

2023 CITY OF LOS ANGELES MECHANICAL CODE

Based on the 2022 CMC and the 2021 UMC®



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2023 CITY OF LOS ANGELES MECHANICAL CODE

Based on the 2022 CMC and 2021 UMC®



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CALIFORNIA BUILDING STANDARDS COMMISSION
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Metro District	201 North Figueroa Street, 4th Floor, Los Angeles 90012
San Fernando Valley District	6262 Van Nuys Boulevard, 2nd Floor Van Nuys 91401
San Pedro District	638 South Beacon Street, 2nd Floor, San Pedro 90731
South Los Angeles District	1968 W. Adams Boulevard, Los Angeles 90018
West Los Angeles District	1828 Sawtelle Boulevard, 2nd Floor, Los Angeles 90025



**CITY OF LOS ANGELES
DEPARTMENT OF BUILDING AND SAFETY**

Published Codes:

2023 Edition of the City of Los Angeles Building Code, Volumes 1 and 2
2023 Edition of the City of Los Angeles Residential Code
2023 Edition of the City of Los Angeles Electrical Code
2023 Edition of the City of Los Angeles Plumbing Code
2023 Edition of the City of Los Angeles Mechanical Code
2023 Edition of the City of Los Angeles Green Code

Related Codes and Standards:

City of Los Angeles Municipal Code
City of Los Angeles Planning and Zoning Code
California Building Standards Code, Parts 2-6, 8, 10-11



CITY OF LOS ANGELES DEPARTMENT OF BUILDING AND SAFETY

The mission of the Department of Building and Safety is to protect the lives and safety of the residents and visitors of the City of Los Angeles and enhance the quality of life, housing, economic prosperity, and job creation. Through a timely, cooperative, and transparent process, the Department advises, guides, and assists customers to achieve compliance with the Building, Zoning, Plumbing, Mechanical, Electrical, Disabled Access, Energy, and Green Codes and local State laws to build safe, well, and fast.

The Department of Building and Safety is the largest organization of its kind in the United States with a dedicated staff of more than 1000 employees. The Department provides service to a population of more than 4 million people in a metropolitan area of more than 470 square miles with its 12 offices located throughout the City.

The Responsibilities of the Department of Building and Safety Are Assigned to Five Bureaus:

The Permit and Engineering Bureau is primarily responsible for the plan checking, report approval, and permit issuance related to building projects within privately owned property in the City of Los Angeles. In the course of carrying out these responsibilities, the Engineering Bureau enforces the structural, building, plumbing, mechanical, electrical, disabled access, green, grading and zoning regulations of the City. In addition, the Engineering Bureau is responsible for reviewing applications for building, plumbing, mechanical and electrical product approvals through its Building Research Section, and Electrical and Mechanical Test Laboratories.

The Inspection Bureau is responsible for inspection of all construction activities for new and existing buildings, plumbing, mechanical, electrical, elevator and pressure vessel systems, the enforcement of applicable State and local laws relating to existing buildings and property, and the administration of various special programs mandated by the City Council.

The Code Enforcement Bureau was created as a part of a reorganization of code enforcement functions in 1999. This Bureau is responsible for the enforcement of Municipal Code requirements for all existing buildings in the City of Los Angeles, except rental multi-family dwellings. The Bureau handles complaints, citations, processing of vacant and nuisance buildings for repair or demolition, Signs, Vehicle Establishment Inspection Program and Proactive Code Enforcement Program among others.

The Resource Management Bureau is responsible for the direction and coordination of administrative and financial projects, systems development, training and acts as the emergency disaster coordinator for all Department operations.

The Technology Service Bureau is responsible to provide oversight over the Build LA Project, and annually provides IT services for more than 3,000 City Staff (Building and Safety and other departments) and over 30,000 public customers; and manages more than 250 servers and 3,000 computer devices.

The Board of Building and Safety Commissioners:

The Board of Building and Safety Commissioners is a five-member board of citizens residing in the City and appointed by the Mayor and confirmed by the City Council. The Commission has the authority to hear and act upon appeals from determinations, orders, or actions of the Department or the Superintendent of Building, pertaining to enforcement of the codes under the jurisdiction of the Department. In addition, the Commission conducts public hearings, as needed, regarding procedures, new codes and various functions of the Department. Finally, the Commission acts in an advisory capacity to the Department and the Superintendent of Building.

The Board of Disabled Access Appeals Commissioners:

The Board of Disabled Access Appeals Commissioners comprises of five qualified persons appointed by the Mayor and confirmed by the City Council. Two members of the commission shall be physically disabled persons, and two members shall be persons experienced in construction. The fifth member may be any resident of the City of Los Angeles. The Commission has the authority to hear and act upon appeals from determinations, orders, or actions of the Department or the Superintendent of Building, pertaining to enforcement of the disabled access codes under the jurisdiction of the Disabled Access Division of the Department.



EFFECTIVE USE OF THE CITY OF LOS ANGELES MECHANICAL CODE

The City Council for the City of Los Angeles has passed an ordinance (operative January 1, 2023) to amend Article 5 of Chapter IX of the Los Angeles Municipal Code and to adopt by reference the 2022 edition of the California Mechanical Code (CMC) and hereinafter shall be called the 2023 edition of the City of Los Angeles Mechanical Code.







Chapters 1 through 17 of the City of Los Angeles Mechanical Code as published by the International Association of Plumbing and Mechanical Officials (hereinafter referred to as the published code), are Divisions 1 through 17, respectively, of Article 5, Chapter IX, of the Los Angeles Municipal Code (LAMC). For uniformity with the California Mechanical Code (CMC) only the division and section numbers of the LAMC are stated in the published code.

For the complete Los Angeles Municipal Code section number, each code section number specified in Chapters 1 through 17 of the published code shall be presumed to be preceded by two digits and a decimal point (specifically "95."). For example, the first section of the published code is Section 95.101.0 of the Los Angeles Municipal Code.

California Building Standard Commission requires the provisions of HCD 1, HCD /AC, HCD 2, DSA/AC, OSHPD 3 and SFM of the CPC be enforced by local jurisdictions. See Sections 1.8.2.1.1 through 1.8.2.1.3, 1.10.3 and 1.11.2.1 for the explanation of application.

SYMBOLS AND NOTATIONS IN THE CODE FOR THE CITY OF LOS ANGELES

To distinguish between model code language and incorporated California amendment, including exclusive California standards, California amendments will appear in italics. The symbols in the margins shall indicate the status of the code changes as follows:

-  This symbol indicates changes by the International Association of Plumbing and Mechanical Officials (IAPMO) from the 2021 edition of the Uniform Mechanical Code (UMC).
-  This symbol indicates deletion by IAPMO of language which was in the 2021 edition of the UMC.
-  This symbol indicates that a change has been made to a California amendment.
-  This symbol indicates deletion of California language.
-  This symbol indicates that a City of Los Angeles amendment has been added to the CMC.
-  This symbol indicates deletion of the CMC language by the City of Los Angeles.

The notations used to identify origin of the amendment.

PREFACE

This document is Part 4 of thirteen parts of the official triennial compilation and publication of the adoptions, amendments and repeal of administrative regulations to *California Code of Regulations, Title 24*, also referred to as the *California Building Standards Code*. Part 4 is known as the *California Mechanical Code* and incorporates, by adoption, the 2021 edition of the *Uniform Mechanical Code* of the International Association of Plumbing and Mechanical Officials with the California amendments.

The *California Building Standards Code* is published in its entirety every three years by order of the California legislature, with supplements published in intervening years. The California legislature delegated authority to various state agencies, boards, commissions and departments to create building regulations to implement the State's statutes. These building regulations or standards, have the same force of law, and take effect 180 days after their publication unless otherwise stipulated. The *California Building Standards Code* applies to occupancies in the State of California as annotated.

A city, county, or city and county may establish more restrictive building standards reasonably necessary because of local climatic, geological or topographical conditions. Findings of the local condition(s) and the adopted local building standard(s) must be filed with the California Building Standards Commission to become effective and may not be effective sooner than the effective date of this edition of the *California Building Standards Code*. Local building standards that were adopted and applicable to previous editions of the *California Building Standards Code* do not apply to this edition without appropriate adoption and the required filing.

Should you find publication (e.g., typographical) errors or inconsistencies in this code or wish to offer comments toward improving its format, please address your comments to:

California Building Standards Commission
2525 Natomas Park Drive, Suite 130
Sacramento, CA 95833-2936
Phone: (916) 263-0916
Web Page: www.dgs.ca.gov/bsc
Email: cbsc@dgs.ca.gov

ACKNOWLEDGEMENTS

The 2022 *California Mechanical Code* (Code) was developed through the outstanding collaborative efforts of the Department of Housing and Community Development, Division of State Architect, Office of the State Fire Marshal, Office of Statewide Health Planning and Development, California Energy Commission, California Department of Public Health, California State Lands Commission, Board of State and Community Corrections, and the California Building Standards Commission (Commission).

This collaborative effort included the assistance of the Commission's Code Advisory Committees and many other volunteers who worked tirelessly to assist the Commission in the production of this Code.

Governor Gavin Newsom

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For questions on California state agency amendments, please refer to the contact list on page iv.

California Code of Regulations Title 24

California Agency Information Contact List

The following state agencies may propose building standards for publication in Title 24. Request notice of such activity with each agency of interest. See Sections 1.2.0 through 1.14.0 of the California Building Code (Part 2 of Title 24) for more detailed information on the regulatory jurisdiction of each state agency.

Board of State and Community Corrections

www.bscc.ca.gov(916) 445-5073
Local Adult and Juvenile
Detention Facility Standards

California Building Standards Commission

www.dgs.ca.gov/bsc(916) 263-0916
State Buildings including UC and
CSU Buildings, Parking Lot and Walkway
Lighting, Green Building Standards
for Non-residential Buildings

California Energy Commission

www.energy.ca.gov**Energy Hotline** (800) 772-3300
Building Efficiency Standards
Appliance Efficiency Standards
Compliance Manual/Forms

California State Lands Commission

www.slc.ca.gov(562) 499-6312
Marine Oil Terminals Standards

California State Library

www.library.ca.gov(916) 323-9843

Department of Consumer Affairs:

Acupuncture Board

www.acupuncture.ca.gov(916) 515-5200
Office Standards

Board of Pharmacy

www.pharmacy.ca.gov(916) 518-3100
Pharmacy Standards

Bureau of Barbering and Cosmetology

www.barbercosmo.ca.gov(800) 952-5210
Barber and Beauty Shop,
and College Standards

Bureau of Household Goods and Services

www.bhgs.dca.ca.gov(916) 999-2041
Insulation Testing Standards

Structural Pest Control Board

www.pestboard.ca.gov(800) 737-8188
Structural Standards

Veterinary Medical Board

www.vmb.ca.gov(916) 515-5220
Veterinary Hospital Standards

Department of Food and Agriculture

www.cdffa.ca.gov(916) 900-5004
Meat & Poultry Packing Plant Standards

(916) 900-5008

Rendering & Collection Center Standards, Dairy Standards

Department of Housing and Community Development

www.hcd.ca.gov(800) 952-8356
Residential - Hotels, Motels, Apartments,
Single-Family Dwellings; and
Permanent Structures in Mobilehome &
Special Occupancy Parks

(916) 445-3338

Factory-Built Housing, Manufactured Housing &
Commercial Modular

Mobilehome - Permits & Inspections

Northern Region - (916) 255-2501

Southern Region - (951) 782-4420

(800) 952-8356

Employee Housing Standards

Department of Public Health

www.dph.ca.gov(916) 449-5661
Organized Camps Standards
Public Swimming Pools Standards

Department of Water Resources

www.water.ca.gov(916) 651-7025
Recycled Water Building Standards

Division of the State Architect

www.dgs.ca.gov/dsa(916) 445-8100

Access Compliance

Fire and Life Safety

Structural Safety

Public Schools Standards

Essential Services Building Standards

Community College Standards

State Historical Building Safety Board

www.dgs.ca.gov(916) 445-8100

Historical Rehabilitation, Preservation,

Restoration or Relocation Standards

California Code of Regulations Title 24
California Agency Information Contact List (continued)

Office of Statewide Health Planning and Development
AKA: California Department of Health Care Access and
Information (HCAI)

www.hcai.ca.gov(916) 440-8300
Hospital Standards
Skilled Nursing Facility Standards &
Clinic Standards

Office of the State Fire Marshal

www.osfm.fire.ca.gov(916) 568-3800
Code Development and Analysis
Fire Safety Standards

How to Distinguish Between Model Code Language and California Amendments

To distinguish between model code language and the incorporated California amendments, including exclusive California standards, California amendments will appear in italic font print.

[BSC] This is an example of a state agency acronym used to identify an adoption or amendment by the agency. The acronyms will appear at California Amendments and in the Matrix Adoption Tables. Sections 1.2.0 through 1.14.0 in Chapter 1, Division 1 of this code, explain the used acronyms, the application of state agency adoptions to building occupancies or building features, the enforcement agency as designated by state law (may be the state adopting agency or local building or fire official), the authority in state law for the state agency to make the adoption, and the specific state law being implemented by the agency's adoption. The following acronyms are used in Title 24 to identify the state adopting agency making an adoption.

Legend of Acronyms of Adopting State Agencies

BSC	California Building Standards Commission (see Section 1.2.0)
BSC-CG	California Building Standards Commission-CALGreen (see Section 1.2.3)
BSCC	Board of State and Community Corrections (see Section 1.3.0)
SFM	Office of the State Fire Marshal (see Section 1.11.0)
HCD-1	Department of Housing and Community Development (see Section 1.8.2.1.1)
HCD-2	Department of Housing and Community Development (see Section 1.8.2.1.3)
HCD-1/AC	Department of Housing and Community Development (see Section 1.8.2.1.2)
DSA-AC	Division of the State Architect-Access Compliance (see Section 1.9.1)
DSA-SS	Division of the State Architect-Structural Safety (see Section 1.9.2)
DSA-SS/CC	Division of the State Architect-Structural Safety/Community Colleges (see Section 1.9.2.2)
OSHPD 1	Office of Statewide Health Planning and Development (see Section 1.10.1)
OSHPD 1R	Office of Statewide Health Planning and Development (see Section 1.10.1)
OSHPD 2	Office of Statewide Health Planning and Development (see Section 1.10.2)
OSHPD 3	Office of Statewide Health Planning and Development (see Section 1.10.3)
OSHPD 4	Office of Statewide Health Planning and Development (see Section 1.10.4)
OSHPD 5	Office of Statewide Health Planning and Development (see Section 1.10.5)
DPH	Department of Public Health (see Section 1.7.0)
AGR	Department of Food and Agriculture (see Section 1.6.0)
CEC	California Energy Commission (see Section 100 in Part 6, the California Energy Code)
CA	Department of Consumer Affairs (see Section 1.6.0): Board of Barbering and Cosmetology Board of Examiners in Veterinary Medicine Board of Pharmacy Acupuncture Board Bureau of Home Furnishings Structural Pest Control Board SPCB
SL	State Library (see Section 1.12.0)
SLC	State Lands Commission (see Section 1.14.0)
DWR	Department of Water Resources (see Section 1.13.0 of Chapter 1 of the California Plumbing Code in Part 5 of Title 24)

The state agencies are available to answer questions about their adoptions. Contact information is provided on page iv of this code.

To learn more about the use of this code refer to the following pages. Training materials on the application and use of this code are available at the website of the California Building Standards Commission www.dgs.ca.gov/bsc.

CALIFORNIA MATRIX ADOPTION TABLES

Format of the Matrix Adoption Tables

The matrix adoption tables, examples of which follow, are non-regulatory aids intended to show the user which state agencies have adopted and/or amended given sections of model code. An agency's statutory authority for certain occupancies or building applications determines which chapter or section may be adopted, repealed, amended or added. See Chapter 1, Division I, Sections 1.2.0 through 1.14.0, for agency authority, building application and enforcement responsibilities.

The side headings identify the scope of the state agencies' adoption as follows:

Adopt the entire UMC chapter without state amendments.

If there is an "X" under a particular state agency's acronym in this row, it means that particular state agency has adopted the entire model code chapter without any state amendments.

Example:

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE CHAPTER 1 - GENERAL CODE PROVISIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter			X																				
Adopt Entire Chapter as amended (amended sections listed below)							S	A	M	P	L	E											
Adopt only those sections that are listed below																							
Chapter/Section																							
202																							

Adopt the entire UMC chapter as amended, state-amended sections are listed below:

If there is an "X" under a particular state agency's acronym in this row, it means that a particular state agency has adopted the entire model code chapter, with state amendments.

Each state-amended section that the agency has added to that particular chapter is listed. There will be an "X" in the column, by that particular section, under the agency's acronym, as well as an "X" by each section that the agency has adopted.

Example:

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE CHAPTER 1 - GENERAL CODE PROVISIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter																							
Adopt Entire Chapter as amended (amended sections listed below)	X		X				S	A	M	P	L	E											
Adopt only those sections that are listed below																							
Chapter/Section																							
202	X		X																				

Adopt only those sections which are listed below:

If there is an “X” under a particular state agency’s acronym in this row, it means that particular state agency is adopting only specific model code or state-amended sections within this chapter. There will be an “X” in the column under the agency’s acronym, as well as an “X” by each section that the agency has adopted.

Example:

**CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 1 - GENERAL CODE PROVISIONS**

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter																							
Adopt Entire Chapter as amended (amended sections listed below)							S	A	M	P	L	E											
Adopt only those sections that are listed below	X																						
Chapter/Section																							
101	X																						
102	X																						

HOW TO DISTINGUISH MODEL CODE LANGUAGE FROM CALIFORNIA AMENDMENTS

To distinguish between model code language and incorporated California Amendments, including exclusive California standards, California amendments will appear in italics font print.

Symbols in the margins indicate the status of code changes as follows:

[BSC] This symbol identifies which State agency(s) by its “acronym” that has amended a section of the model code. For a complete listing of State agency acronyms, see the Application Section within Chapter 1, Division I.

|| This symbol indicates that a change has been made to a California amendment.

| This symbol indicates that a section, paragraph, or table has been revised or relocated within IAPMO model code language.

> This symbol indicates deletion of California language.

→ This symbol indicates where an entire section, paragraph, or table has been deleted from IAPMO model code language.

Revision Markings

A double right angle (») in the margin indicates that the text or a table has been relocated within the code. The table found on page xx points out the relocations in the 2021 edition of the Uniform Mechanical Code.

TIA TIA indicates that the revision is the result of a Tentative Interim Amendment.
TIA For further information on tentative interim amendments see Section 5 of the IAPMO
TIA Regulations Governing Committee Projects available at <http://codes.iapmo.org/>

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another document. This reprinted material is not the complete and official position of the source document on the referenced subject that is represented by the standard in its entirety. Material contained in this document that is taken or extracted from NFPA standards is used with permission of the National Fire Protection Association. This material is not the complete and official position of the NFPA on the reference subject, which is represented solely by the relevant standard in its entirety. NFPA standards can be accessed at www.nfpa.org. In addition, this extracted material may include revisions or modifications developed through IAPMO’s standards development process. Therefore, NFPA disclaims responsibility for the content of this Code.

Text that is extracted pursuant to IAPMO’s Extract Guidelines, but outside of the regular revision process is denoted with the use of the source document in the margin. This text is not fully processed by IAPMO in accordance with ANSI’s public announcement consensus requirements for an American National Standard (ANS) nor approved by ANSI’s Board of Standards Review. The next revision cycle processes such text in accordance with those requirements.

Important Notices and Disclaimers

The 2021 edition of the *Uniform Mechanical Code* is developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on mechanical issues. While the International Association of Plumbing and Mechanical Officials (IAPMO) administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its codes and standards.

IAPMO disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this document. IAPMO also makes no guarantee or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this document available, IAPMO is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is IAPMO undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

Updating IAPMO Codes

Users of IAPMO codes should be aware that IAPMO codes may be amended from time to time through the issuance of Tentative Interim Amendments or corrected by Errata. IAPMO codes consist of the current edition of the document together with any Tentative Interim Amendment and any Errata in effect.

In order to determine whether an IAPMO code has been amended through the issuance of Tentative Interim Amendments or corrected by Errata, please visit the IAPMO Group codes information pages on IAPMO's website (www.iapmo.org). The codes information pages provide a list of IAPMO codes with up-to-date, specific information including any issued Tentative Interim Amendments and Errata.

To access the codes information pages for a specific code, go to <http://codes.iapmo.org> to select from the list of IAPMO codes. For Tentative Interim Amendments, go to the standard council decisions. For Errata, select the archived revision information.

Origin and Development

The industry has long recognized the advantages of a statewide adopted mechanical code. The first edition of the *Uniform Mechanical Code*® (UMC®) was adopted by IAPMO in 1967. The widespread use of this code over the past five decades by jurisdictions throughout the United States and internationally is testament to its merit.

Publishing of the 2003 *Uniform Mechanical Code* was a significant milestone because it was the first time in the history of the United States a mechanical code was developed through a true consensus process. The 2021 edition represents the most current approaches in the mechanical field and is the seventh edition developed under the ANSI consensus process. Contributions to the content of this code consists of diverse interests as consumers, enforcing authorities, installers/maintainers, labor, manufacturers, research/standards/testing laboratories, special experts, and users.

The *Uniform Mechanical Code* provides consumers with complete requirements for the installation and maintenance of heating, ventilating, cooling, and refrigeration systems, while, at the same time, allowing latitude for innovation and new technologies. The public at large is invited and encouraged to take part in IAPMO's open consensus code development process. This code is updated every three years. The *Uniform Mechanical Code* is dedicated to all those who, in working to achieve "the ultimate mechanical code," have unselfishly devoted their time, effort, and personal funds to create and maintain this, the finest mechanical code in existence today.

The *Uniform Mechanical Code* updates every three years in revision cycles that begin twice each year that takes two years to complete.

Each revision cycle advances according to a published schedule that includes final dates for all major events and contains four basic steps as follows:

1. Public and Committee Proposal Stage;
2. Comment Stage;
3. Association Technical Meeting;
4. Council Appeals and Issuance of Code.

IAPMO develops "full consensus" codes built on a foundation of maximum participation and agreement by a broad range of interests. This philosophy has led to producing technically sound codes that promote health and safety, yet do not stifle design or development.

It is important to stress that the process remains committed to the principles of consensus code development where consensus Technical Committees and Correlating Committees revise codes. The public and membership is offered multiple opportunities to debate, provide input and raise concerns through Amending Motions at the annual Assembly Consideration Session. Anyone may submit an appeal related to the issuance of a document through the IAPMO Standards Council.

The 2021 *Uniform Mechanical Code* is supported by the Mechanical Contractors Association of America (MCAA), the Plumbing-Heating-Cooling Contractors National Association (PHCC-NA), the United Association (UA), and the World Plumbing Council (WPC). The presence of these logos, while reflecting support, does not imply any ownership of the copyright to the UMC, which is held exclusively by IAPMO. Further, the logos of these associations indicate the support of IAPMO's open consensus process being used to develop IAPMO's codes and standards.

FOREWORD

The addresses of the organizations are as follows:

ASSE – 18927 Hickory Creek Drive, Suite 220 • Mokena, IL 60448 • (708) 995-3019

MCAA – 1385 Piccard Drive • Rockville, MD 20850 • (301) 869-5800

PHCC-NA – PO Box 6808 • Falls Church, VA 22040-6808 • (800) 533-7694

RPA – 18927 Hickory Creek Drive, Suite 220 • Mokena, IL 60448 • (877) 427-6601

UA – Three Park Place • Annapolis, MD 21401 • (410) 269-2000

WPC – World Plumbing Council Secretariat, Auf der Mauer 11 • Postfach CH 8021 • Zurich
Switzerland • www.WorldPlumbing.org

Adoption

The *Uniform Mechanical Code* is available for adoption and use by jurisdictions in the United States and Internationally. Its use within a governmental jurisdiction is accomplished through adoption by reference in accordance with applicable jurisdictional laws. At adoption, jurisdictions should insert the applicable information in bracketed words in the sample ordinance. The sample legislation for adoption of the *Uniform Mechanical Code* on page xi provides key components, regulations and resolutions.

Revision Markings

Solid vertical lines in the margins indicate a technical change from the requirements of the 2021 edition. An arrow (←) in the margin indicates where an entire section, paragraph, exception, figure, or table has been deleted, or an item in a list of items or a table has been deleted.

A double right angle (⟨⟨) in the margin indicates that the text or a table has been relocated within the code. The table found on page xiii points out the relocations in the 2021 edition of the *Uniform Mechanical Code*.

TIA TIA indicates that the revision is the result of a Tentative Interim Amendment.
TIA For further information on tentative interim amendments see Section 5 of the IAPMO
TIA Regulations Governing Committee Projects available at <http://codes.iapmo.org/>

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FORMAT OF THE UNIFORM MECHANICAL CODE

The format of the *Uniform Mechanical Code* (UMC) arranges each chapter in accordance with a specific subject matter. However, Chapter 3 is dedicated to general requirements that are applicable to every chapter. The subject matters are divided as follows:

CHAPTERS	SUBJECTS
1	Administration
2	Definitions
3	General Regulations
4	Ventilation Air
5	Exhaust Systems
6	Duct Systems
7	Combustion Air
8	Chimneys and Vents
9	Installation of Specific Appliances
10	Boilers and Pressure Vessels
11	Refrigeration
12	Hydronics
13	Fuel Gas Piping
14	Process Piping
15	Solar Energy Systems
16	Stationary Power Plants
17	Referenced Standards
Appendix A	Residential Plans Examiner Review Form for HVAC System Design
Appendix B	Procedures to be Followed to Place Gas Equipment in Operation
Appendix C	Installation and Testing of Oil (Liquid) Fuel-Fired Equipment
Appendix D	Fuel Supply: Manufactured/Mobile Home Parks and Recreational Vehicle Parks
Appendix E	Sustainable Practices
Appendix F	Geothermal Energy Systems
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Appendix H	Example Calculation of Outdoor Air Rate

FORMAT OF THE UNIFORM MECHANICAL CODE

The following is a summary of the scope and intent of the provisions addressed within the chapters and appendices of the *Uniform Mechanical Code*:

Chapter 1 Administration.

Chapter 1 regulates the application, enforcement, and administration of subsequent requirements of the code. As well as establishing the scope of the code, this chapter is concerned with enforcing the requirements contained in the body of the code. A mechanical code, as with any other code, is intended to be adopted as a legally enforceable document to safeguard health, safety, property and public welfare. The code cannot be effective without satisfactory provisions for its administration and enforcement. The Authority Having Jurisdiction is to review the proposed and completed work and to decide whether a mechanical system conforms to the code requirements. As a public servant, the Authority Having Jurisdiction enforces the code in an unbiased, proper manner. The design professional is responsible for the design of a safe mechanical system. The contractor is responsible for installing the system in accordance with the plans.

Chapter 2 Definitions.

To maintain consistency and encourage the use of common terminology, Chapter 2 establishes definitions to provide clarity of terms and promote the use of a common language throughout the code. Understanding definitions within the context of their application enables greater collaboration, efficiency, standardization and interpretation in applying and enforcing terms used throughout the code. Codes are technical documents, and every term can impact the meaning of the code text. Terms not defined have a normally accepted meaning.

Chapter 3 General Regulations.

Chapter 3 regulates the general requirements, not specific to other chapters, for installing mechanical systems. Many regulations are not specific mechanical requirements, but relate to the overall mechanical system. This chapter contains safety requirements for appliance location and installation, appliance and system access, condensate disposal, and clearances to combustibles, and return or outside air used in mechanical systems. Listing method of approval, based on applicable nationally recognized standards, for the safe and proper installation of mechanical systems is essential to ensure protection of public health, safety, and welfare. The safety requirements provide protection for piping, material, and structures, with provisions for installation practices, removing stress and strain of the pipe, sleeving, and hanger support. The building's structural stability is protected by the regulations for cutting and notching of structural members.

Chapter 4 Ventilation Air.

Chapter 4 regulates the minimum requirements for ventilation air supply, exhaust, and makeup air for spaces within a building. Building ventilation is one important factor affecting the relationship between airborne transmission of respiratory infections and the health and productivity of workers. Ventilation air may be composed of mechanical or natural ventilation, infiltration, recirculated air, transfer air, or a suitable combination of that. Providing a comfortable and healthy indoor environment for building occupants is of primary concern. When considering how much ventilation should be supplied, typical and unusual significant sources of indoor pollution need to be controlled. Areas such as kitchens, bathrooms, and laundries are all built to allow specific functions. These spaces produce pollutants such as moisture, odors, volatile organic compounds, particles, or combustion byproducts. The purpose of local exhaust is to control concentrates of these pollutants in the room into which they were emitted in and to reduce the spread of the pollutants into other parts of the occupancy. Local exhaust ventilation is the source control for pollution that is expected in certain rooms. Using local exhaust to extract contaminants before they can mix with the indoor environment is essential.

Chapter 5 Exhaust Systems.

Chapter 5 regulates the minimum requirements for exhaust systems. Chapter 5 contains two parts: part I provides exhaust requirements for environmental air ducts and product conveying ducts; part II provides exhaust requirements for commercial kitchens. Environmental air ducts include exhaust ducts used for transporting the air from domestic kitchens, bathrooms, and clothes dryers. Systems that carry nonabrasive exhaust, such as smoke, moderately abrasives such as sawdust, and high abrasives such as manganese or acid vapors use product-conveying ducts. Part II provides the minimum fire safety requirements related to the design, installation, inspection, and maintenance of grease-type operations, such as cooking, for both fuel-gas and solid fuel. Cooking produces a significant amount of smoke, fumes, vapors, heat, and other pollutants. Therefore, acceptable kitchen ventilation is necessary to provide the occupants protection from smoke, unpleasant odors, pollutants, dangerous gases, and to prevent fires from the build-up of grease. There are two types of exhaust hoods (Type I and Type II) used in commercial kitchen applications. Type I hoods are intended to be installed above equipment or

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appliances that generate grease or smoke. Type II hoods are intended to be installed above equipment or dishwashers that generate steam, heat, or products of combustion, or where grease or smoke is not present. Type II hood exhaust system requirements are addressed in Section 519.0.

Chapter 6 Duct Systems.

Chapter 6 regulates requirements for ducts and plenums that are portions of a heating, cooling, absorption or evaporative cooling, or exhaust system. This chapter contains material and installation requirements for metal, gypsum, factory-made, flexible, and plastic ducts. It also contains fire protection requirements, smoke dampers, and automatic shutoff for the building's air distribution system.

Chapter 7 Combustion Air.

Chapter 7 regulates combustion air requirements for the ventilation and dilution of flue gases for appliances installed in buildings. It applies to fuel-gas appliances except for direct vent appliances and clothes dryers. Chapter 5 provides makeup air for clothes dryers. Chapter 7 provides acceptable methods for supplying satisfactory combustion air to ensure proper combustion. Combustion air can be supplied by using indoor combustion air or by introducing the air from the outdoors.

Combustion is the rapid oxidation of fuel to release energy. The oxygen required to release the energy from the fuel normally comes from the air. Incomplete combustion of fuel occurs when inadequate oxygen is provided to the appliance. Combustion is needed to provide ventilation cooling for the casing and internal controls. When a lack of oxygen occurs, some of the carbon is not oxidized, and carbon monoxide forms.

Chapter 8 Chimneys and Vents.

Chapter 8 regulates the installation, design, and construction of venting systems for fuel-burning appliances. The provisions addressed within this chapter follow procedures an installer would use to design or evaluate a venting system. Many requirements apply to the design and construction of venting systems, chimneys, installation of gas vents, and the sizing of venting system for a Category I appliance. Sizing venting systems require rigorous engineering calculations. However, the venting sizing requirements and sizing tables in this chapter already perform the calculations for the benefit of the end user.

Combustion appliances produce products of incomplete combustion, including potentially harmful carbon monoxide (CO). It is desirable to vent these products to the outdoors. Although the gas is clean-burning fuel, the products of combustion must not be allowed to collect within a building.

Chapter 9 Installation of Specific Appliances.

Chapter 9 regulates the minimum requirements for the design, construction and installation of specific appliances. The provisions address the minimum requirements for gas-fired appliances, oil-fired appliances, wood-fired appliances, and electric-type appliances. In addition to the requirements of this chapter, appliances are also required to comply with the general requirements of Chapter 3.

Chapter 10 Boilers and Pressure Vessels.

Chapter 10 regulates the construction, installation, operation, repair, and alteration of boilers and pressure vessels. A low-pressure boiler provides steam at a pressure that does not exceed 15 psig, a gauge pressure more than 160 psi (1103 kPa) or heats water to a temperature more than 250°F (121°C). Potable water heaters are free from the requirements of Chapter 10 as they are within the scope of the Uniform Plumbing Code (UPC).

Pressure vessels store large amounts of energy and must comply with ASME Boiler and Pressure Vessel Code (BPVC) Section VIII. The stored energy must be contained to prevent disastrous failures. Boilers must comply with ASME BPVC Section I, ASME BPVC Section IV, or NFPA 85. Installing a safety relief valve and expansion tank prevents pressures in the tank from exceeding the design threshold.

Chapter 11 Refrigeration.

Chapter 11 regulates the design, installation, and construction requirements of refrigeration systems and the installation and construction of cooling towers. Refrigeration is a method used for achieving heat transfer to cool spaces. Refrigerants are the most common medium used to transfer the heat energy from the low-temperature level to the high-temperature level. Table 1102.3 lists the most commonly used refrigerants and is labeled by a number. The concentration limits provided in Table 1102.3 are useful for the quantity of refrigerant required to cool a volume of space safely.

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A major milestone reached in the industry was the introduction of lower flammability refrigerants such as A2L and B2L. The industry's concerns to address lower Global Warming Potential (GWP) refrigerants led to the development of these lower flammability refrigerants. Chapter 11 does not only include these lower flammability refrigerants in Table 1102.3, but it also contains specific A2L and B2L provisions to address the precautions necessary for the proper use of these products.

In addition, Chapter 11 addresses other minimum requirements for refrigeration systems such as refrigeration machinery rooms (including ventilation), relief valves, and pressure vessels. Apart from refrigerants, the chapter also addresses minimum requirements for systems that use other mediums such as ammonia and brine systems. For ammonia systems, such systems are required to comply with IIAR 2, IIAR 3, IIAR4, and IIAR 5.

Chapter 12 Hydronics.

Chapter 12 regulates hydronic systems that are part of heating, cooling, ventilation, and conditioning systems. Such piping systems include steam, hot water, chilled water, steam condensate, and the ground source heat pumps systems. The ground source heat pumps provisions in this chapter apply to the hydronic portions of the system. It is worth noting Appendix F addresses added provisions for ground source heat pumps for geothermal energy systems.

Materials for piping and tubing must meet the working temperature and pressure of the system. In addition, materials must be compatible with the transfer medium to prevent deformation, bursting, or any chemical action between the material and the transfer medium. The allowable joining methods for piping or tubing are provided for application and enforcement purposes.

Chapter 13 Fuel Gas Piping.

Chapter 13 regulates gas piping systems in a building, structure or within the property lines of buildings up to 5 psi. Gas piping systems must supply the minimum volume of gas required by each gas appliance to perform their proper operation under working conditions without exceeding the maximum pressure specified by each manufacturer. Because of the hazards associated with fuel gas, it is important to ensure the gas system has been inspected and tested, and that it is safe to turn on the gas supply to the building.

Chapter 14 Process Piping.

Chapter 14 regulates process piping that typically is found in refineries. Process piping is considered the piping or tubing portion that transports liquid or gas, which is used directly in research, laboratory, or production process. This chapter may be used with another chapter of the code. For example, refrigeration piping, fuel gas piping, or fuel oil piping may need to comply with this chapter for process piping and the applicable chapter for materials, design, and installation.

Chapter 15 Solar Energy Systems.

Chapter 15 refers the user to the Uniform Solar, Hydronics and Geothermal Code (USHGC) for installations about solar energy systems. Reference is also made to Section 1203.0 as the heat source provisions are applicable to solar energy systems.

Chapter 16 Stationary Power Plants.

This chapter provides minimum requirements for stationary fuel cell power plants. A fuel cell is a device that produces electricity by a chemical reaction. Fuel cells have been used mostly for satellites. However, the costs of fuel cells have decreased to a point where they are now economically attainable. With the increase in electricity costs, fuel cells are being considered as an alternative for producing electricity.

Chapter 17 Referenced Standards.

Chapter 17 provides two comprehensive tables with referenced standards. The standards listed in Table 1701.1 are applied as indicated in the applicable reference section(s). A list of additional approved standards, publications, practices, and guides that are not referenced in specific sections appear in Table 1701.2.

Referenced standards set forth specific details of accepted practices, materials specifications, or test methods in many specialized applications. Standards provide an efficient method of conveying complex information and specifications on the performance requirements for materials, products, systems, application, and installation. The manner and purpose for a standard's use and, in turn, code compliance, must be definitive in all references to the standard. If the standard is intended to

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be a requirement for judging code compliance, the code must state its intent for use. The standard should adequately address a defined need and at the same time specify the minimum performance requirements, technical characteristics and methods of testing, and required test results.

The referenced standards tables are organized in a manner that makes it easy to find specific standards in alphabetical order, and by acronym of the publishing agency of the standard. The tables list the title of the standard, the edition, and any addenda. Contact information for each publishing agency is provided at the end of the chapter.

Appendix A Residential Plans Examiner Review Form for HVAC System Design.

A residential plans examiner review form is located in this appendix as an example to assist users in identifying whether the HVAC system has followed the approved procedures for system design (loads, equipment, and ducts).

Appendix B Procedures to be Followed to Place Gas Equipment in Operation.

Appendix B provides requirements for the procedures that apply after an appliance is installed in place, piped, and connected to its venting system. The requirements include adjusting the burner input, air adjustments, verifying operation of safety shutoffs, automatic ignition, and protective devices, checking draft for vent-connected appliances, and operating instructions.

Appendix C Installation and Testing of Oil (Liquid) Fuel-Fired Equipment.

Appendix C governs the installation, testing, or repair of oil or liquid fuel-burning equipment used in buildings or structures and equipment.

Appendix D Fuel Supply: Manufactured/Mobile Home Parks and Recreational Vehicle Parks.

The provisions of this appendix apply to the fuel gas piping systems of mobile home and recreational vehicle parks. These provisions also apply to the use, maintenance, and installation for supplying fuel gas for accessory buildings or structures, and building components.

Appendix E Sustainable Practices.

This appendix provides a comprehensive set of technically sound provisions that encourage sustainable practices and works toward improving the design and construction of mechanical systems that result in a positive long-term environmental impact. Environmental sustainability is important because it involves natural resources that human beings need for economic or manufactured capital. Their sustainability is defined by their reliance on infinitely available resources that are naturally occurring, constant, and free to access.

Appendix F Geothermal Energy Systems.

Appendix F regulates the design, installation, construction and location of geothermal energy systems. In order to properly design a geothermal system, it is important to know the seasonal variation in the soil temperature, as well as the soil's inherent capability to store and transmit heat, namely its heat capacity and thermal conductivity.

Materials for piping and tubing must meet the working temperature and pressure of the system. In addition, materials must be compatible with the transfer medium to prevent deformation, bursting, or any chemical action between the material and the transfer medium. The allowable joining methods for piping or tubing are provided for application and enforcement purposes.

Appendix G Sizing of Venting Systems and Outdoor Combustion and Ventilation Opening Design.

Appendix G provides added information on the sizing of gas vents. This appendix is useful to the end user for the proper sizing of venting systems. A series of examples are given that show how to use the tables and other requirements of Chapter 8. In addition, Appendix G shows an example of how to determine the required combination of indoor and outdoor combustion air opening sizes for appliances under Chapter 7. The combustion air example also provides a table that contains the required volume of space per the appliance Btu/h input based on the standard method.

Appendix H Example Calculation of Outdoor Air Rate.

Appendix H gives an example of how to calculate the required outdoor air rate under Chapter 4.

SAMPLE LEGISLATION FOR ADOPTION OF THE UNIFORM MECHANICAL CODE

The Uniform Codes are designed to be adopted by jurisdictions through an ordinance. Jurisdictions wishing to adopt the 2021 *Uniform Mechanical Code* as an enforceable regulation governing mechanical systems by reference should ensure the legal basis under which adoption and implementation are included in the ordinance.

The following sample ordinance is a guide for drafting an ordinance for adoption that addresses key components regulations and resolutions.

ORDINANCE NO.

An ordinance of the [JURISDICTION] adopting the 2021 edition of the *Uniform Mechanical Code*, regulating and controlling the design, construction, quality of materials, erection, installation, alteration, repair, location, relocation, replacement, addition to, use or maintenance of mechanical systems in the [JURISDICTION]; providing for the issuance of permits and collection of fees therefor; repealing Ordinance No. of the [JURISDICTION] and all other ordinances and parts of the ordinances in conflict therewith.

The [GOVERNING BODY] of the [JURISDICTION] does ordain as follows:

Section 1 Codes Adopted by Reference. That certain documents, three (3) copies of which are on file in the office of the [JURISDICTION'S KEEPER OF RECORDS] and the [JURISDICTION], being marked and designated as the 2021 *Uniform Mechanical Code*, including Appendix Chapters [FILL IN THE APPENDIX CHAPTERS BEING ADOPTED], as published by the International Association of Plumbing and Mechanical Officials, be and is hereby adopted as the Code of the [JURISDICTION], in the State of [STATE NAME] regulating and controlling the design, construction, quality of materials, erection, installation, alteration, repair, location, relocation, replacement, addition to, use or maintenance of mechanical systems as herein provided; providing for the issuance of permits and collection of fees therefor; and each and all of the regulations, provisions, penalties, conditions and terms of such 2021 *Uniform Mechanical Code* on file in the office of the [JURISDICTION] are hereby referred to, adopted, and made a part hereof, as if fully set out in this ordinance.

Section 2 Modifications. The following sections are hereby revised:

Section 101.1. Insert: [NAME OF JURISDICTION]

Section 104.5. Insert: [APPROPRIATE FEE SCHEDULE]

Section 3 Conflicting Ordinances Repealed. That Ordinance No. of [JURISDICTION] entitled [TITLE OF THE ORDINANCE OR ORDINANCES IN EFFECT AT THE PRESENT TIME SO THAT THEY WILL BE REPEALED BY MENTION] and all other ordinances or parts of ordinances in conflict herewith are hereby repealed.

Section 4 Preemption. [JURISDICTION] hereby fully occupies and preempts the entire field of regulation of design, construction, quality of materials, erection, installation, alteration, repair, location, relocation, replacement, addition to, use or maintenance of mechanical systems; and provision for the issuance of permits and collection of fees therefor; within the boundaries of [JURISDICTION]. [AS APPROPRIATE] Cities, towns, and counties or other municipalities may enact only those laws and ordinances relating to this field as specifically authorized by state law and consistent with this ordinance. Local laws and ordinances that are inconsistent with, more restrictive than, or exceed the requirements of [ORDINANCE NO.] shall not be enacted and are hereby expressly preempted and repealed, regardless of the nature of the code, charter, or home rule status of such city, town, county, or municipality.

Section 5 Severability. That if any section, subsection, sentence, clause or phrase of this ordinance is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this ordinance. The [GOVERNING BODY] hereby declares that it would have passed this ordinance, and each section, subsection, clause or phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses and phrases be declared unconstitutional.

Section 6 Legal Notice. That the [JURISDICTION'S KEEPER OF RECORDS] is hereby ordered and directed to cause this ordinance to be published. (An additional provision may be required to direct the number of times the ordinance is to be published and to specify that it is to be in a newspaper in general circulation. Posting may also be required.)

Section 7 Violations and Penalties. [INCORPORATE PENALTIES FOR VIOLATIONS]

Section 8 Effective Date. That this ordinance and the rules, regulations, provisions, requirements, orders and matters established and adopted hereby shall take effect and be in full force and effect [TIME PERIOD] from and after the date of its final passage and adoption.

COMMITTEE ON UNIFORM MECHANICAL CODE

These lists represent the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred.

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JT Baca, State of New Mexico [E]

Carl Crimmins, MN State Pipe Trades, Retired [SE]

James Majerowicz, Plumbers JAC LU 130 [L]

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David Straub, Ex-Officio IAPMO [E]

COMMITTEE MEMBERSHIP CLASSIFICATION ABBREVIATIONS

These classifications apply to Technical Committee members and represent their principal interest in the activity of a committee.

- M** *Manufacturer*: A representative of a maker or marketer of a product, assembly or system, or portion thereof, that is affected by the standard.
- U** *User*: A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.
- I/M** *Installer/Maintainer*: A representative of an entity that is in the business of installing or maintaining a product, assembly or system affected by the standard.
- L** *Labor*: A labor representative or employee concerned with safety in the workplace.
- R/S/T** *Research/Standards/Testing Laboratory*: A representative of an independent research organization; an organization that develops codes, standards or other similar documents; or an independent testing laboratory.
- E** *Enforcing Authority*: A representative or an agency or an organization that promulgates and/or enforces standards.
- C** *Consumer*: A person who is, or represents, the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in the User classification.
- SE** *Special Expert*: A person not representing any of the previous classifications, but who has special expertise in the scope of the standard or portion thereof.

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CHAPTER 1

ADMINISTRATION

Part I – General.

101.0 Title, Scope, and General.

101.1 Title. This article is a portion of the Los Angeles Municipal Code and shall be known as the Los Angeles Mechanical Code. Whenever the word Code is used in this article, it shall mean the Los Angeles Mechanical Code.

101.2 Purpose. The purpose of this article is to safeguard life, health, property and public welfare by regulating the design, construction, installation, alteration, repair, quality of materials, location, operation and maintenance of heating, ventilating, air-conditioning and refrigeration equipment and other miscellaneous heat-producing appliances installed in the City. The provisions of this Code are not intended to apply to equipment installed on railroad cars, motor vehicles, aircraft or on shipboards that are not used as permanent occupancies for longer than six months.

101.3 Scope. The provisions of this Code shall apply to the addition to or erection, installation, alteration, repair, relocation, replacement, use, or maintenance of heating, ventilation, cooling, refrigeration systems; incinerators; or other miscellaneous heat-producing appliances within this jurisdiction.

Additions, alterations, repairs to, and replacement of equipment or systems shall be in accordance with the provisions for new equipment and systems, except as otherwise provided in LAMC Section 102.0.

101.3.1 Conflicts. Where, in a specific case, different sections of this Code or referenced standards specify different materials, methods of construction, or other requirements, the most restrictive shall govern as determined by the Authority Having Jurisdiction. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall prevail. [OSHPD 1, 2, 3 & 4]

101.3.1.1 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.

101.3.2 Design and Testing. The design and testing of equipment regulated by this Code shall be subject to the approval of the Authority Having Jurisdiction.

101.3.3 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.

102.0 Application to Existing Mechanical Systems.

Sections 104.0 through 104.4 of Chapter 1, Division II of the CMC are adopted by reference, Section 104.5 of Chapter 1, Division II of the CMC is not adopted, and in lieu thereof, Section 102.5 of this Code shall apply.

102.1 Additions, Alterations, or Repairs. Additions, alterations, or repairs shall be permitted to be made to a mechanical system without requiring the existing mechanical system to be in accordance with the requirements of this Code, provided the addition, alteration, or repair is in accordance with that required for a new mechanical system. Additions, alterations, or repairs shall not cause an existing system to become unsafe or create unhealthy or overloaded conditions.

Minor additions, alterations, and repairs to existing mechanical systems shall be permitted to be installed in accordance with the law in effect at the time the original installation was made, where approved by the Authority Having Jurisdiction.

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 systems.

102.3 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 Article 1, Chapter IX of the LAMC, shall be in accordance with the requirements of this Code that are applicable to the new use or occupancy.

102.4 Maintenance. Mechanical systems, materials, and appurtenances, both existing and new, and parts thereof, shall be maintained in operating condition in accordance with the original design and in a safe and hazard-free condition. Devices or safeguards that are 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 and equipment. To determine compliance with this subsection, the Authority Having Jurisdiction shall be permitted to cause mechanical systems or equipment to be reinspected.

102.4.1 Commercial HVAC Systems. Commercial HVAC systems both existing and new, and parts thereof shall be inspected and maintained in operating condition in accordance with ASHRAE/ACCA 180. The owner or the owner's designated agent shall be responsible for maintenance of mechanical systems and equipment. To determine compliance with this subsection, the Authority Having Jurisdiction shall be permitted to cause a HVAC system to be reinspected.

102.4.2 Residential HVAC Systems. Residential HVAC systems both existing and new, and parts thereof shall be inspected in accordance with ACCA 4 QM. The owner or the owner's designated agent shall be responsible for maintenance of mechanical systems and equip-

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ment. To determine compliance with this subsection, the Authority having Jurisdiction shall be permitted to cause a HVAC system to be reinspected.

102.5 Moved Buildings. Apartment houses and dwellings moved into or within the City and all other buildings moved within the City, may retain the existing heating, ventilation, air-conditioning and refrigeration equipment and other miscellaneous heat-producing appliances, provided the building does not become or continue to be a substandard residential building or a residential building subject to repair. However, existing mechanical equipment, including vents, which is not in good and safe condition and not working properly shall be corrected.

Existing heating, ventilation, air-conditioning and refrigeration equipment and other miscellaneous heat-producing appliances in any building, other than an apartment house or dwelling, moved from outside the City to inside the City shall comply with all the requirements of this Code.

New heating, ventilating, air-conditioning and refrigeration equipment and miscellaneous heat-producing appliances that are installed in any building relocated into or within the City shall conform to the provisions of this Code.

102.6 Existing Buildings. In existing buildings or premises in which mechanical systems are to be altered, repaired, replaced, 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 determination in order that health and safety requirements, as they pertain to mechanical, shall be observed.

103.0 Alternate Materials and Methods of Construction Equivalency.

103.1 General. 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.

104.0 Modifications.

Appeals or requests for slight modifications in individual cases from the requirements of this Code shall be made in accordance with the procedure established in LAMC Sections 98.0403.1 and 98.0403.2.

105.0 Testing.

105.1 General. The Authority Having Jurisdiction shall have authority to require tests, as proof of equivalency.

105.2 Approved Standards. 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.

105.3 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.

Part II – Organization and Enforcement.

106.0 Powers and Duties of the Department.

106.1 General. The powers of the Department and the Board are enumerated in Section 98.0403.1 of the Los Angeles Municipal Code.

106.2 Interpretation.

- (1) If two or more pertinent limitations are not identical, those limitations shall prevail that provide the greater safety to persons, property or public welfare.
- (2) The Superintendent of Building or a duly authorized representative is empowered to make all interpretations concerning the provisions of this Code.

106.4 Stop Orders. Where work is being done contrary to the provisions of this Code, the Authority Having Jurisdiction shall have the authority to order the work stopped by notice in writing served on persons engaged in 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 or authorized representative shall be permitted to disconnect fuel gas utility service or energy supplies to a building, structure, premises, or equipment regulated by this Code in case of emergency where necessary to eliminate an immediate hazard to life or property. The Authority Having Jurisdiction shall, wherever possible, notify the serving utility, the owner, and the occupant of the building, structure, or premises of the decision to disconnect prior to taking such action, and shall notify such serving utility, owner, and occupant of the building, structure, or premises in writing of such disconnection immediately thereafter.

106.6 Authority to Condemn Equipment. Where the Authority Having Jurisdiction ascertains that an equipment, or portion thereof, regulated by this Code has become hazardous to life, health, or property, it shall order in writing that the equipment either be removed or restored to a safe or sanitary condition. The written notice shall contain a fixed time limit for compliance with such order. Persons shall not use or maintain defective equipment after receiving a notice.

Where equipment or an installation is to be disconnected, written notice of the disconnection and causes therefore shall be given within 24 hours to the serving utility, owner, and occupant of the building, structure, or premises. Where equipment is maintained in violation of this Code, and in violation of a notice issued pursuant to the provisions of this section, the Authority Having Jurisdiction shall institute an action to prevent, restrain, correct, or abate the violation.

106.7 Connection after Order to Disconnect. Persons shall not make connections from an energy, fuel, or power supply nor supply energy or fuel to any equipment regulated by this Code that has been disconnected or ordered to be disconnected by the Authority Having Jurisdiction until it has authorized the reconnection and use of such equipment.

106.9 Cooperation of Other Officials and Officers. 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.

107.0 Unsafe Equipment.

107.1 General. Equipment regulated by this Code that is unsafe or that constitutes a fire or health hazard or is otherwise dangerous to human life is, for the purpose of this section, unsafe. Use of equipment regulated by this Code constituting a hazard to safety, health, or public welfare by reason of inadequate maintenance, dilapidation, obsolescence, fire hazard, disaster, damage, or abandonment is, for the purpose of this section, an unsafe use. Unsafe equipment is hereby declared to be a public nuisance and shall be abated by repair, rehabilitation, demolition, or removal in accordance with procedures as may be adopted by this jurisdiction. As an alternative, the Authority Having Jurisdiction or other employee or official of this jurisdiction, as designated by the governing body, shall be permitted to institute other action to prevent, restrain, correct, or abate the violation.

108.0 Appeals.

In order to hear and decide appeals of orders, decisions or determinations made by the building official relative to the application and interpretations of this Code, the appeal process shall be made in accordance with the procedure established in Sections 98.0403.1 and 98.0403.2 of the Los Angeles Municipal Code.

109.0 Prohibited Acts.

No person shall sell, offer for sale, display for sale, advertise for sale, loan, rent, or lease, dispose of by way of gift, premium or otherwise, any equipment regulated by this Code unless such equipment is listed by an approved testing agency or is of a type and construction approved by the Department.

Part III – Permits and Inspections.

111.0 Permits.

111.1 General. No person shall install or alter, repair, relocate, replace or add to any installed heating, ventilating, air-conditioning, or refrigeration equipment or other miscellaneous heat-producing appliances unless a permit for the work has been obtained from the Department, except as provided in this Code.

Exceptions:

- (1) A separate permit shall not be required for installation of any heating, ventilating, air-conditioning, or refrigeration equipment or other miscellaneous heat-producing appliances for which a combined building/mechanical permit has been obtained pursuant to LAMC Subdivision 91.107.2.2.
- (2) No person shall be subject to a fine or payment of an investigation fee for starting and doing any emergency repair work without a permit being first obtained, if a permit for the work is obtained on or before 12:00 noon on the third day the office of the Department is open for public business after the work was started. (See Section 98.0402 of the Los Angeles Municipal Code.)
- (3) No permit shall be required for:
 - (A) Any portable ventilating equipment.
 - (B) Any portable comfort-cooling unit.
 - (C) Any steam, hot or chilled water piping within any comfort- heating or cooling system regulated by this Code.
 - (D) Any portable evaporative cooler.
 - (E) Any unit refrigeration system.
 - (F) Any cooking range, broiler unit or domestic-type clothes dryer.
 - (G) Any replacement or repairing of a compressor, provided the compressor replaced or repaired is of the same horsepower rating and is installed in the same location.
 - (H) Any replacement or repair of controls, motors and components which are not part of, or used for, any emergency smoke-control system required by the Building Code or the Fire Code.
 - (I) Any replacement or repair of any component part of listed factory-assembled comfort-heating or comfort-cooling equipment which does not alter its original approval and complies with all other applicable requirements of this Code.
 - (J) Any repair of equipment not specified here, if the total value of the repair is less than \$500.00 for labor and material. For the purpose of this requirement, no permit shall be required where the work is performed on more than one piece of equipment or duct system that is located in the same building, provided the total value of material and labor for any separate and individual repair does not exceed \$500.00.
 - (K) The replacement of defective forced-air units with one of equivalent size, Btu/hr (W) rating and vent capacity when the vent does not require replacement or relocation in a detached single-family dwelling and the replacement is performed by a contractor with a valid Certificate of Registration pursuant to LAMC Subsection 91.1704.1. A Certificate of Compliance pursuant to LAMC Subsection 91.108.12 must be filed with the City in lieu of a permit.

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- (L) The replacement of defective air-conditioning units when they are replaced with one of equivalent size and Btu/hr (W) rating by a contractor with a valid Certificate of Registration pursuant to LAMC Subsection 91.1704.1. A Certificate of Compliance pursuant to LAMC Subsection 91.108.12 must be filed with the City in lieu of a permit.

The foregoing exemptions for permit requirements shall not apply where the equipment is regulated by the California Energy Commission, or the equipment is used to provide the required heating capacity for any residential occupancy, or the equipment is used as part of an emergency smoke-control system.

The foregoing exemptions from permit requirements shall not be deemed to allow any equipment regulated by this Code to be installed in a manner contrary to other provisions of this Code.

111.2 Permit Required. A permit shall be obtained for all heating, ventilating, air-conditioning or refrigeration equipment or other miscellaneous heat-producing appliances moved with, or installed in, a relocated building in the City.

111.3 Separate Permit. A separate permit shall be obtained for the equipment installed in each separate building or structure and for the work required by each building permit.

111.4 Incidental Gas. Any qualified installer as specified in LAMC Subsection 112.4 may install incidental gas piping to connect any heating appliance or absorption unit to the existing gas piping system, provided:

- (1) The incidental piping installation complies with the requirements as set forth in the Los Angeles Plumbing Code; and
- (2) There is an existing gas supply meter on the premises serving the gas piping system.

112.0 Application for Permit.

112.1 Applications.

- (1) To obtain a permit, the applicant shall file an application on forms furnished by the Department. The application shall contain all information necessary to the lawful enforcement of the provisions of this Code.
- (2) The application shall be accompanied by approved plans and specifications when required by this Code.
- (3) When the Department determines that the information on the application is in conformance with this Code, the Department shall issue a permit upon receipt of the total fees.

112.2 Plans and Specifications.

- (1) Except for minor installations satisfactory to the Department, plans and specifications for the complete installation of comfort-heating systems, comfort-cooling systems, absorption units, ventilation systems and hoods shall be filed with the Department and approved before the issuance of any permit for the following:
 - (A) Comfort-Heating, Comfort-Cooling, Absorption Unit and Ventilation Systems:

- (1) Installations where the aggregate Btu/h input capacity is 500,000 Btu/h (146,500 W) and over for comfort heating, or for comfort cooling, or for absorption units.

Exceptions:

- (1) Duct alterations.
- (2) Addition of air conditioning equipment having a rating of 5 tons or less.
- (3) Addition of general ventilation exhaust fans having a rating of 2000 cfm or less.
- (4) Replacing air conditioning equipment with the same size and type.

(B) Smoke-control systems.

(C) Any comfort-cooling compressor or refrigeration compressor for any system which requires a machinery room.

(D) Any commercial cooking hood and ventilation system, except for approved vent-less hoods that are installed in accordance with the manufacturer's installation instructions and other conditions of approval as determined by the Los Angeles City Testing Laboratory.

(E) Product conveying ventilation systems.

- (2) One complete set of plans and specifications shall be filed for checking before approval is given by the Department. After approval, the plans shall be returned to the applicant. The approved set of plans shall be on the job site for availability during construction and inspection.
- (3) When the plans and specifications do not comply with provisions of this Code, the necessary changes or revisions shall be made.
- (4) The information contained on the plans shall be clearly legible and specifically indicated. No plan shall be of a scale smaller than 1/8 inch per foot.
- (5) Specifications, when submitted, shall be legible and definitively stated, and be included either on the plans or on separate sheets.
- (6) The approval of any plans or specifications shall not be construed to sanction any violation of this Code.
- (7) No person shall materially deviate from approved plans or specifications or fail, neglect or refuse to comply with those plans or specifications unless permission to do so has first been obtained from the Department.
- (8) Plans and specifications shall be prepared by and bear the signature and registration number of a professional engineer in an appropriate discipline who is duly registered by the State of California Board of Registration for Professional Engineers and Land Surveyors, except as provided by the State of California Business and Professions Code.

112.3 Information on Plans and Specifications.

- (1) The plans or specifications shall show all of the following:

- (A) The layout for each floor with dimensions of all working spaces and a legend of all symbols used;
- (B) The location, size and materials of all air ducts, air inlets and air outlets;
- (C) The location of all fans, warm-air furnaces, boilers, absorption units, refrigerant compressors and condensers;
- (D) The rated capacity or horsepower of all boilers, warm-air furnaces, heat exchangers, blower fans, refrigerant compressors and absorption units;
- (E) The location, size and materials of all combustion products, vents and chimneys;
- (F) The location and area of all ventilation and combustion-air openings and ducts;
- (G) The location of all air dampers, fire dampers, smoke-control dampers and combustion-products-type smoke detectors;
- (H) The information necessary to show compliance of the mechanical equipment with the state energy standards;
- (I) The occupancy of each area served by any heating, air-conditioning or ventilation system;
- (J) The location of all required fire- resistive separations that are penetrated by ducts or openings of any heating, air-conditioning or ventilation system;
- (K) The complete drawings of all commercial hoods and ventilation systems, including the cooking appliances served by the hoods, and verify:
 - (1) The interconnection of the fire- extinguishing system and fuel shutoff devices;
 - (2) Compliance with Health Department requirements; and
 - (3) Compliance with South Coast Air Quality Management District requirements.
- (L) The weight of the equipment.

- (2) All plans and specifications required by this section shall be drawn with indelible pencil or drawn or printed in ink, or made by reproduction process which produces a permanent print. Every sheet of each set of plans and specifications shall show the address of the proposed work and the name and address of the owner or lessee of the premises.

The plans and specifications shall be of sufficient clarity to show that the proposed installation will conform to the provisions of this Code and of all applicable laws, ordinances, rules, regulations and orders.

112.4 Qualified Installer. It is unlawful for any person who is not a qualified installer to install, alter, reconstruct or repair any equipment regulated by this Code unless the person is under the direct supervision of a qualified installer.

A qualified installer is:

- (1) A person who holds a valid contractor's license in the proper classification issued by the State of California; or

- (2) A person who holds a valid Maintenance Certificate of Registration issued pursuant to the provisions of this Code; or
- (3) A person who is the owner of a single-family dwelling and has demonstrated to the satisfaction of the Department his or her qualifications to satisfactorily perform mechanical work in the dwelling which is occupied by the owner, and their accessory buildings, provided that all of the following conditions are met:
 - (A) The work is performed prior to sale of the dwelling.
 - (B) The home owner has actually resided in the residence for the 12 months prior to completion of the work.
 - (C) The homeowner has not availed himself or herself of this exemption on more than two structures during any three year period.
- (4) A person who is employed by a governmental agency that is required to comply with the provisions of this Code, and who is qualified, as determined by the Department, to supervise or control any work regulated by this Code.

113.0 Permit Issuance.

113.1 Issuance. The issuance of a permit is not an approval or an authorization of the work specified therein. A permit is merely an application for inspection, the issuance of which entitles the permittee to inspection of the work described therein.

113.2 Effect of Issuance. Neither the issuance of a permit nor the approval by the Department of any plans or specifications shall constitute an approval of any work or material that is in violation of any provision of this Code or of any other applicable law.

113.3 Expiration of Permits. Permits shall expire as provided for in Section 98.0602 of the Los Angeles Municipal Code.

113.4 Revocation of Permits. Permits may be revoked as provided for in Section 98.0601 of the Los Angeles Municipal Code.

114.0 Permit Fees.

114.1 Permit Fees. Before any permit required by this Code is issued, the applicant shall pay to the Department the following fees:

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PERMIT FEE SCHEDULE FOR HEATING, VENTILATING, AIR-CONDITIONING AND REFRIGERATION EQUIPMENT AND MISCELLANEOUS HEAT-PRODUCING APPLIANCES

Permit

Fee

1.	a.	For issuing permit	\$24.00
	b.	For issuing a supplementary permit (the fee for which shall be the difference between the fee paid for the original permit and the fee which would have been required had the original permit included the entire installation, repair, relocation or alteration plus	\$20.00
2.		For the installation or relocation of each fuel-burning heating appliance regulated by this Code	\$19.00
3.		For each air inlet and air outlet served by any heating, air-conditioning or ventilation system	\$5.00
		or for each 1,000 square feet (92.9 m ²) or fraction thereof of conditioned area for any heating or air-conditioning system using perforated building material in lieu of conventional air inlets and outlets	\$38.00
4.	a.	For the installation of each appliance vent system, factory-built chimney and each absorption unit vent system regulated by this Code	\$12.00
	b.	For the installation of each unlisted single-wall metal chimney (smokestack)	\$57.00
		Note: This fee shall not apply to a vent system which is an integral part of an appliance or an absorption unit, which is listed for outdoor installation.	
5.		For the repair of, alteration of or addition to each refrigeration system, fuel- burning heating appliance, comfort-cooling unit, absorption unit, or each comfort-heating, cooling, absorption, ventilation or evaporative cooling system, including the installation of controls regulated by this Code.....	\$24.00
6.	a.	For each ventilation system which is serving a commercial cooking hood	\$33.00
	b.	For each environmental air and commercial-type clothes dryer ventilation system regulated by this Code.....	\$12.00
	c.	For each product-conveying duct system regulated by this Code	\$59.00
7.		For the installation of each hood	\$33.00
8.	a.	For the installation of each comfort-cooling compressor of 25-horsepower (87.9 k/W) rating or less and each absorption unit having an input capacity of 500,000 Btu/h (2299.3 L/W) or less	\$24.00
	b.	For the installation of each refrigeration compressor of 25-horsepower rating (87.9 k/W) or less, other than a compressor for a unit refrigeration system	\$38.00
9.	a.	For the installation of each comfort-cooling compressor over 25-horsepower (87.9 k/W) rating and under 50-horsepower (175.8 k/W) rating, and each absorption unit having an input capacity over 500,000 Btu/h (2299.3 L/W) and under 1,000,000 Btu/h (4598.6 L/W)	\$59.00
	b.	For the installation of each refrigeration compressor over 25-horsepower (87.9 k/W) rating and under 50-horsepower (175.8 k/W) rating.....	\$77.00
10.	a.	For the installation of each comfort-cooling compressor of 50-horsepower (175.8 k/W) rating and over, and each absorption unit having an input capacity of 1,000,000 Btu/h (4598.6 L/W) and over	\$116.00
	b.	For the installation of each refrigeration compressor of 50-horsepower (175.8 k/W) rating and over	\$158.00
11.		For the installation of each air-handling unit used for the distribution of conditioned air supply	\$24.00
		Note: This fee shall not apply to an air-handling unit which is a portion of a factory-assembled appliance, comfort-cooling unit, evaporative cooler or absorption unit for which a permit is required elsewhere in this Code.	
12.		For the installation of each evaporative cooler which is not classified as a portable evaporative cooler	\$24.00
13.		When it shall be necessary to make an extra inspection trip due to the applicant having given an incorrect address or wrong location for any permit when obtaining a permit required by this Code, a fee shall be paid by the applicant for correcting the address or location given in such permit.....	\$36.00

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14.	For the installation of incidental gas piping for each existing individual metered system up to and including five outlets (see LAMC Subsection 111.4) (Amended by Ord. No. 185,587, Eff. 7/16/18.)	\$25.00
	For each outlet over five.....	\$7.00
	Note: For the purpose of this fee, incidental gas piping shall mean any addition made to an existing low-pressure gas piping system to accommodate gas-burning equipment regulated by this Code. This fee shall not apply if such piping is less than six feet (1.8 m) in length and connects to an existing gas outlet.	
15.	For the installation of each fire damper	\$12.00
16.	For the installation of each smoke-control damper which is a portion of a smoke-control system that is required by the Los Angeles Municipal Code	\$12.00
17.	For each smoke detector which is required by the Los Angeles Mechanical Code	\$10.00
18.	For witnessing the performance test of any emergency mechanical smoke-control system, stair shaft pressurization system, smoke detector or smoke damper which is a portion of that system. For each hour or fraction thereof	\$108.00
19.	For witnessing the performance test of any heating or cooling equipment for automatic shutoff. For each hour or fraction thereof	\$108.00
20.	For witnessing the performance test of any ventilating system serving commercial food heat-processing equipment. For each hour or fraction thereof	\$108.00
21.	For the minimum inspection	\$93.00
22.	For each additional inspection	\$93.00
23.	Minimum inspection fee. LAMC Section 98.0412:	
a.	For the installation of a single fixture described in this section	\$57.00
b.	Where the cumulative fees described in this section total less than the minimum fee required by the Los Angeles Mechanical Code	\$93.00
24.	For transfer of a permit.....	\$50.00
	Note: Items 18, 19 and 20. For the purpose of witness fee requirements, more than one system of the same category can be inspected in the same building spaces if completed within the same hour. For each additional category or additional hour or fraction thereof a fee of \$75.00 is required. These fees are not to be included in determining plan check fee.	

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114.2 Plan Check Fees.

(A) Before formally accepting a set of plans and specifications for checking, the Department shall collect a plan check fee.

A complete schedule of the permit fees due shall be included with each set of plans submitted to the Department.

The plan check fees required by the provisions of this section are in addition to the inspection fees required by LAMC Subsections 114.5 and 114.8.

A fee as specified in Paragraph 1 of LAMC Subsection 114.2 shall be collected by the Department prior to approval for each set of plans submitted beyond the two required by this Code containing more than 10 sheets including calculations and documentation.

(B) **Off-Hour Plan Check.** Upon request by an applicant and accepted by the Department, an off-hour plan check fee per LAMC Section 98.0422 may be collected. (Amended by Ord. No. 185,587, Eff. 7/16/18.)

Plan check fee shall be as follows:

(1) All projects

TYPE OF INSTALLATION	STANDARD DESIGN	ADDITIONAL FEE FOR CHECKING ANALYSIS OF ANNUAL ENERGY BUDGET
Installation of equipment as listed in Section 114.1	70% of permit fee \$93.00 minimum; plus a surcharge of 10% of permit fee, \$72.00 minimum, for checking compliance with State Energy Standards Note: For conditioned areas where the number of air inlets and air outlets is unknown, \$12.00 for each 1000 sq. ft. or fraction thereof.	60% of permit fee, \$144.00 minimum, \$4,037.00 maximum

(2) In addition to the above fee, a plan checking fee shall be assessed for checking the following systems:

- (a) Commercial cooking ventilation systems, serving type I hoods, each\$216.00
- (b) Commercial cooking ventilation systems, serving type II hoods each.....\$144.00
- (c) Type I, Type II or fume hoods, each.....\$72.00
- (d) Product conveying ventilation systems\$216.00
- (e) Engineering calculations of smoke control systems, each.....\$1,081.00
- (f) Engineering calculations of stair shaft pressurization systems, each\$216.00
- (g) Engineered and/or proprietary duct joints, each HVAC system, minimum\$144.00
- (h) The Department may collect a plan check fee as specified in LAMC Section 98.0415(e) for the following plan check services: (Amended by Ord. No. 185,587, Eff. 7/16/18.)
 - (1) Specially engineered systems;
 - (2) Engineered systems not listed in LAMC Subsection 114.1;
 - (3) Review of expired plans, provided that the original approved plans are submitted along with the new plans and the new plans have no changes other than those required to comply with the current code;
 - (4) Review of plans revised for reasons other than to comply with plan check corrections;
 - (5) Review of “As Built” plans provided that the original approved plans are submitted along with the new plans;
 - (6) Any time not included in the original plan check fee.

114.3 Expiration of Plan Check. Plan check approval shall expire as provided for in Section 98.0603 of the Los Angeles Municipal Code.

114.4 Minimum Inspection Fee.

- (1) A minimum fee as specified in LAMC Section 98.0412 shall be paid to the Department for each mechanical installation for which a permit is required by this Code.
- (2) When the cumulative fees and the issuing fee set forth in this Code are less than the minimum fee, the minimum fee shall be paid, which shall include the issuing fee.

- (3) The fee for single fixture shall apply to the installation of only one mechanical fixture/equipment and shall include the issuing fee. Where the fee for a single fixture exceeds the minimum fee for single fixtures, this fee shall not apply.

114.5 Fees for Miscellaneous Permits.

- (1) When permission has been obtained from the Department, a permit may be issued for that portion of equipment to be concealed if the permit cannot be issued until required plans have been approved. The miscellaneous permit shall not be an authorization for the installation of any other equipment.

The permittee shall submit plans along with this permit application which shall clearly designate the equipment to be concealed and the building area involved. If the work done on the miscellaneous permit is not in accordance with the final approved plans, the permittee shall be responsible for making all necessary corrections for compliance with the Code.

A fee as specified in LAMC Section 98.0412 shall be paid for the inspection of this installation and shall be limited to one inspection trip and one re-inspection trip. This fee is in addition to the permit-issuing fee specified in LAMC Subsection 114.1.

- (2) A miscellaneous permit fee as specified in LAMC Section 98.0412 shall be paid for inspection of the installation of equipment regulated by this Code which requires an inspection for determination of Code compliance and where such installation inspection is not provided for in the permit fee schedule specified in LAMC Subsection 114.1. This fee is in addition to the permit issuing fee specified in LAMC Subsection 114.1.

114.6 Investigation Fee. Except as provided in LAMC Subsection 111.1, whenever any work for which a permit is required under the provisions of this Code has been commenced without the authorization of a permit, a special investigation shall be made before a permit may be issued for the work. In addition to the permit fee, an investigation fee shall be collected as provided for in LAMC Section 98.0402.

114.7 Transfer of Permits and Plan Checks. No permit shall be transferable from the original permittee to any other person, unless the property owner authorizes the transfer in writing. Upon authorization, the new permittee shall file with the Department a new permit and pay to the Department a fee as specified in LAMC Section 98.0415 for issuing the new permit. This fee includes the issuing permit fee specified in the fee schedule set forth in LAMC Subsection 114.1.

