

CHAPTER 1

ADMINISTRATION

COMM 64 SUBCHAPTER I PURPOSE, SCOPE, APPLICATION AND COMPLIANCE

Comm 64.0001 Purpose and scope.

(1) Purpose.

- (a) The purpose of ch. Comm 64 is to regulate the design, installation, operation and maintenance of heating, ventilating and air-conditioning systems in buildings and structures as specified in ch. Comm 61.
- (b) The installation of fuel gas distribution piping and equipment, fuel gas-fired appliances and fuel gas-fired appliance venting systems shall be regulated by ch. Comm 65.
- (c) Fixed electric space heating equipment shall comply with ch. Comm 16.

- (2) **Scope.** The scope of ch. Comm 64 is as specified in s. Comm 61.02.

Comm 64.0002 Application.

- (1) **General.** The application of ch. Comm 64 is as specified in s. Comm 61.03 and as modified in this section.
- (2) **Applicability.** All heating, ventilating and air-conditioning systems shall be designed, installed, maintained and operated so as to provide the service and results required within the provisions of ch. Comm 64. The minimum requirements established in each part of ch. Comm 64 shall be complied with as they apply to the structures and facilities covered in the IBC.

Note: The administrative rules pertaining to energy conservation, ch. Comm 63, may be applied retroactively to existing buildings and structures.

- (3) **Existing systems.** The provisions for existing systems shall be as specified in pars. (a) and (b).

(a) Additions.

1. The provisions of ch. Comm 64 shall apply to all additions to existing buildings and structures as specified in s. Comm 61.03.
2. Except when an existing heating, ventilation and air-conditioning system is extended to serve an addition, existing system components are not required to be replaced if the provisions in ch. Comm 64 are met within the addition.

(b) Alterations.

1. The provisions of ch. Comm 64 shall apply to all alterations in any building or structure

which affect the replacement of major equipment as specified in s. Comm 61.03.

2. When an existing heating, ventilating and air-conditioning system serves a remodeled or altered space that has not undergone a change in occupancy classification, the existing system components are not required to be replaced if the provisions in ch. Comm 64 that applied to the original construction of the space are met.

Note: "Occupancy classification" refers to the entries in Table 64.0403.

Note: Compliance with ch. Comm 64 shall not constitute assurance of proper installation or operation of the heating, ventilating and air-conditioning system. This chapter is not to be used as a design manual, but it is established as a minimum standard for safety, health and general welfare of the public.

Note: Maintenance and repair to existing equipment when there is no change to the building or occupancy, is considered an alteration.

- (4) **Retroactivity.** Retroactivity shall apply as specified in s. Comm 61.03.

- (5) **Conflicts.** Conflicts between rules and other requirements shall apply as specified in s. Comm 61.03.

Comm 64.0003 Compliance. All buildings and structures shall comply with the IMC and the changes, additions or omissions under subch. II.

Comm 64.0004 Approval of drawings and specifications. All drawings and specifications shall be submitted to the department in accordance with the provisions of subch. III, ch. Comm 61.

COMM 64 SUBCHAPTER II CHANGES, ADDITIONS OR OMISSIONS TO THE INTERNATIONAL MECHANICAL CODE (IMC)

Comm 64.0100 Changes, additions or omission to the International Mechanical Code® (IMC). Changes, additions or omission to the *International Mechanical Code* are specified in this subchapter and are rules of the department and are not requirements of the IMC.

Note: This code subchapter is numbered to correspond to the numbering used within the model code; i.e., s. Comm 64.0102 refers to section IMC 102.

SECTION 101 GENERAL Deleted

SECTION 102 APPLICABILITY

102.1 - 102.2 Deleted.

102.3 Maintenance. Mechanical systems, both existing and new, and parts thereof shall be maintained in proper operating condition in accordance with the original design and in a safe and sanitary condition. Devices or safeguards which are required by this code shall be maintained in compliance with the code edition under which they were installed. The owner or the owner's designated agent shall be responsible for maintenance of mechanical systems. To determine compliance with this provision, the code official shall have the authority to require a mechanical system to be reinspected.

Comm 64.0102 Operating and maintenance manual.

- (1) The designer or installer shall provide the owner with written instructions for the operation and maintenance of the system and equipment. An operating and maintenance manual shall be provided to the building owner or operator. The manual shall include basic data relating to the operation and maintenance of HVAC systems and equipment.
- (2) Required routine maintenance actions shall be clearly identified. Where applicable, HVAC controls information such as diagrams, schematics, control sequence descriptions, and maintenance and calibration information shall be included.

102.4 - 102.7 Deleted.

102.8 Referenced codes and standards. The codes and standards referenced herein shall be those that are listed in Chapter 15 and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference. Where differences occur between provisions of this code and the referenced standards, the provisions of this code shall apply.

102.9 Deleted.

SECTIONS 103-107 Deleted

SECTION 108 VIOLATIONS

108.1 - 108.6 Deleted.

108.7 Unsafe mechanical systems. A mechanical system that is unsafe, constitutes a fire or health hazard, or is otherwise dangerous to human life, as regulated by this code, is hereby declared as an unsafe mechanical system. Use of a mechanical system regulated by this code constituting a hazard to health, safety or welfare by reason of inadequate maintenance, dilapidation, fire hazard, disaster, damage or abandonment is hereby declared an unsafe use. Such unsafe equipment and appliances

are hereby declared to be a public nuisance and shall be abated by repair, rehabilitation, demolition or removal.

108.7.1 Authority to condemn mechanical systems. Whenever the code official determines that any mechanical system, or portion thereof, regulated by this code has become hazardous to life, health, property, or has become insanitary, the code official shall order in writing that such system either be removed or restored to a safe condition. A time limit for compliance with such order shall be specified in the written notice. A person shall not use or maintain a defective mechanical system after receiving such notice.

When such mechanical system is to be disconnected, written notice as prescribed in Section 108.2 shall be given. In cases of immediate danger to life or property, such disconnection shall be made immediately without such notice.

108.7.2 Authority to order disconnection of energy sources. The code official shall have the authority to order disconnection of energy sources supplied to a building, structure or mechanical system regulated by this code, when it is determined that the mechanical system or any portion thereof has become hazardous or unsafe. Written notice of such order to disconnect service and the causes therefor shall be given within 24 hours to the owner and occupant of such building, structure or premises, provided, however, that in cases of immediate danger to life or property, such disconnection shall be made immediately without such notice. Where energy sources are provided by a public utility, the code official shall immediately notify the serving utility in writing of the issuance of such order to disconnect.

108.7.3 Connection after order to disconnect. A person shall not make energy source connections to mechanical systems regulated by this code which have been disconnected or ordered to be disconnected by the code official, or the use of which has been ordered to be discontinued by the code official until the code official authorizes the reconnection and use of such mechanical systems.

When a mechanical system is maintained in violation of this code, and in violation of a notice issued pursuant to the provisions of this section, the code official shall institute appropriate action to prevent, restrain, correct or abate the violation.

SECTION 109 MEANS OF APPEAL Deleted

CHAPTER 2

DEFINITIONS

SECTION 201 GENERAL

201.1 Scope. Unless otherwise expressly stated, the following words and terms shall, for the purposes of this code, have the meanings indicated in this chapter.

201.2 Interchangeability. Words used in the present tense include the future; words in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural, the singular.

201.3 Terms defined in other codes. Where terms are not defined in this code and are defined in the *International Building Code*, *ICC Electrical Code*, *International Fire Code*, *International Fuel Gas Code* or the *International Plumbing Code*, such terms shall have meanings ascribed to them as in those codes.

201.4 Terms not defined. Where terms are not defined through the methods authorized by this section, such terms shall have ordinarily accepted meanings such as the context implies.

SECTION 202 GENERAL DEFINITIONS

ABRASIVE MATERIALS. Moderately abrasive particulate in high concentrations, and highly abrasive particulate in moderate and high concentrations, such as alumina, bauxite, iron silicate, sand and slag.

ACCESS (TO). That which enables a device, appliance or equipment to be reached by ready access or by a means that first requires the removal or movement of a panel, door or similar obstruction [see also "Ready access (to)"].

AIR. All air supplied to mechanical equipment and appliances for combustion, ventilation, cooling, etc. Standard air is air at standard temperature and pressure, namely, 70°F (21°C) and 29.92 inches of mercury (101.3 kPa).

AIR CHANGE. The introduction of new, cleaned, or recirculated air to a space. [Comm 64.0202 (1) (a)]

AIR CHANGE RATE. Airflow in volume units per hour divided by the building space volume in identical volume units. [Comm 64.0202 (1) (b)]

AIR CONDITIONING. The treatment of air so as to control simultaneously the temperature, humidity, cleanness and distribution of the air to meet the requirements of a conditioned space.

AIR-CONDITIONING SYSTEM. A system that consists of heat exchangers, blowers, filters, supply, exhaust and return ducts, and shall include any apparatus installed in connection therewith.

AIR DISTRIBUTION SYSTEM. Any system of ducts, plenums and air-handling equipment that circulates air within a space or spaces and includes systems made up of one or more air-handling units.

AIR, EXHAUST. Air being removed from any space, appliance or piece of equipment and conveyed directly to the atmosphere by means of openings or ducts.

AIR-HANDLING UNIT. A blower or fan used for the purpose of distributing supply air to a room, space or area.

AIR, MAKEUP. Air that is provided to replace air being exhausted.

ALTERATION. A change in a mechanical system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

APPLIANCE. A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

APPLIANCE, EXISTING. Any appliance regulated by this code which was legally installed prior to the effective date of this code, or for which a permit to install has been issued.

APPLIANCE TYPE.

High-heat appliance. Any appliance in which the products of combustion at the point of entrance to the flue under normal operating conditions have a temperature greater than 2,000°F (1093°C).

Low-heat appliance (residential appliance). Any appliance in which the products of combustion at the point of entrance to the flue under normal operating conditions have a temperature of 1,000°F (538°C) or less.

Medium-heat appliance. Any appliance in which the products of combustion at the point of entrance to the flue under normal operating conditions have a temperature of more than 1,000°F (538°C), but not greater than 2,000°F (1093°C).

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

APPROVED. Accepted by the department. [Comm 64.0202 (2) (a)]

AUTOMATIC BOILER. Any class of boiler that is equipped with the controls and limit devices specified in Chapter 10.

BASE FLOOD ELEVATION. A reference point, determined in accordance with the *International Building Code*, based on the depth or peak elevation of flooding, including wave height, which has a 1 percent (100-year flood) or greater chance of occurring in any given year.

BATHROOM. A room containing a bathtub, shower, spa or similar bathing fixture.

BOILER. A closed heating appliance intended to supply hot water or steam for space heating, processing or power purposes. Low-pressure boilers operate at pressures less than or equal to 15 pounds per square inch (psi) (103 kPa) for steam and 160 psi (1103 kPa) for water. High-pressure boilers operate at pressures exceeding those pressures.

BOILER ROOM. A room primarily utilized for the installation of a boiler.

BRAZED JOINT. A gas-tight joint obtained by the joining of metal parts with metallic mixtures or alloys which melt at a temperature above 1,000°F (538°C), but lower than the melting temperature of the parts to be joined.

BRAZING. A metal joining process wherein coalescence is produced by the use of a nonferrous filler metal having a melting point above 1,000°F (538°C), but lower than that of the base metal being joined. The filler material is distributed between the closely fitted surfaces of the joint by capillary attraction.

BTU. Abbreviation for British thermal unit, which is the quantity of heat required to raise the temperature of 1 pound (454 g) of water 1°F (0.56°C) (1 Btu = 1055 J).

BUILDING. Any structure occupied or intended for supporting or sheltering any occupancy.

CHIMNEY. A primarily vertical structure containing one or more flues, for the purpose of carrying gaseous products of combustion and air from a fuel-burning appliance to the outside atmosphere.

Factory-built chimney. A listed and labeled chimney composed of factory-made components, assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

Masonry chimney. A field-constructed chimney composed of solid masonry units, bricks, stones or concrete.

Metal chimney. A field-constructed chimney of metal.

CHIMNEY CONNECTOR. A pipe that connects a fuel-burning appliance to a chimney.

CLEARANCE. The minimum distance through air measured between the heat-producing surface of the mechanical appliance, device or equipment and the surface of the combustible material or assembly.

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.

CLOTHES DRYER. An appliance used to dry wet laundry by means of heat. Dryer classifications are as follows:

Type 1. Factory-built package, multiple production. Primarily used in family living environment. Usually the smallest unit physically and in function output.

Type 2. Factory-built package, multiple production. Used in business with direct intercourse of the function with the public. Not designed for use in individual family living environment.

CODE. These regulations, subsequent amendments thereto, or any emergency rule or regulation that the administrative authority having jurisdiction has lawfully adopted.

CODE OFFICIAL. The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.

COMBUSTIBLE ASSEMBLY. Wall, floor, ceiling or other assembly constructed of one or more component materials that are not defined as noncombustible.

COMBUSTIBLE LIQUIDS. Any liquids having a flash point at or above 100°F (38°C), and that are divided into the following classifications:

Class II. Liquids having flash points at or above 100°F (38°C) and below 140°F (60°C).

Class IIIA. Liquids having flash points at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB. Liquids having flash points at or above 200°F (93°C).

COMBUSTIBLE MATERIAL. Any material not defined as noncombustible.

COMBUSTION. In the context of this code, refers to the rapid oxidation of fuel accompanied by the production of heat or heat and light.

COMBUSTION AIR. Air necessary for complete combustion of a fuel, including theoretical air and excess air.

COMBUSTION CHAMBER. The portion of an appliance within which combustion occurs.

COMBUSTION PRODUCTS. Constituents resulting from the combustion of a fuel with the oxygen of the air, including the inert gases, but excluding excess air.

COMMERCIAL FOOD HEAT-PROCESSING APPLIANCES. Appliances used in a food-processing establishment for heat-processing food or utensils, and which produce grease vapors, steam, fumes, smoke or odors that are required to be removed through a local exhaust ventilation system. Such appliances include deep fat fryers; upright broilers; griddles; broilers; fry grills; steam-jacketed kettles; hot-top ranges; charbroilers; ovens; barbecues; rotisseries; and similar appliances. For the purpose of this definition, a food-processing establishment shall include any building or a portion thereof used for the processing of food.

COMPENSATING HOODS. Compensating hoods are those having integral (built-in) makeup air supply. The makeup air supply for such hoods is generally supplied from: short-circuit flow from inside the hood, air curtain flow from the bottom of the front face, and front face discharge from the outside front wall of the hood. The compensating makeup airflow can also be supplied from the rear or side of the hood, or the rear, front, or sides of the cooking equipment. The makeup airflow can be one or a combination of methods.

COMPRESSOR. A specific machine, with or without accessories, for compressing a gas.

COMPRESSOR, POSITIVE DISPLACEMENT. A compressor in which increase in pressure is attained by changing the internal volume of the compression chamber.

COMPRESSOR UNIT. A compressor with its prime mover and accessories.

CONCEALED LOCATION. A location that cannot be accessed without damaging permanent parts of the building structure or finish surface. Spaces above, below or behind readily removable panels or doors shall not be considered as concealed.

CONDENSATE. The liquid that condenses from a gas (including flue gas) caused by a reduction in temperature.

CONDENSER. A heat exchanger designed to liquefy refrigerant vapor by removal of heat.

CONDENSING UNIT. A specific refrigerating machine combination for a given refrigerant, consisting of one or more power-driven compressors, condensers, liquid receivers (when required), and the regularly furnished accessories.

CONDITIONED SPACE. An area, room or space being heated or cooled by any equipment or appliance.

CONFINED SPACES. A space having a volume less than 50 cubic feet per 1,000 British thermal units per hour (Btu/h) (4.8 m³/kW) of the aggregate input rating of all appliances installed in that space.

CONSTRUCTION DOCUMENTS. All of the written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of the project necessary for obtaining a building permit. The construction drawings shall be drawn to an appropriate scale.

CONTROL. A manual or automatic device designed to regulate the gas, air, water or electrical supply to, or operation of, a mechanical system.

CONVERSION BURNER. A burner designed to supply gaseous fuel to an appliance originally designed to utilize another fuel.

COOKING APPLIANCE. See "Commercial food heat-processing appliances."

DAMPER. A manually or automatically controlled device to regulate draft or the rate of flow of air or combustion gases.

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

DESIGN WORKING PRESSURE. The maximum allowable working pressure for which a specific part of a system is designed.

DHFS. The Wisconsin Department of Health and Family Services. [Comm 64.0202 (1) (c)]

DIRECT REFRIGERATION SYSTEM. A system in which the evaporator or condenser of the refrigerating system is in di-

rect contact with the air or other substances to be cooled or heated.

DIRECT-VENT APPLIANCES. Appliances that are constructed and installed so that all air for combustion is derived from the outside atmosphere and all flue gases are discharged to the outside atmosphere.

DRAFT. The pressure difference existing between the appliance or any component part and the atmosphere, that causes a continuous flow of air and products of combustion through the gas passages of the appliance to the atmosphere.

Induced draft. The pressure difference created by the action of a fan, blower or ejector, that is located between the appliance and the chimney or vent termination.

Natural draft. The pressure difference created by a vent or chimney because of its height, and the temperature difference between the flue gases and the atmosphere.

DRIP. The container placed at a low point in a system of piping to collect condensate and from which the condensate is removable.

DRY CLEANING SYSTEMS. Dry cleaning plants or systems are classified as follows:

Type I. Those systems using Class I flammable liquid solvents having a flash point below 100°F (38°C).

Type II. Those systems using Class II combustible liquid solvents having a flash point at or above 100°F (38°C) and below 140°F (60°C).

Type III. Those systems using Class III combustible liquid solvents having a flash point at or above 140°F (60°C).

Types IV and V. Those systems using Class IV nonflammable liquid solvents.

DUCT. A tube or conduit utilized for conveying air. The air passages of self-contained systems are not to be construed as air ducts.

DUCT FURNACE. A warm-air furnace normally installed in an air distribution duct to supply warm air for heating. This definition shall apply only to a warm-air heating appliance that, for air circulation, depends on a blower not furnished as part of the furnace.

DUCT SYSTEM. A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling equipment and appliances.

DWELLING. A building or portion thereof that contains not more than two dwelling units.

DWELLING UNIT. A single unit providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

ELECTRIC HEATING APPLIANCE. An appliance that produces heat energy to create a warm environment by the application of electric power to resistance elements, refrigerant compressors or dissimilar material junctions.

EQUIPMENT. All piping, ducts, vents, control devices and other components of systems other than appliances which are

permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.

EQUIPMENT, EXISTING. Any equipment regulated by this code which was legally installed prior to the effective date of this code, or for which a permit to install has been issued.

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. The equipment and appliances 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. That part of the system in which liquid refrigerant is vaporized to produce refrigeration.

EXCESS AIR. The amount of air provided in addition to theoretical air, to achieve complete combustion of a fuel, thereby preventing the formation of dangerous products of combustion.

EXHAUST AIR. Air removed from a space and not reused.

EXHAUST SYSTEM. An assembly of connected ducts, plenums, fittings, registers, grilles and hoods through which air is conducted from the space or spaces and exhausted to the outside atmosphere.

FIREPLACE. An assembly consisting of a hearth and fire chamber of noncombustible material and provided with a chimney, for use with solid fuels.

Factory-built fireplace. A listed and labeled fireplace and chimney system composed of factory-made components, and assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

Masonry fireplace. A field-constructed fireplace composed of solid masonry units, bricks, stones or concrete.

FIREPLACE STOVE. A chimney-connected, solid-fuel-burning stove (appliance) having part of its fire chamber open to the room.

FLAME SAFEGUARD. A device that will automatically shut off the fuel supply to a main burner or group of burners when the means of ignition of such burners becomes inoperative, and when flame failure occurs on the burner or group of burners.

FLAME SPREAD INDEX. The numerical value assigned to a material tested in accordance with ASTM E 84.

FLAMMABILITY CLASSIFICATION. Refrigerants shall be assigned to one of the three classes — 1, 2 or 3 in accordance with ASHRAE 34. For Classes 2 and 3, the heat of combustion shall be calculated assuming that combustion products are in the gas phase and in their most stable state.

Class 1. Refrigerants that do not show flame propagation when tested in air at 14.7 psia (101 kPa) and 70°F (21°C).

Class 2. Refrigerants having a lower flammability limit (LFL) of more than 0.00625 pound per cubic foot (0.10 kg/m³) at 70°F (21°C) and 14.7 psia (101 kPa) and a heat of combustion of less than 8,174 Btu/lb. (19 000 kJ/kg).

Class 3. Refrigerants that are highly flammable, having a LFL of less than or equal to 0.00625 pound per cubic foot (0.10 kg/m³) at 70°F (21°C) and 14.7 psia (101 kPa) or a heat of combustion greater than or equal to 8,174 Btu/lb. (19 000 kJ/kg).

FLAMMABLE LIQUIDS. Any liquid that has a flash point below 100°F (38°C), and has a vapor pressure not exceeding 40 psia (276 kPa) at 100°F (38°C). Flammable liquids shall be known as Class I liquids and shall be divided into the following classifications:

Class IA. Liquids having a flash point below 73°F (23°C) and a boiling point below 100°F (38°C).

Class IB. Liquids having a flash point below 73°F (23°C) and a boiling point at or above 100°F (38°C).

Class IC. Liquids having a flash point at or above 73°F (23°C) and below 100°F (38°C).

FLAMMABLE VAPOR OR FUMES. Mixtures of gases in air at concentrations equal to or greater than the LFL and less than or equal to the upper flammability limit (UFL).

FLASH POINT. The minimum temperature corrected to a pressure of 14.7 psia (101 kPa) at which the application of a test flame causes the vapors of a portion of the sample to ignite under the conditions specified by the test procedures and apparatus. The flash point of a liquid shall be determined in accordance with ASTM D 56, ASTM D 93 or ASTM D 3278.

FLOOD ZONES

Flood-hazard zone. Areas that have been determined to be prone to flooding, but not subject to high-velocity waters or wave action.

High-hazard zone. Areas of tidal influence that have been determined to be subject to wave heights in excess of 3 feet (914 mm) or subject to high-velocity wave runoff or wave-induced erosion.

FLOOR AREA, NET. The actual occupied area, not including unoccupied accessory areas or thicknesses of walls.

FLOOR FURNACE. A completely self-contained furnace suspended from the floor of the space being heated, taking air for combustion from outside such space and with means for observing flames and lighting the appliance from such space.

FLUE. A passageway within a chimney or vent through which gaseous combustion products pass.

FLUE CONNECTION (BREECHING). A passage for conducting the products of combustion from a fuel-fired appliance to the vent or chimney (see also "Chimney connector" and "Vent connector").

FLUE GASES. Products of combustion and excess air.

FLUE LINER (LINING). A system or material used to form the inside surface of a flue in a chimney or vent, for the purpose of protecting the surrounding structure from the effects of combustion products and conveying combustion products without leakage to the atmosphere.

FUEL GAS. A natural gas, manufactured gas, liquefied petroleum gas or a mixture of these.

FUEL OIL. Kerosene or any hydrocarbon oil having a flash point not less than 100°F (38°C).

FUEL-OIL PIPING SYSTEM. A closed piping system that connects a combustible liquid from a source of supply to a fuel-oil-burning appliance.

FURNACE. A completely self-contained heating unit that is designed to supply heated air to spaces remote from or adjacent to the appliance location.

FURNACE ROOM. A room primarily utilized for the installation of fuel-burning space-heating and water-heating appliances other than boilers (see also "Boiler room").

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

GROUND SOURCE HEAT PUMP LOOP SYSTEM. Piping buried in horizontal or vertical excavations or placed in a body of water for the purpose of transporting heat transfer liquid to and from a heat pump. Included in this definition are closed loop systems in which the liquid is recirculated and open loop systems in which the liquid is drawn from a well or other source.

HAZARDOUS LOCATION. Any location considered to be a fire hazard for flammable vapors, dust, combustible fibers or other highly combustible substances. The location is not necessarily categorized in the *International Building Code* as a high-hazard use group classification.

HEAT EXCHANGER. A device that transfers heat from one medium to another.

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 TRANSFER LIQUID. The operating or thermal storage liquid in a mechanical system, including water or other liquid base, and additives at the concentration present under operating conditions used to move heat from one location to another. Refrigerants are not included as heat transfer liquids.

HIGH-PROBABILITY SYSTEMS. A refrigeration system in which the basic design or the location of components is such that a leakage of refrigerant from a failed connection, seal or component will enter an occupancy classified area, other than the machinery room.

HIGH-SIDE PRESSURE. The parts of a refrigerating system subject to condenser pressure.

HOOD. An air-intake device used to capture by entrapment, impingement, adhesion or similar means, grease and similar contaminants before they enter a duct system.

Type I. A kitchen hood for collecting and removing grease vapors and smoke.

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

IGNITION SOURCE. A flame, spark or hot surface capable of igniting flammable vapors or fumes. Such sources include appliance burners, burner ignitors and electrical switching devices.

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH). The concentration of airborne contaminants that poses a threat of death, immediate or delayed permanent adverse health effects, or effects that could prevent escape from such an environment. This contaminant concentration level is established by the National Institute of Occupational Safety and Health (NIOSH) based on both toxicity and flammability. It is generally expressed in parts per million by volume (ppm v/v) or milligrams per cubic meter (mg/m³).

INDIRECT REFRIGERATION SYSTEM. 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 shown below:

Closed system. A system in which a secondary fluid is either cooled or heated by the refrigerating system and then circulated within a closed circuit in indirect contact with the air or other substance to be cooled or heated.

Double-indirect open-spray system. A system in which the secondary substance for an indirect open-spray system is heated or cooled by an intermediate coolant circulated from a second enclosure.

Open-spray system. A system in which a secondary coolant is cooled or heated by the refrigerating system and then circulated in direct contact with the air or other substance to be cooled or heated.

Vented closed system. A system in which a secondary coolant is cooled or heated by the refrigerating system and then passed through a closed circuit in the air or other substance to be cooled or heated, except that the evaporator or condenser is placed in an open or appropriately vented tank.

JOINT, FLANGED. A joint 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. A general form of gas-tight joints obtained by the joining of metal parts through a positive-holding mechanical construction, such as flanged joint, screwed joint or flared joint.

JOINT, PLASTIC ADHESIVE. A joint made in thermoset plastic piping by the use of an adhesive substance which forms a continuous bond between the mating surfaces without dissolving either one of them.

JOINT, PLASTIC HEAT FUSION. A joint made in thermoplastic piping by heating the parts sufficiently to permit fusion of the materials when the parts are pressed together.

JOINT, PLASTIC SOLVENT CEMENT. A joint made in thermoplastic piping by the use of a solvent or solvent cement which forms a continuous bond between the mating surfaces.

JOINT, SOLDERED. A gas-tight joint obtained by the joining of metal parts with metallic mixtures of alloys which melt at temperatures between 400°F (204°C) and 1,000°F (538°C).

JOINT, WELDED. A gas-tight joint obtained by the joining of metal parts in molten state.

LABELED. Devices, equipment, appliances or materials to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and by whose label the manufacturer attests to compliance with applicable nationally recognized standards.

LIMIT CONTROL. A device responsive to changes in pressure, temperature or level for turning on, shutting off or throttling the gas supply to an appliance.

LIMITED CHARGE SYSTEM. A system in which, with the compressor idle, the design pressure will not be exceeded when the refrigerant charge has completely evaporated.

LISTED. Equipment, appliances or materials included in a list published by a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment, appliances or materials, and whose listing states either that the equipment, appliances or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner. Not all testing laboratories, inspection agencies and other organizations concerned with product evaluation use the same means for identifying listed equipment, appliances or materials. Some do not recognize equipment, appliances or materials as listed unless they are also labeled. The authority having jurisdiction shall utilize the system employed by the listing organization to identify a listed product.

