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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.

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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.

FOREWORD

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.

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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 2018 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/

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another document. A reference in brackets { } following a section or paragraph indicates material that has been extracted from another document and has been modified further by the Technical Committee. 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.

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
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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

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

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.

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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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Tim Orris, Air Movement and Control Association International (AMCA) [R/S/T]
James Pavesic, United Association [L]
Chris Ruch, National Energy Management Institute (NEMI) [R/S/T]
Robert Sewell, Plumbers & Steamfitters Local 159 [L]
Jason Shelton, Air Duct Council [M]
Chuck White, Plumbing Heating Cooling Contractors (PHCC) [I/M]

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CHAPTER 1
ADMINISTRATION

101.0 General.

101.1 Title. This document shall be known as the "Uniform Mechanical Code," may be cited as such, and will be referred to herein as "this code."

101.2 Scope. The provisions of this code shall apply to the erection, installation, alteration, repair, relocation, replacement, addition to, use, or maintenance of mechanical systems within this jurisdiction.

101.3 Purpose. This code is an ordinance providing minimum requirements and standards for the protection of the public health, safety, and welfare.

101.4 Unconstitutional. Where a section, subsection, sentence, clause, or phrase of this code is, for a reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this code. The legislative body hereby declares that it would have passed this code, and each section, subsection, sentence, clause, or phrase thereof, irrespective of the fact that one or more sections, subsections, sentences, clauses, and phrases are declared unconstitutional.

101.5 Validity. Where a provision of this code, or the application thereof to a person or circumstance, is held invalid, the remainder of the code, or the application of such provision to other persons or circumstances, shall not be affected thereby.

102.0 Applicability.

102.1 Conflicts Between Codes. Where the requirements within the jurisdiction of this mechanical code conflict with the requirements of the plumbing code, the plumbing code shall prevail. In instances where this code, applicable standards, or the manufacturer's installation instructions conflict, the more stringent provisions shall prevail. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall prevail.

102.2 Existing Installations. Mechanical systems lawfully in existence at the time of the adoption of this code shall be permitted to have their use, maintenance, or repair continued where the use, maintenance, or repair is in accordance with the original design and location and no hazard to life, health, or property has been created by such mechanical system.

102.3 Maintenance. Mechanical systems, materials, and appurtenances, both existing and new, of a premise under the Authority Having Jurisdiction shall be maintained in operating condition. Devices or safeguards required by this code shall be maintained in accordance with the code edition under which installed.

The owner or the owner's designated agent shall be responsible for maintenance of mechanical systems. To determine compliance with this subsection, the Authority Having Jurisdiction shall be permitted to cause a mechanical system to be reinspected.

102.3.1 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.

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

102.4 Additions, Alterations, Renovations, or Repairs. Additions, alterations, renovations, or repairs shall conform to that required for a new system without requiring the existing mechanical system to be in accordance with the requirements of this code. Additions, alterations, renovations, or repairs shall not cause an existing system to become unsafe, insanitary or overloaded.

Additions, alterations, renovations, or repairs to existing mechanical system installations shall comply with the provisions for new construction, unless such deviations are found to be necessary and are first approved by the Authority Having Jurisdiction.

102.5 Health and Safety. Where compliance with the provisions of this code fails to eliminate or alleviate a nuisance, or other dangerous or insanitary condition that involves health or safety hazards, the owner or the owner's agent shall install such additional mechanical system facilities or shall make such repairs or alterations as ordered by the Authority Having Jurisdiction.

102.6 Changes in Building Occupancy. Mechanical systems that are a part of a building or structure undergoing a change in use or occupancy, as defined in the building code, shall be in accordance with the requirements of this code that are applicable to the new use or occupancy.

102.7 Moved Structures. Parts of the mechanical system of a building and part thereof that is moved from one foundation to another, or from one location to another, shall be in accordance with the provisions of this code for new installations and completely tested as prescribed elsewhere in this section for new work, except that walls or floors need not be removed during such test where equivalent means of inspection acceptable to the Authority Having Jurisdiction are provided.

102.8 Appendices. The provisions in the appendices are intended to supplement the requirements of this code and shall not be considered part of this code unless formally adopted as such.

103.0 Duties and Powers of the Authority Having Jurisdiction.

103.1 General. The Authority Having Jurisdiction shall be the Authority duly appointed to enforce this code. For such purposes, the Authority Having Jurisdiction shall have the powers of a law enforcement officer. The Authority Having Jurisdiction shall have the power to render interpretations of this code and to adopt and enforce rules and regulations supplemental to this code as deemed necessary in order to clarify the application of the provisions of this code. Such interpretations, rules, and regulations shall comply with the intent and purpose of this code.

In accordance with the prescribed procedures and with the approval of the appointing authority, the Authority Having Jurisdiction shall be permitted to appoint such number of technical officers, inspectors, and other employees as shall be authorized from time to time. The Authority Having Jurisdiction shall be permitted to deputize such inspectors or employees as necessary to carry out the functions of the code enforcement agency.

The Authority Having Jurisdiction shall be permitted to request the assistance and cooperation of other officials of this jurisdiction so far as required in the discharge of the duties required by this code or other pertinent law or ordinance.

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

103.3 Applications and Permits. The Authority Having Jurisdiction shall be permitted to require the submission of plans, specifications, drawings, and such other information in accordance with the Authority Having Jurisdiction, prior to the commencement of, and at a time during the progress of, work regulated by this code.

The issuance of a permit upon construction documents shall not prevent the Authority Having Jurisdiction from thereafter requiring the correction of errors in said construction documents or from preventing construction operations being carried on thereunder where in violation of this code or of other pertinent ordinance or from revoking a certificate of approval where issued in error.

103.3.1 Licensing. Provision for licensing shall be determined by the Authority Having Jurisdiction.

103.4 Right of Entry. Where it is necessary to make an inspection to enforce the provisions of this code, or where the Authority Having Jurisdiction has reasonable cause to believe that there exists in a building or upon a premises a condition or violation of this code that makes the building or premises unsafe, insanitary, dangerous, or hazardous, the Authority Having Jurisdiction shall be permitted to enter the building or premises at reasonable times to inspect or to perform the duties imposed upon the Authority Having Jurisdiction by this code, provided that where such building or premises is occupied, the Authority Having Jurisdiction shall present credentials to the occupant and request entry. Where such building or premises is unoccupied, the Authority Having Jurisdiction shall first make a reasonable effort to locate the owner or other person having charge or control of the building or premises and request entry. Where entry is refused, the Authority Having Jurisdiction has recourse to every remedy provided by law to secure entry.

Where the Authority Having Jurisdiction shall have first obtained an inspection warrant or other remedy provided by law to secure entry, no owner, occupant, or person having charge, care or control of a building or premises shall fail or neglect, after a request is made as herein provided, to promptly permit entry herein by the Authority Having Jurisdiction for the purpose of inspection and examination pursuant to this code.

104.0 Permits.

104.1 Permits Required. It shall be unlawful for a person, firm, or corporation to make an installation, alteration, repair, replacement, or remodel a mechanical system regulated by this code except as permitted in Section 104.2, or to cause the same to be done without first obtaining a separate mechanical permit for each separate building or structure.

104.2 Exempt Work. A permit shall not be required for the following:

(1) A portable heating appliance, portable ventilating equipment, a portable cooling unit, or a portable evaporative cooler.

(2) A closed system of steam, hot, or chilled water piping within heating or cooling equipment regulated by this code.

(3) Replacement of a component part that does not alter its original approval and is in accordance with other applicable requirements of this code.

(4) Refrigerating equipment that is part of the equipment for which a permit has been issued pursuant to the requirements of this code.

(5) A unit refrigerating system.

Exemption from the permit requirements of this code shall not be deemed to grant authorization for work to be done in violation of the provisions of the code or other laws or ordinances of this jurisdiction.

104.3 Application for Permit. To obtain a permit, the applicant shall first file an application therefore in writing on a form furnished by the Authority Having Jurisdiction for that purpose. Such application shall:

(1) Identify and describe the work to be covered by the permit for which application is made.

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(2) Describe the land upon which the proposed work is to be done by legal description, street address, or similar description that will readily identify and definitely locate the proposed building or work.

(3) Indicate the use or occupancy for which the proposed work is intended.

(4) Be accompanied by construction documents and other data in accordance with Section 104.3.1.

(5) Be signed by the permittee or the permittee's authorized agent. The Authority Having Jurisdiction shall be permitted to require evidence to indicate such authority.

(6) Give such other data and information in accordance with the Authority Having Jurisdiction.

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

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

104.3.2 Plan Review Fees. Where a plan or other data is required to be submitted in accordance with Section 104.3.1, a plan review fee shall be paid at the time of submitting construction documents for review.

The plan review fees for mechanical system work shall be determined and adopted by this jurisdiction.

The plan review fees specified in this subsection are separate fees from the permit fees specified in Section 104.5.

Where plans are incomplete or changed so as to require additional review, a fee shall be charged at the rate shown in Table 104.5.

104.3.3 Time Limitation of Application. Applications for which no permit is issued within 180 days following the date of application shall expire by limitation, plans and other data submitted for review thereafter, shall be returned to the applicant or destroyed by the Authority Having Jurisdiction. The Authority Having Jurisdiction shall be permitted to extend the time for action by the applicant for a period not to exceed 180 days upon request by the applicant showing that circumstances beyond the control of the applicant have prevented action from being taken. No application shall be extended more than once. In order to renew action on an application after expiration, the applicant shall resubmit plans and pay a new plan review fee.

104.4 Permit Issuance. The application, construction documents, and other data filed by an applicant for a permit shall be reviewed by the Authority Having Jurisdiction. Such plans shall be permitted to be reviewed by other departments of this jurisdiction to verify compliance with applicable laws under their jurisdiction. Where the Authority Having Jurisdiction finds that the work described in an application for permit and the plans, specifications, and other data filed therewith are in accordance with the requirements of the code and other pertinent laws and ordinances and that the fees specified in Section 104.5 have been paid, the Authority Having Jurisdiction shall issue a permit therefore to the applicant.

104.4.1 Approved Plans or Construction Documents. Where the Authority Having Jurisdiction issues the permit where plans are required, the Authority Having Jurisdiction shall endorse in writing or stamp the construction documents "APPROVED." Such approved construction documents shall not be changed, modified, or altered without authorization from the Authority Having Jurisdiction, and the work shall be done in accordance with approved plans.

The Authority Having Jurisdiction shall be permitted to issue a permit for the construction of a part of a mechanical system before the entire construction documents for the whole system have been submitted or approved, provided adequate information and detailed statements have been filed in accordance with pertinent requirements of this code. The holder of such permit shall be permitted to proceed at the holder's risk without assurance that the permit for the entire building, structure, or mechanical system will be granted.

104.4.2 Validity of Permit. The issuance of a permit or approval of construction documents shall not be construed to be a permit for, or an approval of, a violation of the provisions of this code or other ordinance of the jurisdiction. No permit presuming to give authority to violate or cancel the provisions of this code shall be valid.

The issuance of a permit based upon plans, specifications, or other data shall not prevent the Authority Having Jurisdiction from thereafter requiring the correction of errors in said plans, specifications, and other data or from preventing building operations being carried on thereunder where in violation of this code or of other ordinances of this jurisdiction.

104.4.3 Expiration. A permit issued by the Authority Having Jurisdiction under the provisions of this code shall expire by limitation and become null and void where the work authorized by such permit is not commenced within 180 days from the date of such permit, or where the work authorized by such permit is suspended or abandoned at a time after the work is commenced for a period of 180 days. Before such work is recommenced, a new permit shall first be obtained to do so, and the fee, therefore, shall be one-half the amount required for a new permit for such work, provided no changes have been made or will be made in the original construction documents for such work, and provided further that such suspension or abandonment has not exceeded 1 year.

104.4.4 Extension. A permittee holding an unexpired permit shall be permitted to apply for an extension of the time within which work shall be permitted to commence under that permit where the permittee is unable to commence work within the time required by this section. The Authority Having Jurisdiction shall be permitted to extend the time for action by the permittee for a period not exceeding 180 days upon written request by the permittee showing that circumstances beyond the control of the permittee have prevented action from being taken. No permit shall be extended more than once. In order to renew action on a permit after expiration, the permittee shall pay a new full permit fee.

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

104.4.6 Retention of Plans. One set of approved construction documents and computations shall be retained by the Authority Having Jurisdiction until final approval of the work is covered therein.

One set of approved construction documents, computations, and manufacturer's installation instructions shall be returned to the applicant, and said set shall be kept on the site of the building or work at times during which the work authorized thereby is in progress.