Note: No plan check shall be transferable from one contractor to another unless the original plans were prepared and signed by a state-licensed engineer in the proper classification.

114.8 Fees for Additional Inspections.

- (1) Each permit shall be entitled to three inspection trips when the job is of a type requiring an inspection before covering or concealing the work. On jobs which may be completely inspected on one inspection trip, two inspection trips will be allowed.

Exception: The number of inspection trips will not be limited on progress jobs, provided, however, that only one inspection will be permitted for checking a correction. For the purpose of this section, progress jobs are those in which circumstances beyond the control of the applicant make it impossible for the installation to be completed at any specific time.

- (2) If more inspection trips than are specified in Subdivision 1 of this subsection are required due to the fault or error on the part of the applicant or the applicant's employees, an additional fee as specified in LAMC Section 98.0412 shall be paid by the applicant for each additional inspection trip.

- (3) The Department may recheck installations at intervals of 30 days or more, where violations continue to exist, until either the violations are cleared or a total of three rechecks are made. The fees specified in Subdivision 2 of this subsection shall apply for each recheck inspection.

- (4) The fees charged under this section are in addition to any other fees shown and the payment of the fees required by this section shall not exempt any person from compliance with other provisions of this Code nor from any penalty prescribed by law.

- (5) Whenever special enforcement procedures are required to obtain compliance with properly executed Department notices or orders, a fee, as specified in LAMC Section 98.0407, shall be assessed in addition to the added trip fee specified in Subdivision 2 of this subsection.

114.9 Inspection Fees for Off-Hours Inspections. The Department may, at its discretion, make emergency inspections at other than normal working hours upon the request of a permittee, provided that additional fees are paid as specified in Section 98.0406 of the Los Angeles Municipal Code.

114.10 Fees for Off-Site Inspections. Upon written request, the Department may, at its discretion, make inspections at locations other than the site upon which a building will be located, provided that location is within 60 miles (96.56 km) of the Los Angeles City Hall.

A fee, in addition to fees charged elsewhere in this Code, at the rate specified in Section 98.0412 of the Los Angeles Municipal Code per hour shall be charged for such inspections, time to include travel to and from the place of inspection, with the minimum fee as specified in Section 98.0412 of the Los Angeles Municipal Code.

115.0 Inspections.

115.1 Inspection.

- (1) All equipment for which a permit is required by this Code shall be inspected by an authorized inspector of the Department.

Exception: Contractors holding a Certificate of Registration complying with Section 91.108.12 of the Los Angeles Municipal Code for detached single-family dwellings.

- (2) No portion of any equipment intended to be enclosed by any permanent portion of the building shall be enclosed until inspected and approved.
- (3) When the installation of any equipment is complete, a second or final inspection shall be made.
- (4) The first and second inspections may be made at the same time if no portion of the equipment is concealed by any permanent portion of any building.

- (5) **Approved Fabricators.** The inspections provided for in this section shall not be required for construction or installation work done on the premises of a Type II fabricator to whom an approval has been issued pursuant to the provisions of Division C of Article 6 of Chapter IX of the Los Angeles Municipal Code.

CALIFORNIA ADMINISTRATION

115.2 Request for Inspection.

- (1) The Department shall require that every request for inspection be filed at least one day before the inspection is desired. This request may be in writing or by telephone at the option of the Department.
- (2) It shall be the duty of the person requesting inspection of any equipment regulated by this Code to provide access to and means for proper inspection for the equipment.
- (3) The removal of any material necessary to permit an inspection shall be required by the Department by written order. The City shall not be liable for any expense entailed in the removal or replacement of any material required to permit the inspection.

116.0 Connection Approval.

116.1 Connection Approval. No equipment regulated by this Code shall be connected to the fuel or power supply until it complies with all applicable requirements of this Code and a final inspection tag of approval has been issued by the Department.

Exception: The requirements of this subsection shall not be considered to prohibit the operation of any equipment installed to replace defective equipment serving an occupied portion of a building, in the event a request for inspection of that equipment has been filed with the Department not more than 48 hours after the replacement work is completed and before any portion of the equipment is concealed by any permanent portion of the building.

116.2 Final Inspection. A final inspection tag of approval may, upon notice, be revoked by the Department if the Department finds that the equipment fails in any respect to comply with the requirements of this Code or that the installation is unsafe, dangerous or a hazard to life or property.

117.0 Unconstitutional.

117.1 Validity of Code. 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.

118.0 Validity.

118.1 Code. 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.

119.0 Registration.

119.1 Maintenance Supervisor. No person shall act in the capacity of a maintenance supervisor or air balancer for smoke-control systems, unless the person has paid the filing

fee and successfully passed an examination as specified in LAMC Subsection 119.3.

Exception: One who holds a valid contractor's license in the proper classification issued by the State of California and personally performs the work.

119.2 Applications.

- (1) Every applicant for Certificate of Qualification as a maintenance supervisor or air balancer shall make an application in writing to the Department on forms furnished for that purpose.
- (2) Every application for a Certificate of Qualification as a comfort heating and cooling or refrigeration maintenance supervisor or air balancer shall be accompanied by a filing fee as specified in LAMC Section 98.0414.
- (3) Every applicant for a Certificate of Qualification as a comfort heating and cooling or refrigeration maintenance supervisor or air balancer shall be examined as required by the provisions of LAMC Subsection 119.3.

Note: For the purpose of this Code, an air balancer holding a Certificate of Qualification may qualify to perform work to comply with the State Energy requirements (Parts 1 and 6, Title 24 of the California Code of Regulations).

119.3 Examinations.

- (1) Every applicant for a Certificate of Qualification as a comfort-heating and cooling maintenance supervisor or a refrigeration maintenance supervisor or air balancer shall be given an examination to evaluate that applicant's knowledge and experience. The extent and scope of the examination shall, in the judgement of the Superintendent of Building, be sufficient to indicate that a person who successfully passes the examination has the necessary ability to repair, maintain, alter and service refrigeration equipment, heating appliances, heating systems, gas piping, gas-control devices, vents for gas appliances, and air balancing in compliance with this Code. The examination shall include a written test and an oral interview.
- (2) The Superintendent of Building is hereby granted the power and authority to make and establish such rules and regulations as he or she may consider necessary for the proper conduct of the examination. The results of each examination shall be subject to review and approval by the Superintendent.

119.4 Failure to Pass Examination. No part of any filing fee shall be returned to any applicant who fails to pass the examination for which the fees were paid. If any applicant shall fail to receive the percentage required at the first examination, the applicant shall be entitled to take a second examination without payment of a second fee, but shall be required to wait at least two weeks before taking the second examination. In case any applicant fails to pass the second examination, the applicant shall be required to wait at least six months before he or she may file another application for examination, at which time the applicant shall pay another filing fee.

119.5 Issuance of Maintenance Certificate of Registration.

- (1) Every applicant for a Maintenance Certificate of Registration shall make application to the Department on forms furnished for that purpose. The application shall provide the following information:
 - (A) Business name and address of applicant.
 - (B) The signature of the responsible managing officer.
 - (C) The name of the maintenance supervisor.
- (2) Before a Maintenance Certificate of Registration is issued to any person, that person shall pay a registration fee as specified in Section 98.0414 of the Los Angeles Municipal Code.
- (3) Each Maintenance Certificate of Registration issued shall expire one year following the date of issuance, but may be renewed from year to year upon payment of an annual renewal fee as specified in Section 98.0414 of the Los Angeles Municipal Code, which must be paid not later than 30 days after the date of expiration.
- (4) The Department shall issue a Certificate of Qualification as a maintenance supervisor or air balancer to any person who has successfully passed the examination prescribed in Section 119.3.
- (5) Every Certificate of Qualification as maintenance supervisor or air balancer shall expire one year following the date of issuance, but may be renewed from year to year by the payment of an annual fee as specified in Section 98.0414 of the Los Angeles Municipal Code within 30 days after the date of expiration.
- (6) A maintenance supervisor shall be limited to perform only the labor for maintenance, repair, addition to or alteration of existing equipment on premises owned by or under control of the holder of a valid Maintenance Certificate of Registration.

119.6 Revocation, Suspension and Voiding of Certificates.

- (1) Any Certificate of Registration or Certificate of Qualification required by this Code may be suspended or revoked in accordance with the provisions of Article 8, Chapter IX of the LAMC.
- (2) Any person whose certificate is revoked hereunder shall not, for a period of 30 days thereafter, be eligible for a new certificate and shall receive a new certificate only after passing the required examination and paying the required fee.
- (3) The revocation of any Certificate of Registration or Certificate of Qualification shall not exempt the holder from any other penalty provided in this Code.
- (4) A Certificate of Registration shall become void 30 days after a maintenance supervisor is no longer in the employ of a holder of a Certificate of Registration.
- (5) A Certificate of Qualification shall become void when the maintenance supervisor is no longer in the employ of the holder of a Certificate of Registration.

119.7 Exhibition of Maintenance Certificate. Every person holding a Certificate of Qualification as a maintenance supervisor or air balancer shall exhibit that certificate to authorized personnel of the Department upon demand.

119.8 Transfer of Certificates. No Certificate of Registration or Qualification shall be transferable.

119.9 Expired Certificates.

- (1) Expired certificates may be renewed at any time within 12 months following the date of expiration provided that, after the first month, the renewal fee shall be increased by 10 percent for each month after the first.
- (2) After a certificate has been expired for one year, it may not be renewed. A new application and payment of the filing fees set forth in LAMC Section 119.0 will be required.

(Pages 13 through 26 have been deleted by City of Los Angeles. Text continues on Page 27.)

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE

CHAPTER 2 – DEFINITIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter																							
Adopt Entire Chapter as amended (amended sections listed below)	X		X	X	X		X	X	X	X		X	X	X									
Adopt only those sections that are listed below																							
Chapter/Section																							
203.0			X	X	X					X	X	X	X	X	X								
204.0			X	X	X					X	X	X	X	X	X								
206.0				X	X																		
207.0			X	X	X					X	X	X	X	X	X								
208.0			X	X				X	X														
209.0	X		X				X	X	X														
210.0										X	X	X	X	X	X								
214.0			X	X	X																		
215.0			X																				
216.0				X	X																		
217.0			X	X	X																		
218.0				X	X																		
222.0				X	X																		
223.0			X	X	X					X	X	X	X	X	X								
228.0										X		X	X	X	X								

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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.

Accessory Dwelling Unit [HCD 1 & HCD 2]. *An attached or detached residential dwelling unit that provides complete independent living facilities for one or more persons and is located on a lot with a proposed or existing primary residence. Accessory dwelling units shall include permanent provisions for living, sleeping, eating, cooking, and sanitation on the same parcel as the single-family or multifamily dwelling is or will be situated. (See Government Code Section 65852.2.)*

Administrative Authority. The Superintendent of Building or an authorized agent.

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]

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, Relief. [OSHPD 1, 1R, 2, 3, 4 & 5] *Air being exhausted directly from a building or a return duct system which is not contaminated by odors or other contaminants and could otherwise be used as return air if not exhausted from the building.*

Air, Return. Air from the conditioned area that is returned 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.

Air Dispersion Systems. Materials intended for use in air handling systems in exposed locations operating under positive pressure.

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

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]

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]

DEFINITIONS

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, Fan-Assisted Combustion. 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]

Appliance, Low-Heat. A fuel-burning appliance that produces a continuous flue gas temperature, at the point of entrance to the flue, of not more than 1000°F (538°C).

Appliance, Medium-Heat. A fuel-burning appliance that produces a continuous flue gas temperature, at the point of entrance to the flue, of more than 1000°F (538°C) and less than 2000°F (1093°C).

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]

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.

Applicant. The person signing the application and paying the fees.

Apprentice. A person who is enrolled in an apprenticeship program approved by the Department of Industrial Relations of the State of California.

Approved. Acceptable to the Authority Having Jurisdiction.

Exception: [HCD 1 & HCD 2] *“Approved” means meeting the approval of the Enforcing Agency, except as otherwise provided by law, when used in connection with any system, material, type of construction, fixture or appliance as the result of investigations and tests conducted by the agency, or by reason of accepted principles or tests by national authorities, or technical, health, or scientific organizations or agencies.*

Notes:

- (1) See Health and Safety Code Section 17920 for “Approved” as applied to residential construction and buildings or structures accessory thereto, as referenced in Sections 1.8.2.1.1 and 1.8.2.1.2.
- (2) See Health and Safety Code Section 17921.1 for “Approved” as applied to the use of hotplates in residential construction referenced in Sections 1.8.2.1.1 and 1.8.2.1.2.
- (3) See Health and Safety Code Section 19966 for “Approved” as applied to Factory-Built Housing as referenced in Sections 1.8.2.1.1 and 1.8.2.1.2.
- (4) See Health and Safety Code Section 18201 for “Approved” as applied to Mobilehome Parks as referenced in Section 1.8.2.1.3.

- (5) See Health and Safety Code Section 18862.1 for “Approved” as applied to Special Occupancy Parks as referenced in Section 1.8.2.1.3.

Approved Testing Agency. An organization primarily established for purposes of testing to approved standards and approved by the Authority Having Jurisdiction. **[HCD 1 & HCD 2]** *“Approved Testing Agency” is any agency which is determined by the Enforcing Agency, except as otherwise provided by statute, to have adequate personnel and expertise to carry out the testing of systems, materials, and various types of construction, fixtures or appliances.*

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. **[HCD 1, HCD 2 and SFM]** *Refer to the California Building Code, Title 24, Part 2 for use and occupancy classification.*

Authority Having Jurisdiction. The City of Los Angeles Department of Building and Safety.

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 vs. composition curve equals zero, which mathematically is expressed as $(dt/dx)_p = 0$, 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]

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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.

Board. The Board of Building and Safety Commissioners of the City of Los Angeles.

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, 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 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)]

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 radiated heat, excepting toasters. [NFPA 54:3.3.15]

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. [HCD 1 & HCD 2] *Any structure used or intended for supporting or sheltering any use or occupancy.*

Exceptions: *“Building” shall not include the following:*

- (1) *Any mobilehome as defined in Health and Safety Code Section 18008.*
- (2) *Any manufactured home as defined in Health and Safety Code Section 18007.*
- (3) *Any commercial modular as defined in Health and Safety Code Section 18001.8 or any special purpose commercial modular as defined in Health and Safety Code Section 18012.5.*
- (4) *Any recreational vehicle as defined in Health and Safety Code Section 18010.*
- (5) *Any multifamily manufactured home, as defined in Health and Safety Code Section 18008.7.*

For additional information, see Health and Safety Code Section 18908.

Building Code. The City of Los Angeles Building Code, set forth in Article 1, Chapter IX of the Los Angeles Municipal Code.

Building Official. See Authority Having Jurisdiction. *For applications listed in Section 1.11.0 regulated by the Office of the State Fire Marshal “Building Official” is the officer charged with the administration and enforcement of this code, or a regular deputy. See “Enforcing Agency”. For the State of California, “Building Official” shall be the “Enforcing Agency” as specified in Section 1.11.0.*

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.

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CAS Number. The Chemical Abstract System registry number.

Central Cooling Plant or Cooling Plant. Environmental cooling equipment installed in a manner to supply cold by means of ducts or pipes to areas other than the room or space in which the equipment is located.

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]

Certificate of Qualification. A Certificate of Qualification as a maintenance supervisor or air balancer as issued by the Department.

Certificate of Registration. A Maintenance Certificate of Registration as issued by the Department.

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]

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]

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 2000°F (1093°C), measured at the appliance flue outlet.

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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.

Classified. 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 indecisiveness 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 54:3.3.19]

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]

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]

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 54:3.3.21]

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 diffused directly into the exhaust within the hood cavity, it becomes a short-circuit hood.

Compressor, Comfort-Cooling. A compressor, which is a portion of a comfort-cooling system or a comfort-cooling unit.

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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 1¼ 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 space normally occupied and being heated or cooled for human comfort by any 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.

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 termi-

nation 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 54:3.3.17.2]

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.

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– 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.

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.

Department. The Department of Building and Safety of the City of Los Angeles. L
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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 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 excessive 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. A nonrecirculating industrial air heater 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]

Direct Gas-Fired Recirculating Industrial Air Heater. An air recirculating heater 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]

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 54:3.3.31]

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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 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 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.

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.

207.0 – E –

Easily Accessible. See Accessible, Readily.

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.

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.

Electrical Code. The City of Los Angeles Electrical Code, set forth in Article 3, Chapter IX of the Los Angeles Municipal Code.

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.

Enforcing Agency. [HCD 1, HCD 2, SFM and OSHPD 1, 1R, 2, 3, 4 & 5] “Enforcing Agency” is the designated department or agency as specified by statute and regulation.

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 Cooler. A device used for reducing the sensible heat of air for cooling by the process of evaporation of water into an airstream.

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.

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]

208.0 – F –

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.

Factory-Built 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 96:3.3.22.2.1]

Family. [HCD 1] “Family” is an individual or two or more persons who are related by blood or marriage, or otherwise, live together in a dwelling unit.

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]

Fire Code. The City of Los Angeles Fire Code, set forth in Article 7, Chapter V of the Los Angeles Municipal Code.

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 E119 or UL 263.

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.

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]

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. Natural, manufactured, liquefied petroleum, or a mixture of these.

Fume Incinerators. Devices utilizing 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]

Furnace, Central. A self-contained appliance for heating air by transfer of heat of combustion through metal to the air and designed to supply heated air through ducts to spaces remote from or adjacent to the appliance location. [NFPA 54:3.3.45.1]

Fusible Link. A form of fixed-temperature heat-detecting device sometimes employed to restrain the operation of an electrical or mechanical control until its designed temperature is reached. [NFPA 96:3.3.28] Such devices are to be replaced following each operation.

Fusible Plug. A device arranged to relieve pressure by operation of a fusible member at a predetermined temperature.

209.0

– G –

Galvanized Steel. A steel that has been coated with a thin layer of zinc for corrosion protection; *conforming to the requirements of ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coat (Galvanized) or Zinc-Iron Alloy-Coat (Galvanized) by the Hot Dip Process.*

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 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.

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.

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

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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]

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)]

210.0 – H –

Hazardous Location. An area or space where combustible dust, ignitable fibers, flammable liquids, volatile liquids, gases, vapors, or mixtures are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

Hazardous Process Piping (HPP). A process material piping or tubing conveying a liquid or gas that has a degree-of-hazard rating in health, flammability, or reactivity of Class 3 or 4, as ranked by the fire code.

Health Facilities. [OSHPD 1, 1R, 2, 3, 4 & 5] *Buildings specified within the statutory authority of the Office of Statewide Health Planning and Development.*

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.

Heat (Energy) Recovery Ventilator. 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.

Heating Degree Day. A unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal annual heating load of a building. For any one day when the mean temperature is less than 65°F (18°C), there exist as many degree days as there is Fahrenheit degrees difference in temperature between mean temperature for the day and 65°F (18°C).

Heating Equipment. Includes warm air furnaces, warm air heaters, combustion products vents, heating air-distribution ducts and fans, and all steam and hot water piping, together with all control devices and accessories installed as part of, or in connection with, any environmental heating system or appliance regulated by this code.

Heating System. A warm air heating plant consisting of a heat exchanger enclosed in a casing, from which the heated air is distributed through ducts to various rooms and areas. A heating system includes the outside air, return air, and supply air system, and all accessory apparatus and equipment installed in connection therewith.

High Limit Control Device. An operating device installed and serving as an integral component of a deep-fat fryer that provides secondary limitation of the grease temperature by automatically disconnecting the thermal energy input when the temperature limit is exceeded. [NFPA 96:3.3.32]

High Purity Piping. A form of process piping but is usually specified for critical clean applications in the semiconductor, pharmaceutical, biotechnology, chemical, fiber optics, food, and dairy industries.

Highside. The parts of a refrigeration system subjected to approximately condenser pressure.

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.

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.

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).

211.0 – I –

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]

DEFINITIONS

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.

212.0

– J –

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, 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.

213.0

– K –

No definitions.

214.0

– L –

Labeled. Equipment or materials bearing a label of a listing agency (accredited conformity assessment body). See Listed (Third Party Certified). [HCD 1 & HCD 2] “Labeled” means *equipment or materials to which has been attached a label, symbol or other identifying mark of an organization, approved by the Department, that maintains a periodic inspection program of production of labeled products, installations, equipment, or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.*

LEL (Lower Explosive Limit). See LFL.

LFL (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 $\frac{1}{8}$ 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.

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 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.

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.

DEFINITIONS

Liquid-Tight. Constructed and performing in such a manner as not to permit 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. **[HCD 1 & HCD 2]** “Listed” means all products that appear in a list published by an approved testing or listing agency. For additional information, see Health and Safety Code Section 17920(h).

Listed and Listing. [SFM] “Listed” and “Listing” are terms referring to equipment or materials included in a list published by an approved testing laboratory, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of current productions of listed equipment or materials and which listing states that the material or equipment complies with approved nationally recognized codes, standards, or tests and has been tested or evaluated and found suitable for use in a specific manner. These terms shall also mean equipment or materials accepted by the State Fire Marshal as conforming to the provisions of these regulations and which are included in a list published by the State Fire Marshal.

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. **[HCD 1 & HCD 2]** “Listing Agency” means an agency approved by the Department that is in the business of listing and labeling products, materials, equipment, and installations tested by an approved testing agency, and that maintains a periodic inspection program on current production of listed products, equipment, and installations, and that at least annually makes available a published report of these listings. For additional information, see Health and Safety Code Section 17920(i).

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.

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– M –

Machinery. The refrigeration equipment forming a part of the refrigeration system, including, but not limited to, the following: compressors, condensers, liquid receivers, evaporators, and connecting piping.

Machinery Room. [SFM] Machinery Room is a room in which a refrigeration system is permanently installed and operated but not including evaporators located in a cold storage room, refrigerator box, air-cooled space or other enclosed space. Closets solely contained within, and opening only into, a room shall not be considered machinery rooms, but shall be considered a part of the machinery rooms in which they are contained or open into. It is not the intent of this definition to cause the space in which unit or self-contained systems of Group I refrigerants are located to be classified as machinery rooms.

Maintenance Certificate of Registration. A certificate issued to the owner or occupant of specified premises for the sole purpose of adding to, altering, maintaining or repairing existing heating, ventilating, air-conditioning, or refrigeration equipment on the premises.

Maintenance Supervisor. Comfort heating and cooling maintenance supervisor or a refrigeration maintenance supervisor.

Mechanical Ventilation. Ventilation provided by mechanically powered equipment, such as motor-driven fans and blowers, but not by devices such as wind-driven turbine ventilators and mechanically operated windows. [ASHRAE 62.1:3]

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).

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– N –

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 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 finish materials. Material required to be noncombustible for reduced clearances

DEFINITIONS

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.

Nuisance. [HCD 1 & HCD 2] “Nuisance” shall mean any nuisance as defined in Health and Safety Code Section 17920(l).

Notes:

1. For applications subject to the Mobilehome Parks Act as referenced in Section 1.8.3.2.2 of this code, refer to California Code of Regulations, Title 25, Division 1, Chapter 2 for the definition of “Nuisance”.
2. For applications subject to the Special Occupancy Parks Act as referenced in Section 1.8.3.2.3 of this code, refer to California Code of Regulations, Title 25, Division 1, Chapter 2.2 for the definition of “Nuisance”.

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 Los Angeles Building Code at Article 1, Chapter IX of the Los Angeles Municipal 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.

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– 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.

PE-RT. Polyethylene of raised temperature.

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.

PEX. Cross-linked polyethylene.

PEX-AL-PEX. Cross-linked polyethylene-aluminum-cross-linked polyethylene.

Pilot. A burner smaller than the main burner that is ignited by a spark or other independent and stable ignition source, and that provides ignition energy required to immediately light off the main burner.

Piping. The pipe or tube mains for interconnecting the various parts of a system. Piping includes pipe, tube, flanges, bolting, gaskets, valves, fittings the pressure-containing parts of other components such as expansion joints, strainers, and devices that serve such purposes as mixing, separating, snubbing, distributing, metering, or controlling flow, pipe-supporting fixtures and structural attachments.

Pitched. To be fixed or set at a desired angle or inclination. [NFPA 96:3.3.39]

Plenum. An air compartment or chamber including uninhabited crawl space areas above a ceiling or below a floor, including air spaces below raised floors of computer/data processing centers or attic spaces, to one or more ducts are connected and that forms part of either the supply-air, return-air, or exhaust-air system, other than the occupiable space being conditioned.

Plumbing Code. The Uniform Plumbing Code promulgated by the International Association of Plumbing and Mechanical Officials, as adopted by this jurisdiction. **[HCD 1 & HCD 2]** Whenever the term “Plumbing Code” is used in this code, it shall mean the California Plumbing Code, Title 24, Part 5.

Portable Cooling Unit. A self-contained refrigerating system, not over 3 horsepower (hp) (2.2 kW) rating that has been factory assembled and tested, installed without supply-air ducts and without connecting any refrigerant-containing parts. This definition shall not include an absorption unit.

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.

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.

DEFINITIONS

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).

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 1½ cubic feet (0.04 m³), for liquids, gases, vapors subjected to pressures exceeding 15 psi (103 kPa), or steam under a pressure.

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

– Q –

Qualified Installer:

(A) A person who holds a valid contractor's license in the proper classification issued by the State of California; or

(B) A person who holds a valid Maintenance Certificate of Registration issued pursuant to the provisions of this Code; or

(C) A person who is the owner of a single-family dwelling and has demonstrated to the satisfaction of the Department his or her qualifications to satisfactorily perform mechanical work in the dwelling which is occupied by the owner, and their accessory buildings, provided that all of the following conditions are met:

- (1) The work is performed prior to sale of the dwelling.
- (2) The homeowner has actually resided in the residence for the 12 months prior to completion of the work.
- (3) The homeowner has not availed himself or herself of this exemption on more than two structures during any three-year period; or

(D) A person who is employed by a governmental agency that is required to comply with the provisions of this Code, and who is qualified, as determined by the Department, to supervise or control any work regulated by this Code.

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]

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– R –

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 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:

Class 1. Refrigerants that do not show flame propagation where tested in air at 14.7 pound-force per square inch absolute (psia) (101 kPa) 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 is 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.

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— 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.

DEFINITIONS

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. A 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 psi (103 kPa) for steam.

Strength, Ultimate. The highest stress level that the component can tolerate without rupture.

Superintendent of Building. Superintendent of Building is the General Manager of the Department of Building and Safety.

System Outdoor Airflow. The rate of outdoor airflow required at the ventilation system outdoor air intake.

222.0

– T –

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]

Testing Agency. [HCD 1 & HCD 2] See “Approved Testing Agency”.

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]

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.

223.0

– U –

UMC. [HCD 1, HCD 2, OSHPD 1, 1R, 2, 3, 4 & 5] The most recent edition of Uniform Mechanical Code published by the International Association of Plumbing and Mechanical Officials.

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.

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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, 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 to a gas vent and is installed 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]

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]

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]

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]

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]

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 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 or condense at constant pressure. [ASHRAE 34:3]

Zone. [OSHPD 1, 2, 3, 4 & 5] *A space or group of spaces within a building for which the heating, or cooling requirements are sufficiently similar that desired conditions can be maintained throughout by a single controlling device.*

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE

CHAPTER 3 – GENERAL REGULATIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X																						
Adopt Entire Chapter as amended (amended sections listed below)			X	X	X			X	X	X	X	X	X	X	X								
Adopt only those sections that are listed below																				X			
Chapter/Section																							
301.7											X												
303.2										†	†	†	†	†	†								
303.7			X					X	X														
303.7.1				X	X																		
305.2 <i>Exception</i>				X	X																		
306.2										X													
311.5																				X			
312.1				X	X			X	X														
316.2				X	X																		
316.5				X	X																		
316.9				X	X																		
318.0										X	X	X	X	X	X								
319.1										X	X			X	X								
319.2												X		X									
320.1										X	X			X	X								
320.2												X		X									
320.3													X										
320.4										X				X									
320.4.4										X				X									
320.5										X	X	X		X	X								
321.0										X	X	X	X	X	X								
322.0										X	X	X	X	X	X								
322.1										X		X	X	X									
323.0										X	X	X		X	X								

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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 *the California Electrical Code*.

- (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 *the California Electrical Code*.

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.

301.7 OSHPD 1R [OSHPD 1R]. For OSHPD 1R, refer to Section 309 of California Existing Building Code for general requirements.

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

GENERAL REGULATIONS

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. [Not adopted for OSHPD 1, 1R, 2, 3, 4 & 5] 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. Movement of appliances with casters shall be limited by a restraining device installed in accordance with the connector and appliance manufacturer's installation instructions.

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 Facilities. Containers, container valves regulating equipment, and appurtenances for the storage and supply of liquefied petroleum gas shall be installed in accordance with *and the California Fire Code*.

303.7.1 Liquefied Petroleum Gas [LP-Gas] Appliances. [HCD 1 & HCD 2] *Liquefied petroleum gas-burning appliances shall not be installed in a pit, basement, or similar location where heavier-than-air gas might collect. Appliances so fueled shall not be installed in an above-grade under-floor space or basement unless such location is provided with an approved means for removal of unburned gas.*

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 ASSE Z359.1 is installed.

303.8.5 Electrical Power. All appliances requiring an external source of electrical power for its operation shall be 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 54:9.1.17]

303.10 Clearances. 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. [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.

303.10.1 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 unlisted 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.

GENERAL REGULATIONS

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

303.11.1 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 54:9.1.12]

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 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.

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 equipment or appliance.

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. 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 condi-

tions, 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 rigidly 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 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]

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 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.

Exception: [HCD 1 & HCD 2] *Liquefied petroleum gas (LP-Gas) appliances as described in Section 303.7.1.*

» **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 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 ¾ of an inch (20 mm) diameter drain to an approved location. Such pan shall be not less than 1½ inches (38 mm) in depth. <<

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.

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).

306.2 Building Automation Systems. [OSHPD 1] *Building automation systems shall provide for localized control in the event of network failure. This capability shall be specified in the construction documentation.*

GENERAL REGULATIONS

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 symbol of an approved agency certifying compliance of equipment with recognized standards.
- (8) 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 combustibles other than mounting or adjacent surfaces, and temperature rating of field-installed wiring connections exceeding 140°F (60°C).

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 and type of refrigerant.
- (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 electrical rating in volts, amperes, or watts of each field replaceable electrical component.

- (9) The symbol of an approved agency certifying compliance of the equipment with recognized standards.
- (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 and type of refrigerant.
- (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.

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 $\frac{1}{8}$ 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.
- (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 $\frac{3}{4}$ 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 overflow, 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.

**TABLE 310.3
MINIMUM CONDENSATE PIPE SIZE**

EQUIPMENT CAPACITY IN TONS OF REFRIGERATION	MINIMUM CONDENSATE PIPE DIAMETER (inches)
Up to 20	$\frac{3}{4}$
21 – 40	1
41 – 90	1 $\frac{1}{4}$
91 – 125	1 $\frac{1}{2}$
126 – 250	2

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 $\frac{1}{8}$ inch per foot (10.4 mm/m) or 1 percent slope, with the pipe running three-quarters full at the following pipe conditions:

Outside Air – 20%		Room Air – 80%	
DB	WB	DB	WB
90°F	73°F	75°F	62.5°F

For SI units: °C = (°F-32)/1.8

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, 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.

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

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

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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 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.

311.3 Prohibited Source. Outside or return air for heating or cooling air systems 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 or a medical-surgical vacuum outlet, 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.

311.5 California Energy Code Requirements for Residential Air Filtration. *In mechanically ventilated residential buildings, air filters shall be provided to clean outdoor air and return air prior to its delivery to occupied spaces where specified in California Energy Code Sections 150.0(m)12 and 160.2(b). The air filters shall comply with California Energy Code requirements for labeling, ventilation system design and installation, air filter efficacy, and air filter pressure drop.*

312.0 Plumbing Connections.

312.1 General. Water supply, sanitary drainage, and back-flow protection shall be in accordance with the *California Plumbing Code*.

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.

313.2 Material. Hangers 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**

PIPE AND TUBE SIZE (inches)	ROD SIZES (inches)
1/2 - 4	3/8
5 - 8	1/2
10 - 12	5/8

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 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.

315.1.1 Testing. Louvers that protect air 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, notching, or otherwise as defined in the *California Building Code* or *California Residential 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, floor/ceiling assemblies, roof/ceiling assemblies, or shaft enclosures shall be protected in accordance with the requirements of the *California Building Code* or *California Residential 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 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 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, notching, 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 *California Building Code* or *California Residential 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

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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 back-filled 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.

318.0 Scope.

318.1 Applicability. This part is applicable to health facilities regulated by OSHPD (See Adoption Tables for application for specific sections).

Note: This section has no corresponding provisions in the UMC. For the scope and authority of each state agency, refer to Chapter 1.

318.2 Services/Systems and Utilities. Refer to Section 1224.4.1, 1225.2.1 and 1228.4.1.1 of the California Building Code.

319.0 Steam and Hot-Water Systems.

319.1 Requirements for Hospitals and Optional Services Provided in Correctional Treatment Centers. [OSHPD 1, 1R, 4 & 5]

319.1.1 Boilers shall have the capacity, based upon the rest ratings published by the Hydronics Institute or another acceptable national standard to supply the normal operating requirements of all connected systems and equipment.

319.1.2 A minimum of two boilers shall be provided. The arrangement of boilers shall be based on the capacity and capability of a boiler or boilers to operate all systems during periods of breakdown or maintenance of any one boiler.

319.1.3 Boiler systems providing space heating shall be designed to maintain a minimum temperature of 60°F (15.6°C) in general patient areas and the temperatures specified in Table 4-A for sensitive areas during periods of breakdown or maintenance of any one boiler.

319.1.4 Boiler feed pumps, condensate return pumps, fuel oil pumps, and heating circulating pumps shall be connected and installed to provide standby service in the

event of pump failure. Installation of duplex pumps or provision of a spare pump will meet this requirement.

319.1.5 At least two sources of heat (e.g. two pieces of equipment) shall be provided for supplying essential services such as sterilizers, hot water for dishwashing, and domestic hot water for minimum patient service, such as handwashing and baths. Booster heaters for dishwashing providing 125°F to 180°F (52°C to 82°C) water may be counted as the second source of heat for that service.

319.2 Requirements for Skilled Nursing, Intermediate Care Facilities and Basic Services Provided in Correctional Treatment Centers. [OSHPD 2 & 4]

319.2.1 Boilers, if provided, shall accommodate Section 319.1.

319.2.2 Two or more interconnected water heaters are an acceptable means to provide two sources of heat for hot water (See Section 319.1.5).

320.0 Air Conditioning and Heating Systems.

320.1 Requirements for Hospitals and Optional Services Provided in Correctional Treatment Centers. [OSHPD 1, 1R, 4 & 5]

320.1.1 The systems shall be designed to provide the temperatures and relative humidity for sensitive areas or rooms shown in Table 4-A. When outdoor humidity and internal moisture sources are not sufficient to meet the requirements of sensitive areas or rooms in Table 4-A, humidification shall be provided by means of the health-care facility air-handling systems. Temperature shall be individually controlled for each operating and delivery room. Burn unit patient rooms that require humidifiers to comply with the requirements of sensitive areas or rooms in Table 4-A shall be provided with individual humidity control. All humidifiers shall use dry steam. Humidifiers shall be located within air handling systems or ductwork to avoid moisture accumulation in downstream components, including filters and insulation.

320.1.2 Heating systems shall be designed based on the "Heating DB 99.6%" column of the Climatic Design Data in ASHRAE Handbook-Fundamentals. The systems shall be thermostatically controlled with appropriate zoning to achieve the above conditions.

320.1.3 Cooling systems shall be designed based on the 0.4% columns of the four Annual Design Conditions titled Cooling, Evaporation, Dehumidification, and Enthalpy shown by the Climate Design Data in ASHRAE Handbook-Fundamentals. The systems shall be thermostatically controlled with appropriate zoning to achieve the above conditions.

320.2 Requirements for Skilled Nursing, Intermediate Care Facilities and Basic Services Provided in Correctional Treatment Centers. [OSHPD 2 & 4]

320.2.1 Systems shall accommodate the provisions of Sections 320.1.2 through 320.1.3.

320.2.2 *Where air conditioning is provided, the system shall be thermostatically controlled in one or more zones.*

320.3 Requirements for Outpatient Facilities and Licensed Clinics. [OSHPD 3]

320.3.1 *The system shall be designed to provide the temperature and humidities for sensitive areas for rooms shown in Table 4-A.*

320.4 Telephone and Technology Equipment Centers. [OSHPD 1 & 4] *Where telecommunications service entrance rooms, technology equipment centers, or technology distribution rooms are provided in accordance with Section 1224.5 of the California Building Code, the following requirements shall apply:*

320.4.1 *Power for HVAC systems serving the room(s) shall be supplied by the Equipment Branch pursuant to the California Electrical Code. Where redundant systems are provided, only one shall be required to be supplied by the Equipment Branch.*

320.4.2 *Mechanical equipment or fixtures that are not directly related to the support of the room shall not be installed in or pass through the room.*

Exception: *Unrelated ductwork may be installed and shall be not less than 10 feet (3048 mm) above the finished floor.*

320.4.3 *HVAC systems shall be provided to maintain environmental conditions recommended in ASHRAE's Thermal Guidelines for Data Processing Environment and the requirements of the specific equipment installed.*

320.4.4 *Technology equipment centers shall have redundant cooling systems each of sufficient capacity to provide required cooling during periods of breakdown or maintenance of either system. One system shall be non-hydronic and on essential power.*

320.5 Psychiatric Services. [OSHPD 1, 1R, 2, 4 & 5] *For projects associated with provision of psychiatric services in acute psychiatric hospitals, general acute-care hospitals, and special treatment program service units in skilled nursing facilities, psychiatric, seclusion, and holding-patient rooms shall be designed with security diffusers, grilles, and registers.*

321.0 Essential Mechanical Provisions. [OSHPD 1, 1R, 2, 3 (Surgical Clinics only) 4 & 5] *During periods of power outages essential electrical power shall be provided for the following equipment:*

321.1 *(Does not apply to OSHPD 3 surgical clinic.) All heating equipment and fans necessary to maintain a minimum temperature of 60°F (15.6°) in patient areas which are not specified in Section 322.0.*

321.2 *All heating equipment and fans necessary to maintain the minimum temperatures listed in Table 4-A for sensitive areas specified in Section 322.0.*

321.3 *Equipment necessary for humidification of the areas listed in Section 322.0.*

321.4 *All supply, return, and exhaust fans required to maintain the positive and negative air balances as required in Table 4-A.*

321.5 *All control components and control systems necessary for the normal operation of equipment required to have essential electrical power.*

321.6 *Alarms for airborne infection isolation rooms and protective environment rooms.*

322.0 Sensitive Areas or Rooms. [OSHPD 1, 1R, 2, 3 (Surgical Clinics) 4 & 5] *The following are sensitive areas or rooms:*

- (1) Operating room, hybrid operation room
- (2) Cystoscopy
- (3) Cardiac catheterization lab
- (4) Trauma/cardiac room
- (5) Delivery room, cesarean operating room
- (6) Gastrointestinal endoscopy procedure room
- (7) Post-anesthesia care unit
- (8) Newborn nursery
- (9) Newborn intensive-care nursery unit
- (10) Intensive care
- (11) Burn unit

322.1 *The following conditions shall be met for sensitive areas or rooms:*

- (1) Thermostats and humidistats shall be either locally resettable and of the non-locking type or remotely resettable and of the locking type.
- (2) Systems shall be capable of maintaining the rooms within the temperature range in Table 4-A during normal operation. Lower or higher temperature shall be permitted when patients' comfort and/or medical conditions require those conditions.
- (3) The humidity ranges listed in Table 4-A are the minimum and maximum limits where control is specifically needed.
- (4) Types of intensive care service spaces are listed in the California Building Code.

323.0 Mechanical Equipment Schedules. [OSHPD 1, 1R, 2, 4 & 5] *Mechanical equipment schedules in the construction documents shall clearly indicate which equipment will be powered by essential power or appropriate special seismic certifications.*

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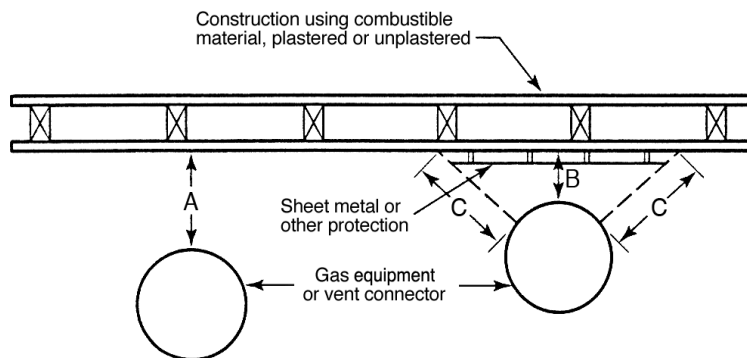
TABLE 303.10.1
REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION^{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11}
[NFPA 54: TABLE 10.2.3]

TYPE OF PROTECTION APPLIED TO AND COVERING ALL SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION	WHERE THE REQUIRED CLEARANCE WITH NO PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE-WALL METAL PIPE IS:									
	36 (INCHES)		18 (INCHES)		12 (INCHES)		9 (INCHES)		6 (INCHES)	
	ALLOWABLE CLEARANCES WITH SPECIFIED PROTECTION (INCHES)									
	USE COLUMN 1 FOR CLEARANCES ABOVE APPLIANCE OR HORIZONTAL CONNECTOR. USE COLUMN 2 FOR CLEARANCES FROM APPLIANCES, VERTICAL CONNECTOR, AND SINGLE-WALL METAL PIPE.									
	ABOVE (COLUMN 1)	SIDES AND REAR (COLUMN 2)	ABOVE (COLUMN 1)	SIDES AND REAR (COLUMN 2)	ABOVE (COLUMN 1)	SIDES AND REAR (COLUMN 2)	ABOVE (COLUMN 1)	SIDES AND REAR (COLUMN 2)	ABOVE (COLUMN 1)	SIDES AND REAR (COLUMN 2)
(1) 3½ inch thick masonry wall without ventilated air space	—	24	—	12	—	9	—	6	—	5
(2) ½ of an inch insulation board over 1 inch glass fiber or mineral wool batts	24	18	12	9	9	6	6	5	4	3
(3) 0.024 inch (nominal 24 gauge) sheet metal over 1 inch glass fiber or mineral wool batts reinforced with wire on rear face with ventilated air space	18	12	9	6	6	4	5	3	3	3
(4) 3½ inch thick masonry wall with ventilated air space	—	12	—	6	—	6	—	6	—	6
(5) 0.024 inch (nominal 24 gauge) sheet metal with ventilated air space	18	12	9	6	6	4	5	3	3	2
(6) ½ of an inch thick insulation board with ventilated air space	18	12	9	6	6	4	5	3	3	3
(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	18	12	9	6	6	4	5	3	3	3
(8) 1 inch glass fiber or mineral wool batts sandwiched between two sheets 0.024 inch (nominal 24 gauge) sheet metal with ventilated air space	18	12	9	6	6	4	5	3	3	3

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

Notes:

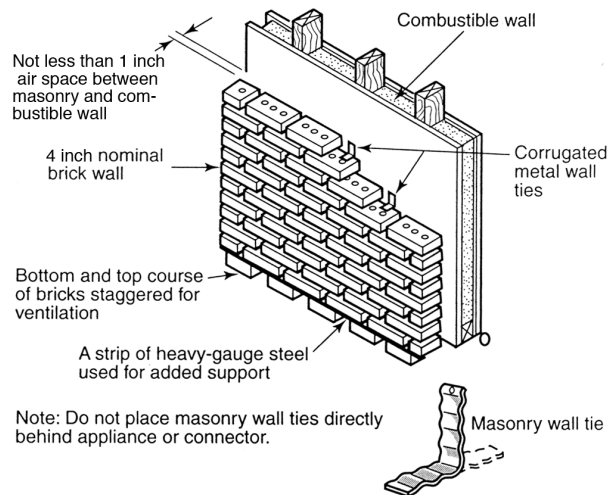
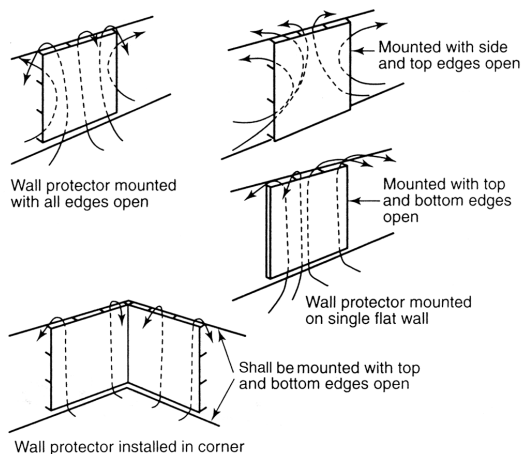
- ¹ Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.
- ² All clearances shall be measured from the outer surface of the combustible material to the nearest point on the surface of the appliance, 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 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:

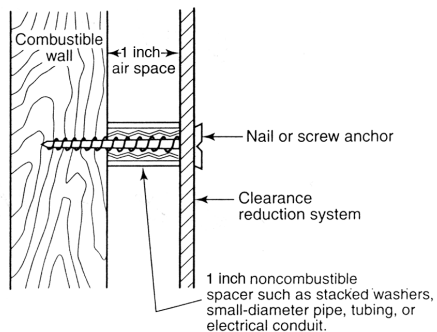
- ¹ A – Equals the clearance with no protection specified in Table 802.7.3.3 and Table 904.2.2 and in the sections applying to various types of equipment.
- ² B – Equals the reduced clearance permitted in accordance with Table 303.10.1.
- ³ The protection applied to the construction using combustible material shall extend far enough in each direction to make C equal to A.

FIGURE 303.10.1(1)^{1, 2, 3}
EXTENT OF PROTECTION NECESSARY TO REDUCE
CLEARANCES FROM GAS APPLIANCE OR VENT CONNECTORS
[NFPA 54: FIGURE 10.3.2.3(a)]



For SI units: 1 inch = 25.4 mm

FIGURE 303.10.1(3)
MASONRY CLEARANCE REDUCTION SYSTEM
[NFPA 54: FIGURE 10.3.2.3(c)]



For SI units: 1 inch = 25.4 mm

Note: Masonry walls can be attached to combustible walls using wall ties. Spacers shall not be used directly behind appliance or connector.

FIGURE 303.10.1(2)
WALL PROTECTOR CLEARANCE REDUCTION SYSTEM
[NFPA 54: FIGURE 10.3.2.3(b)]

GENERAL REGULATIONS

**TABLE 313.3
HANGERS AND SUPPORTS**

MATERIALS	TYPES OF JOINTS	HORIZONTAL	VERTICAL
Cast	Lead and Oakum	5 feet, except 10 feet where 10 foot lengths are installed ^{1, 2, 3}	Base and each floor, not to exceed 15 feet
	Compression Gasket	Every other joint, unless over 4 feet then support each joint ^{1, 2, 3}	Base and each floor, not to exceed 15 feet
Cast-Iron Hubless	Shielded Coupling	Every other joint, unless over 4 feet then support each joint ^{1, 2, 3, 4}	Base and each floor, not to exceed 15 feet
Copper & Copper Alloys	Soldered, Brazed, Threaded, or Mechanical	1½ inches and smaller, 6 feet; 2 inches and larger, 10 feet	Each floor, not to exceed 10 feet ⁵
Steel Pipe for Water DWV	Threaded or Welded	¾ inch and smaller, 10 feet; 1 inch and larger, 12 feet	Every other floor, not to exceed 25 feet ⁵
Steel Pipe for Gas	Threaded or Welded	½ inch, 6 feet; ¾ inch and 1 inch, 8 feet; 1¼ inches and larger, 10 feet	½ inch, 6 feet; ¾ inch and 1 inch, 8 feet; 1¼ inches every floor level
Schedule 40 PVC and ABS	Solvent Cemented	All sizes, 4 feet; allow for expansion every 30 feet ³	Base and each floor; provide mid-story guides; provide for expansion every 30 feet
CPVC	Solvent Cemented	1 inch and smaller, 3 feet; 1¼ inches and larger, 4 feet	Base and each floor; provide mid-story guides
CPVC-AL-CPVC	Solvent Cemented	½ inch, 5 feet; ¾ inch, 65 inches; 1 inch, 6 feet	Base and each floor; provide mid-story guides
Lead	Wiped or Burned	Continuous Support	Not to exceed 4 feet
Steel	Mechanical	In accordance with standards acceptable to the Authority Having Jurisdiction	
PEX	Cold Expansion, Insert and Compression	1 inch and smaller, 32 inches; 1¼ inches and larger, 4 feet	Base and each floor; provide mid-story guides
PEX-AL-PEX	Metal insert and metal compression	½ inch } ¾ inch } All sizes 98 inches 1 inch }	Base and each floor; provide mid-story guides
PE-AL-PE	Metal insert and metal compression	½ inch } ¾ inch } All sizes 98 inches 1 inch }	Base and each floor; provide mid-story guides
PE-RT	Insert and Compression	1 inch and smaller, 32 inches; 1¼ inches and larger, 4 feet	Base and each floor; provide mid-story guides
Polypropylene (PP)	Fusion weld (socket, butt, saddle, electrofusion), threaded (metal threads only), or mechanical	1 inch and smaller, 32 inches; 1¼ inches and larger, 4 feet	Base and each floor; provide mid-story guides

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.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 4 – VENTILATION AIR

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter																							
Adopt Entire Chapter as amended (amended sections listed below)	X		X	X	X			X	X											X			
Adopt only those sections that are listed below										X	X	X	X	X	X								
Chapter/Section																							
401.0			X							X		X	X	X									
401.1										X	X	X	X	X	X								
401.2 with exception		X						X	X														
401.2.1		X						X	X														
402.0										X	X	X	X	X	X								
402.1								X	X	X	X	X	X	X	X					X			
402.2										†		†	†	†	†								
402.1.2										X	X	X	X	X	X								
402.3				X	X					†		†	†	†	†								
403.0										X	X	X	X	X	X								
403.7.2.1 – 403.7.2.4			X	X	X																		
405.3				X	X																		
406.0										X	X	X	X	X	X								
407.0 and subsections										X	X	X	X	X	X								
408.0 and subsections										X	X	X	X	X	X								
409.0 and subsections										X	X	X	X	X	X								
410.0 and subsections										X	X	X	X	X	X								
411.0 and subsections										X		X	X	X	X								
412.0 and subsections										X		X	X	X	X								
413.0 and subsections										X		X	X	X	X								
414.0 and subsections										X		X	X	X	X								
415.0 and subsections										X		X	X	X	X								
416.0 – 416.2										X		X	X	X	X								
416.3															X								
416.4										X		X	X	X	X								
417.0										X		X	X	X	X								
418.0 and subsections										X	X	X	X	X	X								
419.0 and subsections										X													
420.0										X		X	X	X	X								

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE

CHAPTER 4 – VENTILATION AIR (continued)

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter																							
Adopt Entire Chapter as amended (amended sections listed below)	X		X	X	X			X	X														
Adopt only those sections that are listed below										X	X	X	X	X	X								
Chapter/Section																							
Table 4-A										X	X	X	X	X	X								
Table 4-B										X	X		X	X									
Table 4-C												X		X									
Table 402.1	X							X	X														
Table 403.7 Notes 11 & 12				X	X																		

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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. **[OSHPD 1, 1R, 2, 3, 4 & 5]** See Sections 404.0 through 418.0. **[SFM]** Air filters shall comply with all requirements of Part 12, Title 24, Chapter 12-71, SFM Standard 12-71-1. 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 Filters. **[BSC-CG], [DSA-SS & DSA-SS/CC]** In mechanically ventilated buildings, provide regularly occupied areas of the building with air filtration media for outside and return air that provides at least a Minimum Efficiency Reporting Value (MERV) of 13. MERV 13 filters shall be installed prior to occupancy, and recommendations for maintenance with filters of the same value shall be included in the operation and maintenance manual in compliance with Chapter 5, Division 5.5. of the California Green Building Standards Code (CALGreen).

Exception: Existing mechanical equipment.

401.2.1 Labeling. Installed filters shall be clearly labeled by the manufacturer indicating the MERV rating.

402.0 Ventilation Air.

402.1 Occupiable Spaces. Occupiable spaces listed in Table 402.1 **[OSHPD 1, 1R, 2, 3, 4 & 5]** and Table 4-A shall be designed to have ventilation (outdoor) air for occupants in accordance with this chapter. **[DSA-SS & DSA-SS/CC]** Ventilation air requirements for occupancies regulated by the California Energy Commission are found in the California Energy Code.

[CEC] Ventilation air requirements for occupancies regulated by the California Energy Commission and found in the California Energy Code supersede those of the California Mechanical Code.

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. **[OSHPD 1, 1R, 2, 3, 4 & 5]-2013,** through Addendum ae. Ventilation rates for areas not specified in Table 4-A shall have minimum ventilation and air change rates per ANSI/ASHRAE Standard 62.1.

Where areas with prescribed ventilation rates in both Standards 62.1 and Table 4-A exist, the higher of the two air change rates shall be used. All supply-air, return air, and exhaust-air systems shall comply with ASHRAE 170. The text of ASHRAE 170 shall be modified as follows:

- (1) ASHRAE 170. Section 6.1.2.1 -- Not adopted.
- (2) ASHRAE 170. Section 6.3.2 -- Not adopted.
- (3) ASHRAE 170. Table 6.4 -- Not adopted.
- (4) ASHRAE 170. Section 6.4-6.4.4 -- Not adopted.
- (5) ASHRAE 170. Section 6.9 -- Not adopted.
- (6) ASHRAE 170. Section 7.1a -- Modify as follows:
Replace reference to Table 7.1 with reference to Table 4-A.
- (7) ASHRAE 170. Section 7.2.1a through e -- Not adopted.
- (8) ASHRAE 170. Section 7.2.2 a through c, and e -- Not adopted.
- (9) ASHRAE 170. Section 7.2.3 -- Not adopted.
- (10) ASHRAE 170. Section 7.3.1 -- Modify as follows:
Replace reference to Table 7.1 with reference to Table 4-A.
- (11) ASHRAE 170. Section 7.4.1 -- Modify as follows:
Delete the Exception that allows for high return grilles.

402.2 Natural Ventilation. **[Not permitted for OSHPD 1, 2, 3, 4 & 5]** Natural ventilation systems shall be designed in accordance with this section and shall include mechanical ventilation systems 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:
 - (a) natural ventilation openings that comply with the requirements of Section 402.2 and are permanently open or have controls that prevent the openings from being closed during periods of expected occupancy or
 - (b) the zone is not served by heating or cooling equipment. **[ASHRAE 62.1:6.4]**

402.2.1 Floor Area to be Ventilated. Spaces, or portions of spaces, to be naturally ventilated shall be located within a distance based on the ceiling height, as determined in accordance with Section 402.2.1.1, Section 402.2.1.2, or Section 402.2.1.3, from operable wall openings in accordance with the requirements of Section

VENTILATION AIR

402.2.2. For spaces with ceilings that are not parallel to the floor, the ceiling height shall be determined in accordance with Section 402.2.1.4. [ASHRAE 62.1:6.4.1]

402.2.1.1 Single Side Opening. For spaces with operable openings on one side of the space, the distance from the operable openings shall be not more than $2H$, where H is the ceiling height. [ASHRAE 62.1:6.4.1.1]

402.2.1.2 Double Side Opening. For spaces with operable openings on two opposite sides of the space, the distance from the operable openings shall be not more than $5H$, where H is the ceiling height. [ASHRAE 62.1:6.4.1.2]

402.2.1.3 Corner Openings. For spaces with operable openings on two adjacent sides of a space, 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 62.1:6.4.1.3]

402.2.1.4 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 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]

402.2.2 Location and Size of Openings. Spaces or portions of spaces to be naturally ventilated shall be permanently open to operable wall openings directly to the outdoors. The openable area shall be not less than 4 percent of the net occupiable floor area. Where openings are covered with louvers or otherwise obstructed, openable 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). [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 where 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. [Not permitted for OSHPD 1, 2, 3, 4 & 5] Where natural ventilation is not permitted by this section or the *California Building Standards 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 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.

402.4 Outdoor Air Intake Protection. Required outdoor-air intakes shall be covered with a screen having not less than $\frac{1}{4}$ of an inch (6.4 mm) openings, and shall have not more than $\frac{1}{2}$ 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. [Not permitted for OSHPD 1, 2, 3, 4 & 5 spaces listed in Table 4-A]

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. [ASHRAE 62.1:6.2.2]

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.

$$V_{bz} = R_p \cdot P_z + R_a \cdot A_z \quad (\text{Equation 403.2.1})$$

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 62.1:6.2.2.2]

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]

$$V_{OZ} = V_{bz} / E_z \quad (\text{Equation 403.2.3})$$

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 (V_{ot}) shall be determined in accordance with Equation 403.3. [ASHRAE 62.1:6.2.3]

$$V_{ot} = V_{oz} \quad (\text{Equation 403.3})$$

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 (V_{ot}) shall be determined in accordance with Equation 403.4. [ASHRAE 62.1:6.2.4]

$$V_{ot} = \sum \text{all zones } V_{oz} \quad (\text{Equation 403.4})$$

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 (V_{ot}) shall be determined in accordance with Section 403.5.1 through Section 403.5.2. [ASHRAE 62.1:6.2.5]

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 62.1:6.2.5.1]

$$V_{ou} = D \sum \text{all zones } (R_p \cdot P_z) + \sum \text{all zones } (R_a \cdot A_z) \quad (\text{Equation 403.5.1})$$

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.

$$D = P_s / \sum \text{all zones } P_z \quad (\text{Equation 403.5.1.1})$$

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 - 6.2.5.3.1]

$$E_v = 0.88 \cdot D + 0.22 \text{ for } D < 0.60 \quad [\text{Equation 403.5.1.3(1)}]$$

$$E_v = 0.75 \text{ for } D \geq 0.60 \quad [\text{Equation 403.5.1.3(2)}]$$

403.5.1.4 Zone Minimum Primary Airflow. For each zone, the minimum primary airflow (V_{pz-min}) shall be determined in accordance with Equation 403.5.1.4. [ASHRAE 62.1:6.2.5.3.2]

$$V_{pz-min} = V_{oz} \cdot 1.5 \quad (\text{Equation 403.5.1.4})$$

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 62.1:6.2.5.4]

$$V_{ot} = V_{ou} / E_v \quad (\text{Equation 403.5.2})$$

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 62.1:6.2.6.1]

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.

$$T = 3v / V_{bz} \quad (\text{Equation 403.6.1})$$

Where:

- T = averaging time period, minutes.
- v = the volume of the ventilation zone where averaging is being applied, cubic foot (m^3).
- V_{bz} = 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/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).

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- (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. [ASHRAE 62.1:6.2.6.2]

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 m²) 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.

403.7.2.1 Alternative Exhaust Ventilation for Enclosed Parking Garages.

403.7.2.2 Minimum Exhaust Rate. [HCD 1 & 2] *In lieu of the exhaust rates in Table 403.7, ventilation systems shall be capable of providing 14,000 cfm (6608 L/s) of exhaust air for each operating vehicle. Number of operating vehicles shall be determined based on 2.5 percent of all parking spaces (and not less than one vehicle).*

403.7.2.3 Exhaust Inlet Distribution. [HCD 1 & 2] *To ensure proper exhaust of contaminated air and fumes from parking garages, exhaust systems*

utilizing multiple exhaust inlets shall be designed so that exhaust inlets are distributed in such a manner that no portion of the parking garage is more than 50 feet (15 240 mm) from an exhaust inlet. Such exhaust inlets shall be installed so that the highest elevation of the exhaust inlet is no greater than 12 inches (305 mm) below the lowest ceiling level.

Exception: *Garage exhaust systems designed without distributed exhaust inlets may have their exhaust inlets designed based on the principles of engineering and mechanics and shall provide the minimum required exhaust rate in Table 403.7.*

403.7.2.4 Exhaust System Operation. [HCD 1 & 2] *Exhaust systems shall operate continuously unless one of the exceptions to continuous operation of Section 403.7.2 is utilized.*

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 62.1:6.2.7]

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] Recirculated air shall not be taken from prohibited locations in accordance with Section 311.3.

403.9.1 Class 1 Air. Recirculation or transfer of Class 1 air to other spaces shall be permitted. [ASHRAE 62.1:5.16.3.1]

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 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 using an energy recover device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device shall be permitted and the recirculated Class 2 air shall not exceed 10 percent of the outdoor air intake flow. [ASHRAE 62.1:5.16.3.2]

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 other spaces. Where using an energy recover device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device shall be permitted and the recirculated Class 3 air shall not exceed 5 percent of the outdoor air intake flow. [ASHRAE 62.1:5.16.3.3]

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]

404.0 Alternative Procedure for Multiple-Zone Systems Ventilation Efficiency.

404.1 General. 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. 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]

$$E_v = \text{minimum } (E_{vz}) \quad (\text{Equation 404.1})$$

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.

$$X_s = V_{ou} / V_{ps} \quad (\text{Equation 404.2})$$

The uncorrected outdoor air intake (V_{ou}) shall be 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 (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 the air supplied to a 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]

$$Z_{pz} = V_{oz} / V_{pz} \quad (\text{Equation 404.3.1})$$

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.

[Equation 404.3.2(1)]

$$E_{vz} = (F_a + X_s \cdot F_b - Z_{pz} \cdot E_p \cdot F_c) / F_a$$

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). 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]

$$F_a = E_p + (1 - E_p) \cdot E_r \quad (\text{Equation 404.3.2(2)})$$

$$F_b = E_p \quad (\text{Equation 404.3.2(3)})$$

$$F_c = 1 - (1 - E_z) \cdot (1 - E_r) \cdot (1 - E_p) \quad (\text{Equation 404.3.2(4)})$$

$$E_p = V_{pz} / V_{dz} \quad (\text{Equation 404.3.2(5)})$$

Where:

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.

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).

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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 secondary recirculation air. [ASHRAE 62.1:A3]

405.0 Indoor Air Quality for Residential Occupancies.

405.1 General. Rooms or occupied spaces within residential occupancies, where the occupants are nontransient, shall be designed to have mechanical ventilation and exhaust air in accordance with Section 405.2 through Section 405.5.

405.1.1 Natural Ventilation. Where approved by the Authority Having Jurisdiction, natural ventilation shall be permitted for Climate Zone 1, Climate Zone 2, or for thermally conditioned buildings for less than 876 hours per year.

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).

$$Q_{tot} = 0.03A_{floor} + 7.5 (N_{br} + 1) \quad (\text{Equation 405.2})$$

Where:

Q_{tot} = Total required ventilation outdoor air rate, CFM

A_{floor} = Floor area, ft²

N_{br} = Number of bedrooms more than 1

For SI Units: 1 cubic foot per minute = 0.00047 m³/s

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. **[HCD 1 & HCD 2]** Each bathroom shall also be mechanically ventilated in accordance with Division 4.5 of the California Green Building Standards Code (CALGreen).

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 ft³/min (0.009 m³/s) for continuous operation.

405.4 Kitchen Exhaust. A mechanical exhaust 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.

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.

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.

406.0 Evaporative Cooling System for Health Care Facilities. **[For OSHPD 1, 1R, 2, 3, 4 & 5]** Direct evaporative cooling systems where the air directly contacts the wetted surface or spray shall be limited in health facilities to nonpatient areas such as laundry rooms, food preparation areas, and boiler or machinery rooms. Similar rooms with high heating-producing equipment will be considered when specifically approved by the enforcing agency. The evaporative pads shall be a synthetic type. Filters shall be required in accordance with Tables 4-B and 4-C except utility rooms, i.e.: boiler or machinery rooms.

407.0 Ventilation System Details. [OSHPD 1, 1R, 2, 3, 4 & 5]

407.1 General.

407.1.1 All supply-air, return air, and exhaust-air systems shall be mechanically operated and such systems for areas listed in Table 4-A shall be operated continuously. Natural ventilation through windows or other openings such as louvers will be considered as supplemental to the required mechanical ventilation systems.

Exceptions:

- (1) Natural ventilation shall not be used in airborne infection isolation rooms and protective environment rooms.
- (2) The number of air changes may be reduced to 25 percent of the indicated value in Table 4-A, when the room is unoccupied, if provisions are made to ensure the following:
 - (1) The number of air changes per hour indicated is reestablished whenever the space is occupied.
 - (2) The pressure relationship with the surrounding rooms is maintained when the air changes per hour are reduced. In areas requiring no continuous directional control as identified in accor-

dance with Table 4-A, ventilation systems may be shut down when the space is unoccupied and ventilation is not otherwise required. Ventilation shall not be reduced in rooms specifically used for airborne infection control, such as waiting rooms, triage rooms, corridors, reception areas, areas adjacent to waiting areas, airborne infection isolation rooms, negative pressure exam room, negative pressure x-ray treatment rooms, and protective environment rooms. All operating and delivery rooms shall maintain a minimum of six air changes per hour of total air when not in use.

407.1.2 Fans serving exhaust systems shall be located at the discharge end of the system. The ventilation rates shown in Table 4-A shall be considered as minimum acceptable rates and shall not be construed as precluding the use of higher ventilation rates if they are required to meet design conditions.

407.1.3 Services/Systems and Utilities. (Refer to Section 1224.4.1 of the California Building Code).

407.2 Outdoor Air Intakes and Exhaust Outlets.

407.2.1 Outdoor Air Intakes. Outdoor air intakes shall be located at least 25 feet (7.62 m) from exhaust outlets of ventilating systems, combustion equipment stacks, medical-surgical vacuum systems, cooling towers, and areas that may collect vehicular exhaust or other noxious fumes. Plumbing vents shall be located in relation to outdoor air intakes per California Plumbing Code. The bottom of outdoor air intakes shall be located as high as practicable, but not less than 10 feet (3048 mm) above ground level. If installed above the roof, they shall be located 18 inches (457 mm) above roof level or 3 feet (914 mm) above a flat roof where heavy snowfall is anticipated.

Exceptions:

- (1) These dimensions may be reduced if it is demonstrated by the submission of details and calculations that location of intakes with respect to exhausts and their orientation, or the use of special filters, provides equal performance.
- (2) The requirements regarding the bottom of outdoor air intakes and installation through the roof do not apply to skilled nursing facilities, intermediate-care facilities or nonsensitive areas in correctional treatment centers.

407.2.2 Exhaust Outlets. Exhaust outlets shall be located a minimum of 10 feet (3048 mm) above adjoining grade and 10 feet (3048 mm) from doors, occupied areas, and operable windows.

Exception: Airborne infection isolation rooms shall comply with Section 414.1.

407.3 Air Balance.

407.3.1 The ventilation systems shall be designed and balanced to provide the general air balance relationship to adjacent areas, shown in Table 4-A. The ventilation

systems shall be balanced in accordance with the latest edition of standards published by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB).

407.4 Air Circulation.

407.4.1 Design of the ventilation system shall provide air movement that is generally from clean to less clean areas.

407.4.1.1 Air supplied to operating rooms, cesarean operating rooms, cardiac catheterization labs, cystoscopy rooms, delivery rooms, and nurseries shall be delivered at or near the ceiling of the area served. In these areas and in morgues and autopsy rooms all air removed from the area shall be removed near floor level. Exhaust or recirculation inlets shall be located not less than 3 inches (76 mm) nor more than 8 inches (203 mm) above the finished floor, except in morgues and autopsy rooms where all of the exhaust air is removed through an autopsy table designed for this purpose. At least two exhaust or recirculation air inlets of equal capacity shall be used in all cardiac catheterization labs, cystoscopy rooms, operating rooms, and delivery rooms and shall be located not less than 3 inches (76 mm) nor more than 8 inches (203 mm) above the finished floor.

Exception: For airborne infection isolation rooms and protective environment rooms, see Sections 414.0 and 415.0.

407.4.1.2 Room supply air outlets and room recirculation and exhaust air inlets installed in nonsensitive areas shall be located not less than 3 inches (76 mm) above the floor.

Exception: For airborne infection isolation rooms and protective environment rooms, see Sections 414.0 and 415.0.

407.4.1.3 Corridors shall not be used to convey supply, return, transfer or exhaust air to or from any room if the corridor is required to be fire resistive construction per the California Building Code.

Exceptions:

- (1) Mechanically exhausted toilet rooms of 50 square feet (4.7 m²) or less and small rooms of 30 square feet (2.79 m²) or less such as janitor closets, housekeeping rooms, and electrical or telephone closets opening directly onto corridor.
- (2) Air transfer caused by pressure differentials in rooms required to have a positive or negative air balance by Table 4-A.

407.4.1.4 No space above a ceiling may be utilized as an outside-air, relief-air, supply-air, exhaust-air, or return-air plenum.

Exception: Designs specifically approved by the enforcing agency.

407.4.1.5 Air from a patient room, exam room, treatment room shall not be transferred to another similar room without first having passed through air filters as required by Table 4-B or Table 4-C.

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407.4.1.6 Supply outlets and return and exhaust air inlets shall be located to prevent short-circuiting.

407.4.1.7 Recirculating Room Units. For spaces where Table 4-A permits air to be recirculated by room units, the portion of the minimum total air changes per hour required for a space that is greater than the minimum outdoor air changes per hour required component may be provided by recirculating room HVAC units. Such recirculating room HVAC units shall:

- (1) not receive nonfiltered, nonconditioned outdoor air;
- (2) serve only a single space; and
- (3) provide filtration per Section 408.2 and Section 408.3 for airflow passing over any surface that is designed to condense water. This filter shall be located upstream of any such cold surface, so that all of the air passing over the cold surface is filtered.

407.5 Variable Air Volume.

407.5.1 Variable Air Volume Systems (VAV). Variable air volume systems subjecting the patient to a fluctuating air movement are not acceptable for airborne infection isolation rooms, protective environment rooms or those critically sensitive areas listed in Section 322.0. For non-sensitive areas, variable air volume systems meeting the following criteria can be considered:

407.5.1.1 The VAV system shall comply with code requirements for outside air, total air, and pressure relationship through the full range of operation from minimum to maximum.

407.5.1.2 The central return or exhaust fan shall be controlled to accomplish the variable air volume requirements of the individual rooms served by the fan as described in Section 407.5.1.3.

407.5.1.3 Spaces with pressure requirements per Table 4-A shall utilize an automatic modulating damper in the return or exhaust air for each space. The damper will modulate from full open to minimum position in conjunction with the supply air VAV terminal equipment.

407.6 Economizers. Systems with economizers shall include modulating relief and/or return fans to ensure compliance with the pressure requirements of spaces listed in Table 4-A.

408.0 Filters. [OSHPD 1, 1R, 2, 3, 4 & 5]

408.1 General. Filter efficiencies shall be certified by the manufacturer and shall be based on ASHRAE 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size when specifically set forth in these standards.

408.1.1 A filter gauge shall be installed across each filter bank serving central air systems. The gauge shall be red lined or a filter alarm light installed to signal when the recommended maximum static pressure drop has been reached.

408.1.2 Central air-handling systems are defined as any unit requiring duct work on the supply or inlet side that serve more than one room.

408.1.3 Filter banks shall be visually inspected for torn media and bypass in filter frames by means of a flashlight or equivalent, both with fans in operation and stopped. Tears in media and bypass in filter frames shall be eliminated in accordance with the manufacturer's directions and the requirements of the enforcing agency prior to commencing operation of the system.

408.1.4 Central air-handling systems shall be maintained in a reasonably clean condition during construction and shall be cleaned as necessary prior to replacement of temporary filter used during construction to ensure that clean air will be delivered to the occupied spaces.

408.1.5 Filter bank No. 1 shall be located upstream of the air-conditioning equipment. Filter bank No. 2 and filter bank No. 3 shall be located downstream of the supply fan and all cooling and humidification equipment with efficiencies as indicated in Table 4-B or Table 4-C.

Exception: Dry steam-type humidifiers for local room humidity control may be installed in the supply air duct downstream of the final filter bank where designs are specifically approved by the enforcing agency. Dry steam is that which is defined in the ASHRAE HVAC Systems and Equipment Handbook.

408.1.6 Filter bank No. 2 and filter bank No. 3 media shall be rigid or supported (noncollapsing type) and shall operate on the principles of impingement, straining, and diffusion.

408.2 Filters for Hospitals.

408.2.1 All air-ventilation systems shall comply with code requirements of this section and shall have filter bank efficiencies as listed in Table 4-B.

408.2.2 Noncentral recirculating air systems providing cooling to high heat producing equipment located in non-sensitive areas shall have a filter with minimum efficiency reporting value (MERV) of 6 based on ASHRAE 52.2.

408.2.3 Noncentral air systems serving any areas not listed in Table 4-B shall have a filter with minimum efficiency reporting value (MERV) of 6 based on ASHRAE 52.2.

408.2.4 Noncentral recirculating air handling systems, for example, through-the-wall units, fan coil units, and heat pumps may be utilized for single patient rooms of one or more beds. Filtration for these units shall have a filter with minimum efficiency reporting value (MERV) of 6, based on ASHRAE 52.2. The air ventilation system providing the minimum air changes of outdoor air shall comply with Table 4-B. These units may be used as recirculating units only. All outdoor air requirements shall be met by a separate central air handling system.

408.3 Filters for Skilled Nursing Facilities, Intermediate Care Facilities, and Correctional Treatment Centers.

408.3.1 The air ventilation systems shall comply with code requirements of this section for skilled nursing facil-

ities, intermediate care facilities and correctional treatment centers and shall have filter bank efficiencies as listed in Table 4-C.