LIVING SPACE. Space within a dwelling unit utilized for living, sleeping, eating, cooking, bathing, washing and sanitation purposes.

LOWER EXPLOSIVE LIMIT (LEL). See "LFL."

LOWER FLAMMABILITY LIMIT (LFL). The minimum concentration of refrigerant that is capable of propagating a flame through a homogeneous mixture of refrigerant and air.

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 SYSTEMS. A refrigeration system in which the basic design or the location of components is such that a leakage of refrigerant from a failed connection, seal or component will not enter an occupancy-classified area, other than the machinery room.

LOW-SIDE PRESSURE. The parts of a refrigerating system subject to evaporator pressure.

MACHINERY ROOM. A room meeting prescribed safety requirements and in which refrigeration systems or components thereof are located (see Sections 1105 and 1106).

MECHANICAL DRAFT SYSTEM. A venting system designed to remove flue or vent gases by mechanical means, that consists of an induced-draft portion under nonpositive static pressure or a forced-draft portion under positive static pressure.

Forced-draft venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static pressure.

Induced-draft venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under nonpositive static vent pressure.

Power venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static vent pressure.

MECHANICAL EQUIPMENT/APPLIANCE ROOM. A room or space in which nonfuel-fired mechanical equipment and appliances are located.

MECHANICAL EXHAUST SYSTEM. A system for removing air from a room or space by mechanical means.

MECHANICAL JOINT. A connection between pipes, fittings, or pipes and fittings, which is neither screwed, caulked, threaded, soldered, solvent cemented, brazed nor welded. Also, a joint in which compression is applied along the centerline of the pieces being joined. Some joints are part of a coupling, fitting or adapter.

MECHANICAL SYSTEM. A system specifically addressed and regulated in this code and composed of components, devices, appliances and equipment.

MODULAR BOILER. A steam or hot-water-heating assembly consisting of a group of individual boilers called modules intended to be installed as a unit with no intervening stop valves. Modules are under one jacket or are individually jacketed. The individual modules shall be limited to a maximum input rating of 400,000 Btu/h (117 228 W) gas, 3 gallons per hour (gph) (11.4 L/h) oil, or 115 kW (electric).

NATURAL DRAFT SYSTEM. A venting system designed to remove flue or vent gases under nonpositive static vent pressure entirely by natural draft.

NATURAL VENTILATION. The movement of air into and out of a space through intentionally provided openings, such as windows and doors, or through nonpowered ventilators.

NONABRASIVE/ABRASIVE MATERIALS. Nonabrasive particulate in high concentrations, moderately abrasive particulate in low and moderate concentrations, and highly abrasive particulate in low concentrations, such as alfalfa, asphalt, plaster, gypsum and salt.

NONCOMBUSTIBLE MATERIALS. Materials that, when tested in accordance with ASTM E 136, have at least three of four specimens tested meeting all of the following criteria:

1. The recorded temperature of the surface and interior thermocouples shall not at any time during the test rise more than 54°F (30°C) above the furnace temperature at the beginning of the test.
2. There shall not be flaming from the specimen after the first 30 seconds.
3. If the weight loss of the specimen during testing exceeds 50 percent, the recorded temperature of the surface and interior thermocouples shall not at any time during the test rise above the furnace air temperature at the beginning of the test.

ning of the test, and there shall not be flaming of the specimen.

OCCUPANCY. The purpose for which a building, or portion thereof, is utilized or occupied.

OFFSET (VENT). A combination of approved bends that make two changes in direction bringing one section of the vent out of line but into a line parallel with the other section.

OUTDOOR AIR. Air taken from the outdoors, and therefore not previously circulated through the system.

OUTDOOR OPENING. A door, window, louver or skylight openable to the outside atmosphere.

OUTLET. A threaded connection or bolted flange in a piping system to which a gas-burning appliance is attached.

PANEL HEATING. A method of radiant space heating in which heat is supplied by large heated areas of room surfaces. The heating element usually consists of warm water piping, warm air ducts, or electrical resistance elements embedded in or located behind ceiling, wall or floor surfaces.

PELLET FUEL-BURNING APPLIANCE. A closed-combustion, vented appliance equipped with a fuel-feed mechanism for burning processed pellets of solid fuel of a specified size and composition.

PIPING. Where used in this code, "piping" refers to either pipe or tubing, or both.

Pipe. A rigid conduit of iron, steel, copper, brass or plastic.

Tubing. Semirigid conduit of copper, aluminum, plastic or steel.

PLASTIC, THERMOPLASTIC. A plastic that is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

PLASTIC, THERMOSETTING. A plastic that is capable of being changed into a substantially infusible or insoluble product when cured under application of heat or chemical means.

POWER BOILER. See "Boiler."

PREMISES. A lot, plot or parcel of land, including any structure thereon.

PRESSURE, FIELD TEST. A test performed in the field to prove system tightness.

PRESSURE-LIMITING DEVICE. A pressure-responsive mechanism designed to stop automatically the operation of the pressure-imposing element at a predetermined pressure.

PRESSURE RELIEF DEVICE. A pressure-actuated valve or rupture member designed to relieve excessive pressure automatically.

PRESSURE RELIEF VALVE. A pressure-actuated valve held closed by a spring or other means and designed to relieve pressure automatically in excess of the device's setting.

PRESSURE VESSELS. Closed containers, tanks or vessels that are designed to contain liquids or gases, or both, under pressure.

PRESSURE VESSELS—REFRIGERANT. Any refrigerant-containing receptacle in a refrigerating system. This does not include evaporators where each separate section does not

exceed 0.5 cubic foot (0.014 m³) of refrigerant-containing volume, regardless of the maximum inside dimensions, evaporator coils, controls, headers, pumps and piping.

PROTECTIVE ASSEMBLY (REDUCED CLEARANCE). Any noncombustible assembly that is labeled or constructed in accordance with Table 308.6 and is placed between combustible materials or assemblies and mechanical appliances, devices or equipment, for the purpose of reducing required airspace clearances. Protective assemblies attached directly to a combustible assembly shall not be considered as part of that combustible assembly.

PURGE. To clear of air, water or other foreign substances.

QUICK-OPENING VALVE. A valve that opens completely by fast action, either manually or automatically controlled. A valve requiring one-quarter round turn or less is considered to be quick opening.

RADIANT HEATER. A heater designed to transfer heat primarily by direct radiation.

READY ACCESS (TO). That which enables a device, appliance or equipment to be directly reached, without requiring the removal or movement of any panel, door or similar obstruction [see "Access (to)"].

RECEIVER, LIQUID. A vessel permanently connected to a refrigeration system by inlet and outlet pipes for storage of liquid refrigerant.

RECIRCULATED AIR. Air removed from a conditioned space and intended for reuse as supply air.

RECLAIMED REFRIGERANTS. Refrigerants reprocessed to the same specifications as for new refrigerants by means including distillation. Such refrigerants have been chemically analyzed to verify that the specifications have been met. Reclaiming usually implies the use of processes or procedures that are available only at a reprocessing or manufacturing facility.

RECOVERED REFRIGERANTS. Refrigerants removed from a system in any condition without necessarily testing or processing them.

RECYCLED REFRIGERANTS. Refrigerants from which contaminants have been reduced by oil separation, removal of noncondensable gases, and single or multiple passes through devices that reduce moisture, acidity and particulate matter, such as replaceable core filter driers. These procedures usually are performed at the field job site or in a local service shop.

REFRIGERANT. A substance utilized to produce refrigeration by its expansion or vaporization.

REFRIGERANT SAFETY CLASSIFICATIONS. Groupings that indicate the toxicity and flammability classes in accordance with Section 1103.1. The classification group is 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. Class 1 indicates refrigerants that do not show flame propagation in air when tested by prescribed

methods at specified conditions. Classes 2 and 3 signify refrigerants with “lower flammability” and “higher flammability,” respectively; the distinction depends on both the LFL and heat of combustion.

Toxicity. Classes A and B signify refrigerants with “lower toxicity” and “higher toxicity,” respectively, based on prescribed measures of chronic (long-term, repeated exposures) toxicity.

REFRIGERATED 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 below 68°F (20°C).

REFRIGERATING SYSTEM. A combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat.

REFRIGERATION CAPACITY RATING. Expressed as 1 horsepower (0.75 kW), 1 ton or 12,000 Btu/h (3.5 kW), shall all mean the same quantity.

REFRIGERATION MACHINERY ROOM. See “Machinery room.”

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.

Direct system. A system in which the evaporator is in direct contact with the material or space refrigerated, or is located in air-circulating passages communicating with such spaces.

Indirect system. A system in which a brine coil cooled by the refrigerant is circulated to the material or space refrigerated, or is utilized to cool the air so circulated. Indirect systems are distinguished by the type or method of application.

REFRIGERATION SYSTEM CLASSIFICATION. Refrigeration systems are classified according to the degree of probability that leaked refrigerant from a failed connection, seal or component will enter an occupied area. The distinction is based on the basic design or location of the components.

REFRIGERATION SYSTEM, MECHANICAL. A combination of interconnected refrigeration-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 to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

RETURN AIR. Air removed from an approved conditioned space or location and recirculated or exhausted.

RETURN AIR SYSTEM. An assembly of connected ducts, plenums, fittings, registers and grilles through which air from the space or spaces to be heated or cooled is conducted back to the supply unit (see also “Supply air system”).

ROOM HEATER VENTED. A free-standing heating unit burning solid or liquid fuel for direct heating of the space in and adjacent to that in which the unit is located.

SAFETY VALVE. A valve that relieves pressure in a steam boiler by opening fully at the rated discharge pressure. The valve is of the spring-pop type.

SELF-CONTAINED EQUIPMENT. Complete, factory-assembled and tested, heating, air-conditioning or refrigeration equipment installed as a single unit, and having all working parts, complete with motive power, in an enclosed unit of said machinery.

SHAFT. An enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and the roof.

SHAFT ENCLOSURE. The walls or construction forming the boundaries of a shaft.

SMOKE DAMPER. A listed device that is designed to resist the passage of air and smoke. The device is arranged to operate automatically, controlled by a smoke detection system, and when required, is capable of being positioned manually from a remote command station.

SMOKE-DEVELOPED INDEX. A numerical value assigned to a material tested in accordance with ASTM E 84.

SOLID FUEL (COOKING APPLICATIONS). Applicable to commercial food service operations only, solid fuel is any bulk material such as hardwood, mesquite, charcoal or briquettes that is combusted to produce heat for cooking operations.

SOURCE CAPTURE SYSTEM. A mechanical exhaust system designed and constructed to capture air contaminants at their source and to exhaust such contaminants to the outdoor atmosphere.

SPOT HEATING. To provide heat to raise the air temperature to the required minimum in the immediate area of the occupants. [Comm 64.0202 (1) (d)]

STEAM-HEATING BOILER. A boiler operated at pressures not exceeding 15 psi (103 kPa) for steam.

STOP VALVE. A shutoff valve for controlling the flow of liquid or gases.

STORY. That portion of a building included between the upper surface of a floor and the upper surface of the floor next above, except that the topmost story shall be that portion of a building included between the upper surface of the topmost floor and the ceiling or roof above.

STRENGTH, ULTIMATE. The highest stress level that the component will tolerate without rupture.

SUPPLY AIR. That air delivered to each or any space supplied by the air distribution system or the total air delivered to all spaces supplied by the air distribution system, which is provided for ventilating, heating, cooling, humidification, dehumidification and other similar purposes.

SUPPLY AIR SYSTEM. An assembly of connected ducts, plenums, fittings, registers and grilles through which air, heated or cooled, is conducted from the supply unit to the space or spaces to be heated or cooled (see also "Return air system").

THEORETICAL AIR. The exact amount of air required to supply oxygen for complete combustion of a given quantity of a specific fuel.

THERMAL RESISTANCE (R). A measure of the ability to retard the flow of heat. The *R*-value is the reciprocal of thermal conductance.

TLV-TWA (THRESHOLD LIMIT VALUE-TIME-WEIGHTED AVERAGE). The time-weighted average concentration of a refrigerant or other chemical in air for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers are repeatedly exposed, day after day, without adverse effects, as adopted by the American Conference of Government Industrial Hygienists (ACGIH).

TOILET ROOM. A room containing a water closet and, frequently, a lavatory, but not a bathtub, shower, spa or similar bathing fixture.

TOXICITY CLASSIFICATION. Refrigerants shall be classified for toxicity to one of two classes in accordance with ASHRAE 34:

Class A. Refrigerants for which toxicity has not been identified at concentrations less than or equal to 400 parts per million (ppm), based on data used to determine Threshold Limit Value-Time-Weighted Average (TLV-TWA) or consistent indices.

Class B. Refrigerants for which there is evidence of toxicity at concentrations below 400 ppm, based on data used to determine TLV-TWA or consistent indices.

TRANSITION FITTINGS, PLASTIC TO STEEL. An adapter for joining plastic pipe to steel pipe. The purpose of this fitting is to provide a permanent, pressure-tight connection between two materials which cannot be joined directly one to another.

UNCONFINED SPACE. A space having a volume not less than 50 cubic feet per 1,000 Btu/h (4.8 m³/kW) of the aggregate input rating of all appliances installed in that space. Rooms communicating directly with the space in which the appliances are installed, through openings not furnished with doors, are considered a part of the unconfined space.

UNIT HEATER. A self-contained appliance of the fan type, designed for the delivery of warm air directly into the space in which the appliance is located.

UNUSUALLY TIGHT CONSTRUCTION. See s. Comm 65.0201.

Note: Section Comm 65.0201 reads: " 'Unusually tight construction' means the total area of outdoor openings is less than 3 percent of the floor area of the space in which equipment is located." [Comm 64.0202 (2) (b)]

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

Pellet vent. A vent listed and labeled for use with listed pellet fuel-burning appliances.

Type L vent. A vent listed and labeled for use with oil-burning appliances that are listed for use with Type L vents.

VENT CONNECTOR. The pipe that connects an approved fuel-fired appliance to a vent.

VENT DAMPER DEVICE, AUTOMATIC. A device intended for installation in the venting system, in the outlet of an individual automatically operated fuel-burning appliance that is designed to open the venting system automatically when the appliance is in operation and to close off the venting system automatically when the appliance is in a standby or shutdown condition.

VENTILATION. The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

VENTILATION AIR. That portion of supply air that comes from the outside (outdoors), plus any recirculated air that has been treated to maintain the desired quality of air within a designated space.

VENTING SYSTEM. A continuous open passageway from the flue collar of an appliance to the outside atmosphere for the purpose of removing flue or vent gases. A venting system is usually composed of a vent or a chimney and vent connector, if used, assembled to form the open passageway.

WATER HEATER. Any heating appliance or equipment that heats potable water and supplies such water to the potable hot water distribution system.

CHAPTER 3

GENERAL REGULATIONS

SECTION 301 GENERAL

301.1 Scope. This chapter shall govern the approval and installation of all equipment and appliances that comprise parts of the building mechanical systems regulated by this code in accordance with Section 101.2.

301.2 Energy utilization. Heating, ventilating and air-conditioning systems of all structures shall be designed and installed for efficient utilization of energy in accordance with the *International Energy Conservation Code*.

Comm 64.0301 (1) Note: See ch. Comm 63 for additional requirements.

301.3 Fuel gas appliances and equipment. The approval and installation of fuel gas distribution piping and equipment, fuel gas-fired appliances and fuel gas-fired appliance venting systems shall be in accordance with the *International Fuel Gas Code*.

301.4 [Comm 64.0301 (2)] Listed and labeled.

- (a) **General.** All appliances regulated by ch. Comm 64 shall be listed and labeled as specified in ch. Comm 64, unless approved by the department in accordance with par. (b) or the product approval criteria in s. Comm 61.60.
- (b) **Unlisted equipment.** The department may approve an installation of unlisted equipment after receipt of all of the following:
 - 1. A statement from the equipment manufacturer indicating the national standard with which the equipment complies.
 - 2. The results of a test conducted by a Wisconsin registered engineer on the output and safety controls in accordance with the national standard used by the manufacturer.

301.5 Labeling. Labeling shall be in accordance with the procedures set forth in Sections 301.5.1 through 301.5.2.3.

301.5.1 Testing. An approved agency shall test a representative sample of the mechanical equipment and appliances being labeled to the relevant standard or standards. The approved agency shall maintain a record of all of the tests performed. The record shall provide sufficient detail to verify compliance with the test standard.

301.5.2 Inspection and identification. The approved agency shall periodically perform an inspection, which shall be in-plant if necessary, of the mechanical equipment and appliances to be labeled. The inspection shall verify that the labeled mechanical equipment and appliances are representative of the mechanical equipment and appliances tested.

301.5.2.1 Independent. The agency to be approved shall be objective and competent. To confirm its objectivity, the agency shall disclose all possible conflicts of interest.

301.5.2.2 Equipment. An approved agency shall have adequate equipment to perform all required tests. The equipment shall be periodically calibrated.

301.5.2.3 Personnel. An approved agency shall employ experienced personnel educated in conducting, supervising and evaluating tests.

301.6 Label information. A permanent factory-applied nameplate(s) shall be affixed to appliances on which shall appear in legible lettering, the manufacturer's name or trademark, the model number, serial number and the seal or mark of the approved agency. A label shall also include the following:

1. Electrical equipment and appliances: Electrical rating in volts, amperes and motor phase; identification of individual electrical components in volts, amperes or watts, motor phase; Btu/h (W) output; and required clearances.
2. Absorption units: Hourly rating in Btu/h (W); minimum hourly rating for units having step or automatic modulating controls; type of fuel; type of refrigerant; cooling capacity in Btu/h (W); and required clearances.
3. Fuel-burning units: Hourly rating in Btu/h (W); type of fuel approved for use with the appliance; and required clearances.
4. Electric comfort heating appliances: Name and trademark of the manufacturer; the model number or equivalent; the electric rating in volts, ampacity and phase; Btu/h (W) output rating; individual marking for each electrical component in amperes or watts, volts and phase; required clearances from combustibles; and a seal indicating approval of the appliance by an approved agency.

301.7 [Comm 64.0301 (3)] Electrical. Electrical wiring, controls and connections to equipment and appliances regulated by this code shall be in accordance with ch. Comm 16.

301.8 [Comm 64.0301 (4)] Plumbing connections. Potable water supply and building drainage system connections to equipment and appliances regulated by this code shall be in accordance with chs. Comm 81-87.

301.9 Fuel types. Fuel-fired appliances shall be designed for use with the type of fuel to which they will be connected and the altitude at which they are installed. Appliances that comprise parts of the building mechanical system shall not be converted for the usage of a different fuel, except where approved and converted in accordance with the manufacturer's instructions. The fuel input rate shall not be increased or decreased beyond

the limit rating for the altitude at which the appliance is installed.

301.10 Vibration isolation. Where vibration isolation of equipment and appliances is employed, an approved means of supplemental restraint shall be used to accomplish the support and restraint.

301.11 Repair. Defective material or parts shall be replaced or repaired in such a manner so as to preserve the original approval or listing.

301.12 Wind resistance. Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressures determined in accordance with the *International Building Code*.

[B] 301.13 Flood hazard. For structures located in a special flood-hazard area, mechanical systems shall comply with the flood-resistant construction requirements of the *International Building Code*.

301.14 Prohibited location. Mechanical systems shall not be located in an elevator shaft.

301.15 Rodent proofing. Buildings or structures and the walls enclosing habitable or occupiable rooms and spaces in which persons live, sleep or work, or in which feed, food or foodstuffs are stored, prepared, processed, served or sold, shall be constructed to protect against the entrance of rodents in accordance with the *International Building Code*.

301.16 Seismic resistance. When earthquake loads are applicable in accordance with the *International Building Code*, mechanical system supports shall be designed and installed for the seismic forces in accordance with the *International Building Code*.

SECTION 302 PROTECTION OF STRUCTURE

302.1 Structural safety. The building or structure shall not be weakened by the installation of mechanical systems. Where floors, walls, ceilings or any other portion of the building or structure are required to be altered or replaced in the process of installing or repairing any system, the building or structure shall be left in a safe structural condition in accordance with the *International Building Code*.

302.2 Penetrations of floor/ceiling assemblies and fire-resistance-rated assemblies. Penetrations of floor/ceiling assemblies and assemblies required to have a fire-resistance rating shall be protected in accordance with the *International Building Code*.

[B] 302.3 Cutting, notching and boring in wood framing. The cutting, notching and boring of wood framing members shall comply with Sections 302.3.1 through 302.3.3.

[B] 302.3.1 Joist notching. Notches on the ends of joists shall not exceed one-fourth the joist depth. Holes bored in joists shall not be within 2 inches (51 mm) of the top or bottom of the joist, and the diameter of any such hole shall not exceed one-third the depth of the joist. Notches in the top or

bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle third of the span.

[B] 302.3.2 Stud cutting and notching. In exterior walls and bearing partitions, any wood stud is permitted to be cut or notched not to exceed 25 percent of its depth. Cutting or notching of studs not greater than 40 percent of their depth is permitted in nonbearing partitions supporting no loads other than the weight of the partition.

[B] 302.3.3 Bored holes. A hole not greater in diameter than 40 percent of the stud depth is permitted to be bored in any wood stud. Bored holes not greater than 60 percent of the depth of the stud are permitted in nonbearing partitions or in any wall where each bored stud is doubled, provided not more than two such successive doubled studs are so bored. In no case shall the edge of the bored hole be nearer than 0.625 inch (15.9 mm) to the edge of the stud. Bored holes shall not be located at the same section of stud as a cut or notch.

[B] 302.4 Cutting, notching and boring in steel framing. The cutting, notching and boring of steel framing members shall comply with Sections 302.4.1 through 302.4.3.

[B] 302.4.1 Cutting, notching and boring holes in structural steel framing. The cutting, notching and boring of holes in structural steel framing members shall be as prescribed by the registered design professional.

[B] 302.4.2 Cutting, notching and boring holes in cold-formed steel framing. Flanges and lips of load-bearing cold-formed steel framing members shall not be cut or notched. Holes in webs of load-bearing cold-formed steel framing members shall be permitted along the centerline of the web of the framing member and shall not exceed the dimensional limitations, penetration spacing or minimum hole edge distance as prescribed by the registered design professional. Cutting, notching and boring holes of steel floor/roof decking shall be as prescribed by the registered design professional.

[B] 302.4.3 Cutting, notching and boring holes in non-structural cold-formed steel wall framing. Flanges and lips of nonstructural cold-formed steel wall studs shall not be cut or notched. Holes in webs of nonstructural cold-formed steel wall studs shall be permitted along the centerline of the web of the framing member, shall not exceed 1.5 inches (38 mm) in width or 4 inches (102 mm) in length, and shall not be spaced less than 24 inches (610 mm) center to center from another hole or less than 10 inches (254 mm) from the bearing end.

SECTION 303 EQUIPMENT AND APPLIANCE LOCATION

303.1 General. Equipment and appliances shall be located as required by this section, specific requirements elsewhere in this code and the conditions of the equipment and appliance listing.

303.2 Hazardous locations. Appliances shall not be located in a hazardous location unless listed and approved for the specific installation.

303.3 Prohibited locations. Fuel-fired appliances shall not be located in, or obtain combustion air from, any of the following rooms or spaces:

1. Sleeping rooms.
2. Bathrooms.
3. Toilet rooms.
4. Storage closets.
5. Surgical rooms.

Exception: This section shall not apply to the following appliances:

1. Direct-vent appliances that obtain all combustion air directly from the outdoors.
2. Solid fuel-fired appliances, provided that the room is not a confined space and the building is not of unusually tight construction.
3. Appliances installed in a dedicated enclosure in which all combustion air is taken directly from the outdoors, in accordance with Section 703. Access to such enclosure shall be through a solid door, weather-stripped in accordance with the exterior door air leakage requirements of the *International Energy Conservation Code* and equipped with an approved self-closing device.

303.4 Protection from damage. Appliances shall not be installed in a location where subject to mechanical damage unless protected by approved barriers.

303.5 Indoor locations. Fuel-fired furnaces and boilers installed in closets and alcoves shall be listed for such installation. For purposes of this section, a closet or alcove shall be defined as a room or space having a volume less than 12 times the total volume of fuel-fired appliances other than boilers and less than 16 times the total volume of boilers. Room volume shall be computed using the gross floor area and the actual ceiling height up to a maximum computation height of 8 feet (2438 mm).

303.6 Outdoor locations. Appliances installed in other than indoor locations shall be listed and labeled for outdoor installation.

303.7 Pit locations. Appliances installed in pits or excavations shall not come in direct contact with the surrounding soil. The sides of the pit or excavation shall be held back a minimum of 12 inches (305 mm) from the appliance. Where the depth exceeds 12 inches (305 mm) below adjoining grade, the walls of the pit or excavation shall be lined with concrete or masonry. Such concrete or masonry shall extend a minimum of 4 inches (102 mm) above adjoining grade and shall have sufficient lateral load-bearing capacity to resist collapse. The appliance shall be protected from flooding in an approved manner.

[B] 303.8 Elevator shafts. Mechanical systems shall not be located in an elevator shaft.

SECTION 304 INSTALLATION

304.1 General. Equipment and appliances shall be installed as required by the terms of their approval, in accordance with the conditions of the listing, the manufacturer's installation instructions and this code. Manufacturer's installation instructions shall be available on the job site at the time of inspection.

304.2 Conflicts. Where conflicts between this code and the conditions of listing or the manufacturer's installation instructions occur, the provisions of this code shall apply.

Exception: Where a code provision is less restrictive than the conditions of the listing of the equipment or appliance or the manufacturer's installation instructions, the conditions of the listing and the manufacturer's installation instructions shall apply.

Comm 64.0304 Note: See s. Comm 61.03 (2) for clarification on the application of different requirements and where the most restrictive requirements apply.

304.3 Elevation of ignition source. Equipment and appliances having an ignition source and located in hazardous locations and public garages, private garages, repair garages, automotive service stations and parking garages shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the floor surface on which the equipment or appliance rests. Such equipment and appliances shall not be installed in Use Group H occupancies or control areas where open use, handling or dispensing of combustible, flammable or explosive materials occurs. For the purpose of this section, rooms or spaces that are not part of the living space of a dwelling unit and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

304.4 Public garages. Appliances located in public garages, service stations, repair garages or other areas frequented by motor vehicles, shall be installed a minimum of 8 feet (2438 mm) above the floor. Where motor vehicles exceed 6 feet (1829 mm) in height and are capable of passing under an appliance, appliances shall be installed a minimum of 2 feet (610 mm) higher above the floor than the height of the tallest vehicle.

Exception: The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 304.3 and NFPA 88B.

304.5 Private garages. Appliances located in private garages and carports shall be installed with a minimum clearance of 6 feet (1829 mm) above the floor.

Exception: The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 304.3.

304.6 Construction and protection. Boiler rooms and furnace rooms shall be protected as required by the *International Building Code*.

304.7 Clearances to combustible construction. Heat-producing equipment and appliances shall be installed to maintain the required clearances to combustible construction as specified in the listing and manufacturer's instructions. Such clearances shall be reduced only in accordance with Section 308. Clearances to combustibles shall include such considerations as door swing, drawer pull, overhead projections or shelving and window swing, shutters, coverings and drapes. Devices such as doorstops or limits, closers, drapery ties or guards shall not be used to provide the required clearances.

304.8 Clearances from grade. Equipment and appliances installed at grade level shall be supported on a level concrete slab or other approved material extending above adjoining grade or shall be suspended a minimum of 6 inches (152 mm) above adjoining grade.