104.5 Fees. Fees shall be assessed in accordance with the provisions of this section and as set forth in the fee schedule, Table 104.5. The fees are to be determined and adopted by this jurisdiction.

104.5.1 Work Commencing Before Permit Issuance. Where work for which a permit is required by this code has been commenced without first obtaining said permit, a special investigation shall be made before a permit is issued for such work.

104.5.2 Investigation Fees. An investigation fee, in addition to the permit fee, shall be collected whether or not a permit is then or subsequently issued. The investigation fee shall be equal to the amount of the permit fee that is required by this code if a permit were to be issued. The payment of such investigation fee shall not exempt a person from compliance with other provisions of this code, nor from a penalty prescribed by law.

104.5.3 Fee Refunds. The Authority Having Jurisdiction shall be permitted to authorize the refunding of a fee as follows:

(1) The amount paid hereunder that was erroneously paid or collected.

(2) Refunding of not more than a percentage, as determined by this jurisdiction where no work has been done under a permit issued in accordance with this code.

The Authority Having Jurisdiction shall not authorize refunding of a fee paid except upon written application filed by the original permittee not to exceed 180 days after the date of fee payment.

105.0 Inspections and Testing.

105.1 General. Mechanical systems for which a permit is required by this code shall be inspected by the Authority Having Jurisdiction.

No mechanical system or portion thereof shall be covered, concealed, or put into use until inspected and approved as prescribed in this code. Neither the Authority Having Jurisdiction nor the jurisdiction shall be liable for expense entailed in the removal or replacement of material required to permit inspection. Mechanical systems regulated by this code shall not be connected to the energy fuel supply lines until authorized by the Authority Having Jurisdiction.

105.2 Required Inspections. New mechanical system work and such portions of existing systems as affected by new work, or changes, shall be inspected by the Authority Having Jurisdiction to ensure compliance with the requirements of this code and to ensure that the installation and construction of the mechanical system are in accordance with approved plans. The Authority Having Jurisdiction shall make the following inspections and other such inspections as necessary. The permittee or the permittee's authorized agent shall be responsible for the scheduling of such inspections as follows:

(1) Underground inspection shall be made after trenches or ditches are excavated and bedded, piping installed, and before backfill is put in place.

(2) Rough-in inspection shall be made prior to the installation of wall or ceiling membranes.

(3) Final inspection shall be made upon completion of the installation.

105.2.1 Uncovering. Where a mechanical system, or part thereof, which is installed, altered, or repaired, is covered or concealed before being inspected, tested, and approved as prescribed in this code, it shall be uncovered for inspection after notice to uncover the work has been issued to the responsible person by the Authority Having Jurisdiction. The requirements of this section shall not be considered to prohibit the operation of mechanical systems installed to replace existing equipment serving an occupied portion of the building in the event a request for inspection of such equipment has been filed with the Authority Having Jurisdiction not more than 72 hours after such replacement work is completed, and before a portion of such mechanical system is concealed by a permanent portion of the building.

105.2.2 Other Inspections. In addition to the inspections required by this code, the Authority Having Jurisdiction shall be permitted to require other inspections to ascertain compliance with the provisions of this code and other laws that are enforced by the Authority Having Jurisdiction.

105.2.3 Inspection Requests. It shall be the duty of the person doing the work authorized by a permit to notify the Authority Having Jurisdiction that such work is ready for inspection. The Authority Having Jurisdiction shall be permitted to require that a request for inspection be filed not less than 1 working day before

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such inspection is desired. Such request shall be permitted to be made in writing or by telephone, at the option of the Authority Having Jurisdiction.

It shall be the duty of the person requesting inspections in accordance with this code to provide access to and means for inspection of such work.

105.2.4 Advance Notice. It shall be the duty of the person doing the work authorized by the permit to notify the Authority Having Jurisdiction, orally or in writing that said work is ready for inspection. Such notification shall be given not less than 24 hours before the work is to be inspected.

105.2.5 Responsibility. It shall be the duty of the holder of a permit to make sure that the work will stand the test prescribed before giving the notification.

The equipment, material, and labor necessary for inspection or tests shall be furnished by the person to whom the permit is issued or by whom inspection is requested.

105.2.6 Reinspections. A reinspection fee shall be permitted to be assessed for each inspection or reinspection where such portion of work for which inspection is called is not complete or where required corrections have not been made.

This provision shall not be interpreted as requiring reinspection fees the first time a job is rejected for failure to be in accordance with the requirements of this code, but as controlling the practice of calling for inspections before the job is ready for inspection or reinspection.

Reinspection fees shall be permitted to be assessed where the approved plans are not readily available to the inspector, for failure to provide access on the date for which the inspection is requested, or for deviating from plans requiring the approval of the Authority Having Jurisdiction.

To obtain reinspection, the applicant shall file an application therefore in writing upon a form furnished for that purpose and pay the reinspection fee in accordance with Table 104.5.

In instances where reinspection fees have been assessed, no additional inspection of the work will be performed until the required fees have been paid.

105.3 Testing of Systems. Mechanical systems shall be tested and approved in accordance with this code or the Authority Having Jurisdiction. Tests shall be conducted in the presence of the Authority Having Jurisdiction or the Authority Having Jurisdiction's duly appointed representative.

No test or inspection shall be required where a mechanical system, or part thereof, is set up for exhibition purposes and has no connection with water or an energy fuel supply. In cases where it would be impractical to provide the required water or air tests, or for minor installations and repairs, the Authority Having Jurisdiction shall be permitted to make such inspection as deemed advisable in order to be assured that the work has been performed in accordance with the intent of this code. Joints and connections in the mechanical system shall be airtight, gastight, or watertight for the pressures required by the test.

105.3.1 Defective Systems. In buildings or premises condemned by the Authority Having Jurisdiction because of an insanitary condition of the mechanical system, or part thereof, the alterations in such system shall be in accordance with the requirements of this code.

105.3.2 Retesting. Where the Authority Having Jurisdiction finds that the work will not pass the test, necessary corrections shall be made, and the work shall be resubmitted for test or inspection.

105.3.3 Approval. Where prescribed tests and inspections indicate that the work is in accordance with this code, a certificate of approval shall be issued by the Authority Having Jurisdiction to the permittee on demand.

105.4 Connection to Service Utilities. No person shall make connections from a source of energy or fuel to a mechanical system or equipment regulated by this code and for which a permit is required until approved by the Authority Having Jurisdiction. The Authority Having Jurisdiction shall be permitted to authorize temporary connection of the mechanical system equipment to the source of energy or fuel for the purpose of testing the equipment.

106.0 Violations and Penalties.

106.1 General. It shall be unlawful for a person, firm, or corporation to erect, construct, enlarge, alter, repair, move, improve, remove, convert, demolish, equip, use, or maintain a mechanical system or permit the same to be done in violation of this code.

106.2 Notices of Correction or Violation. Notices of correction or violation shall be written by the Authority Having Jurisdiction and shall be permitted to be posted at the site of the work or mailed or delivered to the permittee or their authorized representative.

Refusal, failure, or neglect to comply with such notice or order within 10 days of receipt thereof, shall be considered a violation of this code and shall be subject to the penalties set forth by the governing laws of the jurisdiction.

106.3 Penalties. A person, firm, or corporation violating a provision of this code shall be deemed guilty of a misdemeanor, and upon conviction thereof, shall be punishable by a fine, imprisonment, or both set forth by the governing laws of the jurisdiction. Each separate day or a portion thereof, during which a violation of this code occurs or continues, shall be deemed to constitute a separate offense.

106.4 Stop Orders. Where work is being done contrary to the provisions of this code, the Authority Having Jurisdiction shall be permitted to order the work stopped by notice in writing served on persons engaged in the doing or causing such work to be done, and such persons shall forthwith stop work until authorized by the Authority Having Jurisdiction to proceed with the work.

106.5 Authority to Disconnect Utilities in Emergencies. The Authority Having Jurisdiction shall have the authority to disconnect a mechanical system to a building, structure, or equipment regulated by this code in case of emergency where necessary to eliminate an immediate hazard to life or property.

106.6 Authority to Condemn. Where the Authority Having Jurisdiction ascertains that a mechanical system or portion thereof, regulated by this code, has become hazardous to life, health, or property, or has become insanitary, the Authority Having Jurisdiction shall order in writing that such mechanical system either be removed or placed in a safe or sanitary condition. The order shall fix a reasonable time limit for compliance. No person shall use or maintain a defective mechanical system after receiving such notice.

Where such mechanical system is to be disconnected, written notice shall be given. In cases of immediate danger to life or property, such disconnection shall be permitted to be made immediately without such notice.

107.0 Board of Appeals.

107.1 General. In order to hear and decide appeals of orders, decisions, or determinations made by the Authority Having Jurisdiction relative to the application and interpretations of this code, there shall be and is hereby created a Board of Appeals consisting of members who are qualified by experience and training to pass upon matters pertaining to mechanical system design, construction, and maintenance and the public health aspects of mechanical systems and who are not employees of the jurisdiction. The Authority Having Jurisdiction shall be an ex-officio member and shall act as secretary to said board but shall have no vote upon a matter before the board. The Board of Appeals shall be appointed by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business and shall render decisions and findings in writing to the appellant with a duplicate copy to the Authority Having Jurisdiction.

107.2 Limitations of Authority. The Board of Appeals shall have no authority relative to interpretation of the administrative provisions of this code, nor shall the board be empowered to waive requirements of this code.

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TABLE 104.5
MECHANICAL PERMIT FEES

Permit Issuance

1. For the issuance of each permit ..... [1]
2. For issuing each supplemental permit for which the original permit has not expired or been canceled or finalized ..... [1]

Unit Fee Schedule

1. Furnaces:
   - For the installation or relocation of each forced-air or gravity-type furnace or burner, including ducts and vents attached to such appliance, not exceeding 100 000 British thermal units per hour (Btu/h) ..... [1]
   - For the installation or relocation of each forced-air or gravity-type furnace or burner, including ducts and vents attached to such appliance, exceeding 100 000 Btu/h ..... [1]
   - For the installation or relocation of each floor furnace, including vent ..... [1]
   - For the installation or relocation of each suspended heater, recessed wall heater, or floor-mounted unit heater ..... [1]
2. Appliance Vents:
   - For the installation, relocation, or replacement of each appliance vent installed and not included in an appliance permit ..... [1]
3. Repairs or Additions:
   - For the repair of, alteration of, or addition to each heating appliance, refrigeration unit, cooling unit, absorption unit, or each heating, cooling, absorption, or evaporative cooling, system including installation of controls regulated by this code ..... [1]
4. Boilers, Compressors, and Absorption Systems:
   - For the installation or relocation of each boiler or compressor, not exceeding 3 horsepower (hp), or each absorption system not exceeding 100 000 Btu/h ..... [1]
   - For the installation or relocation of each boiler or compressor exceeding 3 hp, not exceeding 15 hp, or each absorption system exceeding 100 000 Btu/h and including 500 000 Btu/h ..... [1]
   - For the installation or relocation of each boiler or compressor exceeding 15 hp, not exceeding 30 hp, or each absorption system exceeding 500 000 Btu/h, not exceeding 1 000 000 Btu/h ..... [1]
   - For the installation or relocation of each boiler or compressor exceeding 30 hp, not exceeding 50 hp, or for each absorption system exceeding 1 000 000 Btu/h, not exceeding 1 750 000 Btu/h ..... [1]
   - For the installation or relocation of each boiler or compressor exceeding 50 hp, or each absorption system exceeding 1 750 000 Btu/h ..... [1]
5. Air Handlers:
   - For each air-handling unit not exceeding 10 000 cubic feet per minute (CFM), including ducts attached thereto ..... [1, 2]
6. Evaporative Coolers:
   - For each air-handling unit exceeding 10 000 CFM ..... [1]
   - For each evaporative cooler other than portable type ..... [1]
7. Ventilation and Exhaust:
   - For each ventilation fan connected to a single duct ..... [1]
   - For each ventilation system that is not a portion of a heating or air-conditioning system authorized by a permit ..... [1]
   - For the installation of each hood that is served by mechanical exhaust, including the ducts for such hood ..... [1]
8. Incinerators:
   - For the installation or relocation of each domestic-type incinerator ..... [1]
   - For the installation or relocation of each commercial or industrial-type incinerator ..... [1]

TABLE 104.5 (continued)
MECHANICAL PERMIT FEES

9. Miscellaneous:
   - For each appliance or piece of equipment regulated by this code, but not classed in other appliance categories, or for which no other fee is listed in this table ..... [1]
10. Fuel Gas Piping:
    - Where Chapter 13 or Appendix B is applicable (See Section 101.2), permit fees for fuel-gas piping shall be as follows:
    - For each gas piping system of one to five outlets ..... [1]
    - For each additional gas piping system, per outlet ..... [1]
11. Process Piping:
    - For each hazardous process piping system (HPP) of one to four outlets ..... [1]
    - For each HPP piping system of five or more outlets, per outlet ..... [1]
    - For each nonhazardous process piping system (NPP) of one to four outlets ..... [1]
    - For each NPP piping system of five or more outlets, per outlet ..... [1]

Other Inspections and Fees

1. Inspections outside of normal business hours, per hour (minimum charge – 2 hours) ..... [1]
2. Reinspection fees assessed under provisions of Section 105.2.6, per inspection ..... [1]
3. Inspections for which no fee is specifically indicated, per hour (minimum charge – ½ hour) ..... [1]
4. Additional plan review required by changes, additions, or revisions to plans or to plans for which an initial review has been completed, per hour (minimum charge – ½ hour) ..... [1]

For SI units: 1000 British thermal units per hour = 0.293 kW, 1 horsepower = 0.746 kW, 1 cubic foot per minute = 0.00047 m^3/s

Notes:

[1] Jurisdiction will indicate their fees here.