408.3.2 Noncentral air systems serving single patient rooms of one or more beds shall comply with Table 4-C.

408.3.3 Noncentral recirculating air-handling systems, i.e. through the wall units, may be utilized for each patient room with one or more beds. Filtration for these units shall have a filter with minimum efficiency reporting value (MERV) of 6, based on ASHRAE 52.2. The air ventilation system providing the minimum air changes of outdoor air shall comply with Table 4-C. These units may be used as recirculating units only. All outdoor air requirements shall be met by a separate central air handling system.

408.3.4 Airborne infection isolation rooms, protective environment rooms, and sensitive areas in correctional treatment centers shall comply with Section 408.2.

408.4 Filters for Outpatient Facilities.

408.4.1 The air ventilation systems shall comply with code requirements of this section for outpatient facilities and shall have filter bank efficiencies as listed in Table 4-B.

408.4.2 Noncentral air systems serving individual rooms shall comply with Table 4-B.

409.0 Ducts. [OSHPD 1, 1R, 2, 3, 4 & 5]

409.1 Ducts which penetrate construction, intended for X-ray or other radiation protection, shall not impair the effectiveness of the protection.

409.2 Duct linings and their use shall meet the requirements of Chapter 6, California Mechanical Code.

409.3 Insulation of Ducts. Cold air ducts shall be insulated wherever necessary or to prevent condensation.

409.4 The anchorage and supporting structural elements for airducts shall be designed to withstand the lateral forces as required by the California Building Code, Title 24, Part 2.

410.0 Laboratory Ventilating Systems and Hoods. [OSHPD 1, 1R, 2, 3, 4 & 5]

410.1 Laboratory Ventilating Systems. Laboratory ventilating systems shall comply with NFPA 99, as required by Section 1224.4.6.4 of the California Building Code.

410.2 Exhaust Hoods and Safety Cabinets. Hoods and safety cabinets may be used for normal exhaust of a space provided minimum air change rates are maintained. If air change standards in Table 4-A do not provide sufficient air for proper operation of exhaust hoods and safety cabinets (when in use), supplementary makeup air (filtered and preheated) shall be provided around these units to maintain the required airflow direction and exhaust velocity. Makeup systems for hoods shall be arranged to minimize "short circuiting" of air and to avoid reduction in air velocity at the point of contaminant capture.

410.3 Laboratory Fume Hoods. Laboratory fume hoods shall meet the following standards:

410.3.1 General Standard. Average face velocity shall be at least 75 feet per minute (0.38 meters per second). Exhaust system shall be separate from the building exhaust system. Exhaust fan shall be located at the discharge end of the system. Exhaust duct system shall be of noncombustible corrosion-resistant material as required to meet the planned usage of the hood.

410.3.2 Special Standards for Use with Strong Oxidants. Fume hoods and their associated equipment in the air stream intended for use with perchloric acid and other strong oxidants shall be constructed of stainless steel or other material consistent with special exposures. Hoods and equipment shall be provided with a water wash and drain system to permit periodic flushing of duct and hood. When perchloric acid or other strong oxidants are only transferred from one container to another, standard laboratory fume hoods and the associated equipment may be used in lieu of stainless steel construction.

410.3.3 Special Standards for Use with Infectious or Radioactive Materials. Each hood shall have a minimum face velocity of 90 to 110 feet per minute (0.45 to 0.56 meters per second) with suitable pressure-independent air-modulating devices and alarms to alert staff of fan shutdown or loss of airflow. Each hood shall have filters with a 99.97 percent efficiency (based on the DOP test method) in the exhaust stream and be designed and equipped to permit the safe removal, disposal, and replacement of contaminated filters. Filters shall be as close to the hood as practical to minimize duct contamination. Fume hoods intended for use with radioactive isotopes shall be constructed of stainless steel or other material suitable for the particular exposure.

411.0 Kitchen and Dining Areas. [OSHPD 1, 2, 3, 4 & 5]

411.1 The air from dining areas may be used to ventilate the food preparation areas only after it has passed through a filter with at least an 80 percent average efficiency based on ASHRAE 52.2 or a minimum efficiency reporting value (MERV) of 13, based on ASHRAE 52.2.

Exception: For skilled nursing facilities, intermediate care facilities and correctional treatment centers, the air from dining area may be used to ventilate food preparation areas only after it has passed through a filter with a 50 percent average efficiency based on ASHRAE 52.2 or a minimum efficiency reporting value (MERV) of 10, based on ASHRAE 52.2.

412.0 Boiler, Mechanical, and Electrical Rooms. [OSHPD 1, 2, 3, 4 & 5]

412.1 Boiler, heater and electrical equipment rooms shall be provided with outdoor air so as to maintain combustion rates of equipment and temperatures in the rooms and in adjoining areas as rated in this chapter.

412.2 Floor surfaces in occupied spaces above such rooms should not exceed a temperature of 85°F (29.4°C), and suitable insulation may be required.

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413.0 Odorous Rooms. [OSHPD 1, 2, 3, 4 & 5]

413.1 Rooms in areas where excessive heat or moisture is generated, where objectional odors or dust are present, or where flammable or toxic gases may accumulate, which are used by health facility personnel or patients, shall be provided with exhaust ventilation to change the air a minimum of ten times per hour.

413.2 Kitchen, morgues and laundries located inside a hospital building or skilled nursing facility in which patients are accommodated, or treated, shall be ventilated with exhaust systems which will provide a minimum of ten air changes per hour and prevent odors from entering patient areas.

414.0 Airborne Infection Isolation Rooms. [OSHPD 1, 2, 3, 4 & 5]

414.1 Exhaust Systems. A separate, dedicated exhaust system shall be provided for airborne infection isolation rooms. The dedicated system may serve more than one airborne infection isolation room, adjoining toilet room and anteroom. The exhaust ducts shall be identified by appropriate labeling with the words "Caution Airborne Infection Isolation Rooms Exhaust" or similar terminology. Such labeling shall be in a manner which is not readily removable and shall appear on the exhaust duct at intervals of not more than 20 feet (6096 mm) and at least once near each room and each story traversed by the exhaust system. Exhaust fans shall comply with Section 407.1.2. The discharge from exhaust fans shall be located above the roof and shall be located a minimum of 25 feet (7620 mm) from areas that may be occupied, doors, operable windows, outdoor air intakes, or other openings into the building. The exhaust fan discharge shall be labeled in a manner which readily identifies the precautions which should be observed. To ensure that the airborne contaminants do not reenter the building, one of the following shall be provided:

414.1.1 Exhaust discharge from fan shall extend at least 7 feet (2134 mm) above the roof and discharge vertically upward. Self-draining stacks or equivalent shall be used for rain protection. Rain caps which divert the exhaust toward the roof shall be prohibited.

414.1.2 Exhaust shall discharge above roof level and through an accessible HEPA filter. The HEPA filter shall be located upstream of the exhaust fan and have a minimum efficiency of 99.97 percent based on the DOP method in accordance with Mil-Std. 282 or a minimum efficiency reporting value (MERV) of 17, based on ASHRAE 52.2. Filter gage shall be installed across the filter. For maintenance of air balance relationship, see Section 407.3.1. The 25-foot (7620 mm) dimension required by Section 414.1 may be reduced when a 99.97 percent HEPA filter or a minimum efficiency reporting value (MERV) of 17, based on ASHRAE 52.2 is used and the reduced dimension is specifically approved by the enforcing agency.

414.2 Air Distribution. The supply outlets and exhaust inlets shall be located to provide airflow patterns that prevent stagnation of the air and eliminate short circuiting of the

supply to the exhaust, and minimize exposure of health care workers to airborne infectious particles. Supply-air outlets shall be located at or near the ceiling and at the end of the airborne infection isolation room which is opposite the head of the bed. Exhaust registers shall be located on the wall behind the patient's head, or as close to that wall as practical and shall be located not less than 3 inches (76 mm) nor more than 24 inches (610 mm) above the finished floor.

Exception: For correctional treatment centers, the location and design of the supply outlets an exhaust or return inlets shall not compromise the safety, security and protection of staff, inmates and property.

415.0 Protective Environment Rooms. [OSHPD 1, 2, 3, 4 & 5]

415.1 Air Distribution. The supply outlets and exhaust and return inlets shall be located to provide airflow patterns that prevent stagnation of the air and eliminate short circuiting of the supply to the exhaust or return. Supply air shall be delivered at or near the ceiling and near the patient's bed. All exhaust or return registers shall be located near the entrance to the protective environment room and not less than 3 inches (76 mm) nor more than 8 inches (203 mm) above the finished floor.

Exception: For correctional treatment centers, the location and design of the supply outlets and exhaust or return inlets shall not compromise the safety, security, and protection of staff, inmates and property.

416.0 Alarms – Airborne Infection Isolation Rooms and Protective Environment Rooms. [OSHPD 1, 2, 3, 4 & 5]

416.1 An alarm system which is based on static pressure control, volumetric control, or directional flow measurement shall be provided for each isolation room. The alarm system shall consist of a display monitor located on the corridor wall near the door to the room and a visual and audible alarm which annunciates at the room and at a nurses' station or other suitable location that will provide responsible surveillance. A time delay shall be provided to allow for routine openings of doors. The alarm shall annunciate when the supply, return, or exhaust fans are interrupted or when the minimum required pressure differential per ASHRAE 170 between the airborne infection isolation room and corridor or between the protective environment room and corridor is not being met during closed door conditions.

416.2 Other acceptable alarm systems will be allowed when designs are specifically approved by the enforcing agency.

416.3 [For OSHPD 4] For correctional treatment centers, the alarm system shall not create false alarms or security hazards.

416.4 Prior to acceptance of the rooms, the alarm system shall be tested and operated to demonstrate to the owner or designated representative that the installation and performance of the system conforms to design intent.

417.0 Testing and Balancing Airborne Infection Isolation Rooms and Protective Environment Rooms. [OSHPD 1, 2, 3, 4 & 5]

Prior to acceptance of the rooms, all mechanical systems shall be tested, balanced, and operated to demonstrate to the owner or designated representative that the installation and performance of the systems conform to design intent. All testing and balancing shall be performed by a qualified independent agency certified by the Associated Air Balance Council (AABC); the National Environmental Balancing Bureau (NEBB); or the Testing, Adjusting and Balancing Bureau (TABB).

418.0 Design Requirements for Ethylene Oxide (ETO) Sterilization Areas. [OSHPD 1, 1R, 2, 3, 4 & 5]

418.1 Air Changes. *The ETO sterilization equipment room shall be provided with minimum air changes per hour per Table 4-A and be maintained at a negative air balance.*

418.2 Exhaust Requirements.

418.2.1 *All air from the ETO sterilizer equipment room shall be exhausted to the outside by a dedicated system or other approved method.*

418.2.2 *The exhaust fan for the dedicated system shall be located at the discharge point of the system and identified as ETO Equipment Room Exhaust.*

418.2.3 Discharge Point. *The discharge point shall be a minimum of 25 feet (7620 mm) away from any outside intake, operable window or personnel passage.*

418.3 Ventilation Requirements.

418.3.1 Aeration Units. *The aeration units shall be ventilated through a nonrecirculating dedicated ventilation exhaust system.*

418.3.2 Capture Box. *When the drain is not located in the ETO sterilizer equipment room, ventilation is required by a capture box.*

418.3.3 Cylinder Change. *When not located in the ETO sterilizer equipment room, exhaust during cylinder change is required by installing a hood that is part of a dedicated ventilation exhaust system, positioned no more than 1 foot (305 mm) above or behind the point where the change of cylinders takes place.*

418.3.4 Sterilizer Relief Valve. *The ventilation of sterilizer relief valve is required through a pipe connected to the outlet of the relief valve exhausted directly to the outdoors at a point high enough to be away from passers by, and not near any windows that open, nor near any air-conditioning or ventilation air intakes.*

418.3.5 Ventilation of Sterilizer Door Area. *The system shall be designed to capture the ETO when the door is opened following the completion of the sterilization process. A hood or canopy closed on each end should be installed over the sterilization door. A hood or canopy shall be connected to a dedicated exhaust ventilation system.*

418.4 Gas Valves. *Installation of gas line hand valves at the connection to the supply cylinders are required to minimize leakage during cylinder change.*

418.5 Alarm Systems. *An Audible and visual alarm system shall be installed to alert sterilizer operating personnel if the air flow falls below design cubic feet per minute (L/s).*

419.0 Neonatal Intensive Care Units. [OSHPD 1]

419.1 Formula Preparation Area. *Air shall be supplied over the formulation preparation area by group E, nonaspirating supply diffusers. Air shall be returned or exhausted by registers located not less than 3 inches (76 mm) nor more than 8 inches (203 mm) above the finished floor in the cleanup area.*

419.2 Treatment Area/Room. *Air shall be supplied over the treatment surface by group E, nonaspirating supply diffusers. Air shall be returned or exhausted by registers located not less than 3 inches (76 mm) nor more than 8 inches (203 mm) above the finished floor; adjacent to the treatment surface.*

420.0 Air Distribution Devices. [OSHPD 1, 2, 3, 4 & 5]

All air distribution devices and supply air outlets shall meet the requirements of ASHRAE 170-2013, Section 6.7.2 and Table 6.7.2.

VENTILATION AIR

TABLE 4-A
PRESSURE RELATIONSHIP AND VENTILATION REQUIREMENTS FOR GENERAL ACUTE CARE
HOSPITALS, SKILLED NURSING FACILITIES, INTERMEDIATE CARE FACILITIES, CORRECTIONAL
TREATMENT CENTERS, OUTPATIENT FACILITIES, AND LICENSED CLINICS

FUNCTION OR SPACE	PRESSURE RELATIONSHIP TO ADJACENT AREAS (f) (n)	MINIMUM OUTDOOR ACH	MINIMUM TOTAL ACH	ALL ROOM AIR EXHAUSTED DIRECTLY TO OUTDOORS (j)	AIR RECIRCULATED BY MEANS OF ROOM UNITS (a)	DESIGN RELATIVE HUMIDITY(k), %	DESIGN TEMPERATURE (l), °F/°C
Airborne infection isolation anteroom (u)	(e)	NR	10	Yes	No	NR	NR
Airborne infection isolation room (u)	Negative	2	12	Yes	No	max 60	70-75/21-24
<i>Airborne infection isolation treatment/exam room</i>	<i>Negative</i>	<i>2</i>	<i>12</i>	<i>Yes</i>	<i>No</i>	<i>NR</i>	<i>NR</i>
<i>Angiography room</i>	<i>Positive</i>	<i>3</i>	<i>15</i>	<i>NR</i>	<i>NR</i>	<i>max 60</i>	<i>70-75/21-24</i>
Bathing room	Negative	NR	10	Yes	No	NR	70-75/21-24
Bathroom	Negative	NR	10	Yes	No	NR	72-78/22-26
Bedpan room	Negative	NR	10	Yes	No	NR	NR
<i>Blood bank/tissue storage</i>	<i>NR</i>	<i>2</i>	<i>6</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>
<i>Blood draw/phlebotomy</i>	<i>NR</i>	<i>2</i>	<i>6</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>
Bronchoscopy, sputum collection, and pentamidine administration (n)	Negative	2	12	Yes	No	NR	68-73/20-23
<i>Cardiac catheterization lab</i>	<i>Positive</i>	<i>3</i>	<i>15</i>	<i>NR</i>	<i>No</i>	<i>max 60</i>	<i>70-75/21-24</i>
Clean linen storage	Positive	NR	2	NR	NR	NR	72-78/22-26
Clean workroom (central medical and surgical supply space)	Positive	2	4	NR	No	max 60	72-78/22-26
Clean workroom or clean holding (support)	Positive	2	4	NR	NR	NR	NR
Critical and intensive care	NR	2	6	NR	No	30-60	70-75/21-24
<i>CT Scan</i>	<i>NR</i>	<i>2</i>	<i>6</i>	<i>NR</i>	<i>NR</i>	<i>max 60</i>	<i>NR</i>
Darkroom (g)	Negative	2	10	Yes	No	NR	NR
Delivery room (caesarean) (m), (n), (o)	Positive	4	20	NR	No	20-60	68-75/20-24
Dialysis treatment area	NR	2	6	NR	NR	NR	72-78/22-26
Dialyzer reprocessing room	Negative	NR	10	Yes	No	NR	NR
Dietary storage	NR	NR	2	NR	No	NR	72-78/22-26
<i>Electroconvulsive therapy procedure room</i>	<i>P</i>	<i>3</i>	<i>15</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>
Emergency department exam/treatment room (p)	NR	2	6	NR	NR	max 60	70-75/21-24
Endoscope cleaning	Negative	2	10	Yes	No	NR	NR
ER decontamination	Negative	2	12	Yes	No	NR	NR
ER waiting rooms	Negative	2	12	Yes (q)	NR	max 65	70-75/21-24
Examination room	NR	2	6	NR	NR	max 60	70-75/21-24
<i>Fast track room</i>	<i>NR</i>	<i>2</i>	<i>6</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>
<i>Fluoroscopy room</i>	<i>Negative</i>	<i>2</i>	<i>6</i>	<i>Yes</i>	<i>No</i>	<i>NR</i>	<i>NR</i>
Food preparation center (i)	NR	2	10	NR	No	NR	72-78/22-26
Gastrointestinal endoscopy procedure room (x)	NR	2	6	NR	No	20-60	68-73/20-23
Hazardous material storage	Negative	2	10	Yes	No	NR	NR
Hydrotherapy	Negative	2	6	NR	NR	NR	72-80/22-27
<i>Infusion room</i>	<i>Positive</i>	<i>2</i>	<i>6</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>
Intermediate care (s)	NR	2	6	NR	NR	max 60	70-75/21-24
<i>Interventional imaging procedure room</i>	<i>Positive</i>	<i>5</i>	<i>15</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>

TABLE 4-A (continued)
PRESSURE RELATIONSHIP AND VENTILATION REQUIREMENTS FOR GENERAL ACUTE CARE HOSPITALS, SKILLED NURSING FACILITIES, INTERMEDIATE CARE FACILITIES, CORRECTIONAL TREATMENT CENTERS, OUTPATIENT FACILITIES, AND LICENSED CLINICS

FUNCTION OR SPACE	PRESSURE RELATIONSHIP TO ADJACENT AREAS (f) (n)	MINIMUM OUTDOOR ACH	MINIMUM TOTAL ACH	ALL ROOM AIR EXHAUSTED DIRECTLY TO OUTDOORS (j)	AIR RECIRCULATED BY MEANS OF ROOM UNITS (a)	DESIGN RELATIVE HUMIDITY(k), %	DESIGN TEMPERATURE (l), °F/°C
<i>IV Prep. room</i>	<i>Positive</i>	2	6	NR	NR	NR	NR
Janitor's closet, <i>housekeeping</i>	Negative	NR	10	Yes	No	NR	NR
Labor/delivery/recovery (LDR) (s)	NR	2	6	NR	NR	max 60	70-75/21-24
Labor/delivery/recovery/postpartum (LDRP) (s)	NR	2	6	NR	NR	max 60	70-75/21-24
Laboratory, bacteriology (v)	Negative	2	6	Yes	NR	NR	70-75/21-24
Laboratory, biochemistry (v)	Negative	2	6	Yes	NR	NR	70-75/21-24
Laboratory, cytology (v)	Negative	2	6	Yes	NR	NR	70-75/21-24
Laboratory, general (v)	Negative	2	6	NR	NR	NR	70-75/21-24
Laboratory, glasswashing	Negative	2	10	Yes	NR	NR	NR
Laboratory, histology (v)	Negative	2	6	Yes	NR	NR	70-75/21-24
Laboratory, infectious disease and virus	Negative	2	6	Yes	NR	NR	70-75/21-24
Laboratory, media transfer (v)	Positive	2	4	NR	NR	NR	70-75/21-24
Laboratory, microbiology (v)	Negative	2	6	Yes	NR	NR	70-75/21-24
Laboratory, nuclear medicine (v)	Negative	2	6	Yes	NR	NR	70-75/21-24
Laboratory, pathology (v)	Negative	2	6	Yes	NR	NR	70-75/21-24
Laboratory, serology (v)	Negative	2	6	Yes	NR	NR	70-75/21-24
Laboratory, sterilizing	Negative	2	10	Yes	NR	NR	70-75/21-24
<i>Lactation</i>	<i>NR</i>	2	6	<i>NR</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>
Laser eye room	Positive	3	15	NR	No	20-60	70-75/21-24
Laundry, general	Negative	2	10	Yes	No	NR	NR
Linen and trash chute room	Negative	NR	10	Yes	No	NR	NR
Medical/anesthesia gas storage (r)	Negative	NR	8	Yes	NR	NR	NR
Medication room	NR	2	4	NR	NR	max 60	70-75/21-24
<i>Morgues and autopsy room (n)</i>	Negative	2	12	Yes	No	NR	68-75/20-24
<i>MRI room</i>	<i>NR</i>	2	6	<i>NR</i>	<i>NR</i>	<i>NR</i>	<i>NR</i>
<i>Negative-pressure x-ray room</i>	<i>Negative</i>	2	12	<i>Yes</i>	<i>No</i>	<i>max 60</i>	<i>72-78/22-26</i>
Newborn intensive care	Positive	2	6	NR	No	30-60	72-78/22-26
<i>Newborn intensive care formula room</i>	<i>P</i>	2	10	<i>NR</i>	<i>No</i>	<i>NR</i>	<i>NR</i>
Newborn/well baby nursery suite	NR	2	6	NR	No	30-60	72-78/22-26
Nonrefrigerated body-holding room (h)	Negative	NR	10	Yes	No	NR	70-75/21-24
Nourishment area or room	NR	NR	2	NR	NR	NR	NR
<i>Nuclear medicine (Gamma, PET, SPECT)</i>	<i>Negative</i>	2	6	<i>Yes</i>	<i>No</i>	<i>NR</i>	<i>NR</i>
Nuclear medicine hot lab	Negative	NR	6	Yes	No	NR	70-75/21-24
Nuclear medicine treatment room	Negative	2	6	Yes	NR	NR	70-75/21-24
<i>Nurse station (aa)</i>	<i>(aa)</i>	<i>(aa)</i>	2	<i>(aa)</i>	<i>(aa)</i>	<i>(aa)</i>	<i>(aa)</i>
<i>Observation</i>	<i>NR</i>	2	6	<i>NR</i>	<i>NR</i>	<i>NR</i>	<i>70-75/21-24</i>
Occupational therapy	NR	2	6	NR	NR	NR	70-75/21-24
Operating room, <i>hybrid operating room (m), (n), (o)</i>	Positive	4	20	NR	No	20-60	68-75/20-24

VENTILATION AIR

TABLE 4-A (continued)
PRESSURE RELATIONSHIP AND VENTILATION REQUIREMENTS FOR GENERAL ACUTE CARE HOSPITALS, SKILLED NURSING FACILITIES, INTERMEDIATE CARE FACILITIES, CORRECTIONAL TREATMENT CENTERS, OUTPATIENT FACILITIES, AND LICENSED CLINICS

FUNCTION OR SPACE	PRESSURE RELATIONSHIP TO ADJACENT AREAS (f) (n)	MINIMUM OUTDOOR ACH	MINIMUM TOTAL ACH	ALL ROOM AIR EXHAUSTED DIRECTLY TO OUTDOORS (j)	AIR RECIRCULATED BY MEANS OF ROOM UNITS (a)	DESIGN RELATIVE HUMIDITY(k), %	DESIGN TEMPERATURE (l), °F/°C
Operating/surgical cystoscopic room (m), (n), (o)	Positive	4	20	NR	No	20-60	68-75/20-24
Patient corridor	NR	NR	2	NR	NR	NR	NR
Patient holding preparation	NR	2	6	NR	No	NR	NR
Patient room	NR	2	4 (y)	NR	NR	max 60	70-75/21-24
Pediatric play area	NR	2	6	NR	NR	NR	NR
Pharmacy (b)	Positive	2	4	NR	NR	NR	NR
Drug room	NR	2	4	NR	NR	NR	NR
HD ante room (b)	Positive	NR	NR	NR	NR	<60	≤68/≤20
HD buffer room (b)	Negative	NR	30	Yes	No	<60	≤68/≤20
HD segregated compounding area (ab)	Negative	NR	12	Yes	NR	NR	NR
HD storage (b)	Negative	NR	12	Yes	NR	NR	NR
Non-HD ante room (b)	Positive	NR	30	NR	NR	<60	≤68/≤20
Non-HD buffer room (b)	Positive	NR	30	NR	No	<60	≤68/≤20
Non-HD segregated compounding area	NR	NR	NR	NR	NR	NR	NR
Physical therapy (nursing facility)	Negative	2	6	NR	NR	NR	70-75/21-24
Physical therapy (diagnostic and treatment)	Negative	2	6	NR	NR	max 65	72-80/22-27
Post-anesthesia care unit	NR	2	6	Yes	No	20-60	70-75/21-24
Pre-screening area	Negative	2	12	Yes (q)	NR	NR	NR
Procedure room (o), (d)	Positive	3	15	NR	No	20-60	70-75/21-24
Protective environment anteroom (t)	(e)	NR	10	NR	No	NR	NR
Protective environment room (t)	Positive	2	12	NR	No	max 60	70-75/21-24
Radiology waiting rooms	Negative	2	12	Yes (q), (w)	NR	max 60	70-75/21-24
Recovery room	NR	2	6	NR	No	20-60	70-75/21-24
Recreation/activity room	NR	2	6	NR	NR	NR	NR
Resident gathering/activity/dining (nursing facility)	NR	4	4	NR	NR	NR	70-75/21-24
Resident room (nursing facility)	NR	2	2	NR	NR	NR	70-75/21-24
Resident unit corridor (nursing facility)	NR	NR	4	NR	NR	NR	NR
Seclusion room	NR	2	6	NR	NR	NR	NR
Semi-restricted corridor	NR	2	4	NR	NR	NR	NR
Shower room	Negative	NR	10	Yes	No	NR	NR
Soiled linen sorting and storage	Negative	NR	10	Yes	No	NR	NR
Soiled or decontamination room	Negative	2	6	Yes	No	NR	72-78/22-26
Soiled workroom or soiled holding, utility room	Negative	2	10	Yes	No	NR	NR
Special purpose room (SNF & ICF only)	NR	2	6	Yes	NR	NR	NR
Speech therapy/audiology room	NR	2	6	NR	NR	NR	NR
Sterile storage	Positive	2	4	NR	NR	max 60	72-78/22-26

TABLE 4-A (continued)
PRESSURE RELATIONSHIP AND VENTILATION REQUIREMENTS FOR GENERAL ACUTE CARE HOSPITALS, SKILLED NURSING FACILITIES, INTERMEDIATE CARE FACILITIES, CORRECTIONAL TREATMENT CENTERS, OUTPATIENT FACILITIES, AND LICENSED CLINICS

FUNCTION OR SPACE	PRESSURE RELATIONSHIP TO ADJACENT AREAS (f) (n)	MINIMUM OUTDOOR ACH	MINIMUM TOTAL ACH	ALL ROOM AIR EXHAUSTED DIRECTLY TO OUTDOORS (j)	AIR RECIRCULATED BY MEANS OF ROOM UNITS (a)	DESIGN RELATIVE HUMIDITY(k), %	DESIGN TEMPERATURE (l), °F/°C
Sterilizer equipment room	Negative	NR	10	Yes	No	NR	NR
Substerile service area	NR	2	6	NR	No	NR	NR
Toilet room	Negative	NR	10	Yes	No	NR	NR
Trauma/cardiac room (crisis or shock) (c)	Positive	3	15	NR	No	20-60	70-75/21-24
Treatment room (surgery and critical care) (p)	NR	2	6	NR	NR	20-60	70-75/21-24
Treatment room (diagnostic and treatment) (x)	NR	2	6	NR	NR	max 60	70-75/21-24
Triage	Negative	2	12	Yes (q)	NR	max 60	70-75/21-24
Ultrasound room	NR	2	6	NR	NR	NR	NR
Unsterile supply	NR	2	2	NR	NR	NR	NR
Waiting area (nuclear medicine)	Negative	2	12	Yes	No	NR	NR
Waiting area primary care clinic	Negative	2	10	Yes(q)	NR	NR	NR
Warewashing	Negative	NR	10	Yes	No	NR	NR
Wound intensive care (burn unit)	NR	2	6	NR	No	40-60	70-75/21-24
X-ray (diagnostic and treatment)	NR	2	6	NR	NR	max 60	72-78/22-26
X-ray (surgery/critical care and catheterization)	Positive	3	15	NR	No	max 60	70-75/21-24

Note: NR = No requirement

Notes for Table 4-A:

- Except where indicated by a “No” in this column, recirculating room HVAC units (with heating or cooling coils) are acceptable for providing that portion of the minimum total air changes per hour that is permitted by Section 407.4.1.7. Because of the cleaning difficulty and potential for buildup of contamination, recirculating room units shall not be used in areas marked “No.” Recirculating devices with HEPA filters shall be permitted in existing facilities as interim, supplemental environmental controls to meet requirements for the control of airborne infectious agents. The design of either portable or fixed systems should prevent stagnation and short circuiting of airflow. The design of such systems shall also allow for easy access for scheduled preventative maintenance and cleaning.
- Additional air change, ISO class, continuous pressure monitoring and filtering requirements for compounding areas shall comply with California Board of Pharmacy regulations Title 16 §1735 & §1751, and USP <797> & <800>. Air supplied to the compounding buffer room and ante room must be introduced through 99.97% minimum HEPA filters located in the ceiling. At least 15 air changes per hour (ACPH) shall be provided to nonhazardous drug (non-HD) compounding buffer rooms through the ceiling. The HEPA filtered air from the PEC in the non-HD buffer room, when added to the HVAC-supplied HEPA-filtered air, shall increase the total HEPA-filtered ACPH to at least 30. If the PEC is used to meet the minimum total ACPH requirements, the PEC must not be turned off except for maintenance. All hazardous drug (HD) compounding areas and PECs shall be exhausted externally through 99.97% HEPA filtration. For both hazardous and non-hazardous compounding, minimum air changes shall be met under dynamic operating conditions as defined by USP. Returns and exhaust grilles shall be mounted low on the wall unless a visual smoke study demonstrates dilution of particles and sweeping out of particles from the entire room. One return/exhaust should be placed near the refrigerator compressor. Anteroom shall have a minimum pressure differential of +0.02 inches water column in relation to the adjacent, non-compounding spaces. Non-HD buffer room shall have a pressure differential of +0.02 to +0.05 inches water column in relation to the anteroom. HD buffer room shall have a pressure differential of -0.01 to -0.03 inches water column in relation to the anteroom.*
- The term *trauma room* as used herein is a first-aid room and/or emergency room used for general initial treatment of accident victims. The operating room within the trauma center that is routinely used for emergency surgery is considered to be an operating room by this standard.
- Pressure relationships need not be maintained when the room is unoccupied.
- See Section 7.2 of ASHRAE 170 and its subsections for pressure-relationship requirements.
- For operating rooms, cardiac catheterization labs, angiography rooms, cystoscopy rooms, delivery rooms, cesarean operating rooms, newborn intensive care, and nurseries provide approximately 15% excess supply air to the room or a sufficient quantity of excess supply air to maintain an appropriate positive air balance based on the room tightness and number of doors. For all rooms not listed in this footnote or not listed in Section 322.0 requiring either a positive or negative air balance, provide approximately 10% differential cfm between supply and return/exhaust airflow but not less than 25 cfm differential shall be provided regardless of room size. Room function, size, and tightness may be considered when determining the differential airflow required. Where continuous directional control is not required, variations between supply cfm and return or exhaust cfm shall be minimized in accordance with Section 407.4.1.3.*
- All air need not be exhausted if darkroom equipment has a scavenging exhaust duct attached and meets ventilation standards regarding NIOSH, OSHA, and local employee exposure limits.^{2,3}

VENTILATION AIR

- h. A nonrefrigerated body-holding room is applicable only to facilities that do not perform autopsies on-site and use the space for short periods while waiting for the body to be transferred.
- i. Minimum total air changes per hour (ach) shall be that required to provide proper makeup air to kitchen exhaust systems as specified in ANSI/ASHRAE Standard 154.⁴ In some cases, excess exfiltration or infiltration to or from exit corridors compromises the exit corridor restrictions of NFPA 90A,⁵ the pressure requirements of NFPA 96,⁶ or the maximum defined in the table. During operation, a reduction to the number of air changes to any extent required for odor control shall be permitted when the space is not in use. (See FGI [2010] in Informative Appendix B.)
- j. In some areas with potential contamination and/or odor problems, exhaust air shall be discharged directly to the outdoors and not recirculated to other areas. Individual circumstances may require special consideration for air exhausted to the outdoors. To satisfy exhaust needs, constant replacement air from the outdoors is necessary when the system is in operation.
- k. The RH ranges listed are the minimum and/or maximum allowable at any point within the design temperature range required for that space.
- l. Systems shall be capable of maintaining the rooms within the range during normal operation. Lower or higher temperature shall be permitted when patients' comfort and/or medical conditions require those conditions.
- m. National Institute for Occupational Safety and Health (NIOSH) criteria documents regarding occupational exposure to waste anesthetic gases and vapors, and control of occupational exposure to nitrous oxide⁷ indicate a need for both local exhaust (scavenging) systems and general ventilation of the areas in which the respective gases are utilized. Refer to NFPA 99 for other requirements.⁸
- n. If pressure-monitoring device alarms are installed, allowances shall be made to prevent nuisance alarms. Short-term excursions from required pressure relationships shall be allowed while doors are moving or temporarily open. Simple visual methods such as smoke trail, ball-in-tube, or flutterstrip shall be permitted for verification of airflow direction.
- o. Surgeons or surgical procedures may require room temperatures, ventilation rates, humidity ranges, and/or air distribution methods that exceed the minimum indicated ranges.
- p. Treatment rooms used for bronchoscopy shall be treated as bronchoscopy rooms. Treatment rooms used for procedures with nitrous oxide shall contain provisions for exhausting anesthetic waste gases.
- q. In a recirculating ventilation system, HEPA filters shall be permitted instead of exhausting the air from these spaces to the outdoors provided that the return air passes through the HEPA filters before it is introduced into any other spaces. The entire minimum total air changes per hour of recirculating airflow shall pass through HEPA filters. When these areas are open to larger, nonwaiting spaces, the exhaust air volume shall be calculated based on the seating area of the waiting area. (**Note:** The intent here is to not require the volume calculation to include a very large space [e.g., an atrium] just because a waiting area opens onto it.)
- r. See NFPA 99 for further requirements.⁸
- s. For intermediate care, labor/delivery/recovery rooms, and labor/delivery/recovery/postpartum rooms, four total ach shall be permitted when supplemental heating and/or cooling systems (radiant heating and cooling, baseboard heating, etc.) are used.
- t. The protective environment airflow design specifications protect the patient from common environmental airborne infectious microbes (i.e., *Aspergillus* spores). *The anteroom shall have negative air pressure in relation to the protective environment room. A door louver, transfer grille, or other acceptable means may be provided to allow for airflow from the protective environment room to the anteroom. The protective environment room shall have positive-pressure in relation to the anteroom and adjoining toilet room.* Recirculation HEPA filters shall be permitted to increase the equivalent room air exchanges; however, the outdoor air changes are still required. Constant-volume airflow is required for consistent ventilation for the protected environment. The pressure relationship to adjacent areas shall remain unchanged if the PE room is utilized as a normal patient room. Rooms with reversible airflow provisions for the purpose of switching between protective environment and AII functions shall not be permitted.
- u. The AII room described in this standard shall be used for isolating the airborne spread of infectious diseases, such as measles, varicella, or tuberculosis. *The airborne infection isolation room shall have negative pressure in relation to the anteroom, and the adjoining toilet room shall have negative pressure in relation to the airborne infection isolation room.* Supplemental recirculating devices using HEPA filters shall be permitted in the AII room to increase the equivalent room air exchanges; however, the minimum outdoor air changes of Table 4-A are still required. AII rooms that are retrofitted from standard patient rooms from which it is impractical to exhaust directly outdoors may be recirculated with air from the AII room, provided that air first passes through a HEPA filter. When the AII room is not utilized for airborne infection isolation, the pressure relationship to adjacent areas, when measured with the door closed, shall remain unchanged and the minimum total air change rate shall be 6 ach. Switching controls for reversible airflow provisions shall not be permitted. The anteroom shall have positive air pressure in relation to the airborne infection isolation room. A door louver, transfer grille, or other acceptable means may be provided to allow for airflow from the anteroom to the airborne infection isolation room.
- v. When required, appropriate hoods and exhaust devices for the removal of noxious gases or chemical vapors shall be provided in accordance with NFPA 99.⁸
- w. The requirement that all room air is exhausted directly to outdoors applies only to radiology waiting rooms programmed to hold patients who are waiting for chest x-rays for diagnosis of respiratory disease.
- x. If the planned space is designated in the organization's operational plan to be utilized for both bronchoscopy and gastrointestinal endoscopy, the design parameters for "bronchoscopy, sputum collection, and pentamidine administration" shall be used.
- y. For single-bed patient rooms using Group D diffusers, a minimum of six total ach shall be provided and calculated based on the volume from finished floor to 6 ft (1.83 m) above the floor.
- z. *This table is based on Table 7.1 in ASHRAE 170, "Ventilation of Healthcare Facilities", and is used with expressed written permission from ASHRAE.*
- aa. *Nurse station pressure relationship and ventilation requirements shall match the area in which it is located.*
- ab. *HD segregated compounding area shall have a differential pressure of -0.01 to -0.03 inches water column in relation to adjacent areas and a minimum of 12 air changes per hour.*

TABLE 4-B
FILTER EFFICIENCIES FOR CENTRAL VENTILATION AND AIR-CONDITIONING SYSTEMS IN GENERAL ACUTE CARE HOSPITALS, ACUTE PSYCHIATRIC HOSPITALS, OUTPATIENT FACILITIES, AND LICENSED CLINICS¹

AREA DESIGNATION	MINIMUM NUMBER OF FILTER BANKS	FILTER EFFICIENCY % FILTER BANK (MINIMUM EFFICIENCY REPORTING VALUE MERV) ⁵		
		NO. 1 ¹	NO. 2 ¹	NO. 3 ¹
Orthopedic operating room, bone marrow transplant operating room, organ transplant operating room, NICU formula preparation room, NICU treatment area/room	3	30%	90%	99.97% ³
		(8)	(14)	(17)
Protective environment rooms	3	30%	90%	99.97% ⁴
		(8)	(14)	(17)
Angiography; cardiac catheterization labs; operating rooms; interventional imaging procedure rooms; delivery rooms nurseries; patient care, treatment, cystoscopy, cesarean operating room, diagnostic, and related areas; airborne infection isolation rooms; areas providing direct patient service or clean supplies such as sterile and clean processes, and patient area corridors	2	30%	90%	—
		(8)	(14)	—
Laboratories	2	30%	80%	—
		(8)	(13)	—
Administrative, med staff support areas, bulk storage, soiled holding areas, food preparation areas, public cafeterias, and laundries	1	30%	—	—
		(8)	—	—
Psychiatric hospitals intended for the care and treatment of inpatients who do not require acute medical services	1	30%	—	—
		(8)	—	—

¹ Based on ASHRAE 52.2.

² Based on DOP test in accordance with MIL-STD-282 or based on ASHRAE 52.2.

³ HEPA filters at air outlet or other locations when approved by the Authority Having Jurisdiction.

⁴ HEPA filter located in the supply duct which serves the positive-pressure isolation room or rooms may serve more than one supply outlet and more than one positive-pressure isolation room. HEPA filter or a filter with minimum efficiency reporting value (MERV) of 17 installation shall be designed and equipped to permit safe removal, disposal and replacement of filters.

⁵ The numbers in parentheses represent MERV rating based on ASHRAE 52.2.

TABLE 4-C
FILTER EFFICIENCIES FOR CENTRAL VENTILATION AND AIR-CONDITIONING SYSTEMS IN SKILLED NURSING FACILITIES AND INTERMEDIATE CARE FACILITIES AND CORRECTIONAL TREATMENT CENTERS¹

AREA DESIGNATION	MINIMUM NUMBER OF FILTER BANKS	FILTER EFFICIENCY % FILTER BANK (MINIMUM EFFICIENCY REPORTING VALUE MERV) ³	
		NO. 1 ¹	NO. 2 ¹
All areas for inpatient care, treatment and/or diagnosis, and those areas providing direct service or cleaning supplies)	2	30%	80%
		(8)	(13)
Administrative, bulk storage, soiled holding, laundries and food prep areas	1	30% ²	—
		(8)	—

¹ Based on ASHRAE 52.2.

² Filters are not required for evaporative coolers serving laundries and food preparation areas.

³ The numbers in parentheses represent MERV rating based on ASHRAE 52.2.

VENTILATION AIR

TABLE 402.1
MINIMUM VENTILATION RATES IN BREATHING ZONE^{1,2}
[ASHRAE 62.1: TABLE 6.2.2.1]

Note: Ventilation air supply requirements for occupancies regulated by the California Energy Commission are found in the California Energy Code.

OCCUPANCY CATEGORY ⁴	PEOPLE OUTDOOR Air Rate R_p (CFM/person)	AREA OUTDOOR Air Rate R_a (CFM/ft ²)	DEFAULT OCCUPANT DENSITY ³ (people/1000 ft ²)	AIR CLASS
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 5-8)	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)	10	0.18	25	2
Daycare sickroom	10	0.18	25	3
Lecture classroom ^h	7.5	0.06	65	1
Lecture hall (fixed seats) ^h	7.5	0.06	150	1
Media center ^a	10	0.12	25	1
Multi-use assembly ^h	7.5	0.06	100	1
Music/theater/dance ^h	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 ^h	5	0.06	25	1
Coffee stations ^h	5	0.06	20	1
Conference/meeting ^h	5	0.06	50	1
Corridors ^h	—	0.06	—	1
Occupiable storage rooms for liquids or gels ^b	5	0.12	2	2
HOTELS, MOTELS, RESORTS, DORMITORIES				
Barracks sleeping areas ^h	5	0.06	20	1
Bedroom/living room ^h	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 ^h	7.5	0.06	30	1
Multipurpose assembly ^h	5	0.06	120	1
OFFICE BUILDINGS				
Break Rooms	5	0.12	50	1
Main entry lobbies ^h	5	0.06	10	1
Occupiable storage rooms for dry materials	5	0.06	2	1
Office space ^h	5	0.06	5	1
Reception areas ^h	5	0.06	30	1
Telephone/data entry ^h	5	0.06	60	1
MISCELLANEOUS SPACES				
Bank or bank lobbies ^h	7.5	0.06	15	1
Bank vaults/safe deposit ^h	5	0.06	5	2
Computer (not printing) ^h	5	0.06	4	1
Freezer and refrigerated spaces (<50°F) ^c	10	—	—	2
General manufacturing (excludes heavy industrial and processes using chemicals)	10	0.18	7	3
Pharmacy (prep. area)	5	0.18	10	2
Photo studios	5	0.12	10	1

TABLE 402.1 (continued)
MINIMUM VENTILATION RATES IN BREATHING ZONE^{1,2}
[ASHRAE 62.1: TABLE 6.2.2.1]

OCCUPANCY CATEGORY ⁴	PEOPLE OUTDOOR Air Rate R_p (CFM/person)	AREA OUTDOOR Air Rate R_a (CFM/ft ²)	DEFAULT OCCUPANT DENSITY ³ (people/1000 ft ²)	AIR CLASS
Shipping/receiving ^b	10	0.12	2	2
Sorting, packing, light assembly	7.5	0.12	7	2
Telephone closets	—	—	—	1
Transportation waiting ^h	7.5	0.06	100	1
Warehouses ^b	10	0.06	—	2
PUBLIC ASSEMBLY SPACES				
Auditorium seating area ^h	5	0.06	150	1
Courtrooms ^h	5	0.06	70	1
Legislative chambers ^h	5	0.06	50	1
Libraries	5	0.12	10	1
Lobbies ^h	5	0.06	150	1
Museums (children's)	7.5	0.12	40	1
Museums/galleries ^h	7.5	0.06	40	1
Places of religious worship ^h	5	0.06	120	1
RESIDENTIAL				
Common corridors ^h	—	0.06	—	1
Dwelling unit ^{f, g, h}	5	0.06	See footnote ^f	1
RETAIL				
Sales (except as below)	7.5	0.12	15	2
Barber shop ^h	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 ^h	7.5	0.06	40	1
Pet shops (animal areas)	7.5	0.18	10	2
Supermarket ^h	7.5	0.06	8	1
SPORTS AND ENTERTAINMENT				
Bowling alley (seating)	10	0.12	40	1
Disco/dance floors ^h	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) ^e	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 ^h	7.5	0.06	150	1
Stages, studios ^{d, h}	10	0.06	70	1
Swimming (pool & deck) ^c	—	0.48	—	2

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.
- ^h Ventilation air for this occupancy category shall be permitted to be reduced to zero where the space is in occupied-standby mode.

VENTILATION AIR

TABLE 403.2.2
ZONE AIR DISTRIBUTION EFFECTIVENESS^{1, 2, 3, 4, 5}
[ASHRAE 62.1: TABLE 6.2.2.2]

AIR DISTRIBUTION CONFIGURATION	E_z
Ceiling supply of cool air.	1.0
Ceiling supply of warm air and floor return.	1.0
Ceiling supply of warm air 15°F or more above space temperature and ceiling return.	0.8
Ceiling supply of warm air less than 15°F above space temperature and ceiling return provided that the 150 feet per minute (fpm) supply air jet reaches to within 4.5 feet of floor level.	1.0 ⁶
Floor supply of cool air and ceiling return provided that the vertical throw is more than 50 fpm at a height of 4.5 feet or more above the floor.	1.0
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.	1.2
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 from the exhaust, return, or both.	0.8
Makeup supply drawn in near to the exhaust, return, or both locations.	0.5

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 403.7
MINIMUM EXHAUST RATES
[ASHRAE 62.1: TABLE 6.5]

OCCUPANCY CATEGORY ⁸	EXHAUST RATE (CFM/unit)	EXHAUST RATE (CFM/ft ²)	AIR CLASS
Arenas ²	—	0.50	1
Art classrooms	—	0.70	2
Auto repair rooms ¹	—	1.50	2
Barber shops	—	0.50	2
Bathroom ^{11,12}	20/50	—	2
Beauty and nail salons	—	0.60	2
Cells with toilet	—	1.00	2
Copy, printing rooms	—	0.50	2
Darkrooms	—	1.00	2
Educational science laboratories	—	1.00	2
Janitor closets, trash rooms, recycling	—	1.00	3
Kitchens – commercial	—	0.70	2
Kitchenettes	—	0.30	2
Locker rooms for athletic, industrial and health care facilities	—	0.50	2
Other locker rooms	—	0.25	2
Shower rooms ^{7,10}	20/50	—	2
Paint spray booths	—	—	4
Parking garages ³	—	0.75	2
Pet shops (animal areas)	—	0.90	2
Refrigerating machinery rooms ⁶	—	—	3
Residential – kitchens ⁷	50/100	—	2
Soiled laundry storage rooms	—	1.00	3
Storage rooms, chemical	—	1.50	4
Toilets – private ^{5,9}	25/50	—	2
Toilets – public ^{4,9}	50/70	—	2
Woodwork shop/classrooms	—	0.50	2

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 comprise 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.
- 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.
- ⁷ For continuous system operation, the lower rates shall be permitted. 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 in accordance with the criteria of Class 1 shall be permitted to be recirculated.
- ¹⁰ Rate is per shower head.
- ¹¹ [HCD 1 & HCD 2] A bathroom is any room containing a bathtub, a shower, a spa, or a similar source of moisture.
- ¹² [HCD 1 & HCD 2] ANSI/ASHRAE 62.2: Tables 5.1 and 5.2.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 5 – EXHAUST SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter				X	X								X										
Adopt Entire Chapter as amended (amended sections listed below)	X		X					X	X	X	X	X		X	X		X						
Adopt only those sections that are listed below		X																			X		
Chapter/Section																							
504.1.1										X	X	X		X	X								
505.12																					X		
505.12.1																					X		
507.7										X		X	X	X	X								
508.4										X	X	X		X	X								
509.2.3			X																				
509.2.3.4																	X						
511.1.6		X						X	X														
512.2.5								X	X														
513.2.2			X					X	X														
513.2.2 Exception 2								X	X														
513.3.5			X					X	X														
513.10			X					X	X														
513.10.1			X					X	X														
516.2.7 Exception			X					X	X														
516.2.9(4)			X					X	X														

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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 $\frac{1}{4}$ of an inch (6.4 mm) openings, and shall have not more than $\frac{1}{2}$ 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 kitchens exhaust ducts shall terminate in accordance with Section 510.9 or Section 519.5.

Part I – Environmental Air Ducts and Product-Conveying 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 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.

504.1.1 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. **[OSHPD 1, 1R, 2, 4 & 5] Exception:** Backdraft dampers are not required when the exhaust fan must operate continuously.

EXHAUST SYSTEMS

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. 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.

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 54:10.4.3.1] 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]

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:

- (1) Exhaust ducts for Type 2 clothes dryers shall comply with Section 504.4. [NFPA 54:10.4.5.1]
- (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]

- (3) Type 2 clothes dryers shall be equipped or installed with lint-controlling means. [NFPA 54:10.4.5.3]
- (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]
- (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] 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) (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 in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.

504.5 Heat (Energy) Recovery Ventilators. Heat (energy) recovery ventilators 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 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 con-

fined 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 dusts that are flammable or hazardous.

505.2 Incompatible Materials. Incompatible materials shall not be conveyed in the same system. [NFPA 91:4.2.2]

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]

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]

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

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- (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 shutdown is necessary for the effective operation of an automatic extinguishing system, it shall be permitted to interlock fire detection and alarm systems to shut down air-moving devices. [NFPA 91:4.2.14.1]

505.7.2 Shut Down Permitted. 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, 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 highly abrasive material in high concentrations.

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 conveying 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

**TABLE 505.9
RANGE OF MINIMUM DUCT DESIGN VELOCITIES¹
(NFPA 91: TABLE A.4.2.5)**

NATURE OF CONTAMINANTS	EXAMPLES	FEET PER MINUTE DESIGN VELOCITY (feet per minute)
Vapors, gases, smoke	All vapors, gases, and smoke	1000 - 2000 ²
Fumes	Welding	2000 - 2500
Very fine light dust	Cotton lint, wood flour, litho powder	2500 - 3000
Dry dusts and powders	Fine rubber dust, molding powder dust, jute lint, cotton dust, shavings (light), soap dust, leather shavings	3000 - 4000
Average industrial dusts	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	3500 - 4000
Heavy dusts	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	4000 - 4500
Heavy or moist dusts	Lead dust with chips, moist cement dust, asbestos chunks from transite pipe cutting machines, buffing lint (sticky), quick-lime dust	4500 and up

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).

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.

505.12 Pharmacies – Compounding Area of Parenteral Solutions. [CA – Board of Pharmacy] *The pharmacy shall have a designated area for the preparation of sterile products for dispensing which shall be ventilated in a manner not interfering with laminar air flow.*

Note: For additional pharmacy building standard requirements, see Chapter 12, California Building Code.

505.12.1 Pharmacies – Laminar Flow Biological Safety Cabinet. [CA – Board of Pharmacy] *In all pharmacies preparing parenteral cytotoxic agents, all compounding shall be conducted within a certified Class II Type A or Class II Type B vertical laminar airflow hood with bag in – bag out design. The pharmacy must ensure that contaminated air plenums that are under positive air pressure are leak tight.*

Note: For additional pharmacy building standard requirements, see Chapter 12, California Building Code.

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 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.

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 vacuum 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.

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TABLE 506.2(1)
MINIMUM SHEET METAL THICKNESS FOR ROUND DUCTS

NEGATIVE PRESSURE (inches water column)	REINF. SPACING (inches)	CLASS 1 (inches)								
		Up to 7	8 to 11	12 to 15	16 to 19	20 to 23	24 to 35	36 to 47	48 to 59	60
To 7	0	0.021 (24 ga.)	0.021 (24 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.127 (10 ga.)	—	—
	96	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
	48	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)
	24	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)
8 to 11	0	0.021 (24 ga.)	0.027 (22 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	—	—	—
	96	0.021 (24 ga.)	0.027 (22 ga.)	0.027 (22 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
	48	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
	24	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.027 (22 ga.)	0.027 (22 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
12 to 15	0	0.021 (24 ga.)	0.033 (20 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	—	—	—
	96	0.021 (24 ga.)	0.027 (22 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.097 (12 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	48	0.021 (24 ga.)	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.097 (12 ga.)
	24	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.027 (22 ga.)	0.027 (22 ga.)	0.027 (22 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
16 to 20	0	0.021 (24 ga.)	0.044 (18 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.112 (11 ga.)	—	—	—	—
	96	0.021 (24 ga.)	0.033 (20 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	48	0.021 (24 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.112 (11 ga.)
	24	0.021 (24 ga.)	0.021 (24 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)
		CLASS 2 (inches)								
To 7	0	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.127 (10 ga.)	—	—
	96	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
	48	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
	24	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
8 to 11	0	0.027 (22 ga.)	0.027 (22 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	—	—	—
	96	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
	48	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
	24	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
12 to 15	0	0.027 (22 ga.)	0.033 (20 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	—	—	—
	96	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.097 (12 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	48	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.097 (12 ga.)
	24	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
16 to 20	0	0.027 (22 ga.)	0.044 (18 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.112 (11 ga.)	—	—	—	—
	96	0.027 (22 ga.)	0.033 (20 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	48	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.097 (12 ga.)
	24	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
		CLASS 3 (inches)								
To 7	0	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.127 (10 ga.)	—	—
	96	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
	48	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
	24	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
8 to 11	0	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	—	—	—
	96	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
	48	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
	24	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)

TABLE 506.2(1) (continued)
MINIMUM SHEET METAL THICKNESS FOR ROUND DUCTS

NEGATIVE PRESSURE (inches water column)	REINF. SPACING (inches)	CLASS 3 (inches)								
		Up to 7	8 to 11	12 to 15	16 to 19	20 to 23	24 to 35	36 to 47	48 to 59	60
12 to 15	0	0.133 (20 ga.)	0.133 (20 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.197 (12 ga.)	—	—	—
	96	0.133 (20 ga.)	0.133 (20 ga.)	0.144 (18 ga.)	0.144 (18 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.197 (12 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	48	0.133 (20 ga.)	0.133 (20 ga.)	0.144 (18 ga.)	0.144 (18 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.168 (14 ga.)
	24	0.133 (20 ga.)	0.133 (20 ga.)	0.144 (18 ga.)	0.144 (18 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.168 (14 ga.)
16 to 20	0	0.133 (20 ga.)	0.144 (18 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.112 (11 ga.)	—	—	—	—
	96	0.133 (20 ga.)	0.133 (20 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	48	0.133 (20 ga.)	0.133 (20 ga.)	0.144 (18 ga.)	0.144 (18 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.197 (12 ga.)
	24	0.133 (20 ga.)	0.133 (20 ga.)	0.144 (18 ga.)	0.144 (18 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.168 (14 ga.)
CLASS 4 (inches)										
To 7	0	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	—	—
	96	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.197 (12 ga.)	0.197 (12 ga.)
	48	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.197 (12 ga.)	0.197 (12 ga.)
	24	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.197 (12 ga.)	0.197 (12 ga.)
8 to 11	0	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	—	—	—
	96	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.197 (12 ga.)	0.197 (12 ga.)
	48	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.197 (12 ga.)	0.197 (12 ga.)
	24	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.197 (12 ga.)	0.197 (12 ga.)
12 to 15	0	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.197 (12 ga.)	—	—	—
	96	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	48	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.155 (16 ga.)	0.168 (14 ga.)	0.168 (14 ga.)	0.197 (12 ga.)	0.197 (12 ga.)	0.097 (12 ga.)
	24	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
16 to 20	0	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.112 (11 ga.)	—	—	—	—
	96	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	48	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
	24	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)

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.

506.6 Explosion Venting. Ducts conveying explosive dusts shall have explosion vents, openings protected by anti-flash-back swing valves, or rupture diaphragms. Openings to relieve

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TABLE 506.2(2)
MINIMUM SHEET METAL THICKNESS FOR RECTANGULAR DUCTS

NEGATIVE PRESSURE (inches water column)	REINF. SPACING (inches)	LONGEST SIDE OF DUCT									
		CLASS 1 (inches)					CLASS 2 (inches)				
		Up to 12	13 to 24	25 to 36	37 to 48	49 to 60	Up to 12	13 to 24	25 to 36	37 to 48	49 to 60
To 7	48	0.021 (24 ga.)	0.033 (20 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	—	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	—
	24	0.021 (24 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
	12	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.021 (24 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
8 to 11	48	0.027 (22 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	—	0.033 (20 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	—
	24	0.027 (22 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.033 (20 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
	12	0.021 (24 ga.)	0.027 (22 ga.)	0.027 (22 ga.)	0.027 (22 ga.)	0.027 (22 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
12 to 15	48	0.044 (18 ga.)	0.097 (12 ga.)	—	—	—	0.044 (18 ga.)	0.044 (18 ga.)	—	—	—
	24	0.044 (18 ga.)	0.055 (16 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
	12	0.027 (22 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.044 (18 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.055 (16 ga.)	0.055 (16 ga.)	0.055 (16 ga.)
16 to 20	48	0.068 (14 ga.)	0.112 (11 ga.)	—	—	—	0.068 (14 ga.)	0.112 (11 ga.)	—	—	—
	24	0.068 (14 ga.)	0.068 (14 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	12	0.033 (20 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.033 (20 ga.)	0.044 (18 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)
		CLASS 3 (inches)					CLASS 4 (inches)				
To 7	48	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	—	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	—
	24	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
	12	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
8 to 11	48	0.044 (18 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	—	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	—
	24	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
	12	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
12 to 15	48	0.044 (18 ga.)	0.097 (12 ga.)	—	—	—	0.055 (16 ga.)	0.097 (12 ga.)	—	—	—
	24	0.044 (18 ga.)	0.055 (16 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
	12	0.044 (18 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)
16 to 20	48	0.068 (14 ga.)	0.112 (11 ga.)	—	—	—	0.055 (16 ga.)	0.112 (11 ga.)	—	—	—
	24	0.068 (14 ga.)	0.068 (14 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.112 (11 ga.)	0.112 (11 ga.)	0.112 (11 ga.)
	12	0.044 (18 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.068 (14 ga.)	0.055 (16 ga.)	0.068 (14 ga.)	0.097 (12 ga.)	0.097 (12 ga.)	0.097 (12 ga.)

For SI units: 1 inch = 25.4 mm, 1 inch water column = 0.249 kPa

explosive forces shall be located outside the building. Where relief devices cannot provide sufficient pressure relief, duct-work 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.

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.

tional 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 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 ½ 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 ½ 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]

TABLE 506.10.4
BASIC MINIMUM CLEARANCES TO UNPROTECTED SURFACES
[NFPA 91: TABLE 4.7.3]

DUCT GAS TEMPERATURE	LARGEST DUCT DIMENSION (inches)	CLEARANCE (inches)
140°F – 600°F incl.	8	8
	>8	12
>600°F – 900°F incl.	8	18
	>8	24
>900°F	All ducts lined with refractory	24

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

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]

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, 4.7.4.1]

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.

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TABLE 506.11
REDUCTION OF DUCT CLEARANCE WITH SPECIFIED FORMS OF PROTECTION
[NFPA 91: TABLE 4.7.4]

FORM OF PROTECTION*	MAXIMUM ALLOWABLE REDUCTION IN CLEARANCE (percent)	
	AS WALL PROTECTOR OR VERTICAL SURFACE	AS CEILING PROTECTOR OR HORIZONTAL SURFACE
3½ inch thick masonry wall without ventilated air space	33	None
½ inch thick noncombustible insulation board over 1 inch glass fiber or mineral wool batts without ventilated air space	50	33
0.024 inch (24 gauge) sheet metal over 1 inch glass fiber or mineral wool batts reinforced with wire, or equivalent on rear face with at least a 1 inch air gap	66	66
3½ inch (90 mm) thick masonry wall with at least a 1 inch air gap	66	None
0.024 inch (24 gauge) sheet metal with at least a 1 inch air gap	66	50
½ inch thick noncombustible insulation board with at least a 1 inch air gap	66	50
0.024 inch (24 gauge) sheet metal with ventilated air space over at least 0.024 inch (24 gauge) sheet metal with at least a 1 inch air gap	66	50
1 inch glass fiber or mineral wool batts sandwiched between two sheets of 0.024 inch (24 gauge) sheet metal with at least a 1 inch air gap	66	50

For SI units: 1 inch = 25.4 mm

* Clearance reduction applied to and covering all combustible surfaces within the distance specified as required clearance with no protection in Table 506.10.4.

- (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 System. Exhaust systems serving Type I hoods shall comply with Section 507.0 through Section 518.0.

507.2 Exhaust System. 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 airflows 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 1978. 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 96:4.2.3.4]

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 96:4.3.3]

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]

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]

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]

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

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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 where subjected to expected building environmental conditions, duct movement under general operating conditions, and duct movement due to fire conditions. [NFPA 96:4.3.4]

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 96:4.3.5]

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]

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. 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 on the premises. [NFPA 96:4.6]

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.

507.7 Pharmaceutical Compounding Exhaust Discharge. [OSHPD 1, 2, 3, 4 & 5] *Exhaust discharge from fans serving the compounding suite shall extend at least 7 feet (2134 mm) above the roof and discharge vertically upward. Self-draining stacks or equivalent shall be used for rain protection. Rain caps which divert the exhaust toward the roof shall be prohibited.*

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 appliance that is in accordance with UL 710B 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.

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 96:5.1.1]

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]

508.3.2.1 Sealed. Internal hood joints, seams, filter support frames, and appurtenances attached inside the hood shall be sealed or otherwise made greasetight. [NFPA 96:5.1.4]

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]

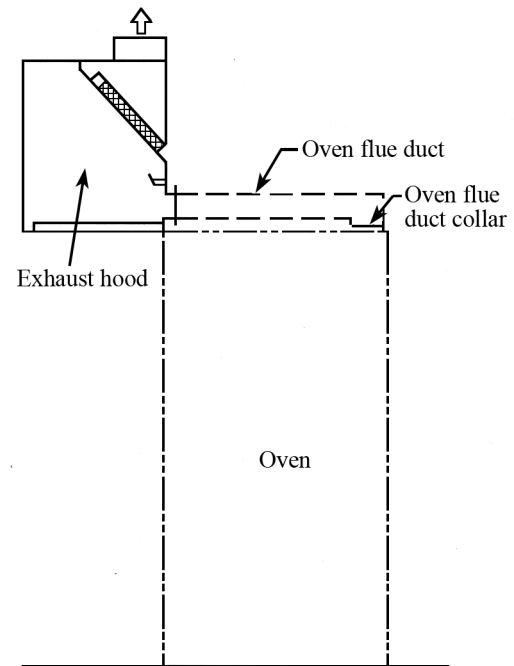


FIGURE 508.3.3
TYPICAL SECTION OF EYEBROW-TYPE HOOD
[NFPA 96: FIGURE 5.1.8.1]

508.3.3.1 Duct Connection. The duct connecting the oven flue(s) to the hood canopy shall be connected with a continuous weld or have a duct-to-duct connection. [See Figure 511.1.2(2) through Figure 511.1.2(4)] [NFPA 96:5.1.8.2]

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 96:5.1.9, 5.1.10]

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]

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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 [OSHPD 1, 1R, 2, 4 & 5] to resist the lateral loads given in the California Building Code, Title 24, Part 2 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.

Exception: Listed exhaust hoods installed in accordance with the manufacturer's installation instructions.

$$E_{NET} = E_{HOOD} - MA_{ID} \quad (\text{Equation 508.5.1.1})$$

Where:

E_{NET} = net hood exhaust

E_{HOOD} = total hood exhaust

MA_{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 508.5.1.2
EXTRA-HEAVY-DUTY COOKING APPLIANCE AIRFLOW**

TYPE OF HOOD	AIRFLOW (cubic foot per minute per linear foot of hood)
Backshelf/pass-over	Not permitted
Double island canopy (per side)	550
Eyebrow	Not permitted
Single island canopy	700
Wall-mounted canopy	550

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, electric and gas wok ranges, and electric and gas over-fired (upright) broilers shall be in accordance with Table 508.5.1.3.

**TABLE 508.5.1.3
HEAVY-DUTY COOKING APPLIANCE AIRFLOW**

TYPE OF HOOD	AIRFLOW (cubic foot per minute per linear foot of hood)
Backshelf/pass-over	400
Double island canopy (per side)	400
Eyebrow	Not permitted
Single island canopy	600
Wall-mounted canopy	400

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, and pressure fryers), and electric and gas conveyor pizza ovens shall be in accordance with Table 508.5.1.4.

**TABLE 508.5.1.4
MEDIUM-DUTY COOKING APPLIANCE AIRFLOW**

TYPE OF HOOD	AIRFLOW (cubic foot per minute per linear foot of hood)
Backshelf/pass-over	300
Double island canopy (per side)	300
Eyebrow	250
Single island canopy	500
Wall-mounted canopy	300

For SI units: 1 cubic foot per minute = 0.00047 m³/s, 1 foot = 304.8 mm

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.

**TABLE 508.5.1.5
LIGHT-DUTY COOKING APPLIANCE AIRFLOW**

TYPE OF HOOD	AIRFLOW (cubic foot per minute per linear foot of hood)
Backshelf/pass-over	250
Double island canopy (per side)	250
Eyebrow	250
Single island canopy	400
Wall-mounted canopy	200

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 linear 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 linear 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, 6.1.2]

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. [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]

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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. **[SFM]** *For applications listed in Section 1.11.0 regulated by the Office of the State Fire Marshal, grease filters shall be Class I when tested in accordance with the test method in Title 24, Part 12, Chapter 12-71, SFM Standard 12-71-1.*

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]

509.2.3.4 [DPH] *Grease filters shall be Class I when tested in accordance with the test method in SFM 12-71-1.*

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]

510.1.1 Fire Hazards. All ducts shall lead directly to the exterior of the building, so as not to unduly increase any fire hazard. [NFPA 96:7.1.2]

510.1.2 Interconnection. Duct systems shall not be interconnected with any other building ventilation or exhaust system. [NFPA 96:7.1.3]

510.1.3 Duct Installation. All ducts shall be installed with a minimum 2 percent slope on horizontal runs up to 75 feet (22 860 mm) and a minimum 8 percent slope on horizontal runs greater than 75 feet (22 860 mm). Fac-

tory-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 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]

510.1.4 Accessibility. Openings required for accessibility shall comply with Section 510.3 through Section 510.3.2. [NFPA 96:7.1.5]

510.1.5 Sign. A sign stating the following shall be placed on all access panels:

ACCESS PANEL – DO NOT OBSTRUCT [NFPA 96:7.1.6]

510.1.6 Bracing and Supports. Duct bracing and supports shall be of noncombustible material, securely attached to the structure and designed to carry gravity and lateral loads within the stress limitations of the building code. Bolts, screws, rivets, and other mechanical fasteners shall not penetrate duct walls.

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]

510.2 Clearance. Clearance between ducts and combustible materials shall be provided in accordance with the requirements of Section 507.4 through Section 507.4.3.3. [NFPA 96:7.2]

510.3 Openings. Openings shall be provided at the sides or at the top of the duct, whichever is more accessible, and at changes of direction. Openings shall be protected by approved access constructed and installed in accordance with the requirements of Section 510.3.7. [NFPA 96:7.3.1, 7.3.2]

Exception: Openings shall not be required in portions of the duct that are accessible from the duct entry or discharge. [NFPA 96:7.3.3]

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]

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 be not less than 1½ 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 96:7.1.7]

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 liquid-tight continuous external weld. [NFPA 96:7.5.2.1]

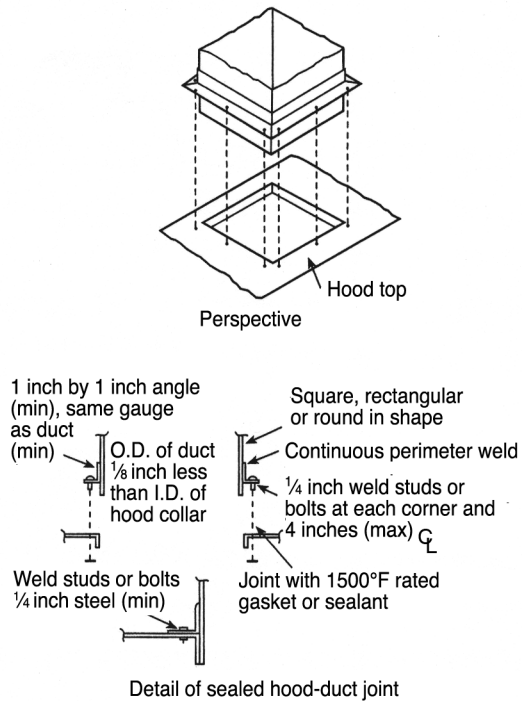
Exceptions:

- (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]

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]

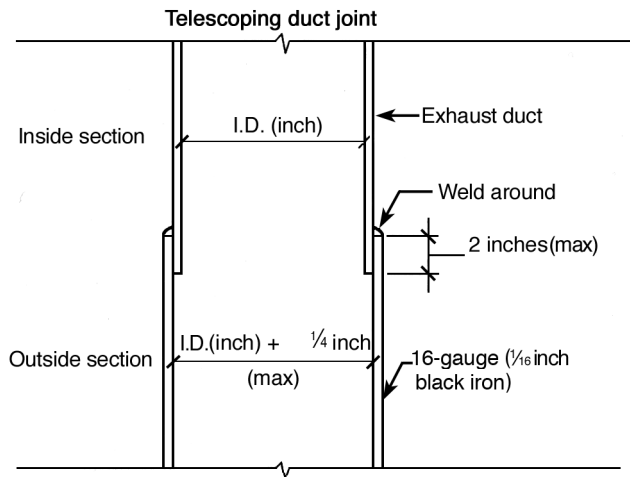
510.5.3.2 Welded Duct Connection. Acceptable duct-to-duct connection shall be as follows:

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

FIGURE 510.5.3
PERMITTED DUCT-TO HOOD COLLAR CONNECTION
[NFPA 96: FIGURE 7.5.2.2]

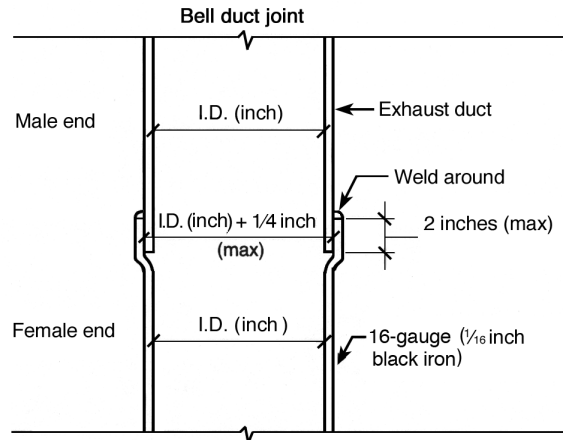


For SI units: 1 inch = 25.4 mm

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.

FIGURE 510.5.3.2(1)
TELESCOPING -TYPE DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(a)]

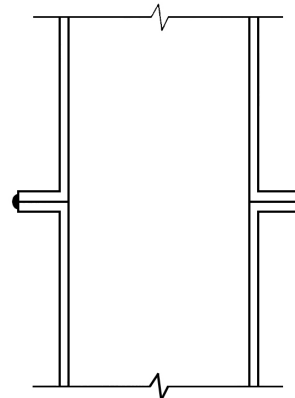


For SI units: 1 inch = 25.4 mm

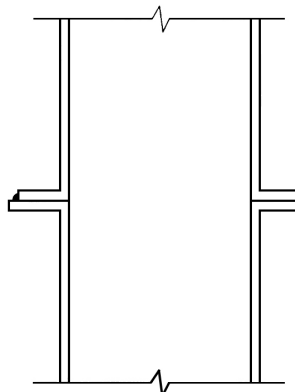
Notes:

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.

FIGURE 510.5.3.2(2)
BELL-TYPE DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(b)]



FLANGE WITH EDGE WELD DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(c)]



FLANGE WITH FILLED WELD DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(d)]

- (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 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 uphill 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. 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]

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]

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 rat-

ing 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

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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.

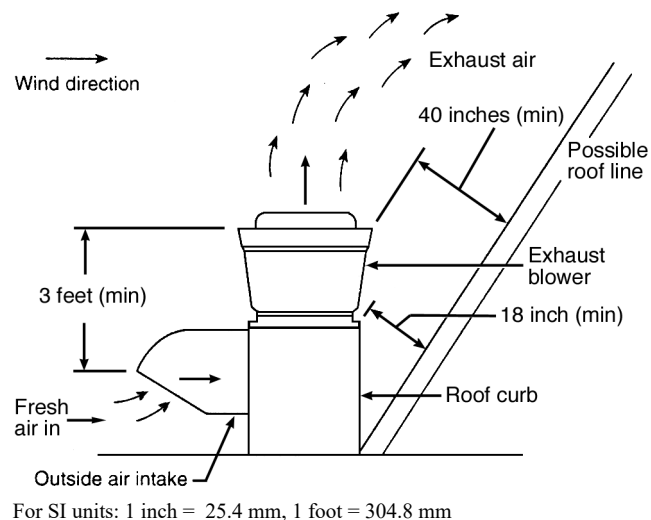
The exhaust system shall terminate as follows:

- (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.