304.9 Guards. Guards shall be provided where appliances, equipment, fans or other components that require service are located within 10 feet (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches (762 mm) above the floor, roof or grade below. The guard shall extend not less than 30 inches (762 mm) beyond each end of such appliance, equipment, fan or component and the top of the guard shall be located not less than 42 inches (1067 mm) above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21-inch-diameter (533 mm) sphere and shall comply with the loading requirements for guards specified in the *International Building Code*.

304.10 Area served. Appliances serving different areas of a building other than where they are installed shall be permanently marked in an approved manner that uniquely identifies the appliance and the area it serves.

SECTION 305 PIPING SUPPORT

305.1 General. All mechanical system piping shall be supported in accordance with this section.

305.2 Materials. Pipe hangers and supports shall have sufficient strength to withstand all anticipated static and specified dynamic loading conditions associated with the intended use. Pipe hangers and supports that are in direct contact with piping shall be of approved materials that are compatible with the piping and that will not promote galvanic action.

305.3 Structural attachment. Hangers and anchors shall be attached to the building construction in an approved manner.

305.4 Interval of support. Piping shall be supported at distances not exceeding the spacing specified in Table 305.4, or in accordance with MSS SP-69.

TABLE 305.4
PIPING SUPPORT SPACING^a

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS pipe	4	10 ^c
Aluminum pipe and tubing	10	15
Brass pipe	10	10
Brass tubing, 1 1/4-inch diameter and smaller	6	10
Brass tubing, 1 1/2-inch diameter and larger	10	10
Cast-iron pipe ^b	5	15
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing, 1 1/4-inch diameter and smaller	6	10
Copper or copper-alloy tubing, 1 1/2-inch diameter and larger	10	10
CPVC pipe or tubing, 1 inch and smaller	3	10 ^c
CPVC pipe or tubing, 1 1/4 inch and larger	4	10 ^c
Steel pipe	12	15
Steel tubing	8	10
Lead pipe	Continuous	4
PB pipe or tubing	2 2/3 (32 inches)	4
PEX tubing	2 2/3 (32 inches)	10 ^c
PVC pipe	4	10 ^c

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

a. See Section 301.14.

b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.

c. Mid-story guide.

SECTION 306 ACCESS AND SERVICE SPACE

306.1 Clearances for maintenance and replacement. Clearances around appliances to elements of permanent construction, including other installed equipment and appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required fire-resistance-rated assembly.

306.1.1 Central furnaces. Central furnaces within compartments or alcoves shall have a minimum working space clearance of 3 inches (76 mm) along the sides, back and top with a total width of the enclosing space being at least 12

inches (305 mm) wider than the furnace. Furnaces having a firebox open to the atmosphere shall have at least 6 inches (152 mm) working space along the front combustion chamber side. Combustion air openings at the rear or side of the compartment shall comply with the requirements of Chapter 7.

Exception: This section shall not apply to replacement appliances installed in existing compartments and alcoves where the working space clearances are in accordance with the equipment or appliance manufacturer's installation instructions.

306.2 Appliances in rooms. Rooms containing appliances requiring access shall be provided with a door and an unobstructed passageway measuring not less than 36 inches (914 mm) wide and 80 inches (2032 mm) high.

Exception: Within a dwelling unit, appliances installed in a compartment, alcove, basement or similar space shall be accessed by an opening or door and an unobstructed passageway measuring not less than 24 inches (610 mm) wide and large enough to allow removal of the largest appliance in the space, provided that a level service space of not less than 30 inches (762 mm) deep and the height of the appliance, but not less than 30 inches (762 mm), is present at the front or service side of the appliance with the door open.

306.3 Appliances in attics. Attics containing appliances requiring access shall be provided with an opening and unobstructed passageway large enough to allow removal of the largest appliance. The passageway shall not be less than 30 inches (762 mm) high and 22 inches (559 mm) wide and not more than 20 feet (6096 mm) in length measured along the centerline of the passageway from the opening to the appliance. The passageway shall have continuous solid flooring not less than 24 inches (610 mm) wide. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present at the front or service side of the appliance. The clear access opening dimensions shall be a minimum of 20 inches by 30 inches (508 mm by 762 mm), where such dimensions are large enough to allow removal of the largest appliance.

Exception: The passageway and level service space are not required where the appliance is capable of being serviced and removed through the required opening.

306.3.1 Electrical requirements. A lighting fixture controlled by a switch located at the required passageway opening and a receptacle outlet shall be provided at or near the appliance location in accordance with the ICC *Electrical Code*.

306.4 Appliances under floors. Underfloor spaces containing appliances requiring access shall be provided with an access opening and unobstructed passageway large enough to remove the largest appliance. The passageway shall not be less than 30 inches (762 mm) high and 22 inches (559 mm) wide, nor more than 20 feet (6096 mm) in length measured along the centerline of the passageway from the opening to the appliance. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present at the front or service side of the appliance. If the depth of the passageway or the service space exceeds 12 inches (305 mm) below the adjoining

grade, the walls of the passageway shall be lined with concrete or masonry. Such concrete or masonry shall extend a minimum of 4 inches (102 mm) above the adjoining grade and shall have sufficient lateral-bearing capacity to resist collapse. The clear access opening dimensions shall be a minimum of 22 inches by 30 inches (559 mm by 762 mm), where such dimensions are large enough to allow removal of the largest appliance.

Exception: The passageway is not required where the level service space is present when the access is open and the appliance is capable of being serviced and removed through the required opening.

306.4.1 Electrical requirements. A lighting fixture controlled by a switch located at the required passageway opening and a receptacle outlet shall be provided at or near the appliance location in accordance with the ICC *Electrical Code*.

306.5 Equipment and appliances on roofs or elevated structures. Where equipment and appliances requiring access are installed on roofs or elevated structures at a height exceeding 16 feet (4877 mm), such access shall be provided by a permanent approved means of access, the extent of which shall be from grade or floor level to the equipment and appliances' level service space. Such access shall not require climbing over obstructions greater than 30 inches (762 mm) high or walking on roofs having a slope greater than 4 units vertical in 12 units horizontal (33-percent slope).

Exception: This section shall not apply to Group R-3 occupancies.

306.6 Sloped roofs. Where appliances are installed on a roof having a slope of 3 units vertical in 12 units horizontal (25-percent slope) or greater and having an edge more than 30 inches (762 mm) above grade at such edge, a level platform shall be provided on each side of the appliance to which access is required by the manufacturer's installation instructions for service, repair or maintenance. The platform shall not be less than 30 inches (762 mm) in any dimension and shall be provided with guards in accordance with Section 304.9.

Comm 64.0306 Exception: These provisions do not apply when the installation consists of fans only.

SECTION 307 CONDENSATE DISPOSAL

307.1 Fuel-burning appliances. Liquid combustion by-products of condensing appliances shall be collected and discharged to an approved plumbing fixture or disposal area in accordance with the manufacturer's installation instructions. Condensate piping shall be of approved corrosion-resistant material and shall not be smaller than the drain connection on the appliance. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1-percent slope).

307.2 Evaporators and cooling coils. Condensate drain systems shall be provided for equipment and appliances containing evaporators or cooling coils. Condensate drain systems shall be designed, constructed and installed in accordance with Sections 307.2.1 through 307.2.4.

307.2.1 Condensate disposal. Condensate from all cooling coils and evaporators shall be conveyed from the drain pan outlet to an approved place of disposal. Condensate shall not discharge into a street, alley or other areas so as to cause a nuisance.

307.2.2 Drain pipe materials and sizes. Components of the condensate disposal system shall be cast iron, galvanized steel, copper, polybutylene, polyethylene, ABS, CPVC or PVC pipe or tubing. All components shall be selected for the pressure and temperature rating of the installation. Condensate waste and drain line size shall be not less than $\frac{3}{4}$ -inch (19 mm) internal diameter and shall not decrease in size from the drain pan connection to the place of condensate disposal. Where the drain pipes from more than one unit are manifolded together for condensate drainage, the pipe or tubing shall be sized in accordance with an approved method. All horizontal sections of drain piping shall be installed in uniform alignment at a uniform slope.

307.2.3 Auxiliary and secondary drain systems. In addition to the requirements of Section 307.2.1, a secondary drain or auxiliary drain pan shall be required for each cooling or evaporator coil where damage to any building components will occur as a result of overflow from the equipment drain pan or stoppage in the condensate drain piping. One of the following methods shall be used:

1. An auxiliary drain pan with a separate drain shall be provided under the coils on which condensation will occur. The auxiliary pan drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The pan shall have a minimum depth of 1.5 inches (38 mm), shall not be less than 3 inches (76 mm) larger than the unit or the coil dimensions in width and length and shall be constructed of corrosion-resistant material. Metallic pans shall have a minimum thickness of not less than 0.0276-inch (0.7 mm) galvanized sheet metal. Non-metallic pans shall have a minimum thickness of not less than 0.0625 inch (1.6 mm).
2. A separate overflow drain line shall be connected to the drain pan provided with the equipment. Such overflow drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The overflow drain line shall connect to the drain pan at a higher level than the primary drain connection.
3. An auxiliary drain pan without a separate drain line shall be provided under the coils on which condensate will occur. Such pan shall be equipped with a water-level detection device that will shut off the equipment served prior to overflow of the pan. The auxiliary drain pan shall be constructed in accordance with Item 1 of this section.

307.2.4 Traps. Condensate drains shall be trapped as required by the equipment or appliance manufacturer.

SECTION 308 CLEARANCE REDUCTION

308.1 Scope. This section shall govern the reduction in required clearances to combustible materials and combustible assemblies for chimneys, vents, kitchen exhaust equipment, mechanical appliances, and mechanical devices and equipment.

308.2 Listed appliances and equipment. The reduction of the required clearances to combustibles for listed and labeled appliances and equipment shall be in accordance with the requirements of this section except that such clearances shall not be reduced where reduction is specifically prohibited by the terms of the appliance or equipment listing.

308.3 Protective assembly construction and installation. Reduced clearance protective assemblies, including structural and support elements, shall be constructed of noncombustible materials. Spacers utilized to maintain an airspace between the protective assembly and the protected material or assembly shall be noncombustible. Where a space between the protective assembly and protected combustible material or assembly is specified, the same space shall be provided around the edges of the protective assembly and the spacers shall be placed so as to allow air circulation by convection in such space. Protective assemblies shall not be placed less than 1 inch (25 mm) from the mechanical appliances, devices or equipment, regardless of the allowable reduced clearance.

308.4 Allowable reduction. The reduction of required clearances to combustible assemblies or combustible materials shall be based on the utilization of a reduced clearance protective assembly in accordance with Section 308.5 or 308.6.

308.5 Labeled assemblies. The allowable clearance reduction shall be based on an approved reduced clearance protective assembly that has been tested and bears the label of an approved agency.

308.6 Reduction table. The allowable clearance reduction shall be based on one of the methods specified in Table 308.6. Where required clearances are not listed in Table 308.6, the reduced clearances shall be determined by linear interpolation between the distances listed in the table. Reduced clearances shall not be derived by extrapolation below the range of the table.

308.7 Solid fuel-burning appliances. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the clearance required for solid fuel-burning appliances that are labeled for installation with clearances of 12 inches (305 mm) or less. Where appliances are labeled for installation with clearances of greater than 12 inches (305 mm), the clearance reduction methods of Table 308.6 shall not reduce the clearance to less than 12 inches (305 mm).

308.8 Masonry chimneys. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the clearances required for masonry chimneys as specified in Chapter 8 and the *International Building Code*.

**TABLE 308.6
CLEARANCE REDUCTION METHODS**

TYPE OF PROTECTIVE ASSEMBLY ^a	REDUCED CLEARANCE WITH PROTECTION (inches) ^a							
	Horizontal combustible assemblies located above the heat source				Horizontal combustible assemblies located beneath the heat source and all vertical combustible assemblies			
	Required clearance to combustibles without protection (Inches) ^a				Required clearance to combustibles without protection (Inches) ^a			
	36	18	9	6	36	18	9	6
Galvanized sheet metal, minimum nominal thickness of 0.024 inch (No. 24 Gage), mounted on 1-inch glass fiber or mineral wool batt reinforced with wire on the back, 1 inch off the combustible assembly	18	9	5	3	12	6	3	3
Galvanized sheet metal, minimum nominal thickness of 0.024 inch (No. 24 Gage), spaced 1 inch off the combustible assembly	18	9	5	3	12	6	3	2
Two layers of galvanized sheet metal, minimum nominal thickness of 0.024 inch (No. 24 Gage), having a 1-inch airspace between layers, spaced 1 inch off the combustible assembly	18	9	5	3	12	6	3	3
Two layers of galvanized sheet metal, minimum nominal thickness of 0.024 inch (No. 24 Gage), having 1 inch of fiberglass insulation between layers, spaced 1 inch off the combustible assembly	18	9	5	3	12	6	3	3
0.5-inch inorganic insulating board, over 1 inch of fiberglass or mineral wool batt, against the combustible assembly	24	12	6	4	18	9	5	3
3.5-inch brick wall, spaced 1 inch off the combustible wall	—	—	—	12	6	6	6	
3.5-inch brick wall, against the combustible wall	—	—	—	24	12	6	5	

For SI: 1 inch = 25.4 mm, °C = [(°F)-32]/1.8, 1 pound per cubic foot = 16.02 kg/m³, 1.0 Btu in/ft² · h · °F = 0.144 W/m² · °K.

a. Mineral wool and glass fiber batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot and a minimum melting point of 1,500°F. In situation material utilized as part of a clearance reduction system shall have a thermal conductivity of 1.0 Btu in/(ft² · h · °F) or less. Insulation board shall be formed of noncombustible material.

308.9 Chimney connector pass-throughs. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the clearances required for chimney connector pass-throughs as specified in Section 803.10.4.

308.10 Masonry fireplaces. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the clearances required for masonry fireplaces as specified in Chapter 8 and the *International Building Code*.

308.11 Kitchen exhaust ducts. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the minimum clearances required by Section 506.3.11 for kitchen exhaust ducts enclosed in a shaft.

heating the entire space as specified in sub. (1), provided the inside design temperature at the fixed work station is at least 60°F (16 °C).

- (3) **Seasonal occupancies.** When approved by the department, heating requirements may be waived, but not ventilation required by this code, during the period of May 15 through September 15 for the following or similar occupancies: drive-in eating places, club houses, outdoor toilets, camp lodge buildings, canning factories and migrant labor camps.

[B] SECTION 309 TEMPERATURE CONTROL

309.1 [Comm 64.0309]

- (1) **Heating system design.** Except as provided in subs. (2) or (3), the heating system shall be designed and operated to maintain a temperature of not less than that shown in Table 64.0403 at 3 feet (914 mm) above the floor within the occupied space during occupied periods.
- (2) **Spot heating.** Spot heating may be used to heat individual fixed work stations in industrial buildings in lieu of

[F] SECTION 310 EXPLOSION VENTING

310.1 Required. Structures occupied for purposes involving explosion hazards shall be provided with explosion control where required by the *International Fire Code*. Explosion control systems shall be designed and installed in accordance with the *International Fire Code*.

**[F] SECTION 311
SMOKE AND HEAT VENTS**

311.1 Required. Approved smoke and heat vents shall be installed in the roofs of one-story buildings where required by the fire prevention code. Smoke and heat vents shall be designed and installed in accordance with the *International Fire Code*.

**SECTION 312
HEATING AND COOLING LOAD CALCULATIONS**

312.1 Load calculations. Heating and cooling system design loads for the purpose of sizing systems, appliances and equipment shall be determined in accordance with the procedures described in the *ASHRAE Handbook of Fundamentals* or an equivalent computation procedure, using the design parameters specified in Chapter 3 of the *International Energy Conservation Code*.

Comm 64.0312 Note: For design parameters in the IECC, refer to ch. Comm 63 or IECC Section 803.

Comm 64.0313 Other requirements.

- (1) **Balancing, final test required.** Every heating, ventilating and air-conditioning system shall be balanced upon installation. The person or agency responsible for balancing of the ventilating system shall document in writing the amount of outdoor air being provided and distributed for the building occupants and any other specialty ventilation. The document shall be retained at the site and shall be made available to the department upon request.
 - (a) Air systems shall be balanced in a manner to minimize losses from damper throttling by first adjusting fan speed then adjusting dampers to meet design flow conditions. Balancing procedures shall be acceptable to the department. Damper throttling alone may be used for air system balancing with fan motors of 1 hp or less, or if throttling results in no greater than 1/3 hp fan horsepower draw above that required if the fan speed were adjusted.
 - (b) Either of the following test methods shall be used:
 1. Hydronic systems shall be balanced in a manner to minimize valve throttling losses by first trimming the pump impeller or adjusting the pump speed then adjusting the valves to meet design flow conditions.
 2. Valve throttling alone may be used for hydronic system balancing under any of the following conditions as specified in subds. 2.a. to d.
 - a. Pumps with pump motors of 10 hp or less.
 - b. If throttling results in no greater than 3 hp pump horsepower draw for pumps of 60 hp or less, or no greater than 5% of pump horsepower draw for pumps greater than 60 hp, above that required if the impeller were trimmed.
 - c. To reserve additional pump pressure capability in open circuit piping systems subject to fouling. Valve throttling pressure drop

shall not exceed that expected for future fouling.

- d. Where it can be shown that throttling will not increase overall building energy costs.

Note: National Environmental Balancing Bureau (NEBB) Procedural Standards, the Associated Air Balance Council (AABC) National Standards, the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), or equivalent balancing procedures are acceptable to the department.

- (2) **Balancing, proper working condition.** HVAC control systems shall be tested to assure that control elements are calibrated, adjusted and in proper working condition.
- (3) **Balancing, operating and maintenance manual.** An operating and maintenance manual shall be provided to the building owner or operator. The manual shall include basic data relating to the operation and maintenance of HVAC systems and equipment. Required routine maintenance actions shall be clearly identified. Where applicable, HVAC controls information such as diagrams, schematics, control sequence descriptions, and maintenance and calibration information shall be included.

CHAPTER 4

VENTILATION

SECTION 401 GENERAL

401.1 Scope. This chapter shall govern the ventilation of spaces within a building intended to be occupied. This chapter does not govern the requirements for smoke control systems.

401.2 [Comm 64.0401 (1)] Ventilation required. Every occupied space shall be ventilated by natural means in accordance with IMC Section 402 or by mechanical means in accordance with IMC Section 403 and as specified in Table 64.0403.

401.3 [Comm 64.0401 (2)] When required.

- (a) **Outside air.** Mechanical ventilation systems shall be operated to provide a continuous source of outside air to all areas while people are present.
- (b) **Operation.**
 - 1. Except as provided in subd. 2., the required building exhaust ventilating systems shall operate continuously when people are in the building to provide the amount of exhaust specified in Table 64.0403.

Note: Chapter Comm 32 may require continuous operation of some exhaust systems, such as purging systems, chloride storage exhaust or industrial exhaust.

- 2. Subdivision 1. does not apply to all of the following:
 - a. Toilet rooms with two or fewer total water closets or urinals, if the required ventilation is provided when the room is occupied.
 - b. Shower rooms with two or fewer showerheads if the required ventilation is provided when the room is occupied.
 - c. Common residential laundry rooms with a total of four or fewer washers and dryers if the required ventilation is provided when the room is occupied.
 - d. Mechanical exhaust systems for natatoriums even when the building is not occupied.

[B] 401.4 [Comm 64.0401 (3)] Exits. Vestibule ventilation for smokeproof enclosures shall be in accordance with the IBC.

401.5 Opening location. Outside air exhaust and intake openings shall be located a minimum of 10 feet (3048 mm) from lot lines or buildings on the same lot. Where openings front on a street or public way, the distance shall be measured to the centerline of the street or public way.

Exception: Group R-3.

Comm 64.0401 (4)

(a) **Additional requirements.**

- 1. Mechanical and required gravity outside air intake openings shall be located a minimum of 10 feet (3048 mm) from any hazardous or noxious contaminant such as vents, chimneys, plumbing vents, streets, alleys, parking lots and loading docks, ex-

cept as otherwise specified in this code. Where a source of contaminant is located within 10 feet (3048 mm) of an intake opening, such opening shall be located a minimum of 2 feet (610 mm) below the contaminant source.

- 2. The lowest side of outside air intake required openings shall be located at least 12 inches (305 mm) vertically from the adjoining grade level, above adjoining roof surfaces, or above the bottom of an areaway.
- 3. If an outside air intake is located in an areaway, the areaway shall have a horizontal cross section equal to or greater than the free area of the outside air intake opening.
- 4. For health care facilities, all of the following shall apply:
 - a. Except as provided under subpar. b., outdoor air intakes shall be located at least 25 feet (7620 mm) from exhaust outlets of ventilating systems, combustion equipment stacks, medical-surgical vacuum systems, plumbing vents or areas that may collect vehicular exhaust or other noxious fumes.
 - b. Plumbing and vacuum vents that terminate at a level above the top of the air intake may be located as close as 10 feet (3048 mm) to an outdoor air intake.
 - c. The bottom of outdoor air intakes serving central systems shall be located at least 6 feet (1829 mm) above ground level or, when installed above the roof, at least 3 feet (914 mm) above roof level.
 - d. Exhaust outlets from areas that may be contaminated shall be located above roof level and arranged to minimize recirculation of exhaust air into the building.

(b) **Exceptions:**

- 1. The setback distances as specified in IMC Section 401.5.1 shall not apply to the combustion air intake of a direct vent appliance.
- 2. Unless a greater distance is specified by the manufacturer, exhaust openings for 100 cfm or less discharge shall be located at least 12 inches (305 mm), measured in any direction, from doors or openable windows.
- 3. The 10-foot (3048 mm) minimum separation does not apply to the intake and exhaust of a factory-packaged rooftop unit or other listed outdoor appliance provided nothing restricts air flow around the unit. The exhaust and intake of the unit shall be located to minimize contamination of outside air.

4. Unless a greater distance is specified by the manufacturer, product of combustion outlets of direct vent appliance vents shall terminate at least 12 inches (305 mm) measured in any direction from doors or openable windows.
5. Where it can be demonstrated that an engineered system design will prevent the maximum concentration of contaminants brought in through the outside air intake from exceeding the maximum contaminant concentration obtainable by providing the separation distances in accordance with sub. (4) (a), the outdoor air intakes may be located in accordance with such engineered system design.

Note: See ch. Comm 82 for plumbing vent setbacks. That rule requires plumbing vents to be 10 feet (3048 mm) from air intakes and 10 feet (3048 mm) horizontally from or 2 feet (610 mm) above roof scuttles, doors or openable windows.

Note: See NFPA standard 45, Fire Protection for Laboratories Using Chemicals, adopted under ch. Comm 10, for chemical fume hood exhaust location. Health care and related facilities may have additional requirements.

401.5.2 Exhaust openings. Outside exhaust openings shall be located so as not to create a nuisance. Exhaust air shall not be directed onto walkways.

Comm 64.0401 (5)

- (a) **Gravity ventilation ducts.** Gravity ventilation ducts shall extend not less than 2 feet (610 mm) above the highest portion of the building within a 10-foot (3048 mm) radius of the duct and shall be provided with a siphon roof ventilator.
- (b) **Barometric relief vents.** Where barometric relief vents are installed on the roof, the discharge openings shall be no less than 2 feet (610 mm) above the roof surface where the vent pierces the roof.

401.6 Outdoor opening protection. Air exhaust and intake openings that terminate outdoors shall be protected with corrosion-resistant screens, louvers or grilles. Openings in louvers, grilles and screens shall be sized in accordance with Table 401.6, and shall be protected against local weather conditions. Outdoor air exhaust and intake openings located in exterior walls shall meet the provisions for exterior wall opening protectives in accordance with the *International Building Code*.

**TABLE 401.6
OPENING SIZES IN LOUVERS, GRILLES AND
SCREENS PROTECTING OUTDOOR EXHAUST AND
AIR INTAKE OPENINGS**

OUTDOOR OPENING TYPE	MINIMUM AND MAXIMUM OPENING SIZES IN LOUVERS, GRILLES AND SCREENS MEASURED IN ANY DIRECTION
Exhaust openings	Not < 1/4 inch and not > 1/2 inch
Intake openings in residential occupancies	Not < 1/4 inch and not > 1/2 inch
Intake openings in other than residential occupancies	> 1/4 inch and not > 1 inch

For SI: 1 inch = 25.4 mm.

401.7 Contaminant sources. Stationary local sources producing air-borne particulates, heat, odors, fumes, spray, vapors, smoke or gases in such quantities as to be irritating or injurious to health shall be provided with an exhaust system in accordance with Chapter 5 or a means of collection and removal of the contaminants. Such exhaust shall discharge directly to an approved location at the exterior of the building.

dance with Chapter 5 or a means of collection and removal of the contaminants. Such exhaust shall discharge directly to an approved location at the exterior of the building.

**[B] SECTION 402
NATURAL VENTILATION**

402.1 General. Natural ventilation of an occupied space shall comply with Chapter 12 of the *International Building Code*.

Comm 64.0402 Natural ventilation shall be permitted only in areas specified in Table 64.0403.

**SECTION 403
MECHANICAL VENTILATION**

403.1 [Comm 64.0403 (1)] Ventilation system.

- (a) Mechanical ventilation shall be provided by a method of supply air and exhaust air. The amount of supply air shall be approximately equal to the amount of return and exhaust air. The system shall not be prohibited from producing negative or positive pressure. The system to convey ventilation air shall be designed and installed in accordance with IMC Chapter 6.
- (b) Ventilation supply systems shall be designed to deliver the required rate of supply air into the occupied zone within an occupied space.

403.2 Outdoor air required. The minimum ventilation rate of required outdoor air shall be determined in accordance with Section 403.3.

Comm 64.0403 (2)

- (a) **Exception:** Where it can be demonstrated that an engineered ventilation system design will prevent the maximum concentration of contaminants from exceeding the maximum obtainable by providing the rate of outdoor air ventilation determined in accordance with IMC Section 403.3, the minimum required rate of outdoor air may be reduced in accordance with such engineered system design.
- (b) **Additional requirement.** The outdoor air shall be free from contamination of any kind in proportions detrimental to the health and comfort of the general population exposed to it.

403.2.1 [Comm 64.0403 (3)] Recirculation of air. The air required by Section 403.3 shall not be recirculated. Air in excess of that required by Section 403.3 shall not be prohibited from being recirculated as a component of supply air to building spaces, except that:

1. Ventilation air shall not be recirculated from one dwelling to another or to dissimilar occupancies.
2. Supply air to a swimming pool and associated deck areas shall not be recirculated unless such air is dehumidified to maintain the relative humidity of the area at 60 percent or less. Air from this area shall not be recirculated to other spaces.
3. Where mechanical exhaust is required by Table 64.0403, recirculation of air from such spaces shall be

prohibited. All air supplied to such spaces shall be exhausted, including any air in excess of that required by Table 64.0403.

Comm 64.0403 (4) (a) Air supply in hospitals and ambulatory surgery centers.

1. In hospitals and ambulatory surgery centers, air supply for operating rooms and delivery rooms that are designed for cesarean sections shall be provided from ceiling outlets located near the center of the work area. Return-air inlets shall be located near the floor level. Each operating room and delivery room designed for cesarean-section deliveries shall have at least two return-air inlets located as remotely from each other as practical.
2. In hospitals and ambulatory surgery centers, air supply outlets for rooms used for invasive procedures shall be located at or near the ceiling. Return or exhaust air inlets shall be located near the floor level. Exhaust grills for anesthesia evacuation and other special applications may be installed in the ceiling.

Comm 64.0403 (4) (b) Note: The following are examples where the department will accept air transferred from: corridor to toilet room; corridor to cloak room or janitor closet; dining room to kitchen; locker room to toilet room; gymnasium to locker room; showroom to garage; and corridor to school vocational shops.