[2] This fee shall not apply to an air-handling unit that is a portion of a factory-assembled appliance, cooling unit, evaporative cooler, or absorption unit for which a permit is required elsewhere in this code.

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CHAPTER 2
DEFINITIONS

201.0 General.

201.1 Applicability. For the purpose of this code, the following terms have the meanings indicated in this chapter.

No attempt is made to define ordinary words, which are used in accordance with their established dictionary meanings, except where a word has been used loosely, and it is necessary to define its meaning as used in this code to avoid misunderstanding.

202.0 Definition of Terms.

202.1 General. The definitions of terms are arranged alphabetically according to the first word of the term.

203.0 – A –

Absorption Unit. An absorption refrigeration system that has been factory-assembled and tested prior to its installation.

Accepted Engineering Practice. That which conforms to technical or scientific-based principles, test, or standards that are accepted by the engineering profession.

Access Panel. A closure device used to cover an opening into a duct, an enclosure, equipment, or an appurtenance. [NFPA 96:3.3.1]

Accessible. Where applied to a device, appliance, or equipment, "accessible" means having access thereto, but which first may require the removal of an access panel, door, or similar obstruction.

Accessible, Readily. Having a direct access without the necessity of removing a panel, door, or similar obstruction.

Air, Class 1. Air with low contaminant concentration, low sensory-irritation intensity, and inoffensive odor. [ASHRAE 62.1:5.16.1]

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, 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]

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.

Approved. Acceptable to the Authority Having Jurisdiction.

Approved Testing Agency. An organization primarily established for purposes of testing to approved standards and approved by the Authority Having Jurisdiction.

Appurtenance. An accessory or a subordinate part that enables the primary device to perform or improves its intended function. [NFPA 96:3.3.5]

Assembly Building. A building or a portion of a building used for the gathering together of 50 or more persons for such purposes as deliberation, education, instruction, worship, entertainment, amusement, drinking, dining, or awaiting transportation.

Authority Having Jurisdiction. The organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, installations, or procedures. The Authority Having Jurisdiction shall be a federal, state, local, or other regional department or an individual such as a plumbing official, mechanical official, labor department official, health department official, building official, or others having statutory authority. In the absence of statutory authority, the Authority Having Jurisdiction may be some other responsible party. This definition shall include the Authority Having Jurisdiction's duly authorized representative.

Automatic. That which provides a function without the necessity of human intervention.

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

Azeotrope. A refrigerant blend containing two or more refrigerants whose equilibrium vapor and liquid phase compositions are the same at a given pressure. At this pressure, the slope of the temperature 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]

204.0 – B –

Baffle Plate. An object placed in or near an appliance to change the direction or retard the flow of air, air-fuel mixtures, or flue gases.

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 Code. The building code that is adopted by this jurisdiction.

Building Official. See Authority Having Jurisdiction.

Burner, Automatic Boiler. A device to convey fuel into the combustion chamber in proximity to its combustion air supply so as to permit a stable, controlled heat release compatible with the burner design and that is equipped with an ignition system to reliably ignite the entire heat release surface of the burner assembly.

205.0 – C –

CAS Number. The Chemical Abstract System registry number.

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

Certified. A formally stated recognition and approval of an acceptable level of competency, acceptable to the Authority Having Jurisdiction. [NFPA 96:3.3.10]

Certified Person. A person trained and certified by the equipment manufacturer, or by a recognized organization through a formal certification program for the system to be serviced or cleaned; that is acceptable to the Authority Having Jurisdiction.

Chimney. One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outdoors. [NFPA 54:3.3.18]

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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.

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, 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 1¾ 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 m^3/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 termination point outside the structure without any portion of the enclosure having a fire resistance rating less than the required value. [NFPA 96:3.3.22.1]

Continuous Pilot. A pilot that burns without turndown throughout the entire period that the boiler is in service, whether or not the main burner is firing.

Continuous Weld. A metal-joining method that produces a product without visible interruption or variation in quality. [NFPA 96:3.3.15] For the purpose of the definition, it specifically includes the exhaust compartment of hoods and welded joints of exhaust ducts, yet specifically does not include filter support frames or appendages inside hoods.

Conversion Burner, Gas. A unit consisting of a burner and its controls utilizing gaseous fuel for installation in an appliance originally utilizing another fuel. [NFPA 54:3.3.17.2]

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.

206.0 – D –

Damper. A valve or plate for controlling draft or the flow of gases, including air. [NFPA 211:3.3.52]

Ceiling Radiation Damper. A listed device installed in a ceiling membrane of a fire-resistance-rated floor-ceiling or roof-ceiling assembly to automatically limit the radiative heat transfer through an air inlet/outlet opening. [NFPA 5000:3.3.140.1]

Combination Fire/Smoke Damper. An automatic-closing metal assembly consisting of one or more louvers, blades, slats, or vanes that closes upon detection of heat or smoke as to restrict the passage of flame and smoke.

Fire Damper. An automatic-closing metal assembly consisting of one or more louvers, blades, slats, or vanes that closes upon detection of heat so as to restrict the passage of flame.

Smoke Damper. A damper arranged to seal off airflow automatically through a part of an air duct system so as to restrict the passage of smoke.

Volume Damper. A device that, when installed, will restrict, retard, or direct the flow of air in any duct, or the products of combustion in any heat-producing equipment, its vent connector, vent, or chimney.

Design Flood Elevation. The elevation of the "design flood," including wave height, relative to the datum specified on the community's legally designated flood hazard map. In areas designated as Zone AO, the design flood elevation is the elevation of the highest existing grade of the building's 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]

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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]

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 National Electrical Code promulgated by the National Fire Protection Association, as adopted by this jurisdiction.

Emergency Alarm System. A system intended to provide notification and warning of abnormal conditions and summon appropriate aid.

Emergency Control Station. An approved location on the premises where signals from emergency equipment are received.

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]

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 fire code adopted by this jurisdiction.

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.

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

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that do not materially restrict free circulation of air by gravity flow when such fans are not in operation. [NFPA 211:3.3.79.12.2]

Grease. Rendered animal fat, vegetable shortening, and other such oily matter used for the purposes of and resulting from cooking, preparing foods, or both. [NFPA 96:3.3.29] Grease might be liberated and entrained with exhaust air or might be visible as a liquid or solid.

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

Grease Filter. A removable component of the grease removal system designed to capture grease and direct it to a safe collection point. [NFPA 96:3.3.24.1]

Grease Filter, Mesh-Type. A filter construction consisting of a net made from intersecting strands with a space between each strand. [NFPA 96:3.3.24.2]

Grease Removal Devices. A system of components designed and intended to process vapors, gases, or air as it is drawn through such devices by collecting the airborne grease particles and concentrating them for further action at some future time, leaving the exiting air with a lower amount of combustible matter.

Greasetight. Constructed and performing in such a manner as not to permit the passage of grease under normal cooking conditions. [NFPA 96:3.3.31]

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.

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/m^3), that represents the maximum level from which one is capable of escaping within 30 minutes without escape-impairing symptoms or irreversible health effects. This level is established by the National Institute of Occupational Safety and Health (NIOSH).

Incinerator. An appliance or combustion chamber for the reduction, by burning, of rubbish, garbage, and other wastes. [NFPA 211:3.3.91]

Industrial Heating Equipment. Includes appliances, devices, or equipment used, or intended to be used, in an industrial, manufacturing, or commercial occupancy for applying heat to any material being processed, but shall not include water heaters, boilers, or portable equipment used by artisans in pursuit of a trade.

Insanitary Location. An area, space, or room where the air is unfit or undesirable for circulation to occupiable parts of a building.

Interconnected. Mutually assembled to another component in such a manner that the operation of one directly affects the other or that the contents of one specific duct system are allowed to encounter or contact the products being moved by another duct system. [NFPA 96:3.3.34]

Interlock. A device that senses a limit or off-limit condition or improper sequence of events and shuts down the offending or related piece of equipment or prevents proceeding in an improper sequence in order to prevent a hazardous condition from developing.

Intermittent Pilot. A pilot that burns during light-off and while the main burner is firing, and that is shut off with the main burner.

Interrupted Pilot. A pilot that burns during light-off and that is shut off during normal operation of the main burner.

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).

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 ⅛ of an inch (3.2 mm), that has a flame-spread index not greater than 50.

(2) Materials, in the form and thickness used, having neither a flame-spread index greater than 25 nor evidence of continued progressive combustion, and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame-spread index greater than 25 nor evidence of continued progressive combustion, where tested in accordance with ASTM E84.

Line Contact Installation. An installation in which a furnace is installed so that building joists, studs, or framing are contacted by the furnace jacket upon the lines formed by the intersection of the jacket sides with the top surface.

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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.

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.

Listing Agency. An agency accredited by an independent and authoritative conformity assessment body to operate a material and product listing and labeling (certification) system and that are accepted by the Authority Having Jurisdiction, which is in the business of listing or labeling. The system includes initial and ongoing product testing, a periodic inspection on current production of listed (certified) products, and that makes available a published report of such listing in which specific information is included that the material or product is in accordance with applicable standards and found safe for use in a specific manner.

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

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

Low-Probability Pump. A pump that (a) is permanently sealed to prevent atmospheric release of the pumped fluid, (b) incorporates a static seal to prevent atmospheric release of the pumped fluid, or (c) incorporates not less than two sequential dynamic shaft seals and automatically shuts down upon failure of any seal to prevent atmospheric release of the pumped fluid. [ASHRAE 15:3]

Lowside. Refers to the parts of a refrigeration system subjected to approximate evaporator pressure.

215.0 – 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.

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 m^3) or less, a heating surface of 20 square feet (1.86 m^2) or less (not applicable to electric boilers), and not exceeding 100 psi (689 kPa).

216.0 – 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 ⅛ of an inch (3.2 mm) thick that has a flame-spread index not higher than 50.

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

Nonhazardous Process Piping (NPP). Production material piping or tubing conveying a liquid or gas that is not classified as hazardous production material piping.

217.0 – O –

Occupancy. The purpose for which a building or part thereof is used or intended to be used.

Occupancy, Nontransient. Occupancy of a dwelling unit or sleeping unit for more than 30 days. [ASHRAE 62.1:3]

Occupancy Classification. Classifications are defined in the building code.

Occupational Exposure Limit (OEL). The time-weighted average (TWA) concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers can be repeatedly exposed without adverse effect, based on the OSHA PEL, ACGIH TLV-TWA, TERA OARSWEEL, 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.

218.0 – P –

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

PE. Polyethylene.

PE-AL-PE. Polyethylene-aluminum-polyethylene.

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.

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.

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 m^3), 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.

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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. A competent and capable person or company that has met the requirements and training for a given field acceptable to the Authority Having Jurisdiction.

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

220.0 – 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 noncondensible 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/ft^3) (0.10012 kg/m^3) 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/ft^3 (0.10012 kg/m^3) 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.

221.0 – S –

Seam, Welded. See Joint, Welded.

Secondary Filtration. Fume incinerators, thermal recovery units, air pollution control devices or other filtration media installed in ducts or hoods located in the path of travel of exhaust products after the initial filtration.