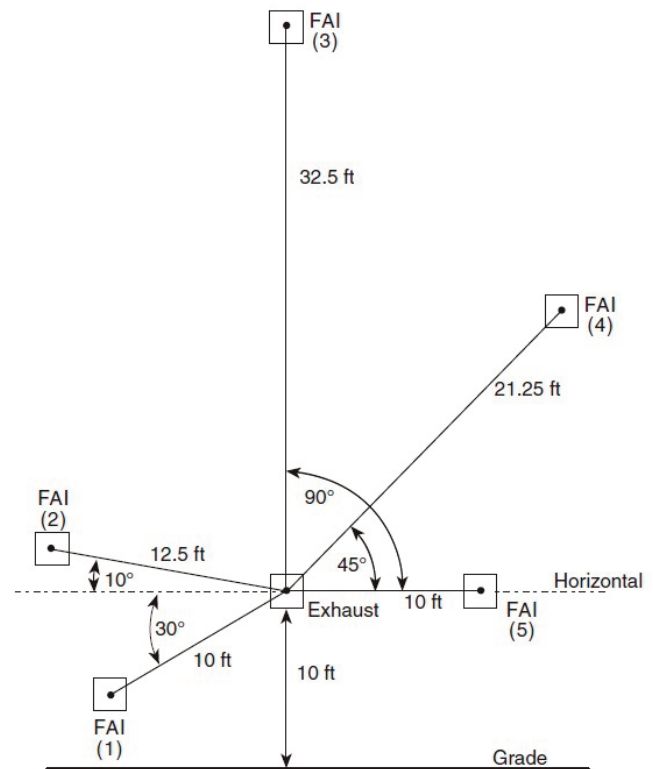
- (2) The exhaust flow shall be directed perpendicularly outward from the wall face or upward.
- (3) All the ductwork shall be pitched to drain the grease back into the hood(s) or with a drain provided to bring the grease back into a container within the building or into a remote grease trap.
- (4) A listed grease duct shall comply with Section 510.3.3 through Section 510.3.7; 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 511.1.1 through Section 511.1.6. Exhaust fans shall comply with UL 762 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]



For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

Notes:

1. Fresh air intake (FAI) applies to an air intake, including an operable door or window.
2. Example:
 - (a) FAIs 1 and 5 are on the same plane of exhaust or lower: 10 feet (3048 mm) min. between closest edges.
 - (b) FAIs 2, 3, and 4 are above plane of exhaust fan:
10 feet + 0.25 feet (3048 mm + 76 mm) per degree between closest edges.

FIGURE 510.9.2
EXHAUST TERMINATION DISTANCE FROM FRESH AIR INTAKE (FAI) OR OPERABLE DOOR OR WINDOW
[NFPA 96: FIGURE 7.8.3]

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 gasketed 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

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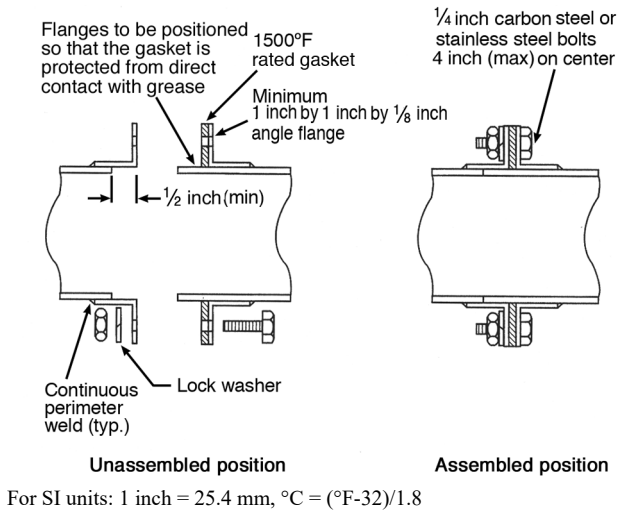


FIGURE 511.1.2(1)
TYPICAL SECTION OF DUCT-TO-FAN
CONNECTION-BUTT JOINT METHOD
[NFPA 96: FIGURE 8.1.3.2(a)]

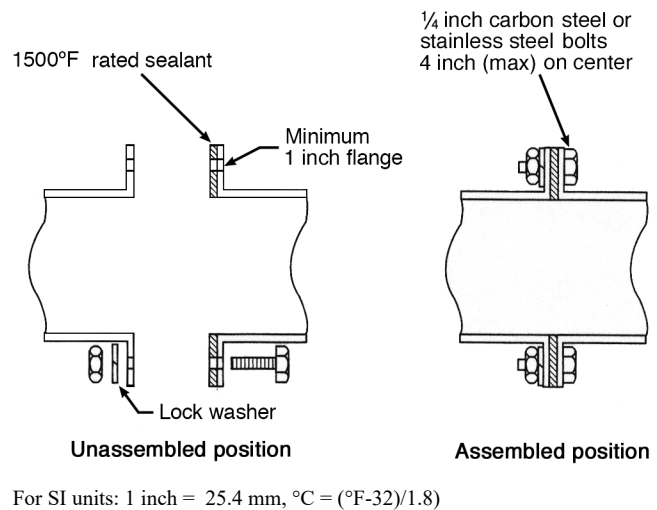


FIGURE 511.1.2(3)
TYPICAL SECTION OF DUCT-TO-FAN
CONNECTION-SEALANT METHOD
[NFPA 96: FIGURE 8.1.3.2(c)]

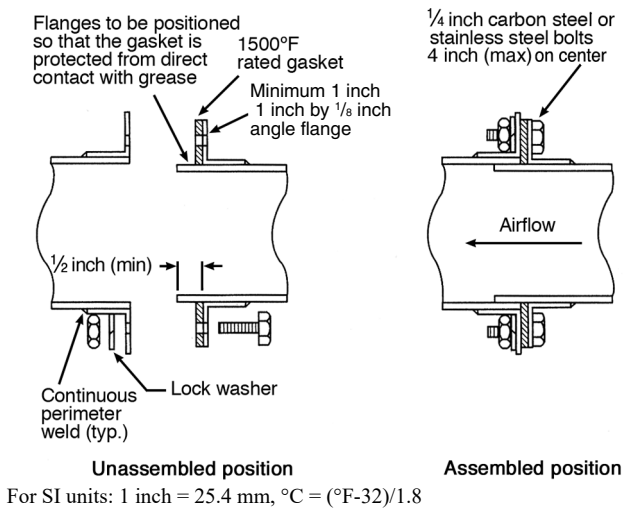


FIGURE 511.1.2(2)
TYPICAL SECTION OF DUCT-TO-FAN
CONNECTION-OVERLAPPING METHOD
[NFPA 96: FIGURE 8.1.3.2(b)]

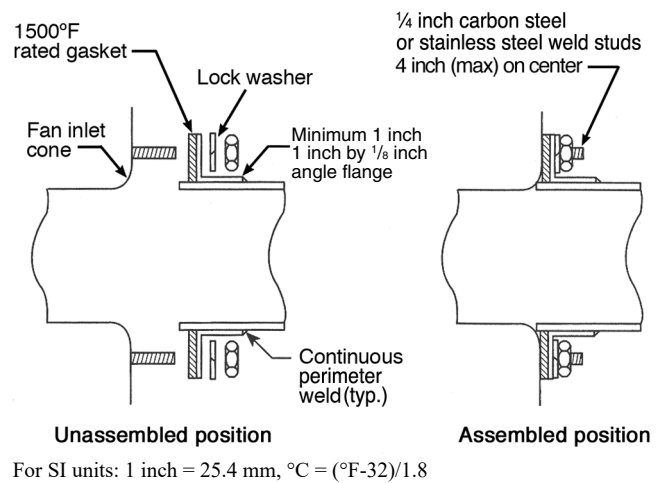


FIGURE 511.1.2(4)
TYPICAL SECTION OF DUCT-TO-FAN CONNECTION-DIRECT
TO FAN INLET CONE METHOD
[NFPA 96: FIGURE 8.1.3.2(d)]

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]
- (2) Flexible connectors shall not be used. [NFPA 96:8.1.4.5]

- (3) Exhaust fans shall have a drain directed to a readily accessible and visible grease receptacle not to exceed 1 gallon (4 L). [NFPA 96:8.1.4.6]

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]

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 *California Electrical Code*. [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).

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, 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 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]

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.

$$E_{NET} = E_{HOOD} - MA_{ID} \quad (\text{Equation 511.3})$$

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

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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 *California Electrical Code*, 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. *Commercial cooking equipment that produce grease laden vapors shall be provided with a Type I Hood, in accordance with this Code, and an automatic fire extinguishing system that is listed and labeled for its intended use as follows:*

- (1) *Wet chemical extinguishing system (NFPA 17A, Standard for Wet Chemical Extinguishing Systems), complying with UL 300, Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Equipment. All existing dry chemical and wet chemical extinguishing systems shall comply with UL 300, Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Equipment.*
- (2) *Carbon dioxide extinguishing systems (NFPA 12, Standard on Carbon Dioxide Extinguishing Systems).*
- (3) *Automatic fire sprinkler systems (NFPA 13, Standard for the Installation of Sprinkler Systems). All existing dry chemical and wet chemical extinguishing systems shall comply with UL 300, no later than the second required servicing of the system following the effective date of this section.*

Exceptions:

- (1) Automatic fire-extinguishing equipment provided as part of listed recirculating systems shall comply with UL 710B. [NFPA 96:10.2.5]
- (2) **[DSA-SS and DSA-SS/CC]** *Public school kitchens, without deep-fat fryers, shall be upgraded to a UL 300, Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Equipment, compliant system during state-funded modernization projects that are under the jurisdiction of the Division of the State Architect.*

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]

513.2.4.3 System Re-evaluation. Changes or modifications to the hazard after installation of the fire-extinguishing systems shall result in re-evaluation of the system design by a properly trained, qualified, and certified person(s). [NFPA 96:10.2.7.4]

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]

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» **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]

» **513.2.5.7 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, *Wet Chemical Extinguishing Systems*. [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 by that system shall 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. Any gas appliance not requiring protection but located under ventilating equipment where protected appliances are located, shall 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. [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. An automatic sprinkler system shall not require a method of manual actuation. [NFPA 96:10.5.1 – 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. [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 *Chapter 3, Title 19 California Code of Regulations* 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 *Chapter 3, Title 19 California Code of Regulations*. [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 96:11.1.2]

514.1.2 Openings. Openings provided for replacing air exhausted through ventilating equipment shall not be restricted by covers, dampers, or other means that would reduce the operating efficiency of the exhaust system. [NFPA 96:11.1.3]

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 96:11.1.4.3]

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 96:11.1.5]

514.1.5 Nonoperational. Cooking equipment shall not be operated while its fire-extinguishing system or exhaust system is nonoperational or impaired. [NFPA 96:11.1.6]

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 96:11.1.7]

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 96:11.1.8]

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 96:11.2.1]

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 96:11.2.2, 11.2.3]

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 96:11.2.4]

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.

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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 96:11.2.5, 11.2.5.1, 11.2.6]

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 96:11.2.7]

514.2.5 Certification. Where required, certificates of inspection and maintenance shall be forwarded to the Authority Having Jurisdiction. [NFPA 96:11.2.8]

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 96:11.4]

TABLE 514.3
SCHEDULE OF INSPECTION FOR GREASE BUILDUP
[NFPA 96: TABLE 11.4]

TYPE OR VOLUME OF COOKING	INSPECTION
Systems serving solid fuel cooking operations.	Monthly
Systems serving high-volume cooking operations. ¹	Quarterly
Systems serving moderate-volume cooking operations.	Semiannually
Systems serving low-volume cooking operations. ²	Annually

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]

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]

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]

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]

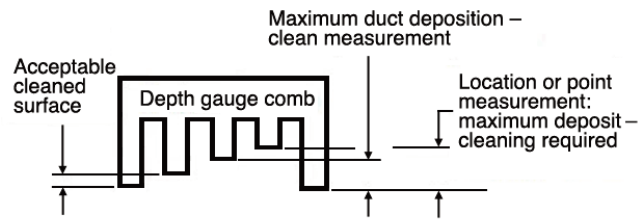


FIGURE 514.4.1.2
DEPTH GAUGE COMB
[NFPA 96: FIGURE 11.6.1.1.2]

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 96:11.6.15]
- 514.4.16 Metal Containers.** Metal containers used to collect grease drippings shall be inspected or emptied at least weekly. [NFPA 96:11.6.16]

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 96:11.7.1]

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 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 96:11.7.2]

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.
- (2) Test data acceptable to the Authority Having Jurisdiction. [NFPA 96:12.1.1]

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 96:12.1.2.1, 12.1.2.1.1]

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 96:12.1.2.2, 12.1.2.2.1]

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 96:12.1.2.3]

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 96:12.1.2.4]

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 96:12.1.2.5]

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 96:12.1.2.5.1]

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 96:12.2]

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 96:13.1]

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]

516.2.1 Gas/Electrically Fueled Cooking Appliances. Only gas-fueled or electrically fueled cooking

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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]

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] The actuation device for the fire damper shall have a maximum temperature rating of 375°F (191°C). [NFPA 96:13.2.10]

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 the *California Electrical Code*.

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 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 the *California Electrical Code*.
- (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 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 96:13.3.2]

516.3.2 Filter Component. Each filter component (grease and odor) shall have an interlock to prove the component is in place. [NFPA 96:13.3.3]

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 96:13.3.4.1]

516.3.3.1 Manual Reset. The sensor shall be a manual reset device or circuit. [NFPA 96:13.3.4.2]

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 96:13.3.5.1 – 13.3.5.3]

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 96:13.4.1 – 13.4.2]

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 96:13.5.1]

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 96:13.5.2]

516.5.2 Locations. The requirements of Section 513.6 shall also apply to recirculating system locations. [NFPA 96:13.5.3]

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 96:13.6.1]

516.6.1 Manufacturer's Instructions. All filters shall be cleaned or replaced in accordance with the manufacturer's instructions. [NFPA 96:13.6.2]

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 96:13.6.3]

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 96:13.6.4]

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 96:13.6.5]

516.6.5 Inspection. Fire-extinguishing equipment shall be inspected in accordance with Section 514.2. [NFPA 96:13.6.6]

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 96:13.6.7]

517.0 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 96:14.1]

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, 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 96:14.1.2]

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 96:14.1.3]

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 96:14.1.4]

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 96:14.1.5]

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 96:14.1.6, 14.1.7]

517.2 Location of Appliances. 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]

517.2.1 Prohibited Location. Solid-fuel cooking appliances shall not be installed in confined spaces. [NFPA 96:14.2.2]

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 96:14.2.3]

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 96:14.2.4]

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 96:14.3.1, 14.3.2]

517.3.1 Separation. Except as permitted in Section 517.3.1.1, exhaust systems serving solid-fuel cooking equipment, including gas or electrically operated equipment, shall be separate from all other exhaust systems. [NFPA 96:14.3.3]

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 96:14.3.5]

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.

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- (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]

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]

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 96:14.4.1]

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]

517.4.3 Prohibited. Wall terminations of solid-fuel exhaust systems shall be prohibited. [NFPA 96:14.4.4]

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 96:14.5.1]

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]

517.5.2 Filters. Filters shall be a minimum of 4 feet (1219 mm) above the appliance cooking surface. [NFPA 96:14.5.3]

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]

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]

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]

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]

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]

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]

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]

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]

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]

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]

517.7.6 Fuel Storage. All fuel storage areas 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 96:14.9.2.8 – 14.9.2.8.2]

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 96:14.7.11]

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]

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]

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]

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]

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.
- (5) 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]

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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]

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 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.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 6 – DUCT SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X																						
Adopt Entire Chapter as amended (amended sections listed below)			X	X	X			X	X	X	X	X	X	X	X								
Adopt only those sections that are listed below																				X			
Chapter/Section																							
601.2.1																				X			
602.1										X	X	X	X	X	X								
602.1, Exception										X	X	X	X	X	X								
602.2.1				X	X																		
603.3.1				X	X																		
603.4.1										X	X	X	X	X	X								
603.4.1.1										X	X	X	X	X	X								
603.9.2				†	†																		
603.9.2.1																				X			
605.1										X	X	X	X	X	X								
605.2										X	X	X	X	X	X								
605.3										X	X	X		X	X								
606.1				X	X																		
606.8			X					X	X														
607.1				X	X																		
607.1.1										X	X	X	X	X	X								
609.1			X					X	X														

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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.

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.

601.2.1 California Energy Code Residential Return Duct Sizing Requirements. *California Energy Code Tables 150.0-B and 150.0-C specify return duct sizing requirements for single return and multiple return duct systems, respectively, that are applicable as an alternative to confirming system airflow via field verification and diagnostic testing. See California Energy Code Section 150.0(m)13 for provisions applicable to newly constructed buildings, and Section 150.2(b)(1)(F)(ii)(a) for alterations.*

602.0 Material.

602.1 General. Materials used for duct systems shall comply with Section 602.2 through Section 602.6 as applicable.

Exception: [OSHPD 1, 1R, 2, 3, 4 & 5] See Section 407.4.1.3.

[Not permitted for OSHPD 1, 1R, 2, 3, 4 & 5] 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.

602.2 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.

602.2.1 Electrical. Electrical wiring in plenums shall comply with the *California Electrical Code*. 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.

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),

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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 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.

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 be not less than the design operating pressure of the air distribution in which the duct is utilized.

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.

603.3.1 Earthquake Loads. Ducts located in structures that are installed in areas classified as seismic design category C, D, E, or F shall be in accordance with the *California Building Code* or *California Residential Code*.

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 the mastic 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. [Not permitted for OSHPD 1, 1R, 2, 3, 4 & 5] 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.

Exception: Residential occupancies.

603.4.1.1 Flexible Ducts. [OSHDP 1, 1R, 2, 3, 4 & 5] *In hospital building projects and all other health-care facilities, including clinics and correctional treatment centers, flexible ducts of not more than 10 feet (3048 mm) in length may be used to connect supply, return or exhaust-air terminal devices to rigid duct systems. Where constant volume, variable volume or mixing boxes are utilized, flexible duct of not more than 10 feet (3048 mm), may be used on the inlet side for alignment. An internal impervious liner shall be provided to isolate insulation material from conditioned air.*

603.4.2 Flexible Air Connectors. Flexible air connectors 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.

» **603.7 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 Flexible. 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 rectangular 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 supported 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 suspending 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 installation instructions.

» **603.8 Protection Against Flood Damage.** In flood hazard 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 elevation. Where the ducts are located below that elevation, the ducts shall be capable of resisting hydrostatic and hydrodynamic 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 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 1½ 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 reinforcements for air ducts and plenums listed and labeled to UL 181, shall be in accordance with the manufacturer's installation instructions. Closure systems for sealing 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 CLOSURE SYSTEM	MARKING
Rigid Metallic or Rigid Fiberglass	UL 181A	Pressure Sensitive Tape	181A-P
Rigid Metallic or Rigid Fiberglass	UL 181A	Mastic Tape	181A-M
Rigid Metallic or Rigid Fiberglass	UL 181A	Heat Sensitive Tape	181A-H
Flexible Air Ducts	UL 181B	Pressure Sensitive Tape*	181B-FX*
Flexible Air Ducts	UL 181B	Mastic*	181B-M*

* Mechanical fasteners shall be used in conjunction with a listed pressure sensitive tape or mastic in accordance with UL 181. Nonmetallic mechanical fasteners shall be listed and labeled in accordance with UL 181B and labeled "181B-C."

» **603.9.2 Duct Leakage Tests.** [Not adopted by HCD] Ductwork shall be leak-tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual. 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

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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:

$$L_{max} = C_L P^{0.65} \quad (\text{Equation 603.9.2})$$

Where:

L_{max} = maximum permitted leakage, (ft³/min)/100 square feet [0.0001 (m³/s)/m²] duct surface area.

C_L = six, duct leakage class, (ft³/min)/100 square feet [0.0001 (m³/s)/m²] duct surface area at 1 inch water column (0.2 kPa).

P = 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).

603.9.2.1 Duct Leakage Tests for Buildings that Meet Air Distribution System Duct Leakage Sealing Criteria in Title 24, Part 6. *For duct leakage testing, see California Energy Code Sections 150.0(m)(11) for single family buildings, Section 160.3(b) for multifamily buildings, and Section 120.4(g) for nonresidential and Hotel Motel buildings.*

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}

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.

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 54:10.3.2.7]

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]

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 the air conditioner is installed within an enclosure, the installation shall comply with Section 604.4. [NFPA 54:10.2.5]

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 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}

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]

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]

» **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. [NFPA 54:10.3.7.4]

» **605.0 Insulation of Ducts.**

» **605.1 General.** Air ducts conveying air at temperatures exceeding 140°F (60°C) shall be insulated to maintain an insulation surface temperature of not more than 140°F (60°C). Insulation material on the exterior of ducts shall be legibly printed with the name of the manufacturer, the thermal resistance (R) value at installed thickness, flame-spread index, and smoke developed index of the composite material. Internal duct liners and insulation shall be installed in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. **[OSHPD 1, 1R, 2, 3, 4 & 5]** Cold air ducts shall be insulated wherever necessary or to prevent condensation.

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.

605.2 [OSHPD 1, 1R, 2, 3 (Surgical Clinics), 4 & 5] Thermal acoustical lining materials shall not be installed within ducts, terminal boxes, sound traps, and other in-duct systems serving areas such as operating, cesarean 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 unless filters with 90 percent average efficiency based on ASHRAE Standard 52.2 or minimum efficiency rating value (MERV) of 14 are installed downstream of the duct lining.

605.3 [OSHPD 1, 1R, 2, 4 & 5] Thermal or acoustical lining materials shall not be installed within ducts which are downstream of the 99.97 percent high-efficiency particulate air (HEPA) filter or with minimum efficiency rating value (MERV) of 17 required in Section 408.2.1 for protective environment rooms.

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 California Building Code or California Residential 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 <<

DUCT SYSTEMS

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 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 to not 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.

606.8 *When the automatic activation of a smoke damper or a combination smoke-fire damper occurs, the HVAC system serving such dampers shall immediately shut down.*

Exceptions:

- (1) *HVAC systems that are part of an engineered smoke evacuation system.*
- (2) *Where the automatic activation causes all the smoke dampers and combination smoke-fire dampers to close in the enclosed space having a common atmosphere where openings are required to be protected.*
- (3) *Where analysis demonstrates shutoff would create a greater hazard.*

The HVAC system shall not be restarted again until all the dampers are reset and fully opened.

» **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 *California Building Code*, shall not have ventilating ceilings.

607.1.1 [OSHPD 1, 1R, 2, 3, 4 & 5] *Ventilating ceilings are not permitted in health 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, *shall be labeled by an approved agency, approved and listed by California State Fire Marshal*, 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, *and installed in accordance with NFPA 72 and the California Building and Fire Codes*.

Exceptions:

- (1) Where the space supplied by the air-moving equipment is served by a total coverage smoke-detection system in accordance with the *California 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.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 7 – COMBUSTION AIR

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X		X	X	X			X	X	X	X	X	X	X	X		X						
Adopt Entire Chapter as amended (amended sections listed below)																							
Adopt only those sections that are listed below																							
Chapter/Section																							

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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 of 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)]

[Equation 701.4.2(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)]

[Equation 701.4.2(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_{other} = All appliances other than fan-assisted input (Btu/h)
- I_{fan} = Fan-assisted appliance input (Btu/h)
- 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 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 701.4.2(1) and Section 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-

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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]

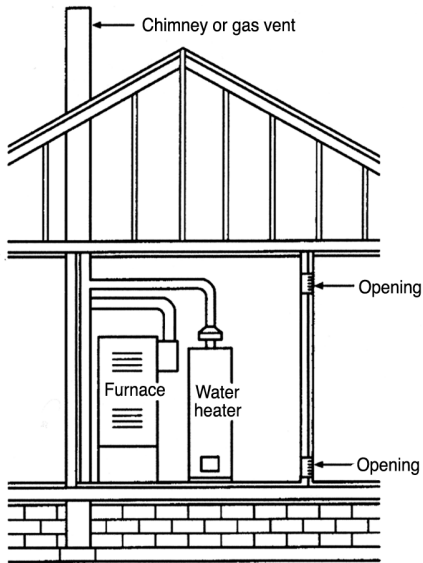


FIGURE 701.5
ALL COMBUSTION AIR FROM ADJACENT INDOOR SPACES
THROUGH INDOOR COMBUSTION AIR OPENINGS
 [NFPA 54: FIGURE A.9.3.2.3(1)]

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. [See 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)

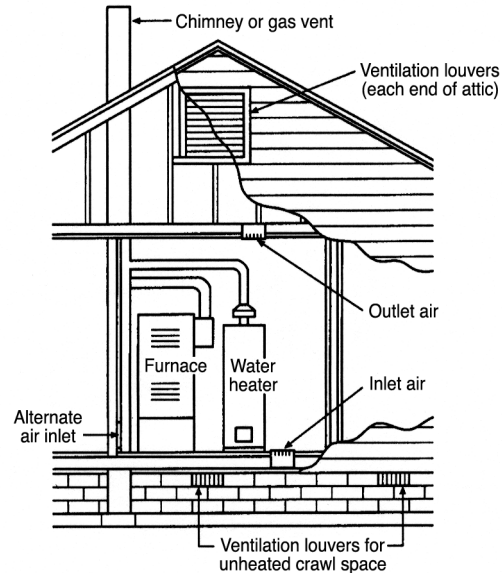


FIGURE 701.6.1(1)
ALL COMBUSTION AIR FROM OUTDOORS – INLET
AIR FROM VENTILATED CRAWL SPACE AND OUTLET AIR TO
VENTILATED ATTIC
 [NFPA 54: FIGURE A.9.3.3.1(a)]

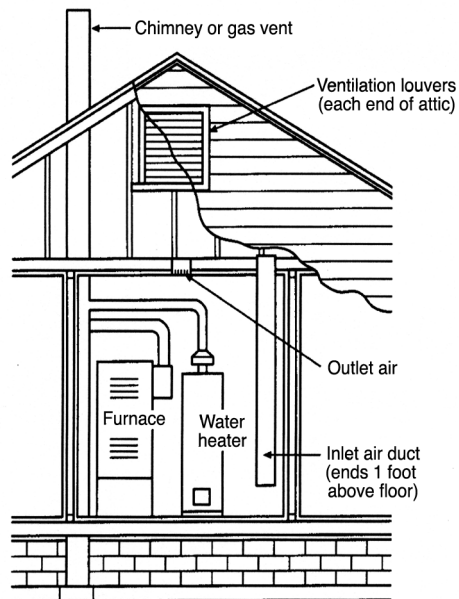


FIGURE 701.6.1(2)
ALL COMBUSTION AIR FROM OUTDOORS
THROUGH VENTILATED ATTIC
 [NFPA 54: FIGURE A.9.3.3.1(b)]

701.7.1 Indoor Openings. Where used, openings connecting the interior spaces shall comply with Section 701.5. [NFPA 54:9.3.4(1)]

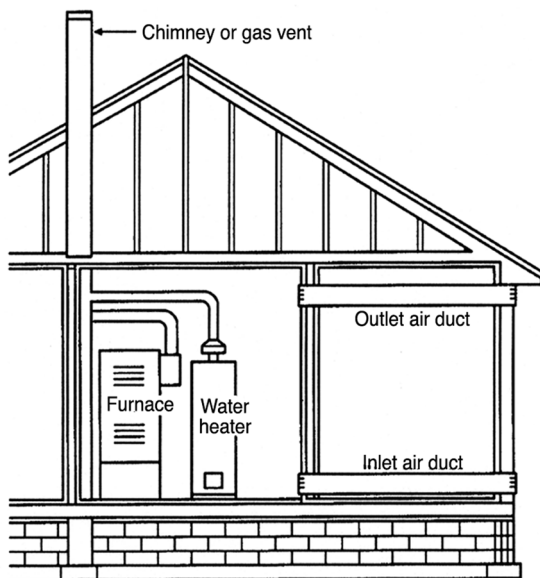


FIGURE 701.6.1(3)
ALL COMBUSTION AIR FROM OUTDOORS
THROUGH HORIZONTAL DUCTS
[NFPA 54: FIGURE A.9.3.3.1(2)]

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. [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]

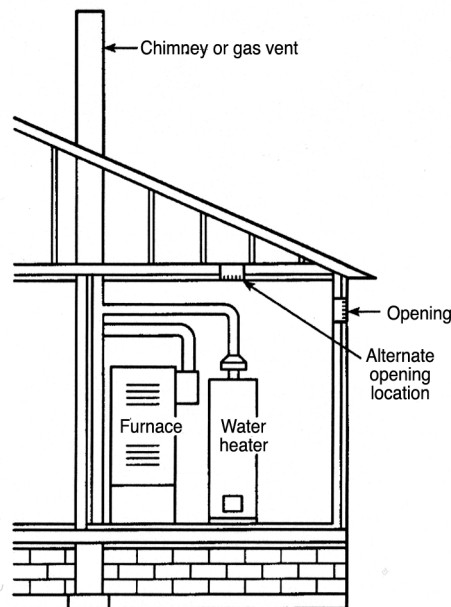


FIGURE 701.6.2
ALL COMBUSTION AIR FROM OUTDOORS THROUGH
SINGLE COMBUSTION AIR OPENING
[NFPA 54: FIGURE A.9.3.3.2]

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

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prevent the main burner from igniting should the louver fail to open during burner startup and to shut down the main burner if the louvers close 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]

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]

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 8 – CHIMNEYS AND VENTS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X		X	X	X			X	X	X	X	X	X	X	X								
Adopt Entire Chapter as amended (amended sections listed below)																							
Adopt only those sections that are listed below																							
Chapter/Section																							

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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 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 802.8.2. [NFPA 54:12.3.5]

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 802.15.1. [NFPA 54:12.4.2]

CHIMNEYS AND VENTS

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 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.

**TABLE 802.4
TYPE OF VENTING SYSTEM TO BE USED
[NFPA 54: TABLE 12.5.1]**

APPLIANCES	TYPE OF VENTING SYSTEM	LOCATION OF REQUIREMENTS
Listed Category I appliances Listed appliances equipped with draft hood Appliances listed for use with Type B gas vent	Type B gas vent	Section 802.6
	Chimney	Section 802.5
	Single-wall metal pipe	Section 802.7
	Listed chimney lining system for gas venting	Section 802.5.3
	Special gas vent listed for these appliances	Section 802.4.3
Listed vented wall furnaces	Type B-W gas vent	Section 802.6, Section 907.0
Category II, Category III, and Category IV appliances	As specified or furnished by manufacturers of listed appliances	Section 802.4.1, Section 802.4.3
Incinerators	In accordance with NFPA 82	
Appliances that can be converted to use of solid fuel	Chimney	Section 802.5
Unlisted combination gas- and oil-burning appliances		
Combination gas- and solid-fuel-burning appliances		
Appliances listed for use with chimneys only		
Unlisted appliances		
Listed combination gas- and oil-burning appliances	Type L vent	Section 802.6
	Chimney	Section 802.5
Decorative appliances in vented fireplace	Chimney	Section 911.2
Gas-fired toilets	Single-wall metal pipe	Section 802.7, Section 929.3
Direct vent appliances	—	Section 802.2.6
Appliances with integral vents	—	Section 802.2.7

- (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 a 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 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]

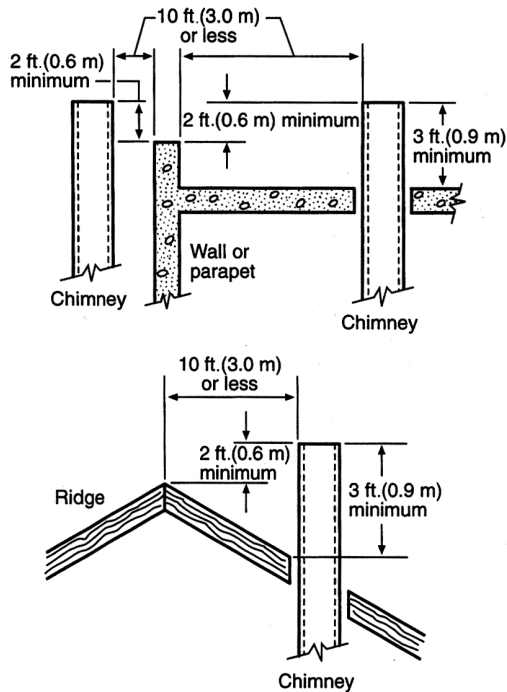
802.5.4.2 Chimney Height. A chimney shall extend at least 5 feet (1524 mm) above the highest connected appliance draft hood outlet or flue collar. [NFPA 54:12.6.2.3]

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]

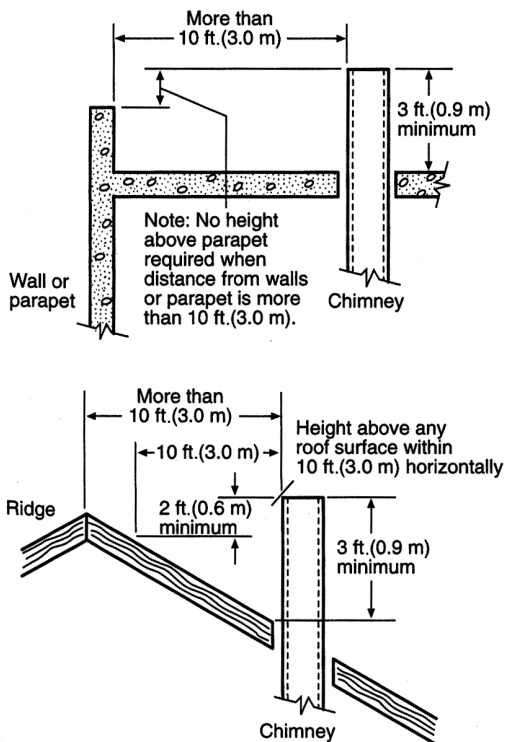
802.5.5 Size of Chimneys. The effective area of a chimney venting system serving listed appliances with draft hoods, Category I appliances, and other appliances listed for use with Type B vents shall be in accordance with one of the following methods:

- (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 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 a chimney venting system connected to two appliances with draft hoods, the effective area of

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(a) Termination 10 ft.(3.0 m) or Less from Ridge, Wall, or Parapet



(b) Termination More Than 10 ft.(3.0 m) from Ridge, Wall, or Parapet

FIGURE 802.5.4
TYPICAL TERMINATION LOCATIONS FOR
CHIMNEYS AND SINGLE-WALL METAL PIPES SERVING
RESIDENTIAL-TYPE AND LOW-HEAT APPLIANCE
[NFPA 54: FIGURE A.12.6.2.1]

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 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]

802.5.8.2 Gas and Solid Fuel-Burning Appliances. 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 sustained 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 Appliances. A single chimney flue serving a listed combination 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 chimneys 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 manufacturer'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 remaining 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 appliance.

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 installation 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 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]

CHIMNEYS AND VENTS

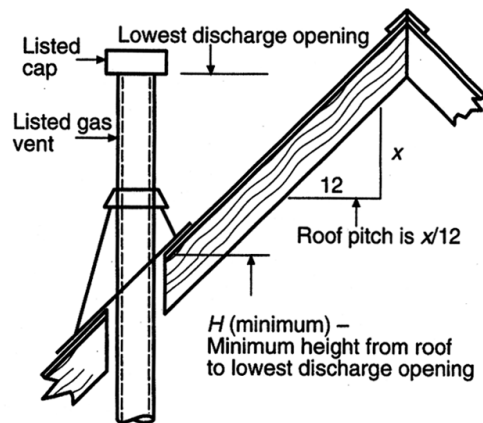


FIGURE 802.6.1
TERMINATION LOCATIONS FOR
GAS VENTS WITH LISTED CAPS 12 INCHES OR LESS IN
SIZE NOT LESS THAN 8 FEET FROM A VERTICAL WALL
[NFPA 54: FIGURE 12.7.3]

TABLE 802.6.1
ROOF PITCH HEIGHT
[NFPA 54: TABLE 12.7.3]

ROOF SLOPE	H (minimum) (feet)
Flat to $\frac{1}{12}$	1.0
Over $\frac{1}{12}$ to $\frac{7}{12}$	1.25
Over $\frac{7}{12}$ to $\frac{8}{12}$	1.5
Over $\frac{8}{12}$ to $\frac{9}{12}$	2.0
Over $\frac{9}{12}$ to $\frac{10}{12}$	2.5
Over $\frac{10}{12}$ to $\frac{11}{12}$	3.25
Over $\frac{11}{12}$ to $\frac{12}{12}$	4.0
Over $\frac{12}{12}$ to $\frac{14}{12}$	5.0
Over $\frac{14}{12}$ to $\frac{16}{12}$	6.0
Over $\frac{16}{12}$ to $\frac{18}{12}$	7.0
Over $\frac{18}{12}$ to $\frac{20}{12}$	7.5
Over $\frac{20}{12}$ to $\frac{21}{12}$	8.0

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

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802.6.1.1 Insulation Shield. Where a vent passes through an insulated assembly, an approved metal shield 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.

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. [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. A common vent shall be permitted in multistory installations to vent Category I appliances located on more than one floor level, provided the venting system is 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]

802.6.3.1 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)

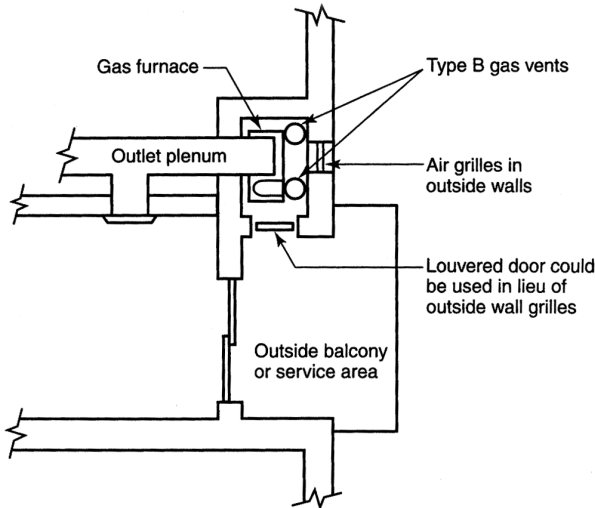


FIGURE 802.6.3.1
PLAN VIEW OF PRACTICAL SEPARATION METHOD
FOR MULTISTORY GAS VENTING
[NFPA 54: FIGURE A.12.7.5.2]

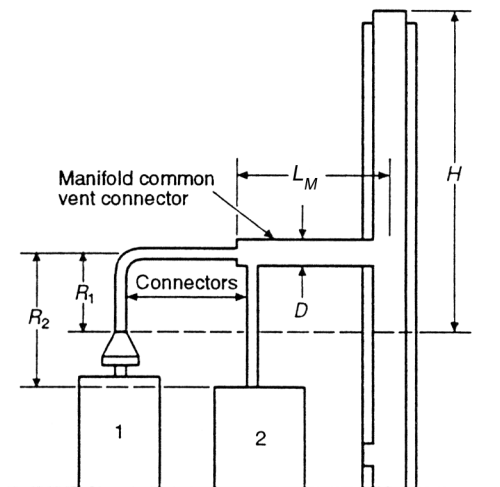


FIGURE 802.6.3.2
USE OF MANIFOLDED COMMON VENT CONNECTOR
[NFPA 54: FIGURE F.1(k)]

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 ceiling at a point where the vent connector enters the gas vent. The label shall read: "This gas vent is for appliances that burn gas. Do not connect to solid or liquid fuel-burning appliances or incinerators." The Authority Having Jurisdiction shall determine whether its area constitutes 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, noncombustible, 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

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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 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]

802.7.3.5 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. [NFPA 54:12.8.4.5]

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]

**TABLE 802.7.3.3
CLEARANCE FOR CONNECTORS*
[NFPA 54: TABLE 12.8.4.4]**

MINIMUM DISTANCE FROM COMBUSTIBLE MATERIAL (inches)				
APPLIANCE	LISTED TYPE B GAS VENT MATERIAL	LISTED TYPE L VENT MATERIAL	SINGLE-WALL METAL PIPE	FACTORY-BUILT CHIMNEY SECTIONS
Listed appliance with draft hoods and appliance listed for use with Type B gas vents	As listed	As listed	6	As listed
Residential boilers and furnaces with listed gas conversion burner and with draft hood	6	6	9	As listed
Residential appliances listed for use with Type L vents	Not permitted	As listed	9	As listed
Listed gas-fired toilets	Not permitted	As listed	As listed	As listed
Unlisted residential appliances with draft hood	Not permitted	6	9	As listed
Residential and low-heat appliance other than those above	Not permitted	9	18	As listed
Medium-heat appliance	Not permitted	Not permitted	36	As listed

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.

802.7.5 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]

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]

**TABLE 802.8.2
THROUGH-THE-WALL DIRECT VENT TERMINATION
CLEARANCES
[NFPA 54: TABLE 12.9.3]**

DIRECT VENT APPLIANCE INPUT RATING	THROUGH THE WALL VENT TERMINAL CLEARANCE FROM ANY AIR OPENING INTO A BUILDING (inches)
10 000 Btu/h and less	6
Greater than 10 000 Btu/h and not exceeding 50 000 Btu/h	9
Greater than 50 000 Btu/h and not exceeding 150 000 Btu/h	12
> 150 000 Btu/h	In accordance with the appliance manufacturer's instructions and in no case less than the clearances specified in Section 802.8.1.

For SI Units: 1 inch = 25.4 mm, 1000 British thermal units per hour = 0.293 kW

802.8.3 Category I through Category IV and Non-categorized Appliances. Through-the-wall vents for Category II and Category IV appliances and noncatego-

rized 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]

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. Where local experience indicates that condensation 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. [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 54:12.11.2.1]

802.10.1.1 Unconditioned Area. 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, 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 other than an attic or a crawl space hav-

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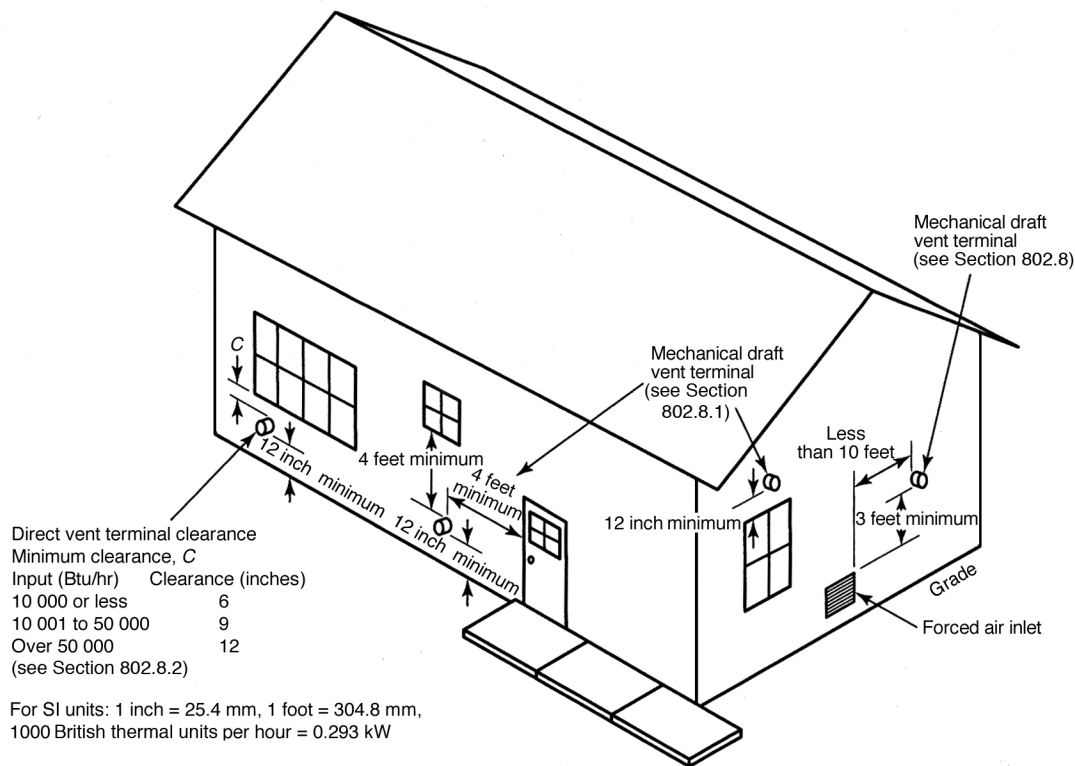


FIGURE 802.8
EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT VENT VENTING SYSTEMS
[NFPA 54: FIGURE A.12.9]

ing 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 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.
 - (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]

TABLE 802.10.1.3
MINIMUM THICKNESS FOR GALVANIZED STEEL VENT CONNECTORS FOR LOW-HEAT APPLIANCES
[NFPA 54: TABLE 12.11.2.4]

DIAMETER OF CONNECTOR (inches)	MINIMUM THICKNESS (inches)
Less than 6	0.019
6 to less than 10	0.023
10 to 12 inclusive	0.029
14 to 16 inclusive	0.034
Over 16	0.056

For SI units: 1 inch = 25.4 mm, 1 square inch = 0.000645 m²

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 chimney sections, if employed, shall be joined together in accordance with the chimney manufacturer's instructions. [NFPA 54:12.11.2.5]

TABLE 802.10.1.4
MINIMUM THICKNESS FOR STEEL VENT CONNECTORS
FOR MEDIUM-HEAT APPLIANCES
[NFPA 54: TABLE 12.11.2.5]

VENT CONNECTOR SIZE		
DIAMETER (inches)	AREA (square inches)	MINIMUM THICKNESS (inches)
Up to 14	Up to 154	0.053
Over 14 to 16	154 to 201	0.067
Over 16 to 18	201 to 254	0.093
Over 18	Larger than 254	0.123

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, 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 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]

802.10.2.4 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]

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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) Sheet metal screws.
- (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 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 54:12.11.7]

802.10.7 Length of Vent Connector. The length of vent connectors shall comply with Section 802.10.7.1 or Section 802.10.7.2.

802.10.7.1 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 54:12.11.8.1]

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 54:12.11.8.2]

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 54:12.11.9]

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. 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 54:12.11.10]

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]

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 54:12.11.12]

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.

Exception: 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.

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 54:12.11.13.2]

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 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]

802.12.2 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 shall not be classified as manually operated dampers. [NFPA 54:12.14]

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]

802.15 Automatically Operated Vent Dampers. An automatically operated vent damper shall be of a listed type. [NFPA 54:12.15]

802.15.1 Listing. Automatically operated vent dampers for oil-fired appliances shall comply with UL 17. The automatic damper control shall comply with UL 378.

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 or in accordance with the following:

- (1) The maximum capacity of the vent system shall be determined using the "NAT Max" column.
- (2) The minimum capacity shall be determined as though the appliance were a fan-assisted appliance, using the "FAN Min" column to determine the minimum capacity of the vent system. Where the corresponding "FAN Min" is "NA," the vent configuration shall not be permitted and an alternative venting configuration shall be utilized. [NFPA 54:13.1.1]

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 (305mm) 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 ($0.90 \times$ 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]

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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. 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 ($0.80 \times$ 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 7 x 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 unventilated 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 appliance 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. 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 vent heights lower than 6 feet (1829 mm) and higher than shown in Table 803.1.2(1) through Table 803.2(9), engineering methods shall be used to calculate vent capacities. [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). 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 (*LM*) 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
[NFPA 54: TABLE 13.2.2]

CONNECTOR DIAMETER (inches)	MAXIMUM CONNECTOR HORIZONTAL LENGTH (feet)
3	4½
4	6
5	7½
6	9
7	10½
8	12
9	13½
10	15
12	18
14	21
16	24
18	27
20	30
22	33
24	36

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

803.2.4 Vent Offsets. Where the common vertical 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

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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, the maximum vent connector capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than 45 degrees up to and including 90 degrees, 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 Connector Rise. The 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]

803.2.12 Vent Height. For multiple appliances all located on one 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 Installations. For multistory installations, 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]

803.2.14 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 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 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. For appliances with more than one input rate, the minimum vent connector capacity (FAN Min) determined from the tables shall be less than the lowest appliance input rating, and the maximum vent connector capacity (FAN Max or NAT Max) 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 con-

sidered 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.
- (3) 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).
- (4) 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).
- (5) 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 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]

803.2.26 Engineering Methods. 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]

803.2.27 Height Entries. Where the actual height of a vent falls between entries in the height column of the applicable table in Table 803.2(1) through Table 803.2(9), 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 54:13.2.30]

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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: $^{\circ}\text{C} = (^{\circ}\text{F} - 32) / 1.8$

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]

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TABLE 803.1.2(1)
TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(a)]*

		NUMBER OF APPLIANCES:									SINGLE					
		APPLIANCE TYPE:									CATEGORY I					
		APPLIANCE VENT CONNECTION:									CONNECTED DIRECTLY TO VENT					
		VENT DIAMETER – D (inch)														
		3		4			5			6			7			
APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR																
HEIGHT H (feet)	LATERAL L (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	0	0	78	46	0	152	86	0	251	141	0	375	205	0	524	285
	2	13	51	36	18	97	67	27	157	105	32	232	157	44	321	217
	4	21	49	34	30	94	64	39	153	103	50	227	153	66	316	211
	6	25	46	32	36	91	61	47	149	100	59	223	149	78	310	205
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	583	320
	2	12	57	40	16	109	75	25	178	120	28	263	180	42	365	247
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	356	237
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	347	227
10	0	0	88	53	0	175	100	0	295	166	0	447	255	0	631	345
	2	12	61	42	17	118	81	23	194	129	26	289	195	40	402	273
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	392	263
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	376	245
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	716	390
	2	11	69	48	15	136	93	20	226	150	22	339	225	38	475	316
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	463	300
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	445	288
	15	35	53	37	48	112	76	61	195	128	76	301	198	98	429	275
20	0	0	97	61	0	202	119	0	349	202	0	540	307	0	776	430
	2	10	75	51	14	149	100	18	250	166	20	377	249	33	531	346
	5	21	71	48	29	143	96	38	242	160	47	367	241	62	519	337
	10	28	64	44	38	133	89	50	229	150	62	351	228	81	499	321
	15	34	58	40	46	124	84	59	217	142	73	337	217	94	481	308
	20	48	52	35	55	116	78	69	206	134	84	322	206	107	464	295
30	0	0	100	64	0	213	128	0	374	220	0	587	336	0	853	475
	2	9	81	56	13	166	112	14	283	185	18	432	280	27	613	394
	5	21	77	54	28	160	108	36	275	176	45	421	273	58	600	385
	10	27	70	50	37	150	102	48	262	171	59	405	261	77	580	371
	15	33	64	NA	44	141	96	57	249	163	70	389	249	90	560	357
	20	56	58	NA	53	132	90	66	237	154	80	374	237	102	542	343
	30	NA	NA	NA	73	113	NA	88	214	NA	104	346	219	131	507	321
50	0	0	101	67	0	216	134	0	397	232	0	633	363	0	932	518
	2	8	86	61	11	183	122	14	320	206	15	497	314	22	715	445
	5	20	82	NA	27	177	119	35	312	200	43	487	308	55	702	438
	10	26	76	NA	35	168	114	45	299	190	56	471	298	73	681	426
	15	59	70	NA	42	158	NA	54	287	180	66	455	288	85	662	413
	20	NA	NA	NA	50	149	NA	63	275	169	76	440	278	97	642	401
	30	NA	NA	NA	69	131	NA	84	250	NA	99	410	259	123	605	376
100	0	NA	NA	NA	0	218	NA	0	407	NA	0	665	400	0	997	560
	2	NA	NA	NA	10	194	NA	12	354	NA	13	566	375	18	831	510
	5	NA	NA	NA	26	189	NA	33	347	NA	40	557	369	52	820	504
	10	NA	NA	NA	33	182	NA	43	335	NA	53	542	361	68	801	493
	15	NA	NA	NA	40	174	NA	50	321	NA	62	528	353	80	782	482
	20	NA	NA	NA	47	166	NA	59	311	NA	71	513	344	90	763	471
	30	NA	NA	NA	NA	NA	NA	78	290	NA	92	483	NA	115	726	449
	50	NA	NA	NA	NA	NA	NA	NA	NA	NA	147	428	NA	180	651	405

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.

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TABLE 803.1.2(1)
TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(a)] (continued)

					NUMBER OF APPLIANCES:						SINGLE					
					APPLIANCE TYPE:						CATEGORY I					
					APPLIANCE VENT CONNECTION:						CONNECTED DIRECTLY TO VENT					
		VENT DIAMETER – D (inch)														
		8			9			10			12			14		
		APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR														
HEIGHT H (feet)	LATERAL L (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	0	0	698	370	0	897	470	0	1121	570	0	1645	850	0	2267	1170
	2	53	425	285	63	543	370	75	675	455	103	982	650	138	1346	890
	4	79	419	279	93	536	362	110	668	445	147	975	640	191	1338	880
	6	93	413	273	110	530	354	128	661	435	171	967	630	219	1330	870
8	0	0	780	415	0	1006	537	0	1261	660	0	1858	970	0	2571	1320
	2	50	483	322	60	619	418	71	770	515	98	1124	745	130	1543	1020
	5	83	473	313	99	607	407	115	758	503	154	1110	733	199	1528	1010
	8	99	463	303	117	596	396	137	746	490	180	1097	720	231	1514	1000
10	0	0	847	450	0	1096	585	0	1377	720	0	2036	1060	0	2825	1450
	2	48	533	355	57	684	457	68	852	560	93	1244	850	124	1713	1130
	5	81	522	346	95	671	446	112	839	547	149	1229	829	192	1696	1105
	10	104	504	330	122	651	427	142	817	525	187	1204	795	238	1669	1080
15	0	0	970	525	0	1263	682	0	1596	840	0	2380	1240	0	3323	1720
	2	45	633	414	53	815	544	63	1019	675	86	1495	985	114	2062	1350
	5	76	620	403	90	800	529	105	1003	660	140	1476	967	182	2041	1327
	10	99	600	386	116	777	507	135	977	635	177	1446	936	227	2009	1289
	15	115	580	373	134	755	491	155	953	610	202	1418	905	257	1976	1250
20	0	0	1057	575	0	1384	752	0	1756	930	0	2637	1350	0	3701	1900
	2	41	711	470	50	917	612	59	1150	755	81	1694	1100	107	2343	1520
	5	73	697	460	86	902	599	101	1133	738	135	1674	1079	174	2320	1498
	10	95	675	443	112	877	576	130	1105	710	172	1641	1045	220	2282	1460
	15	111	654	427	129	853	557	150	1078	688	195	1609	1018	248	2245	1425
	20	125	634	410	145	830	537	167	1052	665	217	1578	990	273	2210	1390
30	0	0	1173	650	0	1548	855	0	1977	1060	0	3004	1550	0	4252	2170
	2	33	826	535	42	1072	700	54	1351	865	74	2004	1310	98	2786	1800
	5	69	811	524	82	1055	688	96	1332	851	127	1981	1289	164	2759	1775
	10	91	788	507	107	1028	668	125	1301	829	164	1944	1254	209	2716	1733
	15	105	765	490	124	1002	648	143	1272	807	187	1908	1220	237	2674	1692
	20	119	743	473	139	977	628	160	1243	784	207	1873	1185	260	2633	1650
	30	149	702	444	171	929	594	195	1189	745	246	1807	1130	305	2555	1585
50	0	0	1297	708	0	1730	952	0	2231	1195	0	3441	1825	0	4934	2550
	2	26	975	615	33	1276	813	41	1620	1010	66	2431	1513	86	3409	2125
	5	65	960	605	77	1259	798	90	1600	996	118	2406	1495	151	3380	2102
	10	86	935	589	101	1230	773	118	1567	972	154	2366	1466	196	3332	2064
	15	100	911	572	117	1203	747	136	1536	948	177	2327	1437	222	3285	2026
	20	113	888	556	131	1176	722	151	1505	924	195	2288	1408	244	3239	1987
	30	141	844	522	161	1125	670	183	1446	876	232	2214	1349	287	3150	1910
100	0	0	1411	770	0	1908	1040	0	2491	1310	0	3925	2050	0	5729	2950
	2	21	1155	700	25	1536	935	30	1975	1170	44	3027	1820	72	4313	2550
	5	60	1141	692	71	1519	926	82	1955	1159	107	3002	1803	136	4282	2531
	10	80	1118	679	94	1492	910	108	1923	1142	142	2961	1775	180	4231	2500
	15	93	1095	666	109	1465	895	126	1892	1124	163	2920	1747	206	4182	2469
	20	105	1073	653	122	1438	880	141	1861	1107	181	2880	1719	226	4133	2438
	30	131	1029	627	149	1387	849	170	1802	1071	215	2803	1663	265	4037	2375
	50	197	944	575	217	1288	787	241	1688	1000	292	2657	1550	350	3856	2250

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 803.1.2(1)
TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(a)] (continued)

		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																
HEIGHT H (feet)	LATERAL L (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	0	0	2983	1530	0	3802	1960	0	4721	2430	0	5737	2950	0	6853	3520
	2	178	1769	1170	225	2250	1480	296	2782	1850	360	3377	2220	426	4030	2670
	4	242	1761	1160	300	2242	1475	390	2774	1835	469	3370	2215	555	4023	2660
	6	276	1753	1150	341	2235	1470	437	2767	1820	523	3363	2210	618	4017	2650
8	0	0	3399	1740	0	4333	2220	0	5387	2750	0	6555	3360	0	7838	4010
	2	168	2030	1340	212	2584	1700	278	3196	2110	336	3882	2560	401	4634	3050
	5	251	2013	1330	311	2563	1685	398	3180	2090	476	3863	2545	562	4612	3040
	8	289	2000	1320	354	2552	1670	450	3163	2070	537	3850	2530	630	4602	3030
10	0	0	3742	1925	0	4782	2450	0	5955	3050	0	7254	3710	0	8682	4450
	2	161	2256	1480	202	2868	1890	264	3556	2340	319	4322	2840	378	5153	3390
	5	243	2238	1461	300	2849	1871	382	3536	2318	458	4301	2818	540	5132	3371
	10	298	2209	1430	364	2818	1840	459	3504	2280	546	4268	2780	641	5099	3340
15	0	0	4423	2270	0	5678	2900	0	7099	3620	0	8665	4410	0	10 393	5300
	2	147	2719	1770	186	3467	2260	239	4304	2800	290	5232	3410	346	6251	4080
	5	229	2696	1748	283	3442	2235	355	4278	2777	426	5204	3385	501	6222	4057
	10	283	2659	1712	346	3402	2193	432	4234	2739	510	5159	3343	599	6175	4019
	15	318	2623	1675	385	3363	2150	479	4192	2700	564	5115	3300	665	6129	3980
20	0	0	4948	2520	0	6376	3250	0	7988	4060	0	9785	4980	0	11 753	6000
	2	139	3097	2000	175	3955	2570	220	4916	3200	269	5983	3910	321	7154	4700
	5	219	3071	1978	270	3926	2544	337	4885	3174	403	5950	3880	475	7119	4662
	10	273	3029	1940	334	3880	2500	413	4835	3130	489	5896	3830	573	7063	4600
	15	306	2988	1910	372	3835	2465	459	4786	3090	541	5844	3795	631	7007	4575
	20	335	2948	1880	404	3791	2430	495	4737	3050	585	5792	3760	689	6953	4550
30	0	0	5725	2920	0	7420	3770	0	9341	4750	0	11 483	5850	0	13 848	7060
	2	127	3696	2380	159	4734	3050	199	5900	3810	241	7194	4650	285	8617	5600
	5	206	3666	2350	252	4701	3020	312	5863	3783	373	7155	4622	439	8574	5552
	10	259	3617	2300	316	4647	2970	386	5803	3739	456	7090	4574	535	8505	5471
	15	292	3570	2250	354	4594	2920	431	5744	3695	507	7026	4527	590	8437	5391
	20	319	3523	2200	384	4542	2870	467	5686	3650	548	6964	4480	639	8370	5310
	30	369	3433	2130	440	4442	2785	540	5574	3565	635	6842	4375	739	8239	5225
50	0	0	6711	3440	0	8774	4460	0	11 129	5635	0	13 767	6940	0	16 694	8430
	2	113	4554	2840	141	5864	3670	171	7339	4630	209	8980	5695	251	10 788	6860
	5	191	4520	2813	234	5826	3639	283	7295	4597	336	8933	5654	394	10 737	6818
	10	243	4464	2767	295	5763	3585	355	7224	4542	419	8855	5585	491	10 652	6749
	15	274	4409	2721	330	5701	3534	396	7155	4511	465	8779	5546	542	10 570	6710
	20	300	4356	2675	361	5641	3481	433	7086	4479	506	8704	5506	586	10 488	6670
	30	347	4253	2631	412	5523	3431	494	6953	4421	577	8557	5444	672	10 328	6603
100	0	0	7914	4050	0	10 485	5300	0	13 454	6700	0	16 817	8600	0	20 578	10 300
	2	95	5834	3500	120	7591	4600	138	9577	5800	169	11 803	7200	204	14 264	8800
	5	172	5797	3475	208	7548	4566	245	9528	5769	293	11 748	7162	341	14 204	8756
	10	223	5737	3434	268	7478	4509	318	9447	5717	374	11 658	7100	436	14 105	8683
	15	252	5678	3392	304	7409	4451	358	9367	5665	418	11 569	7037	487	14 007	8610
	20	277	5619	3351	330	7341	4394	387	9289	5613	452	11 482	6975	523	13 910	8537
	30	319	5505	3267	378	7209	4279	446	9136	5509	514	11 310	6850	592	13 720	8391
	50	415	5289	3100	486	6956	4050	572	8841	5300	659	10 979	6600	752	13 354	8100

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 803.1.2(2)
TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(b)]*

					NUMBER OF APPLIANCES:						SINGLE						
					APPLIANCE TYPE:						CATEGORY I						
					APPLIANCE VENT CONNECTION:						SINGLE-WALL METAL CONNECTOR						
		VENT DIAMETER – D (inch)															
		3			4			5			6			7			
		APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR															
HEIGHT H (feet)	LATERAL L (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	
6	0	38	77	45	59	151	85	85	249	140	126	373	204	165	522	284	
	2	39	51	36	60	96	66	85	156	104	123	231	156	159	320	213	
	4	NA	NA	33	74	92	63	102	152	102	146	225	152	187	313	208	
	6	NA	NA	31	83	89	60	114	147	99	163	220	148	207	307	203	
8	0	37	83	50	58	164	93	83	273	154	123	412	234	161	580	319	
	2	39	56	39	59	108	75	83	176	119	121	261	179	155	363	246	
	5	NA	NA	37	77	102	69	107	168	114	151	252	171	193	352	235	
	8	NA	NA	33	90	95	64	122	161	107	175	243	163	223	342	225	
10	0	37	87	53	57	174	99	82	293	165	120	444	254	158	628	344	
	2	39	61	41	59	117	80	82	193	128	119	287	194	153	400	272	
	5	52	56	39	76	111	76	105	185	122	148	277	186	190	388	261	
	10	NA	NA	34	97	100	68	132	171	112	188	261	171	237	369	241	
15	0	36	93	57	56	190	111	80	325	186	116	499	283	153	713	388	
	2	38	69	47	57	136	93	80	225	149	115	337	224	148	473	314	
	5	51	63	44	75	128	86	102	216	140	144	326	217	182	459	298	
	10	NA	NA	39	95	116	79	128	201	131	182	308	203	228	438	284	
	15	NA	NA	NA	NA	NA	72	158	186	124	220	290	192	272	418	269	
20	0	35	96	60	54	200	118	78	346	201	114	537	306	149	772	428	
	2	37	74	50	56	148	99	78	248	165	113	375	248	144	528	344	
	5	50	68	47	73	140	94	100	239	158	141	363	239	178	514	334	
	10	NA	NA	41	93	129	86	125	223	146	177	344	224	222	491	316	
	15	NA	NA	NA	NA	NA	80	155	208	136	216	325	210	264	469	301	
	20	NA	NA	NA	NA	NA	NA	186	192	126	254	306	196	309	448	285	
30	0	34	99	63	53	211	127	76	372	219	110	584	334	144	849	472	
	2	37	80	56	55	164	111	76	281	183	109	429	279	139	610	392	
	5	49	74	52	72	157	106	98	271	173	136	417	271	171	595	382	
	10	NA	NA	NA	91	144	98	122	255	168	171	397	257	213	570	367	
	15	NA	NA	NA	115	131	NA	151	239	157	208	377	242	255	547	349	
	20	NA	NA	NA	NA	NA	NA	181	223	NA	246	357	228	298	524	333	
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	389	477	305	
50	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	
	10	NA	NA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	
	15	NA	NA	NA	112	148	NA	145	275	174	199	441	280	244	646	405	
	20	NA	NA	NA	NA	NA	NA	176	257	NA	236	420	267	285	622	389	
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	315	376	NA	373	573	NA	
100	0	NA	NA	NA	49	214	NA	69	403	NA	100	659	395	131	991	555	
	2	NA	NA	NA	51	192	NA	70	351	NA	98	563	373	125	828	508	
	5	NA	NA	NA	67	186	NA	90	342	NA	125	551	366	156	813	501	
	10	NA	NA	NA	85	175	NA	113	324	NA	153	532	354	191	789	486	
	15	NA	NA	NA	132	162	NA	138	310	NA	188	511	343	230	764	473	
	20	NA	NA	NA	NA	NA	NA	168	295	NA	224	487	NA	270	739	458	
	30	NA	NA	NA	NA	NA	NA	231	264	NA	301	448	NA	355	685	NA	
	50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	540	584	NA	

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 803.1.2(2)
TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(b)] (continued)*

				NUMBER OF APPLIANCES:				SINGLE					
				APPLIANCE TYPE:				CATEGORY I					
				APPLIANCE VENT CONNECTION:				SINGLE-WALL METAL CONNECTOR					
				VENT DIAMETER – D (inch)									
				8		9		10		12			
APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR													
HEIGHT H (feet)	LATERAL L (feet)	FAN		NAT Max	FAN		NAT Max	FAN		NAT Max	FAN		NAT Max
		Min	Max		Min	Max		Min	Max		Min	Max	
6	0	211	695	369	267	894	469	371	1118	569	537	1639	849
	2	201	423	284	251	541	368	347	673	453	498	979	648
	4	237	416	277	295	533	360	409	664	443	584	971	638
	6	263	409	271	327	526	352	449	656	433	638	962	627
8	0	206	777	414	258	1002	536	360	1257	658	521	1852	967
	2	197	482	321	246	617	417	339	768	513	486	1120	743
	5	245	470	311	305	604	404	418	754	500	598	1104	730
	8	280	458	300	344	591	392	470	740	486	665	1089	715
10	0	202	844	449	253	1093	584	351	1373	718	507	2031	1057
	2	193	531	354	242	681	456	332	849	559	475	1242	848
	5	241	518	344	299	667	443	409	834	544	584	1224	825
	10	296	497	325	363	643	423	492	808	520	688	1194	788
15	0	195	966	523	244	1259	681	336	1591	838	488	2374	1237
	2	187	631	413	232	812	543	319	1015	673	457	1491	983
	5	231	616	400	287	795	526	392	997	657	562	1469	963
	10	284	592	381	349	768	501	470	966	628	664	1433	928
	15	334	568	367	404	742	484	540	937	601	750	1399	894
20	0	190	1053	573	238	1379	750	326	1751	927	473	2631	1346
	2	182	708	468	227	914	611	309	1146	754	443	1689	1098
	5	224	692	457	279	896	596	381	1126	734	547	1665	1074
	10	277	666	437	339	866	570	457	1092	702	646	1626	1037
	15	325	640	419	393	838	549	526	1060	677	730	1587	1005
	20	374	616	400	448	810	526	592	1028	651	808	1550	973
30	0	184	1168	647	229	1542	852	312	1971	1056	454	2996	1545
	2	175	823	533	219	1069	698	296	1346	863	424	1999	1308
	5	215	806	521	269	1049	684	366	1324	846	524	1971	1283
	10	265	777	501	327	1017	662	440	1287	821	620	1927	1243
	15	312	750	481	379	985	638	507	1251	794	702	1884	1205
	20	360	723	461	433	955	615	570	1216	768	780	1841	1166
	30	461	670	426	541	895	574	704	1147	720	937	1759	1101
50	0	176	1292	704	220	1724	948	295	2223	1189	428	3432	1818
	2	168	971	613	209	1273	811	280	1615	1007	401	2426	1509
	5	204	953	602	257	1252	795	347	1591	991	496	2396	1490
	10	253	923	583	313	1217	765	418	1551	963	589	2347	1455
	15	299	894	562	363	1183	736	481	1512	934	668	2299	1421
	20	345	866	543	415	1150	708	544	1473	906	741	2251	1387
	30	442	809	502	521	1086	649	674	1399	848	892	2159	1318
100	0	166	1404	765	207	1900	1033	273	2479	1300	395	3912	2042
	2	158	1152	698	196	1532	933	259	1970	1168	371	3021	1817
	5	194	1134	688	240	1511	921	322	1945	1153	460	2990	1796
	10	238	1104	672	293	1477	902	389	1905	1133	547	2938	1763
	15	281	1075	656	342	1443	884	447	1865	1110	618	2888	1730
	20	325	1046	639	391	1410	864	507	1825	1087	690	2838	1696
	30	418	988	NA	491	1343	824	631	1747	1041	834	2739	1627
	50	617	866	NA	711	1205	NA	895	1591	NA	1138	2547	1489

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 803.1.2(3)
MASONRY CHIMNEY [NFPA 54: TABLE 13.1(c)]*

					NUMBER OF APPLIANCES:						SINGLE					
					APPLIANCE TYPE:						CATEGORY I					
					APPLIANCE VENT CONNECTION:						TYPE B DOUBLE-WALL CONNECTOR					
		TYPE B DOUBLE-WALL CONNECTOR DIAMETER – D (inch) TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM														
		3			4			5			6			7		
		APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR														
HEIGHT H (feet)	LATERAL L (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	2	NA	NA	28	NA	NA	52	NA	NA	86	NA	NA	130	NA	NA	180
	5	NA	NA	25	NA	NA	49	NA	NA	82	NA	NA	117	NA	NA	165
8	2	NA	NA	29	NA	NA	55	NA	NA	93	NA	NA	145	NA	NA	198
	5	NA	NA	26	NA	NA	52	NA	NA	88	NA	NA	134	NA	NA	183
	8	NA	NA	24	NA	NA	48	NA	NA	83	NA	NA	127	NA	NA	175
10	2	NA	NA	31	NA	NA	61	NA	NA	103	NA	NA	162	NA	NA	221
	5	NA	NA	28	NA	NA	57	NA	NA	96	NA	NA	148	NA	NA	204
	10	NA	NA	25	NA	NA	50	NA	NA	87	NA	NA	139	NA	NA	191
15	2	NA	NA	35	NA	NA	67	NA	NA	114	NA	NA	179	53	475	250
	5	NA	NA	35	NA	NA	62	NA	NA	107	NA	NA	164	NA	NA	231
	10	NA	NA	28	NA	NA	55	NA	NA	97	NA	NA	153	NA	NA	216
	15	NA	NA	NA	NA	NA	48	NA	NA	89	NA	NA	141	NA	NA	201
20	2	NA	NA	38	NA	NA	74	NA	NA	124	NA	NA	201	51	522	274
	5	NA	NA	36	NA	NA	68	NA	NA	116	NA	NA	184	80	503	254
	10	NA	NA	NA	NA	NA	60	NA	NA	107	NA	NA	172	NA	NA	237
	15	NA	NA	NA	NA	NA	NA	NA	NA	97	NA	NA	159	NA	NA	220
	20	NA	NA	NA	NA	NA	NA	NA	NA	83	NA	NA	148	NA	NA	206
30	2	NA	NA	41	NA	NA	82	NA	NA	137	NA	NA	216	47	581	303
	5	NA	NA	NA	NA	NA	76	NA	NA	128	NA	NA	198	75	561	281
	10	NA	NA	NA	NA	NA	67	NA	NA	115	NA	NA	184	NA	NA	263
	15	NA	NA	NA	NA	NA	NA	NA	NA	107	NA	NA	171	NA	NA	243
	20	NA	NA	NA	NA	NA	NA	NA	NA	91	NA	NA	159	NA	NA	227
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	188
50	2	NA	NA	NA	NA	NA	92	NA	NA	161	NA	NA	251	NA	NA	351
	5	NA	NA	NA	NA	NA	NA	NA	NA	151	NA	NA	230	NA	NA	323
	10	NA	NA	NA	NA	NA	NA	NA	NA	138	NA	NA	215	NA	NA	304
	15	NA	NA	NA	NA	NA	NA	NA	NA	127	NA	NA	199	NA	NA	282
	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	185	NA	NA	264
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
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.														

