidizing biocide shall be added and recirculated in accordance with the manufacturer’s instructions.
(3) The cooling tower system shall be fully drained.

Note: It is possible that the cooling tower equipment is drained, but the cooling tower system remains in operation. A system operating on standby mode is not considered shut down. If water remains in the cooling tower system, the system is not considered shut down and water must circulate with regular biocide additions and active management.

F 401.1.4 Records. Records of all procedures and actions performed shall be kept.
F 501.0 System Shutdown.
F 501.1 General. Cooling towers that are in shutdown mode shall comply with the following:
(1) Operating configurations and conditions that may occur after periods of extended inactivity lasting more than three days, including idling or low circulation while not being fully drained.

F 501.2 Shutdown Procedures. System start-up and shutdown procedures shall include, but not be limited to, the following:
(1) Management of hazardous conditions associated with untreated water, including the following:

<table>
<thead>
<tr>
<th>LEGIONELLA CONCENTRATIONS IN COLONY FORMING UNITS (CFU/mL)</th>
<th>REMEDIATION ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>Maintain the established water treatment program</td>
</tr>
<tr>
<td>≥10 and &lt;100</td>
<td>Review water treatment program, institute immediate online disinfection, and retest water 3 days to 7 days after disinfection.</td>
</tr>
<tr>
<td>≥100 and &lt;1000</td>
<td>Review water treatment program, institute immediate online disinfection, and retest water 3 days to 7 days after disinfection.</td>
</tr>
<tr>
<td>≥1000</td>
<td>Review water treatment program, institute immediate online disinfection, and retest water 3 days to 7 days after disinfection. If the results of a retest are still ≥1000 CFU/mL, carry out system decontamination.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>HETEROPTROPIC PLATE COUNT AND DIP SLIDE RESULT (CFU/mL)</th>
<th>PROCESS TRIGGERED BY TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;10 000</td>
<td>Maintain water chemistry and biocide levels.</td>
</tr>
<tr>
<td>2</td>
<td>≥10 000 to &lt;100 000</td>
<td>Initiate immediate disinfection by increasing biocide concentration or using a different biocide within 24 hours, review treatment program, retest water within 3 days to 7 days.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsequent test results shall be interpreted in accordance with this table until level 1 is reached.</td>
</tr>
<tr>
<td>3</td>
<td>≥100 000 to &lt;1 000 000</td>
<td>Initiate immediate disinfection by increasing biocide concentration or using a different biocide within 24 hours, reviewing treatment program, performing visual inspection to evaluate need to perform cleaning and further disinfection. Retest water within 3 days to 7 days.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsequent test results shall be interpreted in accordance with this Table until level 1 is reached.</td>
</tr>
<tr>
<td>4</td>
<td>≥1 000 000</td>
<td>Initiate immediate disinfection by increasing biocides within 24 hours. Within 48 hours perform remediation of the tower by hyperhalogenating, cleaning, and flushing. Review treatment program, retest water within 3 days to 7 days.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsequent test results shall be interpreted in accordance with this Table until level 1 is reached.</td>
</tr>
</tbody>
</table>

Notes:
1. Performed by an accredited laboratory
2. At a minimum, dose the cooling water system with 5 ppm to 10 ppm free halogen residual for at least 1 hour; pH 7.0 to 7.6

Note: There is no evidence that HPC values alone directly relate to human health risk, based on epidemiological studies and a lack of correlation with the occurrence of waterborne pathogens. Threshold concentrations of HPC were selected based on interference with the coliform test and not health-related considerations. HPC is an analytic method used to measure the variety of heterotrophic bacteria that are common in water. Legionella require specialized culture media for isolation and detection, do not grow on the media used for HPC testing, and their presence is not correlated with HPC values. HPC is a useful tool for monitoring the efficiency of the water treatment process, measuring bacterial regrowth, and evaluating the function of disinfection systems.
(a) Shutdown that includes all chemical pretreatment steps, pump cycling protocols, and procedures for system drainage for shutdown periods longer than three days, or the duration specified by the water management program.

(b) Start-up from a drained system shall be in accordance with manufacturer’s recommendations.

(c) Start-up from an undrained or stagnant system that exceeds three days, or the number of idle days specified by the water management program or the manufacturer’s recommendations.

**F 501.3 Legionella Prevention.** The mechanical hydronic system shall be checked that it is safe to use after a prolonged shutdown to minimize the risk of Legionnaires’ disease and other diseases associated with water.

**Note:** Stagnant or standing water in a mechanical hydronic system can increase the risk for growth and spread of Legionella and other biofilm-associated bacteria. When water is stagnant, hot water temperatures can decrease to the Legionella growth range 77 °F (25°C) through 110°F (43°C). Stagnant water can also lead to low or undetectable levels of disinfectant, such as chlorine.

**F 501.3.1 Maintenance Personnel.** Personal protective equipment shall be provided for maintenance personnel. Maintenance personnel shall wear personal protective equipment in accordance with the facility’s risk assessment. Respiratory protection may be appropriate in enclosed spaces where aerosol generation is likely. Personal protective equipment shall be used in accordance with all local state and Federal requirements. Where respirators are used, a respiratory protection program in accordance with 29 CFR 1910.134 shall be required.

**Note:** Maintenance personnel at increased risk of developing Legionnaires’ disease, such as those with weakened immune systems, should consult with a medical provider regarding participation in flushing, cooling tower cleaning, or other activities that may generate aerosols.

**F 601.0 System Restart.**

**F 601.1 Startup Procedures.** When a cooling tower has been shut down or left untreated for five or more days, a full startup procedure shall be completed before startup or continuing operation. The startup procedure shall be completed as follows:

1. Clean the cooling tower through power washing and/or scrubbing, not more than 15 days before the first use, to remove biofilm, scale or other debris. Once cleaned, disinfect with an approved biocide(s) to kill pathogens, such as Legionella.

2. Enlist a qualified person or building owner designee to conduct and document the pre-startup inspection. The required inspection shall be as follows:

   a. Visually assessing the cooling tower system.

   b. Inspecting all components for the presence of contaminants and other adverse conditions.

   c. Checking that the water treatment equipment is working properly.

   d. Records of the procedure shall be completed.

3. Once disinfected, the cooling tower system shall be filled with water and begin circulating biocides and chemicals, as specified in the water management program. At this point, the system shall be considered operational and shall meet the requirements of the Authority Having Jurisdiction.

4. Collect and analyze a water sample for the presence of Legionella. The sample shall be analyzed by a laboratory as approved by the Authority Having Jurisdiction. The results shall be interpreted and the actions described in Table F 301.4(2) shall be performed.

5. Startup records of all procedures and actions performed shall be kept on file. Startup records shall include, but not be limited to, the following:

   a. Cooling tower system ID

   b. System startup date

   c. Individual cooling tower startup date (if different than the system startup date)

   d. Dates and procedures for startup cleaning and disinfection

   e. Service provider

   f. Pre-startup inspection

   g. Legionella sampling and test results

   h. Disinfection dose and circulation time

   i. Water monitoring

   j. Treatment logs
APPENDIX G
SIZING OF VENTING SYSTEMS AND OUTDOOR COMBUSTION AND VENTILATION OPENING DESIGN
(The content of this Appendix is based on Annex F and Annex I of NFPA 54)

G 101.0 General.
G 101.1 Applicability. This appendix provides general guidelines for sizing venting systems serving appliances equipped with draft hoods, Category I appliances, and appliances listed for use with Type B vents.