Self-Contained. Having all essential working parts, except energy and control connections, so contained in a case or framework that they do not depend on appliances or fastenings outside of the machine.

Service Corridor. A fully enclosed passage used for transporting hazardous production materials and purposes other than required exiting.

Service Piping. The piping and equipment between the street gas main and the gas piping system inlet that is installed by, and is under the control and maintenance of, the serving gas supplier.

Shaft. An interior space enclosed by walls or construction extending through one or more stories or basements that connect openings in successive floors, or floors and roof, to accommodate elevators, dumbwaiters, mechanical equipment, or similar devices to transmit light or ventilation air.

Shaft Enclosure. The walls or construction forming the boundaries of a shaft.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Single Hazard Area. Where two or more hazards can be simultaneously involved in fire by reason of their proximity, as determined by the Authority Having Jurisdiction. [NFPA 96:3.3.44]

Smoke Detector. An approved device that senses visible or invisible particles of combustion.

Solid Cooking Fuel. 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.

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

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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]

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 –

Unit Heater. A heating appliance designed for nonresidential space heating and equipped with an integral means for circulation of air.

Unusually Tight Construction. Construction where:

(1) Walls and ceilings exposed to the outdoors have a continuous water vapor retarder with a rating of 1 perm or less with openings gasketed or sealed.

(2) Weatherstripping is on openable windows and doors.

(3) Caulking or sealants are applied to areas such as joints around window and door frames, between sole plates and floors, between wall-ceiling joints, between wall panels, and at penetrations for plumbing, electrical, and gas lines and at other openings.

Use (Material). The placing in action or making available for service by opening or connecting a container utilized for confinement of material, whether a solid, liquid, or gas.

224.0 – V –

Vacuum. A pressure less than that exerted by the atmosphere.

Valve, Pressure-Relief. A pressure-actuated valve held closed by a spring or other means and designed to automatically relieve pressure in excess of its setting.

Valve, Stop. A device in a piping system to shut off the flow of the fluid.

Valve, Three-Way-Type Stop. A manually operated valve with one inlet that alternately can stop flow to either of two outlets.

Valves, Companion or Block. Pairs of mating stop valves valving off sections of refrigeration systems and arranged so that these sections may be joined before opening these valves or separated after closing them.

Vent, 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]

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CHAPTER 3
GENERAL REGULATIONS

301.0 General.

301.1 Applicability. This chapter covers general requirements for heating, ventilating, air-conditioning, refrigeration, miscellaneous heat-producing, and energy-utilizing equipment or appliances. Such equipment or appliances shall comply with the requirements of this code.

301.2 Approval. Equipment or appliance shall be approved by the Authority Having Jurisdiction for safe use or comply with applicable nationally recognized standards as evidenced by the listing and label of an approved agency. A list of accepted standards is included in Chapter 17. Defective materials or parts shall be replaced in such a manner as not to invalidate an approval.

301.3 Design of Equipment. The installer or contractor shall furnish satisfactory evidence that the appliance is constructed in accordance with the requirements of this code. The permanently attached label of an approved agency shall be permitted to be accepted as such evidence.

301.4 Electrical Connections. For equipment regulated by this code:

(1) Equipment requiring electrical connections of more than 50 volts shall have a positive means of disconnect adjacent to and in sight from the equipment served.

Exception: Other power disconnect means shall be acceptable where in accordance with NFPA 70.

(2) A 120 volt receptacle shall be located within 25 feet (7620 mm) of the equipment for service and maintenance purposes. The receptacle outlet shall be on the supply side of the disconnect switch. The receptacle need not be located on the same level as the equipment.

(3) Electrical wiring, controls, and connections to equipment and appliances regulated by this code shall be in accordance with NFPA 70.

301.5 Oil-Burning Appliances. The tank, piping, and valves for appliances burning oil shall be installed in accordance with the requirements of NFPA 31.

301.6 Personnel Protection. A metal guard shall be provided around exposed flywheels, fans, pulleys, belts, and moving machinery that are portions of a heating, ventilating, or refrigerating system.

302.0 Materials – Standards and Alternates.

302.1 Minimum Standards. Listed pipe, pipe fittings, appliances, appurtenances, equipment, materials, and devices used in a mechanical system shall be listed (third-party certified) by a listing agency (accredited conformity assessment body) as complying with the approved applicable recognized standards referenced in this code, and shall be free from defects. Unless otherwise provided for in this code, materials, appurtenances, or devices used or entering into the construction of mechanical systems, or parts thereof, shall be submitted to the Authority Having Jurisdiction for approval prior to being installed.

302.1.1 Marking. Each length of pipe and each pipe fitting, material, and device used in a mechanical system shall have cast, stamped, or indelibly marked on it any markings required by the applicable referenced standards and listing agency, and the manufacturer's mark or name, which shall readily identify the manufacturer to the end user of the product. Where required by the approved standard that applies, the product shall be marked with the weight and the quality of the product. Materials and devices used or entering into the construction of mechanical systems, or parts thereof, shall be marked and identified in a manner satisfactory to the Authority Having Jurisdiction. Such marking shall be done by the manufacturer. Field markings shall not be acceptable.

Exception: Markings shall not be required on nipples created from cutting and threading of approved pipe.

302.1.2 Standards. Standards listed or referred to in this chapter or other chapters cover materials that will conform to the requirements of this code, where used in accordance with the limitations imposed in this or other chapters thereof and their listing. Where a standard covers materials of various grades, weights, quality, or configurations, the portion of the listed standard that is applicable shall be used. Design and materials for special conditions or materials not provided for herein shall be permitted to be used by special permission of the Authority Having Jurisdiction after the Authority Having Jurisdiction has been satisfied as to their adequacy. A list of mechanical standards that appear in specific sections of this code is referenced in Table 1701.1. Standards referenced in Table 1701.1 shall be applied as indicated in the applicable referenced section. A list of additional approved standards, publications, practices and guides that are not referenced in specific sections of this code appear in Table 1701.2.

302.1.3 Existing Buildings. In existing buildings or premises in which mechanical installations are to be altered, repaired, or renovated, the Authority Having Jurisdiction has discretionary powers to permit deviation from the provisions of this code, provided that such proposal to deviate is first submitted for proper determination in order that health and safety requirements, as they pertain to mechanical systems, shall be observed.

302.2 Alternate Materials and Methods of Construction Equivalency. Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code. Technical documentation shall be submitted to the Authority Having

Jurisdiction to demonstrate equivalency. The Authority Having Jurisdiction shall have the authority to approve or disapprove the system, method, or device for the intended purpose.

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

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

302.2.1.1 Tests. Tests shall be made in accordance with approved testing standards, by an approved testing agency at the expense of the applicant. In the absence of such standards, the Authority Having Jurisdiction shall have the authority to specify the test procedure.

302.2.1.2 Request by the Authority Having Jurisdiction. The Authority Having Jurisdiction shall have the authority to require tests to be made or repeated where there is reason to believe that a material or device no longer is in accordance with the requirements on which its approval was based.

302.3 Alternative Engineered Design. An alternative engineered design shall comply with the intent of the provisions of this code and shall provide an equivalent level of quality, strength, effectiveness, fire resistance, durability, and safety. Material, equipment, or components shall be designed and installed in accordance with the manufacturer's installation instructions.

302.3.1 Permit Application. The registered design professional shall indicate on the design documents that the mechanical system, or parts thereof, is an alternative engineered design so that it is noted on the construction permit application. The permit and permanent permit records shall indicate that an alternative engineered design was part of the approved installation.

302.3.2 Technical Data. The registered design professional shall submit sufficient technical data to substantiate the proposed alternative engineered design and to prove that the performance meets the intent of this code.

302.3.3 Design Documents. The registered design professional shall provide two complete sets of signed and sealed design documents for the alternative engineered design for submittal to the Authority Having Jurisdiction. The design documents shall include floor plans of the work. Where appropriate, the design documents shall indicate location, sizing, and loading of appurtenances, equipment, appliances, and devices.

302.3.4 Design Approval. An approval of an alternative engineered design shall be at the discretion of the Authority Having Jurisdiction. The exercise of this discretionary approval by the Authority Having Jurisdiction shall have no effect beyond the jurisdictional boundaries of said Authority Having Jurisdiction. An alternative engineered design so approved shall not be considered as in accordance with the requirements, intent, or both of this code for a purpose other than that granted by the Authority Having Jurisdiction.

302.3.5 Design Review. The Authority Having Jurisdiction shall have the authority to require testing of the alternative engineered design in accordance with Section 302.2.1, including the authority to require an independent review of the design documents by a registered design professional selected by the Authority Having Jurisdiction and at the expense of the applicant.

302.3.6 Inspection and Testing. The alternative engineered design shall be tested and inspected in accordance with the submitted testing and inspection plan and the requirements of this code.

303.0 Installation.

303.1 Listed Appliances. The installation of equipment and appliances regulated by this code shall be in accordance with the conditions of the listing, the manufacturer's installation instructions and this code. The manufacturer's installation and operating instructions shall be attached to the appliance. Clearances of listed equipment and appliances from combustible materials shall be as specified in the listing or on the rating plate.

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

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

303.3 Unlisted Appliances. Except as otherwise permitted in this code, unlisted equipment and appliances shall be approved by the Authority Having Jurisdiction prior to being installed. Unlisted equipment and appliances shall be installed in accordance with the manufacturer's installation instructions and with clearances from combustible materials in accordance with Section 303.10 or Section 303.10.1.

303.4 Anchorage of Appliances. Appliances designed to be fixed in position shall be securely fastened in place in accordance with the manufacturer's installation instructions. Supports for appliances shall be designed and constructed to sustain vertical and horizontal loads within the stress limitations specified in the building code.

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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 NFPA 58.

303.8 Appliances on Roofs. Appliances on roofs shall be designed or enclosed so as to withstand climatic conditions in the area in which they are installed. Where enclosures are provided, each enclosure shall permit easy entry and movement, shall be of reasonable height, and shall have at least a 30 inch (762 mm) clearance between the entire service access panel(s) of the appliance and the wall of the enclosure. [NFPA 54:9.4.1.1]

303.8.1 Load Capacity. Roofs on which appliances are to be installed shall be capable of supporting the additional load or shall be reinforced to support the additional load. [NFPA 54:9.4.1.2]

303.8.2 Fasteners. All access locks, screws, and bolts shall be of corrosion-resistant material. [NFPA 54:9.4.1.3]

303.8.3 Installation of Appliances on Roofs. Appliances shall be installed in accordance with the manufacturer's installation instructions. [NFPA 54:9.4.2.1]

303.8.4 Edge of Roof Clearance. Appliances shall be installed on a well-drained surface of the roof. At least 6 feet (1829 mm) of clearance shall be available between any part of the appliance and the edge of a roof or similar hazard, or rigidly fixed rails, guards, parapets, or other building structures at least 42 inches (1067 mm) in height shall be provided on the exposed side. [NFPA 54:9.4.2.2]

303.8.4.1 Guards and Rails. Guards or rails shall be required where the following exist:

(1) The clearance between the appliance and a roof edge or open end of an equipment platform is less than 6 feet (1829 mm).

(2) The open end of the equipment platform is located more than 30 inches (762 mm) above the roof, floor, or grade below.

Where guards or rails are installed, they shall be constructed so as to prevent the passage of a 21 inch (533 mm) diameter ball, resist the imposed loading conditions, and shall extend not less than 30 inches (762 mm) beyond each side of the equipment or appliance.

Exception: Guards shall not be required where a permanent fall arrest anchorage connector system in accordance with 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.

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 conditions, especially snow, and shall be constructed so as to permit access from the roof side unless deliberately locked on the inside.

At least 6 feet (1829 mm) of clearance shall be available between the access opening and the edge of the roof or similar hazard, or 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]

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305.1.1 Physical Damage. Appliances installed in garages, warehouses, or other areas subject to mechanical damage shall be guarded against such damage by being installed behind protective barriers or by being elevated or located out of the normal path of vehicles.

305.1.2 Access from the Outside. Where appliances are installed in a separate, enclosed space having access only from outside of the garage, such appliances shall be permitted to be installed at floor level, providing the required combustion air is taken from the exterior of the garage. [NFPA 54:9.1.10.3]

305.1.3 Cellulose Nitrate Plastic Storage. Heating equipment located in rooms where cellulose nitrate plastic is stored or processed shall be in accordance with the fire code.