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 803.1.2(3)
MASONRY CHIMNEY [NFPA 54: TABLE 13.1(c)] (continued)*

				NUMBER OF APPLIANCES:				SINGLE					
				APPLIANCE TYPE:				CATEGORY I					
				APPLIANCE VENT CONNECTION:				TYPE B DOUBLE-WALL CONNECTOR					
				TYPE B DOUBLE-WALL CONNECTOR DIAMETER – <i>D</i> (inch) TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM									
				8		9		10		12			
APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR													
HEIGHT <i>H</i> (feet)	LATERAL <i>L</i> (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	2	NA	NA	247	NA	NA	320	NA	NA	401	NA	NA	581
	5	NA	NA	231	NA	NA	298	NA	NA	376	NA	NA	561
8	2	NA	NA	266	84	590	350	100	728	446	139	1024	651
	5	NA	NA	247	NA	NA	328	149	711	423	201	1007	640
	8	NA	NA	239	NA	NA	318	173	695	410	231	990	623
10	2	68	519	298	82	655	388	98	810	491	136	1144	724
	5	NA	NA	277	124	638	365	146	791	466	196	1124	712
	10	NA	NA	263	155	610	347	182	762	444	240	1093	668
15	2	64	613	336	77	779	441	92	968	562	127	1376	841
	5	99	594	313	118	759	416	139	946	533	186	1352	828
	10	126	565	296	148	727	394	173	912	567	229	1315	777
	15	NA	NA	281	171	698	375	198	880	485	259	1280	742
20	2	61	678	375	73	867	491	87	1083	627	121	1548	953
	5	95	658	350	113	845	463	133	1059	597	179	1523	933
	10	122	627	332	143	811	440	167	1022	566	221	1482	879
	15	NA	NA	314	165	780	418	191	987	541	251	1443	840
	20	NA	NA	296	186	750	397	214	955	513	277	1406	807
30	2	57	762	421	68	985	558	81	1240	717	111	1793	1112
	5	90	741	393	106	962	526	125	1216	683	169	1766	1094
	10	115	709	373	135	927	500	158	1176	648	210	1721	1025
	15	NA	NA	353	156	893	476	181	1139	621	239	1679	981
	20	NA	NA	332	176	860	450	203	1103	592	264	1638	940
	30	NA	NA	288	NA	NA	416	249	1035	555	318	1560	877
50	2	51	840	477	61	1106	633	72	1413	812	99	2080	1243
	5	83	819	445	98	1083	596	116	1387	774	155	2052	1225
	10	NA	NA	424	126	1047	567	147	1347	733	195	2006	1147
	15	NA	NA	400	146	1010	539	170	1307	702	222	1961	1099
	20	NA	NA	376	165	977	511	190	1269	669	246	1916	1050
	30	NA	NA	327	NA	NA	468	233	1196	623	295	1832	984
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.

CHIMNEYS AND VENTS

TABLE 803.1.2(4)
MASONRY CHIMNEY [NFPA 54: TABLE 13.1(d)]*

		NUMBER OF APPLIANCES: SINGLE									CATEGORY I					
		APPLIANCE TYPE: CATEGORY I									SINGLE-WALL METAL CONNECTOR					
		APPLIANCE VENT CONNECTION: SINGLE-WALL METAL CONNECTOR									SINGLE-WALL METAL CONNECTOR DIAMETER – <i>D</i> (inch) TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM					
		3			4			5			6			7		
APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR																
HEIGHT <i>H</i> (feet)	LATERAL <i>L</i> (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	2	NA	NA	28	NA	NA	52	NA	NA	86	NA	NA	130	NA	NA	180
	5	NA	NA	25	NA	NA	48	NA	NA	81	NA	NA	116	NA	NA	164
8	2	NA	NA	29	NA	NA	55	NA	NA	93	NA	NA	145	NA	NA	197
	5	NA	NA	26	NA	NA	51	NA	NA	87	NA	NA	133	NA	NA	182
	8	NA	NA	23	NA	NA	47	NA	NA	82	NA	NA	126	NA	NA	174
10	2	NA	NA	31	NA	NA	61	NA	NA	102	NA	NA	161	NA	NA	220
	5	NA	NA	28	NA	NA	56	NA	NA	95	NA	NA	147	NA	NA	203
	10	NA	NA	24	NA	NA	49	NA	NA	86	NA	NA	137	NA	NA	189
15	2	NA	NA	35	NA	NA	67	NA	NA	113	NA	NA	178	166	473	249
	5	NA	NA	32	NA	NA	61	NA	NA	106	NA	NA	163	NA	NA	230
	10	NA	NA	27	NA	NA	54	NA	NA	96	NA	NA	151	NA	NA	214
	15	NA	NA	NA	NA	NA	46	NA	NA	87	NA	NA	138	NA	NA	198
20	2	NA	NA	38	NA	NA	73	NA	NA	123	NA	NA	200	163	520	273
	5	NA	NA	35	NA	NA	67	NA	NA	115	NA	NA	183	NA	NA	252
	10	NA	NA	NA	NA	NA	59	NA	NA	105	NA	NA	170	NA	NA	235
	15	NA	NA	NA	NA	NA	NA	NA	NA	95	NA	NA	156	NA	NA	217
	20	NA	NA	NA	NA	NA	NA	NA	NA	80	NA	NA	144	NA	NA	202
30	2	NA	NA	41	NA	NA	81	NA	NA	136	NA	NA	215	158	578	302
	5	NA	NA	NA	NA	NA	75	NA	NA	127	NA	NA	196	NA	NA	279
	10	NA	NA	NA	NA	NA	66	NA	NA	113	NA	NA	182	NA	NA	260
	15	NA	NA	NA	NA	NA	NA	NA	NA	105	NA	NA	168	NA	NA	240
	20	NA	NA	NA	NA	NA	NA	NA	NA	88	NA	NA	155	NA	NA	223
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	182
50	2	NA	NA	NA	NA	NA	91	NA	NA	160	NA	NA	250	NA	NA	350
	5	NA	NA	NA	NA	NA	NA	NA	NA	149	NA	NA	228	NA	NA	321
	10	NA	NA	NA	NA	NA	NA	NA	NA	136	NA	NA	212	NA	NA	301
	15	NA	NA	NA	NA	NA	NA	NA	NA	124	NA	NA	195	NA	NA	278
	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	180	NA	NA	258
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
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.														

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 803.1.2(4)
MASONRY CHIMNEY [NFPA 54: TABLE 13.1(d)] (continued)*

				NUMBER OF APPLIANCES:				SINGLE					
				APPLIANCE TYPE:				CATEGORY I					
				APPLIANCE VENT CONNECTION:				SINGLE-WALL METAL CONNECTOR					
		SINGLE-WALL METAL CONNECTOR DIAMETER – D (inch) TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM											
		8			9			10			12		
		APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR											
HEIGHT H (feet)	LATERAL L (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	2	NA	NA	247	NA	NA	319	NA	NA	400	NA	NA	580
	5	NA	NA	230	NA	NA	297	NA	NA	375	NA	NA	560
8	2	NA	NA	265	NA	NA	349	382	725	445	549	1021	650
	5	NA	NA	246	NA	NA	327	NA	NA	422	673	1003	638
	8	NA	NA	237	NA	NA	317	NA	NA	408	747	985	621
10	2	216	518	297	271	654	387	373	808	490	536	1142	722
	5	NA	NA	276	334	635	364	459	789	465	657	1121	710
	10	NA	NA	261	NA	NA	345	547	758	441	771	1088	665
15	2	211	611	335	264	776	440	362	965	560	520	1373	840
	5	261	591	312	325	755	414	444	942	531	637	1348	825
	10	NA	NA	294	392	722	392	531	907	504	749	1309	774
	15	NA	NA	278	452	692	372	606	873	481	841	1272	738
20	2	206	675	374	258	864	490	252	1079	625	508	1544	950
	5	255	655	348	317	842	461	433	1055	594	623	1518	930
	10	312	622	330	382	806	437	517	1016	562	733	1475	875
	15	NA	NA	311	442	773	414	591	979	539	823	1434	835
	20	NA	NA	292	NA	NA	392	663	944	510	911	1394	800
30	2	200	759	420	249	982	556	340	1237	715	489	1789	1110
	5	245	737	391	306	958	524	417	1210	680	600	1760	1090
	10	300	703	370	370	920	496	500	1168	644	708	1713	1020
	15	NA	NA	349	428	884	471	572	1128	615	798	1668	975
	20	NA	NA	327	NA	NA	445	643	1089	585	883	1624	932
	30	NA	NA	281	NA	NA	408	NA	NA	544	1055	1539	865
50	2	191	837	475	238	1103	631	323	1408	810	463	2076	1240
	5	NA	NA	442	293	1078	593	398	1381	770	571	2044	1220
	10	NA	NA	420	355	1038	562	447	1337	728	674	1994	1140
	15	NA	NA	395	NA	NA	533	546	1294	695	761	1945	1090
	20	NA	NA	370	NA	NA	504	616	1251	660	844	1898	1040
	30	NA	NA	318	NA	NA	458	NA	NA	610	1009	1805	970
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.

CHIMNEYS AND VENTS

TABLE 803.1.2(5)

SINGLE-WALL METAL PIPE OR TYPE B ASBESTOS-CEMENT VENT [NFPA 54: TABLE 13.1(e)]*

		NUMBER OF APPLIANCES: SINGLE							
		APPLIANCE TYPE: DRAFT HOOD-EQUIPPED							
		APPLIANCE VENT CONNECTION: CONNECTED DIRECTLY TO PIPE OR VENT							
		DIAMETER – D (inch)							
		TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM							
		3	4	5	6	7	8	10	12
HEIGHT H (feet)	LATERAL L (feet)	APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR							
		MAXIMUM APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR							
6	0	39	70	116	170	232	312	500	750
	2	31	55	94	141	194	260	415	620
	5	28	51	88	128	177	242	390	600
8	0	42	76	126	185	252	340	542	815
	2	32	61	102	154	210	284	451	680
	5	29	56	95	141	194	264	430	648
	10	24	49	86	131	180	250	406	625
10	0	45	84	138	202	279	372	606	912
	2	35	67	111	168	233	311	505	760
	5	32	61	104	153	215	289	480	724
	10	27	54	94	143	200	274	455	700
	15	NA	46	84	130	186	258	432	666
15	0	49	91	151	223	312	420	684	1040
	2	39	72	122	186	260	350	570	865
	5	35	67	110	170	240	325	540	825
	10	30	58	103	158	223	308	514	795
	15	NA	50	93	144	207	291	488	760
	20	NA	NA	82	132	195	273	466	726
20	0	53	101	163	252	342	470	770	1190
	2	42	80	136	210	286	392	641	990
	5	38	74	123	192	264	364	610	945
	10	32	65	115	178	246	345	571	910
	15	NA	55	104	163	228	326	550	870
	20	NA	NA	91	149	214	306	525	832
30	0	56	108	183	276	384	529	878	1370
	2	44	84	148	230	320	441	730	1140
	5	NA	78	137	210	296	410	694	1080
	10	NA	68	125	196	274	388	656	1050
	15	NA	NA	113	177	258	366	625	1000
	20	NA	NA	99	163	240	344	596	960
	30	NA	NA	NA	NA	192	295	540	890
50	0	NA	120	210	310	443	590	980	1550
	2	NA	95	171	260	370	492	820	1290
	5	NA	NA	159	234	342	474	780	1230
	10	NA	NA	146	221	318	456	730	1190
	15	NA	NA	NA	200	292	407	705	1130
	20	NA	NA	NA	185	276	384	670	1080
	30	NA	NA	NA	NA	222	330	605	1010

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}

			NUMBER OF APPLIANCES:				SINGLE	
			APPLIANCE TYPE:				NAT	
			APPLIANCE VENT CONNECTION:				TYPE B DOUBLE-WALL CONNECTOR	
MINIMUM ALLOWABLE INPUT RATING OF SPACE-HEATING APPLIANCE IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
6 8 10 15 20 30 50	Local 99% winter design temperature: 37°F or greater							
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	NA	0	0	0	0	0	0	0
	NA	NA	123	190	249	184	0	0
	NA	NA	NA	NA	NA	393	334	0
50	NA	NA	NA	NA	NA	NA	NA	579
6 8 10 15 20 30 50	Local 99% winter design temperature: 27°F to 36°F							
	0	0	68	116	156	180	212	266
	0	0	82	127	167	187	214	263
	0	51	97	141	183	201	225	265
	NA	NA	NA	NA	233	253	274	305
	NA	NA	NA	NA	NA	307	330	362
	NA	NA	NA	NA	NA	419	445	485
50	NA	NA	NA	NA	NA	NA	763	
6 8 10 15 20 30 50	Local 99% winter design temperature: 17°F to 26°F							
	NA	NA	NA	NA	NA	215	259	349
	NA	NA	NA	NA	197	226	264	352
	NA	NA	NA	NA	214	245	278	358
	NA	NA	NA	NA	NA	296	331	398
	NA	NA	NA	NA	NA	352	387	457
	NA	NA	NA	NA	NA	NA	507	581
50	NA	NA	NA	NA	NA	NA	NA	
6 8 10 15 20 30 50	Local 99% winter design temperature: 5°F to 16°F							
	NA	NA	NA	NA	NA	NA	NA	416
	NA	NA	NA	NA	NA	NA	312	423
	NA	NA	NA	NA	NA	289	331	430
	NA	NA	NA	NA	NA	NA	393	485
	NA	NA	NA	NA	NA	NA	450	547
	NA	NA	NA	NA	NA	NA	NA	682
50	NA	NA	NA	NA	NA	NA	972	
6 8 10 15 20 30 50	Local 99% winter design temperature: -10°F to 4°F							
	NA	NA	NA	NA	NA	NA	NA	484
	NA	NA	NA	NA	NA	NA	NA	494
	NA	NA	NA	NA	NA	NA	NA	513
	NA	NA	NA	NA	NA	NA	NA	586
	NA	NA	NA	NA	NA	NA	NA	650
	NA	NA	NA	NA	NA	NA	NA	805
50	NA	NA	NA	NA	NA	NA	1003	
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.

CHIMNEYS AND VENTS

TABLE 803.2(1)

TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)]*

				NUMBER OF APPLIANCES:							TWO OR MORE					
				APPLIANCE TYPE:							CATEGORY I					
				APPLIANCE VENT CONNECTION:							TYPE B DOUBLE-WALL CONNECTOR					
		VENT CONNECTOR CAPACITY														
		TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER – D (inch)														
		3		4		5		6		7						
APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR																
VENT HEIGHT H (feet)	CONNECTOR RISE R (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	22	37	26	35	66	46	46	106	72	58	164	104	77	225	142
	2	23	41	31	37	75	55	48	121	86	60	183	124	79	253	168
	3	24	44	35	38	81	62	49	132	96	62	199	139	82	275	189
8	1	22	40	27	35	72	48	49	114	76	64	176	109	84	243	148
	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
10	1	22	43	28	34	78	50	49	123	78	65	189	113	89	257	154
	2	23	47	33	36	86	59	51	136	93	67	206	134	91	282	182
	3	24	50	37	37	92	67	52	146	104	69	220	150	94	303	205
15	1	21	50	30	33	89	53	47	142	83	64	220	120	88	298	163
	2	22	53	35	35	96	63	49	153	99	66	235	142	91	320	193
	3	24	55	40	36	102	71	51	163	111	68	248	160	93	339	218
20	1	21	54	31	33	99	56	46	157	87	62	246	125	86	334	171
	2	22	57	37	34	105	66	48	167	104	64	259	149	89	354	202
	3	23	60	42	35	110	74	50	176	116	66	271	168	91	371	228
30	1	20	62	33	31	113	59	45	181	93	60	288	134	83	391	182
	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	43	32	137	76	45	223	119	59	358	172	81	490	234
	3	22	75	48	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	44	30	161	79	42	267	123	55	447	178	75	619	242
	3	20	84	50	31	163	89	44	272	138	57	452	200	78	627	272

	COMMON VENT CAPACITY											
	TYPE B DOUBLE-WALL COMMON VENT DIAMETER – D (inch)											
	4			5			6			7		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR											
VENT HEIGHT H (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	92	81	65	140	116	103	204	161	147	309	248	200
8	101	90	73	155	129	114	224	178	163	339	275	223
10	110	97	79	169	141	124	243	194	178	367	299	242
15	125	112	91	195	164	144	283	228	206	427	352	280
20	136	123	102	215	183	160	314	255	229	475	394	310
30	152	138	118	244	210	185	361	297	266	547	459	360
50	167	153	134	279	244	214	421	353	310	641	547	423
100	175	163	NA	311	277	NA	489	421	NA	751	658	479

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(1)
TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)] (continued)

		NUMBER OF APPLIANCES:				TWO OR MORE				
		APPLIANCE TYPE:				CATEGORY I				
		APPLIANCE VENT CONNECTION:				TYPE B DOUBLE-WALL CONNECTOR				
		VENT CONNECTOR CAPACITY								
		TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER – <i>D</i> (inch)								
		8			9			10		
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	CONNECTOR RISE <i>R</i> (feet)	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	92	296	185	109	376	237	128	466	289
	2	95	333	220	112	424	282	131	526	345
	3	97	363	248	114	463	317	134	575	386
8	1	100	320	194	118	408	248	138	507	303
	2	103	356	230	121	454	294	141	564	358
	3	105	384	258	123	492	330	143	612	402
10	1	106	341	200	125	436	257	146	542	314
	2	109	374	238	128	479	305	149	596	372
	3	111	402	268	131	515	342	152	642	417
15	1	110	389	214	134	493	273	162	609	333
	2	112	419	253	137	532	323	165	658	394
	3	115	445	286	140	565	365	167	700	444
20	1	107	436	224	131	552	285	158	681	347
	2	110	463	265	134	587	339	161	725	414
	3	113	486	300	137	618	383	164	764	466
30	1	103	512	238	125	649	305	151	802	372
	2	105	535	282	129	679	360	155	840	439
	3	108	555	317	132	706	405	158	874	494
50	1	97	627	257	120	797	330	144	984	403
	2	100	645	306	123	820	392	148	1014	478
	3	103	661	343	126	842	441	151	1043	538
100	1	91	810	266	112	1038	341	135	1285	417
	2	94	822	316	115	1054	405	139	1306	494
	3	97	834	355	118	1069	455	142	1327	555

	COMMON VENT CAPACITY								
	TYPE B DOUBLE-WALL COMMON VENT DIAMETER – <i>D</i> (inch)								
	8			9			10		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	404	314	260	547	434	335	672	520	410
8	444	348	290	602	480	378	740	577	465
10	477	377	315	649	522	405	800	627	495
15	556	444	365	753	612	465	924	733	565
20	621	499	405	842	688	523	1035	826	640
30	720	585	470	979	808	605	1209	975	740
50	854	706	550	1164	977	705	1451	1188	860
100	1025	873	625	1408	1215	800	1784	1502	975

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)*

				NUMBER OF APPLIANCES:				TWO OR MORE					
				APPLIANCE TYPE:				CATEGORY I					
				APPLIANCE VENT CONNECTION:				TYPE B DOUBLE-WALL CONNECTOR					
				VENT CONNECTOR CAPACITY									
				TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER – D (inch)									
				12		14			16			18	
				APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR									
VENT HEIGHT H (feet)	CONNECTOR RISE R (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	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	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	888	263	2731	1346	336	3606	1760	414	4842	2220
	6	208	2035	1064	272	2811	1642	346	3714	2150	426	4968	2700

	COMMON VENT CAPACITY											
	TYPE B DOUBLE-WALL COMMON VENT DIAMETER – D (inch)											
	12			14			16			18		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR											
VENT HEIGHT H (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	900	696	588	1284	990	815	1735	1336	1065	2253	1732	1345
8	994	773	652	1423	1103	912	1927	1491	1190	2507	1936	1510
10	1076	841	712	1542	1200	995	2093	1625	1300	2727	2113	1645
15	1247	986	825	1794	1410	1158	2440	1910	1510	3184	2484	1910
20	1405	1116	916	2006	1588	1290	2722	2147	1690	3561	2798	2140
30	1658	1327	1025	2373	1892	1525	3220	2558	1990	4197	3326	2520
50	2024	1640	1280	2911	2347	1863	3964	3183	2430	5184	4149	3075
100	2569	2131	1670	3732	3076	2450	5125	4202	3200	6749	5509	4050

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(1)
TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)] (continued)*

				NUMBER OF APPLIANCES:		TWO OR MORE				
				APPLIANCE TYPE:		CATEGORY I				
				APPLIANCE VENT CONNECTION:		TYPE B DOUBLE-WALL CONNECTOR				
		VENT CONNECTOR CAPACITY								
		TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER – <i>D</i> (inch)								
		20		22		24				
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	CONNECTOR RISE <i>R</i> (feet)	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max
6	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	471	2737	1800	560	3319	2180	662	3957	2590
	6	478	3018	2180	568	3665	2640	669	4373	3130
10	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	486	2887	1890	581	3502	2280	686	4175	2710
	6	494	3169	2290	589	3849	2760	694	4593	3270
15	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	523	3197	2060	624	3881	2490	734	4631	2960
	6	533	3470	2510	634	4216	3030	743	5035	3600
20	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	554	3447	2180	661	4190	2630	772	5005	3130
	6	567	3708	2650	671	4511	3190	785	5392	3790
30	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	619	3840	2365	728	4861	2860	847	5606	3410
	6	632	4080	2875	741	4976	3480	860	5961	4150
50	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	580	4601	2633	709	5569	3185	851	6633	3790
	6	594	4808	3208	724	5826	3885	867	6943	4620
100	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	523	5982	2750	639	7254	3330	769	8650	3950
	6	539	6143	3350	654	7453	4070	786	8892	4810

	COMMON VENT CAPACITY								
	TYPE B DOUBLE-WALL COMMON VENT DIAMETER – D (inch)								
	20			22			24		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT H (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	2838	2180	1660	3488	2677	1970	4206	3226	2390
8	3162	2439	1860	3890	2998	2200	4695	3616	2680
10	3444	2665	2030	4241	3278	2400	5123	3957	2920
15	4026	3133	2360	4971	3862	2790	6016	4670	3400
20	4548	3552	2640	5573	4352	3120	6749	5261	3800
30	5303	4193	3110	6539	5157	3680	7940	6247	4480
50	6567	5240	3800	8116	6458	4500	9837	7813	5475
100	8597	6986	5000	10 681	8648	5920	13 004	10 499	7200

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(2)

TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(b)]*

					NUMBER OF APPLIANCES:						TWO OR MORE								
					APPLIANCE TYPE:						CATEGORY I								
					APPLIANCE VENT CONNECTION:						SINGLE-WALL METAL CONNECTOR								
					VENT CONNECTOR CAPACITY														
					SINGLE-WALL METAL VENT CONNECTOR DIAMETER – D (inch)														
					3			4			5			6			7		
					APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR														
VENT HEIGHT H (feet)	CONNECTOR RISE R (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT			
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max			
6	1	NA	NA	26	NA	NA	46	NA	NA	71	NA	NA	102	207	223	140			
	2	NA	NA	31	NA	NA	55	NA	NA	85	168	182	123	215	251	167			
	3	NA	NA	34	NA	NA	62	121	131	95	175	198	138	222	273	188			
8	1	NA	NA	27	NA	NA	48	NA	NA	75	NA	NA	106	226	240	145			
	2	NA	NA	32	NA	NA	57	125	126	89	184	193	127	234	266	173			
	3	NA	NA	35	NA	NA	64	130	138	100	191	208	144	241	287	197			
10	1	NA	NA	28	NA	NA	50	119	121	77	182	186	110	240	253	150			
	2	NA	NA	33	84	85	59	124	134	91	189	203	132	248	278	183			
	3	NA	NA	36	89	91	67	129	144	102	197	217	148	257	299	203			
15	1	NA	NA	29	79	87	52	116	138	81	177	214	116	238	291	158			
	2	NA	NA	34	83	94	62	121	150	97	185	230	138	246	314	189			
	3	NA	NA	39	87	100	70	127	160	109	193	243	157	255	333	215			
20	1	49	56	30	78	97	54	115	152	84	175	238	120	233	325	165			
	2	52	59	36	82	103	64	120	163	101	182	252	144	243	346	197			
	3	55	62	40	87	107	72	125	172	113	190	264	164	252	363	223			
30	1	47	60	31	77	110	57	112	175	89	169	278	129	226	380	175			
	2	51	62	37	81	115	67	117	185	106	177	290	152	236	397	208			
	3	54	64	42	85	119	76	122	193	120	185	300	172	244	412	235			
50	1	46	69	34	75	128	60	109	207	96	162	336	137	217	460	188			
	2	49	71	40	79	132	72	114	215	113	170	345	164	226	473	223			
	3	52	72	45	83	136	82	119	221	123	178	353	186	235	486	252			
100	1	45	79	34	71	150	61	104	249	98	153	424	140	205	585	192			
	2	48	80	41	75	153	73	110	255	115	160	428	167	212	593	228			
	3	51	81	46	79	157	85	114	260	129	168	433	190	222	603	256			

	COMMON VENT CAPACITY											
	TYPE B DOUBLE-WALL COMMON VENT DIAMETER – D (inch)											
	4			5			6			7		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR											
VENT HEIGHT H (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	NA	78	64	NA	113	99	200	158	144	304	244	196
8	NA	87	71	NA	126	111	218	173	159	331	269	218
10	NA	94	76	163	137	120	237	189	174	357	292	236
15	121	108	88	189	159	140	275	221	200	416	343	274
20	131	118	98	208	177	156	305	247	223	463	383	302
30	145	132	113	236	202	180	350	286	257	533	446	349
50	159	145	128	268	233	208	406	337	296	622	529	410
100	166	153	NA	297	263	NA	469	398	NA	726	633	464

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(2)
TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(b)] (continued)

		NUMBER OF APPLIANCES: TWO OR MORE								
		APPLIANCE TYPE: CATEGORY I								
		APPLIANCE VENT CONNECTION: SINGLE-WALL METAL CONNECTOR								
		VENT CONNECTOR CAPACITY								
		SINGLE-WALL METAL VENT CONNECTOR DIAMETER – <i>D</i> (inch)								
		8			9			10		
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	CONNECTOR RISE <i>R</i> (feet)	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	262	293	183	325	373	234	447	463	286
	2	271	331	219	334	422	281	458	524	344
	3	279	361	247	344	462	316	468	574	385
8	1	285	316	191	352	403	244	481	502	299
	2	293	353	228	360	450	292	492	560	355
	3	302	381	256	370	489	328	501	609	400
10	1	302	335	196	372	429	252	506	534	308
	2	311	369	235	381	473	302	517	589	368
	3	320	398	265	391	511	339	528	637	413
15	1	312	380	208	397	482	266	556	596	324
	2	321	411	248	407	522	317	568	646	387
	3	331	438	281	418	557	360	579	690	437
20	1	306	425	217	390	538	276	546	664	336
	2	317	453	259	400	574	331	558	709	403
	3	326	476	294	412	607	375	570	750	457
30	1	296	497	230	378	630	294	528	779	358
	2	307	521	274	389	662	349	541	819	425
	3	316	542	309	400	690	394	555	855	482
50	1	284	604	245	364	768	314	507	951	384
	2	294	623	293	376	793	375	520	983	458
	3	304	640	331	387	816	423	535	1013	518
100	1	269	774	249	345	993	321	476	1236	393
	2	279	788	299	358	1011	383	490	1259	469
	3	289	801	339	368	1027	431	506	1280	527

	COMMON VENT CAPACITY								
	TYPE B DOUBLE-WALL COMMON VENT DIAMETER – <i>D</i> (inch)								
	8			9			10		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	398	310	257	541	429	332	665	515	407
8	436	342	285	592	473	373	730	569	460
10	467	369	309	638	512	398	787	617	487
15	544	434	357	738	599	456	905	718	553
20	606	487	395	824	673	512	1013	808	626
30	703	570	459	958	790	593	1183	952	723
50	833	686	535	1139	954	689	1418	1157	838
100	999	846	606	1378	1185	780	1741	1459	948

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)]*

					NUMBER OF APPLIANCES:						TWO OR MORE					
					APPLIANCE TYPE:						CATEGORY I					
					APPLIANCE VENT CONNECTION:						TYPE B DOUBLE-WALL CONNECTOR					
		VENT CONNECTOR CAPACITY														
		TYPE B DOUBLE-WALL VENT CONNECTOR DIAMETER – D (inch)														
		3			4			5			6			7		
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR														
VENT HEIGHT H (feet)	CONNECTOR RISE R (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	24	33	21	39	62	40	52	106	67	65	194	101	87	274	141
	2	26	43	28	41	79	52	53	133	85	67	230	124	89	324	173
	3	27	49	34	42	92	61	55	155	97	69	262	143	91	369	203
8	1	24	39	22	39	72	41	55	117	69	71	213	105	94	304	148
	2	26	47	29	40	87	53	57	140	86	73	246	127	97	350	179
	3	27	52	34	42	97	62	59	159	98	75	269	145	99	383	206
10	1	24	42	22	38	80	42	55	130	71	74	232	108	101	324	153
	2	26	50	29	40	93	54	57	153	87	76	261	129	103	366	184
	3	27	55	35	41	105	63	58	170	100	78	284	148	106	397	209
15	1	24	48	23	38	93	44	54	154	74	72	277	114	100	384	164
	2	25	55	31	39	105	55	56	174	89	74	299	134	103	419	192
	3	26	59	35	41	115	64	57	189	102	76	319	153	105	448	215
20	1	24	52	24	37	102	46	53	172	77	71	313	119	98	437	173
	2	25	58	31	39	114	56	55	190	91	73	335	138	101	467	199
	3	26	63	35	40	123	65	57	204	104	75	353	157	104	493	222
30	1	24	54	25	37	111	48	52	192	82	69	357	127	96	504	187
	2	25	60	32	38	122	58	54	208	95	72	376	145	99	531	209
	3	26	64	36	40	131	66	56	221	107	74	392	163	101	554	233
50	1	23	51	25	36	116	51	51	209	89	67	405	143	92	582	213
	2	24	59	32	37	127	61	53	225	102	70	421	161	95	604	235
	3	26	64	36	39	135	69	55	237	115	72	435	180	98	624	260
100	1	23	46	24	35	108	50	49	208	92	65	428	155	88	640	237
	2	24	53	31	37	120	60	51	224	105	67	444	174	92	660	260
	3	25	59	35	38	130	68	53	237	118	69	458	193	94	679	285

	COMMON VENT CAPACITY														
	MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches)														
	12			19			28			38			50		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR														
VENT HEIGHT <i>H</i> (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	NA	74	25	NA	119	46	NA	178	71	NA	257	103	NA	351	143
8	NA	80	28	NA	130	53	NA	193	82	NA	279	119	NA	384	163
10	NA	84	31	NA	138	56	NA	207	90	NA	299	131	NA	409	177
15	NA	NA	36	NA	152	67	NA	233	106	NA	334	152	523	467	212
20	NA	NA	41	NA	NA	75	NA	250	122	NA	368	172	565	508	243
30	NA	NA	NA	NA	NA	NA	NA	270	137	NA	404	198	615	564	278
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	620	328
100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	348

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(3)
MASONRY CHIMNEY [NFPA 54: TABLE 13.2(c)] (continued)*

		NUMBER OF APPLIANCES: TWO OR MORE								
		APPLIANCE TYPE: CATEGORY I								
		APPLIANCE VENT CONNECTION: TYPE B DOUBLE-WALL CONNECTOR								
		VENT CONNECTOR CAPACITY								
		TYPE B DOUBLE-WALL VENT CONNECTOR DIAMETER – <i>D</i> (inch)								
		8			9			10		
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	CONNECTOR RISE <i>R</i> (feet)	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	104	370	201	124	479	253	145	599	319
	2	107	436	232	127	562	300	148	694	378
	3	109	491	270	129	633	349	151	795	439
8	1	113	414	210	134	539	267	156	682	335
	2	116	473	240	137	615	311	160	776	394
	3	119	517	276	139	672	358	163	848	452
10	1	120	444	216	142	582	277	165	739	348
	2	123	498	247	145	652	321	168	825	407
	3	126	540	281	147	705	366	171	893	463
15	1	125	511	229	153	658	297	184	824	375
	2	128	558	260	156	718	339	187	900	432
	3	131	597	292	159	760	382	190	960	486
20	1	123	584	239	150	752	312	180	943	397
	2	126	625	270	153	805	354	184	1011	452
	3	129	661	301	156	851	396	187	1067	505
30	1	119	680	255	145	883	337	175	1115	432
	2	122	715	287	149	928	378	179	1171	484
	3	125	746	317	152	968	418	182	1220	535
50	1	115	798	294	140	1049	392	168	1334	506
	2	118	827	326	143	1085	433	172	1379	558
	3	121	854	357	147	1118	474	176	1421	611
100	1	109	907	334	134	1222	454	161	1589	596
	2	113	933	368	138	1253	497	165	1626	651
	3	116	956	399	141	1282	540	169	1661	705

	COMMON VENT CAPACITY								
	MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches)								
	63			78			113		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	NA	458	188	NA	582	246	1041	853	NA
8	NA	501	218	724	636	278	1144	937	408
10	606	538	236	776	686	302	1226	1010	454
15	682	611	283	874	781	365	1374	1156	546
20	742	668	325	955	858	419	1513	1286	648
30	816	747	381	1062	969	496	1702	1473	749
50	879	831	461	1165	1089	606	1905	1692	922
100	NA	NA	499	NA	NA	669	2053	1921	1058

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)]*

					NUMBER OF APPLIANCES:						TWO OR MORE								
					APPLIANCE TYPE:						CATEGORY I								
					APPLIANCE VENT CONNECTION:						SINGLE-WALL METAL CONNECTOR								
					VENT CONNECTOR CAPACITY														
					SINGLE-WALL METAL VENT CONNECTOR DIAMETER – <i>D</i> (inch)														
					3			4			5			6			7		
					APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR														
VENT HEIGHT <i>H</i> (feet)	CONNECTOR RISE <i>R</i> (feet)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT			
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max			
6	1	NA	NA	21	NA	NA	39	NA	NA	66	179	191	100	231	271	140			
	2	NA	NA	28	NA	NA	52	NA	NA	84	186	227	123	239	321	172			
	3	NA	NA	34	NA	NA	61	134	153	97	193	258	142	247	365	202			
8	1	NA	NA	21	NA	NA	40	NA	NA	68	195	208	103	250	298	146			
	2	NA	NA	28	NA	NA	52	137	139	85	202	240	125	258	343	177			
	3	NA	NA	34	NA	NA	62	143	156	98	210	264	145	266	376	205			
10	1	NA	NA	22	NA	NA	41	130	151	70	202	225	106	267	316	151			
	2	NA	NA	29	NA	NA	53	136	150	86	210	255	128	276	358	181			
	3	NA	NA	34	97	102	62	143	166	99	217	277	147	284	389	207			
15	1	NA	NA	23	NA	NA	43	129	151	73	199	271	112	268	376	161			
	2	NA	NA	30	92	103	54	135	170	88	207	295	132	277	411	189			
	3	NA	NA	34	96	112	63	141	185	101	215	315	151	286	439	213			
20	1	NA	NA	23	87	99	45	128	167	76	197	303	117	265	425	169			
	2	NA	NA	30	91	111	55	134	185	90	205	325	136	274	455	195			
	3	NA	NA	35	96	119	64	140	199	103	213	343	154	282	481	219			
30	1	NA	NA	24	86	108	47	126	187	80	193	347	124	259	492	183			
	2	NA	NA	31	91	119	57	132	203	93	201	366	142	269	518	205			
	3	NA	NA	35	95	127	65	138	216	105	209	381	160	277	540	229			
50	1	NA	NA	24	85	113	50	124	204	87	188	392	139	252	567	208			
	2	NA	NA	31	89	123	60	130	218	100	196	408	158	262	588	230			
	3	NA	NA	35	94	131	68	136	231	112	205	422	176	271	607	255			
100	1	NA	NA	23	84	104	49	122	200	89	182	410	151	243	617	232			
	2	NA	NA	30	88	115	59	127	215	102	190	425	169	253	636	254			
	3	NA	NA	34	93	124	67	133	228	115	199	438	188	262	654	279			

	COMMON VENT CAPACITY														
	MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches)														
	12			19			28			38			50		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR														
VENT HEIGHT <i>H</i> (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	NA	NA	25	NA	118	45	NA	176	71	NA	255	102	NA	348	142
8	NA	NA	28	NA	128	52	NA	190	81	NA	276	118	NA	380	162
10	NA	NA	31	NA	136	56	NA	205	89	NA	295	129	NA	405	175
15	NA	NA	36	NA	NA	66	NA	230	105	NA	335	150	NA	400	210
20	NA	NA	NA	NA	NA	74	NA	247	120	NA	362	170	NA	503	240
30	NA	NA	NA	NA	NA	NA	NA	NA	135	NA	398	195	NA	558	275
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	612	325
100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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)*

		NUMBER OF APPLIANCES: TWO OR MORE								
		APPLIANCE TYPE: CATEGORY I								
		APPLIANCE VENT CONNECTION: SINGLE-WALL METAL CONNECTOR								
		VENT CONNECTOR CAPACITY								
		SINGLE-WALL METAL VENT CONNECTOR DIAMETER – <i>D</i> (inch)								
		8		9			10			
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	CONNECTOR RISE <i>R</i> (feet)	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	292	366	200	362	474	252	499	594	316
	2	301	432	231	373	557	299	509	696	376
	3	309	491	269	381	634	348	519	793	437
8	1	313	407	207	387	530	263	529	672	331
	2	323	465	238	397	607	309	540	766	391
	3	332	509	274	407	663	356	551	838	450
10	1	333	434	213	410	571	273	558	727	343
	2	343	489	244	420	640	317	569	813	403
	3	352	530	279	430	694	363	580	880	459
15	1	349	502	225	445	646	291	623	808	366
	2	359	548	256	456	706	334	634	884	424
	3	368	586	289	466	755	378	646	945	479
20	1	345	569	235	439	734	306	614	921	387
	2	355	610	266	450	787	348	627	986	443
	3	365	644	298	461	831	391	639	1042	496
30	1	338	665	250	430	864	330	600	1089	421
	2	348	699	282	442	908	372	613	1145	473
	3	358	729	312	452	946	412	626	1193	524
50	1	328	778	287	417	1022	383	582	1302	492
	2	339	806	320	429	1058	425	596	1346	545
	3	349	831	351	440	1090	466	610	1386	597
100	1	315	875	328	402	1181	444	560	1537	580
	2	326	899	361	415	1210	488	575	1570	634
	3	337	921	392	427	1238	529	589	1604	687

	COMMON VENT CAPACITY								
	MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches)								
	63			78			113		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	NA	455	187	NA	579	245	NA	846	NA
8	NA	497	217	NA	633	277	1136	928	405
10	NA	532	234	771	680	300	1216	1000	450
15	677	602	280	866	772	360	1359	1139	540
20	765	661	321	947	849	415	1495	1264	640
30	808	739	377	1052	957	490	1682	1447	740
50	NA	821	456	1152	1076	600	1879	1672	910
100	NA	NA	494	NA	NA	663	2006	1885	1046

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(5)

SINGLE-WALL METAL PIPE OR TYPE B ASBESTOS-CEMENT VENT [NFPA 54: TABLE 13.2(e)]*

		NUMBER OF APPLIANCES: TWO OR MORE					
		APPLIANCE TYPE: DRAFT HOOD-EQUIPMENT					
		APPLIANCE VENT CONNECTION: DIRECT TO PIPE OR VENT					
		VENT CONNECTOR CAPACITY					
		VENT CONNECTOR DIAMETER – D (inch)					
TOTAL VENT HEIGHT H (feet)	CONNECTOR RISE R (feet)	3	4	5	6	7	8
MAXIMUM APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR							
6-8	1	21	40	68	102	146	205
	2	28	53	86	124	178	235
	3	34	61	98	147	204	275
15	1	23	44	77	117	179	240
	2	30	56	92	134	194	265
	3	35	64	102	155	216	298
30 and up	1	25	49	84	129	190	270
	2	31	58	97	145	211	295
	3	36	68	107	164	232	321

COMMON VENT CAPACITY							
COMMON VENT DIAMETER – D (inch)							
TOTAL VENT HEIGHT H (feet)	4	5	6	7	8	10	12
COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR							
6	48	78	111	155	205	320	NA
8	55	89	128	175	234	365	505
10	59	95	136	190	250	395	560
15	71	115	168	228	305	480	690
20	80	129	186	260	340	550	790
30	NA	147	215	300	400	650	940
50	NA	NA	NA	360	490	810	1190

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)]*

				NUMBER OF APPLIANCES:		TWO OR MORE		
				APPLIANCE TYPE:		NAT + NAT		
				APPLIANCE VENT CONNECTION:		TYPE B DOUBLE-WALL CONNECTOR		
COMBINED APPLIANCE MAXIMUM INPUT RATING IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
6	25	46	71	103	143	188	246	NA
8	28	53	82	119	163	218	278	408
10	31	56	90	131	177	236	302	454
15	NA	67	106	152	212	283	365	546
20	NA	NA	NA	NA	NA	325	419	648
30	NA	NA	NA	NA	NA	NA	496	749
50	NA	NA	NA	NA	NA	NA	NA	922
100	NA	NA	NA	NA	NA	NA	NA	NA

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(7)
EXTERIOR MASONRY CHIMNEY [NFPA 54: TABLE 13.2(g)]^{1, 2}

				NUMBER OF APPLIANCES: TWO OR MORE		TWO OR MORE		
				APPLIANCE TYPE:		NAT + NAT		
				APPLIANCE VENT CONNECTION:		TYPE B DOUBLE-WALL CONNECTOR		
MINIMUM ALLOWABLE INPUT RATING OF SPACE-HEATING APPLIANCE IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
Local 99% winter design temperature: 37°F or greater								
6	0	0	0	0	0	0	0	NA
8	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	NA	0	0	0	0	0	0	0
20	NA	NA	NA	NA	NA	184	0	0
30	NA	NA	NA	NA	NA	393	334	0
50	NA	NA	NA	NA	NA	NA	NA	579
100	NA	NA	NA	NA	NA	NA	NA	NA
Local 99% winter design temperature: 27°F to 36°F								
6	0	0	68	NA	NA	180	212	NA
8	0	0	82	NA	NA	187	214	263
10	0	51	NA	NA	NA	201	225	265
15	NA	NA	NA	NA	NA	253	274	305
20	NA	NA	NA	NA	NA	307	330	362
30	NA	NA	NA	NA	NA	NA	445	485
50	NA	NA	NA	NA	NA	NA	NA	763
100	NA	NA	NA	NA	NA	NA	NA	NA
Local 99% winter design temperature: 17°F to 26°F								
6	NA	NA	NA	NA	NA	NA	NA	NA
8	NA	NA	NA	NA	NA	NA	264	352
10	NA	NA	NA	NA	NA	NA	278	358
15	NA	NA	NA	NA	NA	NA	331	398
20	NA	NA	NA	NA	NA	NA	387	457
30	NA	NA	NA	NA	NA	NA	NA	581
50	NA	NA	NA	NA	NA	NA	NA	862
100	NA	NA	NA	NA	NA	NA	NA	NA
Local 99% winter design temperature: 5°F to 16°F								
6	NA	NA	NA	NA	NA	NA	NA	NA
8	NA	NA	NA	NA	NA	NA	NA	NA
10	NA	NA	NA	NA	NA	NA	NA	430
15	NA	NA	NA	NA	NA	NA	NA	485
20	NA	NA	NA	NA	NA	NA	NA	547
30	NA	NA	NA	NA	NA	NA	NA	682
50	NA	NA	NA	NA	NA	NA	NA	NA
100	NA	NA	NA	NA	NA	NA	NA	NA
Local 99% winter design temperature: 4°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.

CHIMNEYS AND VENTS

TABLE 803.2(8)
EXTERIOR MASONRY CHIMNEY [NFPA 54: TABLE 13.2(h)]*

				NUMBER OF APPLIANCES:		TWO OR MORE		
				APPLIANCE TYPE:		FAN + NAT		
				APPLIANCE VENT CONNECTION:		TYPE B DOUBLE-WALL CONNECTOR		
COMBINED APPLIANCE MAXIMUM INPUT RATING IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
6	74	119	178	257	351	458	582	853
8	80	130	193	279	384	501	636	937
10	84	138	207	299	409	538	686	1010
15	NA	152	233	334	467	611	781	1156
20	NA	NA	250	368	508	668	858	1286
30	NA	NA	NA	404	564	747	969	1473
50	NA	NA	NA	NA	NA	831	1089	1692
100	NA	NA	NA	NA	NA	NA	NA	1921

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(9)
EXTERIOR MASONRY CHIMNEY [NFPA 54: TABLE 13.2(i)]^{1, 2}

				NUMBER OF APPLIANCES:		TWO OR MORE		
				APPLIANCE TYPE:		FAN + NAT		
				APPLIANCE VENT CONNECTION:		TYPE B DOUBLE-WALL CONNECTOR		
MINIMUM ALLOWABLE INPUT RATING OF SPACE-HEATING APPLIANCE IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT <i>H</i> (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
Local 99% winter design temperature: 37°F or greater								
6	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	NA	0	0	0	0	0	0	0
20	NA	NA	123	190	249	184	0	0
30	NA	NA	NA	334	398	393	334	0
50	NA	NA	NA	NA	NA	714	707	579
100	NA	NA	NA	NA	NA	NA	NA	1600
Local 99% winter design temperature: 27°F to 36°F								
6	0	0	68	116	156	180	212	266
8	0	0	82	127	167	187	214	263
10	0	51	97	141	183	201	225	265
15	NA	111	142	183	233	253	274	305
20	NA	NA	187	230	284	307	330	362
30	NA	NA	NA	330	319	419	445	485
50	NA	NA	NA	NA	NA	672	705	763
100	NA	NA	NA	NA	NA	NA	NA	1554
Local 99% winter design temperature: 17°F to 26°F								
6	0	55	99	141	182	215	259	349
8	52	74	111	154	197	226	264	352
10	NA	90	125	169	214	245	278	358
15	NA	NA	167	212	263	296	331	398
20	NA	NA	212	258	316	352	387	457
30	NA	NA	NA	362	429	470	507	581
50	NA	NA	NA	NA	NA	723	766	862
100	NA	NA	NA	NA	NA	NA	NA	1669
Local 99% winter design temperature: 5°F to 16°F								
6	NA	78	121	166	214	252	301	416
8	NA	94	135	182	230	269	312	423
10	NA	111	149	198	250	289	331	430
15	NA	NA	193	247	305	346	393	485
20	NA	NA	NA	293	360	408	450	547
30	NA	NA	NA	377	450	531	580	682
50	NA	NA	NA	NA	NA	797	853	972
100	NA	NA	NA	NA	NA	NA	NA	1833
Local 99% winter design temperature: -10°F to 4°F								
6	NA	NA	145	196	249	296	349	484
8	NA	NA	159	213	269	320	371	494
10	NA	NA	175	231	292	339	397	513
15	NA	NA	NA	283	351	404	457	586
20	NA	NA	NA	333	408	468	528	650
30	NA	NA	NA	NA	NA	603	667	805
50	NA	NA	NA	NA	NA	NA	955	1003
100	NA	NA	NA	NA	NA	NA	NA	NA
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.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 9 – INSTALLATION OF SPECIFIC APPLIANCES

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X		X					X	X				X										
Adopt Entire Chapter as amended (amended sections listed below)				X	X					X	X	X		X	X								
Adopt only those sections that are listed below																	X						
Chapter/Section																							
902.2										X	X	X		X	X								
911.0																	X						
911.1										X	X	X		X	X								
911.2.2				†	†																		
912.1				†	†																		
912.2(1)				X	X																		
916.2.1				X	X																		
916.2.1.1				X	X																		
930.0				†	†																		
930.1				†	†																		

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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 Appliance. 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]

[OSHPD 1, 1R, 2, 4 & 5] Warm air furnaces shall not be installed under openable windows on exterior walls.

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. [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. 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]

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

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shall be located in a mechanical room separate or partitioned off from other areas with provisions for combustion and dilution air from outdoors. Direct vent appliances in such facilities shall be in accordance with the appliance manufacturer's installation instructions. [NFPA 54:9.1.6.2]

902.13 Process Air. In addition to air needed for combustion in commercial or industrial processes, process air 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 be installed. [NFPA 54:9.1.18]

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]

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]

903.0 Air-Conditioning Appliances.

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.

903.2.1 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 54:10.2.1]

903.2.2 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 54:10.2.2]

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.
- (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

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described in Table 303.10.1 and such reduction is allowed by the manufacturer's installation instructions. [NFPA 54:10.2.3(3)]

- (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)]
- (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(5)]

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]

» **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]

» **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. [NFPA 54:10.2.7]

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.

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- (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 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]

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 54:10.3.6]

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

TABLE 904.2.2
CLEARANCES TO COMBUSTIBLE MATERIAL FOR UNLISTED FURNACES AND BOILERS*
[NFPA 54: TABLE 10.3.2.2]

APPLIANCE	MINIMUM CLEARANCE (inches)					
	ABOVE AND SIDES OF FUR- NACE PLENUM	TOP OF BOILER	JACKET SIDES AND REAR	FRONT	DRAFT HOOD AND BAROMETRIC DRAFT REGULATOR	SINGLE-WALL VENT CONNECTOR
1. Automatically fired, forced air or gravity system, equipped with temperature limit control that cannot be set higher than 250°F.	6	—	6	18	6	18
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.	6	6	6	18	18	18
3. Central heating boilers and furnaces, other than in 1 or 2.	18	18	18	18	18	18

For SI units: 1 inch = 25.4 mm, °C = (°F-32)/1.8, 1 pound-force per square inch = 6.8947 kPa

* See Section 904.1 for additional requirements for central heating boilers and furnaces.

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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.

905.0 Duct Furnaces.

905.1 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.

905.2 Installation of Duct Furnaces. Duct furnaces shall be installed in accordance with the manufacturer's instructions. [NFPA 54:10.10.2]

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 54:10.10.3]

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 54:10.10.4]

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 54:10.10.5]

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, furnace, and the cooling coil and the air throughput necessary for heating or cooling, whichever is greater. [NFPA 54:10.10.6.1]

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 54:10.10.6.2]

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 Heat Exchangers. Where a duct furnace is installed downstream of an evaporative cooler or air washer, the heat exchanger shall be constructed of corro-

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sion-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]

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 54:10.10.7]

905.8 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 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 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 *the California Electrical Code*.

906.0 Floor Furnaces.

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.

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 54:10.11.2.1]
- (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 350°F (177°C) above room temperature. [NFPA 54:10.11.2.2]

906.3 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.11.3]

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 54:10.11.4]

906.5 Bracing. The space provided for the furnace shall be framed with doubled joists and with headers not lighter than the joists. [NFPA 54:10.11.5]

906.6 Support. Means shall be provided to support the furnace when the floor register is removed. [NFPA 54:10.11.6]

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 54:10.11.7]

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 54:10.11.8]

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 54:10.11.9]

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906.10 Wind Protection. Floor furnaces shall be protected, where necessary, against severe wind conditions. [NFPA 54:10.11.10]

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 non-combustible material. [NFPA 54:10.11.11]

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 54:10.11.12]

906.13 Oil-Fired Floor Furnaces. Oil-fired floor furnaces shall comply with UL 729 and installed in accordance with the manufacturer's installation instructions.

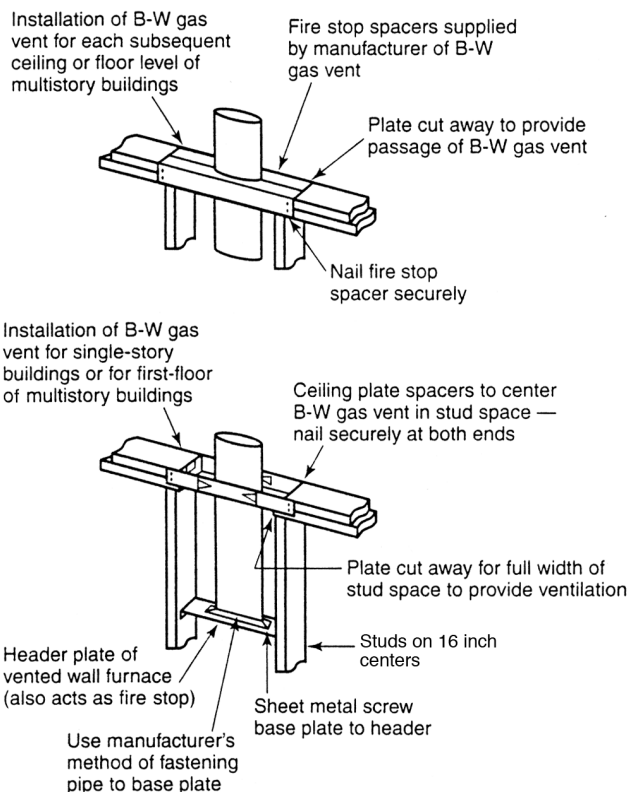
907.0 Wall Furnaces.

907.1 Installation. Listed wall furnaces shall be installed in accordance with their listings and the manufacturer's installation instructions. Wall furnaces installed in or attached to combustible material shall be listed for such installation.

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 Figure 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]

907.1.3 Direct Vent Wall Furnaces. Direct vent wall furnaces shall be installed with the vent 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]



For SI units: 1 inch = 25.4 mm

FIGURE 907.1.2
INSTALLATION OF TYPE B-W GAS VENTS FOR
VENTED WALL FURNACES
[NFPA 54: FIGURE 10.26.1.3]

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]

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]

907.3 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.26.3]

907.4 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 Electric Clothes Dryers. Commercial electric clothes dryers shall comply with UL 1240 and installed in accordance with the manufacturer's installation instructions. Residential and coin-operated electric clothes dryers shall

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comply with UL 2158 and installed in accordance with the manufacturer's installation instructions.

908.2 Gas-Fired Clothes Dryers. Gas-fired clothes dryers shall comply with Section 908.2.1 through Section 908.2.3.

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 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.

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.

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]

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 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] **[OSHPD 1, 1R, 2, 4 & 5]** *A vented decorative appliance shall not be located in any hospital, skilled nursing facility, intermediate care facility, or correctional treatment center.*

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 non-combustible materials. These appliances shall not be thermostatically controlled. [NFPA 54:10.6.2]

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.

911.2.2 Reserved. ||

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]

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]

912.0 Gas Fireplaces, Vented.

912.1 Reserved. ||

912.2 Installation. The installation of vented gas fireplaces shall comply with the following requirements:

- (1) **[HCD 1 & HCD 2]** *Any newly installed gas fireplace shall be a direct-vent sealed-combustion type.*
- (2) 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.
- (3) 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.
- (4) Panels, grilles, and access doors that are required to be removed for normal servicing operations shall not be attached to the building.
- (5) 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.

912.3 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.7.3]

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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.

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 industrial air heaters of the non-recirculating type shall be listed in accordance with CSA Z83.4. [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. [NFPA 54:10.8.2.1, 10.8.2.2]

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 air to the non-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. [NFPA 54:10.8.5]

914.6 Atmospheric Vents, Gas Reliefs, or Bleeds. Non-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 54:10.8.6]

914.7 Relief Openings. The design of the installation shall include adequate provisions to permit the non-recirculating direct gas-fired industrial air heater 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 54:10.8.7]

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]

914.7.2 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]

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]

CHIMNEY HEIGHT (feet)	MINIMUM PERMANENT FREE OPENING (square inches)*						
	8	13	20	29	39	51	64
	APPLIANCE INPUT RATING (Btu/h)						
6	7800	14 000	23 200	34 000	46 400	62 400	80 000
8	8400	15 200	25 200	37 000	50 400	68 000	86 000
10	9000	16 800	27 600	40 400	55 800	74 400	96 400
15	9800	18 200	30 200	44 600	62 400	84 000	108 800
20	10 600	20 200	32 600	50 400	68 400	94 000	122 200
30	11 200	21 600	36 600	55 200	76 800	105 800	138 600

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.

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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 54:10.9.2.1, 10.9.2.2]

→ **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. 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]

916.0 Room Heaters.

916.1 Electric Room Heaters. Electric room heaters shall comply with UL 2021.

916.2 Gas-Fired Room Heaters. Gas-fired room heaters shall comply with Section 916.2.1 through Section 916.2.4.

916.2.1 Prohibited Installations. Unless specifically permitted by the Authority Having Jurisdiction, unvented room heaters shall not be installed as primary heat sources. Unvented room heaters shall not be permitted in spaces that do not have the required volume of indoor air as defined in Section 701.4.

[HCD 1 & HCD 2] *Unvented fuel-burning room heaters shall not be installed, used, maintained, or permitted to exist in a Group R Occupancy.*

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. [NFPA 54:10.22.1]
- (3) Portable oil fired unvented heating appliances used as supplemental heating in storage occupancies, utility occupancies, and in accordance with the fire code.

[HCD 1 & HCD 2] *Unvented fuel-burning room heaters shall not be installed, used, maintained, or permitted to exist in a Group R Occupancy.*

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 54:10.22.3]

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916.2.3 Clearance. A room heater shall be placed so as not to cause a hazard to walls, floors, curtains, furniture, doors where open, and to the free movements of persons within the room. Heaters designed and marked, "For use in noncombustible fireplace only," shall not be installed elsewhere. Listed room heaters shall be installed in accordance with their listings and the manufacturer's installation instructions. In no case shall the clearances be such as to interfere with combustion air and accessibility. Unlisted room heaters shall be installed with clearances from combustible material not less than the following:

- (1) Circulating type room heaters having an outer jacket surrounding the combustion chamber, arranged with openings at top and bottom so that air circulates between the inner and outer jacket, and without openings in the outer jacket to permit direct radiation, shall have clearance at sides and rear of not less than 12 inches (305 mm).
- (2) Radiating type room heaters other than those of the circulating type described in Section 916.2.3(1) shall have clearance at sides and rear of not less than 18 inches (457 mm), except that heaters that make use of metal, asbestos, or ceramic material to direct radiation to the front of the heater shall have a clearance of 36 inches (914 mm) in front and, where constructed with a double back of metal or ceramic, shall be permitted to be installed with a clearance of 18 inches (457 mm) at sides and 12 inches (305 mm) at rear. Combustible floors under unlisted room heaters shall be protected in an approved manner.

916.2.4 Wall-Type Room Heaters. Wall-type room heaters shall not be installed in or attached to walls of combustible material unless listed for such installation. [NFPA 54:10.22.5]

916.3 Solid-Fuel-Type Room Heaters. Solid-fuel type room heaters shall comply with UL 1482.

917.0 Unit Heaters.

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 54:10.25.1]

917.2 Clearance. Suspended-type unit heaters shall comply with the following requirements:

- (1) A listed unit heater 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.

917.2.1 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 Combustion and Circulating Air. Combustion and circulating air shall be provided in accordance with Section 701.0. [NFPA 54:10.25.3]

917.4 Ductwork. A unit heater shall not be attached to a warm air duct system unless listed and marked for such installation. [NFPA 54:10.25.4]

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 54:10.25.5]

917.6 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 Food Service Appliance, Floor-Mounted.

918.1 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.

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.

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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 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.

918.3.1 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 $\frac{3}{8}$ 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 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 unsealed 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 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 $\frac{3}{16}$ of an inch (4.8 mm) in thickness. [NFPA 54:10.12.3.2]

918.4 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 54:10.12.4.1, 10.12.4.2]

918.5 Combustible Material Adjacent to Cooking Top. Listed and unlisted food service ranges shall be installed to provide clearance to combustible material 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, 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]

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]

918.7 Level Installation. Floor-mounted food service appliances shall be installed level on a firm foundation. [NFPA 54:10.12.7]

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]

919.0 Food Service Appliances, Counter Appliances.

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 54:10.13.1]

919.2 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 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, shall be installed with a horizontal clearance from combustible material of not less than 12 inches (305 mm). Reduced clearances for gas food service counter appliances shall be 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). [NFPA 54:10.13.3]

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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 $\frac{1}{4}$ 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 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 Gas-Fired Household Cooking Appliances. Gas-fired household cooking appliances shall comply with Section 920.3 through Section 920.4.3.

920.3 Floor-Mounted Units. Floor mounted units shall be installed in accordance with Section 920.3.1 and Section 920.3.2.

920.3.1 Clearance from Combustible Material.

The clearances specified as follows 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 installed 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 (457 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.

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 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 $\frac{1}{4}$ 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 $\frac{1}{4}$ of an inch (6.4 mm) between the hood and the underside of the combustible material or metal cabinet, and the hood is 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. Microwave ovens shall comply with UL 923.

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 $\frac{1}{4}$ 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 $\frac{1}{4}$ 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 Level Installation. Cooking appliances shall be installed so that the cooking top, broiler pan, or oven racks are level. [NFPA 54:10.14.3]

921.0 Cooking Appliances Listing.

921.1 Commercial Electric Ranges. Commercial electric ranges shall comply with UL 197 and installed in accordance with the manufacturer's installation instructions.

INSTALLATION OF SPECIFIC APPLIANCES

921.2 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.

921.3 Oil-Burning Ranges. Oil-burning ranges shall comply with UL 896 and installed in accordance with the manufacturer's installation instructions.

922.0 Open-Top Broiler Units.

922.1 Listed Units. Listed open-top broiler units shall be installed in accordance with the manufacturer's installation instructions. [NFPA 54:10.18.1]

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 ¼ 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). [NFPA 54:10.18.3]

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]

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]

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.

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)]

- (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)]

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. 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. [NFPA 54:10.15.2.2]

TABLE 924.2.1
CLEARANCES FOR UNLISTED OUTDOOR
OPEN-FLAME ILLUMINATING APPLIANCES
[NFPA 54:TABLE 10.15.2.2]

FLAME HEIGHT ABOVE BURNER HEAD (inches)	MINIMUM CLEARANCE FROM COMBUSTIBLE MATERIAL (feet)*	
	HORIZONTAL	VERTICAL
12	2	6
18	3	8
24	3	10
30	4	12

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

* Measured from the nearest portion of the burner head.

924.3 Mounting on Buildings. Illuminating appliances designed for 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 54:10.15.3]

924.4 Mounting on Posts. Illuminating appliances designed for post mounting shall be securely and rigidly attached to a post. Posts shall be rigidly mounted. 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 $\frac{3}{4}$ 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 54:10.15.4]

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 54:10.15.5]

925.0 Incinerators and Crematories.

925.1 Field Constructed Commercial-Industrial Incinerators. Field constructed commercial-industrial incinerators shall be constructed and installed in accordance with NFPA 82.

925.2 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 Residential Incinerators. Residential incinerators shall comply with UL 791 and installed in accordance with the manufacturer's installation instructions.

926.0 Infrared Heaters.

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 54:10.17.1]

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.

926.3 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 54:10.17.3.1]

926.3.1 Exhaust Openings. Exhaust openings for removing flue products shall be above the level of the heaters. [NFPA 54:10.17.3.2]

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]

927.0 Pool Heaters.

927.1 Location. A pool heater shall be located or protected so as to minimize accidental contact of hot surfaces by persons. [NFPA 54:10.20.1]

927.2 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 its listing and the manufacturer's installation instructions.
- (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). [NFPA 54:10.20.3.1]

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 valving, 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]

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]

928.0 Refrigerators.

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]

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 54:10.21.2]

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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.

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]

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]

930.0 Appliances for Installation in Manufactured Housing. *[Not adopted by HCD]*

930.1 General. *[Not adopted by HCD]* 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]

931.0 Small Ceramic Kilns.

931.1 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 noncommercial purposes.

931.2 Installation. Kilns shall be installed in accordance with the manufacturer's installation instructions and the provisions of this code.

931.3 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 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. Electric kilns shall be listed and labeled in accordance with UL 499.

931.5 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 931.5.1 through Section 931.5.4.

931.5.1 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 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 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 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 Exterior Installations. Kilns shall be installed with minimum clearances as specified in Section 931.5.1. Whenever 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 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]

932.1.1 Listed Units. Listed outdoor open flame decorative appliances shall be installed in accordance with the manufacturer's installation instructions. [NFPA 54:10.31.1]

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]

933.0 Evaporative Cooling Systems.

933.1 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 933.2 through Section 933.4.3. Evaporative cooling systems shall be provided with outside air as specified for cooling systems in Section 403.0.

933.2 Location. Evaporative cooling systems shall be installed so as to minimize the probability of damage from an external source.

933.3 Access, Inspection, and Repair. Evaporative coolers shall be accessible for inspection, service, and replacement without removing permanent construction.

933.4 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 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 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 CSA NGV 5.1 and installed in accordance to the appliance manufacturer's installation instructions. [NFPA 54:10.28]

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 10 – BOILERS AND PRESSURE VESSELS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X		X					X	X								X						
Adopt Entire Chapter as amended (amended sections listed below)				X	X					X	X	X	X	X	X								
Adopt only those sections that are listed below																							
Chapter/Section																							
1001.2				X	X																		
1001.2.1										X	X	X	X	X	X								

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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.

1001.2 Boiler Rooms and Enclosures. Boiler rooms and enclosures shall comply with the *California Building Code*.

1001.2.1 [OSHPD 1, 1R, 2, 3, 4 & 5] *In no case shall boiler room volume or clearances be reduced below those required by the conditions of the boiler listing. The boiler and the boiler room ventilation system, including fans, controls, and damper motors shall be on essential power when required by Section 321.0. The ventilation system shall either operate continuously, or, if interlocked with the boiler(s) it shall not interfere with the proper boiler operation. Listed boilers shall be installed with clearances in accordance with the manufacturer's instructions.*

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 Heater. 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

BOILERS AND PRESSURE VESSELS

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:

- (1) Oil temperature
- (2) Oil suction pressure
- (3) High and low gas pressure
- (4) Stack temperature
- (5) 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 an automatic boiler 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 airtight 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. Equation 1004.4 shall not be used for diaphragm-type expansion tanks.

$$V_t = \frac{(0.00041t - 0.0466) V_s}{\left(\frac{P_a}{P_f} - \frac{P_a}{P_o}\right)} \quad (\text{Equation 1004.4})$$

Where:

V_t = Minimum volume of expansion tank, gallons

V_s = Volume of system, not including expansion tank, gallons

t = Average operating temperature, °F

P_a = Atmospheric pressure, feet H₂O absolute

P_f = Fill pressure, feet H₂O absolute

P_o = Maximum operating pressure, feet H₂O absolute

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 SYSTEMS¹

INSTALLED EQUIVALENT DIRECT RADIATION ² (square feet)	TANK CAPACITY (gallons)
Up to 350	18
Up to 450	21
Up to 650	24
Up to 900	30
Up to 1100	35
Up to 1400	40
Up to 1600	2 to 30
Up to 1800	2 to 30
Up to 2000	2 to 35
Up to 2400	2 to 40

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 SYSTEMS¹**

SYSTEM VOLUME ² (gallons)	TANK CAPACITY DIAPHRAGM TYPE (gallons)	TANK CAPACITY NON- DIAPHRAGM TYPE (gallons)
100	9	15
200	17	30
300	25	45
400	33	60
500	42	75
1000	83	150
2000	165	300

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.

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.

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. 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.

BOILERS AND PRESSURE VESSELS

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)
- (2) 5000 pounds steam per hour (0.6299 kg/s) capacity
- (3) 1000 square foot (92.9 m²) heating surface

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.

BOILERS AND PRESSURE VESSELS

TABLE 1003.2.1
CONTROLS AND LIMIT DEVICES FOR AUTOMATIC BOILERS

BOILER GROUP	FUEL	FUEL INPUT RANGE ¹ (INCLUSIVE), BTU/H	TYPE OF PILOT ²	SAFETY CONTROL TIMING (NOMINAL MAXIMUM TIME IN SECONDS)				ASSURED FUEL SUPPLY CONTROL ⁴	ASSURED AIR SUPPLY CONTROL ⁵	LOW FIRE START UP CONTROL ⁶	PRE-PURGING CONTROL ⁷	HOT WATER TEMPERATURE AND LOW WATER LIMIT CONTROLS ⁸	STEAM PRESSURE AND LOW WATER LIMIT CONTROLS ⁹	APPROVED FUEL SHUT-OFF ¹⁰	CONTROL AND LIMIT DEVICE SYSTEM DESIGN ¹¹
				TRIAL FOR PILOT	TRIAL FOR MAIN BURNER FRAME		MAIN BURNER FLAME FAILURE ³								
					DIRECT ELECTRIC IGNITION	FLAME PILOT									
A	Gas	0 - 400 000	Any type	90	Not Required	90	90	Not Required	Required	Not Required	Not Required	Required	Required	Not Required	Required
B	Gas	400 001 - 2 500 000	Interrupted or Intermittent	15	15	15	2-4	Not Required	Required	Not Required	Not Required	Required	Required	Not Required	Required
C	Gas	2 500 001 - 5 000 000	Interrupted or Intermittent	15	15	15	2-4	Required	Required	Required	Required	Required	Required	Required	Required
D	Gas	Over 5 000 000	Interrupted	15	15	15	2-4	Required	Required	Required	Required	Required	Required	Required	Required
E	Oil	0 - 400 000	Any type	Not Required	90	90	90	Not Required	Required	Not Required	Not Required	Required	Required	Not Required	Required
F	Oil	400 001 - 1 000 000	Interrupted	Not Required	30	30	2-4	Required	Required	Not Required	Not Required	Required	Required	Not Required	Required
G	Oil	1 000 001 - 3 000 000	Interrupted	Not Required	15	15	2-4	Required	Required	Not Required	Not Required	Required	Required	Not Required	Required
H	Oil	Over 3 000 000	Interrupted	15	15	60	2-4	Required	Required	Required	Required	Required	Required	Required	Required
K	Electric	All	Not required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Required	Required	Not Required	Required
L	Gas, Oil and/or Coal	12 500 000 or more	Any	10 sec Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per ASME Power Boiler Code, Section 1 and NFPA 85	Per ASME Power Boiler Code, Section 1 and NFPA 85	Per NFPA 85	Per NFPA 85
M	Heat Recovery Steam Generator	Any	None	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per NFPA 85	Per ASME Boiler & Pressure Code & NFPA 85	Per ASME Boiler & Pressure Code & NFPA 85	Per NFPA 85	Per NFPA 85

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 nonrecycling 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 power 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-steam pressure 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.
- 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.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 11 – REFRIGERATION

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X			X	X												X						
Adopt Entire Chapter as amended (amended sections listed below)			X					X	X	X	X	X	X	X	X								
Adopt only those sections that are listed below																							
Chapter/Section																							
1104.3, <i>Exception</i>										X					X								
1104.6, <i>Exceptions 1 & 2</i>			X																				
1108.4			X					X	X														
Table 1104.1										X	X	X	X	X	X								

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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.

Part I – Refrigeration Systems.

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 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 high-probability system shall be a direct system or 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 low-probability system shall be an indirect closed system, double indirect system, or 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. 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 m²) 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]

REFRIGERATION

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 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.

[OSHPD 1 & 4] Exception: For technology equipment centers not attached to a patient care area the amounts shown in Table 1102.3 may be calculated at 100 percent.

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 1106.2.2.2.
- (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.

1104.6 Applications for Human Comfort and for Non-industrial 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.

Exceptions:

- (1) Listed equipment, units having a factory-sealed refrigerating system, containing no more than 2.2 lbs. (1kg) of A2L refrigerant installed in accordance with the listing and the manufacturer's installation instructions.

- (2) *Listed equipment for non-residential applications, having a factory-sealed refrigerating system and containing no more than 4 lbs. (1.8 kg) of A2L refrigerant installed in accordance with the listing and the manufacturer's installation instructions.*

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 designations as in accordance with Table 1102.3 shall not be mixed in a system.

Exception: 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. [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. [ASHRAE 15:5.3]

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. 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) Equipment containing Group A1 refrigerants shall be permitted to be supported by the same materials permitted for the building type.
- (2) The use of approved vibration isolators specifically designed for the normal, wind, and seismic loads encountered, shall be permitted.

A compressor or portion of a condensing unit supported from the ground shall rest on a concrete or other approved base extending not less than 3 inches (76 mm) above the adjoining ground level.

1105.3 Access. An unobstructed readily accessible opening and passageway not less than 36 inches (914 mm) in width and 80 inches (2032 mm) in height shall be provided and maintained to the compressor, valves required by this chapter, or other portions of the system requiring routine maintenance.

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 unobstructed 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

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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 cubical 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 I; Group R, Division 1; or Group S Occupancy, unless separated by a one-hour fire-resistive 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. 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 330 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.

1106.2.1 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]

1106.2.2.1 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 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.

1106.2.2.2 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.

1106.2.3 Mechanical Ventilation. Machinery rooms shall be vented to the outdoors, utilizing mechanical ventilation in accordance with Section 1106.2.4 and Section 1106.2.5.

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.

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

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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**

REFRIGERANT	MINIMUM AIR FLOW* (CFM)
R-32	32 500
R-143a	28 600
R-444A	13 700
R-444B	22 400
R-445A	16 400
R-446A	50 500
R-447A	50 200
R-447B	29 600
R-451A	14 900
R-451B	14 900
R-452B	31 500
R-454A	4290
R-454B	6650
R-454C	32 800
R-455A	4770
R-457A	31 400
R-1234yf	16 500
R-1234zeE	12 600

For SI units: 1 cubic foot per minute = 0.00047 m³/s

* The values were tabulated from the following equation:

$$Q_{A2L} \geq [(\rho \cdot v \cdot A) / (LFL \cdot 0.50)] \quad (\text{Equation 1106.2.5.2})$$

Where:

ρ = 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.

1106.3 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 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.

$$F = \sqrt{G} \quad (\text{Equation 1106.4})$$

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 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)]

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 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]

1106.7 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 refrigeration

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 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]

1106.12 Exits. Exits shall comply with the building code for special hazards.

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.

1107.1.1 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.

1107.1.2 Doors. Doors communicating with the building shall be approved, self-closing, tight-fitting fire doors.

1107.1.3 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.