G 101.2 Examples Using Single Appliance Venting Tables. See Figure G 101.2(1) through Figure G 101.2(14). [NFPA 54:F.1]

Table 803.1.2(1) is used when sizing a Type B double-wall gas vent connected directly to the appliance.

Note: The appliance can be either Category I draft hood-equipped or fan-assisted type.

Table 803.1.2(2) is used when sizing a single-wall metal vent connector attached to a Type B double-wall gas vent.

Note: The appliance can be either Category I draft hood-equipped or fan-assisted type.

Table 803.1.2(3) is used when sizing a Type B double-wall gas vent connector attached to a tile-lined masonry chimney.

Notes:
1. A is the equivalent cross-sectional area of the tile liner.
2. The appliance can be either Category I draft hood-equipped or fan-assisted type.

Table 803.1.2(4) is used when sizing a single-wall vent connector attached to a tile-lined masonry chimney.

Notes:
1. A is the equivalent cross-sectional area of the tile liner.
2. The appliance can be either Category I draft hood-equipped or fan-assisted type.
Asbestos cement Type B or single-wall metal vent serving a single draft hood-equipped appliance. [See Table 803.1.2(5)]

**FIGURE G 101.2(5)**
ASBESTOS CEMENT TYPE B OR SINGLE-WALL METAL VENT SYSTEM SERVING A SINGLE DRAFT HOOD-EQUIPPED APPLIANCE

[**NFPA 54: FIGURE F.1(e)**]

**TABLE 803.2(1)** is used when sizing Type B double-wall gas vent connectors attached to a Type B double-wall common vent.

**Note:** Each appliance can be either Category I draft hood-equipped or fan-assisted type.

**FIGURE G 101.2(6)**
VENT SYSTEM SERVING TWO OR MORE APPLIANCES WITH TYPE B DOUBLE-WALL VENT AND TYPE B DOUBLE-WALL VENT CONNECTORS

[**NFPA 54: FIGURE F.1(0)**]

**FIGURE G 101.2(7)**
VENT SYSTEM SERVING TWO OR MORE APPLIANCES WITH TYPE B DOUBLE-WALL VENT AND SINGLE-WALL METAL VENT CONNECTORS

[**NFPA 54: FIGURE F.1(g)**]

**FIGURE G 101.2(8)**
MASONRY CHIMNEY SERVING TWO OR MORE APPLIANCES WITH TYPE B DOUBLE-WALL VENT CONNECTORS

[**NFPA 54: FIGURE F.1(h)**]
Table 803.2(4) is used when sizing single-wall metal vent connectors attached to a tile-lined masonry chimney.

Notes:
1. \( A \) is the equivalent cross-sectional area of the tile liner.
2. Each appliance can be either Category I draft hood-equipped or fan-assisted type.

Example: Manifolded common vent connector \( L_M \) can be no greater than 18 times the common vent connector manifold inside diameter; that is, a 4 inch (102 mm) inside diameter common vent connector manifold should not exceed 72 inches (1829 mm) in length. [See Section 803.2.3]

Note: This is an illustration of a typical manifolded vent connector. Different appliance, vent connector, or common vent types are possible. [See Section 803.2]

Example: Offset common vent

Note: This is an illustration of a typical offset vent. Different appliance, vent connector, or vent types are possible. [See Section 803.1 and Section 803.2]
Example 1: Single Draft Hood-Equipped Appliance.

An installer has a 120 000 British thermal units per hour (Btu/h) (35 kW) input appliance with a 5 inch (127 mm) diameter draft hood outlet that needs to be vented into a 10 foot (3048 mm) high Type B vent system. What size vent should be used assuming: (1) a 5 foot (1524 mm) lateral single-wall metal vent connector is used with two 90 degree elbows or (2) a 5 foot (1524 mm) lateral single-wall metal vent connector is used with three 90 degree elbows in the vent system? (See Figure G 101.3)

Solution:

Table 803.1.2(2) should be used to solve this problem because single-wall metal vent connectors are being used with a Type B vent, as follows:

1. Read down the first column in Table 803.1.2(2) until the row associated with a 10 foot (3048 mm) height and 5 foot (1524 mm) lateral is found. Read across this row until a vent capacity greater than 120 000 Btu/h (35 kW) is located in the shaded columns labeled NAT Max for draft hood-equipped appliances. In this case, a 5 inch (127 mm) diameter vent has a capacity of 122 000 Btu/h (35.7 kW) and can be used for this application.

2. If three 90 degree elbows are used in the vent system, the maximum vent capacity listed in the tables must be reduced by 10 percent. This implies that the 5 inch (127 mm) diameter vent has an adjusted capacity of only 110 000 Btu/h (32 kW). In this case, the vent system must be increased to 6 inches (152 mm) in diameter. See the following calculations:

\[
122 000 \text{ Btu/h (35.7 kW)} \times 0.90 = 110 000 \text{ Btu/h (32 kW)}
\]

From Table 803.1.2(2), select 6 inches (152 mm) vent.

\[
186 000 \text{ Btu/h (54.5 kW)} \times 0.90 = 167 000 \text{ Btu/h (49 kW)}
\]

This figure is greater than the required 120 000 Btu/h (35 kW). Therefore, use a 6 inch (152 mm) vent and connector where three elbows are used. [NFPA 54:F.1.1]

An installer has an 80 000 Btu/h (23.4 kW) input fan-assisted appliance that must be installed using 10 feet (3048 mm) of lateral connector attached to a 30 foot (9144 mm) high Type B vent. Two 90-degree (1.57 rad) elbows are needed for the installation. Can a single-wall metal vent connector be used for this application? (See Figure G 101.4)

Solution:
Table 803.1.2(2) refers to the use of single-wall metal vent connectors with Type B vent. In the first column find the row associated with a 30 foot (9144 mm) height and a 10 foot (3048 mm) lateral. Read across this row, looking at the FAN Min and FAN Max columns, to find that a 3 inch (76 mm) diameter single-wall metal vent connector is not recommended. Moving to the next larger size single-wall connector [4 inch (102 mm)] we find that a 4 inch (102 mm) diameter single-wall metal vent connector has a recommended minimum vent capacity of 91 000 Btu/h (26.7 kW) and a recommended maximum vent capacity of 144 000 Btu/h (42 kW). The 80 000 Btu/h (23.4 kW) fan-assisted appliance is outside this range, so the conclusion is that a single-wall metal vent connector cannot be used to vent this appliance using 10 feet (3048 mm) of lateral for the connector. However, if the appliance cannot be moved closer to the vertical vent, a Type B vent could be used as the connector material.

G 101.5 Example 3: Interpolating Between Table Values.

An installer has an 80 000 Btu/h (23.4 kW) input appliance with a 4 inch (102 mm) diameter draft hood outlet that needs to be vented into a 12 foot (3658 mm) high Type B vent. The vent connector has a 5 foot (1524 mm) lateral length and is also Type B. Can this appliance be vented using a 4 inch (102 mm) diameter vent?