» **305.2 Pit Location.** Where excavation is necessary to install an appliance, the depth shall extend not less than 6 inches (152 mm) below and 12 inches (305 mm) on all sides of the appliance, except on the service side, which shall have 30 inches (762 mm). Where the depth of the excavation for either the appliance or passageway exceeds 12 inches (305 mm), walls shall be lined with concrete or masonry 4 inches (102 mm) above the adjoining ground level.

» **305.3 Flood Hazard Areas.** For buildings located in flood hazard areas, heating, ventilating, air-conditioning, refrigeration, miscellaneous heat-producing, and energy-utilizing equipment and appliances shall be elevated at or above the elevation in accordance with the building code for utilities and attendant equipment or the elevation of the lowest floor, whichever is higher.

Exception: Equipment and appliances shall be permitted to be located below the elevation in accordance with the building code for utilities and attendant equipment or the elevation of the lowest floor, whichever is higher, provided that the systems are designed and installed to prevent water from entering or accumulating within their components and the systems are constructed to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to such elevation.

» **305.3.1 Coastal High Hazard Areas.** Mechanical systems in buildings located in coastal high hazard areas shall be in accordance with the requirements of Section 305.3, and mechanical systems, pipes, and appurtenances shall not be mounted on or penetrate through walls that are intended to breakaway under flood loads in accordance with the building code.

» **305.3.2 Air Exhaust and Intake Openings.** Outside air exhaust openings and air intake openings shall be located at or above the elevation required by the building code for utilities and attendant equipment or the elevation of the lowest floor, whichever is higher.

» **305.4 Elevator Shaft.** Unless required for the functionality and safety of the elevator system, mechanical systems shall not be located in an elevator shaft.

305.5 Drainage Pan. Where a water heater is located in an attic, in or on an attic ceiling assembly, floor-ceiling assembly, or floor-subfloor assembly 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).

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 ⅛ 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:

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(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 ¾ of an inch (20 mm) nominal pipe size, discharging at a point that is readily observed.

310.2.1 Protection of Appurtenances. Where insulation or appurtenances are installed where damage is capable of resulting from a condensate drain pan overfill, such installations shall occur above the rim of the drain pan with supports. Where the supports are in contact with the condensate waste, the supports shall be of approved corrosion-resistant material.

310.3 Condensate Waste Pipe Material and Sizing. Condensate waste pipes from air-cooling coils shall be sized in accordance with the equipment capacity as specified in Table 310.3. The material of the piping shall comply with the pressure and temperature rating of the appliance or equipment, and shall be approved for use with the liquid being discharged.

TABLE 310.3
MINIMUM CONDENSATE PIPE SIZE

EQUIPMENT CAPACITY IN TONS OF REFRIGERATION	MINIMUM CONDENSATE PIPE DIAMETER (inches)
Up to 20	¾
21 – 40	1
41 – 90	1¼
91 – 125	1½
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 ⅛ 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 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 a heating or cooling air system shall not be taken from the following locations:

(1) Less than 10 feet (3048 mm) in distance from an appliance vent outlet, a vent opening of a plumbing drainage system, or the discharge outlet of an exhaust fan, unless the outlet is 3 feet (914 mm) above the outside-air inlet.

(2) Less than 10 feet (3048 mm) above the surface of an abutting public way, sidewalk, street, alley, or driveway.

(3) A hazardous or insanitary location, or a refrigeration machinery room as defined in this code.

(4) An area, the volume of which is less than 25 percent of the entire volume served by such system, unless there is a permanent opening to an area the volume of which is equal to 25 percent of the entire volume served.

Exception: Such openings where used for a heating or cooling air system in a dwelling unit shall be permitted to be reduced to not less than 50 percent of the required area, provided the balance of the required return air is taken from a room or hall having not less than three doors leading to other rooms served by the furnace.

(5) A closet, bathroom, toilet room, or kitchen.

(6) Rooms or spaces containing a fuel-burning appliance therein. Where such room or space serves as source of return-air.

Exceptions:

(1) This shall not apply to fireplaces, fireplace appliances, residential cooking appliances, direct vent appliances, enclosed furnaces, and domestic-type clothes dryers installed within the room or space.

(2) This shall not apply to a gravity-type or listed vented wall heating or cooling air system.

(3) This shall not apply to a blower-type heating or cooling air system installed in accordance with the following requirements:

(a) Where the return air is taken from a room or space having a volume exceeding 1 cubic foot (0.03 m^3) for each 10 Btu/h (0.003 kW) fuel input rating of fuel-burning appliances therein.

(b) Not less than 75 percent of the supply air is discharged back into the same room or space.

(c) Return-air inlets shall not be located within 10 feet (3048 mm) from an appliance firebox or draft diverter in the same enclosed room or confined space.

311.4 Return-Air Limitations. Return air from one dwelling unit shall not discharge into another dwelling unit through the heating or cooling air system.

312.0 Plumbing Connections.

312.1 General. Water supply, sanitary drainage, and backflow protection shall be in accordance with the plumbing code.

313.0 Hangers and Supports.

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)
½ - 4	⅜
5 - 8	½
10 - 12	⅝

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.

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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 building code.

316.3 Corrosion, Erosion, and Mechanical Damage. Piping or tubing subject to corrosion, erosion, or mechanical damage shall be protected in an approved manner.

316.4 Protectively Coated Pipe. Protectively coated pipe or tubing shall be inspected and tested, and a visible void, damage, or imperfection to the pipe coating shall be repaired in an approved manner.

316.5 Fire-Resistant Construction. Piping, tubing, and duct system penetrations of fire-resistance-rated walls, partitions, floors, floor/ceiling assemblies, roof/ceiling assemblies, or shaft enclosures shall be protected in accordance with the requirements of the building code.

316.6 Steel Nail Plates. Plastic piping or tubing, copper or copper alloy piping or tubing, and ducts penetrating framing members to within 1 inch (25.4 mm) of the exposed framing shall be protected by steel nail plates not less than No. 18 gauge (0.0478 inches) (1.2141 mm) in thickness. The steel nail plate shall extend along the framing member not less than 1½ inches (38 mm) beyond the outside diameter of the pipe or tubing.

Exception: See 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 building code.

316.10 Rodentproofing. Mechanical system shall be constructed in such a manner as to restrict rodents or vermin from entering a building by following the ductwork from the outside into the building.

316.11 Metal Collars. In or on buildings where openings have been made in walls, floors, or ceilings for the passage of ductwork or pipes, such openings shall be closed and protected by the installation of approved metal collars securely fastened to the adjoining structure.

317.0 Trenching, Excavation, and Backfill.

317.1 Trenches. Trenches deeper than the footings of a building or structure, and paralleling the same, shall be located not less than 45 degrees (0.79 rad) from the bottom exterior edge of the footing, or as approved in accordance with Section 302.0.

317.2 Tunneling and Driving. Tunneling and driving shall be permitted to be done in yards, courts, or driveways of a building site. Where sufficient depth is available to permit, tunnels shall be permitted to be used between open-cut trenches. Tunnels shall have a clear height of 2 feet (610 mm) above the pipe and shall be limited in length to one-half the depth of the trench, with a maximum length of 8 feet (2438 mm). Where pipes are driven, the drive pipe shall be not less than one size larger than the pipe to be laid.

317.3 Open Trenches. Excavations required to be made for the installation of a mechanical system or part thereof, within the walls of a building, shall be open trench work and shall be kept open until it has been inspected, tested, and accepted.

317.4 Excavations. Excavations shall be completely backfilled as soon after inspection as practicable. Precaution shall be taken to ensure compactness of backfill around piping without damage to such piping. Trenches shall be backfilled in thin layers to 12 inches (305 mm) above the top of the piping with clean earth, which shall not contain stones, boulders, cinderfill, frozen earth, construction debris, or other materials that will damage or break the piping or cause corrosive action. Mechanical devices such as bulldozers, graders, etc., shall be permitted to then be used to complete backfill to grade. Fill shall be properly compacted. Precautions shall be taken to ensure permanent stability for pipe laid in filled or made ground.

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

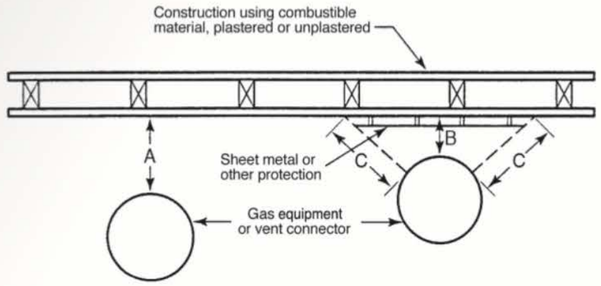
TYPE OF PROTECTION APPLIED TO AND COVERING ALL SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION	WHERE THE REQUIRED CLEARANCE WITH NO PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE-WALL METAL PIPE IS:									
	36 (INCHES)		18 (INCHES)		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/ft^3) (128 kg/m^3) 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•ft^2•°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.

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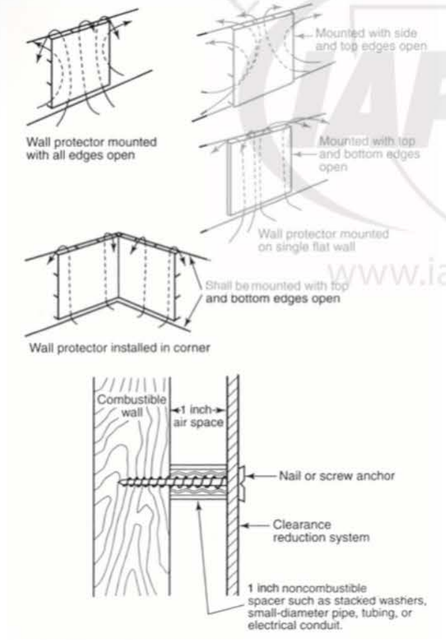
Notes:

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.

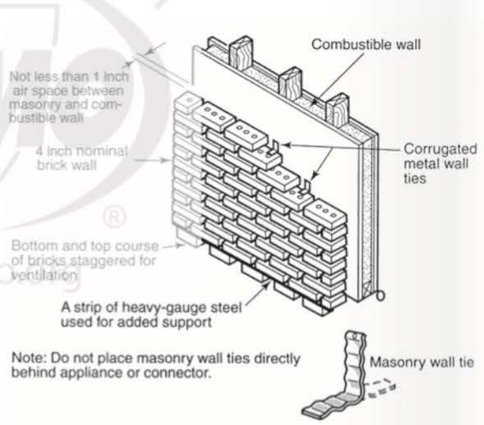
FIGURE 303.10.1(1)[1, 2, 3]
EXTENT OF PROTECTION NECESSARY TO REDUCE CLEARANCES FROM GAS APPLIANCE OR VENT CONNECTORS
[NFPA 54: FIGURE 10.3.2.3(a)]



For SI units: 1 inch = 25.4 mm

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)]



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)]

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, 6½ 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, 1 inch: All sizes 98 inches	Base and each floor; provide mid-story guides
PE-AL-PE	Metal insert and metal compression	½ inch, ¾ inch, 1 inch: All sizes 98 inches	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.

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CHAPTER 4
VENTILATION AIR

401.0 General.

401.1 Applicability. This chapter contains requirements for ventilation air supply, exhaust, and makeup air requirements for occupiable spaces within a building. Spaces within buildings, except those within a dwelling unit in residential occupancies where occupants are nontransient, shall comply with Section 402.0 through Section 404.0. Requirements for ventilation air rate for dwelling units in residential occupancies, where the occupants are nontransient, shall be in accordance with Section 405.0.

402.0 Ventilation Air.

402.1 Occupiable Spaces. Occupiable spaces listed in Table 402.1 shall be designed to have ventilation (outdoor) air for occupants in accordance with this chapter.

402.1.1 Construction Documents. The outdoor air ventilation rate and air distribution assumptions made in the design of the ventilation system shall be clearly identified on the construction documents.

402.1.2 Ventilation in Health Care Facilities. Mechanical ventilation for health care facilities shall be designed and installed in accordance with this code and ASHRAE 170.

402.2 Natural Ventilation. 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 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 m^2). [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. Where natural ventilation is not permitted by this section or the building code, mechanical ventilation systems shall be designed, constructed, and installed to provide a method of supply air and exhaust air. Mechanical ventilation systems shall include controls, manual or automatic, that enable the fan system to operate 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 ¼ of an inch (6.4 mm) openings, and shall have not more than ½ of an inch (12.7 mm) openings.

402.4.1 Weather Protections. Outdoor air intakes that are part of the mechanical ventilation system shall be designed to manage rain entrainment, to prevent rain intrusion, and manage water from snow in accordance with ASHRAE 62.1.