403.2.2 [Comm 64.0403 (5)] Transfer air. Except where recirculation from such spaces is prohibited by Table 64.0403, air transferred from occupied spaces is not prohibited from serving as makeup air for required exhaust systems in such spaces as kitchens, baths, toilet rooms, elevators and smoking lounges. The amount of transfer air and exhaust air shall be sufficient to provide the flow rates as specified in Sections 403.3 and 403.3.1. The required outdoor air rates specified in Table 64.0403 shall be introduced directly into such spaces or into the occupied spaces from which air is transferred or a combination of both.

403.3 [Comm 64.0403 (6)] Ventilation rate.

(a) Ventilation rate determination.

1. Except as provided in pars. (c) and (d), ventilation systems shall be designed to have the capacity to supply the minimum outdoor airflow rate determined in accordance with Table 64.0403 based on the occupancy of the space, the occupant load and a minimum of 7.5 cfm of outside air per person, or other parameters stated in Table 64.0403.
2. a. Except as provided in subpars. b. to d., the occupant load utilized for design of the ventilation system shall not be less than the number determined from the estimated maximum occupant load rate indicated in Table 64.0403.
b. The estimated maximum occupant load rate may be determined using other means with justification acceptable to the department to show that a different number of occupants is reasonable.
c. Where there is no value indicated for the net square feet per person in Table 64.0403, the actual number of occupants shall be used to determine the required amount of outside air.

d. Ventilation rates for occupancies not represented in Table 64.0403 shall be determined by an approved engineering analysis, or by using the most similar occupancy in the table.

3. The ventilation system shall be designed to supply the required rate of ventilation air continuously during the period the building is occupied, except as otherwise stated in other provisions of this chapter.

Note: See Table 64.0403 for specific occupancies.

(b) Adjacent spaces with differing ventilation requirements.

1. Except as provided in subd. 2., spaces with different ventilation requirements shall be provided with a complete solid separation, or the most stringent ventilation requirement shall apply to all unseparated areas.
2. The separation as specified in subd. 1. is not required where an engineered ventilation design system will prevent the concentration of contaminants from exceeding that obtainable by providing a physical separation.

(c) Exceptions for certain occupancies.

1. **Toilet rooms.** A toilet room that has only one water closet or urinal and no bathtub or shower may be provided with either natural ventilation via a window or louvered opening with at least 2 square feet (0.2 m^2) of area openable directly to the outside or mechanical exhaust ventilation as specified in Table 64.0403.
2. **Janitor closets.** A janitor closet that has only one service sink may be provided with either natural ventilation via a window or louvered opening with at least 2 square feet (0.2 m^2) of area openable directly to the outside or mechanical exhaust ventilation as specified in Table 64.0403.
3. **Locker and shower rooms.** An adjoining locker room, shower room and toilet room shall be exhausted at the rate specified in Table 64.0403 based on the largest amount of exhaust required for any of the three rooms. A negative pressure relationship shall be maintained in the shower and toilet rooms with respect to the locker room.
4. **Chemical or septic toilets.** Chemical or septic toilets and composting privies are prohibited in spaces under negative pressure. Toilet rooms with chemical or septic toilets shall be provided with natural ventilation via a window, louver or skylight with at least 2 square feet (0.2 m^2) of area openable directly to the outside. The opening shall be provided with a screen to limit the passage of insects and vermin.
5. **Pool ventilation.** In a natatorium, the volume of supply air and exhaust air may be reduced to a minimum of 1 cfm per square foot [$0.00508 \text{ m}^3/(\text{s} \cdot \text{m}^2)$] of pool surface provided automatic humidity controls perform so as not to create accelerated building material deterioration from moisture condensation.

**TABLE 64.0403
REQUIRED MINIMUM INSIDE TEMPERATURE AND OUTDOOR VENTILATION AIR**

OCCUPANCY CLASSIFICATION ^l	VENTILATION REQUIREMENTS BASIS OF CAPACITY				
	Minimum Inside Temperature (degrees F)	Estimated Maximum Occupant Load (persons per 1,000 sq. ft.) ^a	Natural Ventilation Allowed	Exhaust ^o (cfm/net sq. ft. floor area)	Air Change Rate ^k (minimum air change per hour with A/C)
Correctional facilities					
Sleeping rooms ^l	68	20	yes	—	—
Dining halls	68	100	no	—	2.0
Guard stations	68	40	yes	—	—
Dry cleaners, laundries					
Coin-operated dry cleaners	68	8	yes	—	1.0
Coin-operated laundries	68	8	yes	—	1.0
Commercial dry cleaner	60	—	no	2.00	—
Commercial laundries	60	—	no	2.00	—
Storage, pick up	60	8	yes	—	1.0
Apartment laundry rooms	60	—	no	0.5	—
Education					
Auditoriums	68	150	no	—	2.0
Classrooms	68	50	no	—	2.0
Day care facilities	68	30	yes only if < 20 children	—	2.0
Laboratories (science)	68	30	no	—	2.0
Corridors with lockers	68	—	—	—	10 cfm/lineal ft. of length
Music rooms	68	50	no	—	2.0
Smoking lounges ^{b,g}	68	—	no	2.00	—
Special education	68	35	no	—	2.0
Training shops	60	30	no	—	—
Food and beverage service					
Bars and cocktail lounges	68	100	no	—	2.0
Cafeterias, fast food	68	100	no	—	2.0
Dining rooms	68	70	no	—	2.0
Kitchens (cooking) ^{f,g}	60	20	yes	—	1.0
Health care facilities					
Hospitals	footnote m	footnote m	no	footnote m	footnote m
Nursing homes					
Ambulatory surgery centers					
Hotels, motels, resorts and dorms					
Assembly rooms	68	120	no	—	2.0
Bathrooms ^{b,g}	68	—	no	35 cfm/room	—
Bedrooms	68	footnote n	yes	—	—
Conference rooms	68	50	no	—	2.0
Dormitory sleeping areas	68	20	yes	—	—
Casinos	68	—	no	2.00	—
Living rooms	68	footnote n	yes	—	—
Lobbies	68	30	no	—	—
Industrial/Factory					
Factories and machine shops	60	13	yes	—	—
Foundries	NMR	13	yes	—	—
Sawmill	NMR	—	yes	—	—
Offices					
Conference rooms	68	50	no	—	1.5
Office spaces	68	7	no	—	1.5
Reception areas	68	60	no	—	1.5
Telecommunication centers and data entry	68	60	no	—	1.5
Places of worship, entertainment and recreation which accommodate less than 100 persons	footnote h	—	yes	footnote h	—
Private dwellings, single and multiple					
Living areas	68	2 people for first bedroom plus one person for each additional bedroom	yes	—	—
Kitchens ^h	68	—	yes	100 cfm intermittent or 20 cfm continuous	—
Toilet rooms and bathrooms ^{a,l}	68	—	no	Mechanical exhaust capacity 50 cfm intermittent or 20 cfm continuous	—
Garages, separated by a solid wall for each dwelling	NMR	—	yes	100 cfm/vehicle	—
Garages, common for multiple units ^b	NMR	—	no	0.5	—

(continued)

TABLE 64.0403—continued
REQUIRED MINIMUM INSIDE TEMPERATURE AND OUTDOOR VENTILATION AIR

OCCUPANCY CLASSIFICATION ^l	VENTILATION REQUIREMENTS BASIS OF CAPACITY				
	Minimum Inside Temperature (degrees F)	Estimated Maximum Occupant Load (persons per 1,000 sq. ft.) ^a	Natural Ventilation Allowed	Exhaust ^a (cfm/net sq. ft. floor area)	Air Change Rate ^k (minimum air change per hour with A/C)
Retail stores, sales floors and showroom floors	68	8	yes	—	1.0
Seasonal occupancies, camps and lodges					
Dining and recreational areas	NMR	15	yes	—	—
Living and sleeping areas	NMR	—	yes	—	—
Club houses	NMR	15	yes	—	—
Drive-ins	NMR	15	yes	—	—
Specialty shops					
Automotive service and repair garages	60	—	no	0.5	—
Barber shop	68	25	no	—	—
Beauty salons ^c	68	—	no	0.5	—
Clothier, furniture specialty shops	68	8	yes	—	1.0
Florist shops	68	8	yes	—	1.0
Hardware, drugs, fabrics stores	68	8	yes	—	1.0
Supermarkets	68	8	yes	—	1.0
Sports and amusement					
Ballrooms and discos	68	100	no	—	2.0
Bleacher areas	68	363 or 18 in./person	no	—	2.0
Bowling centers (seating areas)	68	70	no	—	2.0
Game rooms	68	70	no	—	2.0
Natatoriums	76	—	—	2.0 cfm/sq. ft. pool area	—
Ice skating rinks (indoor)	NMR	5	no	—	—
Playing floor (gymnasiums)	68	30	no	—	2.0
Roller skating rinks (indoor)	60	30	no	—	2.0
Spectator areas (non-bleacher)	68	150	no	—	2.0
Storage					
Chlorine storage and handling rooms	NMR	—	no	2.00	—
Enclosed parking garages ^d	NMR	—	no	0.50	—
Warehouses	NMR	—	—	—	—
Theaters					
Auditoriums	68	150	no	—	2.0
Lobbies	68	150	no	—	—
Stages, studios	68	70	no	—	2.0
Ticket booths	68	60	no	—	2.0
Transportation					
Platforms	NMR	100	no	—	2.0
Waiting rooms	68	100	no	—	2.0
Utility and public spaces					
Elevators ^e	NMR	—	no	1.00	—
Janitor closets ^l	NMR	—	no	2.0 or 75 cfm/sink	—
Locker and dressing rooms ^b	70	—	no	0.5	—
Shower rooms	70	—	no	2.00	—
Toilet rooms ^{b, g, i}	68	—	no	75 cfm/TF	—
Smoking lounges ^{b, g}	68	—	no	2.0	—
Workrooms					
Bank vault	68	5	no	—	—
Meat processing workroom	NMR	10	yes	—	—
Pharmacy	68	20	yes	—	1.5
Photo studio	68	10	yes	—	1.0
Printing	60	13	yes	footnote o	—

For SI: 1 inch = 25.4 mm, 1 cubic foot per minute per square foot = 0.00508 m³/(s·m²), °C = [(°F) - 32]/1.8.

CFM = Cubic feet per minute; LF = Linear foot; NMR = No minimum requirement; TF = Toilet fixtures (water closets and urinals); A/C = Air conditioning.

- Based upon net floor area.
- Mechanical exhaust is required and the recirculation of air from these spaces that would otherwise be allowed by IMC Section 403.2.1 is prohibited.
- The classification of a "beauty" shop depends on the types of services provided. Only beauty salons routinely provide chemical processing of hair to produce texture or color changes, or manicures or other services with a similar need for air-borne contaminant and odor control.
- Enclosed parking garages are parking garages with less than 30% open areas in the total wall area enclosing the garage. Ventilation systems in enclosed parking garages shall comply with IMC Section 404. A mechanical ventilation system shall not be required in garages having a floor area of 850 square feet or less and used for the storage of 5 or fewer motorized vehicles. Requirements for parking garages shall apply to all buildings, or parts of buildings, into which motor vehicles are driven for loading or unloading or are stored.
- The ventilation rate is based upon cubic feet per minute per square foot of the floor area being ventilated.
- The sum of the outdoor and transfer air from adjacent spaces shall be sufficient to provide an exhaust rate of not less than 1.5 cfm/sf.
- Transfer air permitted in accordance with IMC Section 403.2.2.
- See specific occupancy classification table entries for inside design temperature and cfm per net square feet floor area requirements.
- This table is intended as a reference guide with generic Use types listed under those Occupancy types most often associated with the use. When Use types are mixed between Occupancy types and the Use type is unlisted within the specific Occupancy type, the use shall be ventilated as required by the same Use type listed in the other Occupancy type. Unlisted occupancies or uses shall be ventilated as required for the most similar listed occupancy classification acceptable to the department. Rooms that are used for different purposes at different times shall be designed for the greatest amount of ventilation required for any of the uses.
- When unseparated toilet fixtures are included in sleeping areas (such as cells), the room shall be ventilated as required for toilet rooms.
- See sub. (5) for specific requirements and exceptions. Units listed as minimum air change per hour with air conditioning unless otherwise specified.
- Natural ventilation may be allowed under this section.
- For air ventilation requirements in healthcare facilities, use American Institute of Architects (AIA) guidelines (AIA Guidelines for Design and Construction of Hospital and Health Care Facilities).
- The minimum mechanical ventilation rate is 15 cfm/room of outside air.
- Refer to IMC Chapter 5 for requirements.

6. Health care facilities. Recirculation and flow of air in health care facilities shall comply with the requirements in Table 2 or Table 6, as applicable, of AIA Guidelines for Design and Construction of Hospital and Health Care Facilities.

(d) Outside air requirement waived.

1. If a mechanical air supply system is provided and the requirement for outdoor air determined in accordance with Table 64.0403 is less than 5 percent of the minimum required air changes per hour, the requirement for outside air may be eliminated.
2. The requirement for outside air or percent of openings specified in Table 64.0403 may be omitted in large volume spaces containing 5,000 or more cubic feet (142 m³) per occupant. Required exhaust ventilation and makeup air shall not be omitted.

403.3.1 [Comm 64.0403 (7)] System operation. The minimum flow rate of outdoor air that the ventilation system must be capable of supplying during its operation shall be permitted to be based on the rate per person indicated in Table 64.0403 and the actual number of occupants present.

403.3.2 Common ventilation system. Where spaces having different ventilation rate requirements are served by a common ventilation system, the ratio of outdoor air to total supply air for the system shall be determined based on the space having the largest outdoor air requirement or shall be determined in accordance with the following formula:

$$Y = \frac{X}{(1 + X - Z)} \quad \text{(Equation 4-1)}$$

where:

$Y = V_{ot}/V_{st}$ = Corrected fraction of outdoor air in system supply.

$X = V_{on}/V_{st}$ = Uncorrected fraction of outdoor air in system supply.

$Z = V_{oc}/V_{sc}$ = Fraction of outdoor air in critical space. The critical space is that space with the greatest required fraction of outdoor air in the supply to this space.

V_{ot} = Corrected total outdoor airflow rate.

V_{st} = Total supply flow rate, i.e., the sum of all supply for all branches of the system.

V_{on} = Sum of outdoor airflow rates for all branches on system.

V_{oc} = Outdoor airflow rate required in critical spaces.

V_{sc} = Supply flow rate in critical space.

Comm 64.0403 (8) Alternative requirements.

(a) General. Except as specified in par. (d), each room served by a mechanical ventilation system shall be provided with the minimum outdoor airflow rate determined individually for each room, or the minimum amount of outside air may be supplied to the system if a minimum air change rate is provided in accordance with this subsection or waived in accordance with par. (c).

(b) Minimum air change.

1. Application.

- a. The required air change shall be provided while people are present.
- b. The air change rate may be based on actual room height or up to 10 feet (3048 mm) from the floor level of the room in question. The volume above 10 feet (3048 mm), in rooms that are more than 10 feet (3048 mm) in height, need not be considered in the air change requirement if the required air change is designed to occur in the lower 10 feet (3048 mm) of the occupied space.
- c. The required minimum air change volume shall be transferred through the air-handling equipment where it is diluted or replaced with outside air, and supplied back to the space.

2. Six air changes per hour. Except as specified in subd. 3 and unless mechanical exhaust is required by Table 64.0403, the total air change rate for each room shall be at least six air changes per hour.

3. Less than six air changes per hour. An air change rate of less than six air changes per hour will be permitted where mechanical cooling (air conditioning) is provided to maintain an interior design temperature of 78°F (25°C) or lower and the heat gain requirement for the space has been satisfied. The air change rate may not be less than the minimum air changes per hour if specified in Table 64.0403.

Note: As specified in s. Comm 64.0403, the amount of outside air required must be maintained even if the air change rate is reduced.

(c) Air change requirement waived. The air change requirement for six air changes per hour may be omitted in any of the following applications:

1. Buildings or rooms utilizing spot heating as the only source of heat.
2. Buildings where the requirement for outside air is waived in accordance with sub. (4) (e).
3. Buildings utilizing natural ventilation as specified in IMC Section 402.

(d) Air change rates in health care facilities. Air change rates in health care facilities shall comply with the requirements in Table 2 or Table 6, as applicable, of AIA Guidelines for Design and Construction of Hospital and Health Care Facilities.

403.3.3 Variable air volume system control. Variable air volume air distribution systems, other than those designed

to supply only 100-percent outdoor air, shall be provided with controls to regulate the flow of outdoor air. Such control system shall be designed to maintain the flow of outdoor air at a rate of not less than that required by Section 403 over the entire range of supply air operating rates.

403.3.4 Balancing. Ventilation systems shall be balanced by an approved method. Such balancing shall verify that the ventilation system is capable of supplying the airflow rates required by Section 403.

($0.00001 \text{ m}^3/\text{s} \cdot \text{m}^2$) of horizontal area and shall be automatically controlled to operate when the relative humidity in the space served exceeds 60 percent.

SECTION 404 ENCLOSED PARKING GARAGES

404.1 [Comm 64.0404 (1)] Enclosed parking garages. Mechanical ventilation systems for enclosed parking garages are not required to operate continuously where the system meets all of the following:

- (a) The system is arranged to operate automatically upon detection of carbon monoxide at a level of 35 parts per million (ppm) by automatic detection devices.
- (b) If diesel fuel vehicles are stored, the system is arranged to operate automatically upon detection of nitrogen dioxide at a level of 1 part per million (ppm) by automatic detection devices.
- (c) The system includes automatic controls for providing exhaust ventilation at a rate of 1/2 cfm per square foot for at least five hours in each 24-hour period.
- (d) The system maintains the garage at negative or neutral pressure relative to other spaces.

404.2 [Comm 64.0404 (2)] Minimum ventilation. Automatic operation of the system shall not reduce the ventilation rate below 7.5 cfm per person and the system shall be capable of producing an exhaust rate of 0.5 cfm per square foot of floor area.

404.3 Occupied spaces accessory to public garages. Connecting offices, waiting rooms, ticket booths and similar uses that are accessory to a public garage shall be maintained at a positive pressure and shall be provided with ventilation in accordance with Section 403.3.

SECTION 405 SYSTEMS CONTROL

405.1 General. Mechanical ventilation systems shall be provided with manual or automatic controls that will operate such systems whenever the spaces are occupied. Air-conditioning systems that supply required ventilation air shall be provided with controls designed to automatically maintain the required outdoor air supply rate during occupancy.

SECTION 406 VENTILATION OF UNINHABITED SPACES

406.1 General. Uninhabited spaces, such as crawl spaces and attics, shall be provided with natural ventilation openings as required by the *International Building Code* or shall be provided with a mechanical exhaust and supply air system. The mechanical exhaust rate shall be not less than 0.02 cfm per square foot

CHAPTER 5

EXHAUST SYSTEMS

SECTION 501 GENERAL

501.1 Scope. This chapter shall govern the design, construction and installation of mechanical exhaust systems, including dust, stock and refuse conveyor systems and exhaust systems serving commercial food heat-processing appliances.

501.2 Independent system required. Single or combined mechanical exhaust systems from bath, toilet, urinal, locker, service sink closets and similar rooms shall be independent of all other exhaust systems. Type I exhaust systems shall be independent of all other exhaust systems except as provided in Section 506.3.6. Single or combined Type II exhaust systems for food-processing operations shall be independent of all other exhaust systems. Kitchen exhaust systems shall be constructed in accordance with Section 505 for domestic equipment and Sections 506 through 509 for commercial equipment.

501.3 Outdoor discharge. The air removed by every mechanical exhaust system shall be discharged outdoors at a point where it will not cause a nuisance and from which it cannot again be readily drawn in by a ventilating system. Air shall not be exhausted into an attic or crawl space.

Exception: Whole-house ventilation-type attic fans that discharge into the attic space of dwelling units having private attics shall not be prohibited.

501.4 Pressure equalization. Mechanical exhaust systems shall be sized to remove the quantity of air required by this chapter to be exhausted. The system shall operate when air is required to be exhausted. Where mechanical exhaust is required in a room or space in other than occupancies in Group R-3, such space shall be maintained with a neutral or negative pressure. If a greater quantity of air is supplied by a mechanical ventilating supply system than is removed by a mechanical exhaust system for a room, adequate means shall be provided for the natural exit of the excess air supplied. If only a mechanical exhaust system is installed for a room or if a greater quantity of air is removed by a mechanical exhaust system than is supplied by a mechanical ventilating supply system for a room, adequate means shall be provided for the natural supply of the deficiency in the air supplied.

Comm 64.0501 Exception: A mechanically exhausted room or space that is within a dwelling unit which is served by an independent heating, ventilating and air-conditioning system is not required to be maintained with negative or neutral pressure.

501.5 Ducts. Where exhaust duct construction is not specified in this chapter, such construction shall comply with Chapter 6.

SECTION 502 REQUIRED SYSTEMS

502.1 [Comm 64.0502] General. An exhaust system shall be provided, maintained and operated as specifically required by this section and for all occupied areas where machines, vats, tanks, furnaces, forges, salamanders and other appliances, equipment and processes in such areas produce or throw off dust or particles sufficiently light to float in the air, or which emit heat, odors, fumes, spray, gas or smoke, in such quantities so as to be injurious to health or safety.

502.1.1 Exhaust location. The inlet to an exhaust system shall be located in the area of heaviest concentration of contaminants.

[F] 502.1.2 Fuel-dispensing areas. The bottom of an air inlet or exhaust opening in fuel-dispensing areas shall be located not more than 18 inches (457 mm) above the floor.

502.1.3 Equipment, appliance and service rooms. Equipment, appliance and system service rooms that house sources of odors, fumes, noxious gases, smoke, steam, dust, spray or other contaminants shall be designed and constructed so as to prevent spreading of such contaminants to other occupied parts of the building.

[F] 502.1.4 Hazardous exhaust. The mechanical exhaust of high concentrations of dust or hazardous vapors shall conform to the requirements of Section 510.

[F] 502.2 Aircraft fueling and defueling. Compartments housing piping, pumps, air eliminators, water separators, hose reels and similar equipment used in aircraft fueling and defueling operations shall be adequately ventilated at floor level or within the floor itself.

[F] 502.3 Battery-charging areas. Ventilation shall be provided in an approved manner in battery-charging areas to prevent a dangerous accumulation of flammable gases.

[F] 502.4 Stationary lead-acid battery systems. Ventilation shall be provided for stationary lead-acid battery systems in accordance with this chapter and Section 502.4.1 or 502.4.2.

[F] 502.4.1 Hydrogen limit. The ventilation system shall be designed to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the room.

[F] 502.4.2 Ventilation rate. Continuous ventilation shall be provided at a rate of not less than 1 cubic foot per minute per square foot (cfm/ft²) [0.00508 m³/(s · m²)] of floor area of the room.

[F] 502.5 Dry cleaning plants. Ventilation in dry cleaning plants shall be adequate to protect employees and the public in accordance with this section and DOL 29 CFR Part 1910.1000, where applicable.

[F] 502.5.1 Type II systems. Type II dry cleaning systems shall be provided with a mechanical ventilation system that

is designed to exhaust 1 cubic foot of air per minute for each square foot of floor area (1 cfm/ft²) [0.00508 m³/(s · m²)] in dry cleaning rooms and in drying rooms. The ventilation system shall operate automatically when the dry cleaning equipment is in operation and shall have manual controls at an approved location.

[F] 502.5.2 Type IV and V systems. Type IV and V dry cleaning systems shall be provided with an automatically activated exhaust ventilation system to maintain a minimum of 100 feet per minute (50.8 m/s) air velocity through the loading door when the door is opened.

Exception: Dry cleaning units are not required to be provided with exhaust ventilation where an exhaust hood is installed immediately outside of and above the loading door which operates at an airflow rate as follows:

$$Q = 100 \times A_{LD} \quad (\text{Equation 5-1})$$

where:

Q = Flow rate exhausted through the hood, cubic feet per minute.

A_{LD} = Area of the loading door, square feet.

[F] 502.5.3 Spotting and pretreating. Scrubbing tubs, scouring, brushing or spotting operations shall be located such that solvent vapors are captured and exhausted by the ventilating system.

[F] 502.6 Application of flammable finishes. Mechanical exhaust as required by this section shall be provided for operations involving the application of flammable finishes.

[F] 502.6.1 During construction. Ventilation shall be provided for operations involving the application of materials containing flammable solvents in the course of construction, alteration or demolition of a structure.

[F] 502.6.2 Limited spraying spaces. Positive mechanical ventilation which provides a minimum of six complete air changes per hour shall be installed in limited spraying spaces. Such system shall meet the requirements of the *International Fire Code* for handling flammable vapors. Explosion venting is not required.

[F] 502.6.3 Spraying areas. Mechanical ventilation of spraying areas shall be provided in accordance with Sections 502.6.3.1 through 502.6.3.7.

502.6.3.1 Operation. Mechanical ventilation shall be kept in operation at all times while spraying operations are being conducted and for a sufficient time thereafter to allow vapors from drying coated articles and finishing material residue to be exhausted. Spraying equipment shall be interlocked with the ventilation of the spraying area such that spraying operations cannot be conducted unless the ventilation system is in operation.

502.6.3.2 Recirculation. Air exhausted from spraying operations shall not be recirculated.

Exceptions:

1. Air exhausted from spraying operations shall be permitted to be recirculated as makeup air for unmanned spray operations provided that:
 - 1.1. Solid particulate has been removed.

- 1.2. The vapor concentration is less than 25 percent of the lower flammability limit (LFL).

- 1.3. Approved equipment is used to monitor the vapor concentration.

- 1.4. An alarm is sounded and spray operations are automatically shut down if the vapor concentration exceeds 25 percent of the LFL.

- 1.5. The spray booths, spray spaces or spray rooms involved in any recirculation process shall be provided with mechanical ventilation that shall automatically exhaust 100 percent of the required air volume in the event of shutdown by approved equipment used to monitor vapor concentrations.

2. Air exhausted from spraying operations shall be permitted to be recirculated as makeup air to manned spraying operations if all of the conditions provided in Exception 1 are included in the installation and documents have been prepared to show that the installation does not present life safety hazards to personnel inside the spray booth, spray space or spray room.

502.6.3.3 Air velocity. Ventilation systems shall be designed, installed and maintained such that the average air velocity over the open face of the booth, or booth cross sectional in the direction of airflow during spraying operations, is not less than 100 feet per minute (0.51 m/s).

502.6.3.4 Ventilation obstruction. Articles being sprayed shall be positioned in a manner that does not obstruct collection of overspray.

502.6.3.5 Independent ducts. Each spray booth and spray room shall have an independent exhaust duct system discharging to the outdoors.

Exceptions:

1. Multiple spray booths having a combined frontal area of 18 square feet (1.67 m²) or less are allowed to have a common exhaust where identical spray-finishing material is used in each booth. If more than one fan serves one booth, such fans shall be interconnected so that all fans operate simultaneously.
2. Where treatment of exhaust is necessary for air pollution control or energy conservation, ducts shall be allowed to be manifolded if all of the following conditions are met:
 - 2.1. The sprayed materials used are compatible and will not react or cause ignition of the residue in the ducts.
 - 2.2. Nitrocellulose-based finishing material shall not be used.
 - 2.3. A filtering system shall be provided to reduce the amount of overspray carried into the duct manifold.
 - 2.4. Automatic sprinkler protection shall be provided at the junction of each booth

exhaust with the manifold, in addition to the protection required by this chapter.

502.6.3.6 Termination point. The termination point for exhaust ducts discharging to the atmosphere shall be located with the following minimum distances.