Solution:
Table 803.1.2(1) is used in the case of an all Type B Vent system. However, Table 803.1.2(1) does not have an entry for a height of 12 feet (3658 mm), and interpolation must be used. Read down the 4 inch (102 mm) diameter NAT Max column to the row associated with 10 foot (3048 mm) height and 5 foot (1524 mm) lateral to find the capacity value of 77 000 Btu/h (22.6 kW). Read further down to the 15 foot (4572 mm) height, 5 foot (1524 mm) lateral row to find the capacity value of 87 000 Btu/h (25.5 kW). The difference between the 15 foot (4572 mm) height capacity value and the 10 foot (3048 mm) height capacity value is 10 000 Btu/h (2.9 kW). Therefore, a single-wall metal vent connector can be used in the installation. [NFPA 54:F.1.3]
G 102.0 Examples Using Common Venting Tables.

G 102.1 Example 4: Common Venting Two Draft Hood-Equipped Appliances. A 35 000 Btu/h (10.3 kW) water heater is to be common vented with a 150 000 Btu/h (44 kW) furnace, using a common vent with a total height of 30 feet (9144 mm). The connector rise is 2 feet (610 mm) for the water heater with a horizontal length of 4 feet (1219 mm). The connector rise for the furnace is 3 feet (914 mm) with a horizontal length of 8 feet (2438 mm). Assume single-wall metal connectors will be used with Type B vent. What size connectors and combined vent should be used in this installation? (See Figure G 102.1)

Solution:

Table 803.2(2) should be used to size single-wall metal vent connectors attached to Type B vertical vents. In the vent connector capacity portion of Table 803.2(2), find the row associated with a 30 foot (9144 mm) vent height. For a 2 foot (610 mm) rise on the vent connector for the water heater, read the shaded columns for draft hood-equipped appliances to find that a 3 inch (76 mm) diameter vent connector has a capacity of 37 000 Btu/h (10.8 kW). Therefore, a 3 inch (76 mm) single-wall metal vent connector can be used with the water heater. For a draft hood-equipped furnace with a 3 foot (914 mm) rise, read across the appropriate row to find that a 4 inch (102 mm) diameter vent connector has a maximum capacity of 120 000 Btu/h (35 kW) (which is too small for the furnace), and a 6 inch (152 mm) diameter vent connector has a maximum vent capacity of 172 000 Btu/h (50 kW). Therefore, a 6 inch (152 mm) diameter vent connector should be used with the 150 000 Btu/h (44 kW) furnace. Because both vent connector horizontal lengths are less than the maximum lengths listed in Section 803.2.1, the table values can be used without adjustments.

In the common vent capacity portion of Table 803.2(2), find the row associated with a 30 foot (9144 mm) vent height and read over to the NAT + NAT portion of the 6 inch (152 mm) diameter column to find a maximum combined capacity of 257 000 Btu/h (75 kW). Since the two appliances total only 185 000 Btu/h (54 kW), a 6 inch (152 mm) common vent can be used. [NFPA 54: FIGURE F.2.1]

G 102.2 Example 5(a): Common Venting a Draft Hood-Equipped Water Heater with a Fan-Assisted Furnace into a Type B Vent. In this case, a 35 000 Btu/h (10.3 kW) input draft hood-equipped water heater with a 4 inch (102 mm) diameter draft hood outlet, 2 feet (610 mm) of connector rise, and 4 feet (1219 mm) of horizontal length is to be common vented with a 100 000 Btu/h (29 kW) fan-assisted furnace with a 4 inch (102 mm) diameter flue collar, 3 feet (914 mm) of connector rise, and 6 feet (1829 mm) of horizontal length. The common vent consists of a 30 foot (9144 mm) height of Type B vent. What are the recommended vent diameters for each connector and the common vent? The installer would like to use a single-wall metal vent connector. (See Figure G 102.2)

Solution:

Water Heater Vent Connector Diameter. Since the water heater vent connector horizontal length of 4 feet (1219 mm) is less than the maximum value listed in Table 803.2(2), the venting table values can be used without adjustments. Using the Vent Connector Capacity portion of Table 803.2(2), read down the Total Vent Height (H) column to 30 feet (9144 mm) and across the 2 feet (610 mm) Connector Rise (R) row. Because the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating greater than the water heater input rating. The table shows that a 3 inch (76 mm) vent connector has a maximum input rating of 37 000 Btu/h (10.8 kW). Although this rating is greater than the water heater input rating, a 3 inch (76 mm) vent connector is prohibited by Section 803.2.18. A 4 inch (102 mm) vent connector has a maximum input rating of 67 000 Btu/h (19.6 kW) and is equal to the draft hood outlet diameter. A 4 inch (102 mm) vent connector is selected. Since the water heater is equipped with a draft hood, there are no minimum input rating restrictions.

Furnace Vent Connector Diameter. Using the Vent Connector Capacity portion of Table 803.2(2), read down the Total Vent Height (H) column to 30 feet (9144 mm) and across the 3 feet (914 mm) Connector Rise (R) row. Because the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating greater than the furnace input rating. The 4 inch (102 mm) vent connector has a maximum input rating of 119 000 Btu/h (34.9 kW) and a minimum input rating of 85 000 Btu/h (24.9 kW).

The 100 000 Btu/h (29 kW) furnace in this example falls within this range, so a 4 inch (102 mm) connector is adequate. Because the furnace vent connector horizontal length of 6 feet (1829 mm) is less than the maximum value listed in Section 803.2.1, the venting table values can be used without adjustment. If the furnace had an input rating of 80 000 Btu/h (23.4 kW), a Type B vent connector would be needed in order to meet the minimum capacity limit.
Common Vent Diameter. The total input to the common vent is 135,000 Btu/h (40 kW). Using the Common Vent Capacity portion of Table 803.2(2), read down the Total Vent Height \( (H) \) column to 30 feet (9144 mm) and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu/h rating equal to or greater than 135,000 Btu/h (40 kW). The 4 inch (102 mm) common vent has a capacity of 132,000 Btu/h (39 kW) and the 5 inch (127 mm) common vent has a capacity of 202,000 Btu/h (59 kW). Therefore, the 5 inch (127 mm) common vent should be used in this example.

Summary: In this example, the installer can use a 4 inch (102 mm) diameter, single-wall metal vent connector for the water heater and a 4 inch (102 mm) diameter, single-wall metal vent connector for the furnace. The common vent should be a 5 inch (127 mm) diameter Type B vent. [NFPA 54:E.2.2]

Solution:

According to Section 803.2.20, Type B vent connectors are required to be used with exterior masonry chimneys. Use Table 803.2(8) and Table 803.2(9) to size FAN+NAT common venting installations involving Type-B double-wall connectors into exterior masonry chimneys.

The local 99 percent winter design temperature needed to use Table 803.2(8) and Table 803.2(9) can be found in ASHRAE Handbook – Fundamentals. For Charlotte, North Carolina, this design temperature is 19°F (-7.2°C).
Chimney Liner Requirement. As in Example 5(b), use the 63 square inch (0.04 m²) internal area columns for this size clay tile liner. Read down the 63 square inches (0.04 m²) column of Table 803.2(8) to the 30 foot (9144 mm) height row to find that the combined appliance maximum input is 747,000 Btu/h (218.9 kW). The combined input rating of the appliances in this installation, 135,000 Btu/h (40 kW), is less than the maximum value, so this criterion is satisfied. Table 803.2(9), at a 19°F (-7.2°C) design temperature, and at the same vent height and internal area used earlier, shows that the minimum allowable input rating of a space-heating appliance is 470,000 Btu/h (137.7 kW). The furnace input rating of 100,000 Btu/h (29 kW) is less than this minimum value. So this criterion is not satisfied, and an alternative venting design needs to be used, such as a Type B vent shown in Example 5(a) or a listed chimney liner system shown in the remainder of the example.