403.0 Ventilation Rates.

403.1 General. The design outdoor air intake flow rate for a ventilation system shall be determined in accordance with Section 403.2 through Section 403.9.4.

403.2 Zone Calculations. Ventilation zone parameters shall be determined in accordance with Section 403.2.1 through Section 403.2.3 for each ventilation zone served by the ventilation system. [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.

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

Where:

A_z = zone floor area, the net occupiable floor area of the ventilation zone, square feet (m^2).

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]

$$V_{oz} = V_{bz}/E_z \qquad \text{(Equation 403.2.3)}$$

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]

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

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]

$$V_{ot} = \sum_{all\ zones} V_{oz} \qquad \text{(Equation 403.4)}$$

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]

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

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.

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

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]

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[Equation 403.5.1.3(1)]

$E_v = 0.88 \cdot D + 0.22$ for $D < 0.60$

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

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

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

» **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]

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

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.

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

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).

(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 m^2) or less and used for the storage of 5 or less vehicles.

403.7.2 Enclosed Parking Garages. Mechanical ventilation systems for enclosed parking garages shall operate continuously.

Exceptions:

(1) Mechanical ventilation systems shall be permitted to operate intermittently where the system is designed to operate automatically upon detection of vehicle operation or the presence of occupants by approved automatic detection devices.

(2) Approved automatic carbon monoxide sensing devices, and nitrogen dioxide detectors shall be permitted to modulate the ventilation system to not exceed a maximum average of 50 parts per million of carbon monoxide, or 1 part per million nitrogen dioxide during an eight-hour period with a concentration of not more than 200 parts per million for carbon monoxide, or 5 parts per million nitrogen dioxide, for a period not exceeding 15 minutes. Automatic sensing devices installed in modulated parking garage ventilation systems shall be approved in accordance with Section 301.2.

403.8 Dynamic Reset. The system shall be permitted to be designed to reset the outdoor air intake flow (V_{ot}), the space or ventilation zone airflow (V_{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]

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

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.

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

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.

$$E_{vz} = 1 + X_s - Z_{pz} \qquad \text{(Equation 404.3.1)}$$

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]

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

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]

$F_a = E_p + (1 - E_p) \cdot E_r$ [Equation 404.3.2(2)]

$F_b = E_p$ [Equation 404.3.2(3)]

$F_c = 1 - (1 - E_z) \cdot (1 - E_r) \cdot (1 - E_p)$ [Equation 404.3.2(4)]

$E_p = V_{pz}/V_{dz}$ [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

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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).

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 ft^3/min (0.007 m^3/s).

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

Where:

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

A_{floor} = Floor area, ft^2

N_{br} = Number of bedrooms more than 1

For SI Units: 1 cubic foot per minute = 0.00047 m^3/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.

405.3.1 Exhaust Rate. The exhaust rate shall be not less than 50 ft^3/min (0.02 m^3/s) for intermittent operation and 20 ft^3/min (0.009 m^3/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 ft^3/min (0.047 m^3/s) for range hoods or 300 ft^3/min (0.141 m^3/s) for mechanical exhaust fans including downdraft appliances. For continuous operated ventilation, the exhaust rate shall be not less than 5 air changes per hour based on kitchen volume for enclosed kitchens.

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 m^2) or 4 percent of the occupied floor area. The openable area shall be based on free, unobstructed area through the opening.

TABLE 402.1
MINIMUM VENTILATION RATES IN BREATHING ZONE[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
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)[e]	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

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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/ft²)	DEFAULT OCCUPANT DENSITY[3] (people/1000 ft²)	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)[c]	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.

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, $E_z = 0.8$

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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
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 m^3/min, 1 square foot = 0.0929 m^2

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.

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CHAPTER 5
EXHAUST SYSTEMS

501.0 General.

501.1 Applicability. This chapter includes requirements for environmental air ducts, product-conveying systems, and commercial hoods and kitchen ventilation. Part I addresses environmental air ducts and product conveying systems. Part II addresses commercial hoods and kitchen ventilation.

502.0 Termination.

502.1 Exhaust Opening Protection. Exhaust openings terminating to the outdoors shall be covered with a corrosion-resistant screen having not less than ¼ of an inch (6.4 mm) openings, and shall have not more than ½ of an inch (12.7 mm) openings.

Exception: Clothes dryers.

502.2 Termination of Exhaust Ducts. Exhaust ducts shall terminate in accordance with Section 502.2.1 through Section 502.2.3.

502.2.1 Environmental Air Ducts. Environmental air duct exhaust shall terminate not less than 3 feet (914 mm) from a property line, 10 feet (3048 mm) from a forced air inlet, 10 feet (3048 mm) above a public walkway, and 3 feet (914 mm) from openings into the building. The discharge of environmental exhaust ducts shall not be directed onto a public walkway.

502.2.2 Product Conveying Ducts. Ducts conveying explosive or flammable vapors, fumes, or dusts shall terminate not less than 30 feet (9144 mm) from a property line, 10 feet (3048 mm) from openings into the building, 6 feet (1829 mm) from exterior walls or roofs, 30 feet (9144 mm) from combustible walls or openings into the building that are in the direction of the exhaust discharge, and 10 feet (3048 mm) above adjoining grade.

Other product-conveying outlets shall terminate not less than 10 feet (3048 mm) from a property line, 3 feet (914 mm) from exterior walls or roofs, 10 feet (3048 mm) from openings into the building, and 10 feet (3048 mm) above adjoining grade.

502.2.3 Commercial Kitchen Ducts. Commercial 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 nonsparking materials, or their casing shall be lined or constructed of such material. Where the size and hardness of materials passing through a fan are capable of producing a spark, both the fan, and the casing shall be of nonsparking materials. Where fans are required to be spark-resistant, their bearings shall not be within the airstream, and parts of the fan shall be grounded. Fans in systems handling materials that are likely to clog the blades, and fans in buffing or woodworking exhaust systems, shall be of the radial-blade or tube-axial type.

Equipment used to exhaust explosive or flammable vapors, fumes, or dusts shall bear an identification plate stating the ventilation rate for which the system was designed.

Fans located in systems conveying corrosives shall be of materials that are resistant to the corrosive or shall be coated with corrosion-resistant materials.

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.

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 m^2) 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 m^2) 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]

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(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 confined to the area in which they are generated by air currents, hoods, or enclosures and shall be exhausted by a duct system to a safe location or treated by removing contaminants. Ducts conveying explosives or flammable vapors, fumes, or dusts shall extend directly to the exterior of the building without entering other spaces and shall not extend into or through ducts and plenums.

Exception: Ducts conveying vapor or fumes having flammable constituents less than 25 percent of their Lower Flammability Limit (LFL) shall be permitted to pass through other spaces.

505.1.1 Mechanical Ventilation. A mechanical ventilation system shall be interlocked to operate with the equipment used to produce vapors, fumes, or 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

(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 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

TABLE 505.9
RANGE OF MINIMUM DUCT DESIGN VELOCITIES[1]
{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).

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Class 5 duct systems shall be protected with an approved corrosion-resistant material. Edges of hoods shall be rounded. The minimum clearance between hoods and combustible construction shall be the clearance required by the duct system.

506.0 Product-Conveying Ducts.

506.1 Materials. Materials used in product-conveying duct systems shall be suitable for the intended use and shall be of 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.

(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

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.)

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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

(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-flashback swing valves, or rupture diaphragms. Openings to relieve explosive forces shall be located outside the building. Where relief devices cannot provide sufficient pressure relief, ductwork shall be designed to withstand an internal pressure of not less than 100 pounds-force per square inch (psi) (689 kPa).

Where a room or building contains a dust explosion hazard that is external to protected equipment, as defined in NFPA 654, such areas shall be provided with deflagration venting to a safe outside location.

506.7 Supports. Supports shall be of noncombustible materials, and the spacing shall not exceed 12 feet (3658 mm) for 8 inch (203 mm) ducts and 20 feet (6096 mm) for larger ducts.

506.8 Fire Protection. Sprinklers or other fire-protection devices shall be installed within ducts having a cross-sectional dimension exceeding 10 inches (254 mm) where the duct conveys flammable vapors or fumes. Sprinklers shall be installed at 12 foot (3658 mm) intervals in horizontal ducts and at changes in direction. In vertical runs, sprinklers shall be installed at the top and at alternate floor levels.

506.8.1 Loads. Duct supports shall be designed to carry the weight of the duct half filled with material. Where sprinkler protection is provided or cleaning of the duct will be performed, the hanger's design shall include

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

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

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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/ft^3) (128 kg/m^3) 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•ft^2•°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.

(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

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.

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]

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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 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.

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/in^3) (5.0 E-06 kg/m^3) where operated with a total airflow of 500 cubic feet per minute (CFM) (0.236 m^3/s).
(2) Recirculating systems listed in accordance with UL 710B and installed in accordance with Section 516.0.

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]

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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]

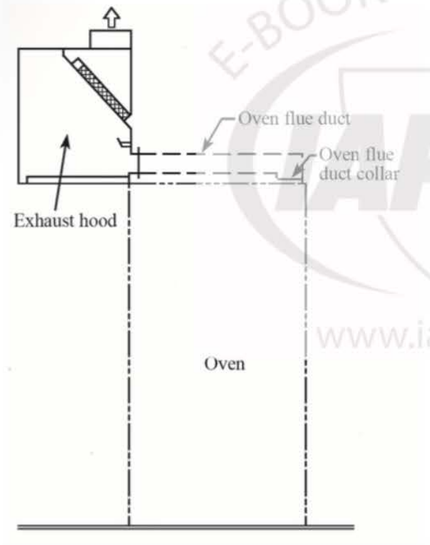


FIGURE 508.3.3
TYPICAL SECTION OF EYEBROW-TYPE HOOD
[NFPA 96: FIGURE 5.1.8.1]

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]

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 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.

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

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.

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508.5.2.1 Installation. Noncanopy-type commercial cooking hoods shall be installed with the edge of the hood set back not more than 1 foot (305 mm) from the edge of the cooking surface, and the vertical distance between the lip of the hood and the cooking surface shall not exceed 3 feet (914 mm).

508.5.2.2 Capacity. In addition to other requirements for hoods specified in this section, the volume of air exhausting through a noncanopy-type hood to the duct system shall be not less than 300 cubic feet per minute per lineal foot [(ft^3/min)/ft)] [0.464 (m^3/s)/m] of cooking equipment. Listed noncanopy exhaust hoods and filters shall be sized and installed in accordance with the terms of their listing and the manufacturer's installation instructions.

508.5.3 Labeling. Type I hoods shall bear a label indicating the exhaust flow rate in cubic feet per minute per lineal foot [(m^3/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]

509.2.3 Grease Filters. Grease filters shall be listed and constructed of steel or other non-combustible material, and shall be of rigid construction that will not distort or crush under normal operation, handling, cleaning, or replacement.

509.2.3.1 Arrangement. Grease filters shall be arranged so that all exhaust air passes through the grease filters. [NFPA 96:6.2.3.4]

509.2.3.2 Accessibility. Grease filters shall be easily accessible for removal. [NFPA 96:6.2.3.5]

509.2.3.3 Angled Installation. Grease filters shall be installed at an angle not less than 45 degrees (0.79 rad) from the horizontal. [NFPA 96:6.2.3.6]

509.2.4 Grease Drip Trays. Grease filters shall be equipped with a grease drip tray beneath their lower edges. [NFPA 96:6.2.4.1]

509.2.4.1 Size and Pitch. Grease drip trays shall be kept to the minimum size needed to collect grease. Grease drip trays shall be pitched to drain into an enclosed metal container having a capacity not exceeding 1 gallon (4 L). [NFPA 96:6.2.4.2, 6.2.4.3]

509.2.5 Grease Filter Orientation. Grease filters that require a specific orientation to drain grease shall be clearly so designated on the face of the filter as to be visible with the filter installed, or the hood or filter shall be constructed so that filters cannot be installed in the wrong orientation. [NFPA 96:6.2.5]

509.3 Solid-Fuel Grease Removal Devices. Where solid-fuel cooking equipment is provided with grease removal devices, these devices shall be in accordance with Section 517.0.

510.0 Exhaust Duct Systems.

510.1 General. Ducts shall not pass through fire walls. [NFPA 96:7.1.1]

510.1.1 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). Factory-built grease ducts shall be permitted to be installed at a lesser slope in accordance with the listing and the manufacturer's instructions. All horizontal ducts shall be provided with access in accordance with Section 510.3.3.