1107.1.4 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.

1107.1.5 Exterior Openings. Exterior openings, where present, shall not be under a fire escape or an open stairway.

1107.1.6 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.

1107.1.7 Group A2L and B2L Refrigerants. Where refrigerant of Groups A2L or B2L are used, the requirements of Class 1, Division 2, of the *California Electrical Code*, 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 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 1107.1.8.

1107.1.8 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 the *California Electrical Code*.

1107.1.9 Refrigeration Systems. As part of the mechanical ventilation system in accordance with Section 1106.2.4, 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 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.

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. 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.

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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 1106.2.2.1.

1108.4 Installation, Maintenance, and Testing. Detection and alarm systems in accordance with Section 1106.2.2.1 shall be installed, maintained, and tested in accordance with the fire code *and with the equipment manufacturer's specification*.

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, 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.

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 where in contact with 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 tub-

ing 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-resistive 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 a 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 elevator, dumbwaiter, or other shaft containing a moving object, or in a 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 $1\frac{3}{8}$ inches (35 mm) nominal size. Mechanical joints, other than approved press-connect joints, shall not be made on tubing exceeding $\frac{3}{4}$ 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 a compressor, compressor unit, or condensing unit.
- (2) The discharge of a compressor, compressor unit, or condensing unit.
- (3) The outlet of a liquid receiver.

Exceptions:

- (1) Systems that have a refrigerant pumpout function capable of storing the refrigerant charge, or are equipped with the provisions for pumpout of the refrigerant.
- (2) 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 a compressor, compressor unit, or condensing unit.
- (2) The discharge outlet of a compressor, compressor unit, or condensing unit.

- (3) The inlet of a 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 a liquid receiver.
- (5) The inlets and outlets of condensers where more than one condenser is used in parallel in the systems.

Exception: Systems that have a refrigerant pumpout function capable of storing the refrigerant charge, or are equipped with the provisions for pumpout of the refrigerant or self-contained systems. [ASHRAE 15:9.12.5]

1110.3 Support. Stop valves installed in copper refrigerant lines of $\frac{3}{4}$ 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]

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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 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 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.

$$V_1 / [W_1 - (V_2 - V_1) / V_{gt}] \quad (\text{Equation 1112.4})$$

Shall be more than V_{gc}

Where:

V_1 = Lowside volume, cubic foot (m³).

V_2 = Total volume of system, cubic foot (m³).

W_1 = 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. 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 dis-

charge 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 refrigerant.
- (2) The system contains less than 6.6 pounds (2.99 kg) of a Group A2, B1 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]

1112.11.2 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 line 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

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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 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 refrigerant, discharge to a floor drain shall be permitted where 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 a refrigerant-containing heat exchanger.
- (3) 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 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 be not 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]

TABLE 1112.12.3
ATMOSPHERIC PRESSURE AT NOMINAL
INSTALLATION ELEVATION (Pa)
[ASHRAE 15: TABLE 9.7.9.3.2]

ELEVATION ABOVE SEA LEVEL, FEET	POUNDS PER SQUARE INCH, ABSOLUTE (P_a)
0	14.7
500	14.4
1000	14.2
1500	13.9
2000	13.7
2500	13.4
3000	13.2
3500	12.9
4000	12.7
4500	12.5
5000	12.2
6000	11.8
7000	11.3
8000	10.9
9000	10.5
10000	10.1

For SI units: 1 foot = 304.8 mm, 1 pound-force per square inch = 6.8947 kPa

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).

$$L = \frac{0.2146 \cdot d^5 (P_0^2 - P_2^2)}{f \cdot C_r^2} - \frac{d \cdot \ln\left(\frac{P_0}{P_2}\right)}{6 \cdot f} \quad [\text{Equation 1112.12.4(1)}]$$

Where:

L = Equivalent length of discharge piping, feet.

C_r = Rated capacity as stamped on the relief device in pounds per minute (lb/min), or in 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):

For conventional relief valves: 15 percent of set pressure:

$$P_0 = (0.15 \cdot P) + P_a \quad [\text{Equation 1112.12.4(2)}]$$

For balanced relief valves: 25 percent of set pressure:

$$P_0 = (0.25 \cdot P) + P_a \quad [\text{Equation 1112.12.4(3)}]$$

For rupture disks alone: fusible plugs, and pilot operated relief devices, 50 percent of set pressure:

$$P_0 = (0.50 \cdot P) + P_a \quad [\text{Equation 1112.12.4(4)}]$$

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 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 atmosphere under critical flow conditions, in pounds of air per minute (kg/s), shall be determined in accordance with the following formulas:

$$C = 0.64 P_1 d^2 \quad [\text{Equation 1112.14(1)}]$$

$$d = 1.25 \sqrt{C/P_1} \quad [\text{Equation 1112.14(2)}]$$

Where:

- C = Rated discharge capacity of air, pounds per minute.
 d = Smallest internal diameter of the inlet pipe, retaining flanges, fusible plug, or rupture member; inches.

For rupture members:

$$[\text{Equation 1112.14(3)}]$$

$$P_I = (\text{rated pressure in psig} \times 1.1) + 14.7$$

For fusible plugs:

P_I = 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 overpressure 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 15:9.7.3]

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

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for a pressure vessel shall be determined in accordance with Equation 1113.5:

$$C = fDL \quad (\text{Equation 1113.5})$$

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 multiply 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]

REFRIGERANT	VALUE OF f
Where used on the lowside of a limited-charge cascade system:	
R-23, R-170, R-744, R-1150, R-508A, R-508B	1
R-13, R-13B1, R-503	2
R-14	2.5
Other applications:	
R-718	0.2
R-717	0.5
R-11, R-32, R-113, R-123, R-142b, R-152a, R-290, R-600, R-600a, R-764	1
R-12, R-22, R-114, R-124, R-134a, R-401A, R-401B, R-401C, R-405A, R-406A, R-407C, R-407D, R-407E, R-409A, R-409B, R-411A, R-411B, R-411C, R-412A, R-414A, R-414B, R-500, R-1270	1.6
R-143a, R-402B, R-403A, R-407A, R-408A, R-413A	2
R-115, R-402A, R-403B, R-404A, R-407B, R-410A, R-410B, R-502, R-507A, R-509A	2.5

* 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.

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 15:9.7.2.3]

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 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) or less shall be marked. [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]

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 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, nonflammable refrigerants permitted for factory tests.
- (2) Mixtures of dry nitrogen, inert gases, or a combination of them with flammable 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 kPa) 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 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
FIELD LEAK TEST PRESSURES (psig)*

REFRIGERANT NUMBER	HIGHSIDE WATER COOLED	HIGHSIDE AIR COOLED	LOWSIDE
11	15	35	15
12	140	220	140
22	230	360	230
113	15	15	15
114	40	80	40
115	275	340	275
123	15	30	15
134a	150	250	150
152a	130	220	130
500	165	265	165
502	250	385	250
744*	—	—	—

For SI units: 1 pound-force per square inch gauge = 6.8947 kPa

* Special design required; test pressures typically exceed 1000 psig (6895 kPa).

1116.3 Test Gases. Tests shall be performed with dry nitrogen or other 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 of them with nonflammable refrigerant in concentrations of

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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 of them with flammable refrigerants in concentrations not exceeding the lower 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 be:

- (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 kPa) 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 kPa) 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 kPa) 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 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.

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. 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.

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TABLE 1102.3
REFRIGERANT GROUPS, PROPERTIES, AND ALLOWABLE QUANTITIES⁸
[ASHRAE 34: TABLE 4-1, TABLE 4-2]

REFRIGERANT	CHEMICAL FORMULA	CHEMICAL NAME ¹ (COMPOSITION FOR BLENDS)	SAFETY GROUP ⁷	OEL ² (ppm)	POUNDS PER 1000 CUBIC FEET OF SPACE
R-11	CCl ₃ F	Trichlorofluoromethane	A1	C1000	0.39
R-12	CCl ₂ F ₂	Dichlorodifluoromethane	A1	1000	5.6
R-12B1	CBrClF ₂	Bromochlorodifluoromethane	—	—	—
R-13	CClF ₃	Chlorotrifluoromethane	A1	1000	—
R-13B1	CBrF ₃	Bromotrifluoromethane	A1	1000	—
R-14	CF ₄	Tetrafluoromethane (carbon tetrafluoride)	A1	1000	25
R-21	CHCl ₂ F	Dichlorofluoromethane	B1	—	—
R-22	CHClF ₂	Chlorodifluoromethane	A1	1000	13
R-23	CHF ₃	Trifluoromethane	A1	1000	7.3
R-30	CH ₂ Cl ₂	Dichloromethane (methylene chloride)	B1	—	—
R-31	CH ₂ ClF	Chlorofluoromethane	—	—	—
R-32	CH ₂ F ₂	Difluoromethane (methylene fluoride)	A2L	1000	4.8
R-40	CH ₃ Cl	Chloromethane (methyl chloride)	B2	—	—
R-41	CH ₃ F	Fluoromethane (methyl fluoride)	—	—	—
R-50	CH ₄	Methane	A3	1000	—
R-113	CCl ₂ FCClF ₂	1, 1, 2-trichloro-1, 2, 2 – trifluoroethane	A1	1000	1.2
R-114	CClF ₂ CClF ₂	1, 2-dichloro-1, 1, 2, 2 tetrafluoroethane	A1	1000	8.7
R-115	CClF ₂ CF ₃	Chloropentafluoroethane	A1	1000	47
R-116	CF ₃ CF ₃	Hexafluoroethane	A1	1000	34
R-123	CHCl ₂ CF ₃	2, 2-dichloro-1, 1, 1, - trifluoroethane	B1	50	3.5
R-124	CHClFCF ₃	2-chloro-1, 1, 1, 2 - tetrafluoroethane	A1	1000	3.5
R-125	CHF ₂ CF ₃	Pentafluoroethane	A1	1000	23
R-134a	CH ₂ FCF ₃	1, 1, 1, 2-tetrafluoroethane	A1	1000	13
R-141b	CH ₃ CCl ₂ F	1, 1-dichloro-1-fluoroethane	—	500	0.78
R-142b	CH ₃ CClF ₂	1-chloro-1, 1-difluoroethane	A2	1000	5.1
R-143a	CH ₃ CF ₃	1, 1, 1-trifluoroethane	A2L	1000	4.5
R-152a	CH ₃ CHF ₂	1, 1-difluoroethane	A2	1000	2.0
R-170	CH ₃ CH ₃	Ethane	A3	1000	0.54
R-E170	CH ₃ OCH ₃	Methoxymethane (Dimethyl ether)	A3	1000	1.0
R-218	CF ₃ CF ₂ CF ₃	Octafluoropropane	A1	1000	43
R-227ea	CF ₃ CHFCF ₃	1, 1, 1, 2, 3, 3, 3-heptafluoropropane	A1	1000	36
R-236fa	CF ₃ CH ₂ CF ₃	1, 1, 1, 3, 3, 3-hexafluoropropane	A1	1000	21
R-245fa	CHF ₂ CH ₂ CF ₃	1, 1, 1, 3, 3-pentafluoropropane	B1	300	12
R-290	CH ₃ CH ₂ CH ₃	Propane	A3	1000	0.56
R-C318	-(CF ₂) ₄ -	Octafluorocyclobutane	A1	1000	41
R-400	zeotrope	R-12/114 (50.0/50.0)	A1	1000	10
R-400	zeotrope	R-12/114 (60.0/40.0)	A1	1000	11
R-401A	zeotrope	R-22/152a/124 (53.0/13.0/34.0)	A1	1000	6.6
R-401B	zeotrope	R-22/152a/124 (61.0/11.0/28.0)	A1	1000	7.2
R-401C	zeotrope	R-22/152a/124 (33.0/15.0/52.0)	A1	1000	5.2
R-402A	zeotrope	R-125/290/22 (60.0/2.0/38.0)	A1	1000	17

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TABLE 1102.3 (continued)
REFRIGERANT GROUPS, PROPERTIES, AND ALLOWABLE QUANTITIES⁸
[ASHRAE 34: TABLE 4-1, TABLE 4-2]

REFRIGERANT	CHEMICAL FORMULA	CHEMICAL NAME ¹ (COMPOSITION FOR BLENDS)	SAFETY GROUP ⁷	OEL ² (ppm)	POUNDS PER 1000 CUBIC FEET OF SPACE
R-402B	zeotrope	R-125/290/22 (38.0/2.0/60.0)	A1	1000	15
R-403A	zeotrope	R-290/22/218 (5.0/75.0/20.0)	A2	1000	7.6
R-403B	zeotrope	R-290/22/218 (5.0/56.0/39.0)	A1	1000	18
R-404A	zeotrope	R-125/143a/134a (44.0/52.0/4.0)	A1	1000	31
R-405A	zeotrope	R-22/152a/142b/C318 (45.0/7.0/5.5/42.5)	—	1000	16
R-406A	zeotrope	R-22/600a/142b (55.0/4.0/41.0)	A2	1000	4.7
R-407A	zeotrope	R-32/125/134a (20.0/40.0/40.0)	A1	1000	19
R-407B	zeotrope	R-32/125/134a (10.0/70.0/20.0)	A1	1000	21
R-407C	zeotrope	R-32/125/134a (23.0/25.0/52.0)	A1	1000	18
R-407D	zeotrope	R-32/125/134a (15.0/15.0/70.0)	A1	1000	16
R-407E	zeotrope	R-32/125/134a (25.0/15.0/60.0)	A1	1000	17
R-407F	zeotrope	R-32/125/134a (30.0/30.0/40.0)	A1	1000	20
R-407G	zeotrope	R-32/125/134a (2.5/2.5/95.0)	A1	1000	13
R-407H	zeotrope	R-32/125/134a (32.5/15.0/52.5)	A1	1000	19
R-407I	zeotrope	R-32/125/124a (19.5/8.5/72.0)	A1	1000	16.0
R-408A	zeotrope	R-125/143a/22 (7.0/46.0/47.0)	A1	1000	21
R-409A	zeotrope	R-22/124/142b (60.0/25.0/15.0)	A1	1000	7.1
R-409B	zeotrope	R-22/124/142b (65.0/25.0/10.0)	A1	1000	7.3
R-410A	zeotrope	R-32/125 (50.0/50.0)	A1	1000	26
R-410B	zeotrope	R-32/125 (45.0/55.0)	A1	—	27
R-411A ⁶	zeotrope	R-1270/22/152a (1.5/87.5/11.0)	A2	990	2.9
R-411B ⁶	zeotrope	R-1270/22/152a (3.0/94.0/3.0)	A2	980	2.8
R-412A	zeotrope	R-22/218/142b (70.0/5.0/25.0)	A2	1000	5.1
R-413A	zeotrope	R-218/134a/600a (9.0/88.0/3.0)	A2	1000	5.8
R-414A	zeotrope	R-22/124/600a/142b (51.0/28.5/4.0/16.5)	A1	1000	6.4
R-414B	zeotrope	R-22/124/600a/142b (50.0/39.0/1.5/9.5)	A1	1000	6.0
R-415A	zeotrope	R-22/152a (82.0/18.0)	A2	1000	2.9
R-415B	zeotrope	R-22/152a (25.0/75.0)	A2	1000	2.1
R-416A ⁶	zeotrope	R-134a/124/600 (59.0/39.5/1.5)	A1	1000	3.9
R-417A ⁶	zeotrope	R-125/134a/600 (46.6/50.0/3.4)	A1	1000	3.5
R-417B	zeotrope	R-125/134a/600 (79.0/18.3/2.7)	A1	1000	4.3
R-417C	zeotrope	R-125/134a/600 (19.5/78.8/1.7)	A1	1000	5.4
R-418A	zeotrope	R-290/22/152a (1.5/96.0/2.5)	A2	1000	4.8
R-419A	zeotrope	R-125/134a/E170 (77.0/19.0/4.0)	A2	1000	4.2
R-419B	zeotrope	R-125/134a/E170 (48.5/48.0/3.5)	A2	1000	4.6
R-420A	zeotrope	R-134a/142b (88.0/12.0)	A1	1000	12
R-421A	zeotrope	R-125/134a (58.0/42.0)	A1	1000	17
R-421B	zeotrope	R-125/134a (85.0/15.0)	A1	1000	21
R-422A	zeotrope	R-125/134a/600a (85.1/11.5/3.4)	A1	1000	18
R-422B	zeotrope	R-125/134a/600a (55.0/42.0/3.0)	A1	1000	16
R-422C	zeotrope	R-125/134a/600a (82.0/15.0/3.0)	A1	1000	18
R-422D	zeotrope	R-125/134a/600a (65.1/31.5/3.4)	A1	1000	16
R-422E	zeotrope	R-125/134a/600a (58.0/39.3/2.7)	A1	1000	16
R-423A	zeotrope	R-134a/227ea (52.5/47.5)	A1	1000	19
R-424A ⁶	zeotrope	R-125/134a/600a/600/601a (50.5/47.0/0.9/1.0/0.6)	A1	970	6.2
R-425A	zeotrope	R-32/134a/227ea (18.5/69.5/12.0)	A1	1000	16

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TABLE 1102.3 (continued)
REFRIGERANT GROUPS, PROPERTIES, AND ALLOWABLE QUANTITIES⁸
[ASHRAE 34: TABLE 4-1, TABLE 4-2]

REFRIGERANT	CHEMICAL FORMULA	CHEMICAL NAME ¹ (COMPOSITION FOR BLENDS)	SAFETY GROUP ⁷	OEL ² (ppm)	POUNDS PER 1000 CUBIC FEET OF SPACE
R-426A ⁶	zeotrope	R-125/134a/600/601a (5.1/93.0/1.3/0.6)	A1	990	5.2
R427A	zeotrope	R-32/125/143a/134a (15.0/25.0/10.0/50.0)	A1	1000	18
R428A	zeotrope	R-125/143a/290/600a (77.5/20.0/0.6/1.9)	A1	1000	23
R-429A	zeotrope	R-E170/152a/600a (60.0/10.0/30.0)	A3	1000	0.81
R-430A	zeotrope	R-152a/600a (76.0/24.0)	A3	1000	1.3
R-431A	zeotrope	R-290/152a (71.0/29.0)	A3	1000	0.69
R-432A	zeotrope	R-1270/E170 (80.0/20.0)	A3	700	0.13
R-433A	zeotrope	R-1270/290 (30.0/70.0)	A3	880	0.34
R-433B	zeotrope	R-1270/290 (5.0/95.0)	A3	950	0.51
R-433C	zeotrope	R-1270/290 (25.0/75.0)	A3	790	0.41
R-434A	zeotrope	R-125/143a/134a/600a (63.2/18.0/16.0/2.8)	A1	1000	20
R-435A	zeotrope	R-E170/152a (80.0/20.0)	A3	1000	1.1
R-436A	zeotrope	R-290/600a (56.0/44.0)	A3	1000	0.50
R-436B	zeotrope	R-290/600a (52.0/48.0)	A3	1000	0.51
R-437A	zeotrope	R-125/134a/600/601 (19.5/78.5/1.4/0.6)	A1	990	5.0
R-438A	zeotrope	R-32/125/134a/600/601a (8.5/45.0/44.2/1.7/0.6)	A1	990	4.9
R-439A	zeotrope	R-32/125/600a (50.0/47.0/3.0)	A2	990	4.7
R-440A	zeotrope	R-290/134a/152a (0.6/1.6/97.8)	A2	1000	1.9
R-441A	zeotrope	R-170/290/600a/600 (3.1/54.8/6.0/36.1)	A3	1000	0.39
R-442A	zeotrope	R-32/125/134a/152a/227ea (31.0/31.0/30.0/3.0/5.0)	A1	1000	21
R-443A	zeotrope	R-1270/290/600a (55.0/40.0/5.0)	A3	580	0.19
R-444A	zeotrope	R-32/152a/1234ze(E) (12.0/5.0/83.0)	A2L	850	5.1
R-444B	zeotrope	R-32/152a/1234ze(E) (41.5/10.0/48.5)	A2L	890	4.3
R-445A	zeotrope	R-744/134a/1234ze (E) (6.0/9.0/85.0)	A2L	930	4.2
R-446A	zeotrope	R-32/1234ze(E)/600 (68.0/29.0/3.0)	A2L	960	2.5
R-447A	zeotrope	R-32/125/1234ze(E) (68.0/3.5/28.5)	A2L	900	2.6
R-447B	zeotrope	R-32/125/1234ze(E) (68.0/8.0/24.0)	A2L	970	23
R-448A	zeotrope	R-32/125/1234yf/134a/1234ze(E) (26.0/26.0/20.0/21.0/7.0)	A1	890	24
R-449A	zeotrope	R-32 /125 /1234yf /134a (24.3/24.7/25.3/25.7)	A1	830	23
R-449B	zeotrope	R-32/125/1234yf/134a (25.2/24.3/23.2/27.3)	A1	850	23
R-449C	zeotrope	R-32/125/1234yf/134a (20.0/20.0/31.0/29.0)	A1	800	23
R-450A	zeotrope	R-134a/1234ze(E) (42.0/58.0)	A1	880	20
R-451A	zeotrope	R-1234yf/134a (89.8/10.2)	A2L	520	5.3
R-451B	zeotrope	R-1234yf/134a (88.8/11.2)	A2L	530	5.3
R-452A	zeotrope	R-32/125/1234yf (11.0/59.0/30.0)	A1	780	27
R-452B	zeotrope	R-32/125/1234yf (67.0/7.0/26.0)	A2L	870	23
R-452C	zeotrope	R-32/125/1234yf (12.5/61.0/26.5)	A1	800	27
R-453A	zeotrope	R-32/125/134a/227ea/600/601a (20.0/20.0/53.8/5.0/0.6/0.6)	A1	1000	7.8
R-454A	zeotrope	R-32/1234yf (35.0/65.0)	A2L	690	28
R-454B	zeotrope	R-32/1234yf (68.9/31.1)	A2L	850	22
R-454C	zeotrope	R-32/1234yf (21.5/78.5)	A2L	620	29

REFRIGERATION

TABLE 1102.3 (continued)
REFRIGERANT GROUPS, PROPERTIES, AND ALLOWABLE QUANTITIES⁸
[ASHRAE 34: TABLE 4-1, TABLE 4-2]

REFRIGERANT	CHEMICAL FORMULA	CHEMICAL NAME ¹ (COMPOSITION FOR BLENDS)	SAFETY GROUP ⁷	OEL ² (ppm)	POUNDS PER 1000 CUBIC FEET OF SPACE
R-455A	zeotrope	R-744/32/1234yf (3.0/21.5/75.5)	A2L	650	23
R-456A	zeotrope	R-32/134a/1234ze(E) (6.0/45.0/49.0)	A1	900	20
R-457A	zeotrope	R-32/1234yf/152a (18.0/70.0/12.0)	A2L	650	25
R-458A	zeotrope	R-32/125/134a/227ea/236fa (20.5/4.0/61.4/13.5/0.6)	A1	1000	18
R-459A	zeotrope	R-32/1234yf/1234ze(E) (68.0/26.0/6.0)	A2L	870	23
R-459B	zeotrope	R-32/1234yf/1234ze(E) (21.0/69.0/10.0)	A2L	640	30
R-460A	zeotrope	R-32/125/134a/1234ze(E) (12.0/52.0/14.0/22.0)	A1	650	24
R-460B	zeotrope	R-32/125/134a/1234ze(E) (28.0/25.0/20.0/27.0)	A1	950	25
R-460C	zeotrope	R-32/125/134a/1234ze(E) (2.5/2.5/46.0/49.0)	A1	900	20.0
R-461A	zeotrope	R-125/143a/134a/227ea/600a (55.0/5.0/32.0/5.0/3.0)	A1	1000	17
R-462A	zeotrope	R-32/125/143a/134a/600 (9.0/42.0/2.0/44.0/3.0)	A2	1000	3.9
R-463A	zeotrope	R-744/32/125/1234yf/134a (6.0/36.0/30.0/14.0/14.0)	A1	990	19
R-464A	zeotrope	R-32/125/1234ze(E)/227ea (27.0/27.0/40.0/6.0)	A1	930	27.0
R-465A	zeotrope	R-32/290/1234yf (21.0/7.9/71.1)	A2	660	2.5
R-500	azeotrope ³	R-12/152a (73.8/26.2)	A1	1000	7.6
R-501	azeotrope ³	R-22/12 (75.0/25.0) ⁴	A1	1000	13
R-502	azeotrope ³	R-22/115 (48.8/51.2)	A1	1000	21
R-503	azeotrope ³	R-23/13 (40.1/59.9)	—	1000	—
R-504	azeotrope ³	R-32/115 (48.2/51.8)	—	1000	28
R-505	azeotrope ³	R-12/31 (78.0/22.0) ⁴	—	—	—
R-506	azeotrope ³	R-31/114 (55.1/44.9)	—	—	—
R-507A ⁵	azeotrope ³	R-125/143a (50.0/50.0)	A1	1000	32
R-508A ⁵	azeotrope ³	R-23/116 (39.0/61.0)	A1	1000	14
R-508B	azeotrope ³	R-23/116 (46.0/54.0)	A1	1000	13
R-509A ⁵	azeotrope ³	R-22/218 (44.0/56.0)	A1	1000	24
R-510A	azeotrope ³	R-E170/600a (88.0/12.0)	A3	1000	0.87
R-511A	azeotrope ³	R-290/E170 (95.0/5.0)	A3	1000	0.59
R-512A	azeotrope ³	R-134a/152a (5.0/95.0)	A2	1000	1.9
R-513A	azeotrope ³	R-1234yf/134a (56.0/44.0)	A1	650	20
R-513B	azeotrope ³	R-1234yf/134a (58.5/41.5)	A1	640	21
R-514A	azeotrope ³	R-1336mzz(Z)/1130 (E) (74.7/25.3)	B1	320	0.86
R-515A	azeotrope ³	R-1234ze(E)/227ea (88.0/12.0)	A1	810	19
R-516A	azeotrope ³	R-1234yf/134a/152a (77.5/8.5/14.0)	A2L	590	7.0
R-600	CH ₃ CH ₂ CH ₂ CH ₃	Butane	A3	1000	0.15
R-600a	CH(CH ₃) ₂ CH ₃	2-methylpropane (isobutene)	A3	1000	0.59
R-601	CH ₃ CH ₂ CH ₂ CH ₂ CH ₃	Pentane	A3	600	0.18

REFRIGERATION

TABLE 1102.3 (continued)
REFRIGERANT GROUPS, PROPERTIES, AND ALLOWABLE QUANTITIES⁸
[ASHRAE 34: TABLE 4-1, TABLE 4-2]

REFRIGERANT	CHEMICAL FORMULA	CHEMICAL NAME ¹ (COMPOSITION FOR BLENDS)	SAFETY GROUP ⁷	OEL ² (ppm)	POUNDS PER 1000 CUBIC FEET OF SPACE
R-601a	(CH ₃) ₂ CHCH ₂ CH ₃	2-methylbutane (isopentane)	A3	600	0.18
R-610	CH ₃ CH ₂ OCH ₂ CH ₃	Ethoxyethane (ethyl ether)	—	400	—
R-611	HCOOCH ₃	Methyl formate	B2	100	—
R-620	—	(Reserved for future assignment)	—	—	—
R-630	CH ₃ NH ₂	Methanamine (methyl amine)	—	—	—
R-631	CH ₃ CH ₂ (NH ₂)	Ethanamine (ethyl amine)	—	—	—
R-702	H ₂	Hydrogen	A3	—	—
R-704	He	Helium	A1	—	—
R-717	NH ₃	Ammonia	B2L	25	0.014
R-718	H ₂ O	Water	A1	—	—
R-720	Ne	Neon	A1	—	—
R-728	N ₂	Nitrogen	A1	—	—
R-732	O ₂	Oxygen	—	—	—
R-740	Ar	Argon	A1	—	—
R-744	CO ₂	Carbon dioxide	A1	5000	3.4
R-744A	N ₂ O	Nitrous oxide	—	—	—
R-764	SO ₂	Sulfur dioxide	B1	—	—
R-1130(E)	CHCl=CHCl	Trans-1,2-dichloroethene	B1	200	0.25
R-1132a	CF ₂ =CH ₂	1, 1-difluoroethylene	A2	500	2.0
R-1150	CH ₂ =CH ₂	Ethene (ethylene)	A3	200	—
R-1224yd(Z)	CF ₃ CF=CHCl	(Z)-1-chloro-2,3,3,3-tetrafluoropropene	A1	1000	23
R-1233zd(E)	CF ₃ CH=CHCl	Trans-1-chloro-3,3,3-trifluoro-1-propene	A1	800	5.3
R-1234yf	CF ₃ CF=CH ₂	2, 3, 3, 3-tetrafluoro-1-propene	A2L	500	4.7
R-1234ze(E)	CF ₃ CH=CHF	Trans-1,3,3,3-tetrafluoro-1-propene	A2L	800	4.7
R-1270	CH ₃ CH=CH ₂	Propene (propylene)	A3	500	0.11
R-1336mzz(Z)	CF ₃ CHCHCF ₃	Cis-1,1,1,4,4,4-hexafluoro-2-butene	A1	500	5.4

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.

REFRIGERATION

**TABLE 1104.1
PERMISSIBLE REFRIGERATION SYSTEMS¹**

	OCCUPANCY GROUP ³	HIGH-PROBABILITY SYSTEM	LOW PROBABILITY SYSTEM	MACHINERY ROOM
	A-1	Group A1 only	Any	Any
	A-2	Group A1 only	Any	Any
	A-3	Group A1 only	Any	Any
	A-4	Group A1 only	Any	Any
	B	roup A1 ² only	Any	Any
	E	Group A1 only	Any	Any
	F-1	Group A1 ² only	Any	Any
	F-2	Any ²	Any	Any
	H-1	Any	Any	Any
	H-2	Any	Any	Any
	H-3	Any	Any	Any
	H-4	Group A1 only	Any	Any
	H-5	Group A1 only	Any	Any
	I-1	None	Any	Any
	I-2	Group A1 only	Any	Any
[OSHPD 1, 1R, 2, 3, 4 & 5]	I-2.1	Group A1 only	Any	Any
	I-3	None	Any	Any
	I-4	Group A1 only	Any	Any
	M	Group A1 ² only	Any	Any
	R-1	Group A1 only	Any	Any
	R-2	Group A1 only	Any	Any
	R-3	Group A1 only	Any	Any
	R-4	Group A1 only	Any	Any
	S-1	Group A1 ² only	Any	Any
	S-2	Any ²	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.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 12 – HYDRONICS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC-CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X							X	X				X										
Adopt Entire Chapter as amended (amended sections listed below)				X	X					X	X	X		X	X								
Adopt only those sections that are listed below																				X			
Chapter/Section																							
1205.2, <i>Note</i>				X	X																		
1210.2										X	X	X		X	X								
1211.6, <i>Note</i>				X	X																		
1217.5.2.1																				X			
1217.7.1																				X			
1220.4.5.1																				X			

This state agency does not adopt sections identified with the following symbol: ‡

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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, chilled water, steam condensate, condenser water, and ground source heat pump 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. 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.

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 Heater. 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 1203.2
WATER HEATERS

TYPE	STANDARDS
Gas-Fired, 75 000 Btu/h or less, Storage	CSA Z21.10.1
Gas-Fired, Above 75 000 Btu/h, Storage and Instantaneous	CSA Z21.10.3
Electric, Space Heating	UL 834
Solid Fuel-Fired	UL 2523

For SI units: 1000 British thermal units per hour = 0.293 kW

1203.3 Tankless Water Heaters. Tankless water heaters 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 System.

1204.1 General. In buildings where potable water and non-potable 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

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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 1204.3
MINIMUM LENGTH OF COLOR FIELD AND SIZE OF LETTERS

OUTSIDE DIAMETER OF PIPE OR COVERING (inches)	MINIMUM LENGTH OF COLOR FIELD (inches)	MINIMUM SIZE OF LETTERS (inches)
½ to 1¼	8	½
1½ to 2	8	¾
2½ to 6	12	1¼
8 to 10	24	2½
over 10	32	3½

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.

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.

Note: [HCD 1 & HCD 2] PEX-AL-PEX is not adopted in the California Plumbing Code for use in potable water supply and distribution systems.

- (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) 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.

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.

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 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 rated 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 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.

1209.4 Closed-Type Tanks. Closed-type expansion tanks 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.

1209.5 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.

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. *[OSHPD 1, 1R, 2, 4 & 5] Pipe connections less than 2½ inches (64 mm) to heating coils, cooling coils, humidifiers, and similar equipment shall have flexible connectors or three (3) 90-degree offsets in close proximity of the connection.*

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

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**TABLE 1210.1
MATERIALS FOR HYDRONIC SYSTEM PIPING, TUBING, AND FITTINGS**

MATERIAL	STANDARDS	
	PIPING/TUBING	FITTINGS
Copper/Copper Alloy	ASTM B42, ASTM B43, ASTM B75, ASTM B88, ASTM B135, ASTM B251 ² , ASTM B302, ASTM B447	ASME B16.15, ASME B16.18, ASME B16.22, ASME B16.23, ASME B16.24, ASME B16.26, ASME B16.29, ASME B16.51, ASSE 1061, IAPMO PS 117
Ductile Iron	AWWA C115/A21.15, AWWA C151/A21.51	AWWA C110/A21.10 ¹ , AWWA C153/A21.53
Steel	ASTM A53, ASTM A106, ASTM A254	ASME B16.5, ASME B16.9, ASME B16.11, ASTM A420
Stainless Steel	ASTM A269, ASTM A312, ASTM A554, ASTM A778	ASTM F1476, ASTM F1548, ASTM F3226, IAPMO PS 117
Gray Iron	—	ASTM A126
Malleable Iron	—	ASME B16.3
Chlorinated Polyvinyl Chloride (CPVC)	ASTM D2846, ASTM F441, ASTM F442, CSA B137.6	ASSE 1061, ASTM D2846, ASTM F437, ASTM F438, ASTM F439, ASTM F1970, CSA B137.6
Polyethylene (PE)	ASTM D1693, ASTM D2513, ASTM D2683, ASTM D2737, ASTM D3035, ASTM D3350, ASTM F714, AWWA C901, CSA B137.1, NSF 358-1	ASTM D2609, ASTM D2683, ASTM D3261, ASTM F1055, CSA B137.1, NSF 358-1
Cross-Linked Polyethylene (PEX)	ASTM F876, ASTM F3253, CSA B137.5, NSF 358-3	ASSE 1061, ASTM F877, ASTM F1055, ASTM F1807, ASTM F1960, ASTM F2080, ASTM F2098, ASTM F2159, ASTM F2735, ASTM F3253, CSA B137.5, NSF 358-3
Polypropylene (PP)	ASTM F2389, CSA B137.11, NSF 358-2	ASTM F2389, CSA B137.11, NSF 358-2
Polyvinyl Chloride (PVC)	ASTM D1785, ASTM D2241, CSA B137.3	ASTM D2464, ASTM D2466, ASTM D2467, ASTM F1970, CSA B137.2, CSA B137.3
Raised Temperature Polyethylene (PE-RT)	ASTM F2623, ASTM F2769, CSA B137.18	ASSE 1061, ASTM F1807, ASTM F2159, ASTM F2735, ASTM F2769, ASTM D3261, ASTM F1055, CSA B137.18
Cross-Linked Polyethylene/Aluminum/Cross-Linked Polyethylene (PEX-AL-PEX)	ASTM F1281, CSA B137.10	ASTM F1281, ASTM F1974, ASTM F2434, CSA B137.10
Polyethylene/Aluminum/Polyethylene (PE-AL-PE)	ASTM F1282, CSA B137.9	ASTM F1282, ASTM F1974, CSA B137.9
Chlorinated Polyvinyl Chloride/Aluminum/ Chlorinated Polyvinyl Chloride (CPVC/AL/CPVC)	ASTM F2855	ASTM D2846

Note:

¹ Ductile and gray iron.

² Only type K, L, or M tubing allowed to be installed.

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 or red in color, shall be permitted for pipe and fittings manufactured in accordance with ASTM D2846, $\frac{1}{2}$ of an inch (15 mm) through 2 inches (50 mm) in diameter or ASTM F442, $\frac{1}{2}$ 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) Threaded joints for CPVC pipe shall be made with pipe threads in accordance with ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded, and 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 CPVC components once the thread sealant has been applied. Female CPVC threaded fittings shall be used with plastic male threads only.

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, $\frac{1}{2}$ of an inch (15 mm) through 2 inches (50 mm) in diameter, $\frac{1}{2}$ 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.

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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 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 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.

Note: [HCD 1 & HCD 2] PEX-AL-PEX is not adopted in the California Plumbing Code for use in potable water supply and distribution systems.

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 ASTM F2620 and shall be made by simultaneously heating the outside surface of a pipe end and the inside of a fitting socket. Where the proper melt is obtained, the pipe and fitting shall be joined by inserting one into the other with applied force. The joint shall fuse together and remain undisturbed until cool.
- (4) Mechanical joints between PE pipe or tubing and fittings shall include insert and mechanical compression fittings that provide a pressure seal resistance to pullout. Joints for insert fittings shall be made by cutting the pipe square, using a cutter designed for plastic piping, and removal of sharp edges. Two stainless steel clamps shall be placed over the end of the pipe. Fittings shall be checked for proper size based on the diameter of the pipe. The end of pipe shall be placed over the barbed insert fitting, making contact with the fitting shoulder. Clamps shall be positioned equal to 180 degrees (3.14 rad) apart and shall be tightened to provide a leak tight joint. Compression type couplings and fittings shall be permitted for use in joining PE piping and tubing. Stiffeners that extend beyond the clamp or nut shall be prohibited. Bends shall be not less than 30 pipe diameters, or the coil radius where bending with the coil. Bends shall not be permitted closer than 10 pipe diameters of a fitting or valve. Mechanical joints shall be designed for their intended use.

1211.9 Polyethylene/Aluminum/Polyethylene (PE-AL-PE). Joints between polyethylene/aluminum/polyethylene (PE-AL-PE) pipe and fittings shall be installed in accordance with one of the following methods:

- (1) Mechanical joints for PE-AL-PE pipe or tubing and fittings shall be either of the metal insert fittings with a split ring and compression nut or metal insert fittings with copper crimp rings. Metal insert fittings shall comply with

ASTM F1974. Crimp insert fittings shall be joined to the pipe by placing the copper crimp ring around the outer circumference of the pipe, forcing the pipe material into the space formed by the ribs on the fitting until the pipe contacts the shoulder of the fitting. The crimp ring shall then be positioned on the pipe so the edge of the crimp ring is $\frac{1}{8}$ of an inch (3.2 mm) to $\frac{1}{4}$ of an inch (6.4 mm) from the end of the pipe. The jaws of the crimping tool shall be centered over the crimp ring and tool perpendicular to the barb. The jaws shall be closed around the crimp ring and shall not be crimped more than once.

- (2) Compression joints for PE-AL-PE pipe or tubing and fittings shall be joined through the compression of a split ring, by a compression nut around the circumference of the pipe. The compression nut and split ring shall be placed around the pipe. The ribbed end of the fitting shall be inserted onto the pipe until the pipe contacts the shoulder of the fitting. Position and compress the split ring by tightening the compression nut onto the insert fitting.

1211.10 Polyethylene of Raised Temperature (PE-RT).

Joints between polyethylene of raised temperature (PE-RT) 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

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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 piping, approved types of adapter or transition fittings designed for the specific transition intended shall be used.

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 Freeze Protection. Hydronic systems and components shall be designed, installed, and protected from freezing.

1215.4 Balancing. System loops shall be installed so that the design flow rates are achieved within the system.

1215.5 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. Chilled water piping, valves, and fittings shall be insulated and vapor sealed to prevent surface condensation.

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

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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 securely affixed to the manifold to indicate the length of the loop and the room(s) and area(s) served.

TABLE 1217.4
MAXIMUM LENGTH OF CONTINUOUS TUBING FROM
A SUPPLY-AND-RETURN MANIFOLD ARRANGEMENT

NOMINAL TUBE SIZE (inches)	MAXIMUM LOOP LENGTH (feet)
$\frac{1}{4}$	125
$\frac{5}{16}$	200
$\frac{3}{8}$	250
$\frac{1}{2}$	300
$\frac{5}{8}$	400
$\frac{3}{4}$	500
1	750

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

1217.5 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.

1217.5.1 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.

1217.5.2 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.

1217.5.2.1 California Energy Code Insulation Requirements for Heated Slab Floors. See *California Energy Code Section 110.8(g) for additional insulation requirements for heated slab floors – a higher level of insulation is required for Climate Zone 16, and more detailed installation requirements apply to all climate zones.*

1217.5.3 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 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 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.

1217.6.1 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.

1217.7 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.

1217.7.1 California Energy Code Pipe Insulation Requirements. *See California Energy Code Sections 150.0(j)2 and 120.3(c) for pipe insulation requirements based on fluid temperature and pipe diameter – where California Energy Code Table 120.3-A specifies insulation greater than R- 12, the higher value is required.*

» **1217.8 Radiant Heating and Cooling Panels.** Radiant heating and cooling panels shall be installed in accordance with the manufacturer's installation instructions.

» **1217.8.1 Electric Heating Panel Systems.** Clearances for electric heating panels or between outlets, junction boxes, mounting luminaries, ventilating, or other openings shall comply with the *California Electrical Code*.

» **1217.8.2 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 heat-transfer 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 storage tanks. Tanks used to store hot water shall be listed for the intended use and constructed in accordance with nationally recognized standards. A pressure- and temperature-relief valve with a set pressure not exceeding 150 percent of the maximum operating pressure of the system, and at a temperature of 210°F (99°C), shall be installed on the storage tank.

Where the normal operating temperature of the boiler or dual-purpose water heater that provides heat input for domestic hot water exceeds 140°F (60°C), a thermostatically controlled mixing valve as specified in Section 1207.3.1 shall be installed to limit the water supplied to the potable hot water system to a temperature of 140°F (60°C) or less. The potability of the water shall be maintained throughout the system.

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).

HYDRONICS

» **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**
LOOP LENGTHS FOR SNOW AND ICE MELT SYSTEMS^{1,2}

NOMINAL TUBE SIZE (inches)	MAXIMUM ACTIVE LOOP LENGTH (feet)	TOTAL LOOP LENGTH (feet)
PE-RT and PEX Tubing		
1/2	115	140
5/8	225	250
3/4	300	325
1	450	475
Copper Tubing ³		
1/2	—	140
3/4	—	280

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

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 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 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.

» **1220.4.5.1 California Energy Code Insulation Requirements for Heated Slab Floors.** See California Energy Code Section 110.8(g) and Table 110.8-A for additional insulation requirements for heated slab floors – a higher level of insulation is required for Climate Zone 16, and more detailed requirements for installing insulation are specified in all climate zones.

» **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.

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.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 13 – FUEL GAS PIPING

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X		X	X	X			X	X	X	X	X	X	X	X								
Adopt Entire Chapter as amended (amended sections listed below)																							
Adopt only those sections that are listed below																							
Chapter/Section																							

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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 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.
- (9) Liquefied natural gas (LNG) installations.
- (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.
- (14) Installation of LP-Gas systems for railroad switch heating.
- (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.
- (19) Fuel gas systems using hydrogen as a fuel.
- (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

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1313.1. Test gauges used in conducting tests shall be in accordance with Section 1303.3.3 through Section 1303.3.3.4.

1303.3.3 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.

1303.3.3.1 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.

1303.3.3.2 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.

1303.3.3.3 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.

1303.3.3.4 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 permitted to 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. 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 54:5.3.1]

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 – 5.3.2.2]

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 54:5.4.1]

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 54:5.4.2.1 – 5.4.2.2] 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]

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. [NFPA 54:5.4.3]

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, shall be such that the supply pressure at the appliance is greater than or equal to the minimum pressure required by the appliance. [NFPA 54:5.4.4]

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]

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]

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]

TABLE 1308.4.1
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES
[NFPA 54: TABLE A.5.4.2.1]

APPLIANCE	INPUT (Btu/h approx.)
Space Heating Units	
Warm air furnace	
Single family	100 000
Multifamily, per unit	60 000
Hydronic boiler	
Single family	100 000
Multifamily, per unit	60 000
Space and Water Heating Units	
Hydronic boiler	
Single family	120 000
Multifamily, per unit	75 000
Water Heating Appliances	
Water heater, automatic storage	
30 to 40 gallon tank	35 000
Water heater, automatic storage	
50 gallon tank	50 000
Water heater, automatic instantaneous	
Capacity at 2 gallons per minute	142 800
Capacity at 4 gallons per minute	285 000
Capacity at 6 gallons per minute	428 400
Water heater, domestic, circulating or side-arm	35 000
Cooking Appliances	
Range, freestanding, domestic	65 000
Built-in oven or broiler unit, domestic	25 000
Built-in top unit, domestic	40 000
Other Appliances	
Refrigerator	3000
Clothes dryer, Type 1 (domestic)	35 000
Gas fireplace direct vent	40 000
Gas log	80 000
Barbecue	40 000
Gaslight	2500

For SI units: 1000 British thermal units per hour = 0.293 kW

1308.5.2 Metallic Pipe. Cast-iron pipe shall not be used. [NFPA 54:5.6.2.1]

1308.5.2.1 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}

1308.5.2.2 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]

Threaded copper, copper alloy, or aluminum alloy pipe shall not be used with gases corrosive to such material. [NFPA 54:5.6.2.4]

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1308.5.2.3 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]

Aluminum alloy pipe shall not be used in exterior locations or underground. [NFPA 54:5.6.2.6]

1308.5.3 Metallic Tubing. Tubing shall not be used with gases corrosive to the tubing material. [NFPA 54:5.6.3.1]

1308.5.3.1 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]

1308.5.3.2 Steel Tubing. Steel tubing shall comply with ASTM A254. [NFPA 54:5.6.3.2]

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 L of ASTM B88 or ASTM B280.

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 54:5.6.3.5]

1308.5.3.5 Corrugated Stainless Steel Tubing. Corrugated stainless steel tubing shall be listed in accordance with CSA LC-1. [NFPA 54:5.6.3.6]

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 54:5.6.4.1.1] 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] 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]

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 54:5.6.4.2]

1308.5.4.2 Anodeless Risers. Anodeless risers shall comply with Section 1308.5.4.2.1 through Section 1308.5.4.2.3. [NFPA 54:5.6.4.3]

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 54:5.6.4.3(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 54:5.6.4.3(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 54:5.6.4.3(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 54:5.6.5]

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 54:5.6.6.1]

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 54:5.6.6.2]

1308.5.6.2 Number of Threads. Field threading of metallic pipe shall be in accordance with Table 1308.5.6.2. [NFPA 54:5.6.6.3]

**TABLE 1308.5.6.2
SPECIFICATIONS FOR THREADING METALLIC PIPE
[NFPA 54: TABLE 5.6.6.3]**

IRON PIPE SIZE (inches)	APPROXIMATE LENGTH OF THREADED PORTION (inches)	APPROXIMATE NUMBER OF THREADS TO BE CUT
½	¾	10
¾	¾	10
1	7/8	10
1¼	1	11
1½	1	11
2	1	11
2½	1½	12
3	1½	12
4	1¾	13

For SI units: 1 inch = 25.4 mm

» **1308.5.6.3 Thread Joint Compounds.** 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 54:5.6.6.4]

» **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 54:5.6.7]

» **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 54:5.6.7.1]

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 54:5.6.7.2]

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 54:5.6.7.3]

» **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 54:5.6.7.4]

» **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.
 - (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]

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 54:5.6.8]

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- » **1308.5.8.1 Joint Design.** The joint shall be designed and installed so that the longitudinal pull-out resistance of the joint will be at least equal to the tensile strength of the plastic piping material. [NFPA 54:5.6.8(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 fusion fittings shall be marked "ASTM D2513." [NFPA 54:5.6.8(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 54:5.6.10.1.2]
- » **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: <<

- (a) Metal (plain or corrugated)
- (b) Composition
- (c) Aluminum "O" rings
- (d) Spiral-wound metal gaskets
- (e) Rubber-faced phenolic
- (f) 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 54:5.7.1]

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]

1308.6.1.1 Subject to 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]

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]

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]

1308.6.3 Meter Protection. Meters shall be protected against overpressure, backpressure, and vacuum. [NFPA 54:5.7.4]

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]

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]

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]

1308.7.2 Location. The gas pressure regulator shall be accessible for servicing. [NFPA 54:5.8.3]

1308.7.3 Regulator Protection. Pressure regulators shall be protected against physical damage. [NFPA 54:5.8.4]

1308.7.4 Venting of Line Pressure Regulators. 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 54:5.8.5.1]

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]

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]

1308.9 Pressure Limitation Requirements. Where piping systems serving appliances designed to operate with a gas supply pressure of 14 inches water column 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 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 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 54:5.9.2.2]

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 54:5.9.2.3]

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 54:5.9.2.4]

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 54:5.9.2.5]

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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 54:5.9.3.1]

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 54:5.9.3.2]

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 54:5.9.4]

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 54:5.9.5]

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 54:5.9.6]

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 54:5.9.7]

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 54:5.9.8.1, 5.9.8.2]

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 54:5.9.9]

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 54:5.10.1.1, 5.10.1.2]

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 54:5.10.2]

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 54:5.11]

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. Shutoff valves of size 1 inch (25 mm) National Pipe Thread and smaller shall be listed. [NFPA 54:5.12]

1308.14 Expansion and Flexibility. Piping systems shall be designed to prevent failure from thermal expansion or contraction. [NFPA 54:5.14.1]

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 54:5.14.2]

1309.0 Excess Flow Valve.

1309.1 General. Where automatic excess flow valves are installed, they shall be listed to CSA Z21.93 and shall be sized and installed in accordance with the manufacturer's instructions. [NFPA 54:5.13]

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]

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)]

1310.1.2 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]

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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. 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. 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. [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 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 – 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 be securely supported and located where it will be protected from physical damage. 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. 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. [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. [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
[NFPA 54: TABLE 7.2.6.2]**

STEEL PIPE, NOMINAL SIZE OF PIPE(inches)	SPACING OF SUPPORTS (feet)	NOMINAL SIZE OF TUBING SMOOTH-WALL (inches O.D.)	SPACING OF SUPPORTS (feet)
½	6	½	4
¾ or 1	8	¾ or ¾	6
1¼ or larger (horizontal)	10	¾ or 1 (horizontal)	8
1¼ or larger (vertical)	Every floor level	1 or larger (vertical)	Every floor level

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 Tops.** 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. [NFPA 54:7.2.6.4]

» **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 1308.5.7.1).
- (3) Press-connect fittings listed to CSA LC 4.

- (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]

1310.4.4 Piping in Floors. 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: 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 1½ 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 1308.7.4, Section 1308.7.5 and Section 1308.8 through Section 1308.10.7. The regulator shall be accessible for service and repair, and vented in accordance with one of the following:

- (1) Where the fuel gas is lighter than air, regulators equipped with a vent limiting means shall be permitted to be vented into the chase. Regulators not equipped with a vent limiting means shall be permitted

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ted to be vented either directly to the outdoors or to a point within the top 1 foot (305 mm) of the chase.

- (2) Where the fuel gas is heavier than air, the regulator vent shall be vented only directly to the outdoors. [NFPA 54:7.4.1]

»» **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 joints are flanged and all pipe-to-flange connections are made by welding or brazing.
- | (3) The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
- | (4) 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
- | (5) The piping is a temporary installation for buildings under construction.
- | (6) The piping serves appliances or equipment used for agricultural purposes.
- | (7) 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]

» **1310.6.1 LP-Gas Systems.** 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 54:5.5.5]

»» **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 piping 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 54:7.8.1]

1310.11.1 Valves Controlling Multiple Systems. Main gas shutoff valves controlling several gas piping systems shall be readily accessible for operation and installed so as to be protected from physical damage. They 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]

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]

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]

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 54:7.8.2.4]

1310.12 Prohibited Devices. 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 Systems Containing Flammable Gas-Air Mixtures. Systems containing flammable gas-air mixtures shall be in accordance with Section 1310.14.1 through Section 1310.14.6.

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) Safety blowout(s) or backfire preventers for systems utilizing flammable mixture lines above 2½ 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

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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) 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.
- (2) 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).
- (3) Air intakes for gas-mixing machines using compressors or blowers shall be taken from outdoors whenever practical.
- (4) 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.
- (5) 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]

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]

» **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 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 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 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. Connectors used with commercial cooking 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 limited 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 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]

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 supply piping and in such a manner so as to prevent the accumulation of water or foreign matter.

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- (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 the 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.

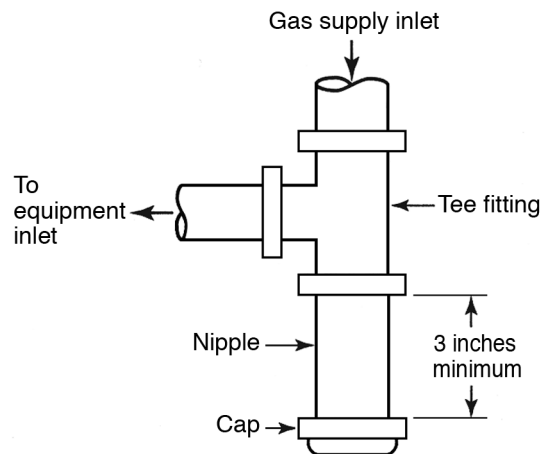
1312.7 Quick-Disconnect Devices. Quick-disconnect devices used to connect appliances to the building piping shall be listed to CSA Z21.41. Where installed indoors, an

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]

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]



For SI units: 1 inch = 25.4 mm

FIGURE 1312.9
METHOD OF INSTALLING A TEE FITTING SEDIMENT TRAP
[NFPA 54: FIGURE 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 Facilities and Piping. Liquefied petroleum 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 54:8.1.2]

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]

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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
SIZE AND LENGTH OF PIPING
[NFPA 54: TABLE 8.3.1]***

NOMINAL PIPING SIZE (inches)	LENGTH OF PIPING (feet)
$\geq 2\frac{1}{2} < 3$	> 50
$\geq 3 < 4$	> 30
$\geq 4 < 6$	> 15
$\geq 6 < 8$	> 10
≥ 8	Any length

For SI units: 1 inch = 25 mm; 1 foot = 304.8 mm

* CSST EHD size of 62 is equivalent to nominal 2 inches (50 mm) pipe or tubing size.

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 1308.4.1 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 ½ of an inch (15 mm).

The size of a piping outlet for a mobile home shall be not less than ¾ 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 54:6.3.1, 6.3.2]

1315.3 Sizing Equations. The inside diameter of smooth wall pipe or tubing shall be determined by Equation 1315.3(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]

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LOW-PRESSURE GAS FORMULA (LESS THAN 1.5 psi) (10.3 kPa) [NFPA 54:6.4.1]

[Equation 1315.3(1)]

$$D = \frac{Q^{0.381}}{19.17 \left(\frac{\Delta H}{Cr \times L} \right)^{0.206}}$$

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
 ΔH = 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]

[Equation 1315.3(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 foot = 304.8 mm, 1 pound-force per square inch = 6.8947 kPa, °C = (°F-32)/1.8, 1 inch mercury column = 3.39 kPa, 1 inch water column = 0.249 kPa

TABLE 1315.3
Cr AND Y FOR NATURAL GAS AND UNDILUTED
PROPANE AT STANDARD CONDITIONS
[NFPA 54: TABLE 6.4.2]

GAS	FORMULA FACTORS	
	Cr	Y
Natural Gas	0.6094	0.9992
Undiluted Propane	1.2462	0.9910

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:

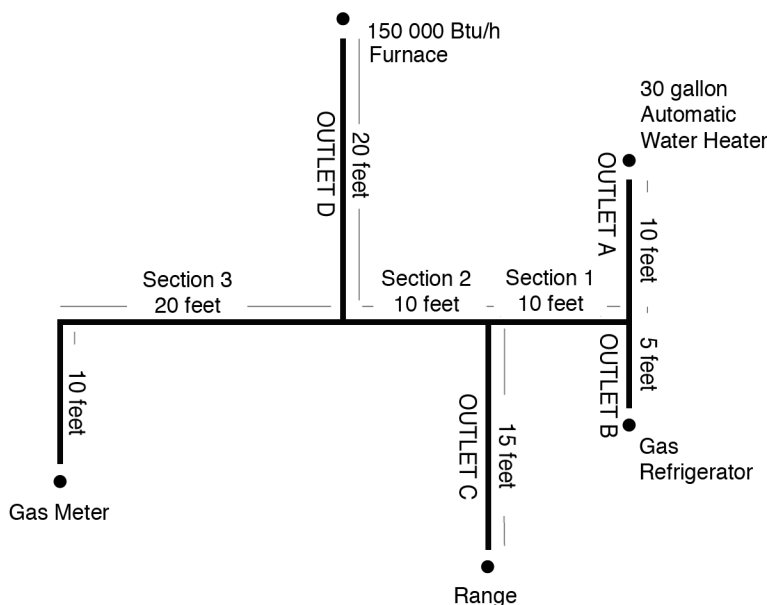
- (1) Measure the length of the pipe from the gas meter location to the most remote outlet on the system.
- (2) Select the length in feet column and row showing the distance, or the next longer distance where the table does not give the exact length.
- (3) Starting at the most remote outlet, find in 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 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.



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).
Maximum gas demand of Outlet B –
3 cubic feet per hour (0.08 m³/h) (from Table 1308.4.1).
Maximum gas demand of Outlet C –
59 cubic feet per hour (1.67 m³/h) (from Table 1308.4.1).
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.

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TABLE 1315.2(1)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(b)]^{1,2}

									GAS:		NATURAL			
									INLET PRESSURE:		LESS THAN 2 psi			
									PRESSURE DROP:		0.5 in. w.c.			
									SPECIFIC GRAVITY:		0.60			
	PIPE SIZE (inch)													
NOMINAL:	½	¾	1	1¼	1½	2	2½	3	4	5	6	8	10	12
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR													
10	172	360	678	1390	2090	4020	6400	11 300	23 100	41 800	67 600	139 000	252 000	399 000
20	118	247	466	957	1430	2760	4400	7780	15 900	28 700	46 500	95 500	173 000	275 000
30	95	199	374	768	1150	2220	3530	6250	12 700	23 000	37 300	76 700	139 000	220 000
40	81	170	320	657	985	1900	3020	5350	10 900	19 700	31 900	65 600	119 000	189 000
50	72	151	284	583	873	1680	2680	4740	9660	17 500	28 300	58 200	106 000	167 000
60	65	137	257	528	791	1520	2430	4290	8760	15 800	25 600	52 700	95 700	152 000
70	60	126	237	486	728	1400	2230	3950	8050	14 600	23 600	48 500	88 100	139 000
80	56	117	220	452	677	1300	2080	3670	7490	13 600	22 000	45 100	81 900	130 000
90	52	110	207	424	635	1220	1950	3450	7030	12 700	20 600	42 300	76 900	122 000
100	50	104	195	400	600	1160	1840	3260	6640	12 000	19 500	40 000	72 600	115 000
125	44	92	173	355	532	1020	1630	2890	5890	10 600	17 200	35 400	64 300	102 000
150	40	83	157	322	482	928	1480	2610	5330	9650	15 600	32 100	58 300	92 300
175	37	77	144	296	443	854	1360	2410	4910	8880	14 400	29 500	53 600	84 900
200	34	71	134	275	412	794	1270	2240	4560	8260	13 400	27 500	49 900	79 000
250	30	63	119	244	366	704	1120	1980	4050	7320	11 900	24 300	44 200	70 000
300	27	57	108	221	331	638	1020	1800	3670	6630	10 700	22 100	40 100	63 400
350	25	53	99	203	305	587	935	1650	3370	6100	9880	20 300	36 900	58 400
400	23	49	92	189	283	546	870	1540	3140	5680	9190	18 900	34 300	54 300
450	22	46	86	177	266	512	816	1440	2940	5330	8620	17 700	32 200	50 900
500	21	43	82	168	251	484	771	1360	2780	5030	8150	16 700	30 400	48 100
550	20	41	78	159	239	459	732	1290	2640	4780	7740	15 900	28 900	45 700
600	19	39	74	152	228	438	699	1240	2520	4560	7380	15 200	27 500	43 600
650	18	38	71	145	218	420	669	1180	2410	4360	7070	14 500	26 400	41 800
700	17	36	68	140	209	403	643	1140	2320	4190	6790	14 000	25 300	40 100
750	17	35	66	135	202	389	619	1090	2230	4040	6540	13 400	24 400	38 600
800	16	34	63	130	195	375	598	1060	2160	3900	6320	13 000	23 600	37 300
850	16	33	61	126	189	363	579	1020	2090	3780	6110	12 600	22 800	36 100
900	15	32	59	122	183	352	561	992	2020	3660	5930	12 200	22 100	35 000
950	15	31	58	118	178	342	545	963	1960	3550	5760	11 800	21 500	34 000
1000	14	30	56	115	173	333	530	937	1910	3460	5600	11 500	20 900	33 100
1100	14	28	53	109	164	316	503	890	1810	3280	5320	10 900	19 800	31 400
1200	13	27	51	104	156	301	480	849	1730	3130	5070	10 400	18 900	30 000
1300	12	26	49	100	150	289	460	813	1660	3000	4860	9980	18 100	28 700
1400	12	25	47	96	144	277	442	781	1590	2880	4670	9590	17 400	27 600
1500	11	24	45	93	139	267	426	752	1530	2780	4500	9240	16 800	26 600
1600	11	23	44	89	134	258	411	727	1480	2680	4340	8920	16 200	25 600
1700	11	22	42	86	130	250	398	703	1430	2590	4200	8630	15 700	24 800
1800	10	22	41	84	126	242	386	682	1390	2520	4070	8370	15 200	24 100
1900	10	21	40	81	122	235	375	662	1350	2440	3960	8130	14 800	23 400
2000	NA	20	39	79	119	229	364	644	1310	2380	3850	7910	14 400	22 700

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).

FUEL GAS PIPING

TABLE 1315.2(2)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(c)]*

						GAS:		NATURAL	
						INLET PRESSURE:		LESS THAN 2 psi	
						PRESSURE DROP:		3.0 in. w.c.	
						SPECIFIC GRAVITY:		0.60	
INTENDED USE: INITIAL SUPPLY PRESSURE OF 8.0 IN. W.C. OR GREATER									
	PIPE SIZE (inch)								
NOMINAL:	½	¾	1	1¼	1½	2	2½	3	4
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	454	949	1790	3670	5500	10 600	16 900	29 800	60 800
20	312	652	1230	2520	3780	7280	11 600	20 500	41 800
30	250	524	986	2030	3030	5840	9310	16 500	33 600
40	214	448	844	1730	2600	5000	7970	14 100	28 700
50	190	397	748	1540	2300	4430	7060	12 500	25 500
60	172	360	678	1390	2090	4020	6400	11 300	23 100
70	158	331	624	1280	1920	3690	5890	10 400	21 200
80	147	308	580	1190	1790	3440	5480	9690	19 800
90	138	289	544	1120	1670	3230	5140	9090	18 500
100	131	273	514	1060	1580	3050	4860	8580	17 500
125	116	242	456	936	1400	2700	4300	7610	15 500
150	105	219	413	848	1270	2450	3900	6890	14 100
175	96	202	380	780	1170	2250	3590	6340	12 900
200	90	188	353	726	1090	2090	3340	5900	12 000
250	80	166	313	643	964	1860	2960	5230	10 700
300	72	151	284	583	873	1680	2680	4740	9660
350	66	139	261	536	803	1550	2470	4360	8890
400	62	129	243	499	747	1440	2290	4050	8270
450	58	121	228	468	701	1350	2150	3800	7760
500	55	114	215	442	662	1280	2030	3590	7330
550	52	109	204	420	629	1210	1930	3410	6960
600	50	104	195	400	600	1160	1840	3260	6640
650	47	99	187	384	575	1110	1760	3120	6360
700	46	95	179	368	552	1060	1690	3000	6110
750	44	92	173	355	532	1020	1630	2890	5890
800	42	89	167	343	514	989	1580	2790	5680
850	41	86	162	332	497	957	1530	2700	5500
900	40	83	157	322	482	928	1480	2610	5330
950	39	81	152	312	468	901	1440	2540	5180
1000	38	79	148	304	455	877	1400	2470	5040
1100	36	75	141	289	432	833	1330	2350	4780
1200	34	71	134	275	412	794	1270	2240	4560
1300	33	68	128	264	395	761	1210	2140	4370
1400	31	65	123	253	379	731	1160	2060	4200
1500	30	63	119	244	366	704	1120	1980	4050
1600	29	61	115	236	353	680	1080	1920	3910
1700	28	59	111	228	342	658	1050	1850	3780
1800	27	57	108	221	331	638	1020	1800	3670
1900	27	56	105	215	322	619	987	1750	3560
2000	26	54	102	209	313	602	960	1700	3460

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.

FUEL GAS PIPING

TABLE 1315.2(3)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(d)]*

						GAS:		NATURAL	
						INLET PRESSURE:		LESS THAN 2 psi	
						PRESSURE DROP:		6.0 in. w.c.	
						SPECIFIC GRAVITY:		0.60	
INTENDED USE: INITIAL SUPPLY PRESSURE OF 11.0 IN. W.C. OR GREATER									
	PIPE SIZE (inch)								
NOMINAL:	½	¾	1	1¼	1½	2	2½	3	4
ACTUAL ID:	0.622	0.824	1.049	1.38	1.61	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	660	1380	2600	5340	8000	15 400	24 600	43 400	88 500
20	454	949	1790	3670	5500	10 600	16 900	29 800	60 800
30	364	762	1440	2950	4410	8500	13 600	24 000	48 900
40	312	652	1230	2520	3780	7280	11 600	20 500	41 800
50	276	578	1090	2240	3350	6450	10 300	18 200	37 100
60	250	524	986	2030	3030	5840	9310	16 500	33 600
70	230	482	907	1860	2790	5380	8570	15 100	30 900
80	214	448	844	1730	2600	5000	7970	14 100	28 700
90	201	420	792	1630	2440	4690	7480	13 200	27 000
100	190	397	748	1540	2300	4430	7060	12 500	25 500
125	168	352	663	1360	2040	3930	6260	11 100	22 600
150	153	319	601	1230	1850	3560	5670	10 000	20 500
175	140	293	553	1140	1700	3270	5220	9230	18 800
200	131	273	514	1056	1580	3050	4860	8580	17 500
250	116	242	456	936	1400	2700	4300	7610	15 500
300	105	219	413	848	1270	2450	3900	6890	14 100
350	96	202	380	780	1170	2250	3590	6340	12 900
400	90	188	353	726	1090	2090	3340	5900	12 000
450	84	176	332	681	1020	1960	3130	5540	11 300
500	80	166	313	643	964	1860	2960	5230	10 700
550	76	158	297	611	915	1760	2810	4970	10 100
600	72	151	284	583	873	1680	2680	4740	9660
650	69	144	272	558	836	1610	2570	4540	9250
700	66	139	261	536	803	1550	2470	4360	8890
750	64	134	252	516	774	1490	2380	4200	8560
800	62	129	243	499	747	1440	2290	4050	8270
850	60	125	235	483	723	1390	2220	3920	8000
900	58	121	228	468	701	1350	2150	3800	7760
950	56	118	221	454	681	1310	2090	3690	7540
1000	55	114	215	442	662	1280	2030	3590	7330
1100	52	109	204	420	629	1210	1930	3410	6960
1200	50	104	195	400	600	1160	1840	3260	6640
1300	47	99	187	384	575	1110	1760	3120	6360
1400	46	95	179	368	552	1060	1690	3000	6110
1500	44	92	173	355	532	1020	1630	2890	5890
1600	42	89	167	343	514	989	1580	2790	5680
1700	41	86	162	332	497	957	1530	2700	5500
1800	40	83	157	322	482	928	1480	2610	5330
1900	39	81	152	312	468	901	1440	2540	5180
2000	38	79	148	304	455	877	1400	2470	5040

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.

FUEL GAS PIPING

TABLE 1315.2(4)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(e)]*

						GAS:		NATURAL	
						INLET PRESSURE:		2.0 psi	
						PRESSURE DROP:		1.0 psi	
						SPECIFIC GRAVITY:		0.60	
	PIPE SIZE (inch)								
NOMINAL:	½	¾	1	1¼	1½	2	2½	3	4
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	1510	3040	5560	11 400	17 100	32 900	52 500	92 800	189 000
20	1070	2150	3930	8070	12 100	23 300	37 100	65 600	134 000
30	869	1760	3210	6590	9880	19 000	30 300	53 600	109 000
40	753	1520	2780	5710	8550	16 500	26 300	46 400	94 700
50	673	1360	2490	5110	7650	14 700	23 500	41 500	84 700
60	615	1240	2270	4660	6980	13 500	21 400	37 900	77 300
70	569	1150	2100	4320	6470	12 500	19 900	35 100	71 600
80	532	1080	1970	4040	6050	11 700	18 600	32 800	67 000
90	502	1010	1850	3810	5700	11 000	17 500	30 900	63 100
100	462	934	1710	3510	5260	10 100	16 100	28 500	58 200
125	414	836	1530	3140	4700	9060	14 400	25 500	52 100
150	372	751	1370	2820	4220	8130	13 000	22 900	46 700
175	344	695	1270	2601	3910	7530	12 000	21 200	43 300
200	318	642	1170	2410	3610	6960	11 100	19 600	40 000
250	279	583	1040	2140	3210	6180	9850	17 400	35 500
300	253	528	945	1940	2910	5600	8920	15 800	32 200
350	232	486	869	1790	2670	5150	8210	14 500	29 600
400	216	452	809	1660	2490	4790	7640	13 500	27 500
450	203	424	759	1560	2330	4500	7170	12 700	25 800
500	192	401	717	1470	2210	4250	6770	12 000	24 400
550	182	381	681	1400	2090	4030	6430	11 400	23 200
600	174	363	650	1330	2000	3850	6130	10 800	22 100
650	166	348	622	1280	1910	3680	5870	10 400	21 200
700	160	334	598	1230	1840	3540	5640	9970	20 300
750	154	322	576	1180	1770	3410	5440	9610	19 600
800	149	311	556	1140	1710	3290	5250	9280	18 900
850	144	301	538	1100	1650	3190	5080	8980	18 300
900	139	292	522	1070	1600	3090	4930	8710	17 800
950	135	283	507	1040	1560	3000	4780	8460	17 200
1000	132	275	493	1010	1520	2920	4650	8220	16 800
1100	125	262	468	960	1440	2770	4420	7810	15 900
1200	119	250	446	917	1370	2640	4220	7450	15 200
1300	114	239	427	878	1320	2530	4040	7140	14 600
1400	110	230	411	843	1260	2430	3880	6860	14 000
1500	106	221	396	812	1220	2340	3740	6600	13 500
1600	102	214	382	784	1180	2260	3610	6380	13 000
1700	99	207	370	759	1140	2190	3490	6170	12 600
1800	96	200	358	736	1100	2120	3390	5980	12 200
1900	93	195	348	715	1070	2060	3290	5810	11 900
2000	91	189	339	695	1040	2010	3200	5650	11 500

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.

FUEL GAS PIPING

TABLE 1315.2(5)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(f)]*

						GAS:		NATURAL	
						INLET PRESSURE:		3.0 psi	
						PRESSURE DROP:		2.0 psi	
						SPECIFIC GRAVITY:		0.60	
	PIPE SIZE (inch)								
NOMINAL:	½	¾	1	1¼	1½	2	2½	3	4
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	2350	4920	9270	19 000	28 500	54 900	87 500	155 000	316 000
20	1620	3380	6370	13 100	19 600	37 700	60 100	106 000	217 000
30	1300	2720	5110	10 500	15 700	30 300	48 300	85 400	174 000
40	1110	2320	4380	8990	13 500	25 900	41 300	73 100	149 000
50	985	2060	3880	7970	11 900	23 000	36 600	64 800	132 000
60	892	1870	3520	7220	10 800	20 800	33 200	58 700	120 000
70	821	1720	3230	6640	9950	19 200	30 500	54 000	110 000
80	764	1600	3010	6180	9260	17 800	28 400	50 200	102 000
90	717	1500	2820	5800	8680	16 700	26 700	47 100	96 100
100	677	1420	2670	5470	8200	15 800	25 200	44 500	90 800
125	600	1250	2360	4850	7270	14 000	22 300	39 500	80 500
150	544	1140	2140	4400	6590	12 700	20 200	35 700	72 900
175	500	1050	1970	4040	6060	11 700	18 600	32 900	67 100
200	465	973	1830	3760	5640	10 900	17 300	30 600	62 400
250	412	862	1620	3330	5000	9620	15 300	27 100	55 300
300	374	781	1470	3020	4530	8720	13 900	24 600	50 100
350	344	719	1350	2780	4170	8020	12 800	22 600	46 100
400	320	669	1260	2590	3870	7460	11 900	21 000	42 900
450	300	627	1180	2430	3640	7000	11 200	19 700	40 200
500	283	593	1120	2290	3430	6610	10 500	18 600	38 000
550	269	563	1060	2180	3260	6280	10 000	17 700	36 100
600	257	537	1010	2080	3110	5990	9550	16 900	34 400
650	246	514	969	1990	2980	5740	9150	16 200	33 000
700	236	494	931	1910	2860	5510	8790	15 500	31 700
750	228	476	897	1840	2760	5310	8470	15 000	30 500
800	220	460	866	1780	2660	5130	8180	14 500	29 500
850	213	445	838	1720	2580	4960	7910	14 000	28 500
900	206	431	812	1670	2500	4810	7670	13 600	27 700
950	200	419	789	1620	2430	4670	7450	13 200	26 900
1000	195	407	767	1580	2360	4550	7240	12 800	26 100
1100	185	387	729	1500	2240	4320	6890	12 200	24 800
1200	177	369	695	1430	2140	4120	6570	11 600	23 700
1300	169	353	666	1370	2050	3940	6290	11 100	22 700
1400	162	340	640	1310	1970	3790	6040	10 700	21 800
1500	156	327	616	1270	1900	3650	5820	10 300	21 000
1600	151	316	595	1220	1830	3530	5620	10 000	20 300
1700	146	306	576	1180	1770	3410	5440	9610	19 600
1800	142	296	558	1150	1720	3310	5270	9320	19 000
1900	138	288	542	1110	1670	3210	5120	9050	18 400
2000	134	280	527	1080	1620	3120	4980	8800	18 000

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.