1. For ducts conveying explosive or flammable vapors, fumes or dusts: 30 feet (9144 mm) from the property line; 10 feet (3048 mm) from openings into the building; 6 feet (1829 mm) from exterior walls and roofs; 30 feet (9144 mm) from combustible walls and openings into the building which are in the direction of the exhaust discharge; 10 feet (3048 mm) above adjoining grade.
2. For other product-conveying outlets: 10 feet (3048 mm) from the property line; 3 feet (914 mm) from exterior walls and roofs; 10 feet (3048 mm) from openings into the building; 10 feet (3048 mm) above adjoining grade.
3. For environmental air duct exhaust: 3 feet (914 mm) from the property line; 3 feet (914 mm) from openings into the building.

502.6.3.7 Fan motors and belts. Electric motors driving exhaust fans shall not be placed inside booths or ducts. Fan rotating elements shall be nonferrous or nonsparking or the casing shall consist of, or be lined with, such material. Belts shall not enter the duct or booth unless the belt and pulley within the duct are tightly enclosed.

[F] 502.6.4 Dipping operations. Vapor areas of dip tank operations shall be provided with mechanical ventilation adequate to prevent the dangerous accumulation of vapors. Required ventilation systems shall be so arranged that the failure of any ventilating fan will automatically stop the dipping conveyor system.

[F] 502.6.5 Electrostatic apparatus. The spraying area in spray-finishing operations involving electrostatic apparatus and devices shall be ventilated in accordance with Section 502.6.3.

[F] 502.6.6 Powder coating. Exhaust ventilation for powder-coating operations shall be sufficient to maintain the atmosphere below one-half of the minimum explosive concentration for the material being applied. Nondeposited, air-suspended powders shall be removed through exhaust ducts to the powder recovery cyclone or receptacle.

[F] 502.6.7 Floor resurfacing operations. To prevent the accumulation of flammable vapors during floor resurfacing operations, mechanical ventilation at a minimum rate of 1 cfm/ft² [0.00508 m³/(s · m²)] of area being finished shall be provided. Such exhaust shall be by approved temporary or portable means. Vapors shall be exhausted to the exterior of the building.

[F] 502.7 Hazardous materials—general requirements. Exhaust ventilation systems for structures containing hazardous materials shall be provided as required in Sections 502.7.1 through 502.7.5.

[F] 502.7.1 Storage in excess of the maximum allowable quantities. Indoor storage areas and storage buildings for hazardous materials in amounts exceeding the maximum al-

lowable quantity per control area shall be provided with mechanical exhaust ventilation or natural ventilation where natural ventilation can be shown to be acceptable for the materials as stored.

Exception: Storage areas for flammable solids complying with the *International Fire Code*.

[F] 502.7.1.1 System requirements. Exhaust ventilation systems shall comply with all of the following:

1. The installation shall be in accordance with this code.
2. Mechanical ventilation shall be provided at a rate of not less than 1 cfm/ft² [0.00508 m³/(s · m²)] of floor area over the storage area.
3. The systems shall operate continuously unless alternate designs are approved.
4. A manual shutoff control shall be provided outside of the room in a position adjacent to the access door to the room or in another approved location. The switch shall be of the break-glass type and shall be labeled: VENTILATION SYSTEM EMERGENCY SHUTOFF.
5. The exhaust ventilation system shall be designed to consider the density of the potential fumes or vapors released. For fumes or vapors that are heavier than air, exhaust shall be taken from a point within 6 inches (152 mm) of the floor.
6. The location of both the exhaust and inlet air openings shall be designed to provide air movement across all portions of the floor or room to prevent the accumulation of vapors.
7. The exhaust ventilation shall not be recirculated within the room or building if the materials stored are capable of emitting hazardous vapors.

[F] 502.7.2 Gas rooms, exhausted enclosures and gas cabinets. The ventilation system for gas rooms, exhausted enclosures and gas cabinets for any quantity of hazardous material shall be designed to operate at a negative pressure in relation to the surrounding area. Highly toxic and toxic gases shall also comply with Sections 502.8.7.1, 502.8.7.2 and 502.8.8.4.

[F] 502.7.3 Indoor dispensing and use. Indoor dispensing and use areas for hazardous materials in amounts exceeding the maximum allowable quantity per control area shall be provided with exhaust ventilation in accordance with Section 502.7.1.

Exception: Ventilation is not required for dispensing and use of flammable solids other than finely divided particles.

[F] 502.7.4 Indoor dispensing and use—point sources. Where gases, liquids or solids in amounts exceeding the maximum allowable quantity per control area and having a hazard ranking of 3 or 4 in accordance with NFPA 704 are dispensed or used, mechanical exhaust ventilation shall be provided to capture fumes, mists or vapors at the point of generation.

Exception: Where it can be demonstrated that the gases, liquids or solids do not create harmful fumes, mists or vapors.

[F] 502.7.5 Closed systems. Where closed systems for the use of hazardous materials in amounts exceeding the maximum allowable quantity per control area are designed to be opened as part of normal operations, ventilation shall be provided in accordance with Section 502.7.4.

[F] 502.8 Hazardous materials—requirements for specific materials. Exhaust ventilation systems for specific hazardous materials shall be provided as required in Section 502.7 and Sections 502.8.1 through 502.8.11.

[F] 502.8.1 Compressed gases—medical gas systems. Rooms for the storage of compressed medical gases in amounts exceeding the maximum allowable exempt quantity per control area, and which do not have an exterior wall, shall be exhausted through a duct to the exterior of the building. Both separate airstreams shall be enclosed in a 1-hour-rated shaft enclosure from the room to the exterior. Approved mechanical ventilation shall be provided at a minimum rate of 1 cfm/ft² [0.00508 m³/(s · m²)] of the area of the room.

Gas cabinets for the storage of compressed medical gases in amounts exceeding the maximum allowable quantity per control area shall be connected to an exhaust system. The average velocity of ventilation at the face of access ports or windows shall be not less than 200 feet per minute (1.02 m/s) with a minimum velocity of 150 feet per minute (0.76 m/s) at any point at the access port or window.

[F] 502.8.2 Corrosives. Where corrosive materials in amounts exceeding the maximum allowable quantity per control area are dispensed or used, mechanical exhaust ventilation in accordance with Section 502.7.4 shall be provided.

[F] 502.8.3 Cryogenics. Storage areas for stationary or portable containers of cryogenic fluids in any quantity shall be ventilated in accordance with Section 502.7. Indoor areas where cryogenic fluids in any quantity are dispensed shall be ventilated in accordance with the requirements of Section 502.7.4 in a manner that captures any vapor at the point of generation.

Exception: Ventilation for indoor dispensing areas is not required where it can be demonstrated that the cryogenic fluids do not create harmful vapors.

[F] 502.8.4 Explosives. Squirrel cage blowers shall not be used for exhausting hazardous fumes, vapors or gases in operating buildings and rooms for the manufacture, assembly or testing of explosives. Only nonferrous fan blades shall be used for fans located within the ductwork and through which hazardous materials are exhausted. Motors shall be located outside the duct.

[F] 502.8.5 Flammable and combustible liquids. Exhaust ventilation systems shall be provided as required by Sections 502.8.5.1 through 502.8.5.5 for the storage, use, dispensing, mixing and handling of flammable and combustible liquids. Unless otherwise specified, this section shall apply to any quantity of flammable and combustible liquids.

Exception: This section shall not apply to flammable and combustible liquids that are exempt from the *International Fire Code*.

[F] 502.8.5.1 Vaults. Vaults that contain tanks of Class I liquids shall be provided with continuous ventilation at a rate of not less than 1 cfm/ft² of floor area [0.00508 m³/(s · m²)], but not less than 150 cfm (4 m³/min). Failure of the exhaust airflow shall automatically shut down the dispensing system. The exhaust system shall be designed to provide air movement across all parts of the vault floor. Supply and exhaust ducts shall extend to a point not greater than 12 inches (305 mm) and not less than 3 inches (76 mm) above the floor. The exhaust system shall be installed in accordance with the provisions of NFPA 91. Means shall be provided to automatically detect any flammable vapors and to automatically shut down the dispensing system upon detection of such flammable vapors in the exhaust duct at a concentration of 25 percent of the LFL.

[F] 502.8.5.2 Storage rooms and warehouses. Liquid storage rooms and liquid storage warehouses for quantities of liquids exceeding those specified in the *International Fire Code* shall be ventilated in accordance with Section 502.7.1.

[F] 502.8.5.3 Cleaning machines. Areas containing machines used for parts cleaning in accordance with the *International Fire Code* shall be adequately ventilated to prevent accumulation of vapors.

[F] 502.8.5.4 Use, dispensing and mixing. Continuous mechanical ventilation shall be provided for the use, dispensing and mixing of flammable and combustible liquids in open or closed systems in amounts exceeding the maximum allowable quantity per control area and for bulk transfer and process transfer operations. The ventilation rate shall be not less than 1 cfm/ft² [0.00508 m³/(s · m²)] of floor area over the design area. Provisions shall be made for the introduction of makeup air in a manner that will include all floor areas or pits where vapors can collect. Local or spot ventilation shall be provided where needed to prevent the accumulation of hazardous vapors.

Exception: Where natural ventilation can be shown to be effective for the materials used, dispensed, or mixed.

[F] 502.8.5.5 Bulk plants or terminals. Ventilation shall be provided for portions of properties where flammable and combustible liquids are received by tank vessels, pipelines, tank cars or tank vehicles, and which are stored or blended in bulk for the purpose of distributing such liquids by tank vessels, pipelines, tank cars, tank vehicles or containers, as required by Sections 502.8.5.5.1 through 502.8.5.5.3.

[F] 502.8.5.5.1 General. Ventilation shall be provided for rooms, buildings and enclosures in which Class I liquids are pumped, used or transferred. Design of ventilation systems shall consider the relatively high specific gravity of the vapors. Where natural ventilation is used, adequate openings in out-

side walls at floor level, unobstructed except by louvers or coarse screens, shall be provided. Where natural ventilation is inadequate, mechanical ventilation shall be provided.

[F] 502.8.5.5.2 Basements and pits. Class I liquids shall not be stored or used within a building having a basement or pit into which flammable vapors can travel, unless such area is provided with ventilation designed to prevent the accumulation of flammable vapors therein.

[F] 502.8.5.5.3 Dispensing of Class I liquids. Containers of Class I liquids shall not be drawn from or filled within buildings unless a provision is made to prevent the accumulation of flammable vapors in hazardous concentrations. Where mechanical ventilation is required, it shall be kept in operation while flammable vapors could be present.

[F] 502.8.6 Highly toxic and toxic liquids. Ventilation exhaust shall be provided for highly toxic and toxic liquids as required by Sections 502.8.6.1 and 502.8.6.2.

[F] 502.8.6.1 Treatment system. This provision shall apply to indoor and outdoor storage and use of highly toxic and toxic liquids in amounts exceeding the maximum allowable quantities per control area. Exhaust scrubbers or other systems for processing vapors of highly toxic liquids shall be provided where a spill or accidental release of such liquids can be expected to release highly toxic vapors at normal temperature and pressure.

[F] 502.8.6.2 Open and closed systems. Mechanical exhaust ventilation shall be provided for highly toxic and toxic liquids used in open systems in accordance with Section 502.7.4. Mechanical exhaust ventilation shall be provided for highly toxic and toxic liquids used in closed systems in accordance with Section 502.7.5.

Exception: Liquids or solids that do not generate highly toxic or toxic fumes, mists or vapors.

[F] 502.8.7 Highly toxic and toxic compressed gases—any quantity. Ventilation exhaust shall be provided for highly toxic and toxic compressed gases in any quantity as required by Sections 502.8.7.1 and 502.8.7.2.

[F] 502.8.7.1 Gas cabinets. Gas cabinets containing highly toxic or toxic compressed gases in any quantity shall comply with Section 502.7.2 and the following requirements:

1. The average ventilation velocity at the face of gas cabinet access ports or windows shall be not less than 200 feet per minute (1.02 m/s) with a minimum velocity of 150 feet per minute (0.76 m/s) at any point at the access port or window.
2. Gas cabinets shall be connected to an exhaust system.
3. Gas cabinets shall not be used as the sole means of exhaust for any room or area.

[F] 502.8.7.2 Exhausted enclosures. Exhausted enclosures containing highly toxic or toxic compressed gases in any quantity shall comply with Section 502.7.2 and the following requirements:

1. The average ventilation velocity at the face of the enclosure shall be not less than 200 feet per minute (1.02 m/s) with a minimum velocity of 150 feet per minute (0.76 m/s).
2. Exhausted enclosures shall be connected to an exhaust system.
3. Exhausted enclosures shall not be used as the sole means of exhaust for any room or area.

[F] 502.8.8 Highly toxic and toxic compressed gases—quantities exceeding the maximum allowable per control area. Ventilation exhaust shall be provided for highly toxic and toxic compressed gases in amounts exceeding the maximum allowable quantities per control area as required by Sections 502.8.8.1 through 502.8.8.6.

[F] 502.8.8.1 Ventilated areas. The room or area in which indoor gas cabinets or exhausted enclosures are located shall be provided with exhaust ventilation. Gas cabinets or exhausted enclosures shall not be used as the sole means of exhaust for any room or area.

[F] 502.8.8.2 Local exhaust for portable tanks. A means of local exhaust shall be provided to capture leakage from indoor and outdoor portable tanks. The local exhaust shall consist of portable ducts or collection systems designed to be applied to the site of a leak in a valve or fitting on the tank. The local exhaust system shall be located in a gas room. Exhaust shall be directed to a treatment system where required by the *International Fire Code*.

[F] 502.8.8.3 Piping and controls—stationary tanks. Filling or dispensing connections on indoor stationary tanks shall be provided with a means of local exhaust. Such exhaust shall be designed to capture fumes and vapors. The exhaust shall be directed to a treatment system where required by the *International Fire Code*.

[F] 502.8.8.4 Gas rooms. The ventilation system for gas rooms shall be designed to operate at a negative pressure in relation to the surrounding area. The exhaust ventilation from gas rooms shall be directed to an exhaust system.

[F] 502.8.8.5 Treatment system. The exhaust ventilation from gas cabinets, exhausted enclosures and gas rooms, and local exhaust systems required in Sections 502.8.8.2 and 502.8.8.3 shall be directed to a treatment system where required by the *International Fire Code*.

[F] 502.8.8.6 Process equipment. Effluent from indoor and outdoor process equipment containing highly toxic or toxic compressed gases which could be discharged to the atmosphere shall be processed through an exhaust scrubber or other processing system. Such systems shall be in accordance with the *International Fire Code*.

[F] 502.8.9 Ozone gas generators. Ozone cabinets and ozone gas-generator rooms for systems having a maximum ozone-generating capacity of one-half pound (0.23 kg) or more over a 24-hour period shall be mechanically ventilated at a rate of not less than six air changes per hour. For cabinets, the average velocity of ventilation at makeup air openings with cabinet doors closed shall be not less than 200 feet per minute (1.02 m/s).

[F] 502.8.10 LP-gas distribution facilities. LP-gas distribution facilities shall be ventilated in accordance with NFPA 58.

[F] 502.8.10.1 Portable container use. Above-grade underfloor spaces or basements in which portable LP-gas containers are used or are stored awaiting use or resale shall be provided with an approved means of ventilation.

Exception: Department of Transportation (DOT) specification cylinders with a maximum water capacity of 2.5 pounds (1 kg) for use in completely self-contained hand torches and similar applications. The quantity of LP-gas shall not exceed 20 pounds (9 kg).

[F] 502.8.11 Silane gas. Exhausted enclosures and gas cabinets for the indoor storage of silane gas in amounts exceeding the maximum allowable quantities per control area shall comply with this section.

1. Exhausted enclosures and gas cabinets shall be in accordance with Section 502.7.2.
2. The velocity of ventilation across unwelded fittings and connections on the piping system shall not be less than 200 feet per minute (1.02 m/s).
3. The average velocity at the face of the access ports or windows in the gas cabinet shall not be less than 200 feet per minute (1.02 m/s) with a minimum velocity of 150 feet per minute (0.76 m/s) at any point at the access port or window.

[F] 502.9 Hazardous production materials (HPM). Exhaust ventilation systems and materials for ducts utilized for the exhaust of HPM shall comply with this section, other applicable provisions of this code, the *International Building Code* and the *International Fire Code*.

[F] 502.9.1 Where required. Exhaust ventilation systems shall be provided in the following locations in accordance with the requirements of this section and the *International Building Code*:

1. Fabrication areas: Exhaust ventilation for fabrication areas shall comply with the *International Building Code*. Additional manual control switches shall be provided where required by the code official.
2. Workstations: A ventilation system shall be provided to capture and exhaust fumes and vapors at workstations.
3. Liquid storage rooms: Exhaust ventilation for liquid storage rooms shall comply with Section 502.7.1.1 and the *International Building Code*.
4. HPM rooms: Exhaust ventilation for HPM rooms shall comply with Section 502.7.1.1 and the *International Building Code*.

5. Gas cabinets: Exhaust ventilation for gas cabinets shall comply with Section 502.7.2. The gas cabinet ventilation system is allowed to connect to a workstation ventilation system. Exhaust ventilation for gas cabinets containing highly toxic or toxic gases shall also comply with Sections 502.8.7 and 502.8.8.

6. Exhausted enclosures: Exhaust ventilation for exhausted enclosures shall comply with Section 502.7.2. Exhaust ventilation for exhausted enclosures containing highly toxic or toxic gases shall also comply with Sections 502.8.7 and 502.8.8.

7. Gas rooms: Exhaust ventilation for gas rooms shall comply with Section 502.7.2. Exhaust ventilation for gas cabinets containing highly toxic or toxic gases shall also comply with Sections 502.8.7 and 502.8.8.

[F] 502.9.2 Penetrations. Exhaust ducts penetrating fire barrier assemblies shall be contained in a shaft of equivalent fire-resistive construction. Exhaust ducts shall not penetrate building separation walls. Fire dampers shall not be installed in exhaust ducts.

[F] 502.9.3 Treatment systems. Treatment systems for highly toxic and toxic gases shall comply with the *International Fire Code*.

502.10 Motion picture projectors. Motion picture projectors shall be exhausted in accordance with Section 502.10.1 or 502.10.2.

502.10.1 Projectors with an exhaust discharge. Projectors equipped with an exhaust discharge shall be directly connected to a mechanical exhaust system. The exhaust system shall operate at an exhaust rate as indicated by the manufacturer's installation instructions.

502.10.2 Projectors without exhaust connection. Projectors without an exhaust connection shall have contaminants exhausted through a mechanical exhaust system. The exhaust rate for electric arc projectors shall be a minimum of 200 cubic feet per minute (cfm) (0.09 m³/s) per lamp. The exhaust rate for xenon projectors shall be a minimum of 300 cfm (0.14 m³/s) per lamp. Xenon projector exhaust shall be at a rate such that the exterior temperature of the lamp housing does not exceed 130°F (54°C). The lamp and projection room exhaust systems, whether combined or independent, shall not be interconnected with any other exhaust or return system within the building.

[F] 502.11 Organic coating processes. Enclosed structures involving organic coating processes in which Class I liquids are processed or handled shall be ventilated at a rate of not less than 1 cfm/ft² [0.00508 m³/(s · m²)] of solid floor area. Ventilation shall be accomplished by exhaust fans that intake at floor levels and discharge to a safe location outside the structure. Noncontaminated intake air shall be introduced in such a manner that all portions of solid floor areas are provided with continuous uniformly distributed air movement.

502.12 Public garages. Mechanical exhaust systems for public garages, as required in Chapter 4, shall operate continuously or in accordance with Section 404.

502.13 Motor vehicle operation. In areas where motor vehicles operate, mechanical ventilation shall be provided in accordance with Section 404.

dance with Section 403. Additionally, areas in which stationary motor vehicles are operated shall be provided with a source capture system that connects directly to the motor vehicle exhaust systems.

Exceptions:

1. This section shall not apply where the motor vehicles being operated or repaired are electrically powered.
2. This section shall not apply to one- and two-family dwellings.
3. This section shall not apply to motor vehicle service areas where engines are operated inside the building only for the duration necessary to move the motor vehicles in and out of the building.

[F] **502.14 Repair garages.** Where Class I liquids or LP-gas are stored or used within a building having a basement or pit wherein flammable vapors could accumulate, the basement or pit shall be provided with ventilation designed to prevent the accumulation of flammable vapors therein.

[F] **502.15 Repair garages for natural gas- and hydrogen-fueled vehicles.** Repair garages used for the repair of natural gas- or hydrogen-fueled vehicles shall be provided with an approved mechanical ventilation system. The mechanical ventilation system shall be in accordance with Sections 502.15.1 and 502.15.2.

Exception: Where approved by the code official, natural ventilation shall be permitted in lieu of mechanical ventilation.

[F] **502.15.1 Design.** Indoor locations shall be ventilated utilizing air supply inlets and exhaust outlets arranged to provide uniform air movement to the extent practical. Inlets shall be uniformly arranged on exterior walls near floor level. Outlets shall be located at the high point of the room in exterior walls or the roof.

1. Ventilation shall be by a continuous mechanical ventilation system or by a mechanical ventilation system activated by a continuously monitoring natural gas detection system activating at a gas concentration of 20 percent of the LFL or higher. In all cases, the system shall shut down the fueling system in the event of failure of the ventilation system.
2. The ventilation rate shall be at least 1 cubic foot per minute per 12 cubic feet [$0.00138 \text{ m}^3/(\text{s} \cdot \text{m}^3)$] of room volume.

[F] **502.15.2 Operation.** The mechanical ventilation system shall operate continuously.

Exceptions:

1. Mechanical ventilation systems that are interlocked with a gas detection system designed in accordance with the *International Fire Code*.
2. Mechanical ventilation systems in garages that are used only for the repair of vehicles fueled by liquid fuels or odorized gases, such as CNG, where the ventilation system is electrically interlocked with the lighting circuit.

502.16 Tire rebuilding or recapping. Each room where rubber cement is used or mixed, or where flammable or combustible solvents are applied, shall be ventilated in accordance with the applicable provisions of NFPA 91.

502.16.1 Buffing machines. Each buffing machine shall be connected to a dust-collecting system that prevents the accumulation of the dust produced by the buffing process.

502.17 Specific rooms. Specific rooms, including bathrooms, locker rooms, smoking lounges and toilet rooms, shall be exhausted in accordance with the ventilation requirements of Chapter 4.

SECTION 503 MOTORS AND FANS

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. Electrical equipment and appliances used in operations that generate explosive or flammable vapors, fumes or dusts shall be interlocked with the ventilation system so that the equipment and appliances 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. Motors and fans shall be provided with a means of access 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. When 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. When fans are required to be spark resistant, their bearings shall not be within the airstream, and all parts of the fan shall be grounded. Fans in systems-handling materials that are capable of clogging the blades, and fans in buffing or woodworking exhaust systems, shall be of the radial-blade or tube-axial type.

503.3 Equipment and appliances identification plate. Equipment and appliances 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.

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

SECTION 504 CLOTHES DRYER EXHAUST

504.1 Installation. Clothes dryers shall be exhausted in accordance with the manufacturer's instructions. Dryer exhaust systems shall be independent of all other systems and shall convey the moisture and any products of combustion to the outside of the building.

504.2 Exhaust penetrations. Ducts that exhaust clothes dryers shall not penetrate or be located within any fireblocking, draftstopping or any wall, floor/ceiling or other assembly re-

quired by the *International Building Code* to be fire-resistance rated, unless such duct is constructed of galvanized steel or aluminum of the thickness specified in Section 603.3 and the fire-resistance rating is maintained in accordance with the *International Building Code*.

504.3 Cleanout. Each vertical riser shall be provided with a means for cleanout.

504.4 Exhaust installation. Dryer exhaust ducts for clothes dryers shall terminate on the outside of the building and shall be equipped with a backdraft damper. Screens shall not be installed at the duct termination. Ducts shall not be connected or installed with sheet metal screws or other fasteners that will obstruct the exhaust flow. Clothes dryer exhaust ducts shall not be connected to a vent connector, vent or chimney. Clothes dryer exhaust ducts shall not extend into or through ducts or plenums.

504.5 Makeup air. Installations exhausting more than 200 cfm (0.09 m³/s) shall be provided with makeup air. Where a closet is designed for the installation of a clothes dryer, an opening having an area of not less than 100 square inches (0.0645 m²) shall be provided in the closet enclosure.

504.6 Domestic clothes dryer ducts. Exhaust ducts for domestic clothes dryers shall be constructed of metal and shall have a smooth interior finish. The exhaust duct shall be a minimum nominal size of 4 inches (102 mm) in diameter. The entire exhaust system shall be supported and secured in place. The male end of the duct at overlapped duct joints shall extend in the direction of airflow. Clothes dryer transition ducts used to connect the appliance to the exhaust duct system shall be limited to single lengths not to exceed 8 feet (2438 mm) and shall be listed and labeled for the application. Transition ducts shall not be concealed within construction.

504.6.1 Maximum length. The maximum length of a clothes dryer exhaust duct shall not exceed 25 feet (7620 mm) from the dryer location to the outlet terminal. The maximum length of the duct shall be reduced 2.5 feet (762 mm) for each 45-degree (0.79 rad) bend and 5 feet (1524 mm) for each 90-degree (1.6 rad) bend.

Exception: Where the make and model of the clothes dryer to be installed is known and the manufacturer's installation instructions for such dryer are provided to the code official, the maximum length of the exhaust duct, including any transition duct, shall be permitted to be in accordance with the dryer manufacturer's installation instructions.

504.6.2 Rough-in required. Where a compartment or space for a domestic clothes dryer is provided, an exhaust duct system shall be installed in accordance with Sections 504.6 and 504.6.1.

504.7 Commercial clothes dryers. The installation of dryer exhaust ducts serving Type 2 clothes dryers shall comply with the appliance manufacturer's installation instructions. Exhaust fan motors installed in exhaust systems shall be located outside of the airstream. In multiple installations, the fan shall operate continuously or be interlocked to operate when any individual unit is operating. Ducts shall have a minimum clearance of 6 inches (152 mm) to combustible materials. Clothes dryer tran-

sition ducts used to connect the appliance to the exhaust duct system shall be limited to single lengths not to exceed 8 feet (2438 mm) in length and shall be listed and labeled for the application. Transition ducts shall not be concealed within construction.

SECTION 505

DOMESTIC KITCHEN EXHAUST EQUIPMENT

505.1 Domestic systems. Where domestic range hoods and domestic appliances equipped with downdraft exhaust are located within dwelling units, such hoods and appliances shall discharge to the outdoors through ducts constructed of galvanized steel, stainless steel, aluminum or copper. Such ducts shall have smooth inner walls and shall be air tight and equipped with a backdraft damper.

Exceptions:

1. Where installed in accordance with the manufacturer's installation instructions and where mechanical or natural ventilation is otherwise provided in accordance with Chapter 4, listed and labeled ductless range hoods shall not be required to discharge to the outdoors.
2. Ducts for domestic kitchen cooking appliances equipped with downdraft exhaust systems shall be permitted to be constructed of Schedule 40 PVC pipe provided that the installation complies with all of the following:
 - 2.1. The duct shall be installed under a concrete slab poured on grade.
 - 2.2. The underfloor trench in which the duct is installed shall be completely backfilled with sand or gravel.
 - 2.3. The PVC duct shall extend not greater than 1 inch (25 mm) above the indoor concrete floor surface.
 - 2.4. The PVC duct shall extend not greater than 1 inch (25 mm) above grade outside of the building.
 - 2.5. The PVC ducts shall be solvent cemented.

SECTION 506

COMMERCIAL KITCHEN GREASE DUCTS AND EXHAUST EQUIPMENT

506.1 General. Commercial kitchen grease ducts and exhaust equipment shall comply with the requirements of this section. Commercial kitchen grease ducts shall be designed for the type of cooking appliance and hood served.