Drains shall be provided at low points in horizontal ducts. Where provided, drains shall be continuously welded to the exhaust duct 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

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(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 liquidtight continuous external weld. [NFPA 96:7.5.2.1]

Exceptions:

(1) Factory-built grease ducts listed in accordance with UL 1978 shall be permitted to incorporate nonwelded joint construction in accordance with their listings. [NFPA 96:7.5.2.1.1]

(2) Duct-to-hood collar connections as shown in Figure 510.5.3 shall not require a liquidtight continuous external weld. [NFPA 96:7.5.2.2]

(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:

(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]

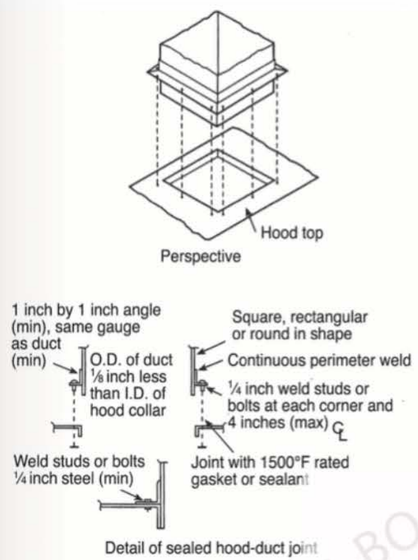
510.5.5 Telescoping and Bell-Type Connections. For telescoping and bell-type connections, the inside duct section shall always be uphill of the outside duct section. [NFPA 96:7.5.5.3] The overlap shall not exceed 2 inches (51 mm) as shown in Figure 510.5.3.2(1).

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]

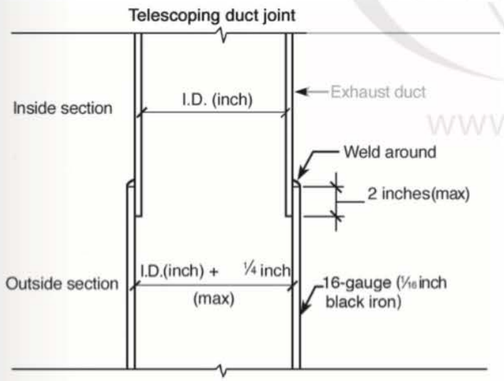
510.6.1 Weather Protection. All ducts shall be protected on the exterior by paint or other suitable weather-protective coating. Ducts constructed of stainless steel shall not be required to have additional paint or weather-protective coatings. Ductwork subject to corrosion shall have minimal contact 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



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]

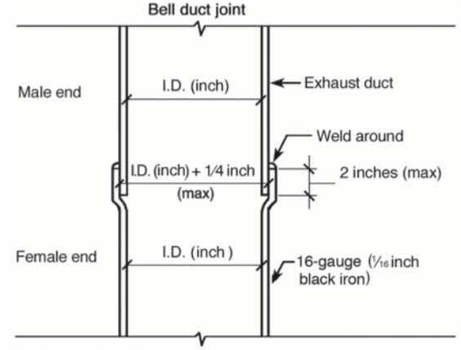


For SI units: 1 inch = 25.4 mm

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)]

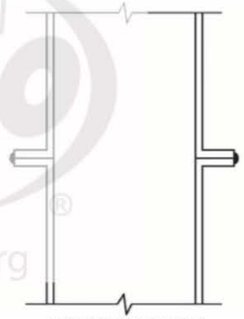


FIGURE 510.5.3.2(3)
FLANGE WITH EDGE WELD DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(c)]

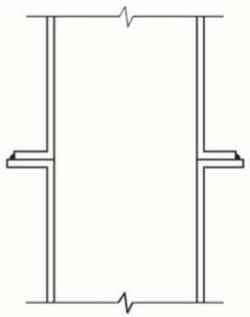


FIGURE 510.5.3.2(4)
FLANGE WITH FILLED WELD DUCT CONNECTION
[NFPA 96: FIGURE 7.5.5.1(d)]

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exterior of the building through weather-protected openings. [NFPA 96:7.7.1.2 – 7.7.1.4]

Exception: The continuous enclosure provisions shall not be required where a field-applied grease duct enclosure or a factory-built grease duct enclosure (see Section 507.4.4 through Section 507.4.6) is protected with a listed duct-through-penetration protection system equivalent to the fire resistance rating of the assembly being penetrated and where the materials are installed in accordance with the conditions of the listings and the manufacturer's instructions and are acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.1.5]

510.7.1 Less than Four Stories. Buildings less than four stories in height shall have an enclosure with a fire resistance rating of not less than 1 hour. [NFPA 96:7.7.2.1.1]

510.7.2 Four Stories or More. Buildings four stories or more in height shall have an enclosure with a fire resistance rating of not less than 2 hours. [NFPA 96:7.7.2.1.2]

510.7.3 Clearance. Clearance from the duct or the exhaust fan to the interior surface of enclosures of combustible construction shall be not less than 18 inches (457 mm). Clearance from the duct to the interior surface of enclosures of noncombustible or limited-combustible construction shall be not less than 6 inches (152 mm). Provisions for reducing clearances as described in Section 507.4 through Section 507.4.3.3 shall not be applicable to enclosures. [NFPA 96:7.7.2.2.1 – 7.7.2.2.3]

Exception: Clearance from the outer surfaces of field-applied grease duct enclosures and factory-built grease duct enclosures to the interior surfaces of construction installed around them shall be permitted to be reduced where the field-applied grease duct enclosure materials and factory-built grease duct enclosures are installed in accordance with the conditions of the listing and the manufacturer's instructions and are acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.2.2.4]

510.7.4 Mechanical and Structural Integrity. Field-applied grease duct enclosures and factory-built grease duct enclosures shall provide mechanical and structural integrity, resiliency, and stability when subjected to expected building environmental conditions, duct movement under general operating conditions, and duct movement as a result of interior and exterior fire conditions. [NFPA 96:7.7.2.2.5]

510.7.5 Materials. For field-applied grease duct enclosures and factory-built grease duct enclosures, the materials and products shall be provided in accordance with Section 510.7.5.1 and Section 510.7.5.2.

510.7.5.1 Protection from Physical Damage. Measures shall be taken to prevent physical damage to any covering or enclosure material. Any damage to the covering or enclosure shall be repaired, and the covering or enclosure shall be restored to meet its intended listing and fire resistance rating and to be acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.3.1, 7.7.3.2]

510.7.5.2 Inspection. In the event of a fire within a kitchen exhaust system, the duct, the enclosure, and the covering directly applied to the duct shall be inspected by qualified personnel to determine whether the duct, the enclosure, and the covering directly applied to the duct are structurally sound, capable of maintaining their fire protection functions, suitable for continued operation, and acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.3.3]

510.7.6 Listed. For listed grease ducts, see Section 510.4.

510.7.7 Fire Doors. Where openings in the enclosure walls are provided, they shall be protected by listed fire doors of proper rating. Fire doors shall be installed in accordance with NFPA 80. Openings on other listed materials or products shall be clearly identified and labeled according to the terms of the listing and the manufacturer's instructions and shall be acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.4.1 – 7.7.4.3] The fire door shall be readily accessible, aligned, and of sufficient size to allow access to the rated access panels on the ductwork. [NFPA 96:7.7.4.4]

510.7.8 Ducts with Enclosure(s). Each duct system shall constitute an individual system serving only exhaust hoods in one fire zone on one floor. Multiple ducts shall not be permitted in a single enclosure unless acceptable to the Authority Having Jurisdiction. [NFPA 96:7.7.5.1 – 7.7.5.2]

510.8 Underground Installations. Grease ducts installed underground shall be approved for underground installation. The material of the grease duct shall be corrosion-resistant and shall comply with Section 510.5.1.

510.8.1 Grease Receptacle. The grease duct shall be sloped to drain the grease back to an approved grease collection device. A grease collection device shall be located at the base of the vertical riser.

510.8.2 Cleanouts. For horizontal installations, cleanouts for cleaning and maintenance shall be provided on the top portion of the grease duct in accordance with Section 510.3 and shall be labeled at the interior portion of the duct.

510.9 Termination of Type I Hood Exhaust System. The exhaust system shall terminate as follows:

(1) Outside the building with a fan or duct.

(2) Through the roof or to the roof from outside, as in Section 510.9.1, or through a wall, as in Section 510.9.2. [NFPA 96:7.8.1]

510.9.1 Rooftop Terminations. Rooftop terminations shall be arranged with or provided with the following:

(1) A minimum of 10 feet (3048 mm) of horizontal clearance from the outlet to adjacent buildings, property lines, and air intakes.

(2) A minimum of 5 feet (1524 mm) of horizontal clearance from the outlet (fan housing) to any combustible structure.

(3) A vertical separation of 3 feet (914 mm) above any air intakes within 10 feet (3048 mm) of the exhaust outlet.

(4) The ability to drain grease out of any traps or low points formed in the fan or duct near the termination of the system into a collection container that is noncombustible, closed, rainproof, and structurally sound for the service to which it is applied and that will not sustain combustion.

(5) A grease collection device that is applied to exhaust systems that does not inhibit the performance of any fan.

(6) Listed grease collection systems that meet the requirements of Section 510.9.1(4) and Section 510.9.1(5).

(7) A listed grease duct complying with Section 507.4.7 or ductwork complying with Section 507.4.8.

(8) A hinged upblast fan supplied with flexible weatherproof electrical cable and service hold-open retainer to permit inspection and cleaning that is listed for commercial cooking equipment with the following conditions:

(a) Where the fan attaches to the ductwork, the ductwork is a minimum of 18 inches (457 mm) away from any roof surface, as shown in Figure 510.9.1.

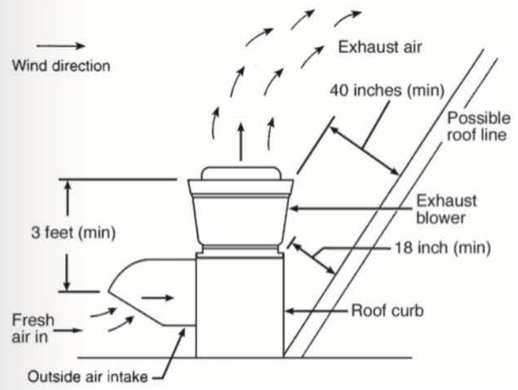
(b) The fan discharges a minimum of 40 inches (1016 mm) away from any roof surface, as shown in Figure 510.9.1.

(9) Other approved fan, provided it meets all of the following criteria:

(a) The fan meets the requirements of Section 510.9.1(3) and Section 511.1.3.

(b) Its discharge or its extended duct discharge meets the requirements of Section 510.9.1(2). (See Section 511.1.3)

(c) Exhaust fan discharge is directed up and away from the roof surface. [NFPA 96:7.8.2.1]



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

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]

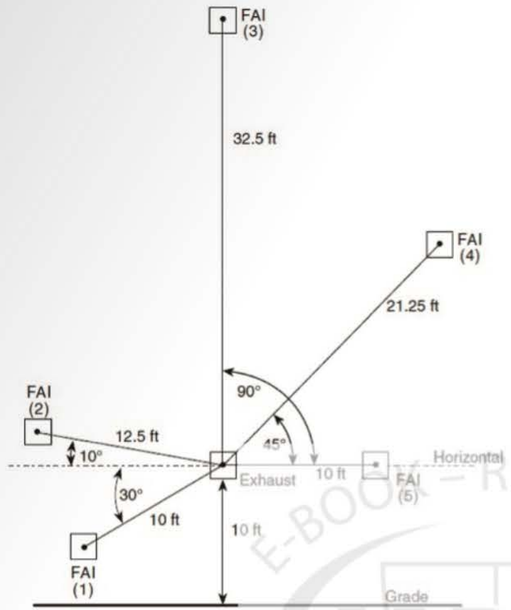
510.10 Solid-Fuel Duct Systems. Where solid-fuel cooking equipment is to be vented, the duct system shall be in accordance with Section 517.0.

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]

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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 greasetight housing. In-line fans shall be connected to the exhaust duct by flanges securely bolted as shown in Figure 511.1.2(1) through Figure 511.1.2(4), or by a system specifically listed for such use. Flexible connectors shall not be used. [NFPA 96:8.1.3.1 – 8.1.3.3]

511.1.2.1 Accessibility. If the design or positioning of the fan allows grease to be trapped, a drain directed to a readily accessible and visible grease receptacle not exceeding 1 gallon (4 L), shall be provided. In-line exhaust fans shall be located in easily accessible areas of adequate size to allow for service or removal. Where the duct system connected to the fan is in an enclosure, the space or room in which the exhaust fan is located shall have the same fire resistance rating as the enclosure. [NFPA 96:8.1.3.4 – 8.1.3.6]

511.1.3 Utility Set Exhaust Fans. Utility set exhaust fans shall be installed in accordance with Section 511.1.3.1 through Section 511.1.3.3.