FUEL GAS PIPING

TABLE 1315.2(6)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2.1(g)]*

						GAS:		NATURAL	
						INLET PRESSURE:		5.0 psi	
						PRESSURE DROP:		3.5 psi	
						SPECIFIC GRAVITY:		0.60	
	PIPE SIZE (inch)								
NOMINAL:	½	¾	1	1¼	1½	2	2½	3	4
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	3190	6430	11 800	24 200	36 200	69 700	111 000	196 000	401 000
20	2250	4550	8320	17 100	25 600	49 300	78 600	139 000	283 000
30	1840	3720	6790	14 000	20 900	40 300	64 200	113 000	231 000
40	1590	3220	5880	12 100	18 100	34 900	55 600	98 200	200 000
50	1430	2880	5260	10 800	16 200	31 200	49 700	87 900	179 000
60	1300	2630	4800	9860	14 800	28 500	45 400	80 200	164 000
70	1200	2430	4450	9130	13 700	26 400	42 000	74 300	151 000
80	1150	2330	4260	8540	12 800	24 700	39 300	69 500	142 000
90	1060	2150	3920	8050	12 100	23 200	37 000	65 500	134 000
100	979	1980	3620	7430	11 100	21 400	34 200	60 400	123 000
125	876	1770	3240	6640	9950	19 200	30 600	54 000	110 000
150	786	1590	2910	5960	8940	17 200	27 400	48 500	98 900
175	728	1470	2690	5520	8270	15 900	25 400	44 900	91 600
200	673	1360	2490	5100	7650	14 700	23 500	41 500	84 700
250	558	1170	2200	4510	6760	13 000	20 800	36 700	74 900
300	506	1060	1990	4090	6130	11 800	18 800	33 300	67 800
350	465	973	1830	3760	5640	10 900	17 300	30 600	62 400
400	433	905	1710	3500	5250	10 100	16 100	28 500	58 100
450	406	849	1600	3290	4920	9480	15 100	26 700	54 500
500	384	802	1510	3100	4650	8950	14 300	25 200	51 500
550	364	762	1440	2950	4420	8500	13 600	24 000	48 900
600	348	727	1370	2810	4210	8110	12 900	22 900	46 600
650	333	696	1310	2690	4030	7770	12 400	21 900	44 600
700	320	669	1260	2590	3880	7460	11 900	21 000	42 900
750	308	644	1210	2490	3730	7190	11 500	20 300	41 300
800	298	622	1170	2410	3610	6940	11 100	19 600	39 900
850	288	602	1130	2330	3490	6720	10 700	18 900	38 600
900	279	584	1100	2260	3380	6520	10 400	18 400	37 400
950	271	567	1070	2190	3290	6330	10 100	17 800	36 400
1000	264	551	1040	2130	3200	6150	9810	17 300	35 400
1100	250	524	987	2030	3030	5840	9320	16 500	33 600
1200	239	500	941	1930	2900	5580	8890	15 700	32 000
1300	229	478	901	1850	2770	5340	8510	15 000	30 700
1400	220	460	866	1780	2660	5130	8180	14 500	29 500
1500	212	443	834	1710	2570	4940	7880	13 900	28 400
1600	205	428	806	1650	2480	4770	7610	13 400	27 400
1700	198	414	780	1600	2400	4620	7360	13 000	26 500
1800	192	401	756	1550	2330	4480	7140	12 600	25 700
1900	186	390	734	1510	2260	4350	6930	12 300	25 000
2000	181	379	714	1470	2200	4230	6740	11 900	24 300

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.

FUEL GAS PIPING

TABLE 1315.2(7)
SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(h)]^{1, 2}

							GAS: NATURAL			
							INLET PRESSURE:		LESS THAN 2 psi	
							PRESSURE DROP:		0.3 in. w.c.	
							SPECIFIC GRAVITY:		0.60	
	TUBE SIZE (inch)									
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	7⁄8	1⅛	1⅜	—	—
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		20	42	85	148	210	448	806	1270	2650
20		14	29	58	102	144	308	554	873	1820
30		11	23	47	82	116	247	445	701	1460
40		10	20	40	70	99	211	381	600	1250
50		NA	17	35	62	88	187	337	532	1110
60		NA	16	32	56	79	170	306	482	1000
70		NA	14	29	52	73	156	281	443	924
80		NA	13	27	48	68	145	262	413	859
90		NA	13	26	45	64	136	245	387	806
100		NA	12	24	43	60	129	232	366	761
125		NA	11	22	38	53	114	206	324	675
150		NA	10	20	34	48	103	186	294	612
175		NA	NA	18	31	45	95	171	270	563
200		NA	NA	17	29	41	89	159	251	523
250		NA	NA	15	26	37	78	141	223	464
300		NA	NA	13	23	33	71	128	202	420
350		NA	NA	12	22	31	65	118	186	387
400		NA	NA	11	20	28	61	110	173	360
450		NA	NA	11	19	27	57	103	162	338
500		NA	NA	10	18	25	54	97	153	319
550		NA	NA	NA	17	24	51	92	145	303
600		NA	NA	NA	16	23	49	88	139	289
650		NA	NA	NA	15	22	47	84	133	277
700		NA	NA	NA	15	21	45	81	128	266
750		NA	NA	NA	14	20	43	78	123	256
800		NA	NA	NA	14	20	42	75	119	247
850		NA	NA	NA	13	19	40	73	115	239
900		NA	NA	NA	13	18	39	71	111	232
950		NA	NA	NA	13	18	38	69	108	225
1000		NA	NA	NA	12	17	37	67	105	219
1100		NA	NA	NA	12	16	35	63	100	208
1200		NA	NA	NA	11	16	34	60	95	199
1300		NA	NA	NA	11	15	32	58	91	190
1400		NA	NA	NA	10	14	31	56	88	183
1500		NA	NA	NA	NA	14	30	54	84	176
1600		NA	NA	NA	NA	13	29	52	82	170
1700		NA	NA	NA	NA	13	28	50	79	164
1800		NA	NA	NA	NA	13	27	49	77	159
1900		NA	NA	NA	NA	12	26	47	74	155
2000		NA	NA	NA	NA	12	25	46	72	151

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(8)
SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(i)]^{1, 2}

							GAS: NATURAL			
							INLET PRESSURE: LESS THAN 2 psi			
							PRESSURE DROP: 0.5 in. w.c.			
							SPECIFIC GRAVITY: 0.60			
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1½	1¾	—	—
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		27	55	111	195	276	590	1060	1680	3490
20		18	38	77	134	190	406	730	1150	2400
30		15	30	61	107	152	326	586	925	1930
40		13	26	53	92	131	279	502	791	1650
50		11	23	47	82	116	247	445	701	1460
60		10	21	42	74	105	224	403	635	1320
70		NA	19	39	68	96	206	371	585	1220
80		NA	18	36	63	90	192	345	544	1130
90		NA	17	34	59	84	180	324	510	1060
100		NA	16	32	56	79	170	306	482	1000
125		NA	14	28	50	70	151	271	427	890
150		NA	13	26	45	64	136	245	387	806
175		NA	12	24	41	59	125	226	356	742
200		NA	11	22	39	55	117	210	331	690
250		NA	NA	20	34	48	103	186	294	612
300		NA	NA	18	31	44	94	169	266	554
350		NA	NA	16	28	40	86	155	245	510
400		NA	NA	15	26	38	80	144	228	474
450		NA	NA	14	25	35	75	135	214	445
500		NA	NA	13	23	33	71	128	202	420
550		NA	NA	13	22	32	68	122	192	399
600		NA	NA	12	21	30	64	116	183	381
650		NA	NA	12	20	29	62	111	175	365
700		NA	NA	11	20	28	59	107	168	350
750		NA	NA	11	19	27	57	103	162	338
800		NA	NA	10	18	26	55	99	156	326
850		NA	NA	10	18	25	53	96	151	315
900		NA	NA	NA	17	24	52	93	147	306
950		NA	NA	NA	17	24	50	90	143	297
1000		NA	NA	NA	16	23	49	88	139	289
1100		NA	NA	NA	15	22	46	84	132	274
1200		NA	NA	NA	15	21	44	80	126	262
1300		NA	NA	NA	14	20	42	76	120	251
1400		NA	NA	NA	13	19	41	73	116	241
1500		NA	NA	NA	13	18	39	71	111	232
1600		NA	NA	NA	13	18	38	68	108	224
1700		NA	NA	NA	12	17	37	66	104	217
1800		NA	NA	NA	12	17	36	64	101	210
1900		NA	NA	NA	11	16	35	62	98	204
2000		NA	NA	NA	11	16	34	60	95	199

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)]^{1, 2}

							GAS: NATURAL			
							INLET PRESSURE: LESS THAN 2 psi			
							PRESSURE DROP: 1.0 in. w.c.			
							SPECIFIC GRAVITY: 0.60			
INTENDED USE: TUBE SIZING BETWEEN HOUSE LINE REGULATOR AND THE APPLIANCE										
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	–	–
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	730	1150	2400
50		16	33	68	119	168	359	647	1020	2130
60		15	30	61	107	152	326	586	925	1930
70		13	28	57	99	140	300	539	851	1770
80		13	26	53	92	131	279	502	791	1650
90		12	24	49	86	122	262	471	742	1550
100		11	23	47	82	116	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	NA	17	24	52	93	147	306
1900		NA	NA	NA	17	24	50	90	143	297
2000		NA	NA	NA	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.

FUEL GAS PIPING

TABLE 1315.2(10)
SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(k)]²

							GAS: NATURAL			
							INLET PRESSURE: LESS THAN 2 psi			
							PRESSURE DROP: 17.0 in. w.c.			
							SPECIFIC GRAVITY: 0.60			
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1½	1¾	—	—
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ¹		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		190	391	796	1390	1970	4220	7590	12 000	24 900
20		130	269	547	956	1360	2900	5220	8230	17 100
30		105	216	439	768	1090	2330	4190	6610	13 800
40		90	185	376	657	932	1990	3590	5650	11 800
50		79	164	333	582	826	1770	3180	5010	10 400
60		72	148	302	528	749	1600	2880	4540	9460
70		66	137	278	486	689	1470	2650	4180	8700
80		62	127	258	452	641	1370	2460	3890	8090
90		58	119	243	424	601	1280	2310	3650	7590
100		55	113	229	400	568	1210	2180	3440	7170
125		48	100	203	355	503	1080	1940	3050	6360
150		44	90	184	321	456	974	1750	2770	5760
175		40	83	169	296	420	896	1610	2540	5300
200		38	77	157	275	390	834	1500	2370	4930
250		33	69	140	244	346	739	1330	2100	4370
300		30	62	126	221	313	670	1210	1900	3960
350		28	57	116	203	288	616	1110	1750	3640
400		26	53	108	189	268	573	1030	1630	3390
450		24	50	102	177	252	538	968	1530	3180
500		23	47	96	168	238	508	914	1440	3000
550		22	45	91	159	226	482	868	1370	2850
600		21	43	87	152	215	460	829	1310	2720
650		20	41	83	145	206	441	793	1250	2610
700		19	39	80	140	198	423	762	1200	2500
750		18	38	77	135	191	408	734	1160	2410
800		18	37	74	130	184	394	709	1120	2330
850		17	35	72	126	178	381	686	1080	2250
900		17	34	70	122	173	370	665	1050	2180
950		16	33	68	118	168	359	646	1020	2120
1000		16	32	66	115	163	349	628	991	2060
1100		15	31	63	109	155	332	597	941	1960
1200		14	29	60	104	148	316	569	898	1870
1300		14	28	57	100	142	303	545	860	1790
1400		13	27	55	96	136	291	524	826	1720
1500		13	26	53	93	131	280	505	796	1660
1600		12	25	51	89	127	271	487	768	1600
1700		12	24	49	86	123	262	472	744	1550
1800		11	24	48	84	119	254	457	721	1500
1900		11	23	47	81	115	247	444	700	1460
2000		11	22	45	79	112	240	432	681	1420

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.

FUEL GAS PIPING

TABLE 1315.2(11)
SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.2.1(I)]²

		GAS: NATURAL								
		INLET PRESSURE: 2.0 psi								
		PRESSURE DROP: 1.0 psi								
		SPECIFIC GRAVITY: 0.60								
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	7⁄8	1½	1¾	–	–
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ¹		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		245	506	1030	1800	2550	5450	9820	15 500	32 200
20		169	348	708	1240	1760	3750	6750	10 600	22 200
30		135	279	568	993	1410	3010	5420	8550	17 800
40		116	239	486	850	1210	2580	4640	7310	15 200
50		103	212	431	754	1070	2280	4110	6480	13 500
60		93	192	391	683	969	2070	3730	5870	12 200
70		86	177	359	628	891	1900	3430	5400	11 300
80		80	164	334	584	829	1770	3190	5030	10 500
90		75	154	314	548	778	1660	2990	4720	9820
100		71	146	296	518	735	1570	2830	4450	9280
125		63	129	263	459	651	1390	2500	3950	8220
150		57	117	238	416	590	1260	2270	3580	7450
175		52	108	219	383	543	1160	2090	3290	6850
200		49	100	204	356	505	1080	1940	3060	6380
250		43	89	181	315	448	956	1720	2710	5650
300		39	80	164	286	406	866	1560	2460	5120
350		36	74	150	263	373	797	1430	2260	4710
400		33	69	140	245	347	741	1330	2100	4380
450		31	65	131	230	326	696	1250	1970	4110
500		30	61	124	217	308	657	1180	1870	3880
550		28	58	118	206	292	624	1120	1770	3690
600		27	55	112	196	279	595	1070	1690	3520
650		26	53	108	188	267	570	1030	1620	3370
700		25	51	103	181	256	548	986	1550	3240
750		24	49	100	174	247	528	950	1500	3120
800		23	47	96	168	239	510	917	1450	3010
850		22	46	93	163	231	493	888	1400	2920
900		22	44	90	158	224	478	861	1360	2830
950		21	43	88	153	217	464	836	1320	2740
1000		20	42	85	149	211	452	813	1280	2670
1100		19	40	81	142	201	429	772	1220	2540
1200		18	38	77	135	192	409	737	1160	2420
1300		18	36	74	129	183	392	705	1110	2320
1400		17	35	71	124	176	376	678	1070	2230
1500		16	34	68	120	170	363	653	1030	2140
1600		16	33	66	116	164	350	630	994	2070
1700		15	31	64	112	159	339	610	962	2000
1800		15	30	62	108	154	329	592	933	1940
1900		14	30	60	105	149	319	575	906	1890
2000		14	29	59	102	145	310	559	881	1830

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)]³

							GAS:		NATURAL	
							INLET PRESSURE:		2.0 psi	
							PRESSURE DROP:		1.5 psi	
							SPECIFIC GRAVITY:		0.60	
INTENDED USE: PIPE SIZING BETWEEN POINT OF DELIVERY AND THE HOUSE LINE REGULATOR. TOTAL LOAD SUPPLIED BY A SINGLE HOUSE LINE REGULATOR NOT EXCEEDING 150 CUBIC FEET PER HOUR ² .										
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅞	1⅞	—	—
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ¹		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		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	38	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)]²

		GAS: NATURAL								
		INLET PRESSURE: 5.0 psi								
		PRESSURE DROP: 3.5 psi								
		SPECIFIC GRAVITY: 0.60								
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	7⁄8	1½	1¾	–	–
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ¹		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		511	1050	2140	3750	5320	11 400	20 400	32 200	67 100
20		351	724	1470	2580	3650	7800	14 000	22 200	46 100
30		282	582	1180	2070	2930	6270	11 300	17 800	37 000
40		241	498	1010	1770	2510	5360	9660	15 200	31 700
50		214	441	898	1570	2230	4750	8560	13 500	28 100
60		194	400	813	1420	2020	4310	7750	12 200	25 500
70		178	368	748	1310	1860	3960	7130	11 200	23 400
80		166	342	696	1220	1730	3690	6640	10 500	21 800
90		156	321	653	1140	1620	3460	6230	9820	20 400
100		147	303	617	1080	1530	3270	5880	9270	19 300
125		130	269	547	955	1360	2900	5210	8220	17 100
150		118	243	495	866	1230	2620	4720	7450	15 500
175		109	224	456	796	1130	2410	4350	6850	14 300
200		101	208	424	741	1050	2250	4040	6370	13 300
250		90	185	376	657	932	1990	3580	5650	11 800
300		81	167	340	595	844	1800	3250	5120	10 700
350		75	154	313	547	777	1660	2990	4710	9810
400		69	143	291	509	722	1540	2780	4380	9120
450		65	134	273	478	678	1450	2610	4110	8560
500		62	127	258	451	640	1370	2460	3880	8090
550		58	121	245	429	608	1300	2340	3690	7680
600		56	115	234	409	580	1240	2230	3520	7330
650		53	110	224	392	556	1190	2140	3370	7020
700		51	106	215	376	534	1140	2050	3240	6740
750		49	102	207	362	514	1100	1980	3120	6490
800		48	98	200	350	497	1060	1910	3010	6270
850		46	95	194	339	481	1030	1850	2910	6070
900		45	92	188	328	466	1000	1790	2820	5880
950		43	90	182	319	452	967	1740	2740	5710
1000		42	87	177	310	440	940	1690	2670	5560
1100		40	83	169	295	418	893	1610	2530	5280
1200		38	79	161	281	399	852	1530	2420	5040
1300		37	76	154	269	382	816	1470	2320	4820
1400		35	73	148	259	367	784	1410	2220	4630
1500		34	70	143	249	353	755	1360	2140	4460
1600		33	68	138	241	341	729	1310	2070	4310
1700		32	65	133	233	330	705	1270	2000	4170
1800		31	63	129	226	320	684	1230	1940	4040
1900		30	62	125	219	311	664	1200	1890	3930
2000		29	60	122	213	302	646	1160	1830	3820

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)]^{1, 2}

									GAS:		NATURAL			
									INLET PRESSURE:		LESS THAN 2 psi			
									PRESSURE DROP:		0.5 in. w.c.			
									SPECIFIC GRAVITY:		0.60			
	TUBE SIZE (EHD) ³													
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR													
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	18	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

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: $L = 1.3 n$, 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.

FUEL GAS PIPING

TABLE 1315.2(15)
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.2.1(p)]^{1, 2}

								GAS:				NATURAL		
								INLET PRESSURE:				LESS THAN 2 psi		
								PRESSURE DROP:				3.0 in. w.c.		
								SPECIFIC GRAVITY:				0.60		
INTENDED USE: INITIAL SUPPLY PRESSURE OF 8.0 INCH WATER COLUMN OR GREATER														
	TUBE SIZE (EHD) ³													
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR													
5	120	160	277	327	529	649	1180	1370	2140	2423	4430	5010	8800	10 100
10	83	112	197	231	380	462	828	958	1530	1740	3200	3560	6270	7160
15	67	90	161	189	313	379	673	778	1250	1433	2540	2910	5140	5850
20	57	78	140	164	273	329	580	672	1090	1249	2200	2530	4460	5070
25	51	69	125	147	245	295	518	599	978	1123	1960	2270	4000	4540
30	46	63	115	134	225	270	471	546	895	1029	1790	2070	3660	4140
40	39	54	100	116	196	234	407	471	778	897	1550	1800	3180	3590
50	35	48	89	104	176	210	363	421	698	806	1380	1610	2850	3210
60	32	44	82	95	161	192	330	383	639	739	1260	1470	2600	2930
70	29	41	76	88	150	178	306	355	593	686	1170	1360	2420	2720
80	27	38	71	82	141	167	285	331	555	644	1090	1280	2260	2540
90	26	36	67	77	133	157	268	311	524	609	1030	1200	2140	2400
100	24	34	63	73	126	149	254	295	498	579	974	1140	2030	2280
150	19	27	52	60	104	122	206	240	409	477	793	936	1660	1860
200	17	23	45	52	91	106	178	207	355	415	686	812	1440	1610
250	15	21	40	46	82	95	159	184	319	373	613	728	1290	1440
300	13	19	37	42	75	87	144	168	234	342	559	665	1180	1320

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: $L = 1.3 n$, 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.

TABLE 1315.2(16)
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.2.1(q)]^{1, 2}

								GAS: NATURAL				NATURAL					
								INLET PRESSURE:				LESS THAN 2 psi					
								PRESSURE DROP:				6.0 in. w.c.					
								SPECIFIC GRAVITY:				0.60					
INTENDED USE: INITIAL SUPPLY PRESSURE OF 11.0 INCH WATER COLUMN OR GREATER																	
	TUBE SIZE (EHD) ³																
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62			
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR																
5	173	229	389	461	737	911	1690	1950	3000	3375	6280	7050	12 400	14 260			
10	120	160	277	327	529	649	1180	1370	2140	2423	4430	5010	8800	10 100			
15	96	130	227	267	436	532	960	1110	1760	1996	3610	4100	7210	8260			
20	83	112	197	231	380	462	828	958	1530	1740	3120	3560	6270	7160			
25	74	99	176	207	342	414	739	855	1370	1564	2790	3190	5620	6400			
30	67	90	161	189	313	379	673	778	1250	1433	2540	2910	5140	5850			
40	57	78	140	164	273	329	580	672	1090	1249	2200	2530	4460	5070			
50	51	69	125	147	245	295	518	599	978	1123	1960	2270	4000	4540			
60	46	63	115	134	225	270	471	546	895	1029	1790	2070	3660	4140			
70	42	58	106	124	209	250	435	505	830	956	1660	1920	3390	3840			
80	39	54	100	116	196	234	407	471	778	897	1550	1800	3180	3590			
90	37	51	94	109	185	221	383	444	735	848	1460	1700	3000	3390			
100	35	48	89	104	176	210	363	421	698	806	1380	1610	2850	3210			
150	28	39	73	85	145	172	294	342	573	664	1130	1320	2340	2630			
200	24	34	63	73	126	149	254	295	498	579	974	1140	2030	2280			
250	21	30	57	66	114	134	226	263	447	520	870	1020	1820	2040			
300	19	27	52	60	104	122	206	240	409	477	793	936	1660	1860			

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: $L = 1.3 n$, 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:		2.0 psi			
									PRESSURE DROP:		1.0 psi			
									SPECIFIC GRAVITY:		0.60			
	TUBE SIZE (EHD) ⁵													
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR													
10	270	353	587	700	1100	1370	2590	2990	4510	5037	9600	10 700	18 600	21 600
25	166	220	374	444	709	876	1620	1870	2890	3258	6040	6780	11 900	13 700
30	151	200	342	405	650	801	1480	1700	2640	2987	5510	6200	10 900	12 500
40	129	172	297	351	567	696	1270	1470	2300	2605	4760	5380	9440	10 900
50	115	154	266	314	510	624	1140	1310	2060	2343	4260	4820	8470	9720
75	93	124	218	257	420	512	922	1070	1690	1932	3470	3950	6940	7940
80	89	120	211	249	407	496	892	1030	1640	1874	3360	3820	6730	7690
100	79	107	189	222	366	445	795	920	1470	1685	3000	3420	6030	6880
150	64	87	155	182	302	364	646	748	1210	1389	2440	2800	4940	5620
200	55	75	135	157	263	317	557	645	1050	1212	2110	2430	4290	4870
250	49	67	121	141	236	284	497	576	941	1090	1890	2180	3850	4360
300	44	61	110	129	217	260	453	525	862	999	1720	1990	3520	3980
400	38	52	96	111	189	225	390	453	749	871	1490	1730	3060	3450
500	34	46	86	100	170	202	348	404	552	783	1330	1550	2740	3090

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.

									GAS:		NATURAL			
									INLET PRESSURE:		5.0 psi			
									PRESSURE DROP:		3.5 psi			
									SPECIFIC GRAVITY:		0.60			
	TUBE SIZE (EHD) ⁵													
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR													
10	523	674	1080	1300	2000	2530	4920	5660	8300	9140	18 100	19 800	34 400	40 400
25	322	420	691	827	1290	1620	3080	3540	5310	5911	11 400	12 600	22 000	25 600
30	292	382	632	755	1180	1480	2800	3230	4860	5420	10 400	11 500	20 100	23 400
40	251	329	549	654	1030	1280	2420	2790	4230	4727	8970	10 000	17 400	20 200
50	223	293	492	586	926	1150	2160	2490	3790	4251	8020	8930	15 600	18 100
75	180	238	403	479	763	944	1750	2020	3110	3506	6530	7320	12 800	14 800
80	174	230	391	463	740	915	1690	1960	3020	3400	6320	7090	12 400	14 300
100	154	205	350	415	665	820	1510	1740	2710	3057	5650	6350	11 100	12 800
150	124	166	287	339	548	672	1230	1420	2220	2521	4600	5200	9130	10 500
200	107	143	249	294	478	584	1060	1220	1930	2199	3980	4510	7930	9090
250	95	128	223	263	430	524	945	1090	1730	1977	3550	4040	7110	8140
300	86	116	204	240	394	479	860	995	1590	1813	3240	3690	6500	7430
400	74	100	177	208	343	416	742	858	1380	1581	2800	3210	5650	6440
500	66	89	159	186	309	373	662	766	1040	1422	2500	2870	5060	5760

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 reg-
ulator 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 equiva-
lent length of tubing to the following equation: $L = 1.3 n$, 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.

FUEL GAS PIPING

TABLE 1315.2(19)
POLYETHYLENE PLASTIC PIPE [NFPA 54: TABLE 6.2.1(t)]*

					GAS: NATURAL			
					INLET PRESSURE: LESS THAN 2 psi			
					PRESSURE DROP: 0.3 in. w.c.			
					SPECIFIC GRAVITY: 0.60			
	PIPE SIZE (inch)							
NOMINAL OD:	½	¾	1	1 ¼	1 ½	2	3	4
DESIGNATION:	SDR 9.3	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
ACTUAL ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR							
10	153	305	551	955	1440	2590	7170	13 900
20	105	210	379	656	991	1780	4920	9520
30	84	169	304	527	796	1430	3950	7640
40	72	144	260	451	681	1220	3380	6540
50	64	128	231	400	604	1080	3000	5800
60	58	116	209	362	547	983	2720	5250
70	53	107	192	333	503	904	2500	4830
80	50	99	179	310	468	841	2330	4500
90	46	93	168	291	439	789	2180	4220
100	44	88	159	275	415	745	2060	3990
125	39	78	141	243	368	661	1830	3530
150	35	71	127	221	333	598	1660	3200
175	32	65	117	203	306	551	1520	2940
200	30	60	109	189	285	512	1420	2740
250	27	54	97	167	253	454	1260	2430
300	24	48	88	152	229	411	1140	2200
350	22	45	81	139	211	378	1050	2020
400	21	42	75	130	196	352	974	1880
450	19	39	70	122	184	330	914	1770
500	18	37	66	115	174	312	863	1670

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.

FUEL GAS PIPING

TABLE 1315.2(20)
POLYETHYLENE PLASTIC PIPE [NFPA 54: TABLE 6.2.1(u)]*

					GAS: NATURAL			
					INLET PRESSURE: LESS THAN 2 psi			
					PRESSURE DROP: 0.5 in. w.c.			
					SPECIFIC GRAVITY: 0.60			
	PIPE SIZE (inch)							
NOMINAL OD:	½	¾	1	1 ¼	1 ½	2	3	4
DESIGNATION:	SDR 9.3	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
ACTUAL ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR							
10	201	403	726	1260	1900	3410	9450	18 260
20	138	277	499	865	1310	2350	6490	12 550
30	111	222	401	695	1050	1880	5210	10 080
40	95	190	343	594	898	1610	4460	8630
50	84	169	304	527	796	1430	3950	7640
60	76	153	276	477	721	1300	3580	6930
70	70	140	254	439	663	1190	3300	6370
80	65	131	236	409	617	1110	3070	5930
90	61	123	221	383	579	1040	2880	5560
100	58	116	209	362	547	983	2720	5250
125	51	103	185	321	485	871	2410	4660
150	46	93	168	291	439	789	2180	4220
175	43	86	154	268	404	726	2010	3880
200	40	80	144	249	376	675	1870	3610
250	35	71	127	221	333	598	1660	3200
300	32	64	115	200	302	542	1500	2900
350	29	59	106	184	278	499	1380	2670
400	27	55	99	171	258	464	1280	2480
450	26	51	93	160	242	435	1200	2330
500	24	48	88	152	229	411	1140	2200

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.

FUEL GAS PIPING

TABLE 1315.2(21)
POLYETHYLENE PLASTIC PIPE [NFPA 54: TABLE 6.2.1(v)]*

					GAS:		NATURAL	
					INLET PRESSURE:		2.0 psi	
					PRESSURE DROP:		1.0 psi	
					SPECIFIC GRAVITY:		0.60	
	PIPE SIZE (inch)							
NOMINAL OD:	½	¾	1	1 ¼	1 ½	2	3	4
DESIGNATION:	SDR 9.3	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
ACTUAL ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR							
10	1860	3720	6710	11 600	17 600	31 600	87 300	169 000
20	1280	2560	4610	7990	12 100	21 700	60 000	116 000
30	1030	2050	3710	6420	9690	17 400	48 200	93 200
40	878	1760	3170	5490	8300	14 900	41 200	79 700
50	778	1560	2810	4870	7350	13 200	36 600	70 700
60	705	1410	2550	4410	6660	12 000	33 100	64 000
70	649	1300	2340	4060	6130	11 000	30 500	58 900
80	603	1210	2180	3780	5700	10 200	28 300	54 800
90	566	1130	2050	3540	5350	9610	26 600	51 400
100	535	1070	1930	3350	5050	9080	25 100	48 600
125	474	949	1710	2970	4480	8050	22 300	43 000
150	429	860	1550	2690	4060	7290	20 200	39 000
175	395	791	1430	2470	3730	6710	18 600	35 900
200	368	736	1330	2300	3470	6240	17 300	33 400
250	326	652	1180	2040	3080	5530	15 300	29 600
300	295	591	1070	1850	2790	5010	13 900	26 800
350	272	544	981	1700	2570	4610	12 800	24 700
400	253	506	913	1580	2390	4290	11 900	22 900
450	237	475	856	1480	2240	4020	11 100	21 500
500	224	448	809	1400	2120	3800	10 500	20 300
550	213	426	768	1330	2010	3610	9990	19 300
600	203	406	733	1270	1920	3440	9530	18 400
650	194	389	702	1220	1840	3300	9130	17 600
700	187	374	674	1170	1760	3170	8770	16 900
750	180	360	649	1130	1700	3050	8450	16 300
800	174	348	627	1090	1640	2950	8160	15 800
850	168	336	607	1050	1590	2850	7890	15 300
900	163	326	588	1020	1540	2770	7650	14 800
950	158	317	572	990	1500	2690	7430	14 400
1000	154	308	556	963	1450	2610	7230	14 000
1100	146	293	528	915	1380	2480	6870	13 300
1200	139	279	504	873	1320	2370	6550	12 700
1300	134	267	482	836	1260	2270	6270	12 100
1400	128	257	463	803	1210	2180	6030	11 600
1500	124	247	446	773	1170	2100	5810	11 200
1600	119	239	431	747	1130	2030	5610	10 800
1700	115	231	417	723	1090	1960	5430	10 500
1800	112	224	404	701	1060	1900	5260	10 200
1900	109	218	393	680	1030	1850	5110	9900
2000	106	212	382	662	1000	1800	4970	9600

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)]^{2, 3}

	GAS: NATURAL	
	INLET PRESSURE:	LESS THAN 2.0 psi
	PRESSURE DROP:	0.3 in. w.c.
	SPECIFIC GRAVITY:	0.60
	PLASTIC TUBING SIZE (CTS) ¹ (inch)	
NOMINAL OD:	½	1
DESIGNATION:	SDR 7	SDR 11
ACTUAL ID:	0.445	0.927
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR	
10	54	372
20	37	256
30	30	205
40	26	176
50	23	156
60	21	141
70	19	130
80	18	121
90	17	113
100	16	107
125	14	95
150	13	86
175	12	79
200	11	74
225	10	69
250	NA	65
275	NA	62
300	NA	59
350	NA	54
400	NA	51
450	NA	47
500	NA	45

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283m³/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)]^{2, 3}

	GAS: NATURAL	
	INLET PRESSURE:	LESS THAN 2.0 psi
	PRESSURE DROP:	0.5 in. w.c.
	SPECIFIC GRAVITY:	0.60
	PLASTIC TUBING SIZE (CTS) ¹ (inch)	
NOMINAL OD:	½	1
DESIGNATION:	SDR 7	SDR 11
ACTUAL ID:	0.445	0.927
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR	
10	72	490
20	49	337
30	39	271
40	34	232
50	30	205
60	27	186
70	25	171
80	23	159
90	22	149
100	21	141
125	18	125
150	17	113
175	15	104
200	14	97
225	13	91
250	12	86
275	11	82
300	11	78
350	10	72
400	NA	67
450	NA	63
500	NA	59

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283m³/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).

FUEL GAS PIPING

TABLE 1315.2(24)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3.1(a)]*

						GAS:		UNDILUTED PROPANE	
						INLET PRESSURE:		10.0 psi	
						PRESSURE DROP:		1.0 psi	
						SPECIFIC GRAVITY:		1.50	
INTENDED USE: PIPE SIZING BETWEEN FIRST STAGE (HIGH PRESSURE) REGULATOR AND SECOND STAGE (LOW PRESSURE) REGULATOR									
	PIPE SIZE (inch)								
NOMINAL INSIDE:	½	¾	1	1¼	1½	2	2½	3	4
ACTUAL:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR								
10	3320	6950	13 100	26 900	40 300	77 600	124 000	219 000	446 000
20	2280	4780	9000	18 500	27 700	53 300	85 000	150 000	306 000
30	1830	3840	7220	14 800	22 200	42 800	68 200	121 000	246 000
40	1570	3280	6180	12 700	19 000	36 600	58 400	103 000	211 000
50	1390	2910	5480	11 300	16 900	32 500	51 700	91 500	187 000
60	1260	2640	4970	10 200	15 300	29 400	46 900	82 900	169 000
70	1160	2430	4570	9380	14 100	27 100	43 100	76 300	156 000
80	1080	2260	4250	8730	13 100	25 200	40 100	70 900	145 000
90	1010	2120	3990	8190	12 300	23 600	37 700	66 600	136 000
100	956	2000	3770	7730	11 600	22 300	35 600	62 900	128 000
125	848	1770	3340	6850	10 300	19 800	31 500	55 700	114 000
150	768	1610	3020	6210	9300	17 900	28 600	50 500	103 000
175	706	1480	2780	5710	8560	16 500	26 300	46 500	94 700
200	657	1370	2590	5320	7960	15 300	24 400	43 200	88 100
250	582	1220	2290	4710	7060	13 600	21 700	38 300	78 100
300	528	1100	2080	4270	6400	12 300	19 600	34 700	70 800
350	486	1020	1910	3930	5880	11 300	18 100	31 900	65 100
400	452	945	1780	3650	5470	10 500	16 800	29 700	60 600
450	424	886	1670	3430	5140	9890	15 800	27 900	56 800
500	400	837	1580	3240	4850	9340	14 900	26 300	53 700
550	380	795	1500	3070	4610	8870	14 100	25 000	51 000
600	363	759	1430	2930	4400	8460	13 500	23 900	48 600
650	347	726	1370	2810	4210	8110	12 900	22 800	46 600
700	334	698	1310	2700	4040	7790	12 400	21 900	44 800
750	321	672	1270	2600	3900	7500	12 000	21 100	43 100
800	310	649	1220	2510	3760	7240	11 500	20 400	41 600
850	300	628	1180	2430	3640	7010	11 200	19 800	40 300
900	291	609	1150	2360	3530	6800	10 800	19 200	39 100
950	283	592	1110	2290	3430	6600	10 500	18 600	37 900
1000	275	575	1080	2230	3330	6420	10 200	18 100	36 900
1100	261	546	1030	2110	3170	6100	9720	17 200	35 000
1200	249	521	982	2020	3020	5820	9270	16 400	33 400
1300	239	499	940	1930	2890	5570	8880	15 700	32 000
1400	229	480	903	1850	2780	5350	8530	15 100	30 800
1500	221	462	870	1790	2680	5160	8220	14 500	29 600
1600	213	446	840	1730	2590	4980	7940	14 000	28 600
1700	206	432	813	1670	2500	4820	7680	13 600	27 700
1800	200	419	789	1620	2430	4670	7450	13 200	26 900
1900	194	407	766	1570	2360	4540	7230	12 800	26 100
2000	189	395	745	1530	2290	4410	7030	12 400	25 400

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(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									
	PIPE SIZE (inch)								
NOMINAL INSIDE:	½	¾	1	1¼	1½	2	2½	3	4
ACTUAL:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR								
10	5890	12 300	23 200	47 600	71 300	137 000	219 000	387 000	789 000
20	4050	8460	15 900	32 700	49 000	94 400	150 000	266 000	543 000
30	3250	6790	12 800	26 300	39 400	75 800	121 000	214 000	436 000
40	2780	5810	11 000	22 500	33 700	64 900	103 000	183 000	373 000
50	2460	5150	9710	19 900	29 900	57 500	91 600	162 000	330 000
60	2230	4670	8790	18 100	27 100	52 100	83 000	147 000	299 000
70	2050	4300	8090	16 600	24 900	47 900	76 400	135 000	275 000
80	1910	4000	7530	15 500	23 200	44 600	71 100	126 000	256 000
90	1790	3750	7060	14 500	21 700	41 800	66 700	118 000	240 000
100	1690	3540	6670	13 700	20 500	39 500	63 000	111 000	227 000
125	1500	3140	5910	12 100	18 200	35 000	55 800	98 700	201 000
150	1360	2840	5360	11 000	16 500	31 700	50 600	89 400	182 000
175	1250	2620	4930	10 100	15 200	29 200	46 500	82 300	167 800
200	1160	2430	4580	9410	14 100	27 200	43 300	76 500	156 100
250	1030	2160	4060	8340	12 500	24 100	38 400	67 800	138 400
300	935	1950	3680	7560	11 300	21 800	34 800	61 500	125 400
350	860	1800	3390	6950	10 400	20 100	32 000	56 500	115 300
400	800	1670	3150	6470	9690	18 700	29 800	52 600	107 300
450	751	1570	2960	6070	9090	17 500	27 900	49 400	100 700
500	709	1480	2790	5730	8590	16 500	26 400	46 600	95 100
550	673	1410	2650	5450	8160	15 700	25 000	44 300	90 300
600	642	1340	2530	5200	7780	15 000	23 900	42 200	86 200
650	615	1290	2420	4980	7450	14 400	22 900	40 500	82 500
700	591	1240	2330	4780	7160	13 800	22 000	38 900	79 300
750	569	1190	2240	4600	6900	13 300	21 200	37 400	76 400
800	550	1150	2170	4450	6660	12 800	20 500	36 200	73 700
850	532	1110	2100	4300	6450	12 400	19 800	35 000	71 400
900	516	1080	2030	4170	6250	12 000	19 200	33 900	69 200
950	501	1050	1970	4050	6070	11 700	18 600	32 900	67 200
1000	487	1020	1920	3940	5900	11 400	18 100	32 000	65 400
1100	463	968	1820	3740	5610	10 800	17 200	30 400	62 100
1200	442	923	1740	3570	5350	10 300	16 400	29 000	59 200
1300	423	884	1670	3420	5120	9870	15 700	27 800	56 700
1400	406	849	1600	3280	4920	9480	15 100	26 700	54 500
1500	391	818	1540	3160	4740	9130	14 600	25 700	52 500
1600	378	790	1490	3060	4580	8820	14 100	24 800	50 700
1700	366	765	1440	2960	4430	8530	13 600	24 000	49 000
1800	355	741	1400	2870	4300	8270	13 200	23 300	47 600
1900	344	720	1360	2780	4170	8040	12 800	22 600	46 200
2000	335	700	1320	2710	4060	7820	12 500	22 000	44 900

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)]*

						GAS:		UNDILUTED PROPANE	
						INLET PRESSURE:		2.0 psi	
						PRESSURE DROP:		1.0 psi	
						SPECIFIC GRAVITY:		1.50	
INTENDED USE: PIPE SIZING BETWEEN 2 PSIG SERVICE AND LINE PRESSURE REGULATOR									
	PIPE SIZE (inch)								
NOMINAL:	½	¾	1	1¼	1½	2	2½	3	4
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR								
10	2680	5590	10 500	21 600	32 400	62 400	99 500	176 000	359 000
20	1840	3850	7240	14 900	22 300	42 900	68 400	121 000	247 000
30	1480	3090	5820	11 900	17 900	34 500	54 900	97 100	198 000
40	1260	2640	4980	10 200	15 300	29 500	47 000	83 100	170 000
50	1120	2340	4410	9060	13 600	26 100	41 700	73 700	150 000
60	1010	2120	4000	8210	12 300	23 700	37 700	66 700	136 000
70	934	1950	3680	7550	11 300	21 800	34 700	61 400	125 000
80	869	1820	3420	7020	10 500	20 300	32 300	57 100	116 000
90	815	1700	3210	6590	9880	19 000	30 300	53 600	109 000
100	770	1610	3030	6230	9330	18 000	28 600	50 600	103 000
125	682	1430	2690	5520	8270	15 900	25 400	44 900	91 500
150	618	1290	2440	5000	7490	14 400	23 000	40 700	82 900
175	569	1190	2240	4600	6890	13 300	21 200	37 400	76 300
200	529	1110	2080	4280	6410	12 300	19 700	34 800	71 000
250	469	981	1850	3790	5680	10 900	17 400	30 800	62 900
300	425	889	1670	3440	5150	9920	15 800	27 900	57 000
350	391	817	1540	3160	4740	9120	14 500	25 700	52 400
400	364	760	1430	2940	4410	8490	13 500	23 900	48 800
450	341	714	1340	2760	4130	7960	12 700	22 400	45 800
500	322	674	1270	2610	3910	7520	12 000	21 200	43 200
550	306	640	1210	2480	3710	7140	11 400	20 100	41 100
600	292	611	1150	2360	3540	6820	10 900	19 200	39 200
650	280	585	1100	2260	3390	6530	10 400	18 400	37 500
700	269	562	1060	2170	3260	6270	9990	17 700	36 000
750	259	541	1020	2090	3140	6040	9630	17 000	34 700
800	250	523	985	2020	3030	5830	9300	16 400	33 500
850	242	506	953	1960	2930	5640	9000	15 900	32 400
900	235	490	924	1900	2840	5470	8720	15 400	31 500
950	228	476	897	1840	2760	5310	8470	15 000	30 500
1000	222	463	873	1790	2680	5170	8240	14 600	29 700
1100	210	440	829	1700	2550	4910	7830	13 800	28 200
1200	201	420	791	1620	2430	4680	7470	13 200	26 900
1300	192	402	757	1550	2330	4490	7150	12 600	25 800
1400	185	386	727	1490	2240	4310	6870	12 100	24 800
1500	178	372	701	1440	2160	4150	6620	11 700	23 900
1600	172	359	677	1390	2080	4010	6390	11 300	23 000
1700	166	348	655	1340	2010	3880	6180	10 900	22 300
1800	161	337	635	1300	1950	3760	6000	10 600	21 600
1900	157	327	617	1270	1900	3650	5820	10 300	21 000
2000	152	318	600	1230	1840	3550	5660	10 000	20 400

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(27)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3.1(d)]*

						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									
	PIPE SIZE (inch)								
NOMINAL INSIDE:	½	¾	1	1¼	1½	2	2½	3	4
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR								
10	291	608	1150	2350	3520	6790	10 800	19 100	39 000
20	200	418	787	1620	2420	4660	7430	13 100	26 800
30	160	336	632	1300	1940	3750	5970	10 600	21 500
40	137	287	541	1110	1660	3210	5110	9030	18 400
50	122	255	480	985	1480	2840	4530	8000	16 300
60	110	231	434	892	1340	2570	4100	7250	14 800
80	101	212	400	821	1230	2370	3770	6670	13 600
100	94	197	372	763	1140	2200	3510	6210	12 700
125	89	185	349	716	1070	2070	3290	5820	11 900
150	84	175	330	677	1010	1950	3110	5500	11 200
175	74	155	292	600	899	1730	2760	4880	9950
200	67	140	265	543	814	1570	2500	4420	9010
250	62	129	243	500	749	1440	2300	4060	8290
300	58	120	227	465	697	1340	2140	3780	7710
350	51	107	201	412	618	1190	1900	3350	6840
400	46	97	182	373	560	1080	1720	3040	6190
450	42	89	167	344	515	991	1580	2790	5700
500	40	83	156	320	479	922	1470	2600	5300
550	37	78	146	300	449	865	1380	2440	4970
600	35	73	138	283	424	817	1300	2300	4700
650	33	70	131	269	403	776	1240	2190	4460
700	32	66	125	257	385	741	1180	2090	4260
750	30	64	120	246	368	709	1130	2000	4080
800	29	61	115	236	354	681	1090	1920	3920
850	28	59	111	227	341	656	1050	1850	3770
900	27	57	107	220	329	634	1010	1790	3640
950	26	55	104	213	319	613	978	1730	3530
1000	25	53	100	206	309	595	948	1680	3420
1100	25	52	97	200	300	578	921	1630	3320
1200	24	50	95	195	292	562	895	1580	3230
1300	23	48	90	185	277	534	850	1500	3070
1400	22	46	86	176	264	509	811	1430	2930
1500	21	44	82	169	253	487	777	1370	2800
1600	20	42	79	162	243	468	746	1320	2690
1700	19	40	76	156	234	451	719	1270	2590
1800	19	39	74	151	226	436	694	1230	2500
1900	18	38	71	146	219	422	672	1190	2420
2000	18	37	69	142	212	409	652	1150	2350

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.

FUEL GAS PIPING

TABLE 1315.2(28)
SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.3.1(e)]²

							GAS:		UNDILUTED PROPANE	
							INLET PRESSURE:		10.0 psi	
							PRESSURE DROP:		1.0 psi	
							SPECIFIC GRAVITY:		1.50	
INTENDED USE: TUBE SIZING BETWEEN FIRST STAGE (HIGH PRESSURE) REGULATOR AND SECOND STAGE (LOW PRESSURE) REGULATOR										
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	7⁄8	1⅞	1⅝	—	—
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ¹		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN THOUSANDS OF BTU PER HOUR								
10		513	1060	2150	3760	5330	11 400	20 500	32 300	67 400
20		352	727	1480	2580	3670	7830	14 100	22 200	46 300
30		283	584	1190	2080	2940	6290	11 300	17 900	37 200
40		242	500	1020	1780	2520	5380	9690	15 300	31 800
50		215	443	901	1570	2230	4770	8590	13 500	28 200
60		194	401	816	1430	2020	4320	7780	12 300	25 600
70		179	369	751	1310	1860	3980	7160	11 300	23 500
80		166	343	699	1220	1730	3700	6660	10 500	21 900
90		156	322	655	1150	1630	3470	6250	9850	20 500
100		147	304	619	1080	1540	3280	5900	9310	19 400
125		131	270	549	959	1360	2910	5230	8250	17 200
150		118	244	497	869	1230	2630	4740	7470	15 600
175		109	225	457	799	1130	2420	4360	6880	14 300
200		101	209	426	744	1060	2250	4060	6400	13 300
250		90	185	377	659	935	2000	3600	5670	11 800
300		81	168	342	597	847	1810	3260	5140	10 700
350		75	155	314	549	779	1660	3000	4730	9840
400		70	144	292	511	725	1550	2790	4400	9160
450		65	135	274	480	680	1450	2620	4130	8590
500		62	127	259	453	643	1370	2470	3900	8120
550		59	121	246	430	610	1300	2350	3700	7710
600		56	115	235	410	582	1240	2240	3530	7350
650		54	111	225	393	558	1190	2140	3380	7040
700		51	106	216	378	536	1140	2060	3250	6770
750		50	102	208	364	516	1100	1980	3130	6520
800		48	99	201	351	498	1060	1920	3020	6290
850		46	96	195	340	482	1030	1850	2920	6090
900		45	93	189	330	468	1000	1800	2840	5910
950		44	90	183	320	454	970	1750	2750	5730
1000		42	88	178	311	442	944	1700	2680	5580
1100		40	83	169	296	420	896	1610	2540	5300
1200		38	79	161	282	400	855	1540	2430	5050
1300		37	76	155	270	383	819	1470	2320	4840
1400		35	73	148	260	368	787	1420	2230	4650
1500		34	70	143	250	355	758	1360	2150	4480
1600		33	68	138	241	343	732	1320	2080	4330
1700		32	66	134	234	331	708	1270	2010	4190
1800		31	64	130	227	321	687	1240	1950	4060
1900		30	62	126	220	312	667	1200	1890	3940
2000		29	60	122	214	304	648	1170	1840	3830

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}

							GAS:		UNDILUTED PROPANE	
							INLET PRESSURE:		11.0 in. w.c.	
							PRESSURE DROP:		0.5 in. w.c.	
							SPECIFIC GRAVITY:		1.50	
INTENDED USE: TUBE SIZING BETWEEN SINGLE OR SECOND STAGE (LOW PRESSURE) REGULATOR AND APPLIANCE										
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	7⁄8	1⅛	1⅜	—	—
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ¹		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN THOUSANDS OF BTU PER HOUR								
10		45	93	188	329	467	997	1800	2830	5890
20		31	64	129	226	321	685	1230	1950	4050
30		25	51	104	182	258	550	991	1560	3250
40		21	44	89	155	220	471	848	1340	2780
50		19	39	79	138	195	417	752	1180	2470
60		17	35	71	125	177	378	681	1070	2240
70		16	32	66	115	163	348	626	988	2060
80		15	30	61	107	152	324	583	919	1910
90		14	28	57	100	142	304	547	862	1800
100		13	27	54	95	134	287	517	814	1700
125		11	24	48	84	119	254	458	722	1500
150		10	21	44	76	108	230	415	654	1360
175		NA	20	40	70	99	212	382	602	1250
200		NA	18	37	65	92	197	355	560	1170
250		NA	16	33	58	82	175	315	496	1030
300		NA	15	30	52	74	158	285	449	936
350		NA	14	28	48	68	146	262	414	861
400		NA	13	26	45	63	136	244	385	801
450		NA	12	24	42	60	127	229	361	752
500		NA	11	23	40	56	120	216	341	710
550		NA	11	22	38	53	114	205	324	674
600		NA	10	21	36	51	109	196	309	643
650		NA	NA	20	34	49	104	188	296	616
700		NA	NA	19	33	47	100	180	284	592
750		NA	NA	18	32	45	96	174	274	570
800		NA	NA	18	31	44	93	168	264	551
850		NA	NA	17	30	42	90	162	256	533
900		NA	NA	17	29	41	87	157	248	517
950		NA	NA	16	28	40	85	153	241	502
1000		NA	NA	16	27	39	83	149	234	488
1100		NA	NA	15	26	37	78	141	223	464
1200		NA	NA	14	25	35	75	135	212	442
1300		NA	NA	14	24	34	72	129	203	423
1400		NA	NA	13	23	32	69	124	195	407
1500		NA	NA	13	22	31	66	119	188	392
1600		NA	NA	12	21	30	64	115	182	378
1700		NA	NA	12	20	29	62	112	176	366
1800		NA	NA	11	20	28	60	108	170	355
1900		NA	NA	11	19	27	58	105	166	345
2000		NA	NA	11	19	27	57	102	161	335

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 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).

FUEL GAS PIPING

TABLE 1315.2(30)
SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.3.1(g)]²

							GAS:		UNDILUTED PROPANE	
							INLET PRESSURE:		2.0 psi	
							PRESSURE DROP:		1.0 psi	
							SPECIFIC GRAVITY:		1.50	
INTENDED USE: TUBE SIZING BETWEEN 2 PSIG SERVICE AND LINE PRESSURE REGULATOR										
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	–	–
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ¹		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN THOUSANDS OF BTU PER HOUR								
10		413	852	1730	3030	4300	9170	16 500	26 000	54 200
20		284	585	1190	2080	2950	6310	11 400	17 900	37 300
30		228	470	956	1670	2370	5060	9120	14 400	29 900
40		195	402	818	1430	2030	4330	7800	12 300	25 600
50		173	356	725	1270	1800	3840	6920	10 900	22 700
60		157	323	657	1150	1630	3480	6270	9880	20 600
70		144	297	605	1060	1500	3200	5760	9090	18 900
80		134	276	562	983	1390	2980	5360	8450	17 600
90		126	259	528	922	1310	2790	5030	7930	16 500
100		119	245	498	871	1240	2640	4750	7490	15 600
125		105	217	442	772	1100	2340	4210	6640	13 800
150		95	197	400	700	992	2120	3820	6020	12 500
175		88	181	368	644	913	1950	3510	5540	11 500
200		82	168	343	599	849	1810	3270	5150	10 700
250		72	149	304	531	753	1610	2900	4560	9510
300		66	135	275	481	682	1460	2620	4140	8610
350		60	124	253	442	628	1340	2410	3800	7920
400		56	116	235	411	584	1250	2250	3540	7370
450		53	109	221	386	548	1170	2110	3320	6920
500		50	103	209	365	517	1110	1990	3140	6530
550		47	97	198	346	491	1050	1890	2980	6210
600		45	93	189	330	469	1000	1800	2840	5920
650		43	89	181	316	449	959	1730	2720	5670
700		41	86	174	304	431	921	1660	2620	5450
750		40	82	168	293	415	888	1600	2520	5250
800		39	80	162	283	401	857	1540	2430	5070
850		37	77	157	274	388	829	1490	2350	4900
900		36	75	152	265	376	804	1450	2280	4750
950		35	72	147	258	366	781	1410	2220	4620
1000		34	71	143	251	356	760	1370	2160	4490
1100		32	67	136	238	338	721	1300	2050	4270
1200		31	64	130	227	322	688	1240	1950	4070
1300		30	61	124	217	309	659	1190	1870	3900
1400		28	59	120	209	296	633	1140	1800	3740
1500		27	57	115	201	286	610	1100	1730	3610
1600		26	55	111	194	276	589	1060	1670	3480
1700		26	53	108	188	267	570	1030	1620	3370
1800		25	51	104	182	259	553	1000	1570	3270
1900		24	50	101	177	251	537	966	1520	3170
2000		23	48	99	172	244	522	940	1480	3090

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(31)
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.3.1(h)]^{1, 2}

									GAS:		UNDILUTED PROPANE			
									INLET PRESSURE:		11.0 in. w.c.			
									PRESSURE DROP:		0.5 in. w.c.			
									SPECIFIC GRAVITY:		1.50			
INTENDED USE: CSST SIZING BETWEEN SINGLE OR SECOND STAGE (LOW PRESSURE) REGULATOR AND APPLIANCE SHUTOFF VALVE														
	TUBE SIZE (EHD) ³													
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR													
5	72	99	181	211	355	426	744	863	1420	1638	2830	3270	5780	6550
10	50	69	129	150	254	303	521	605	971	1179	1990	2320	4110	4640
15	39	55	104	121	208	248	422	490	775	972	1620	1900	3370	3790
20	34	49	91	106	183	216	365	425	661	847	1400	1650	2930	3290
25	30	42	82	94	164	192	325	379	583	762	1250	1480	2630	2940
30	28	39	74	87	151	177	297	344	528	698	1140	1350	2400	2680
40	23	33	64	74	131	153	256	297	449	610	988	1170	2090	2330
50	20	30	58	66	118	137	227	265	397	548	884	1050	1870	2080
60	19	26	53	60	107	126	207	241	359	502	805	961	1710	1900
70	17	25	49	57	99	117	191	222	330	466	745	890	1590	1760
80	15	23	45	52	94	109	178	208	307	438	696	833	1490	1650
90	15	22	44	50	90	102	169	197	286	414	656	787	1400	1550
100	14	20	41	47	85	98	159	186	270	393	621	746	1330	1480
150	11	15	31	36	66	75	123	143	217	324	506	611	1090	1210
200	9	14	28	33	60	69	112	129	183	283	438	531	948	1050
250	8	12	25	30	53	61	99	117	163	254	390	476	850	934
300	8	11	23	26	50	57	90	107	147	234	357	434	777	854

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: $L = 1.3 n$, 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.

FUEL GAS PIPING

TABLE 1315.2(32)
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.3.1(i)]^{1, 2, 3, 4}

									GAS:		UNDILUTED PROPANE			
									INLET PRESSURE:		2.0 psi			
									PRESSURE DROP:		1.0 psi			
									SPECIFIC GRAVITY:		1.50			
INTENDED USE: CSST SIZING BETWEEN 2 PSIG SERVICE AND LINE PRESSURE REGULATOR														
	TUBE SIZE (EHD) ⁵													
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR													
10	426	558	927	1110	1740	2170	4100	4720	7130	7958	15 200	16 800	29 400	34 200
25	262	347	591	701	1120	1380	2560	2950	4560	5147	9550	10 700	18 800	21 700
30	238	316	540	640	1030	1270	2330	2690	4180	4719	8710	9790	17 200	19 800
40	203	271	469	554	896	1100	2010	2320	3630	4116	7530	8500	14 900	17 200
50	181	243	420	496	806	986	1790	2070	3260	3702	6730	7610	13 400	15 400
75	147	196	344	406	663	809	1460	1690	2680	3053	5480	6230	11 000	12 600
80	140	189	333	393	643	768	1410	1630	2590	2961	5300	6040	10 600	12 200
100	124	169	298	350	578	703	1260	1450	2330	2662	4740	5410	9530	10 900
150	101	137	245	287	477	575	1020	1180	1910	2195	3860	4430	7810	8890
200	86	118	213	248	415	501	880	1020	1660	1915	3340	3840	6780	7710
250	77	105	191	222	373	448	785	910	1490	1722	2980	3440	6080	6900
300	69	96	173	203	343	411	716	829	1360	1578	2720	3150	5560	6300
400	60	82	151	175	298	355	616	716	1160	1376	2350	2730	4830	5460
500	53	72	135	158	268	319	550	638	1030	1237	2100	2450	4330	4880

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: $L = 1.3 n$, 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(33)
CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.3.1(j)]^{1, 2, 3, 4}

									GAS:		UNDILUTED PROPANE			
									INLET PRESSURE:		5.0 psi			
									PRESSURE DROP:		3.5 psi			
									SPECIFIC GRAVITY:		1.50			
	TUBE SIZE (EHD) ⁵													
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR													
10	826	1070	1710	2060	3150	4000	7830	8950	13 100	14 441	28 600	31 200	54 400	63 800
25	509	664	1090	1310	2040	2550	4860	5600	8400	9339	18 000	19 900	34 700	40 400
30	461	603	999	1190	1870	2340	4430	5100	7680	8564	16 400	18 200	31 700	36 900
40	396	520	867	1030	1630	2030	3820	4400	6680	7469	14 200	15 800	27 600	32 000
50	352	463	777	926	1460	1820	3410	3930	5990	6717	12 700	14 100	24 700	28 600
75	284	376	637	757	1210	1490	2770	3190	4920	5539	10 300	11 600	20 300	23 400
80	275	363	618	731	1170	1450	2680	3090	4770	5372	9990	11 200	19 600	22 700
100	243	324	553	656	1050	1300	2390	2760	4280	4830	8930	10 000	17 600	20 300
150	196	262	453	535	866	1060	1940	2240	3510	3983	7270	8210	14 400	16 600
200	169	226	393	464	755	923	1680	1930	3050	3474	6290	7130	12 500	14 400
250	150	202	352	415	679	828	1490	1730	2740	3124	5620	6390	11 200	12 900
300	136	183	322	379	622	757	1360	1570	2510	2865	5120	5840	10 300	11 700
400	117	158	279	328	542	657	1170	1360	2180	2498	4430	5070	8920	10 200
500	104	140	251	294	488	589	1050	1210	1950	2247	3960	4540	8000	9110

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: $L = 1.3 n$, 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.

FUEL GAS PIPING

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								
	PIPE SIZE (inch)							
NOMINAL OD:	½	¾	1	1¼	1½	2	3	4
DESIGNATION:	SDR 9.3	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
ACTUAL ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR							
10	340	680	1230	2130	3210	5770	16 000	30 900
20	233	468	844	1460	2210	3970	11 000	21 200
30	187	375	677	1170	1770	3180	8810	17 000
40	160	321	580	1000	1520	2730	7540	14 600
50	142	285	514	890	1340	2420	6680	12 900
60	129	258	466	807	1220	2190	6050	11 700
70	119	237	428	742	1120	2010	5570	10 800
80	110	221	398	690	1040	1870	5180	10 000
90	103	207	374	648	978	1760	4860	9400
100	98	196	353	612	924	1660	4590	8900
125	87	173	313	542	819	1470	4070	7900
150	78	157	284	491	742	1330	3690	7130
175	72	145	261	452	683	1230	3390	6560
200	67	135	243	420	635	1140	3160	6100
250	60	119	215	373	563	1010	2800	5410
300	54	108	195	338	510	916	2530	4900
350	50	99	179	311	469	843	2330	4510
400	46	92	167	289	436	784	2170	4190
450	43	87	157	271	409	736	2040	3930
500	41	82	148	256	387	695	1920	3720

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)]*

					GAS:		UNDILUTED PROPANE	
					INLET PRESSURE:		2.0 psi	
					PRESSURE DROP:		1.0 psi	
					SPECIFIC GRAVITY:		1.50	
INTENDED USE: PE PIPE SIZING BETWEEN 2 PSI SERVICE REGULATOR AND LINE PRESSURE REGULATOR								
	PIPE SIZE (inch)							
NOMINAL OD:	½	¾	1	1¼	1½	2	3	4
DESIGNATION:	SDR 9.3	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
ACTUAL ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR							
10	3130	6260	11 300	19 600	29 500	53 100	147 000	284 000
20	2150	4300	7760	13 400	20 300	36 500	101 000	195 000
30	1730	3450	6230	10 800	16 300	29 300	81 100	157 000
40	1480	2960	5330	9240	14 000	25 100	69 400	134 100
50	1310	2620	4730	8190	12 400	22 200	61 500	119 000
60	1190	2370	4280	7420	11 200	20 100	55 700	108 000
70	1090	2180	3940	6830	10 300	18 500	51 300	99 100
80	1010	2030	3670	6350	9590	17 200	47 700	92 200
90	952	1910	3440	5960	9000	16 200	44 700	86 500
100	899	1800	3250	5630	8500	15 300	42 300	81 700
125	797	1600	2880	4990	7530	13 500	37 500	72 400
150	722	1450	2610	4520	6830	12 300	33 900	65 600
175	664	1330	2400	4160	6280	11 300	31 200	60 300
200	618	1240	2230	3870	5840	10 500	29 000	56 100
250	548	1100	1980	3430	5180	9300	25 700	49 800
300	496	994	1790	3110	4690	8430	23 300	45 100
350	457	914	1650	2860	4320	7760	21 500	41 500
400	425	851	1530	2660	4020	7220	12 000	38 600
450	399	798	1440	2500	3770	6770	18 700	36 200
500	377	754	1360	2360	3560	6390	17 700	34 200
550	358	716	1290	2240	3380	6070	16 800	32 500
600	341	683	1230	2140	3220	5790	16 000	31 000
650	327	654	1180	2040	3090	5550	15 400	29 700
700	314	628	1130	1960	2970	5330	14 700	28 500
750	302	605	1090	1890	2860	5140	14 200	27 500
800	292	585	1050	1830	2760	4960	13 700	26 500
850	283	566	1020	1770	2670	4800	13 300	25 700
900	274	549	990	1710	2590	4650	12 900	24 900
950	266	533	961	1670	2520	4520	12 500	24 200
1000	259	518	935	1620	2450	4400	12 200	23 500
1100	246	492	888	1540	2320	4170	11 500	22 300
1200	234	470	847	1470	2220	3980	11 000	21 300
1300	225	450	811	1410	2120	3810	10 600	20 400
1400	216	432	779	1350	2040	3660	10 100	19 600
1500	208	416	751	1300	1960	3530	9760	18 900
1600	201	402	725	1260	1900	3410	9430	18 200
1700	194	389	702	1220	1840	3300	9130	17 600
1800	188	377	680	1180	1780	3200	8850	17 100
1900	183	366	661	1140	1730	3110	8590	16 600
2000	178	356	643	1110	1680	3020	8360	16 200

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(36)
POLYETHYLENE PLASTIC TUBING [NFPA 54: TABLE 6.3.1(m)]²

	GAS: UNDILUTED PROPANE	
	INLET PRESSURE: 11.0 in. w.c.	
	PRESSURE DROP: 0.5 in. w.c.	
	SPECIFIC GRAVITY: 1.50	
INTENDED USE: SIZING BETWEEN INTEGRAL 2-STAGE REGULATOR AT TANK OR SECOND-STAGE (LOW PRESSURE REGULATOR) AND THE BUILDING		
	PLASTIC TUBING SIZE (CTS) ¹ (inch)	
NOMINAL OD:	½	1
DESIGNATION:	SDR 7	SDR 11
ACTUAL ID:	0.445	0.927
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR	
10	121	828
20	83	569
30	67	457
40	57	391
50	51	347
60	46	314
70	42	289
80	39	269
90	37	252
100	35	238
125	31	211
150	28	191
175	26	176
200	24	164
225	22	154
250	21	145
275	20	138
300	19	132
350	18	121
400	16	113
450	15	106
500	15	100

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.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 14 – PROCESS PIPING

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X		X					X	X	X	X	X	X	X	X								
Adopt Entire Chapter as amended (amended sections listed below)																							
Adopt only those sections that are listed below																							
Chapter/Section																							

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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 cov-

ered 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

PROCESS PIPING

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 semi-conductor 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 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, a continuous gas-monitoring system shall be connected to the emergency control station.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 15 – SOLAR ENERGY SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter								X	X														
Adopt Entire Chapter as amended (amended sections listed below)				X	X																		
Adopt only those sections that are listed below																							
Chapter/Section																							
1502.0				X	X																		

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

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.

1502.0 General. [HCD 1 & HCD 2] *For applications listed in Section 1.8.2 regulated by the Department of Housing and Community Development, see Health and Safety Code Section 17959.1, Civil Code Sections 714 and 801.5, and Government Code Section 65850.5.*

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 16 – STATIONARY POWER PLANTS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X		X	X	X			X	X														
Adopt Entire Chapter as amended (amended sections listed below)																							
Adopt only those sections that are listed below																							
Chapter/Section																							

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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 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] 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]

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]

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.

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
CHAPTER 17 – REFERENCED STANDARDS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X			X	X																		
Adopt Entire Chapter as amended (amended sections listed below)			X					X	X	X	X	X	X	X	X								
Adopt only those sections that are listed below																							
Chapter/Section																							
Table 1701.1	X		X				X	X	X	X	X	X	X	X									

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CHAPTER 17

REFERENCED STANDARDS

1701.0 General.

1701.1 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.