According to Section 803.2.19, Table 803.2(1) or Table 803.2(2) is used for sizing corrugated metallic liners in masonry chimneys, with the maximum common vent capacities reduced by 20 percent. This example will be continued assuming Type B vent connectors.

Water Heater Vent Connector Diameter. Using Table 803.2(1) Vent Connector Capacity, read down the total Vent Height (H) column to 30 feet (9144 mm), and read across the 2 feet (610 mm) Connector Rise (R) row to the first Btu/hour rating in the NAT Max column that is equal to or greater than the water heater input rating. The table shows that a 3 inch (76 mm) vent connector has a maximum capacity of 39,000 Btu/h (11.4 kW). Although this rating is greater than the water heater input rating, a 3 inch (76 mm) vent connector is prohibited by Section 803.2.20. A 4 inch (102 mm) vent connector has a maximum input rating of 70,000 Btu/h (20.5 kW).

### TABLE G 102.3

**MASONRY CHIMNEY LINER DIMENSIONS WITH CIRCULAR EQUIVALENTS**

<table>
<thead>
<tr>
<th>NOMINAL LINER SIZE (inches)</th>
<th>INSIDE DIMENSIONS OF LINER (inches)</th>
<th>INSIDE DIAMETER OR EQUIVALENT DIAMETER (inches)</th>
<th>EQUIVALENT AREA (square inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 x 8</td>
<td>2½ x 6½</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 x 8</td>
<td>6½ x 6½</td>
<td>7.4</td>
<td>42.7</td>
</tr>
<tr>
<td>8 x 12</td>
<td>6½ x 10½</td>
<td>9.0</td>
<td>63.6</td>
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<td>9¼ x 9½</td>
<td>10.4</td>
<td>83.3</td>
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<tr>
<td>12 x 16</td>
<td>9½ x 13½</td>
<td>11.8</td>
<td>107.5</td>
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<tr>
<td>16 x 16</td>
<td>13¼ x 13¼</td>
<td>14.0</td>
<td>153.9</td>
</tr>
<tr>
<td>16 x 20</td>
<td>13 x 17</td>
<td>15.0</td>
<td>176.7</td>
</tr>
<tr>
<td>20 x 20</td>
<td>16½ x 16¼</td>
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<td>254.4</td>
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<tr>
<td>20 x 24</td>
<td>16½ x 20½</td>
<td>18.2</td>
<td>260.2</td>
</tr>
<tr>
<td></td>
<td>20.0</td>
<td>314.1</td>
<td></td>
</tr>
<tr>
<td>24 x 24</td>
<td>20¼ x 20¼</td>
<td>22.1</td>
<td>380.1</td>
</tr>
<tr>
<td>24 x 28</td>
<td>20½ x 24¼</td>
<td>24.1</td>
<td>456.2</td>
</tr>
<tr>
<td>28 x 28</td>
<td>24¼ x 24¼</td>
<td>26.4</td>
<td>543.3</td>
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<tr>
<td>30 x 30</td>
<td>25½ x 25½</td>
<td>27.0</td>
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</tr>
<tr>
<td>30 x 36</td>
<td>25½ x 31½</td>
<td>30.0</td>
<td>706.8</td>
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<tr>
<td>36 x 36</td>
<td>31½ x 31½</td>
<td>34.4</td>
<td>929.4</td>
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<tr>
<td></td>
<td>36.0</td>
<td>1017.9</td>
<td></td>
</tr>
</tbody>
</table>

For SI units, 1 inch = 25.4 mm, 1 square inch = 0.000645 m²

* Where liner sizes differ dimensionally from those shown in this table, equivalent diameters can be determined from published tables for square and rectangular ducts of equivalent carrying capacity or by other engineering methods.
and is equal to the draft hood outlet diameter. A 4 inch (102 mm) vent connector is selected.

Furnace Vent Connector Diameter. Using Table 803.2(1), Vent Connector Capacity, read down the total Vent Height (H) column to 30 feet (9144 mm), and read across the 3 feet (914 mm) Connector Rise (R) row to the first Btu/h rating in the FAN MAX column that is equal to or greater than the furnace input rating. The 100 000 Btu/h (29 kW) furnace in this example falls within this range, so a 4 inch (102 mm) connector is adequate.

Chimney Liner Diameter. The total input to the common vent is 135 000 Btu/h (40 kW). Using the Common Vent Capacity portion of Table 803.2(1), read down the total Vent Height (H) column to 30 feet (9144 mm) and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu/h rating greater than 135 000 Btu/h (40 kW). The 4 inch (102 mm) common vent has a capacity of 138 000 Btu/h (40.4 kW). Reducing the maximum capacity by 20 percent results in a maximum capacity for a 4 inch (102 mm) corrugated liner of 110 000 Btu/h (32 kW), less than the total input of 135 000 Btu/h (40 kW). So a larger liner is needed. The 5 inch (127 mm) common vent capacity listed in Table 803.2(1) is 210 000 Btu/h (62 kW), and after reducing by 20 percent is 168 000 Btu/h (49.2 kW). Therefore, a 5 inch (127 mm) corrugated metal liner should be used in this example.

Single Wall Connectors. Once it has been established that relining the chimney is necessary, Type B double-wall vent connectors are not specifically required. This example could be redone using Table 803.2(2) for single-wall vent connectors. For this case, the vent connector and liner diameters would be the same as found for Type B double-wall connectors. [NFPA 54:F.2.4]

G 103.0 Example of Combination Indoor and Outdoor Combustion Air Opening Design. Determine the required combination of indoor and outdoor combustion air opening sizes for the following appliance installation example.

Example Installation: A fan-assisted furnace and a draft hood-equipped water heater with the following inputs are located in a 15 foot by 30 foot (4572 mm by 9144 mm) basement with an 8 foot (2438 mm) ceiling. No additional indoor spaces can be used to help meet the appliance combustion air needs.

Fan-Assisted Furnace Input: 100 000 Btu/h (29 kW)
Draft Hood-Equipped Water Heater Input: 40 000 Btu/h (11.7 kW)

Solution:
(1) Determine the total available room volume.
   Appliance room volume.
   15 feet by 30 feet (4572 mm by 9144 mm) with an 8 foot (2438 mm) ceiling = 3600 cubic feet (101.94 m³)

(2) Determine the total required volume.
The Standard Method to determine combustion air is used to calculate the required volume.
The combined input for the appliances located in the basement is calculated as follows:
100 000 Btu/h (29 kW) + 40 000 Btu/h (11.7 kW) = 140 000 Btu/h (41 kW)
The Standard Method requires that the required volume be determined based on 50 cubic feet per 1000 Btu/h (4.83 m³/kW).
Using Table G 103.0 the required volume for a 140 000 Btu/h (41 kW) water heater combined input is 7000 cubic feet (198.22 m³).

Conclusion:
The indoor volume is insufficient to supply combustion air since the total of 3600 cubic feet (101.94 m³) does not meet the required volume of 7000 cubic feet (198.22 m³). Therefore, additional combustion air must be provided from the outdoors.