Comm 64.0506 (1) Note: See Table 64.0403 for modifications in regarding required cfm/person.

506.2 Corrosion protection. Ducts exposed to the outside atmosphere or subject to a corrosive environment shall be protected against corrosion in an approved manner.

506.3 Ducts serving Type I hoods. Commercial kitchen exhaust systems serving Type I hoods shall be designed, constructed and installed in accordance with Sections 506.3.1 through 506.3.13.3.

506.3.1 Exhaust fans. Exhaust fan housings serving a Type I hood shall be constructed of steel.

Exception: Fans listed and labeled as power roof ventilators for restaurant cooking appliances.

506.3.1.1 Fan motor. Exhaust fan motors shall be located outside of the exhaust airstream.

506.3.2 Grease duct materials. Grease ducts serving a Type I hood shall be constructed of steel not less than 0.055 inch (1.4 mm) (No. 16 Gage) in thickness or stainless steel not less than 0.044 inch (1.1 mm) (No. 18 Gage) in thickness.

Exception: Listed and labeled factory-built commercial kitchen grease ducts installed in accordance with Section 304.1.

506.3.3 Joints, seams and penetrations of grease ducts. Joints, seams and penetrations of grease ducts shall be made with a continuous liquid-tight weld or braze made on the external surface of the duct system.

Comm 64.0506 (2) (a) Alternative. Joints may be made with any other means that provide a liquid-tight seal at 1500°F (815°C).

Exceptions:

1. Penetrations shall not be required to be welded or brazed where sealed by devices that are listed for the application.
2. Internal welding or brazing shall not be prohibited provided that the joint is formed or ground smooth and is provided with ready access for inspection.
3. Listed and labeled factory-built commercial kitchen grease ducts installed in accordance with Section 304.1.

506.3.3.1 [Comm 64.0506 (2) (b)] Duct joint types.

1. Duct joints shall be butt joints or overlapping duct joints of either the telescoping bell type or flanged. Overlapping joints shall be installed to prevent ledges and obstructions from collecting grease or interfering with gravity drainage to the intended collection point.
2. The difference between the inside cross-sectional dimensions of overlapping sections of duct shall not exceed 0.25 inch (6 mm).
3. The length of overlap for overlapping duct joints shall not exceed 2 inches (51 mm).

506.3.3.2 Duct-to-hood joints. Duct-to-hood joints shall be made with continuous internal or external liquid-tight welded or brazed joints. Such joints shall be smooth, accessible for inspection, and without grease traps.

Exceptions: This section shall not apply to:

1. A vertical duct-to-hood collar connection made in the top plane of the hood in accordance with all of the following:
 - 1.1. The hood duct opening shall have a 1-inch-deep (25 mm), full perimeter, welded flange turned down into the

hood interior at an angle of 90 degrees from the plane of the opening.

- 1.2. The duct shall have a 1-inch-deep (25 mm) flange made by a 1-inch by 1-inch (25 mm by 25 mm) angle iron welded to the full perimeter of the duct not less than 1 inch (25 mm) above the bottom end of the duct.
- 1.3. A gasket rated for use at not less than 1,500°F (815°C) is installed between the duct flange and the top of the hood.
- 1.4. The duct-to-hood joint shall be secured by stud bolts not less than 0.25 inch (6.4 mm) in diameter welded to the hood with a spacing not greater than 4 inches (102 mm) on center for the full perimeter of the opening. All bolts and nuts are to be secured with lockwashers.

2. Listed and labeled duct-to-hood collar connections installed in accordance with Section 304.1.

506.3.3.3 Duct-to-exhaust fan connections. Duct-to-exhaust fan connections shall be flanged and gasketed at the base of the fan for listed and labeled vertical discharge fans; shall be flanged, gasketed, and bolted to the inlet of the fan for side-inlet utility fans; and shall be flanged, gasketed, and bolted to the inlet and outlet of the fan for in-line fans.

506.3.3.4 Vibration isolation. A vibration isolation connector for connecting a duct to a fan shall consist of noncombustible packing in a metal sleeve joint of approved design or shall be a coated-fabric flexible duct connector listed and labeled for the application. Vibration isolation connectors shall be installed only at the connection of a duct to a fan inlet or outlet.

506.3.4 Grease duct supports. Grease duct bracing and supports shall be of noncombustible material securely attached to the structure and designed to carry gravity and seismic loads within the stress limitations of the *International Building Code*. Bolts, screws, rivets and other mechanical fasteners shall not penetrate duct walls.

506.3.5 Air velocity. Grease duct systems serving a Type I hood shall be designed and installed to provide an air velocity within the duct system of not less than 1,500 feet per minute (7.6 m/s).

Exception: The velocity limitations shall not apply within duct transitions utilized to connect ducts to differently sized or shaped openings in hoods and fans, provided that such transitions do not exceed 3 feet (914 mm) in length and are designed to prevent the trapping of grease.

506.3.6 Separation of grease duct system. A separate grease duct system shall be provided for each Type I hood. A separate grease duct system is not required where all of the following conditions are met:

1. All interconnected hoods are located within the same story.

2. All interconnected hoods are located within the same room or in adjoining rooms.
3. Interconnecting ducts do not penetrate assemblies required to be fire-resistance rated.
4. The grease duct system does not serve solid fuel-fired appliances.

506.3.7 Clearances. Grease duct systems serving a Type I hood shall have a clearance to combustible construction of not less than 18 inches (457 mm).

Exception: Listed and labeled factory-built commercial kitchen grease ducts installed in accordance with Section 304.1.

506.3.8 Prevention of grease accumulation. Duct systems serving a Type I hood shall be constructed and installed so that grease cannot collect in any portion thereof, and the system shall slope not less than one-fourth unit vertical in 12 units horizontal (2-percent slope) toward the hood or toward an approved grease reservoir. Where horizontal ducts exceed 75 feet (22 860 mm) in length, the slope shall be not less than one unit vertical in 12 units horizontal (8.3-percent slope). Exhaust fans shall be positioned so that the discharge will not impinge on the roof, other equipment or appliances or parts of the structure. A vertical discharge fan shall be manufactured with an approved drain outlet at the bottom of the housing to permit drainage of grease to an approved grease reservoir.

Comm 64.0506 (2) (c) Fan listing. Fans serving commercial kitchen hoods shall be listed for use with grease-laden air.

506.3.9 Cleanouts and other openings. Grease duct systems shall not have openings therein other than those required for proper operation and maintenance of the system. Any portion of such system having sections not provided with access from the duct entry or discharge shall be provided with cleanout openings. Cleanout openings shall be equipped with tight-fitting doors constructed of steel having a thickness not less than that required for the duct. Doors shall be equipped with a substantial method of latching, sufficient to hold the door tightly closed. Doors shall be designed so that they are operable without the use of a tool. Door assemblies, including any frames and gasketing, shall be approved for the purpose, and shall not have fasteners that penetrate the duct. Listed and labeled access door assemblies shall be installed in accordance with the terms of the listing.

506.3.9.1 Personnel entry. Where ductwork is large enough to allow entry of personnel, not less than one approved or listed opening having dimensions not less than 20 inches by 20 inches (508 mm by 508 mm) shall be provided in the horizontal sections, and in the top of vertical risers. Where such entry is provided, the duct and its supports shall be capable of supporting the additional load and the cleanouts specified in Section 506.3.10 are not required.

506.3.10 Horizontal cleanouts. Cleanouts located on horizontal sections of ducts shall be spaced not more than 20 feet (6096 mm) apart. The cleanouts shall be located on the side

of the duct with the opening not less than 1.5 inches (38 mm) above the bottom of the duct, and not less than 1 inch (25 mm) below the top of the duct. The opening minimum dimensions shall be 12 inches (305 mm) on each side. Where the dimensions of the side of the duct prohibit the cleanout installation prescribed herein, the openings shall be on the top of the duct or the bottom of the duct. Where located on the top of the duct, the opening edges shall be a minimum of 1 inch (25 mm) from the edges of the duct. Where located in the bottom of the duct, cleanout openings shall be designed to provide internal damming around the opening, shall be provided with gasketing to preclude grease leakage, shall provide for drainage of grease down the duct around the dam, and shall be approved for the application. Where the dimensions of the sides, top or bottom of the duct preclude the installation of the prescribed minimum-size cleanout opening, the cleanout shall be located on the duct face that affords the largest opening dimension and shall be installed with the opening edges at the prescribed distances from the duct edges as previously set forth in this section.

506.3.11 Duct enclosure. A grease duct serving a Type I hood that penetrates a ceiling, wall or floor shall be enclosed from the point of penetration to the outlet terminal. A duct shall only penetrate exterior walls at locations where unprotected openings are permitted by the *International Building Code*. Ducts shall be enclosed in accordance with the *International Building Code* requirements for shaft construction. The duct enclosure shall be sealed around the duct at the point of penetration and vented to the outside of the building through the use of weather-protected openings. The enclosure shall be separated from the duct by a minimum of 6 inches (152 mm) and a maximum of 12 inches (305 mm) and shall serve a single grease exhaust duct system (see Section 506.3.7).

Exceptions:

1. The shaft enclosure provisions of this section shall not be required where a duct penetration is protected with a through-penetration firestop system classified in accordance with ASTM E 814 and having an "F" and "T" rating equal to the fire-resistance rating of the assembly being penetrated and where the surface of the duct is continuously covered on all sides from the point at which the duct penetrates a ceiling wall or floor to the outlet terminal with a classified and labeled material, system, method of construction or product specifically evaluated for such purpose, in accordance with a nationally recognized standard for such enclosure materials.
2. A duct enclosure shall not be required for a grease duct that penetrates only a nonfire-resistance-rated roof/ceiling assembly.

506.3.12 Fire-resistive access opening. Where cleanout openings are located in ducts within a fire-resistance-rated enclosure, access openings shall be provided in the enclosure at each cleanout point. Access openings shall be equipped with tight-fitting sliding or hinged doors that are equal in fire-resistive protection to that of the shaft or enclosure. An approved sign shall be placed on access opening

panels with wording as follows: "ACCESS PANEL. DO NOT OBSTRUCT."

506.3.13 Type I exhaust outlets. Exhaust outlets for grease ducts serving commercial food heat-processing appliances shall conform to the requirements of Sections 506.3.13.1 through 506.3.13.3.

506.3.13.1 Termination above the roof. Exhaust outlets that terminate above the roof shall have the discharge opening located not less than 40 inches (1016 mm) above the roof surface.

506.3.13.2 Termination through an exterior wall. Exhaust outlets shall be permitted to terminate through exterior walls where the smoke, grease, gases, vapors, and odors in the discharge from such terminations do not create a public nuisance or a fire hazard. Such terminations shall not be located where protected openings are required by the *International Building Code*. Other exterior openings shall not be located within 3 feet (914 mm) of such terminations.

506.3.13.3 Termination location. Exhaust outlets shall be located not less than 10 feet (3048 mm) horizontally from parts of the same or contiguous buildings, adjacent property lines and air intake openings into any building and shall be located not less than 10 feet (3048 mm) above the adjoining grade level.

Exceptions:

1. Exhaust outlets shall terminate not less than 5 feet (1524 mm) from an adjacent building, adjacent property line and air intake openings into a building where air from the exhaust outlet discharges away from such locations.
2. The minimum horizontal distance between vertical discharge fans and parapet-type building structures shall be 2 feet (610 mm) provided that such structures are not higher than the top of the fan discharge opening.

506.4 Ducts serving Type II hoods. Commercial kitchen exhaust systems serving Type II hoods shall comply with Sections 506.4.1 and 506.4.2.

506.4.1 Type II exhaust outlets. Exhaust outlets for ducts serving Type II hoods shall comply with Sections 401.5 and 401.5.2. Such outlets shall be protected against local weather conditions and shall meet the provisions for exterior wall opening protectives in accordance with the *International Building Code*.

506.4.2 Ducts. Ducts and plenums serving Type II hoods shall be constructed of rigid metallic materials. Duct construction, installation, bracing and supports shall comply with Chapter 6. Ducts subject to positive pressure and ducts conveying moisture-laden or waste-heat-laden air shall be constructed, joined and sealed in an approved manner.

SECTION 507 COMMERCIAL KITCHEN HOODS

507.1 General. Commercial kitchen exhaust hoods shall comply with the requirements of this section. Hoods shall be Type I or Type II and shall be designed to capture and confine cooking vapors and residues.

Exception: Factory-built commercial exhaust hoods which are tested in accordance with UL 710, listed, labeled and installed in accordance with Section 304.1 shall not be required to comply with Sections 507.4, 507.5, 507.7, 507.12, 507.13, 507.15 and 507.16.

507.2 Where required. A Type I or Type II hood shall be installed at or above all commercial food heat-processing appliances. A Type II hood shall be installed above commercial dishwashing machines.

Exceptions:

1. Food heat-processing appliances installed within a dwelling unit.
2. Under-counter-type commercial dishwashing machines.

507.2.1 Type I and Type II hoods. A Type I hood shall be installed at or above all commercial food heat-processing appliances that produce grease vapors or smoke. A Type I or Type II hood shall be installed at or above all commercial food heat-processing appliances that produce fumes, steam, odor or heat.

507.2.2 Domestic cooking appliances used for commercial purposes. Domestic cooking appliances utilized for commercial purposes shall be provided with Type I or II hoods as required for the type of appliances and processes in accordance with Sections 507.2 and 507.2.1.

507.2.3 Solid fuel. Type I hoods for use over solid fuel-burning cooking appliances shall discharge to an exhaust system that is independent of other exhaust systems.

507.3 Fuel-burning appliances. Where vented fuel-burning appliances are located in the same room or space as the hood, provisions shall be made to prevent the hood system from interfering with normal operation of the appliance vents.

507.4 Type I materials. Type I hoods shall be constructed of steel not less than 0.043 inch (1.09 mm) (No. 18 MSG) in thickness, or stainless steel not less than 0.037 inch (0.94 mm) (No. 20 MSG) in thickness.

507.5 Type II hood materials. Type II hoods shall be constructed of steel not less than 0.030 inch (0.76 mm) (No. 22 Gage) in thickness, stainless steel not less than 0.024 inch (0.61 mm) (No. 24 Gage) in thickness, copper sheets weighing not less than 24 ounces per square foot (7.3 kg/m²), or of other approved material and gage.

507.6 Supports. Type I hoods shall be secured in place by noncombustible supports. All Type I and Type II hood supports shall be adequate for the applied load of the hood, the unsupported ductwork, the effluent loading, and the possible weight of personnel working in or on the hood.

507.7 Hood joints, seams and penetrations. Hood joints, seams and penetrations shall comply with Sections 507.7.1 and 507.7.2.

507.7.1 Type I hoods. External hood joints, seams and penetrations for Type I hoods shall be made with a continuous external liquid-tight weld or braze to the lowest outermost perimeter of the hood. Internal hood joints, seams, penetrations, filter support frames, and other appendages attached inside the hood shall not be required to be welded or brazed but shall be otherwise sealed to be grease tight.

Exceptions:

1. Penetrations shall not be required to be welded or brazed where sealed by devices that are listed for the application.
2. Internal welding or brazing of seams, joints, and penetrations of the hood shall not be prohibited provided that the joint is formed smooth or ground so as to not trap grease, and is readily cleanable.
3. External hood joints and seams tested and listed in accordance with the requirements of UL 710 shall not be required to be welded or brazed.

507.7.2 Type II hoods. Joints, seams and penetrations for Type II hoods shall be constructed as set forth in Chapter 6, shall be sealed on the interior of the hood and shall provide a smooth surface that is readily cleanable and water tight.

507.8 Cleaning and grease gutters. A hood shall be designed to provide for thorough cleaning of the entire hood. Grease gutters shall drain to an approved collection receptacle that is fabricated, designed and installed to allow access for cleaning.

507.9 Clearances for Type I hood. A Type I hood shall be installed with a clearance to combustibles of not less than 18 inches (457 mm).

Exception: Clearance shall not be required from gypsum wallboard attached to noncombustible structures provided that a smooth, cleanable, nonabsorbent and noncombustible material is installed between the hood and the gypsum wallboard over an area extending not less than 18 inches (457 mm) in all directions from the hood.

507.10 Hoods penetrating a ceiling. Type I hoods or portions thereof penetrating a ceiling, wall or furred space shall comply with all the requirements of Section 506.3.11.

507.11 Grease filters. Type I hoods shall be equipped with listed grease filters designed for the specific purpose. Grease-collecting equipment shall be provided with access for cleaning. The lowest edge of a grease filter located above the cooking surface shall be not less than the height specified in Table 507.11.

TABLE 507.11
MINIMUM DISTANCE BETWEEN THE LOWEST EDGE OF A GREASE FILTER AND THE COOKING SURFACE OR THE HEATING SURFACE

TYPE OF COOKING APPLIANCE	HEIGHT ABOVE COOKING SURFACE (feet)
Without exposed flame	0.5
Exposed flame and burners	2
Exposed charcoal and charcoal type	3.5

For SI: 1 foot = 304.8 mm.

507.11.1 Criteria. Filters shall be of such size, type and arrangement as will permit the required quantity of air to pass through such units at rates not exceeding those for which the filter or unit was designed or approved. Filter units shall be installed in frames or holders so as to be readily removable without the use of separate tools, unless designed and installed to be cleaned in place and the system is equipped for such cleaning in place. Removable filter units shall be of a size that will allow them to be cleaned in a dishwashing machine or pot sink. Filter units shall be arranged in place or provided with drip-intercepting devices to prevent grease or other condensate from dripping into food or on food preparation surfaces.

507.11.2 Mounting position. Filters shall be installed at an angle of not less than 45 degrees (0.79 rad) from the horizontal and shall be equipped with a drip tray beneath the lower edge of the filters.

507.12 Canopy size and location. The inside lower edge of canopy-type commercial cooking hoods shall overhang or extend a horizontal distance of not less than 6 inches (152 mm) beyond the edge of the cooking surface, on all open sides. The vertical distance between the front lower lip of the hood and the cooking surface shall not exceed 4 feet (1219 mm).

Exception: The hood shall be permitted to be flush with the outer edge of the cooking surface where the hood is closed to the appliance side by a noncombustible wall or panel.

507.13 [Comm 64.0507] Capacity of hoods. A kitchen exhaust hood shall be provided with a capture velocity to capture the grease vapors effectively and may be designed through engineering analysis, or based on this section and the requirements in IMC Sections 507.13.1 through 507.13.4.

where:

A = The horizontal surface area of the hood, in square feet (m^2).

D = Distance in feet (m) between the lower lip of the hood and the cooking surface.

P = That part of the perimeter of the hood that is open, in feet (m).

Q = Quantity of air, in cubic feet per minute (m^3/s).

507.13.1 Solid fuel-burning cooking appliances. The minimum airflow for Type I hoods used for solid fuel-burning cooking appliances, grease-burning charbroilers and similar appliances shall be:

Number of exposed sides	Formula	For SI:
4 (island or central hood)	$Q = 300A$	$Q = 1.52A$
3 or less	$Q = 200A$	$Q = 1.02A$
Alternate formula	$Q = 100PD$	$Q = 0.51PD$

507.13.2 High temperature. The minimum airflow for Type I hoods used for high-temperature appliances such as deep-fat fryers shall be determined as follows:

Number of exposed sides	Formula	For SI:
4 (island or central hood)	$Q = 150A$	$Q = 0.76A$
3 or less	$Q = 100A$	$Q = 0.51A$
Alternate formula	$Q = 100PD$	$Q = 0.51PD$

507.13.3 Medium temperature. The minimum airflow for Type I hoods used for medium-temperature appliances such as rotisseries, grills and ranges shall be determined as follows:

Number of exposed sides	Formula	
	For SI:	
4 (island or central hood)	$Q = 100A$	$Q = 0.51A$
3 or less	$Q = 75A$	$Q = 0.38A$
Alternate formula	$Q = 50PD$	$Q = 0.25PD$

507.13.4 Low temperature. The minimum airflow for Type I hoods used for low-temperature appliances such as medium-to-low temperature ranges, roasters, roasting ovens, pastry ovens and appliances approved for use under a Type II hood, such as pizza ovens, shall be determined as follows:

Number of exposed sides	Formula	
	For SI:	
4 (island or central hood)	$Q = 75A$	$Q = 0.38A$
3 or less	$Q = 50A$	$Q = 0.25A$
Alternate formula	$Q = 50PD$	$Q = 0.25PD$

507.14 Noncanopy size and location. Noncanopy-type hoods shall be located a maximum of 3 feet (914 mm) above the cooking surface. The edge of the hood shall be set back a maximum of 1 foot (305 mm) from the edge of the cooking surface.

507.15 Capacity for noncanopy hoods. In addition to all 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 cfm per linear foot [$0.46 \text{ m}^3/(\text{s} \cdot \text{m})$] of the cooking appliances.

507.16 Exhaust outlets. Exhaust outlets located within the 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 hood.

507.17 Performance test. A performance test shall be conducted upon completion and before final approval of the installation of a ventilation system serving commercial food heat-processing appliances. The test shall verify the rate of airflow and proper operation as specified in this chapter. The permit holder shall furnish the necessary test equipment and devices required to perform the tests.

SECTION 508 COMMERCIAL KITCHEN MAKEUP AIR

508.1 Makeup air. Makeup air shall be supplied during the operation of commercial kitchen exhaust systems that are provided for commercial food heat-processing appliances. The amount of makeup air supplied shall be approximately equal to the amount of exhaust air. The makeup air shall not reduce the effectiveness of the exhaust system. Makeup air shall be provided by gravity or mechanical means or both. For mechanical makeup air systems, the exhaust and makeup air systems shall be electrically interlocked to insure that makeup air is provided whenever the exhaust system is in operation.

Exception: This section shall not apply to dwelling units.

508.1.1 Makeup air temperature. The temperature differential between makeup air and the air in the conditioned space shall not exceed 10°F (6°C).

Exceptions:

1. Makeup air that is part of the air-conditioning system.
2. Makeup air that does not decrease the comfort conditions of the occupied space.

508.2 Compensating hoods. Manufacturers of compensating hoods shall provide a label indicating minimum exhaust flow and maximum makeup airflow that provides capture and containment of the exhaust effluent.

SECTION 509 FIRE SUPPRESSION SYSTEMS

509.1 Where required. Commercial food heat-processing appliances required by Section 507.2.1 to have a Type I hood shall be provided with an approved automatic fire suppression system complying with the *International Building Code* and the *International Fire Code*.

SECTION 510 HAZARDOUS EXHAUST SYSTEMS

510.1 General. This section shall govern the design and construction of duct systems for hazardous exhaust and shall determine where such systems are required. Hazardous exhaust systems are systems designed to capture and control hazardous emissions generated from product handling or processes, and convey those emissions to the outdoors. Hazardous emissions include flammable vapors, gases, fumes, mists or dusts, and volatile or airborne materials posing a health hazard, such as toxic or corrosive materials. For the purposes of this section, the health-hazard rating of materials shall be as specified in NFPA 704.

510.2 Where required. A hazardous exhaust system shall be required wherever operations involving the handling or processing of hazardous materials, in the absence of such exhaust systems and under normal operating conditions, have the potential to create one of the following conditions:

1. A flammable vapor, gas, fume, mist or dust is present in concentrations exceeding 25 percent of the lower flammability limit of the substance for the expected room temperature.
2. A vapor, gas, fume, mist or dust with a health-hazard rating of 4 is present in any concentration.
3. A vapor, gas, fume, mist or dust with a health-hazard rating of 1, 2 or 3 is present in concentrations exceeding 1 percent of the median lethal concentration of the substance for acute inhalation toxicity.

[F] 510.2.1 Lumber yards and woodworking facilities. Equipment or machinery located inside buildings at lumber yards and woodworking facilities which generates or emits combustible dust shall be provided with an approved dust-collection and exhaust system installed in conformance with this section and the *International Fire Code*. Equip-

ment and systems that are used to collect, process or convey combustible dusts shall be provided with an approved explosion-control system.

[F] 510.2.2 Combustible fibers. Equipment or machinery within a building which generates or emits combustible fibers shall be provided with an approved dust-collecting and exhaust system. Such systems shall comply with this code and the *International Fire Code*.

510.3 Design and operation. The design and operation of the exhaust system shall be such that flammable contaminants are diluted in noncontaminated air to maintain concentrations in the exhaust flow below 25 percent of the contaminant's lower flammability limit.

510.4 Independent system. Hazardous exhaust systems shall be independent of other types of exhaust systems. Incompatible materials, as defined in the *International Fire Code*, shall not be exhausted through the same hazardous exhaust system. Hazardous exhaust systems shall not share common shafts with other duct systems, except where such systems are hazardous exhaust systems originating in the same fire area.

Contaminated air shall not be recirculated to occupied areas unless the 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.

510.5 Design. Systems for removal of vapors, gases and smoke shall be designed by the constant velocity or equal friction methods. Systems conveying particulate matter shall be designed employing the constant velocity method.

510.5.1 Balancing. Systems conveying explosive or radioactive materials shall be prebalanced by duct sizing. Other systems shall be balanced by duct sizing 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.

510.5.2 Emission control. 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.

510.5.3 Hoods required. Hoods or enclosures shall be used where contaminants originate in a limited area of a space. 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.

510.5.4 Contaminant capture and dilution. The velocity and circulation of air in work areas shall be such that contaminants are captured by an airstream at the area where the emissions are generated and conveyed into a product-conveying duct system. Contaminated air from work areas where hazardous contaminants are generated shall be diluted below the thresholds specified in Section 510.2 with air that does not contain other hazardous contaminants.

510.5.5 Makeup air. Makeup air shall be provided at a rate approximately equal to the rate that air is exhausted by the

hazardous exhaust system. Makeup-air intakes shall be located so as to avoid recirculation of contaminated air.

510.5.6 Clearances. The minimum clearance between hoods and combustible construction shall be the clearance required by the duct system.

510.5.7 Ducts. Hazardous exhaust duct systems shall extend directly to the exterior of the building and shall not extend into or through ducts and plenums.

510.6 Penetrations. Penetrations of structure elements by a hazardous exhaust system shall conform to the *International Building Code*.

510.7 Suppression required. Ducts shall be protected with an approved automatic fire suppression system installed in accordance with the *International Building Code*.

Exception: An approved automatic fire suppression system shall not be required in ducts conveying materials, fumes, mists and vapors that are nonflammable and noncombustible.

510.8 Duct construction. Ducts utilized to convey hazardous exhaust shall be constructed of approved G90 galvanized sheet steel, with a minimum nominal thickness as specified in Table 510.8.

Nonmetallic ducts utilized in systems exhausting nonflammable corrosive fumes or vapors shall be listed and labeled. Nonmetallic duct shall have a flame spread index of 25 or less and a smoke-developed index of 50 or less, when tested in accordance with ASTM E 84. Ducts shall be approved for installation in such an exhaust system.

Where the products being exhausted are detrimental to the duct material, the ducts shall be constructed of alternative materials that are compatible with the exhaust.

**TABLE 510.8
MINIMUM DUCT THICKNESS**

DIAMETER OF DUCT OR MAXIMUM SIDE DIMENSION	MINIMUM NOMINAL THICKNESS		
	Nonabrasive materials	Nonabrasive/ abrasive materials	Abrasive materials
0-8 inches	0.028 inch (No. 24 Gage)	0.034 inch (No. 22 Gage)	0.040 inch (No. 20 Gage)
9-18 inches	0.034 inch (No. 22 Gage)	0.040 inch (No. 20 Gage)	0.052 inch (No. 18 Gage)
19-30 inches	0.040 inch (No. 20 Gage)	0.052 inch (No. 18 Gage)	0.064 inch (No. 16 Gage)
Over 30 inches	0.052 inch (No. 18 Gage)	0.064 inch (No. 16 Gage)	0.079 inch (No. 14 Gage)

For SI: 1 inch = 25.4 mm.