511.1.3.1 At the Rooftop. Fans installed at the rooftop termination point shall be in accordance with the following:

(1) Section 510.9.1 and Section 510.9.1.2.
(2) Vibration isolation connectors shall be permitted.
(3) A drain shall be directed to a readily accessible and visible grease receptacle not to exceed 1 gallon (4 L).

511.1.3.2 Within the Building. Fans installed within the building shall be in accordance with the following:

(1) Located in an accessible area of adequate size to allow for service or removal. [NFPA 96:8.1.4.2]
(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]

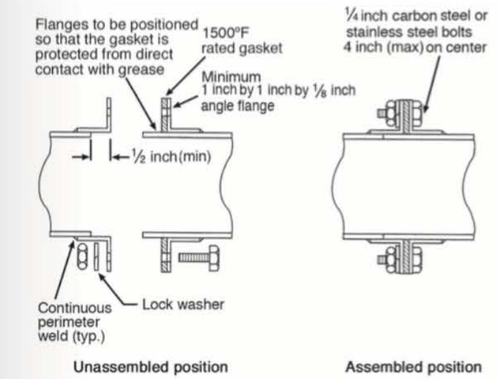
511.1.4 Construction. Exhaust fan housings shall be constructed of carbon steel not less than 0.060 inch (1.524 mm) (No. 16 MSG) in thickness, of stainless steel not less than 0.048 of an inch (1.219 mm) (No. 18 MSG) in thickness, or, if listed, in accordance with the terms of the listing. [NFPA 96:8.1.5]

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 NFPA 70. [NFPA 96:8.1.7]

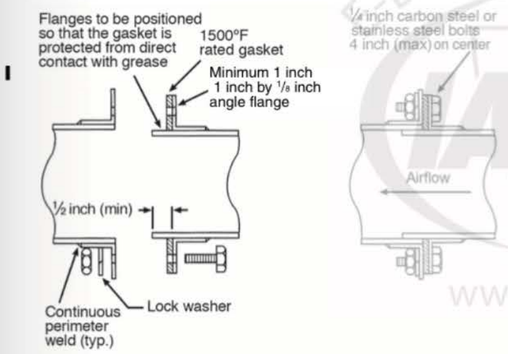
511.2 Airflow. The air velocity through a duct shall be not less than 500 feet per minute (ft/min) (2.54 m/s) and not exceed 2500 ft/min (12.7 m/s).

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]



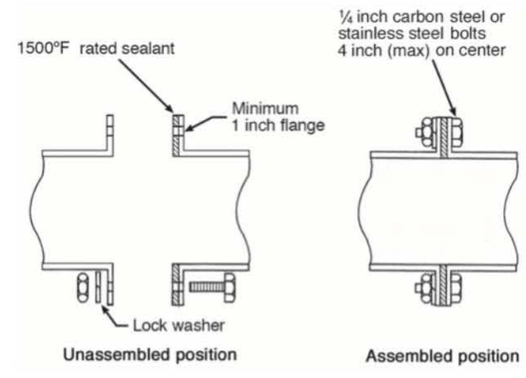
For SI units: 1 inch = 25.4 mm, °C = (°F-32)/1.8

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



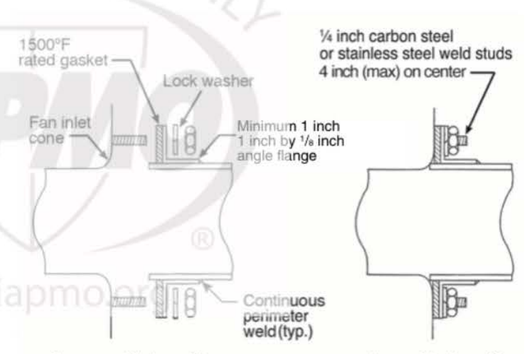
For SI units: 1 inch = 25.4 mm, °C = (°F-32)/1.8

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



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

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



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

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)]

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

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performance of Type I hoods. A field test shall be conducted with all appliances under the hood at operating temperatures, all the hoods operating at design airflows, and with all sources of replacement air operating at design airflows for the restaurant. Capture and containment shall be verified visually by observing smoke or steam produced by actual cooking operation or by simulating cooking using devices such as smoke candles or smoke puffers. Smoke bombs shall not be used. [ASHRAE 154:4.7.2]

511.2.3 Exhaust Fan Operation. A hood exhaust fan(s) shall continue to operate after the extinguishing system has been activated unless fan shutdown is required by a listed component of the ventilation system or by the design of the extinguishing system. The hood exhaust fan shall start upon 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.

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

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 provision to bleed air from outdoors or from adjacent spaces into the master exhaust duct where required to maintain the necessary minimum air velocity in the master exhaust duct. [NFPA 96:8.4.1]

511.4.1 Connections. Bleed air ducts shall connect to the top or side of the master exhaust duct. [NFPA 96:8.4.2]

511.4.2 Fire Damper. The bleed-air duct shall have a fire damper at least 12 inches (305 mm) from the exhaust duct connection. [NFPA 96:8.4.3]

511.4.3 Construction and Clearance. The bleed-air duct shall have the same construction and clearance requirements as the main exhaust duct from the connection to the exhaust duct to at least 12 inches (305 mm) on both sides of the fire damper. [NFPA 96:8.4.4]

511.4.4 Adjustment. Each bleed air duct shall have a means of adjusting (e.g., by using volume dampers) the bleed air quantity. [NFPA 96:8.4.5]

511.4.5 Adjustment Location. Means to adjust the bleed air quantity shall be installed between the fire damper and the source of bleed air. [NFPA 96:8.4.6]

511.4.6 Bleed Air Duct. A bleed air duct shall not be used for the exhaust of grease-laden vapors and shall be so labeled. [NFPA 96:8.4.7]

511.4.7 Disconnect. Unused tenant exhaust connections to the master exhaust duct that are not used as bleed air connections shall be disconnected and sealed at the main duct. [NFPA 96:8.4.8]

511.5 Solid-Fuel Air Movement Requirements. Where solid-fuel cooking equipment is used, exhaust and replacement air also shall be in accordance with Section 517.0.

512.0 Auxiliary Equipment.

512.1 Dampers. Dampers shall not be installed in exhaust ducts or exhaust duct systems. [NFPA 96:9.1.1]

512.1.1 Use. Where specifically listed for such use or where required as part of a listed device or system, dampers in exhaust ducts or exhaust duct systems shall be permitted. [NFPA 96:9.1.2]

512.2 Electrical Equipment. Wiring systems of any type shall not be installed in ducts. [NFPA 96:9.2.1]

512.2.1 Device Installation in Ducts. Motors, lights, and other electrical devices shall be permitted to be installed in ducts or hoods or to be located in the path of travel of exhaust products only where specifically listed for such use. [NFPA 96:9.2.2]

512.2.2 Lighting Units. Lighting units on hoods shall not be located in concealed spaces except as permitted by Section 512.2.3 and Section 512.2.4. [NFPA 96:9.2.3.2]

512.2.3 Concealed Spaces. Lighting units shall be permitted in concealed spaces where such units are part of a listed exhaust hood. [NFPA 96:9.2.3.3]

512.2.4 Listed Lighting Units. Listed lighting units specifically listed for such use and installed in accordance with the terms of the listing shall be permitted to be installed in concealed spaces. [NFPA 96:9.2.3.4]

512.2.5 Standard. Electrical equipment shall be installed in accordance with NFPA 70, with due regard to the effects of heat, vapor, and grease on the equipment.

512.3 Other Equipment. Fume incinerators, thermal recovery units, air pollution control devices, or other devices shall be permitted to be installed in ducts or hoods or to be located in the path of travel of exhaust products where specifically listed for such use. [NFPA 96:9.3.1]

512.3.1 Access Required. Equipment shall have space provided to all access panels or doors for the safe removal and servicing of control devices, such as filters, electrostatic precipitator cells, and odor control media beds, and for cleaning of the equipment housing. [NFPA 96:9.3.1.3]

512.3.2 Downgrading. Downgrading other parts of the exhaust system due to the installation of approved devices, whether listed or not, shall not be allowed. [NFPA 96:9.3.2]

512.3.3 Fire-Extinguishing System. Any equipment installed in the path of exhaust products that provides secondary filtration or air pollution control shall be provided with an approved automatic fire-extinguishing system, installed in accordance with the fire-extinguishing system manufacturer's instructions. [NFPA 96:9.3.3]

512.3.3.1 Protection. The fire-extinguishing system required by Section 512.3.3 shall provide protection for the component sections of the equipment, and ductwork downstream of the equipment. [NFPA 96:9.3.3.1]

512.3.3.2 Filter Media. Filter media used in secondary filtration or air pollution control units and not complying with Section 509.2.3 shall have fire protection that is adequate for the filter media being used in accordance with the fire-extinguishing system manufacturer's instructions. [NFPA 96:9.3.3.2]

512.3.4 Source of Ignition. If the equipment provides a source of ignition, it shall be provided with detection to operate the fire-extinguishing system protecting the equipment. [NFPA 96:9.3.4]

512.3.5 Air Recirculation. Where a cooking exhaust system employs an air pollution control device that recirculates air into the building, the requirements of Section 516.0 shall apply. [NFPA 96:9.3.5]

512.3.6 Carbon Monoxide Detector Required. If the heat source is non-electric and open flames are used, a carbon monoxide detector shall be installed in both the kitchen and dining areas. [NFPA 96:9.3.7]

512.4 Solid-Fuel Auxiliary Equipment. Where solid fuel cooking comprises a part of a cooking operation, additional provisions, and equipment as described in Section 517.0 shall be used where required.

513.0 Fire-Extinguishing Equipment.

513.1 General. Fire-extinguishing equipment for the protection of grease removal devices, hood exhaust plenums, and exhaust duct systems shall be provided. [NFPA 96:10.1.1]

513.1.1 Devices in Exhaust Ducts. Fume incinerators, thermal recovery units, air pollution control devices, or other devices installed in the exhaust duct, shall be protected by an automatic fire-extinguishing system. [NFPA 96:10.1.3]

513.1.2 Protection. Cooking equipment that produces grease-laden vapors and that might be a source of ignition of grease in the hood, grease removal device, or duct shall be protected by fire-extinguishing equipment. [NFPA 96:10.1.2]

513.2 Types of Equipment. Fire-extinguishing equipment shall include both automatic fire-extinguishing systems as primary protection and portable fire extinguishers as secondary backup. [NFPA 96:10.2.1]

513.2.1 Identification. A placard shall be conspicuously placed near each Class K extinguisher that states that the fire protection system shall be activated prior to using the fire extinguisher. [NFPA 96:10.2.2]

513.2.2 Standard. Automatic fire-extinguishing systems shall comply with UL 300 or other equivalent standards and shall be installed in accordance with the requirements of the listing. In existing dry or wet chemical systems not in compliance with UL 300, the fire-extinguishing system shall be made to comply with this section when any of the following occurs:

(1) The cooking medium is changed from animal oils and fats to vegetable oils.

(2) The positioning of the cooking equipment is changed.

(3) Cooking equipment is replaced.

(4) The equipment is no longer supported by the manufacturer. [NFPA 96:10.2.3, 10.2.3.1]

Exception: Automatic fire-extinguishing equipment provided as part of listed recirculating systems shall comply with UL 710B. [NFPA 96:10.2.5]

513.2.3 Installation. Automatic fire-extinguishing systems shall be installed in accordance with the terms of their listing, the manufacturer's installation instructions, and the following standards where applicable:

(1) NFPA 12

(2) NFPA 13

(3) NFPA 17

(4) NFPA 17A

513.2.4 Modification of Existing Hood Systems. Any abandoned pipe or conduit from a previous installation shall be removed from within the hood, plenum, and exhaust duct. [NFPA 96:10.2.7.1]

513.2.4.1 Sealing. Penetrations and holes resulting from the removal of conduit or piping shall be sealed with listed or equivalent liquid-tight sealing devices. [NFPA 96:10.2.7.2]

513.2.4.2 Obstructions. The addition of obstructions to spray patterns from the cooking appliance nozzle(s) such as baffle plates, shelves, or any modification shall not be permitted. [NFPA 96:10.2.7.3]

513.2.4.3 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]

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