(3) Determine the ratio of the available volume to the required volume:
   3600 cubic feet
   7000 cubic feet
   = 0.51

(4) Determine the reduction factor to be used to reduce the full outdoor air opening size to the minimum required based on ratio of indoor spaces:
   1.00 – 0.51 (from Step 3) = 0.49

(5) Determine the single outdoor combustion air opening size as though all combustion air is to come from outdoors. In this example, the combustion air opening directly communicates with the outdoors:

\[
\frac{140 000 \text{ Btu/h}}{3000 \text{ British thermal units per square inch (Btu/in²)}} = 47 \text{ square inches (0.03 m²)}
\]

(6) Determine the minimum outdoor combustion air opening area:

\[
\text{Outdoor opening area} = 0.49 \text{ (from Step 4) } \times 47 \text{ square inches (0.03 m²)}
= 23 \text{ square inches (0.01 m²)}
\]

Section 701.7.3(3) requires the minimum dimension of the air opening should not be less than 3 inches (76 mm). [NFPA 54:1.1]
### TABLE G 103.0
STANDARD METHOD: REQUIRED VOLUME, ALL APPLIANCES
[NFPA 54: TABLE A.9.3.2.1]

<table>
<thead>
<tr>
<th>APPLIANCE INPUT (Btu/h)</th>
<th>REQUIRED VOLUME (cubic feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>250</td>
</tr>
<tr>
<td>10 000</td>
<td>500</td>
</tr>
<tr>
<td>15 000</td>
<td>750</td>
</tr>
<tr>
<td>20 000</td>
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<td>25 000</td>
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<td>290 000</td>
<td>14 500</td>
</tr>
<tr>
<td>300 000</td>
<td>15 000</td>
</tr>
</tbody>
</table>

For SI units: 1000 British thermal units per hour = 0.293 kW, 1 cubic foot = 0.0283 m³
APPENDIX H
IMPACT OF WATER TEMPERATURE ON THE POTENTIAL FOR LEGIONELLA GROWTH

Part I – General

**H 101.0 General.**

**H 101.1 Applicability.** Part I of this appendix provides guidelines on the impact of water temperature in minimizing Legionella growth potential associated with occupiable commercial, institutional, multi-unit residential, and industrial building mechanical systems. Legionella control for plumbing systems shall be in accordance with the plumbing code.

This appendix shall not include single-family residential buildings. This appendix shall not be considered a risk management guidance document for scalding or Legionella.

**Note:** Published documents which address Legionella risk management include ASHRAE 188 or ASHRAE Guideline 12.

Published documents which address professional qualifications for Legionella risk assessment include ASSE Series 12000.

There are additional factors associated with the potential for scalding and Legionella growth other than temperature.

For scalding potential, other factors include, but are not limited to, user age, health, body part, length of contact time, and water source.

For Legionella growth potential other factors include, but are not limited to, water source and plumbing system: size, design, circulation rate, water age, disinfectant residual, piping material and component complexity.

**H 102.0 Definitions.**

**H 102.1 General.** For the purpose of this appendix, the following definitions shall apply.

**Biofilm.** Microorganisms and the slime they secrete that grow on any continually moist surface.

**Control.** The management to maintain compliance with established criteria.

**Disinfection.** Chemical or physical control measures or procedures used to kill or inactivate pathogens.

**Disinfection, Online.** The procedure while the equipment is in operation.

**Disinfection, Offline.** The procedure while the equipment is not in operation.

**Halogenation.** A chemical reaction that involves the addition of one or more halogens, including, but not limited to, chlorine, bromine, or iodine, commonly used to disinfect water systems.

**Hazard.** See Risk.

**Legionella Concentrations.** The extent of colonization of Legionella measured in Colony Forming Units per milliliter (CFU/mL).

**Legionella Growth Potential.** The likelihood that Legionella bacteria will reproduce.

**Monitor.** Observing and checking the progress or quality of (something) or measuring the physical and chemical characteristics of control measures.

**Nutrient.** Any element or compound essential as a raw material for an organism’s growth and development.

**Risk.** The potential to cause harm resulting from exposure.

**Test.** The measurement of the physical, chemical, or microbial characteristics or quality of water.

**Water Management Plan.** A comprehensive risk management plan for controlling Legionella growth in building water systems.

**H 103.0 Building Water Systems and System Equipment Documentation.**

**H 103.1 Design Documentation.** Construction documents shall be required for new construction, renovation, refurbishment, replacement, or repurposing of an occupiable building water system, including a water management plan, and shall be submitted to the Authority Having Jurisdiction.

**H 103.2 Onsite Documentation.** Documentation shall be maintained onsite and shall be readily accessible to the Authority Having Jurisdiction.

**H 104.0 Potential Exposure.**

**H 104.1 Legionella Growth Potential.** The Authority Having Jurisdiction shall have the authority to require documentation to address Legionella growth potential, where water temperatures in a water system are within ranges shown in Figure H 104.1 that pose a Legionella growth potential.

**H 104.2 Scald Potential.** Where the water system’s temperature(s) range pose(s) a scald potential, protection shall be provided in accordance with the plumbing code.

**H 105.0 Disinfection.**

**H 105.1 Disinfection Documentation.** Where required by the Authority Having Jurisdiction, documentation for disinfection of building mechanical systems shall be provided by the registered design professional in the construction documents.

**H 105.1.1 Copper-Silver Ionization.** Copper-silver ionization methods and procedures shall include the following documentation.

1. Copper and silver ionization concentrations.
2. Methods and documentation for monitoring ion levels.
3. Electrode cleaning cycles and methods.
**H 105.1 Ultraviolet Light.** Ultraviolet light methods shall include the following documentation:

1. Locations of ultraviolet light units.
2. Cleaning cycles and methods of the quartz sleeves and housing.

**H 105.2 Chemical Disinfection.** Chemical biocide treatment shall be permitted to be used in accordance with the following:

1. Oxidizing biocides in accordance with manufacturer’s guidelines.
2. Non-oxidizing biocides in accordance with manufacturer’s guidelines.
3. Alternating the use of different types of biocides, dose, and frequency is recommended.
4. These treatment methods can be used for continuous, online disinfection or shock treatment online or offline.

**H 105.3 Non-Chemical Treatment.** Non-chemical treatment devices shall be permitted to be used in accordance with manufacturer’s guidelines.

1. **H 105.3.1 Thermal Shock.** Thermal treatment using heat shock at 158°F (70°C) for 30 minutes shall be permitted in accordance with applicable guidelines and the manufacturer’s instructions.

2. **H 105.3.2 Physical Cleaning.** When implemented, physical cleaning shall only be performed as an offline method and shall be performed before the chemical disinfection methods in Section 105.1 have been performed. Building outdoor air intakes shall be closed during physical cleaning prior to commencing. Physical cleaning shall be in accordance with the manufacturer’s instructions.

**H 105.4 Inspection and Maintenance.** The system shall be monitored and maintained to prevent scale buildup, sediment, corrosion, and biofouling.

**H 105.5 Frequency of Cleaning and Disinfection.** Where a water management plan is implemented, the frequency of cleaning and disinfection logs shall be readily accessible to the water management team and the Authority Having Jurisdiction.

**H 105.6 Control Measures.** Evaluation of control measures for Legionella shall consider potential unintended consequences of such measures that may affect overall health risk, including the formation of toxic disinfection byproducts (whether regulated or unregulated), resultant increase in other plumbing-associated pathogens, and scalding.