510.8.1 Duct joints. Ducts shall be made tight with lap joints having a minimum lap of 1 inch (25 mm).

510.8.2 Clearance to combustibles. Ducts shall have a clearance to combustibles in accordance with Table 510.8.2. Exhaust gases having temperatures in excess of 600°F (316°C) shall be exhausted to a chimney in accordance with Section 511.2.

TABLE 510.8.2
CLEARANCE TO COMBUSTIBLES

TYPE OF EXHAUST OR TEMPERATURE OF EXHAUST (°F)	CLEARANCE TO COMBUSTIBLES (inches)
Less than 100	1
100-600	12
Flammable vapors	6

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

510.8.3 Explosion relief. Systems exhausting potentially explosive mixtures shall be protected with an approved explosion relief system or by an approved explosion prevention system designed and installed in accordance with NFPA 69. An explosion relief system shall be designed to minimize the structural and mechanical damage resulting from an explosion or deflagration within the exhaust system. An explosion prevention system shall be designed to prevent an explosion or deflagration from occurring.

510.9 Supports. Ducts shall be supported at intervals not exceeding 10 feet (3048 mm). Supports shall be constructed of noncombustible material.

SECTION 511 DUST, STOCK AND REFUSE CONVEYING SYSTEMS

511.1 Dust, stock and refuse conveying systems. Dust, stock and refuse conveying systems shall comply with the provisions of Section 510 and Sections 511.1.1 through 511.2.

511.1.1 Collectors and separators. Cyclone collectors and separators and associated supports shall be constructed of noncombustible materials and shall be located on the exterior of the building or structure. A collector or separator shall not be located nearer than 10 feet (3048 mm) to combustible construction or to an unprotected wall or floor opening, unless the collector is provided with a metal vent pipe that extends above the highest part of any roof within a distance of 30 feet (9144 mm).

511.1.2 Discharge pipe. Discharge piping shall conform to the requirements for ducts, including clearances required for high-heat appliances, as contained in this code. A delivery pipe from a cyclone collector shall not convey refuse directly into the firebox of a boiler, furnace, dutch oven, refuse burner, incinerator or other appliance.

511.1.3 Conveying system exhaust discharge. An exhaust system shall discharge to the outside of the building either directly by flue, or indirectly through the separator, bin or vault into which the system discharges.

511.1.4 Spark protection. The outlet of an open-air exhaust terminal shall be protected with an approved metal or other noncombustible screen to prevent the entry of sparks.

511.1.5 Explosion relief vents. A safety or explosion relief vent shall be provided on all systems that convey combustible refuse or stock of an explosive nature, in accordance with the requirements of the *International Building Code*.

511.1.5.1 Screens. Where a screen is installed in a safety relief vent, the screen shall be attached so as to permit ready release under the explosion pressure.

511.1.5.2 Hoods. The relief vent shall be provided with an approved noncombustible cowl or hood, or with a counterbalanced relief valve or cover arranged to prevent the escape of hazardous materials, gases or liquids.

511.2 Exhaust outlets. Outlets for exhaust that exceed 600°F (315°C) shall be designed as a chimney in accordance with Table 511.2.

The termination point for exhaust ducts discharging to the atmosphere shall not be less than the following:

1. Ducts conveying explosive or flammable vapors, fumes or dusts: 30 feet (9144 mm) from 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 which are in the direction of the exhaust discharge; and 10 feet (3048 mm) above adjoining grade.
2. Other product-conveying outlets: 10 feet (3048 mm) from property line; 3 feet (914 mm) from exterior wall or roof; 10 feet (3048 mm) from openings into the building; and 10 feet (3048 mm) above adjoining grade.
3. Environmental air duct exhaust: 3 feet (914 mm) from property line; and 3 feet (914 mm) from openings into the building.

SECTION 512 SUBSLAB SOIL EXHAUST SYSTEMS

512.1 General. When a subslab soil exhaust system is provided, the duct shall conform to the requirements of this section.

512.2 Materials. Subslab soil exhaust system duct material shall be air duct material listed and labeled to the requirements of UL 181 for Class 0 air ducts, or any of the following piping materials that comply with the *International Plumbing Code* as building sanitary drainage and vent pipe: cast iron; galvanized steel; brass or copper pipe; copper tube of a weight not less than that of copper drainage tube, Type DWV; and plastic piping.

512.3 Grade. Exhaust system ducts shall not be trapped and shall have a minimum slope of one-eighth unit vertical in 12 units horizontal (1-percent slope).

512.4 Termination. Subslab soil exhaust system ducts shall extend through the roof and terminate at least 6 inches (152 mm) above the roof and at least 10 feet (3048 mm) from any operable openings or air intake.

512.5 Identification. Subslab soil exhaust ducts shall be permanently identified within each floor level by means of a tag, stencil or other approved marking.

SECTION 513 SMOKE CONTROL SYSTEMS

[B] 513.1 Scope and purpose. This section applies to mechanical and passive smoke control systems that are required by the

**TABLE 511.2
CONSTRUCTION, CLEARANCE AND TERMINATION REQUIREMENTS FOR
SINGLE-WALL METAL CHIMNEYS**

CHIMNEYS SERVING	MINIMUM THICKNESS		TERMINATION				CLEARANCE			
	Wall	Lining	Above roof opening (feet)	Above any part of building within (feet)			Combustible construction (inches)		Noncombustible construction	
				10	25	50	Interior inst.	Exterior inst.	Interior inst.	Exterior inst.
Low-heat appliances (1,000°F normal operation)	0.127" (No. 10 MSG)	None	3	2	—	—	18	6	Up to 18" diameter, 2" Over 18" diameter, 4"	
Medium-heat appliances (2,000°F maximum) ^b	0.127" (No. 10 MSG)	Up to 18" dia. — 2½" Over 18"–4½" on 4½" bed	10	—	10	—	36	24		
High-heat appliances (Over 2,000°F) ^a	0.127" (No. 10 MSG)	4½" laid on 4½" bed	20	—	—	20	See Footnote c			

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, °C = [(°F) - 32]/1.8.

a. Lining shall extend from bottom to top of outlet.

b. Lining shall extend from 24 inches below connector to 24 feet above.

c. Clearance shall be as specified by the design engineer and shall have sufficient clearance from buildings and structures to avoid overheating combustible materials (maximum 160°F).

International Building Code. The purpose of this section is to establish minimum requirements for the design, installation and acceptance testing of smoke control systems that are intended to provide a tenable environment for the evacuation or relocation of occupants. These provisions are not intended for the preservation of contents, the timely restoration of operations, or for assistance in fire suppression or overhaul activities. Smoke control systems regulated by this section serve a different purpose than the smoke- and heat-venting provisions found in Section 910 of the *International Building Code*.

[B] 513.2 General design requirements. Buildings, structures, or parts thereof required by this code to have a smoke control system or systems shall have such systems designed in accordance with the applicable requirements of Section 909 of the *International Building Code* and the generally accepted and well-established principles of engineering relevant to the design. The construction documents shall include sufficient information and detail to describe adequately the elements of the design necessary for the proper implementation of the smoke control systems. These documents shall be accompanied with sufficient information and analysis to demonstrate compliance with these provisions

[B] 513.3 Special inspection and test requirements. In addition to the ordinary inspection and test requirements which buildings, structures and parts thereof are required to undergo, smoke control systems subject to the provisions of Section 909 of the *International Building Code* shall undergo special inspections and tests sufficient to verify the proper commissioning of the smoke control design in its final installed condition. The design submission accompanying the construction documents shall clearly detail procedures and methods to be used and the items subject to such inspections and tests. Such commissioning shall be in accordance with generally accepted engineering practice and, where possible, based on published

standards for the particular testing involved. The special inspections and tests required by this section shall be conducted under the same terms as found in Section 1707 of the *International Building Code*.

[B] 513.4 Analysis. A rational analysis supporting the types of smoke control systems to be employed, their methods of operation, the systems supporting them, and the methods of construction to be utilized shall accompany the submitted construction documents and shall include, but not be limited to, the items indicated in Sections 513.4.1 through 513.4.6.

[B] 513.4.1 Stack effect. The system shall be designed such that the maximum probable normal or reverse stack effects will not adversely interfere with the system's capabilities. In determining the maximum probable stack effects, altitude, elevation, weather history and interior temperatures shall be used.

[B] 513.4.2 Temperature effect of fire. Buoyancy and expansion caused by the design fire in accordance with Section 513.9 shall be analyzed. The system shall be designed such that these effects do not adversely interfere with its capabilities.

[B] 513.4.3 Wind effect. The design shall consider the adverse effects of wind. Such consideration shall be consistent with the wind-loading provisions of the *International Building Code*.

[B] 513.4.4 HVAC systems. The design shall consider the effects of the heating, ventilating and air-conditioning (HVAC) systems on both smoke and fire transport. The analysis shall include all permutations of systems' status. The design shall consider the effects of fire on the HVAC systems.

[B] 513.4.5 Climate. The design shall consider the effects of low temperatures on systems, property and occupants. Air inlets and exhausts shall be located so as to prevent snow or ice blockage.

[B] 513.4.6 Duration of operation. All portions of active or passive smoke control systems shall be capable of continued operation after detection of the fire event for not less than 20 minutes.

[B] 513.5 Smoke barrier construction. Smoke barriers shall comply with the *International Building Code*. Smoke barriers shall be constructed and sealed to limit leakage areas exclusive of protected openings. The maximum allowable leakage area shall be the aggregate area calculated using the following leakage area ratios:

1. Walls: $A/A_w = 0.00100$
2. Exit enclosures: $A/A_w = 0.00035$
3. All other shafts: $A/A_w = 0.00150$
4. Floors and roofs: $A/A_f = 0.00050$

where:

A = Total leakage area, square feet (m^2).

A_f = Unit floor or roof area of barrier, square feet (m^2).

A_w = Unit wall area of barrier, square feet (m^2).

The leakage area ratios shown do not include openings due to doors, operable windows or similar gaps. These shall be included in calculating the total leakage area.

[B] 513.5.1 Leakage area. Total leakage area of the barrier is the product of the smoke barrier gross area times the allowable leakage area ratio. Compliance shall be determined by achieving the minimum air pressure difference across the barrier with the system in the smoke control mode for mechanical smoke control systems. Passive smoke control systems tested using other approved means such as door fan testing shall be as approved by the code official.

[B] 513.5.2 Opening protection. Openings in smoke barriers shall be protected by automatic-closing devices actuated by the required controls for the mechanical smoke control system. Door openings shall be protected by door assemblies complying with the requirements of the *International Building Code* for doors in smoke barriers.

Exceptions:

1. Passive smoke control systems with automatic-closing devices actuated by spot-type smoke detectors listed for releasing service installed in accordance with the *International Building Code*.
2. Fixed openings between smoke zones which are protected utilizing the airflow method.
3. In Group I-2 where such doors are installed across corridors, a pair of opposite-swinging doors without a center mullion shall be installed having vision panels with approved fire-rated glazing materials in approved fire-rated frames, the area of which shall not exceed that tested. The doors shall be close fitting within operational tolerances, and shall not have undercuts, louvers or grilles. The

doors shall have head and jamb stops, astragals or rabbets at meeting edges and automatic-closing devices. Positive latching devices are not required.

4. Group I-3.

5. Openings between smoke zones with clear ceiling heights of 14 feet (4267 mm) or greater and bank down capacity of greater than 20 minutes as determined by the design fire size.

[B] 513.5.2.1 Ducts and air transfer openings. Ducts and air transfer openings are required to be protected with a minimum Class II, 250°F (121°C) smoke damper complying with the *International Building Code*.

[B] 513.6 Pressurization method. The primary mechanical means of controlling smoke shall be by pressure differences across smoke barriers. Maintenance of a tenable environment is not required in the smoke control zone of fire origin.

[B] 513.6.1 Minimum pressure difference. The minimum pressure difference across a smoke barrier shall be 0.05-inch water gage (12.4 Pa) in fully sprinklered buildings.

In buildings permitted to be other than fully sprinklered, the smoke control system shall be designed to achieve pressure differences at least two times the maximum calculated pressure difference produced by the design fire.

[B] 513.6.2 Maximum pressure difference. The maximum air pressure difference across a smoke barrier shall be determined by required door-opening or closing forces. The actual force required to open exit doors when the system is in the smoke control mode shall be in accordance with the *International Building Code*. Opening and closing forces for other doors shall be determined by standard engineering methods for the resolution of forces and reactions. The calculated force to set a side-hinged, swinging door in motion shall be determined by:

$$F = F_{dc} + K(WA\Delta P)/2(W-d) \quad (\text{Equation 5-2})$$

where:

A = Door area, square feet (m^2).

d = Distance from door handle to latch edge of door, feet (m).

F = Total door opening force, pounds (N).

F_{dc} = Force required to overcome closing device, pounds (N).

K = Coefficient 5.2 (1.0).

W = Door width, feet (m).

ΔP = Design pressure difference, inches (Pa) water gage.

[B] 513.7 Airflow design method. When approved by the code official, smoke migration through openings fixed in a permanently open position, which are located between smoke control zones by the use of the airflow method, shall be permitted. The design airflows shall be in accordance with this section. Airflow shall be directed to limit smoke migration from the fire zone. The geometry of openings shall be considered to prevent flow reversal from turbulent effects.

[B] 513.7.1 Velocity. The minimum average velocity through a fixed opening shall not be less than:

$$v = 217.2 [h (T_f - T_o) / (T_f + 460)]^{1/2} \quad (\text{Equation 5-3})$$

$$\text{For SI: } v = 119.9 [h (T_f - T_o) / T_f]^{1/2}$$

where:

h = Height of opening, feet (m).

T_f = Temperature of smoke, °F (°K).

T_o = Temperature of ambient air, °F (°K).

v = Air velocity, feet per minute (m/minute).

[B] 513.7.2 Prohibited conditions. This method shall not be employed where either the quantity of air or the velocity of the airflow will adversely affect other portions of the smoke control system, unduly intensify the fire, disrupt plume dynamics or interfere with exiting. In no case shall airflow toward the fire exceed 200 feet per minute (1.02 m/s). Where the formula in Section 513.7.1 requires airflow to exceed this limit, the airflow method shall not be used.

[B] 513.8 Exhaust method. When approved by the code official, mechanical smoke control for large enclosed volumes, such as in atria or malls, shall be permitted to utilize the exhaust method. The design exhaust volumes shall be in accordance with this section.

[B] 513.8.1 Exhaust rate. The height of the lowest horizontal surface of the accumulating smoke layer shall be maintained at least 10 feet (3048 mm) above any walking surface which forms a portion of a required egress system within the smoke zone. The required exhaust rate for the zone shall be the largest of the calculated plume mass flow rates for the possible plume configurations. Provisions shall be made for natural or mechanical supply of outside air from outside or adjacent smoke zones to make up for the air exhausted. Makeup airflow rates, when measured at the potential fire location, shall not exceed 200 feet per minute (1.02 m/s) toward the fire. The temperature of the makeup air shall be such that it does not expose temperature-sensitive fire protection systems beyond their limits

[B] 513.8.2 Axisymmetric plumes. The plume mass flow rate (m_p), in pounds per second (kg/s), shall be determined by placing the design fire center on the axis of the space being analyzed. The limiting flame height shall be determined by:

$$z_l = 0.533 Q_c^{2/5} \quad (\text{Equation 5-4})$$

$$\text{For SI: } z_l = 0.166 Q_c^{2/5}$$

where:

m_p = Plume mass flow rate, pounds per second (kg/s).

Q = Total heat output.

Q_c = Convective heat output, British thermal units per second (kW).

(The value of Q_c shall not be taken as less than $0.70Q$).

z = Height from top of fuel surface to bottom of smoke layer, feet (m).

z_l = Limiting flame height, feet (m). The z_l value must be greater than the fuel equivalent diameter (see Section 513.9).

for $z > z_l$

$$m_p = 0.022 Q_c^{1/3} z^{5/3} + 0.0042 Q_c$$

$$\text{For SI: } m_p = 0.071 Q_c^{1/3} z^{5/3} + 0.0018 Q_c$$

for $z = z_l$

$$m_p = 0.011 Q_c$$

$$\text{For SI: } m_p = 0.035 Q_c$$

for $z < z_l$

$$m_p = 0.0208 Q_c^{3/5} z$$

$$\text{For SI: } m_p = 0.032 Q_c^{3/5} z$$

To convert m_p from pounds per second of mass flow to a volumetric rate, the following formula shall be used:

$$V = 60 m_p / \rho \quad (\text{Equation 5-5})$$

where:

V = Volumetric flow rate, cubic feet per minute (m³/s).

ρ = Density of air at the temperature of the smoke layer, pounds per cubic foot (T : in °F) [kg/m³ (T : in °C)].

[B] 513.8.3 Balcony spill plumes. The plume mass flow rate (m_p) for spill plumes shall be determined using the geometrically probable width based on architectural elements and projections in the following formula:

$$m_p = 0.124 (QW^2)^{1/3} (z_b + 0.25H) \quad (\text{Equation 5-6})$$

$$\text{For SI: } m_p = 0.36 (QW^2)^{1/3} (z_b + 0.25H)$$

where:

H = Height above fire to underside of balcony, feet (m).

m_p = Plume mass flow rate, pounds per second (kg/s).

Q = Total heat output.

W = Plume width at point of spill, feet (m).

z_b = Height from balcony, feet (m).

[B] 513.8.4 Window plumes. The plume mass flow rate (m_p) shall be determined from:

$$m_p = 0.077 (A_w H_w^{1/2})^{1/3} (z_w + a)^{5/3} + 0.18 A_w H_w^{1/2} \quad (\text{Equation 5-7})$$

$$\text{For SI: } m_p = 0.68 (A_w H_w^{1/2})^{1/3} (z_w + a)^{5/3} + 1.5 A_w H_w^{1/2}$$

where:

A_w = Area of the opening, square feet (m²).

H_w = Height of the opening, feet (m).

m_p = Plume mass flow rate, pounds per second (kg/s).

z_w = Height from the top of the window or opening to the bottom of the smoke layer, feet (m).

$$a = 2.4 A_w^{2/5} H_w^{1/5} - 2.1 H_w$$

[B] 513.8.5 Plume contact with walls. When a plume contacts one or more of the surrounding walls, the mass flow rate shall be adjusted for the reduced entrainment resulting

from the contact provided that the contact remains constant. Use of this provision requires calculation of the plume diameter, that shall be calculated by:

$$d = 0.48 [(T_c + 460)/(T_a + 460)]^{1/2} z \quad (\text{Equation 5-8})$$

For SI: $d = 0.48 (T_c/T_a)^{1/2} z$

where:

d = Plume diameter, feet (m).

T_a = Ambient air temperature, °F (°K).

T_c = Plume centerline temperature, °F (°K).

$$= .60 (T_a + 460) Q_c^{2/3} z^{-5/3} + T_a$$

z = Height at which T_c is determined, feet (m).

For SI: $T_c = .08 T_a Q_c^{2/3} z^{-5/3} + T_a$

[B] 513.9 Design fire. The design fire shall be based on a Q of not less than 5,000 Btu per second (5275kW) unless a rational analysis is performed by the registered design professional and approved by the code official. The design fire shall be based on the analysis in accordance with Section 513.4 and this section.

[B] 513.9.1 Factors considered. The engineering analysis shall include the characteristics of the fuel, fuel load, effects included by the fire, and whether the fire is likely to be steady or unsteady.

[B] 513.9.2 Separation distance. Determination of the design fire shall include consideration of the type of fuel, fuel spacing and configuration. The ratio of the separation distance to the fuel equivalent radius shall not be less than 4. The fuel equivalent radius shall be the radius of a circle of equal area to floor area of the fuel package. The design fire shall be increased if other combustibles are within the separation distance as determined by:

$$R = [Q/(12\pi q'')]^{1/2} \quad (\text{Equation 5-9})$$

where:

q'' = Incident radiant heat flux required for nonpiloted ignition, Btu/ft² · s (W/m²).

Q = Heat release from fire, Btu/s (kW).

R = Separation distance from target to center of fuel package, feet (m).

[B] 513.9.3 Heat-release assumptions. The analysis shall make use of the best available data from approved sources and shall not be based on excessively stringent limitations of combustible material.

[B] 513.9.4 Sprinkler effectiveness assumptions. A documented engineering analysis shall be provided for conditions that assume fire growth is halted at the time of sprinkler activation.

[B] 513.10 Equipment. Equipment such as, but not limited to, fans, ducts, automatic dampers and balance dampers shall be suitable for their intended use, suitable for the probable exposure temperatures that the rational analysis indicates, and as approved by the code official.

[B] 513.10.1 Exhaust fans. Components of exhaust fans shall be rated and certified by the manufacturer for the probable temperature rise to which the components will be exposed. This temperature rise shall be computed by:

$$T_s = (Q_c/mc) + (T_a) \quad (\text{Equation 5-10})$$

where:

c = Specific heat of smoke at smoke-layer temperature, Btu/lb.°F (kJ/kg × K).

m = Exhaust rate, pounds per second (kg/s).

Q_c = Convective heat output of fire, Btu/s (kW).

T_a = Ambient temperature, °F (°K).

T_s = Smoke temperature, °F (°K).

Exception: Reduced T_s as calculated based on the assurance of adequate dilution air.

[B] 513.10.2 Ducts. Duct materials and joints shall be capable of withstanding the probable temperatures and pressures to which they are exposed as determined in accordance with Section 513.10.1. Ducts shall be constructed and supported in accordance with Chapter 6. Ducts shall be leak tested to 1.5 times the maximum design pressure in accordance with nationally accepted practices. Measured leakage shall not exceed 5 percent of design flow. Results of such testing shall be a part of the documentation procedure. Ducts shall be supported directly from fire-resistance-rated structural elements of the building by substantial, noncombustible supports.

Exception: Flexible connections, for the purpose of vibration isolation, that are constructed of approved fire-resistance-rated materials.

[B] 513.10.3 Equipment, inlets and outlets. Equipment shall be located so as to not expose uninvolved portions of the building to an additional fire hazard. Outdoor air inlets shall be located so as to minimize the potential for introducing smoke or flame into the building. Exhaust outlets shall be so located as to minimize reintroduction of smoke into the building and to limit exposure of the building or adjacent buildings to an additional fire hazard.

[B] 513.10.4 Automatic dampers. Automatic dampers, regardless of the purpose for which they are installed within the smoke control system shall be listed and conform to the requirements of approved recognized standards.

[B] 513.10.5 Fans. In addition to other requirements, belt-driven fans shall have 1.5 times the number of belts required for the design duty with the minimum number of belts being two. Fans shall be selected for stable performance based on normal temperature and, where applicable, elevated temperature. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Fans shall be supported and restrained by noncombustible devices in accordance with the structural design requirements of the *International Building Code*. Motors driving fans shall not be operating beyond their nameplate horsepower (kilowatts) as determined from measurement of actual current draw. Motors driving fans shall have a minimum service factor of 1.15.

[B] 513.11 Power systems. The smoke control system shall be supplied with two sources of power. Primary power shall be the normal building power systems. Secondary power shall be from an approved standby source complying with the ICC *Electrical Code*. The standby power source and its transfer

switches shall be in a separate room from the normal power transformers and switch gear and shall be enclosed in a room of not less than 1-hour fire-resistance-rated construction, ventilated directly to and from the exterior. Power distribution from the two sources shall be by independent routes. Transfer to full standby power shall be automatic and within 60 seconds of failure of the primary power. The systems shall comply with the *ICC Electrical Code*.

[B] 513.11.1 Power sources and power surges. Elements of the smoke management system relying on volatile memories or the like shall be supplied with uninterruptable power sources of sufficient duration to span 15-minute primary power interruption. Elements of the smoke management system susceptible to power surges shall be suitably protected by conditioners, suppressors or other approved means.

[B] 513.12 Detection and control systems. Fire detection systems providing control input or output signals to mechanical smoke control systems or elements thereof shall comply with the requirements of Chapter 9 of the *International Building Code* and NFPA 72. Such systems shall be equipped with a control unit complying with UL 864 and listed as smoke control equipment.

Control systems for mechanical smoke control systems shall include provisions for verification. Verification shall include positive confirmation of actuation, testing, manual override, the presence of power downstream of all disconnects and, through a preprogrammed weekly test sequence report, abnormal conditions audibly, visually and by printed report.

[B] 513.12.1 Wiring. In addition to meeting the requirements of the *ICC Electrical Code*, all wiring, regardless of voltage, shall be fully enclosed within continuous raceways.

[F] 513.12.2 Activation. Smoke control systems shall be activated in accordance with the *International Building Code*.

[F] 513.12.3 Automatic control. Wherever completely automatic control is required or used, the automatic-control sequences shall be initiated from an appropriately zoned automatic sprinkler system complying with Section 903.3.1.1 of the *International Fire Code* or from an appropriately zoned, total coverage smoke detection system complying with NFPA 72.

[B] 513.13 Control-air tubing. Control-air tubing shall be of sufficient size to meet the required response times. Tubing shall be flushed clean and dry prior to final connections. Tubing shall be adequately supported and protected from damage. Tubing passing through concrete or masonry shall be sleeved and protected from abrasion and electrolytic action.

[B] 513.13.1 Materials. Control-air tubing shall be hard-drawn copper, Type L, ACR in accordance with ASTM B 42, ASTM B 43, ASTM B 68, ASTM B 88, ASTM B 251 and ASTM B 280. Fittings shall be wrought copper or brass, solder type in accordance with ASME B 16.18 or ASME B 16.22. Changes in direction shall be made with appropriate tool bends. Brass compression-type fittings shall be used at final connection to devices; other joints shall be brazed using a BCuP5 brazing alloy with solidus above 1,100°F

(593°C) and liquids below 1,500°F (816°C). Brazing flux shall be used on copper-to-brass joints only.

Exception: Nonmetallic tubing used within control panels and at the final connection to devices provided all of the following conditions are met:

1. Tubing shall be listed by an approved agency for flame and smoke characteristics.
2. Tubing and connected device shall be completely enclosed within a galvanized or paint-grade steel enclosure of not less than 0.030 inch (0.76 mm) (No. 22 galvanized sheet gage) thickness. Entry to the enclosure shall be by copper tubing with a protective grommet of neoprene or teflon or by suitable brass compression to male barbed adapter.
3. Tubing shall be identified by appropriately documented coding.
4. Tubing shall be neatly tied and supported within the enclosure. Tubing bridging cabinets and doors or moveable devices shall be of sufficient length to avoid tension and excessive stress. Tubing shall be protected against abrasion. Tubing serving devices on doors shall be fastened along hinges.

[B] 513.13.2 Isolation from other functions. Control tubing serving other than smoke control functions shall be isolated by automatic isolation valves or shall be an independent system.

[B] 513.13.3 Testing. Test control-air tubing at three times the operating pressure for not less than 30 minutes without any noticeable loss in gauge pressure prior to final connection to devices.

[B] 513.14 Marking and identification. The detection and control systems shall be clearly marked at all junctions, accesses and terminations.

[F] 513.15 Control diagrams. Identical control diagrams shall be provided and maintained as required by the *International Fire Code*.

[F] 513.16 Fire fighter's smoke control panel. A fire fighter's smoke control panel for fire department emergency response purposes only shall be provided in accordance with the *International Fire Code*.

[F] 513.17 System response time. Smoke control system activation shall comply with the *International Fire Code*.

[F] 513.18 Acceptance testing. Devices, equipment, components and sequences shall be tested in accordance with the *International Fire Code*.

[F] 513.19 System acceptance. Acceptance of the smoke control system shall be in accordance with the *International Fire Code*.