TABLE 1701.1
REFERENCED STANDARDS

STANDARD NUMBER	STANDARD TITLE	APPLICATION	REFERENCED SECTION
49 CFR 192.281	Plastic Pipe	Piping, Plastic	1308.5.4.2.2
49 CFR 192.283	Plastic Pipe: Qualifying Joining Procedures	Piping, Plastic	1308.5.4.2.2
AABC-2016	Total System Balance, 7th Edition	Balancing	314.1(1)
ACCA Manual B-2009	Balancing and Testing Air and Hydronic Systems	Balancing	314.1(2)
ACCA Manual D-2016	Residential Duct Systems	Ducts, Balancing	601.2
ACCA Manual J-2016	Residential Load Calculations	Ducts	1105.1
ACCA Manual S-2014	Residential Equipment Selection	Equipment	1105.1
ACCA Manual Zr-2018	Residential Zoning	Ducts	601.2
ACCA 4 QM-2019	Maintenance of Residential HVAC Systems	HVAC Systems	102.3.2
AHRI 700-2017a	Specifications for Refrigerants	Refrigerants	1104.7, 1104.7.3
AMCA 540-2013	Louvers Impacted by Wind Borne Debris	Louvers	315.1.2
AMCA 550-2015	Test Method for High Velocity Wind Driven Rain Resistant Louvers	Louvers	315.1.1
ASHRAE 15-2016	Safety Standard for Refrigeration Systems	Refrigeration Systems	1102.1, 1106.1, Table 1113.5
ASHRAE 34-2016	Designation and Safety Classification of Refrigerants	Refrigeration Classifications	1102.3, 1103.1, Table 1102.3, Table 1106.2.5.2
ASHRAE 62.1-2016	Ventilation for Acceptable Indoor Air Quality	Indoor Air Quality Ventilation	402.4.1
ASHRAE 111-2008	Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems	Balancing	314.1(3)
ASHRAE 129-1997 (R2002)	Measuring Air-Change Effectiveness	Air Change Effectiveness	Table 403.2.2
ASHRAE 154-2016	Ventilation for Commercial Cooking Operations	Commercial Kitchens	510.5.6
ASHRAE 170-2013	Ventilation of Health Care Facilities	Ventilation	402.1.2
ASHRAE/ACCA 180-2018	Inspection and Maintenance of Commercial Building HVAC Systems	Maintenance	102.3.1, 1013.3
ASHRAE Handbook-2017	Fundamentals	Climatic Conditions	Figure 803.1.2(6)

REFERENCED STANDARDS

TABLE 1701.1 (continued)
REFERENCED STANDARDS

STANDARD NUMBER	STANDARD TITLE	APPLICATION	REFERENCED SECTION
ASME B1.20.1-2013	Pipe Threads, General Purpose (Inch)	Joints	1211.2(3), 1211.4(7), 1211.12(3), 1211.13(2), 1308.5.6
ASME B16.1-2015	Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250	Fittings	1308.5.9
ASME B16.3-2016	Malleable Iron Threaded Fittings: Classes 150 and 300	Fittings	Table 1210.1
ASME B16.5-2017	Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch	Fittings	Table 1210.1, 1308.5.9.1(1)
ASME B16.9-2018	Factory-Made Wrought Buttwelding Fittings	Fittings	Table 1210.1
ASME B16.11-2016	Forged Fittings, Socket-Welding and Threaded	Fittings	Table 1210.1
ASME B16.15-2018	Cast Copper Alloy Threaded Fittings: Classes 125 and 250	Fittings	Table 1210.1
ASME B16.18-2018	Cast Copper Alloy Solder Joint Pressure Fittings	Fittings	Table 1210.1
ASME B16.20-2017	Metallic Gaskets for Pipe Flanges	Joints	1308.5.10.2
ASME B16.21-2016	Nonmetallic Flat Gaskets for Pipe Flanges	Fuel Gas Piping	1308.5.10.3
ASME B16.22-2018	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings	Fittings	Table 1210.1
ASME B16.23-2016	Cast Copper Alloy Solder Joint Drainage Fittings: DWV	Fittings	Table 1210.1
ASME B16.24-2016	Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500	Fittings	Table 1210.1, 1308.5.9.2
ASME B16.26-2018	Cast Copper Alloy Fittings for Flared Copper Tubes	Fittings	Table 1210.1
ASME B16.29-2017	Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings – DWV	Fittings	Table 1210.1
ASME B16.42-2016	Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300	Fuel Gas Piping	1308.5.9.3
ASME B16.47-2017	Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch	Fuel Gas Piping	1308.5.9.1(2)
ASME B16.51-2018	Copper and Copper Alloy Press-Connect Pressure Fittings	Fittings	Table 1210.1
ASME B31.3-2016	Process Piping	Process Piping	1406.1
ASME B31.5-2016	Refrigeration Piping and Heat Transfer Components	Refrigeration Piping	1109.1.1, 1109.1.3
ASME B36.10M-2018	Welded and Seamless Wrought Steel Pipe	Fuel Gas Piping	1308.5.2.1
ASME BPVC Section I-2017	Rules for Construction of Power Boilers	Boilers	1002.1(1), Table 1003.2.1
ASME BPVC Section IV-2017	Rules for Construction of Heating Boilers	Boilers	1002.1(2)
ASME BPVC Section VIII.1-2017	Rules for Construction of Pressure Vessels Division 1	Pressure Vessels	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

REFERENCED STANDARDS

TABLE 1701.1 (continued)
REFERENCED STANDARDS

STANDARD NUMBER	STANDARD TITLE	APPLICATION	REFERENCED SECTION
ASME CSD-1-2018	Controls and Safety Devices for Automatically Fired Boilers	Boilers	1003.2.1
ASSE 1013-2011	Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers	Backflow Protection	1202.2
ASSE 1017-2009	Temperature Actuated Mixing Valves for Hot Water Distribution Systems	Valves	1207.3.1
ASSE 1061-2015	Push-Fit Fittings	Fittings	1211.2(1), 1211.4(5), Table 1210.1
ASSE 1079-2012	Dielectric Pipe Fittings	Fittings	1211.14.1
ASSE Z359.1-2016	The Fall Protection Code	Miscellaneous	303.8.4.1
ASTM A53/A53M-2018	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless	Piping	1308.5.2.1(1), Table 1210.1
ASTM A106/A106M-2018	Seamless Carbon Steel Pipe for High-Temperature Service	Piping	1308.5.2.1(2), Table 1210.1
ASTM A126-2004 (R2014)	Gray Iron Castings for Valves, Flanges, and Pipe Fittings	Piping	Table 1210.1
ASTM A254/A254M-2012	Copper-Brazed Steel Tubing	Piping	1308.5.3.2, Table 1210.1
ASTM A268/A268M-2010 (R2016)	Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service	Tubing	1308.5.3.1(1)
ASTM A269/A269M-2015a	Seamless and Welded Austenitic Stainless Steel Tubing for General Service	Piping, Tubing	1308.5.3.1(2), Table 1210.1
ASTM A312/A312M-2018a	Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes	Piping Ferrous	1308.5.2.1(3), Table 1210.1
ASTM A420/A420M-2016	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service	Fittings	Table 1210.1
ASTM A554-2016	Welded Stainless Steel Mechanical Tubing	Piping	Table 1210.1
ASTM A778/A778M-2016	Welded, Unannealed Austenitic Stainless Steel Tubular Products	Piping	Table 1210.1
ASTM B32-2008 (R2014)	Solder Metal	Joints	1211.4(6)
ASTM B42-2015a	Seamless Copper Pipe, Standard Sizes	Piping	Table 1210.1
ASTM B43-2015	Seamless Red Brass Pipe, Standard Sizes	Piping	Table 1210.1
ASTM B75/B75M-2011	Seamless Copper Tube	Piping	Table 1210.1
ASTM B88-2016	Seamless Copper Water Tube	Piping	1308.5.3.3, Table 1210.1
ASTM B135/B135M-2017	Seamless Brass Tube	Piping	Table 1210.1
ASTM B210-2012	Aluminum and Aluminum-Alloy Drawn Seamless Tubes	Piping	1308.5.3.4
ASTM B241/B241M-2016	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube	Piping	1308.5.2.3, 1308.5.3.4
ASTM B251/B251M-2017	General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	Piping	Table 1210.1
ASTM B280-2018	Seamless Copper Tube for Air Conditioning and Refrigeration Field Service	Piping	1109.1.2, 1308.5.3.3

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STANDARD NUMBER	STANDARD TITLE	APPLICATION	REFERENCED SECTION
ASTM B302-2017	Threadless Copper Pipe, Standard Sizes	Piping	Table 1210.1
ASTM B447-2012a	Welded Copper Tube	Piping	Table 1210.1
ASTM B813-2016	Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube	Joints	1211.4(6)
ASTM B828-2016	Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings	Joints	1211.4(6)
ASTM B1003-2016	Seamless Copper Tube for Linesets	Piping	1109.1.2
ASTM C315-2007 (R2016)	Clay Flue Liners and Chimney Pots	Venting Systems	803.1.11.1
ASTM C411-2017	Hot-Surface Performance of High-Temperature Thermal Insulation	Duct Coverings and Linings	605.1.2
ASTM D1693-2015	Environmental Stress-Cracking of Ethylene Plastics	Piping	Table 1210.1
ASTM D1785-2015 ^{e1}	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120	Piping	Table 1210.1
ASTM D2241-2015	Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)	Piping	Table 1210.1
ASTM D2464-2015	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	Fittings	Table 1210.1
ASTM D2466-2017	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40	Fittings	Table 1210.1
ASTM D2467-2015	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	Fittings	Table 1210.1
ASTM D2513-2018a	Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings	Piping	1308.5.4, 1308.5.4.2.2, 1308.5.8.2, 1310.1.7.1(1), Table 1210.1
ASTM D2564-2012 (R2018)	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems	Joints	1211.12(2)
ASTM D2609-2015	Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe	Fittings	Table 1210.1
ASTM D2683-2014	Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing	Fittings	Table 1210.1
ASTM D2737-2012a	Polyethylene (PE) Plastic Tubing	Piping, Plastic	Table 1210.1
ASTM D2846/D2846M-2017b ^{e1}	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems	Piping	1211.2(2), 1211.3(2), Table 1210.1
ASTM D3035-2015	Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter	Piping	Table 1210.1
ASTM D3139-1998 (R2011)	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals	Joints	1211.12(1)
ASTM D3261-2016	Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing	Fittings	Table 1210.1
ASTM D3350-2014	Polyethylene Plastics Pipe and Fittings Materials	Piping, Fittings	Table 1210.1
ASTM E84-2018b	Surface Burning Characteristics of Building Materials	Miscellaneous	508.3.4, 602.2, 605.1.1, 605.1.2, 1201.2
ASTM E779-2019	Determining Air Leakage Rate by Fan Pressurization	Air Ducts	405.2.1
ASTM E814-2013a (R2017)	Fire Tests of Penetration Firestop Systems	Miscellaneous	507.4.4, 507.4.5

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ASTM E2231-2018	Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics	Insulation of Ducts	605.1.2
ASTM E2336-2016	Fire Resistive Grease Duct Enclosure Systems	Grease Ducts	507.4.2.2, 507.4.5
ASTM F437-2015	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	Fittings	Table 1210.1
ASTM F438-2017	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40	Fittings	Table 1210.1
ASTM F439-2013	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	Fittings	Table 1210.1
ASTM F441/F441M-2015	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80	Piping	Table 1210.1
ASTM F442/F442M-2013 ^{cl}	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)	Piping	Table 1210.1, 1211.2(2)
ASTM F493-2014	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings	Joints	1211.2(2), 1211.3(2)
ASTM F656-2015	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings	Joints	1211.2(2), 1211.3(2), 1211.12(2)
ASTM F714-2013	Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter	Piping, Plastic	Table 1210.1
ASTM F876-2017	Crosslinked Polyethylene (PEX) Tubing	Piping	1211.5, Table 1210.1
ASTM F877-2018a	Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems	Piping	Table 1210.1
ASTM F1055-2016a	Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing	Fittings	Table 1210.1
ASTM F1281-2017	Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe	Piping	Table 1210.1
ASTM F1282-2017	Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe	Piping	Table 1210.1
ASTM F1476-2007 (R2013)	Performance of Gasketed Mechanical Couplings for Use in Piping Applications	Fittings	Table 1210.1
ASTM F1548-2001 (R2018)	Performance of Fittings for Use with Gasketed Mechanical Couplings Used in Piping Applications	Fittings	Table 1210.1
ASTM F1807-2018a	Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing	Fittings	Table 1210.1
ASTM F1960-2018a	Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing	Fittings	Table 1210.1
ASTM F1970-2012 ^{cl}	Special Engineered Fittings, Appurtenances or Valves for Use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (COPE) Systems	Piping	Table 1210.1
ASTM F1973-2013 (R2018)	Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems	Fuel Gas	1310.1.7.1(2)
ASTM F1974-2009 (R2015)	Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure Pipe	Fittings	1211.6(1), 1211.9(1), Table 1210.1

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ASTM F2080-2018	Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR9 Polyethylene of Raised Temperature (PE-RT) Pipe	Fittings	Table 1210.1
ASTM F2098-2018	Stainless Steel Clamps for Securing SDR9 Cross-linked Polyethylene (PEX) Tubing to Metal Insert and Plastic Insert Fittings	Joints	Table 1210.1
ASTM F2158-2008 (R2016)	Residential Central-Vacuum Tube and Fittings	Exhaust Systems	506.1(3), 506.2(2)
ASTM F2159-2018a	Plastic Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing	Fittings	Table 1210.1
ASTM F2389-2017a	Pressure-Rated Polypropylene (PP) Piping Systems	Piping	1211.11(1), Table 1210.1
ASTM F2434-2018	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	Fittings	1211.6(1), Table 1210.1
ASTM F2509-2015	Field-Assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene and Polyamide-11 (PA11) Gas Distribution Pipe and Tubing	Fuel Gas	1310.1.7.1(3)
ASTM F2620-2013	Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings	Joints	1211.8(1), 1211.8(3)
ASTM F2623-2014	Polyethylene of Raised Temperature (PE-RT) SDR9 Tubing	Piping	Table 1210.1
ASTM F2735-2018	Plastic Insert Fittings for SDR9 Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing	Fittings	Table 1210.1
ASTM F2769-2018	Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems	Piping, Fittings	Table 1210.1
ASTM F2855-2012	Specification for Chlorinated Poly (Vinyl Chloride)/Aluminum/Chlorinated Poly (Vinyl Chloride) (CPVC-AL-CPVC) Composite Pressure Tubing	Piping, Plastic	Table 1210.1
ASTM F2945-2018	Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings	Tubing, Fittings	1308.5.4
ASTM F3226/F3226M-2016 ^{e1}	Metallic Press-Connect Fittings for Piping and Tubing Systems	Fittings	Table 1210.1
ASTM F3253-2018	Crosslinked Polyethylene (PEX) Tubing with Oxygen Barrier for Hot- and Cold-Water Hydronic Distribution Systems	Piping	Table 1210.1
AWS A5.8M/A5.8-2011-AMD 1	Filler Metals for Brazing and Braze Welding	Joints	1211.4(1)
AWWA C110-2012	Ductile-Iron and Gray-Iron Fittings	Fittings	Table 1210.1
AWWA C111-2017	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings	Joints	1211.7(1), 1211.7(2)
AWWA C115-2011	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Treaded Flanges	Piping	Table 1210.1
AWWA C151-2017	Ductile-Iron Pipe, Centrifugally Cast	Piping, Ferrous	Table 1210.1
AWWA C153-2011	Ductile-Iron Compact Fittings	Fittings	Table 1210.1

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AWWA C901-2017	Polyethylene (PE) Pressure Pipe and Tubing, ¾ in. (19 mm) Through 3 in. (76 mm) for Water Service	Piping, Plastic	Table 1210.1
CSA B137.1-2017	Polyethylene (PE) Pipe, Tubing, and Fittings for Cold-Water Pressure Services	Piping	Table 1210.1
CSA B137.2-2017	Polyvinylchloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications	Piping, Plastic	Table 1210.1
CSA B137.3-2017	Rigid Polyvinylchloride (PVC) Pipe and Fittings for Pressure Applications	Piping, Plastic	Table 1210.1
CSA B137.5-2017	Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications	Piping	Table 1210.1
CSA B137.6-2017	Chlorinated Polyvinylchloride (CPVC) Pipe, Tubing, and Fittings for Hot- and Cold-Water Distribution Systems	Piping, Plastic	Table 1210.1
CSA B137.9-2017	Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure-Pipe Systems	Piping	Table 1210.1
CSA B137.10-2017	Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Composite Pressure-Pipe Systems	Piping	Table 1210.1
CSA B137.11-2017	Polypropylene (PP-R) Pipe and Fittings for Pressure Applications	Piping	1211.11(1), Table 1210.1
CSA B137.18-2017	Polyethylene of Raised Temperature Resistance (PE-RT) Tubing Systems for Pressure Applications	Piping, Plastic	Table 1210.1
CSA FC 1-2014	Fuel Cell Technologies-Part 3-100: Stationary Fuel Cell Power Systems-Safety	Fuel Cell Power Plants	1601.1
CSA LC 1-2018	Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (same as CSA 6.26)	Fuel Gas	1308.5.3.5, 1310.4.1(4), 1311.3
CSA LC 4a-2013 (R2017)	Press-Connect Metallic Fittings For Use in Fuel Gas Distribution Systems (same as CSA 6.32a)	Fuel Gas	1308.5.7.1, 1308.5.7.2, 1308.5.7.3, 1310.4.1(3)
CSA NGV 5.1-2016	Residential Fueling Appliances	Appliances	938.1
CSA Z21.8-1994 (R2017)	Installation of Domestic Gas Conversion Burners	Fuel Gas, Appliances	909.1
CSA Z21.10.1-2017	Gas Water Heaters, Volume I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less (same as CSA 4.1)	Fuel Gas, Appliances	Table 1203.2
CSA Z21.10.3-2017	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)	Fuel Gas, Appliances	Table 1203.2
CSA Z21.24-2015	Connectors for Gas Appliances (same as CSA 6.10)	Fuel Gas	1312.1(3), 1312.2
CSA Z21.41-2014	Quick Disconnect Devices for Use with Gas Fuel Appliances (same as CSA 6.9)	Fuel Gas	1312.7
CSA Z21.54-2014	Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances (same as CSA 8.4)	Fuel Gas	1312.3.2
CSA Z21.69-2015	Connectors for Moveable Gas Appliances (same as CSA 6.16)	Fuel Gas	1312.1.1
CSA Z21.75-2016	Connectors for Outdoor Gas Appliances and Manufactured Homes (same as CSA 6.27)	Appliances	1312.1(4)
CSA Z21.80a-2012	Line Pressure Regulators (same as CSA 6.22a)	Fuel Gas	1308.7.1, 1308.7.4(1)
CSA Z21.90-2015	Gas Convenience Outlets and Optional Enclosures (same as CSA 6.24)	Gas Outlets	1312.8
CSA Z21.93-2017	Excess Flow Valves for Natural and Propane Gas with Pressures up to 5 psig (same as CSA 6.30)	Fuel Gas	1309.1

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CSA Z83.4-2017	Non-Recirculating Direct Gas-Fired Heating and Forced Ventilation Appliances for Commercial and Industrial Application (same as CSA 3.7)	Air Heaters, Non-Recirculating, Non-Recirculating Heaters	914.1
CSA Z83.18-2017	Recirculating Direct Gas-Fired Heating and Forced Ventilation Appliances for Commercial and Industrial Applications	Air Heaters, Industrial Heaters, Recirculating	915.1
IAPMO PS 117-2017	Press and Nail Connections	Fittings	Table 1210.1
IIAR 2-2014	Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems	Ammonia Refrigeration Systems	1102.2
IIAR 3-2017	Ammonia Refrigeration Valves	Ammonia Refrigeration Systems	1102.2
IIAR 4-2015	Installation of Closed-Circuit Ammonia Refrigeration Systems	Ammonia Refrigeration	1102.2
IIAR 5-2013	Start-Up and Commissioning of Closed Circuit Ammonia Refrigeration Systems	Ammonia Refrigeration Systems	1102.2
MSS SP-58-2018	Pipe Hangers and Supports-Materials, Design, Manufacture, Selection, Application, and Installation	Miscellaneous	1310.3.5
NEBB-2015	Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems, 8 th Edition	Balancing	314.1(4)
NFPA 2-2019	Hydrogen Technologies Code	Gaseous Hydrogen Systems	937.1
NFPA 10-2021	Portable Fire Extinguishers	Fire Extinguishing	513.10, 513.10.1, 513.11, 517.7.4
NFPA 12-2018	Carbon Dioxide Extinguishing Systems	Fire Extinguishing	513.2.3(1)
NFPA 13-2022 <i>*See California Fire Code for amendments</i>	Installation of Sprinkler Systems	Miscellaneous	513.2.3(2), 517.7.6
NFPA 17-2020	Dry Chemical Extinguishing Systems	Fire Extinguishing	513.2.3(3), 513.3.5
NFPA 17A-2020	Wet Chemical Extinguishing Systems	Fire Extinguishing	513.2.3(4), 513.2.5.6, 513.3.5
NFPA 30A-2021	Motor Fuel Dispensing Facilities and Repair Garages	Miscellaneous	303.11.1
NFPA 31-2016	Installation of Oil-Burning Equipment	Fuel Gas, Appliances	301.5, 1002.2.2, 1301.1
NFPA 37-2018	Installation and Use of Stationary Combustion Engines and Gas Turbines	Generators	1602.1, 1602.3
NFPA 51-2018	Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes	Fuel Gas Systems	902.7
NFPA 52-2019	Vehicular Natural Gas Fuel Systems Code	CNG Vehicle Fuel Systems	938.1
NFPA 54/Z223.1-2018	National Fuel Gas Code	Fuel Gas	516.2.1
NFPA 58-2020	Liquefied Petroleum Gas Code	Fuel Gas	303.7, 516.2.1, 1308.5.4.2.3, 1308.5.8.4, 1310.6(7), 1312.11
NFPA 68-2018	Explosion Protection by Deflagration Venting	Product Conveying Ducts	505.3.3

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NFPA 69-2019	Explosion Prevention Systems	Explosion Prevention	505.3.1
NFPA 70-2020 <i>*See California Electrical Code for amendments</i>	National Electrical Code	Miscellaneous	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
NFPA 80-2019	Fire Doors and Other Opening Protectives	Fire Doors	510.7.7
NFPA 82-2019	Incinerators and Waste and Linen Handling Systems and Equipment	Incinerator Chutes	802.2.8, Table 802.4, 925.1
NFPA 85-2019	Boiler and Combustion Systems Hazards Code	Appliances	1002.1(3), 1011.1, Table 1003.2.1
NFPA 86-2019	Ovens and Furnaces	Product Conveying Ducts	505.3.2
NFPA 88A-2019	Parking Structures	Miscellaneous	303.11
NFPA 90A-2018	Installation of Air-Conditioning and Ventilating Systems	HVAC	604.1
NFPA 90B-2018	Installation of Warm Air Heating and Air-Conditioning Systems	HVAC	604.1
NFPA 211-2019	Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances	Fuel Gas Appliances	517.7, 517.7.1, 801.2, 801.3, 802.5.2, 802.5.3, 802.5.7.1, 802.5.7.3, 902.10
NFPA 262-2019	Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces	Certification	602.2.1
NFPA 409-2016	Aircraft Hangars	Miscellaneous	303.12
NFPA 654-2020	Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids	Dust Explosion Prevention, Gutters	506.6, Table 505.9
NFPA 780-2017	Installation of Lightning Protection Systems	Fuel Gas	1311.5
NFPA 853-2020	Installation of Stationary Fuel Cell Power Systems	Fuel Cell Power Plants, Fuel Cells	1601.1
NFPA 1192-2018	Recreational Vehicles	Fuel Gas Piping	1302.3(18)
NSF 358-1-2017	Polyethylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems	Piping, Plastic	Table 1210.1
NSF 358-2-2017	Polypropylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems	Piping, Plastic	Table 1210.1
NSF 358-3-2016	Cross-linked polyethylene (PEX) pipe and fittings for water-based ground-source (geothermal) heat pump systems	Piping, Plastic	Table 1210.1
SMACNA-2002	HVAC Systems Testing, Adjusting and Balancing, 3rd Edition	Balancing	314.1(5)
SMACNA-2017	HVAC Duct Construction Standards Metal and Flexible, 4 th Edition	Ducts, Metal and Flexible	504.4.5, 506.2, 602.3, 603.3, 603.4, 603.7.1, 603.9, 603.11, 605.1
SMACNA-2012	HVAC Air Duct Leakage Test Manual, 2 nd Edition	Ducts	603.9.2, 603.10

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SMACNA-2015	Phenolic Duct Construction Standards	Duct Systems	602.4.1
UL 17-2008	Vent or Chimney Connector Dampers for Oil-Fired Appliances (with revisions through September 25, 2013)	Vent Dampers	802.15.1
UL 103-2010	Factory-Built Chimneys for Residential Type and Building Heating Appliances (with revisions through March 15, 2017)	Fuel Gas, Appliances	802.5.1, 802.5.1.1
UL 127-2011	Factory-Built Fireplaces (with revisions through July 27, 2016)	Fireplaces	802.5.1.1, 913.1, 913.1.1
UL 181-2013	Factory-Made Air Ducts and Air Connectors (with revisions through April 18, 2017)	Air Connectors, Air Ducts	602.3, 602.4.1, 602.4.4, 603.1.4, 603.1.5, 603.4, 603.9.1, 605.1.1, Table 603.9.1
UL 181A-2013	Closure Systems for Use with Rigid Air Ducts (with revisions through March 22, 2017)	Air Ducts	603.9.1, Table 603.9.1
UL 181B-2013	Closure Systems for Use with Flexible Air Ducts and Air Connectors (with revisions through March 21, 2017)	Air Connectors, Air Ducts	603.9.1, Table 603.9.1
UL 197-2010	Commercial Electric Cooking Appliances (with revisions through January 26, 2018)	Appliances, Commercial Cooking, Electric Appliances	921.1
UL 207-2009	Refrigerant-Containing Components and Accessories, Nonelectrical (with revisions through June 27, 2014)	Refrigeration Components	1109.2
UL 268A-2008	Smoke Detectors for Duct Application (with revisions through August 12, 2016)	Smoke Detectors	609.1
UL 295-2017	Commercial-Industrial Gas Burners	Gas Burners	910.2
UL 296-2017	Oil Burners (with revisions through November 29, 2017)	Fuel Gas, Appliances	910.1
UL 300-2005	Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment (with revisions through December 16, 2014)	Certification	513.2.2, 513.2.5, 517.3.1.1(6)
UL 378-2006	Draft Equipment (with revisions through September 17, 2013)	Fuel Gas, Appliances	802.3.3, 802.15.1
UL 391-2010	Solid-Fuel and Combination-Fuel Central and Supplementary Furnaces (with revisions through June 12, 2014)	Furnaces, Solid Fuel	904.10
UL 412-2011	Refrigeration Unit Coolers (with revisions through August 28, 2018)	Refrigeration	934.2
UL 427-2011	Refrigerating Units (with revisions through February 10, 2017)	Refrigeration Systems	934.3
UL 441-2016	Gas Vents (with revisions through July 27, 2016)	Fuel Gas	802.1
UL 467-2013	Grounding and Bonding Equipment	Grounding and Bonding	1311.2.5
UL 471-2010	Commercial Refrigerators and Freezers (with revisions through November 8, 2018)	Freezers, Refrigerators	934.1
UL 499-2014	Electric Heating Appliances (with revisions through February 23, 2017)	Kilns	931.4
UL 555-2006	Fire Dampers (with revisions through October 21, 2016)	Dampers	606.2
UL 555C-2014	Ceiling Dampers (with revisions through May 1, 2017)	Dampers	606.3
UL 555S-2014	Smoke Dampers (with revisions through October 27, 2016)	Dampers	606.1
UL 641-2010	Type L Low-Temperature Venting Systems (with revisions through April 23, 2018)	Equipment	802.1

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UL 651-2011	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings (with revisions through June 15, 2016)	Piping, Plastic	1308.5.4.1
UL 705-2017	Power Ventilators (with revisions through October 8, 2018)	Power Ventilators	504.4.2.3
UL 710-2012	Exhaust Hoods for Commercial Cooking Equipment (with revisions through June 25, 2018)	Exhaust Hoods, Hoods	507.3.1, 508.2, 508.2.1
UL 710B-2011	Recirculating Systems (with revisions through August 14, 2014)	Exhaust Hoods	508.1, 513.2.2, 516.2.2, 516.2.3
UL 710C-2006	Ultraviolet Radiation Systems For Use In The Ventilation Control of Commercial Cooking Operations	Exhaust Hoods, Hoods	508.2.1
UL 723-2018	Test for Surface Burning Characteristics of Building Materials	Miscellaneous	508.3.4, 602.2, 605.1.1, 605.1.2, 1201.2
UL 726-1995	Oil-Fired Boiler Assemblies (with revisions through October 9, 2013)	Fuel Gas, Appliances	1002.2.1
UL 727-2018	Oil-Fired Central Furnaces	Fuel Gas, Appliances	904.11
UL 729-2003	Oil-Fired Floor Furnaces (with revisions through November 22, 2016)	Furnaces, Floor, Oil Fired Furnaces	906.13
UL 730-2003	Oil-Fired Wall Furnaces (with revisions through November 22, 2016)	Furnaces, Wall, Oil Fired	907.4
UL 731-2018	Oil-Fired Unit Heaters	Heaters, Oil Fired	917.6
UL 737-2011	Fireplace Stoves (with revisions through August 19, 2015)	Fireplace Stoves	913.2
UL 762-2013	Power Roof Ventilators for Restaurant Exhaust Appliances	Ventilators	511.1
UL 778-2016	Motor Operated Water Pumps (with revisions through October 20, 2017)	Pumps	1208.1
UL 791-2006	Residential Incinerators (with revisions through November 7, 2014)	Incinerators	925.3
UL 795-2016	Commercial-Industrial Gas Heating Equipment	Heating Equipment, Gas Fired	904.12
UL 834-2004	Heating, Water Supply, and Power Boilers - Electric (with revisions through September 24, 2018)	Appliances	1002.3, Table 1203.2
UL 858-2014	Household Electric Ranges (with revisions through June 4, 2018)	Electric Ranges, Ranges	920.1
UL 867-2011	Electrostatic Air Cleaners (with revisions through August 7, 2018)	Filters	936.1
UL 896-1993	Oil-Burning Stoves (with revisions through November 22, 2016)	Stoves, Oil Fired	921.3
UL 900-2015	Air Filter Units	Air Filters, Filters	311.2
UL 907-2016	Fireplace Accessories	Fireplace Accessories	913.3
UL 921-2016	Commercial Dishwashers (with revisions through September 20, 2017)	Appliances	519.1
UL 923-2013	Microwave Cooking Appliances (with revisions through July 19, 2017)	Microwaves	920.3.2(3), 920.4.2(3)
UL 959-2010	Medium Heat Appliance Factory-Built Chimneys (with revisions through June 12, 2014)	Fuel Gas, Appliances	802.5.1
UL 1046-2010	Grease Filters for Exhaust Ducts (with revisions through April 17, 2017)	Filters-Grease	509.1, 509.1.1, 518.1(4)

REFERENCED STANDARDS

TABLE 1701.1 (continued)
REFERENCED STANDARDS

STANDARD NUMBER	STANDARD TITLE	APPLICATION	REFERENCED SECTION
UL 1240-2005	Electric Commercial Clothes-Drying Equipment (with revisions through March 16, 2018)	Clothes Dryers, Commercial	908.1
UL 1479-2015	Fire Tests of Penetration Firestops	Miscellaneous	507.4.4, 507.4.5
UL 1482-2011	Solid-Fuel Type Room Heaters (with revisions through August 19, 2015)	Room Heaters, Solid Fuel Heaters	802.5.1.1, 916.3
UL 1738-2010	Venting Systems for Gas-Burning Appliances Categories II, III, and IV (with revisions through November 7, 2014)	Fuel Gas, Appliances	802.4.1, 802.4.2, 802.4.3
UL 1777-2015	Chimney Liners	Chimneys, Liners	802.5.3(2), 803.1.11.2
UL 1812-2013	Ducted Heat Recovery Ventilators (with revisions through July 19, 2018)	Heat Recovery Ventilators	504.5
UL 1815-2012	Nonducted Heat Recovery Ventilators (with revisions through July 19, 2018)	Heat Recovery Ventilators	504.5
UL 1820-2004	Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics (with revisions through July 13, 2017)	Surface Burning Test, Pneumatic Tubing	602.2.3
UL 1887-2004	Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics (with revisions through July 13, 2017)	Surface Burning Test, Fire Sprinkler Pipe	602.2.2
UL 1963-2011	Refrigerant Recovery/Recycling Equipment (with revisions through October 11, 2013)	Refrigerant Equipment	1101.2
UL 1978-2010	Grease Ducts (with revisions through April 28, 2017)	Ducts, Grease	507.3.1, 510.4.1, 510.5.2, 510.5.3
UL 1995-2015	Heating and Cooling Equipment	HVAC, Electric	903.1, 904.13
UL 1996-2009	Electric Duct Heaters (with revisions through July 15, 2016)	Duct Heaters	905.8
UL 2021-2015	Fixed and Location-Dedicated Electric Room Heaters (with revisions through December 14, 2016)	Product, Heating, Electric	916.1
UL 2043-2013	Fire Test for Heat and Visible Smoke Release For Discrete Products and Their Accessories Installed in Air-Handling Spaces (with revisions through July 13, 2018)	Surface Burning Test, Discrete Products	602.2.4
UL 2158-2018	Electric Clothes Dryers	Clothes Dryers, Electric	908.1
UL 2158A-2013	Clothes Dryer Transition Duct (with revisions through April 18, 2017)	Clothes Dryer Exhaust	504.4
UL 2162-2014	Commercial Wood-Fired Baking Ovens-Refractory Type	Baking Ovens	921.2
UL 2200-2012	Stationary Engine Generator Assemblies (with revisions through July 29, 2015)	Assemblies	1602.3
UL 2221-2010	Tests of Fire Resistive Grease Duct Enclosure Assemblies	Duct Wrap, Grease Duct Enclosure	507.4.4.1
UL 2518-2016	Air Dispersion Systems	Duct Systems	602.4.3, 603.12
UL 2523-2009	Solid Fuel-Fired Hydronic Heating Appliances, Water Heaters, and Boilers (with revisions through March 16, 2018)	Appliances	1002.4, Table 1203.2
UL 2561-2016	1400 Degree Fahrenheit Factory-Built Chimneys (with revisions through April 19, 2018)	Chimneys	802.5.1
UL 2790-2010	Commercial Incinerators (with revisions through October 8, 2014)	Incinerators	925.2

REFERENCED STANDARDS

TABLE 1701.1 (continued)
REFERENCED STANDARDS

STANDARD NUMBER	STANDARD TITLE	APPLICATION	REFERENCED SECTION
UL 60335-2-40-2017	Household and Similar Electrical Appliances – Safety – Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers	Appliances	903.1, 904.13
UL 60335-2-89-2017	Household and Similar Electrical Appliances – Safety – Part 2-89: Particular Requirements for Commercial Refrigerating Appliances with an Incorporated or Remote Refrigerant Unit or Compressor	Appliances	934.1, 934.2, 934.3

REFERENCED STANDARDS

1701.2 Standards, Publications, Practices, and Guides.

The standards, publications, practices and guides listed in Table 1701.2 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.

**TABLE 1701.2
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES**

DOCUMENT NUMBER	DOCUMENT TITLE	APPLICATION
ACCA Manual N-2012	Commercial Load Calculations	Ducts
ACCA Manual Q-1990	Low Pressure, Low Velocity Duct System Design	Ducts
AHRI 870-2016	Performance Rating of Direct Geoechange Heat Pumps	Heat Pumps
AHRI 1200-2013	Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets	Commercial Refrigerated Display Merchandisers and Storage Cabinets
AHRI 1230-2014a	Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment	Refrigerants
AMCA 500-D-2018	Laboratory Methods of Testing Dampers for Rating	Dampers
ASCE 25-2016	Earthquake-Actuated Automatic Gas Shutoff Devices	Fuel Gas
ASHRAE 52.2-2012	General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size	Cleaning Devices
ASHRAE 55-2017	Thermal Environmental Conditions for Human Occupancy	Miscellaneous
ASHRAE 62.2-2016	Ventilation and Acceptable Indoor Air Quality in Residential Buildings	Ventilation
ASHRAE/IES 90.1-2016	Energy Standard for Buildings Except Low-Rise Residential Buildings	Energy
ASHRAE/IES 90.2-2018	Energy-Efficient Design of Low-Rise Residential Buildings	Energy, Dwellings
ASHRAE 127-2012	Method of Testing for Rating Computer and Data Processing Room Unitary Air Conditioners	Air Conditioners
ASHRAE/ACCA 183-2007 (R2017)	Peak Cooling and Heating Load Calculations in Buildings Except Low-Rise Residential Buildings	Cooling and Heating Load, Miscellaneous
ASHRAE 194-2012	Method of Test for Direct-Expansion Ground-Source Heat Pumps	Ground-Source Heat Pumps
ASHRAE Handbook-2016	HVAC Systems and Equipment	Design
ASME A13.1-2015	Scheme for the Identification of Piping Systems	Piping
ASME A112.18.6/CSA B125.6-2017	Flexible Water Connectors	Piping
ASME B1.20.3-1976 (R2018)	Dryseal Pipe Threads (Inch)	Joints
ASME B16.33-2012 (R2017)	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 175 psi (Sizes NPS ½ through NPS 2)	Valves
ASME B16.50-2018	Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings	Fittings
ASTM A568/A568M-2017a	Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for	Piping
ASTM A653/A653M-2017	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process	Piping, Ferrous
ASTM A733-2016	Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples	Piping, Ferrous

REFERENCED STANDARDS

TABLE 1701.2 (continued)
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

DOCUMENT NUMBER	DOCUMENT TITLE	APPLICATION
ASTM B370-2012	Standard Specification for Copper Sheet and Strip for Building Construction	Miscellaneous
ASTM B687-1999 (R2016)	Brass, Copper, and Chromium-Plated Pipe Nipples	Piping, Copper Alloy
ASTM C518-2017	Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus	Certification: Calibration, Error Analysis, Heat Flow Meter Apparatus, Heat Flux, Instrument Verification, Thermal Conductivity, Thermal Resistance, Thermal Testing, Tunnel Test
ASTM D93-2018	Flash Point by Pensky-Martens Closed Cup Tester	Certification
ASTM D396-2018a	Fuel Oils	Boiler
ASTM D2517-2018	Reinforced Epoxy Resin Gas Pressure Pipe and Fittings	Piping, Plastic
ASTM E96/E96M-2016	Water Vapor Transmission of Materials	Miscellaneous
ASTM E136-2016a	Behavior of Materials in a Vertical Tube Furnace at 750°C	Furnace
AWS B2.4-2012	Welding Procedure and Performance Qualification for Thermoplastics	Joints, Certification
CSA/IGSHPA C448-2016	Design and Installation of Ground Source Heat Pump Systems for Commercial and Residential Buildings	Miscellaneous
CSA C448.1-2016	Design and Installation of Ground Source Heat Pump Systems for Commercial and Institutional Buildings	Ground-Source Heat Pumps
CSA C448.2-2016	Design and Installation of Ground Source Heat Pump Systems for Residential and Other Small Buildings	Ground-Source Heat Pumps
CSA Z21.1-2016	Household Cooking Gas Appliances	Household Cooking Appliances, Gas Fired
CSA Z21.5.1-2017	Gas Clothes Dryers, Volume I, Type 1 Clothes Dryers (same as CSA 7.1)	Fuel Gas, Appliances
CSA Z21.5.2-2016	Gas Clothes Dryers, Volume II, Type 2 Clothes Dryers (same as CSA 7.2)	Fuel Gas, Appliances
CSA Z21.11.2-2016	Gas-Fired Room Heaters, Volume II, Unvented Room Heaters	Room Heaters, Unvented Heaters
CSA Z21.12b-1994 (R2015)	Draft Hoods	Fuel Gas, Appliances
CSA Z21.13-2017	Gas-Fired Low Pressure Steam and Hot Water Boilers (same as CSA 4.9)	Fuel Gas, Appliances
CSA Z21.15b-2013 (R2014)	Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves (same as CSA 9.1b)	Fuel Gas
CSA Z21.17a-2008 (R2014)	Domestic Gas Conversion Burners (same as CSA 2.7a)	Conversion Burner Installation, Gas Burners
CSA Z21.18b-2012 (R2016)	Gas Appliance Pressure Regulators (same as CSA 6.3b)	Appliance Regulators, Gas Refrigerators, Pressure Regulators
CSA Z21.19-2014	Refrigerators Using Gas Fuel (same as CSA 1.4)	Gas Refrigerators, Refrigerators
CSA Z21.20a-2008 (R2016)	Automatic Gas Ignition Systems and Components	Automatic Ignition, Gas Ignition, Ignition

REFERENCED STANDARDS

TABLE 1701.2 (continued)
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

DOCUMENT NUMBER	DOCUMENT TITLE	APPLICATION
CSA Z21.21-2015	Automatic Valves for Gas Appliances (same as CSA 6.5)	Appliance Valves, Automatic Gas Valves, Valves
CSA Z21.22-2015	Relief Valves for Hot Water Supply Systems (same as CSA 4.4)	Valves
CSA Z21.40.1a-1997/CGA 2.91a-M97 (R2017)	Gas-Fired, Heat Activated Air-Conditioning and Heat Pump Appliances	Gas Fired Air Conditioning, Gas Fired Heat Pump
CSA Z21.42-2013	Gas-Fired Illuminating Appliances	Illuminating Appliances
CSA Z21.47-2016	Gas-Fired Central Furnaces (same as CSA 2.3)	Fuel Gas, Appliances
CSA Z21.50-2016	Vented Decorative Gas Appliances (same as CSA 2.22)	Appliances, Decorative Appliances
CSA Z21.56-2017	Gas-Fired Pool Heaters (same as CSA 4.7)	Fuel Gas, Swimming Pools, Spas, and Hot Tubs
CSA Z21.58-2018	Outdoor Cooking Gas Appliances (same as CSA 1.6)	Cooking Appliances
CSA Z21.60-2017	Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces (same as CSA 2.26)	Decorative Appliances, Decorative Fireplace Appliances
CSA Z21.61-1983 (R2013)	Gas-Fired Toilets	Toilets
CSA Z21.66-2015	Automatic Damper Devices for Use with Gas-Fired Appliances (same as CSA 6.14)	Vent Dampers, Automatic Dampers
CSA Z21.71a-2005 (R2016)	Automatic Intermittent Pilot Ignition Systems for Field Installation	Automatic Pilot Ignition, Pilot Ignition
CSA Z21.86-2016	Vented Gas-Fired Space Heating Appliances (same as CSA 2.32)	Fuel Gas Appliances
CSA Z21.88-2017	Vented Gas Fireplace Heaters (same as CSA 2.33)	Fireplace Heaters
CSA Z83.8-2016	Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces (same as CSA 2.6)	Fuel Gas Appliances
CSA Z83.11-2016	Gas Food Service Equipment (same as CSA 1.8)	Fuel Gas, Appliances
CSA Z83.19-2017	Gas-Fired High-Intensity Infrared Heaters (same as CSA 2.35)	High Intensity Heaters, Infrared Heaters
CSA Z83.20-2016	Gas-Fired Low-Intensity Infrared Heaters (same as CSA 2.34)	Infrared Heaters, Low Intensity Heaters
IAPMO IGC 293-2012	Tubing and Fittings for Special Hydronic Radiant Drywall Panels	HVAC, Fittings, Tubing
IAPMO IGC 315-2016	Water Manifold Systems	Fittings
IAPMO IGC 327-2016	Flexible Metallic Expansion Joints for Pressure Systems	Joints
IAPMO IGC 332-2017a	Hydronic Radiators	Miscellaneous
IAPMO PS 120-2004	Flashing and Stand Combination for Air Conditioning Units (Residential or Commercial Unit Curb)	Air Conditioning Flashing Stand
ISO 13256-1-1998 (R2012)	Water Source Heat Pumps-Testing and Rating for Performance-Water-to-Air and Brine-to-Air Heat Pumps	Water-Source Heat Pumps
ISO 13256-2-1998	Water Source Heat Pumps-Testing and Rating for Performance-Water-to-Water and Brine-to-Water Heat Pumps	Water-Source Heat Pumps

REFERENCED STANDARDS

TABLE 1701.2 (continued)
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

DOCUMENT NUMBER	DOCUMENT TITLE	APPLICATION
MSS SP-67-2017	Butterfly Valves	Valves
MSS SP-80-2013	Bronze Gate, Globe, Angle, and Check Valves	Valves
MSS SP-104-2018	Wrought Copper Solder-Joint Pressure Fittings	Fittings
MSS SP-106-2012	Cast Copper Alloy Flanges and Flanged Fittings: Class 125, 150, and 300	Fittings
MSS SP-109-2018	Weld-Fabricated Copper Solder-Joint Pressure Fittings	Fittings
NFPA 30-2018	Flammable and Combustible Liquids Code	Combustible Liquids, Flammable Liquids
NFPA 91-2015	Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids	Product Conveying Ducts
NFPA 96-2017	Ventilation Control and Fire Protection of Commercial Cooking Operations	Commercial Cooking
NFPA 221-2018	High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls	Building Fire Walls, Fire Barrier
NFPA 259-2018	Test Method for Potential Heat of Building Materials	Testing, Building Mate- rials
NFPA 274-2018	Test Method to Evaluate Fire Performance Characteristics of Pipe Insulation	Pipe Insulation
NFPA 501A-2017	Fire Safety Criteria for Manufactured Home Installations, Sites, and Commu- nities	Miscellaneous
NFPA 5000-2018	Building Construction and Safety Code	Miscellaneous
NGWA-01-2014	Water Well Construction Standard	Water Wells
NSF 60-2017	Drinking Water Treatment Chemicals - Health Effects	Miscellaneous
NSF 358-4-2018	Polyethylene of Raised Temperature (PE-RT) Tubing and Fittings for Water-Based Ground-Source (Geothermal) Heat Pump Systems	Ground-Source Heat Pumps
SAE J512-1997	Automotive Tube Fittings	Fittings
SMACNA-2003	Fibrous Glass Duct Construction Standard, 7 th Edition	Fiberglass Ducts
SMACNA-2008	IAQ Guidelines for Occupied Buildings Under Construction, 2 nd Edition	Ventilation
UL 21-2014	LP-Gas Hose (with revisions through July 28, 2017)	Hose, LPG Hose
UL 33-2010	Heat Responsive Links for Fire-Protection Service (with revisions through April 14, 2015)	Fusible Links
UL 51-2013	Power-Operated Pumps and Bypass Valves for Anhydrous Ammonia, LP- Gas, and Propylene (with revisions through October 5, 2018)	Ammonia Pumps, LP- Gas Pumps, Pumps
UL 80-2007	Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids (with revi- sions through January 16, 2014)	Fuel Gas
UL 125-2014	Flow Control Valves for Anhydrous Ammonia and LP-Gas (with revisions through January 12, 2018)	Fuel Gas
UL 132-2015	Safety Relief Valves for Anhydrous Ammonia and LP-Gas (with revisions through January 12, 2018)	Fuel Gas
UL 144-2012	LP-Gas Regulators (with revisions through November 05, 2014)	Fuel Gas
UL 174-2004	Household Electric Storage Tank Water Heaters (with revisions through Decem- ber 15, 2016)	Appliances

REFERENCED STANDARDS

TABLE 1701.2 (continued)
STANDARDS, PUBLICATIONS, PRACTICES, AND GUIDES

DOCUMENT NUMBER	DOCUMENT TITLE	APPLICATION
UL 180-2012	Liquid-Level Gauges for Oil Burner Fuels and other combustible liquids (with revisions through May 12, 2017)	Gauges, Level Gauges
UL 252-2017	Compressed Gas Regulators (with revisions through August 10, 2018)	Fuel Gas
UL 343-2008	Pumps for Oil-Burning Appliances (with revisions through December 14, 2017)	Fuel Gas, Appliances
UL 353-1994	Limit Controls (with revisions through November 8, 2011)	Controls
UL 404-2010	Gauges, Indicating Pressure, for Compressed Gas Service (with revisions through February 11, 2015)	Fuel Gas
UL 429-2013	Electrically Operated Valves	Valves
UL 443-2006	Steel Auxiliary Tanks for Oil-Burner Fuel (with revisions through March 8, 2013)	Fuel Gas
UL 525-2008	Flame Arresters (with revisions through October 13, 2017)	Flame Arrestors
UL 565-2013	Liquid-Level Gauges for Anhydrous Ammonia and LP-Gas (with revisions through February 23, 2018)	Fuel Gas
UL 569-2013	Pigtails and Flexible Hose Connectors for LP-Gas (with revisions through July 28, 2017)	Fuel Gas
UL 732-2018	Oil-Fired Storage Tank Water Heaters (with revisions through August 9, 2018)	Fuel Gas, Appliances
UL 733-1993	Oil-Fired Air Heaters and Direct-Fired Heaters (with revisions through October 9, 2013)	Water Heaters, Direct Fired, Oil Fired
UL 842-2015	Valves for Flammable Fluids (with revisions through October 27, 2017)	Valves
UL 984-1996	Hermetic Refrigerant Motor-Compressors (with revisions through September 23, 2005)	Compressors, Refrigeration
UL 1453-2016	Electric Booster and Commercial Storage Tank Water Heaters (with revisions through May 18, 2018)	Appliances
UL 1746-2007	External Corrosion Protection Systems for Steel Underground Storage Tanks (with revisions through December 19, 2014)	Tanks

ABBREVIATIONS IN TABLE 1701.1 AND TABLE 1701.2

AABC	Associated Air Balance Council, 1220 19th Street NW, Suite 410, Washington, DC 20036.
ACCA	Air Conditioning Contractors of America Association, Inc., 2800 S Shirlington Road, Suite 300, Arlington, VA 22206.
AHRI	Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Boulevard, Suite 400, Arlington, VA 22201.
AMCA	Air Movement and Control Association, 30 West University Drive, Arlington Heights, IL 60004-1806.
ANSI	American National Standards Institute, Inc., 25 W. 43rd Street, 4th Floor, New York, NY 10036.
ASCE	American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.
ASME	American Society of Mechanical Engineering, Two Park Avenue, New York, NY 10016-5990.
ASSE	American Society of Sanitary Engineering, 18927 Hickory Creek Drive, Suite 220, Mokena, IL 60448.
ASTM	ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.
AWS	American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672.
AWWA	American Water Works Association, 6666 W. Quincy Avenue, Denver, CO 80235.
CFR	Code of Federal Regulations, U.S Government Publishing Office, 723 North Capitol Street, N.W. Washington, DC 20401-001.
CGA	Canadian Gas Association, 243 Consumers Road, Suite 1200, North York, Ontario, Canada M2J 5E3.
CSA	Canadian Standards Association, 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3.
e1	An editorial change since the last revision or reapproval.
IAPMO	International Association of Plumbing and Mechanical Officials, 4755 E. Philadelphia Street, Ontario, CA 91761.
IES	Illuminating Engineering Society, 120 Wall St. Fl 17, New York, NY 10005-4026.
IGSHPA	International Ground Source Heat Pump Association, 1723 W. Tyler Ave. Stillwater, OK 74078.
IIAR	International Institute of Ammonia Refrigeration, 1001 N. Fairfax Street, Suite 503, Alexandria, VA 22314.
ISO	International Organization for Standardization, 1 ch. de la Voie-Creuse, Casa Postale 56, CH-1211 Geneva 20, Switzerland.
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park Street NE, Vienna, VA 22180.
NEBB	National Environmental Balancing Bureau, 8575 Grovemont Circle, Gaithersburg, MD 20877.
NFPA	National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.
NGWA	National Ground Water Association, 601 Dempsey Road, Westerville, Ohio 43081-8978.
NSF	NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105.
SAE	Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, 4201 Lafayette Center Drive, Chantilly, VA 20151-1219.
UL	Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.

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 PLAN EXAMINER REVIEW FORM FOR HVAC SYSTEM DESIGN (Loads, Equipment, Ducts) [ACCA]

^L
_A This appendix has not been adopted.

(Pages 351 through 352 have been deleted by City of Los Angeles. Text continues on Page 353.)

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE

APPENDIX B – PROCEDURES TO BE FOLLOWED TO PLACE GAS EQUIPMENT IN OPERATION

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X									X	X	X	X	X	X								
Adopt Entire Chapter as amended (amended sections listed below)																							
Adopt only those sections that are listed below																							
Chapter/Section																							

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

APPENDIX B

PROCEDURES TO BE FOLLOWED TO PLACE GAS EQUIPMENT IN OPERATION

The provisions contained in this appendix are not mandatory unless specifically adopted by a state agency, or referenced in the adopting ordinance.

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 54:11.2]

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, it 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]

CALIFORNIA MECHANICAL CODE – MATRIX ADOPTION TABLE
APPENDIX C – INSTALLATION AND TESTING OF OIL (LIQUID) FUEL-FIRED EQUIPMENT

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the code user. See Chapter 1 for state agency authority and building applications.)

Adopting Agency	BSC	BSC- CG	SFM	HCD			DSA			OSHDPD						BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
				1	2	1-AC	AC	SS	SS/CC	1	1R	2	3	4	5								
Adopt Entire Chapter	X									X	X	X	X	X	X								
Adopt Entire Chapter as amended (amended sections listed below)																							
Adopt only those sections that are listed below																							
Chapter/Section																							

This state agency does not adopt sections identified with the following symbol: †

The Office of the State Fire Marshal's adoption of this chapter or individual sections is applicable to structures regulated by other state agencies pursuant to Section 1.11.0.

APPENDIX C

INSTALLATION AND TESTING OF OIL (LIQUID) FUEL-FIRED EQUIPMENT

The provisions contained in this appendix are not mandatory unless specifically adopted by a state agency, or referenced in the adopting ordinance.

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.

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 only 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 and 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 gasses) 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 not 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

APPENDIX C

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.

Tank, Gravity. A supply tank from which the oil or fuel is delivered directly to the burner by gravity.

Tank, Integral. A tank that is furnished by the manufacturer as an integral part of an oil or fuel-burning appliance.

Tank Storage. A separate tank that is not connected to the oil or fuel-burning appliance.

Tank Supply. A separate tank connected directly or by a pump to the oil or fuel-burning appliance.

Tank, Vacuum or Barometric. A tank not exceeding 5 gallons (19 L) capacity that maintains a definite level of oil or fuel in a sump or similar receptacle by barometric feed. Fuel is delivered from the sump to the burner by gravity.

Valve, Manual Oil, Gas, or Fuel Shutoff. A manually operated valve in a fuel line for the purpose of turning on or completely shutting off the fuel supply to the burner.

Valve, Oil, Gas, or Fuel Control. An automatically or manually operated device consisting essentially of a fuel valve for controlling the fuel supply to a burner.

C 103.0 Standards and Accepted Practices.

C 103.1 General. The installation, testing, and repair of oil or liquid fuel-burning equipment systems shall be in accordance with Section C 103.0, the standards listed in Chapter 17, and other information outlined in this code such as, but not limited to, combustion air, flue and breeching requirements, room clearances and dimensions, and control requirements.

C 104.0 Approval of Equipment.

C 104.1 General. Oil or liquid fuel-burning equipment shall be approved.

C 105.0 Placing Equipment in Operation.

C 105.1 General. After completion of installations, the installer shall test safety and operating controls and venting before placing the burner in service. The correct input of liquid fuel shall be determined, and the fuel-to-air ratio shall be set. Each oil or liquid fuel burner shall be adjusted to its input according to the manufacturer's instructions. Overrating the burners or the appliance is prohibited. The input range shall be appropriate to the appliance:

- (1) For conversion burners installed in hot water (liquid) boilers or warm air furnaces, the rate of flow of the oil or liquid fuel in British thermal units per hour (Btu/h) (kW) shall be adjusted to within plus or minus 5 percent of the design load, not to exceed the design rate of the appliance.
- (2) For conversion burners installed in steam boilers, the oil or liquid fuel hourly input demand shall be adjusted to

be in accordance with the steam load requirements. The oil or liquid fuel input demand necessitated by an oversized boiler shall be established and added to total input demand.

C 106.0 Pilot Operation.

C 106.1 General. Igniter or pilot flames shall be effective to ignite the oil or liquid fuel at the main burner or burners and shall be adequately protected from drafts. Pilot flames shall not become extinguished during the pilot cycle where the main burner or burners are turned on or off in a normal manner either manually or by automatic controls.

C 107.0 Burner Operation.

C 107.1 General. In making tests to determine compliance with the requirements of Section C 107.1, the following care shall be exercised to prevent the accumulation of unburned liquid fuel in the appliance that will result in an explosion or fire:

- (1) The flames from the burner shall ignite freely the liquid fuel where operating at the lowest firing position.
- (2) Burner flames shall not flash back where the liquid fuel is turned on or off by an automatic control mechanism.
- (3) Main burner flames shall ignite freely from the pilot where the pilot flame is reduced to a minimum point that will actuate the pilot safety device.
- (4) Where ignition is made in a normal manner, the flame will not flash outside the appliance.
- (5) Burners shall not expel liquid fuel through air openings where operating at prevailing pressure.
- (6) Burners shall have a liquid-fuel air mixture to ensure smooth ignition of the main burner.

C 108.0 Method of Test.

C 108.1 General Test Methods.

- (1) The flue gas, venting, safety and operating controls of the appliance shall be checked by the installer to ensure their proper and safe operation.
- (2) Method of test – atmospheric, induced draft or fan assisted types.
 - (a) 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.

Appliance designs incorporating induced-draft assemblies require a flue gas sample to be taken ahead of the draft regulator or induced draft fan.

- (3) 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 75 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 and 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).

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- (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, maximum five seconds closing time.
 - (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.

Direct-spark ignition shall be allowed where approved by the Authority Having Jurisdiction and where used on number 2 or lighter oil.

- (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) 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.

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.
 - (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.
 - (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) A separate firing rate control valve.
 - (p) The burner oil pump shall automatically not operate or rotate while the alternate fuel is firing.
 - (q) 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.
 - (r) A separate relief device is required on each transfer pump.
 - (s) One low oil or liquid fuel-pressure interlock reset from flame safeguard or manually.
 - (t) Burners with automatic controls, prepurge, proof-of-closure, modulation, or postpurge shall not use relays external to the flame safeguard to accomplish these functions.
- (5) More than 12 500 000 Btu/h (3663.4 kW) per burner inputs. 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.

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- (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

^L
_A This appendix has not been adopted.

(Pages 367 through 372 have been deleted by City of Los Angeles. Text continues on Page 373.)

APPENDIX E

SUSTAINABLE PRACTICES

^L_A This appendix has not been adopted.

(Pages 375 through 480 have been deleted by City of Los Angeles. Text continues on Page 481.)

APPENDIX F

GEOHERMAL ENERGY SYSTEMS

^L
_A This appendix has not been adopted.

(Pages 483 through 492 have been deleted by City of Los Angeles. Text continues on Page 493.)

APPENDIX G

SIZING OF VENTING SYSTEMS AND OUTDOOR COMBUSTION AND VENTILATION OPENING DESIGN

^L
_A This appendix has not been adopted.

(Pages 495 through 504 have been deleted by City of Los Angeles. Text continues on Page 505.)

APPENDIX H

EXAMPLE CALCULATION OF OUTDOOR AIR RATE

^L
^A This appendix has not been adopted.

(Pages 507 through 508 have been deleted by City of Los Angeles. Text continues on Page 509.)

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.

UNIT CONVERSIONS		
MULTIPLY	BY	TO OBTAIN
Acres.....	43 560	Square feet (ft ²)
Acre-feet	43 560	Cubic feet (ft ³)
Acre-feet	325 851	Gallons (U. S. liquid)
Atmosphere (atm).....	76.0	Centimeters of mercury (0°C)
Atmosphere (standard) (atm).....	76.0	Centimeters of mercury (0°C)
Atmosphere (standard) (atm).....	33.90	Feet of water (4°C)
Atmosphere (standard) (atm).....	29.92	Inches of mercury
Atmosphere (standard) (atm).....	101.32501	Kilopascals (kPa)
Atmosphere (standard) (atm).....	14.70	Pounds-force/square inch (lbf/in ²)
Barrels.....	42	Gallons (gal)
Barrels.....	158.9873	Liters (L)
British thermal units (Btu).....	1055.055	Joules (J)
British thermal units/hour (Btu/h)	0.000293	Kilowatts (kW)
British thermal units/hour (Btu/h)	0.293	Watts (W)
British thermal unit hour (Btu/h)	1.055056	Kilojoules (kJ)
British thermal unit hour (Btu/h)	1055.056	Joule (J)
British thermal units/minute (Btu/min)	12.97	Foot pounds-force/second (ft•lbf/s)
British thermal units/minute (Btu/min)	0.02358	Horsepower (hp) (international)
British thermal unit per hour square foot degree Fahrenheit [Btu/(h•ft ² •°F)]	5.678263	Watt per square meter kelvin [W/(m ² •K)]
British thermal unit inch per hour foot degree Fahrenheit [Btu•in/(h•ft ² •°F)]	0.14442279	Watt per meter kelvin [W/(m•K)]
Candelas per square inch (cd/in ²).....	1.550003 x 10 ³	Candela per square meters (cd/m ²)
Celsius (°C).....	°C + 273.15	Kelvin (k)
Celsius (°C).....	1.8 x °C + 32	Fahrenheit (°F)
Centimeters (cm)	0.3937	Inches (in)
Centimeters of mercury (0°C)	0.01316	Atmosphere (standard)
Centimeters of mercury (0°C)	0.446	Feet of water (4°C)
Centimeters of mercury (0°C)	27.84	Pounds-force/square feet (lbf/ft ²)
Centimeters of mercury (0°C)	0.1934	Pounds-force/square inch (lbf/in ²)
Circumference	6.283	Radians (rad)
Cubic feet (ft ³)	1728	Cubic inches (in ³)
Cubic feet (ft ³)	0.0283	Cubic meters (m ³)
Cubic feet (ft ³)	0.03704	Cubic yards (yd ³)
Cubic feet (ft ³)	7.48052	Gallons (U.S. liquid) (gal)
Cubic feet (ft ³)	28.32	Liters (L)
Cubic feet (ft ³)	29.92	Quarts (U.S. liquid)
Cubic feet/hour (ft ³ /h).....	0.0283	Cubic meters/hour (m ³ /h)

USEFUL TABLES

UNIT CONVERSIONS (continued)

MULTIPLY	BY	TO OBTAIN
Cubic feet/minute (ft ³ /min).....	0.000472	Cubic meters/second (m ³ /s)
Cubic feet/minute (ft ³ /min).....	0.1247	Gallons/second
Cubic feet/minute (ft ³ /min).....	0.47194	Liters/second (L/s)
Cubic feet/second (ft ³ /s)	646 316.89	Gallons/day
Cubic feet/second (ft ³ /s)	448.831	Gallons/minute (gpm)
Cubic inches (in ³)	1.64 x 10 ⁻⁵	Cubic meters (m ³)
Cubic inches (in ³)	0.01639	Liters (L)
Cubic meters (m ³)	264.17	Gallons (U.S. liquid)
Cubic yards (yd ³)	27	Cubic feet (ft ³)
Cubic yards (yd ³)	0.76455	Cubic meters (m ³)
Cubic yards (yd ³)	201.97	Gallons (U.S. liquid)
Degrees (deg).....	0.0174	Radians (rad)
Fahrenheit (°F).....	(°F-32)/1.8	Celsius (°C)
Feet (ft)	0.3048	Meters (m)
Feet (ft)	304.8	Millimeters (mm)
Feet of water (4°C)	0.0295	Atmosphere (standard) (atm)
Feet of water (4°C)	0.8827	Inches of mercury (0°C)
Feet of water (4°C)	62.43	Pounds-force/square feet
Feet of water (4°C)	0.4335	Pounds-force/square inch
Feet/minute (ft/min).....	0.01667	Feet/second (ft/s)
Feet/minute (ft/min).....	0.01136	Miles/hour (mi/h)
Feet/second (ft/s)	0.3048	Meters/second (m/s)
Feet/second (ft/s)	0.6818	Miles/hour (mi/h)
Feet/second (ft/s)	0.01136	Miles/minute (mi/min)
Foot lambert (fL)	3.426259	Candela per square meter (cd/m ²)
Foot pounds-force (ft•lbf).....	1.355	Joules (J)
Foot pounds-force/minute (ft•lbf/min)	2.260 x 10 ⁻⁵	Kilowatts (kW)
Foot pounds-force/second (ft•lbf/s).....	1.356 x 10 ⁻³	Kilowatts (kW)
Gallons (U.S. liquid) (gal).....	231	Cubic inches (in ³)
Gallons (U.S. liquid) (gal).....	0.003785	Cubic meters (m ³)
Gallons (U.S. liquid) (gal).....	0.1337	Cubic feet (ft ³)
Gallons (U.S. liquid) (gal).....	3.785	Liters (L)
Gallons (U.S. liquid) (gal).....	4	Quarts (U.S. liquid)
Gallons/day.....	4.3 x 10 ⁻⁵	Liters/second
Gallons/minute (gal/min) (gpm).....	8.0208	Cubic feet/hour (ft ³ /h)
Gallons/minute (gal/min) (gpm).....	0.003785412	Cubic meters/minute (m ³ /min)
Gallons/minute (gal/min) (gpm).....	0.00223	Cubic feet/second (ft ³ /s)
Gallons/minute (gal/min) (gpm).....	6.309020 x 10 ⁻⁵	Cubic meters/second (m ³ /s)
Gallons/minute (gal/min) (gpm).....	0.06309	Liters/second (L/s)
Grains (gr)	0.00006479	Kilograms (kg)
Horsepower (hp).....	0.7457	Kilowatts (kW)
Horsepower-hours.....	2.684 x 10 ⁺⁶	Joules (J)
Horsepower-hours	0.7457	Kilowatt-hours (kW•h)
Inch (water column at 60°F).....	0.24884	Kilopascals (kPa)
Inches (in).....	2.54	Centimeters (cm)

UNIT CONVERSIONS (continued)

MULTIPLY	BY	TO OBTAIN
Inches (in)	25.4	Millimeters (mm)
Inches/hour	25.4	Millimeters/hour (mm/h)
Inches of mercury (0°C)	0.03342	Atmosphere (standard) (atm)
Inches of mercury (0°C)	1.133	Feet of water (4°C)
Inches mercury (0°C)	3.3863	Kilopascals (kPa)
Inches of mercury (0°C)	0.4912	Pounds-force/square inch
Inches of water (4°C).....	0.002458	Atmosphere (standard) (atm)
Inches of water (4°C).....	0.07356	Inches of mercury (0°C)
Inches of water (4°C).....	5.202	Pounds-force/square feet
Inches of water (4°C).....	0.03613	Pounds-force/square inch
Joules (J).....	9.480×10^{-4}	British thermal units (Btus)
Joules (J).....	0.7376	Foot-pounds
Joules (J).....	2.778×10^{-4}	Watt-hours
Kelvin (K).....	°K - 273.15	Celsius (°C)
Kilograms (kg).....	2.2046	Pounds (lbs)
Kilograms (kg)	1.102×10^{-3}	Tons (short)
Kilopascals (kPa).....	0.145038	Pounds-force/square inch
Kilometers (km).....	0.6214	Miles (statute)
Kilometers/hour (km/h)	0.6214	Miles/hour (mi/h)
Kilowatts (kW)	3412.14	British thermal units/hour (Btus/hour)
Kilowatts (kW).....	1.341	Horsepower (hp)
Kilowatt-hours	3413	British thermal units (Btus)
Kilowatt-hours	$2.655 \times 10^{+6}$	Foot-pounds (ft•lbs)
Kilowatt-hours	$3.6 \times 10^{+6}$	Joules (J)
Kip (1000 lbf).....	4.448222	Kilonewtons (kN)
Kip-foot	1.35671	Kilonewton meters (kN•m)
Kips per square inch (kip/in ²).....	6.8947	Megapascals (MPa)
Lambert (la).....	3.183099×10^3	Candela per square meter (cd/m ²)
Liters (L).....	0.03531	Cubic feet (ft ³)
Liters (L).....	61.02	Cubic inches (in ³)
Liters (L).....	0.001	Cubic meters (m ³)
Liters (L).....	0.2642	Gallons (U.S. liquid)
Lumens per square foot (lm/ft ²) (footcandle).....	10.76391	Lux (lx)
Meters (m)	3.281	Feet (ft)
Meters (m)	39.37	Inches (in)
Meters (m)	1.094	Yards
Meters/second (m/s)	3.281	Feet/second (ft/s)
Meters/second (m/s)	2.237	Miles/hour (mi/h)
Miles (mi)	5280	Feet (ft)
Miles (statute).....	1.609	Kilometers (km)
Miles/hour (mi/h).....	88	Feet/minute (ft/min)
Miles/hour (mi/h).....	1.467	Feet/second (ft/s)
Miles/hour (mi/h).....	1.609344	Kilometers/hour (km/h)
Miles/hour (mi/h).....	26.82	Meters/minute (m/min)
Miles/hour (mi/h).....	0.44704	Meters/second (m/s)

USEFUL TABLES

UNIT CONVERSIONS (continued)

MULTIPLY	BY	TO OBTAIN
Millimeters (mm).....	0.1	Centimeters (cm)
Millimeters (mm).....	0.03937	Inches (in)
Millimeters (mm).....	0.001	Meters (m)
Minutes (min).....	2.908882×10^{-4}	Radians (rads)
Ounces/square inch (oz/in ²).....	43.94185	Kilograms/square meter (kg/m ²)
Ounces/square foot (oz/ft ²)	0.03051517	Kilograms/square meter (kg/m ²)
Ounces (oz).....	0.02834	Kilograms (kg)
Ounces (oz).....	29.57353	Milliliters (mL)
Pints	0.4731765	Liters (L)
Pound-force feet (lbf•ft)	1.355818	Newton meters (N•m)
Pound-force inch (lbf•in).....	0.1129848	Newton meters (N•m)
Pound-force per foot (lbf/ft)	14.5939	Newton meters (N•m)
Pound-force per square foot (lbf/ft ²)	47.88026	Pascals (Pa)
Pound-force per square inch (lbf/in ²)	6.89476	Kilopascals (kPa)
Pound-force per inch (lbf/in)	175.1268	Newton meters (N•m)
Pounds/cubic inch (lb/in ³).....	2.767990×10^4	Kilograms/cubic meter (kg/m ³)
Pounds/cubic yard (lb/yd ³)	0.5932764	Kilograms/cubic meter (kg/m ³)
Pounds (lb).....	0.45359	Kilograms (kg)
Pounds/cubic foot (lb/ft ³)	16.0184	Kilograms/cubic meters (kg/m ³)
Pounds/foot (lb/ft)	1.4881	Kilograms/meters (kg/m)
Pounds/square inch (lb/in ²).....	703.1	Kilograms-force/square meter (kg/m ²)
Pounds/square foot (lb/ft ²).....	4.882427	Kilograms-force/square meter (kg/m ²)
Pounds-force (lbf).....	4.4482	Newtons (N)
Pounds-force/square inch (psi).....	0.06805	Atmosphere (standard) (atm)
Pounds-force/square inch (psi).....	2.307	Feet of water (4°C)
Pounds-force/square inch (psi).....	2.036	Inches of mercury (0°C)
Pounds-force/square inch (psi).....	6.89476	Kilopascals (kPa)
Quarts (U.S. dry) (dry qt)	67.20	Cubic inches (in ³)
Quarts (U.S. liquid) (liq qt)	57.75	Cubic inches (in ³)
Quarts (liquid)	0.9463529	Liters (L)
Radians (rads).....	57.30	Degrees (deg)
Seconds (s)	4.848137×10^{-6}	Radians (rads)
Square acre	0.404687	Square kilometers (km ²)
Square feet (ft ²).....	144	Square inches (in ²)
Square feet (ft ²).....	0.0929	Square meters (m ²)
Square inches (in ²).....	645.16	Square millimeters (mm ²)
Square inches (in ²).....	0.000645	Square meters (m ²)
Square meters (m ²)	1550	Square inches (in ²)
Square miles (mi ²)	640	Acres
Square miles (mi ²)	2.589988	Square kilometers (km ²)
Square millimeters (mm ²)	1.550×10^{-3}	Square inches (in ²)
Square yards (yd ²)	9	Square feet (ft ²)
Square yards (yd ²)	0.8361274	Square meters (m ²)
Temperature (°C) + 17.28	1.8	Temperature (°F)
Temperature (°F) – 32	$\frac{5}{9}$	Temperature (°C)

USEFUL TABLES

UNIT CONVERSIONS (continued)

MULTIPLY	BY	TO OBTAIN
Ton-force (tonf) (2000 lbf)	8.896443	Kilonewtons (kN)
Ton-force foot (tonf•f/ft)	2.71342	Kilonewton meters (kN•m)
Ton-force per square foot (tonf/ft ²)	95.7605	Kilopascals (kPa)
Ton-force per square inch (tonf/in ²)	13.7895	Megapascals (MPa)
Tons (metric)	1000	Kilograms (kg)
Tons (long) (2240 lbs)	1016.047	Kilograms (kg)
Tons (short)	2000	Pounds (lbs)
Watts	3.4121	British thermal units per hour (Btus/hour)
Watts	1.341 x 10 ⁻³	Horsepower (hp)
Yards (y)	0.9144	Meters (m)

SI SYMBOLS AND PREFIXES

SI PREFIXES			
MULTIPLICATION FACTOR		PREFIX	SYMBOL
1 000 000 000 000 000 000	= E+18	exa	E
1 000 000 000 000 000	= E+15	peta	P
1 000 000 000 000	= E+12	tera	T
1 000 000 000	= E+09	giga	G
1 000 000	= E+06	mega	M
1 000	= E+03	kilo	k
100	= E+02	hecto	h
10	= E+01	deka	da
0.1	= E-01	deci	d
0.01	= E-02	centi	c
0.001	= E-03	milli	m
0.000 001	= E-06	micro	μ
0.000 000 001	= E-09	nano	n
0.000 000 000 001	= E-12	pico	p
0.000 000 000 000 001	= E-15	femto	f
0.000 000 000 000 000 001	= E-18	atto	a

USEFUL TABLES

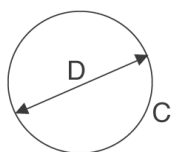
AREAS AND CIRCUMFERENCES OF CIRCLES

DIAMETER		CIRCUMFERENCE		AREA	
Inches	mm	Inches	mm	Inches ²	mm ²
1/8	6	0.40	10	0.01227	8.0
1/4	8	0.79	20	0.04909	31.7
3/8	10	1.18	30	0.11045	71.3
1/2	15	1.57	40	0.19635	126.7
3/4	20	2.36	60	0.44179	285.0
1	25	3.14	80	0.7854	506.7
1 1/4	32	3.93	100	1.2272	791.7
1 1/2	40	4.71	120	1.7671	1140.1
2	50	6.28	160	3.1416	2026.8
2 1/2	65	7.85	200	4.9087	3166.9
3	80	9.43	240	7.0686	4560.4
4	100	12.55	320	12.566	8107.1
5	125	15.71	400	19.635	12 667.7
6	150	18.85	480	28.274	18 241.3
7	175	21.99	560	38.485	24 828.9
8	200	25.13	640	50.265	32 428.9
9	225	28.27	720	63.617	41 043.1
10	250	31.42	800	78.540	50 670.9

EQUAL PERIPHERIES

$$S = 0.7854 D$$

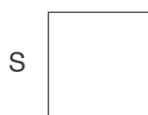
$$D = 1.2732 S$$



$$S = 0.8862 D$$

$$D = 1.1284 S$$

$$S = 0.2821 C$$



EQUAL AREAS

$$\text{Area of square (S')} =$$

$$1.2732 \times \text{area of circle}$$

$$\text{Area of square (S)} =$$

$$0.6366 \times \text{area of circle}$$

$$C \approx D = 2\pi R$$

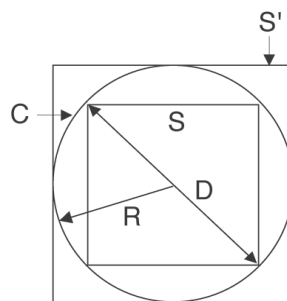
$$C = 3.5446 \sqrt{\text{area}}$$

$$D = 0.3183 C = 2R$$

$$D = 1.1283 \sqrt{\text{area}}$$

$$\text{Area} \approx R^2 = 0.7854 D^2$$

$$\text{Area} = 0.07958 C^2 \approx \frac{D^2}{4}$$



$$\pi \approx 3.1416$$

**APPROXIMATE MINIMUM THICKNESS FOR CARBON SHEET STEEL CORRESPONDING
TO MANUFACTURER'S STANDARD GAUGE AND GALVANIZED SHEET GAUGE NUMBERS**

CARBON SHEET STEEL			GALVANIZED SHEET		
MANUFACTURER'S STANDARD GAUGE NO.	DECIMAL AND NOMINAL THICKNESS EQUIVALENT (inch)	RECOMMENDED MINIMUM THICKNESS EQUIVALENT* (inch)	GALVANIZED SHEET GAUGE NO.	DECIMAL AND NOMINAL THICKNESS EQUIVALENT (inch)	RECOMMENDED MINIMUM THICKNESS EQUIVALENT* (inch)
8	0.1644	0.156	8	0.1681	0.159
9	0.1495	0.142	9	0.1532	0.144
10	0.1345	0.127	10	0.1382	0.129
11	0.1196	0.112	11	0.1233	0.114
12	0.1046	0.097	12	0.1084	0.099
13	0.0897	0.083	13	0.0934	0.084
14	0.0747	0.068	14	0.0785	0.070
15	0.0673	0.062	15	0.0710	0.065
16	0.0598	0.055	16	0.0635	0.058
17	0.0538	0.050	17	0.0575	0.053
18	0.0478	0.044	18	0.0516	0.047
19	0.0418	0.038	19	0.0456	0.041
20	0.0359	0.033	20	0.0396	0.036
21	0.0329	0.030	21	0.0366	0.033
22	0.0299	0.027	22	0.0336	0.030
23	0.0269	0.024	23	0.0306	0.027
24	0.0239	0.021	24	0.0276	0.024
25	0.0209	0.018	25	0.0247	0.021
26	0.0179	0.016	26	0.0217	0.019
27	0.0164	0.014	27	0.0202	0.017
28	0.0149	0.013	28	0.0187	0.016
—	—	—	29	0.0172	0.014
—	—	—	30	0.0157	0.013

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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HISTORY NOTE APPENDIX

2022 CALIFORNIA MECHANICAL CODE

CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 4

HISTORY:

For prior code history, see the History Note Appendix to the California Mechanical Code, 2019 Triennial Edition, effective January 1, 2020.

- 1. (BSC 01/21, CEC 03/21, DSA-SS 01/21, HCD 01/21, OSHPD 01/21, SFM 01/21) Adoption by reference the 2021 Uniform Mechanical Code with necessary amendments to become the 2022 California Mechanical Code, and repeal of the 2018 edition of the Uniform Mechanical Code; effective on January 1, 2023.*

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