**Part II – Minimizing Legionella Growth Potential in Cooling Towers and Other Mechanical Systems.**

1. **H 201.0 General.**

2. **H 201.1 Applicability.** Part II of this appendix applies to water sources that frequently provide optimal conditions for growth of Legionella organisms in accordance with Figure H 104.1, including, but not limited to, cooling towers, evaporative condensers, decorative water features, filters, ice makers, evaporative air coolers, fluid coolers that use evaporation...
to reject heat, industrial processes that use water to remove excess heat, industrial and municipal waste treatment plants, and other mechanical systems.

H 201.2 Water Management Plan, Where Required. A water management plan shall be established when required by the criteria of the Authority Having Jurisdiction.

H 201.3 Water Management Plan, Where Implemented. Where a water management plan is implemented, the plan shall be in accordance with the following:

1. Determine a water management plan team.
2. Provide description of the building’s water system.
3. Identify areas of Legionella growth potential in accordance with temperature ranges as shown in Figure H 104.1.
4. Determine applicable control measures and monitoring procedures.
5. Ensure the water management plan is effective and operating as designed.
6. Document and communicate all the activities of the water management plan.

H 201.4 Water Sampling. An analysis of water samples from a source capable of being contaminated with Legionella bacteria shall be performed as required by the Authority Having Jurisdiction to determine the number of organisms present in Colony Forming Units per milliliter (CFU/mL) of Legionella in the sample. The minimum remediation action shall be in accordance with Table H 201.5 and Figure H 201.5.

H 201.5 Legionella Test Levels. A means of controlling Legionella shall be established in accordance with applicable levels as stated in Section H 201.5.1 through Section H 201.5.4.

H 201.5.1 Levels Less than 10 CFU/mL. Water samples containing Legionella levels less than 10 CFU/mL shall be permitted to maintain the established water treatment plan in accordance with Table H 201.5.

H 201.5.2 Levels Between 10 CFU/mL and 100 CFU/mL. Water samples containing Legionella levels greater than 10 CFU/mL but less than 100 CFU/mL shall require the water treatment plan to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5.

H 201.5.3 Levels Between 100 CFU/mL and 1000 CFU/mL. Water samples containing Legionella levels greater than 100 CFU/mL but less than 1000 CFU/mL shall require the water treatment plan to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table H 201.5. Prepare to execute emergency response plan in case Legionella levels reach over 1000 CFU/mL.

H 201.5.4 Levels Greater than 1000 CFU/mL. Water samples containing Legionella levels greater than 1000 CFU/mL shall require the water treatment plan to be reviewed, notify Authority Having Jurisdiction (if required), institute immediate online disinfection, and retest water 3 to 7 days after decontamination. If retest ≥1000 CFU/mL, repeat system decontamination.

H 201.6 Air Sampling. Air sampling for Legionella shall not be used as a means of measuring potential Legionella exposure.

H 202.0 Cooling Towers.

H 202.1 General. Cooling towers shall be installed, maintained, and tested as required by this Appendix and the Authority Having Jurisdiction.

H 202.2 Risk Factors. The following risk factors shall be identified, assessed, controlled, and monitored:

1. Stagnant water due to dead legs, intermittent operation, or seasonal usage.
2. The presence of nutrients or biofilm.
(3) Water temperature within a range that supports microbial growth as specified in Figure H 104.1.
(4) Water exposed to direct sunlight which promotes algae growth.
(5) Water quality, including, but not limited to, the following factors:
   (a) System cleanliness
   (b) pH levels
   (c) Presence of corrosion
   (d) Presence of scale and biofouling
   (e) Conductivity levels
   (f) Dissolved and suspended solids
   (g) Control of water treatment chemicals
   (h) Control of bleed-off or blowdown
(6) System size
(7) Physical condition of system
(8) Aerosol generation, dispersion, and drift elimination
(9) System site location
(10) Access for inspection, cleaning, and maintenance
(11) Concentration of Legionella as specified in Table H 201.5.

**H 202.3 Water Temperature.** The system shall be designed to maintain low sump-water operating temperatures.

**H 202.4 Drift Eliminators.** Drift eliminators shall be installed in accordance with Section 1126.0, Section E 403.2, and Section E 403.5.1; and shall be accessible to allow inspection, maintenance, and cleaning of internal components.

**H 202.5 Side Stream Filtration.** When suspended solids are visible in the cooling tower water system, side stream filtration shall be permitted to be used to control suspended solids in cooling tower circulating water. Makeup water quality, design of cooling tower fill, recirculation rate, and total system volume shall be included in the design of such equipment.

**H 202.6 Equipment Site Location.** The site location of new or replacement open- or closed-circuit cooling towers or evaporative condensers shall be in accordance with the following:

1. Shall not be located where contamination from building systems or facility processes can be drawn into the equipment. Equipment shall be installed no less than 10 feet (3048 mm) away from building exhaust or plumbing vents.
2. Shall not be located where equipment discharges into occupied spaces, roadways, walkways, outdoor air intakes, and building openings. Equipment shall be installed no less than 10 feet (3048 mm) away from building intakes or plumbing vents.

**H 202.7 System Commissioning.** System commissioning shall include procedures for cleaning of the cooling system. Ongoing water treatment in accordance with Section H 201.5 shall be initiated once the system is charged with water.

**H 202.8 System Start-Up and Shutdown.** System start-up and shutdown procedures shall include, but not be limited to the following:

1. Management of hazardous conditions associated with untreated water, including the following:
   a. Shutdown that includes all chemical pretreatment steps, pump cycling protocols, and procedures for system drainage for shutdown periods longer than 3 days, or the duration specified by the water management plan.
   b. Start-up from a drained system shall be in accordance with manufacturer’s recommendations.
   c. Start-up from an undrained or stagnant system that exceeds 3 days, or the number of idle days specified by the water management plan or the manufacturer’s recommendations.

**H 202.9 System Maintenance and Inspection.** System components requiring maintenance and inspection shall be accessible. A schedule for maintenance and inspection of system shall be included in the water management plan documents. Cooling tower maintenance and inspection shall include, but not be limited to, the following areas:

1. Water treatment system
2. Louvers
3. Piping dead legs
4. Cold water basins
5. Crossflow hot water basin
6. Counterflow spray system
7. Drift eliminators
8. Fill material and fill air entrance and exit surfaces
9. Purging of stagnant water or low-flow zones within the basin

**H 202.10 Water Treatment.** Water treatment shall control microbiological activity, scale, corrosion, sediment, and solids in the system, and shall be in accordance with the following:

1. All equipment and chemicals used shall be specified for the purpose of treating the open recirculating loop.
2. The minimum required schedule for inspection, maintenance, cleaning, and monitoring, and a corrective action plan.
3. The minimum requirements for documenting system water treatment.

**H 202.11 Disinfection.** Methods for disinfection of cooling towers shall include, but not be limited to, the halogenation methods and procedures for flushing and disinfection in accordance with Section 1122.0 and for reclaimed (recycled) and onsite treated nonpotable water in accordance with Section E 403.5.2.

The responsible person for initiating disinfection shall be identified in the water management plan documents and the disinfection process shall include the following:
Online disinfection.

Emergency disinfection.

H 202.12 Water Treatment Chemicals. Water treatment chemicals, such as biocides, shall be applied using an automated dosing system at regular intervals. The frequency and quantity of chemical dosing shall be based on the microbial activity of the system and the chemical parameters of the circulating water.

H 202.13 Makeup Valves. The location of cooling tower makeup valves shall be in accordance with the registered design professional construction documents and approved by the Authority Having Jurisdiction. Makeup valves shall be provided with backflow prevention in accordance with ASME A112.1.2 for air gaps or backflow preventers in accordance with the plumbing code.

H 202.14 Emergency Response Plan. An emergency response plan shall be provided when required by with the Authority Having Jurisdiction and shall include, but not be limited to, the following:

1. Procedures to be followed if there are cases of Legionellosis associated with the use of cooling towers or evaporative condensers.
2. Procedures to be followed if cooling towers or evaporative condensers reach Legionella levels of 1000 CFU/mL or greater.
3. Testing for Legionella shall be performed. Procedures shall include the type of tests to be performed, sampling, and the interpretation of test results.
4. Procedures for emergency disinfection.
5. Procedures for other actions identified by the water management plan to prevent exposure to contaminated water.

H 202.15 Control of Bleed-Off. An automated bleed-off, or blowdown, system shall be used to remove water from the system and replace with makeup water to limit the concentration of dissolved and suspended solids. Additional manual bleed-off shall be permitted to be used to control scale or biofouling. The water for bleed-off shall be taken from the return line of the cooling water system to the cooling tower. Bleed-off shall only occur while chemical dosing is turned off.

H 202.16 Alternative Systems. Alternative systems and technologies that do not pose microbial risk and do not provide the opportunity for Legionella bacteria to grow shall be evaluated, including but not limited to off-peak thermal storage and geothermal coupled options.

H 203.0 Other Mechanical Systems.

H 203.1 General. Other mechanical systems and portions thereof shall be installed, maintained, and tested as required by this section and the Authority Having Jurisdiction.

H 203.2 Sand Filters. Sand filters shall be maintained or replaced in accordance with applicable guidelines as determined by the Authority Having Jurisdiction.

H 203.3 Water Softeners. Water softeners shall be installed and maintained in accordance with the plumbing code.

H 203.4 Dehumidifiers. Dehumidifiers shall be required in enclosed areas with swimming pools, spas, and hot tubs. Dehumidifiers shall be maintained in accordance with ASHRAE 188 and the manufacturer’s instructions.

H 203.5 Misters, Atomizers, Air Washers, Nebulizers, and Humidifiers. Misters, atomizers, air washers, nebulizers, and humidifiers shall be disinfected in accordance with ASHRAE 188. The minimum remediation action for humidifiers shall be in accordance with Table H 203.5.

### TABLE H 203.5

<table>
<thead>
<tr>
<th>LEGIONELLA CONCENTRATIONS IN COLONY FORMING UNITS (CFU/mL)</th>
<th>REMEDIATION ACTION</th>
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<tr>
<td>≥1 and &lt;10</td>
<td>Prompt cleaning and/or biocide treatment of the system.</td>
</tr>
<tr>
<td>≥10</td>
<td>Immediate cleaning and/or biocide treatment. Take prompt steps to prevent employee exposure.</td>
</tr>
</tbody>
</table>

H 203.6 Evaporative Air Coolers. Evaporative air coolers shall be completely drained and cleaned in accordance with the manufacturer’s instructions. When not in use, evaporative air coolers shall be completely drained.

H 203.7 Ice Machines. Ice machines shall be flushed and maintained in accordance with ASHRAE 188.

H 203.8 Spas and Hot Tubs. Spas and hot tubs shall be maintained and tested in accordance with ASHRAE Guide-line 12 and cleaned and disinfected in accordance with the manufacturer’s recommendations.

H 203.9 Decorative Water Features. Decorative water features shall be maintained in accordance with ASHRAE 188. Decorative water features shall be drained, cleaned, and disinfected in accordance with the manufacturer’s instructions and the Authority Having Jurisdiction.

H 203.10 Water Supply Systems. The minimum remediation action for water supply systems shall be in accordance with the plumbing code.
101.0 Example Calculation of Outdoor Air Rate.

101.1 Example Calculation. Determine the outdoor air rate required for a single zone AC unit serving an interior 2000 square feet (185.81 m²) conference/meeting room with a design occupancy of 100 people. The system supplies and returns air from the ceiling. (See Chapter 4 of this code for guidelines)

Solution:
In accordance with Table 403.2.2, the zone air distribution effectiveness is 1.0 since the system supplies cooling only from the ceiling. Using the rates from Table 402.1 for a conference/meeting room, the minimum system outdoor air rate is calculated to be:

\[ V_{ot} = \frac{R_p P_z + R_a A_z}{E_z} \]  

(Equation H101.1)

\[ = \frac{5 \times 100 + 0.06 \times 2000}{1.0} \]

\[ = 620 \text{ cubic feet per minute (ft}^3/\text{min)} \]

Where:
\(A_z\) = zone floor area: the net occupiable floor area of the zone in square feet.
\(P_z\) = zone population: The largest number of people expected to occupy the zone during typical usage. Where the number of people expected to occupy the zone fluctuates, \(P_z\) shall be permitted to be estimated based on averaging approaches described in Section 403.6.1. Where \(P_z\) cannot be accurately predicted during design, it shall be estimated based on the zone floor area and the default occupant density in accordance with Table 402.1.
\(R_p\) = outdoor airflow rate required per person in accordance with Table 402.1.
\(R_a\) = outdoor airflow rate required per unit area in accordance with Table 402.1.
\(E_z\) = zone air distribution effectiveness in accordance with Table 403.2.2.

For SI units: 1 square foot = 0.0929 m², 1 cubic foot per minute = 0.00047 m³/s
APPENDIX J
PROFESSIONAL QUALIFICATIONS

J 101.0 General.
J 101.1 Scope. The provisions of this appendix address minimum qualifications for installers, inspectors, or employers for systems covered within the scope of this code.

J 102.0 Qualifications.
J 102.1 General. Where permits are required, the Authority Having Jurisdiction shall have the authority to require contractors, installers, or service technicians to demonstrate competency. Where determined by the Authority Having Jurisdiction, the contractor or technician shall be licensed or certified to perform such work. Professional qualifications shall be required for an individual to demonstrate the required level of competency.

J 102.2 Inspectors and Plans Examiners. Professional qualification for mechanical system inspectors and mechanical plans examiners shall be in accordance with ASSE/IAPMO/ANSI Series 16000.
   J 102.2.1 Qualification for Mechanical Inspector. Professional qualification for mechanical inspectors shall be in accordance with ASSE 16020.
   J 102.2.2 Qualification for Mechanical Plan Examiner. Professional qualification for mechanical plan examiners shall be in accordance with ASSE 16050.

J 102.3 Residential Mechanical Service Technician. Professional qualification for residential mechanical service technicians shall be in accordance with ASSE/IAPMO/ANSI Series 13000.
   J 102.3.1 Qualification for Residential Mechanical Service Technician. Professional qualification for residential mechanical service technicians shall be with accordance ASSE 13020.

J 102.4 Hydronic Systems. Personnel qualification for installers and designers of hydronic heating and cooling systems, as well as installers of solar water heaters shall be in accordance with ASSE/IAPMO/ANSI Series 19000.
   J 102.4.1 Qualification for Solar Water Heating System Installer. Professional qualification for solar water heating system installers shall be in accordance with ASSE 19110.
   J 102.4.2 Qualification for Hydronic Heating and Cooling System Installer. Professional qualification for hydronic heating and cooling system installers shall be in accordance with ASSE 19210.
   J 102.4.3 Qualification for Hydronic Heating and Cooling System Designer. Professional qualification for hydronic heating and cooling system designers shall be in accordance with ASSE 19220.

J 102.5 Water Management and Infection Control Risk Assessment for Building Systems. Professional qualification for construction and maintenance personnel and employers to identify and manage potentially hazardous exposure to bloodborne, waterborne and airborne pathogens. Also includes qualifications for members of a water safety team involved in the development of a risk assessment analysis, and water management and sampling plan, for protection from Legionella and other waterborne pathogens and persons who conduct a facility risk assessment and implement a water safety and management program to reduce the risk of infections due to Legionella. Qualifications are in accordance with ASSE/IAPMO/ANSI Series 12000.
   J 102.5.1 Qualification for Environment of Care, Infection Control and Construction Risk Assessment. Professional qualification for general knowledge of the environment of care, infection control and construction risk assessment procedures to protect facility operations, occupants, workers or any individual who has the potential for harm caused by construction activities shall be in accordance with ASSE 12010.
   J 102.5.2 Qualification for Environment of Care, Infection Control and Construction Risk Assessment Professional Qualification Standard for Construction and Maintenance Employers. Professional qualification for general knowledge of the environment of care, infection control and construction risk assessment requirements and procedures to protect facility operations, occupants, workers, or any individual who has the potential for harm caused by construction activities shall be in accordance with ASSE 12020. It also provides general knowledge of employer responsibilities to the worker and to the facility.
   J 102.5.3 Qualification for Water Quality Program, Pipefitters and HVAC Technicians. Professional qualification for water quality program for pipefitters and HVAC technicians shall be in accordance with ASSE 12062.
   J 102.5.4 Legionella Water Safety and Management Personnel. Professional qualification of persons who conduct a facility risk assessment and implement a water safety and management program to reduce the risk of infections due to Legionella shall be in accordance with ASSE 12080.
USEFUL TABLES  
CONVERSION TABLES

**Note:** The information contained in these tables are not part of this American National Standard (ANS) and have not been processed in accordance with ANSI’s requirements for an ANS. As such, these tables may contain material that has not been subjected to public review or a consensus process. In addition, they do not contain requirements necessary for conformance to the standard.

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<td>BY</td>
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<td>Yards</td>
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<td>Feet/minute (ft/min)</td>
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**UNIT CONVERSIONS (continued)**

**USEFUL TABLES**

- **Miles (statute)** ............................................................. 1.609 ............................ **Kilometers (km)**
- **Miles/hour (mi/h)** ..................................................... 1.609344 ............................ **Kilometers/hour (km/h)**
- **Miles/hour (mi/h)** ............................................................. 88 ............................ **Feet/minute (ft/min)**
- **Miles/hour (mi/h)** ............................................................ 1.467 ............................ **Feet/second (ft/s)**
- **Miles/hour (mi/h)** ............................................................ 26.82 ............................ **Meters/minute (m/min)**
- **Miles/hour (mi/h)** .......................................................... 0.44704 ............................ **Meters/second (m/s)**
### USEFUL TABLES

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<td>Quarts (U.S. liquid) (liq qt)</td>
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<tr>
<td>Temperature (°C) + 17.28</td>
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<tr>
<td>Temperature (°F) – 32</td>
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</table>

Temperature (°C) – 32 = 59

Temperature (°F) + 17.28 = 1.8

Temperature (°F) – 32 = Temperature (°C)

MULTIPLY BY TO OBTAIN

- To convert millimeters to centimeters, multiply by 0.1
- To convert inches to millimeters, multiply by 25.4
- To convert square inches to square centimeters, multiply by 6.4516
- To convert cubic inches to cubic centimeters, multiply by 16.3871
- To convert liters to cubic meters, multiply by 0.001
- To convert cubic inches to milliliters, multiply by 16.3871
- To convert kilograms to pounds, multiply by 2.20462
- To convert pounds to kilograms, multiply by 0.453596
- To convert pounds to kilograms-force, multiply by 1019.716
- To convert kilograms-force to pounds, multiply by 0.980665
- To convert pascals to pounds per square inch, multiply by 0.070307
- To convert pounds per square inch to pascals, multiply by 6.89476
UNIT CONVERSIONS (continued)

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<td>Ton-force per square foot (tonf/ft²)</td>
<td>95.7605 Kilopascals (kPa)</td>
</tr>
<tr>
<td>Ton-force per square inch (tonf/in²)</td>
<td>13.7895 Megapascals (MPa)</td>
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<tr>
<td>Tons (metric)</td>
<td>1000 Kilonewtons (kN)</td>
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<td>Tons (long) (2240 lbs)</td>
<td>1016.047 Kilonewtons (kN)</td>
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<td>Tons (short)</td>
<td>2000 Pounds (lbs)</td>
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<td>Watts</td>
<td>3.4121 British thermal units per hour (Btus/hour)</td>
</tr>
<tr>
<td>Watts</td>
<td>1.341 x 10⁻³ Horsepower (hp)</td>
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<td>Yards (y)</td>
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SI SYMBOLS AND PREFIXES

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<th>PREFIX</th>
<th>SYMBOL</th>
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<td>tera</td>
<td>E+12</td>
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### AREAS AND CIRCUMFERENCES OF CIRCLES

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**EQUAL PERIPHERIES**

\[ S = 0.7854 D \]

\[ D = 1.2732 S \]

**EQUAL AREAS**

Area of square (\( S' \)) = 1.2732 \( \times \) area of circle

Area of square (\( S \)) = 0.6366 \( \times \) area of circle

\( C = \pi D = 2\pi R \)

\( C = 3.5446 \ \text{varea} \)

\( D = 0.3183 \ C = 2R \)

\( D = 1.1283 \ \text{varea} \)

Area = \( \pi R^2 = 0.7854 \ D^2 \)

Area = 0.07958 \( C^2 = \frac{D^2}{4} \)
## Approximate Minimum Thickness for Carbon Sheet Steel Corresponding to Manufacturer’s Standard Gauge and Galvanized Sheet Gauge Numbers

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<th>Manufacturer’s Standard Gauge No.</th>
<th>Decimal and Nominal Thickness Equivalent (inch)</th>
<th>Recommended Minimum Thickness Equivalent* (inch)</th>
<th>Galvanized Sheet Gauge No.</th>
<th>Decimal and Nominal Thickness Equivalent (inch)</th>
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<td>30</td>
<td>0.0157</td>
<td>0.013</td>
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</table>

For SI units: 1 inch = 25.4 mm

* The thickness of the sheets set forth in the code correspond to the thickness shown under these columns. They are the approximate minimum thicknesses and are based on the following references:

Carbon Sheet Steel—Thickness 0.071 inch (1.803 mm) and over:
ASTM A 568, Table 3, Thickness Tolerances of Hot-Rolled Sheet (Carbon Steel).

Carbon Sheet Steel—Thickness less than 0.071 inch (1.803 mm):
ASTM A 568, Table 23, Thickness Tolerances of Cold-Rolled Sheet (Carbon and High-Strength Low Alloy).

Galvanized Sheet Steel—All thicknesses:
ASTM A 653, Table 4, Thickness Tolerances of Hot-Dip Galvanized Sheet.

Minimum thickness is the difference between the thickness equivalent of each gauge and the maximum negative tolerance for the widest rolled width.
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