[B] 513.20 Underground building smoke exhaust system. Where required by the *International Building Code* for underground buildings, a smoke exhaust system shall be provided in accordance with this section.

[B] 513.20.1 Exhaust capability. Where compartmentation is required, each compartment shall have an independent, automatically activated smoke exhaust system

capable of manual operation. The system shall have an air supply and smoke exhaust capability that will provide a minimum of six air changes per hour.

[F] 513.20.2 Operation. The smoke exhaust system shall be operated in accordance with the *International Fire Code*.

[F] 513.20.3 Alarm required. Activation of the smoke exhaust system shall activate an audible alarm at a constantly attended location in accordance with the *International Fire Code*.

CHAPTER 6

DUCT SYSTEMS

SECTION 601 GENERAL

601.1 Scope. Duct systems used for the movement of air in air-conditioning, heating, ventilating and exhaust systems shall conform to the provisions of this chapter except as otherwise specified in Chapters 5 and 7.

Exception: Ducts discharging combustible material directly into any combustion chamber shall conform to the requirements of NFPA 82.

[B] 601.2 Air movement in egress elements. Exit and exit access corridors shall not serve as supply, return, exhaust, relief or ventilation air ducts or plenums except as permitted by the *International Building Code*.

601.3 Contamination prevention. Exhaust ducts under positive pressure, chimneys, and vents shall not extend into or pass through ducts or plenums.

SECTION 602 PLENUMS

602.1 General. A plenum is an enclosed portion of the building structure that is designed to allow air movement, and thereby serve as part of an air distribution system. Supply, return, exhaust, relief and ventilation air plenums shall be limited to uninhabited crawl spaces, areas above a ceiling or below the floor, attic spaces and mechanical equipment rooms. Plenums shall be limited to one fire area. Fuel-fired appliances shall not be installed within a plenum.

602.2 Construction. Plenum enclosures shall be constructed of materials permitted for the type of construction classification of the building.

The use of gypsum boards to form plenums shall be limited to systems where the air temperatures do not exceed 125°F (52°C) and the building and mechanical system design conditions are such that the gypsum board surface temperature will be maintained above the airstream dew-point temperature. Air plenums formed by gypsum boards shall not be incorporated in air-handling systems utilizing evaporative coolers.

602.2.1 Materials exposed within plenums. Except as required by Sections 602.2.1.1 through 602.2.1.4, materials exposed within plenums shall be noncombustible or shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84.

Exceptions:

1. Rigid and flexible ducts and connectors shall conform to Section 603.
2. Duct coverings, linings, tape and connectors shall conform to Sections 603 and 604.

3. This section shall not apply to materials exposed within plenums in one- and two-family dwellings.

4. This section shall not apply to smoke detectors.

602.2.1.1 Wiring. Combustible electrical or electronic wiring methods and materials, optical fiber cable, and optical fiber raceway exposed within a plenum shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread not greater than 5 feet (1524 mm) when tested in accordance with UL 910. Only type OFNP (plenum-rated nonconductive optical fiber cable) shall be installed in plenum-rated optical fiber raceways. Wiring, cable, and raceways addressed in this section shall be listed and labeled as plenum rated and shall be installed in accordance with ICC *Electrical Code*.

602.2.1.2 Fire sprinkler piping. Plastic fire sprinkler piping exposed within a plenum shall be used only in wet pipe systems and shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread of not greater than 5 feet (1524 mm) when tested in accordance with UL 1887. Piping shall be listed and labeled.

602.2.1.3 Pneumatic tubing. Combustible pneumatic tubing exposed within a plenum shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread of not greater than 5 feet (1524 mm) when tested in accordance with UL 1820. Combustible pneumatic tubing shall be listed and labeled.

602.2.1.4 Combustible electrical equipment. Combustible electrical equipment exposed within a plenum shall have a peak rate of heat release not greater than 100 kilowatts, a peak optical density not greater than 0.50, and an average optical density not greater than 0.15 when tested in accordance with UL 2043. Combustible electrical equipment shall be listed and labeled.

602.3 Stud cavity and joist space plenums. Stud wall cavities and the spaces between solid floor joists to be utilized as air plenums shall comply with the following conditions:

1. Such cavities or spaces shall not be utilized as a plenum for supply air.
2. Such cavities or spaces shall not be part of a required fire-resistance-rated assembly.
3. Stud wall cavities shall not convey air from more than one floor level.
4. Stud wall cavities and joist space plenums shall comply with the floor penetration protection requirements of the *International Building Code*.

5. Stud wall cavities and joist space plenums shall be isolated from adjacent concealed spaces by approved fireblocking as required in the *International Building Code*.

602.4 Flood hazard. For structures located in a flood-hazard zone or a high-hazard zone, plenum spaces shall be located above the base flood elevation or shall be protected so as to prevent water from entering or accumulating within the plenum space during floods up to the base flood elevation. If the plenum spaces are located below the base flood elevation, they shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the base flood elevation.

SECTION 603

DUCT CONSTRUCTION AND INSTALLATION

603.1 General. An air distribution system shall be designed and installed to supply the required distribution of air. The installation of an air distribution system shall not affect the fire protection requirements specified in the *International Building Code*. Ducts shall be constructed, braced, reinforced and installed to provide structural strength and durability.

603.2 Duct classification. Ducts shall be classified based on the maximum operating pressure of the duct at pressures of positive or negative 0.5, 1.0, 2.0, 3.0, 4.0, 6.0, or 10.0 inches of water column. The pressure classification of ducts shall equal or exceed the design pressure of the air distribution in which the ducts are utilized.

603.3 Metallic ducts. All metallic ducts shall be constructed as specified in the SMACNA *HVAC Duct Construction Standards—Metal and Flexible*.

Exception: Ducts installed within single dwelling units shall have a minimum thickness as specified in Table 603.3.

TABLE 603.3
DUCT CONSTRUCTION MINIMUM SHEET METAL
THICKNESSES FOR SINGLE DWELLING UNITS

DUCT SIZE	GALVANIZED STEEL		APPROXIMATE ALUMINUM B&S GAGE
	Minimum thickness (inches)	Equivalent galvanized Gage No.	
Round ducts and enclosed rectangular ducts 14" or less Over 14"	0.013	30	26
	0.016	28	24
Exposed rectangular ducts 14" or less Over 14"	0.016	28	24
	0.019	26	22

For SI: 1 inch = 25.4 mm.

Comm 64.0603 Note: For DHFS licensed healthcare facilities as specified in chs. HFS 124, 131, 132, and 134, also refer to the following standards: Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), *HVAC Duct Construction Standards—Metal and Flexible*, 1995 edition.

603.4 Nonmetallic ducts. Nonmetallic ducts shall be constructed with Class 0 or Class 1 duct material in accordance with UL 181. Fibrous duct construction shall conform to the SMACNA *Fibrous Glass Duct Construction Standards* or NAIMA *Fibrous Glass Duct Construction Standards*. The

maximum air temperature within nonmetallic ducts shall not exceed 250°F (121°C).

603.4.1 Gypsum ducts. The use of gypsum boards to form air shafts (ducts) shall be limited to return air systems where the air temperatures do not exceed 125°F (52°C) and the gypsum board surface temperature is maintained above the airstream dew-point temperature. Air ducts formed by gypsum boards shall not be incorporated in air-handling systems utilizing evaporative coolers.

Comm 64.0603 Note: For DHFS licensed healthcare facilities as specified in chs. HFS 124, 131, 132, and 134, also refer to the following standards: Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), *HVAC Duct Construction Standards—Metal and Flexible*, 1995 edition.

603.5 Flexible air ducts and flexible air connectors. Flexible air ducts, both metallic and nonmetallic, shall comply with Sections 603.5.1, 603.5.1.1, 603.5.3 and 603.5.4. Flexible air connectors, both metallic and nonmetallic, shall comply with Sections 603.5.2 through 603.5.4.

603.5.1 Flexible air ducts. Flexible air ducts, both metallic and nonmetallic, shall be tested in accordance with UL 181. Such ducts shall be listed and labeled as Class 0 or Class 1 flexible air ducts and shall be installed in accordance with Section 304.1.

603.5.1.1 Duct length. Flexible air ducts shall not be limited in length.

603.5.2 Flexible air connectors. Flexible air connectors, both metallic and nonmetallic, shall be tested in accordance with UL 181. Such connectors shall be listed and labeled as Class 0 or Class 1 flexible air connectors and shall be installed in accordance with Section 304.1.

603.5.2.1 Connector length. Flexible air connectors shall be limited in length to 14 feet (4267 mm).

603.5.3 Air temperature. The design temperature of air to be conveyed in flexible air ducts and flexible air connectors shall be less than 250°F (121°C).

603.5.4 Flexible air duct and air connector clearance. Flexible air ducts and air connectors shall be installed with a minimum clearance to an appliance as specified in the appliance manufacturer's installation instructions.

603.6 Rigid duct penetrations. Duct system penetrations of walls, floors, ceilings and roofs and air transfer openings in such building components shall be protected as required by Section 607.

603.7 Underground ducts. Ducts shall be approved for underground installation. Metallic ducts not having an approved protective coating shall be completely encased in a minimum of 2 inches (51 mm) of concrete.

603.7.1 Slope. Ducts shall slope to allow drainage to a point provided with access.

603.7.2 Sealing. Ducts shall be sealed and secured prior to pouring the concrete encasement.

603.7.3 Flood hazard. All underground ducts located in a flood-hazard zone or a high-hazard zone shall be located above the base flood elevation or shall be protected so as to prevent water from entering or accumulating within the

ducts during floods up to the base flood elevation. If the ducts are located below the base flood elevation, the ducts shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the base flood elevation.

603.7.4 Plastic ducts and fittings. Plastic ducts shall be constructed of PVC having a minimum pipe stiffness of 8 psi (55 kPa) at 5-percent deflection when tested in accordance with ASTM D 2412. Plastic duct fittings shall be constructed of either PVC or high-density polyethylene. Plastic duct and fittings shall be utilized in underground installations only. The maximum design temperature for systems utilizing plastic duct and fittings shall be 150°F (66°C).

603.8 Joints, seams and connections. All longitudinal and transverse joints, seams and connections shall be securely fastened and sealed in accordance with the *International Energy Conservation Code*.

603.9 Supports. Ducts shall be supported with approved hangers at intervals not exceeding 10 feet (3048 mm) or by other approved duct support systems designed in accordance with the *International Building Code*. Flexible and other factory-made ducts shall be supported in accordance with the manufacturer's installation instructions.

603.10 Furnace connections. Ducts connecting to a furnace shall have a clearance to combustibles in accordance with the furnace manufacturer's installation instructions.

603.11 Condensation. Provisions shall be made to prevent the formation of condensation on the exterior of any duct.

603.12 Location. Ducts shall not be installed in or within 4 inches (102 mm) of the earth, except where such ducts comply with Section 603.7.

603.13 Mechanical protection. Ducts installed in locations where they are exposed to mechanical damage by vehicles or from other causes shall be protected by approved barriers.

603.14 Weather protection. All ducts including linings, coverings and vibration isolation connectors installed on the exterior of the building shall be adequately protected against the elements.

603.15 Registers, grilles and diffusers. Duct registers, grilles and diffusers shall be installed in accordance with the manufacturer's installation instructions. Balancing dampers or other means of supply air adjustment shall be provided in the branch ducts or at each individual duct register, grille or diffuser.

603.15.1 Floor registers. Floor registers shall resist, without structural failure, a 200-pound (890 N) concentrated load on a 2-inch-diameter (51 mm) disc applied to the most critical area of the exposed face.

Comm 64.0300 Specific criteria for operating rooms and autopsy rooms. In operating rooms of hospitals and ambulatory surgery center rooms and autopsy rooms, the bottoms of ventilation supply and return openings shall be at least 3 inches (76 mm) above the floor.

SECTION 604 INSULATION

604.1 General. Duct insulation shall conform to the requirements of Sections 604.2 through 604.11 and the *International Energy Conservation Code*.

604.2 Surface temperature. Ducts that operate at temperatures exceeding 120°F (49°C) shall have sufficient thermal insulation to limit the exposed surface temperature to 120°F (49°C).

604.3 Coverings and linings. Coverings and linings, including adhesives when used, shall have a flame spread index not more than 25 and a smoke-developed index not more than 50, when tested in accordance with ASTM E 84. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C 411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F (121°C).

604.4 Foam plastic insulation. Foam plastic shall conform to the requirements of Section 604 and the *International Building Code*.

604.5 Appliance insulation. Listed and labeled appliances that are internally insulated shall be considered as conforming to the requirements of Section 604.

604.6 Penetration of assemblies. Duct coverings shall not penetrate a wall or floor required to have a fire-resistance rating or required to be fireblocked.

604.7 Identification. External duct insulation and factory-insulated flexible duct shall be legibly printed or identified at intervals not greater than 36 inches (914 mm) with the name of the manufacturer; the thermal resistance *R*-value at the specified installed thickness; and the flame spread and smoke-developed indexes of the composite materials. All duct insulation product *R*-values shall be based on insulation only, excluding air films, vapor retarders, or other duct components, and shall be based on tested *C*-values at 75°F (24°C) mean temperature at the installed thickness, in accordance with recognized industry procedures. The installed thickness of duct insulation used to determine its *R*-values shall be determined as follows:

1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
2. For duct wrap, the installed thickness shall be assumed to be 75 percent (25-percent compression) of nominal thickness.
3. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

604.8 Lining installation. Linings shall be interrupted at the area of operation of a fire damper and at a minimum of 6 inches (152 mm) upstream of and 6 inches (152 mm) downstream of electric-resistance and fuel-burning heaters in a duct system. Metal nosings or sleeves shall be installed over exposed duct liner edges that face opposite the direction of airflow.

Comm 64.0604 (1) General.

(a) 1. Except as provided under subd. 2., in hospitals and ambulatory surgery centers, duct linings exposed to air movement shall not be used in ducts serving operating rooms, delivery rooms, labor, delivery and recovery rooms, nurseries, protective environment rooms and critical care units.

2. In hospitals and ambulatory surgery centers, the requirement in subd. 1. does not apply to mixing boxes and acoustical traps that have special coverings over such lining to mitigate fungal and microbial growth.

(b) In hospitals and ambulatory surgery centers, duct lining shall not be installed within 15 feet (4572 mm) downstream of humidifiers or as necessary to prevent moisture accumulation in the lining.

Comm 64.0604 (3) Exception: The distances from a listed duct lining to a heater may be reduced in accordance with the duct lining listing.

604.9 Thermal continuity. Where a duct liner has been interrupted, a duct covering of equal thermal performance shall be installed.

604.10 Service openings. Service openings shall not be concealed by duct coverings unless the exact location of the opening is properly identified.

604.11 Vapor retarders. Where ducts used for cooling are externally insulated, the insulation shall be covered with a vapor retarder having a maximum permeance of 0.05 perm [$2.87 \text{ ng}/(\text{Pa} \cdot \text{s} \cdot \text{m}^2)$] or aluminum foil having a minimum thickness of 2 mils (0.051 mm). Insulations having a permeance of 0.05 perms [$2.87 \text{ ng}/(\text{Pa} \cdot \text{s} \cdot \text{m}^2)$] or less shall not be required to be covered. All joints and seams shall be sealed to maintain the continuity of the vapor retarder.

604.12 Weatherproof barriers. Insulated exterior ducts shall be protected with an approved weatherproof barrier.

604.13 Internal insulation. Materials used as internal insulation and exposed to the airstream in ducts shall be shown to be durable when tested in accordance with UL 181. Exposed internal insulation that is not impermeable to water shall not be used to line ducts or plenums from the exit of a cooling coil to the downstream end of the drain pan.

SECTION 605 AIR FILTERS

605.1 General. Heating and air-conditioning systems of the central type shall be provided with approved air filters. Filters shall be installed in the return air system, upstream from any heat exchanger or coil, in an approved convenient location. Liquid adhesive coatings used on filters shall have a flash point not lower than 325°F (163°C).

Comm 64.0605 Exceptions:

(1) Central air-handling systems in hospitals, nursing homes and ambulatory surgery centers shall comply with the applicable filtration requirements specified in section 7.31.D8, 8.31.D5, 9.31.D8 or 11.31.D4 of the AIA Guidelines for Design and Construction of Hospital and Health Care Facilities.

(2) Noncentral air-handling systems in hospitals, nursing homes and ambulatory surgery centers shall be equipped with permanent cleanable or replaceable filters with a minimum efficiency of 68 percent weight arrestance.

(3) In hospitals and ambulatory surgery centers, noncentral air-handling systems shall be used as recirculating units only. All outdoor air requirements shall be met by a separate central air-handling system with the filtration as provided in sub. (1).

(4) Preheat coils for snow melting that are single row, have a maximum 8 fins per inch, are accessible for pressure washing and have ductwork that is designed for drainage need not be provided with air filters.

605.2 Approval. Media-type and electrostatic-type air filters shall be listed and labeled. Air filters utilized within dwelling units shall be designed for the intended application and shall not be required to be listed and labeled.

605.3 Airflow over the filter. Ducts shall be constructed to allow an even distribution of air over the entire filter.

SECTION 606 SMOKE DETECTION SYSTEMS CONTROL

606.1 Controls required. Air distribution systems shall be equipped with smoke detectors listed and labeled for installation in air distribution systems, as required by this section.

606.2 Where required. Smoke detectors shall be installed where indicated in Sections 606.2.1 through 606.2.3.

Exception: Smoke detectors shall not be required where air distribution systems are incapable of spreading smoke beyond the enclosing walls, floors and ceilings of the room or space in which the smoke is generated.

606.2.1 Return air systems. Smoke detectors shall be installed in return air systems with a design capacity greater than 2,000 cfm (0.9 m³/s), in the return air duct or plenum upstream of any filters, exhaust air connections, outdoor air connections, or decontamination equipment and appliances.

Comm 64.0606 (1) Note: For DHFS licensed healthcare facilities, as specified in chs. HFS 124, 131, 132, and 134, also refer to NFPA standard 90A section 4-4.2A for air handling units between 2,000 cfm and 15,000 cfm.

Exception: Smoke detectors are not required in the return air system where the space served by the air distribution system is protected by a system of area smoke detectors in accordance with the *International Building Code*. The area smoke detector system shall comply with Section 606.4.

606.2.2 Common supply and return air systems. Where multiple air-handling systems share common supply or return air ducts or plenums with a combined design capacity greater than 2,000 cfm (0.9 m³/s), the return air system shall be provided with smoke detectors in accordance with Section 606.2.1.

Exception: Individual smoke detectors shall not be required for each variable air volume (VAV) zone unit or

VAV-type fan-powered terminal unit, provided that such units do not have an individual design capacity greater than 2,000 cfm (0.9 m³/s) and will be shut down by activation of one of the following:

1. Smoke detectors required by Sections 606.2.1 and 606.2.3.
2. An approved area smoke detector system located in the return air plenum serving such units.
3. An area smoke detector system as prescribed in the exception to Section 606.2.1.

In all cases, the smoke detectors shall comply with Sections 606.4 and 606.4.1.

606.2.3 Return air risers. Where return air risers serve two or more stories and are part of a return air system having a design capacity greater than 15,000 cfm (7.1 m³/s), smoke detectors shall be installed at each story. Such smoke detectors shall be located upstream of the connection between the return air riser and any air ducts or plenums.

606.3 Installation. Smoke detectors required by this section shall be installed in accordance with NFPA 72. The required smoke detectors shall be installed to monitor the entire airflow conveyed by the system including return air and exhaust or relief air. Access shall be provided to smoke detectors for inspection and maintenance.

606.4 Controls operation. Upon activation, the smoke detectors shall shut down the air distribution system. Air distribution systems that are part of a smoke control system shall switch to the smoke control mode upon activation of a detector.

606.4.1 Supervision. The smoke detectors shall be connected to a fire alarm system. The actuation of a smoke detector shall activate a visible and audible supervisory signal at a constantly attended location.

Exceptions:

1. The supervisory signal at a constantly attended location is not required where the smoke detector activates the building's alarm-indicating appliances.
2. In occupancies not required to be equipped with a fire alarm system, actuation of a smoke detector shall activate a visible and an audible signal in an approved location. Smoke detector trouble conditions shall activate a visible or audible signal in an approved location and shall be identified as air duct detector trouble.

Comm 64.0606 (2) Note: For DHFS licensed healthcare facilities as specified in chs. HFS 124, 131, 132, and 134, also refer to NFPA standard 90A section 4-3.2 for smoke dampers isolating air handling units.

**[B] SECTION 607
DUCTS AND AIR TRANSFER OPENINGS**

607.1 General. The provisions of this section shall govern the protection of duct penetrations and air transfer openings in fire-resistance-rated assemblies.

607.1.1 Ducts and air transfer openings without dampers. Ducts and air transfer openings that penetrate fire-resistant-rated assemblies and are not required to have dampers

by this section shall comply with the requirements of Section 711 of the *International Building Code*.

607.2 Installation. Fire dampers, smoke dampers, combination fire/smoke dampers and ceiling dampers located within air distribution and smoke control systems shall be installed in accordance with the requirements of this section, and the manufacturer's installation instructions and listing.

607.2.1 Smoke control system. Where the installation of a fire damper will interfere with the operation of a required smoke control system in accordance with Section 513, approved alternative protection shall be utilized.

607.2.2 Hazardous exhaust ducts. Fire dampers for hazardous exhaust duct systems shall comply with Section 510.

607.3 Damper testing and ratings. Dampers shall be listed and bear the label of an approved testing agency indicating compliance with the standards in this section. Fire dampers shall comply with the requirements of UL 555. Only fire dampers labeled for use in dynamic systems shall be installed in heating, ventilation and air-conditioning systems designed to operate with fans on during a fire. Smoke dampers shall comply with the requirements of UL 555S. Combination fire/smoke dampers shall comply with the requirements of both UL 555 and 555S. Ceiling radiation dampers shall comply with the requirements of UL 555C.

607.3.1 Fire protection rating. Fire dampers shall have the minimum fire protection rating specified in Table 607.3.1 for the type of penetration.

607.3.1.1 Fire damper actuating device. The fire damper actuating device shall meet one of the following requirements:

1. The operating temperature shall be approximately 50°F (27.8°C) above the normal temperature within the duct system, but not less than 160°F (71°C).
2. The operating temperature shall be not more than 286°F (141°C) where located in a smoke control system complying with Section 513.
3. Where a combination fire/smoke damper is located in a smoke control system complying with Section 513, the operating temperature rating shall be approximately 50°F (27.8°C) above the maximum smoke control system designed operating temperature, or a maximum temperature of 350°F (177°C). The temperature shall not exceed the UL 555S degradation test temperature rating for a combination fire/smoke damper.

**TABLE 607.3.1
FIRE DAMPER RATING**

TYPE OF PENETRATION	MINIMUM DAMPER RATING (hour)
Less than 3-hour fire-resistance-rated assemblies	1½
3-hour or greater fire-resistance-rated assemblies	3

607.3.2 Smoke damper ratings. Smoke damper leakage ratings shall not be less than Class II. Elevated temperature ratings shall be not less than 250°F (121°C).

607.3.2.1 Smoke damper actuation methods. The smoke damper shall close upon actuation of a listed smoke detector or detectors installed in accordance with Section 907.10 and one of the following methods, as applicable:

1. Where a damper is installed within a duct, a smoke detector shall be installed in the duct within 5 feet (1524 mm) of the damper with no air outlets or inlets between the detector and the damper. The detector shall be listed for the air velocity, temperature and humidity anticipated at the point where it is installed. Other than in mechanical smoke control systems, dampers shall be closed upon fan shutdown where local smoke detectors require a minimum velocity to operate.
2. Where a damper is installed above smoke barrier doors in a smoke barrier, a spot-type detector listed for releasing service shall be installed on either side of the smoke barrier door opening.
3. Where a damper is installed within an unducted opening in a wall, spot-type detector listed for releasing service shall be installed within 5 feet (1524 mm) horizontally of the damper.
4. Where a damper is installed in a corridor wall, the damper shall be permitted to be controlled by a smoke detection system installed in the corridor.
5. Where a total-coverage smoke detector system is provided within areas served by an HVAC system, dampers shall be permitted to be controlled by the smoke detection system.

607.4 Access and identification. Fire and smoke dampers shall be provided with an approved means of access, large enough to permit inspection and maintenance of the damper and its operating parts. The access shall not affect the integrity of fire-resistance-rated assemblies. The access openings shall not reduce the fire-resistance rating of the assembly. Access points shall be permanently identified on the exterior by a label having letters not less than 0.5 inch (12.7 mm) in height reading: SMOKE DAMPER or FIRE DAMPER. Access doors in ducts shall be tight fitting and suitable for the required duct construction.

607.5 Where required. Fire dampers, smoke dampers, combination fire/smoke dampers and ceiling radiation dampers shall be provided at the location prescribed in this section. Where an assembly is required to have both fire dampers and smoke dampers, combination fire/smoke dampers or a fire damper and a smoke damper shall be required.

607.5.1 Fire walls. Ducts and air transfer openings permitted in fire walls in accordance with Section 705.11 of the *International Building Code* shall be protected with approved fire dampers installed in accordance with their listing.

607.5.2 Fire barriers. Duct penetrations and air transfer openings in fire barriers shall be protected with approved fire dampers installed in accordance with their listing.

Exceptions: Fire dampers are not required at penetrations of fire barriers where any of the following apply:

1. Penetrations are tested in accordance with ASTM E 119 as part of the fire-resistance rated assembly.
2. Ducts are used as part of an approved smoke control system in accordance with Section 513.
3. Such walls are penetrated by ducted HVAC systems, have a required fire-resistance rating of 1 hour or less, are in areas of other than Group H and are in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 of the *International Building Code*.

607.5.3 Fire partitions. Duct penetrations in fire partitions shall be protected with approved fire dampers installed in accordance with their listing.

Exceptions: In occupancies other than Group H, fire dampers are not required where any of the following apply:

1. The partitions are tenant separation and corridor walls in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 of the *International Building Code*.
2. The duct system is constructed of approved materials in accordance with this code and the duct penetrating the wall meets all of the following minimum requirements:
 - 2.1. The duct shall not exceed 100 square inches (0.06 m²).
 - 2.2. The duct shall be constructed of steel a minimum of 0.0217 inch (0.55 mm) in thickness.
 - 2.3. The duct shall not have openings that communicate the corridor with adjacent spaces or rooms.
 - 2.4. The duct shall be installed above a ceiling.
 - 2.5. The duct shall not terminate at a wall register in the fire-resistance-rated wall.

607.5.4 Corridors/smoke barriers. A listed smoke damper designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a smoke barrier wall or a corridor wall required to have smoke and draft control doors in accordance with the *International Building Code*.

Exceptions:

1. Smoke dampers are not required in corridor penetrations where the building is equipped throughout with an approved smoke control system in accordance with Section 513 and smoke dampers are not necessary for the operation and control of the system.
2. Smoke dampers are not required in smoke barrier penetrations where the openings in ducts are limited to a single smoke compartment and the ducts are constructed of steel.

3. Smoke dampers are not required in corridor penetrations where the duct is constructed of steel not less than 0.019 inch (0.48 mm) in thickness and there are no openings serving the corridor.

607.5.4.1 Smoke damper. The smoke damper shall close upon actuation of a listed smoke detector or detectors installed in accordance with the *International Building Code* and one of the following methods, as applicable:

1. Where a damper is installed within a duct, a smoke detector shall be installed in the duct within 5 feet (1524 mm) of the damper with no air outlets or inlets between the detector and the damper. The detector shall be listed for the air velocity, temperature and humidity anticipated at the point where it is installed.
2. Where a damper is installed above smoke barrier doors in a smoke barrier, a spot-type detector listed for releasing service shall be installed on either side of the smoke barrier door opening.
3. Where a damper is installed within an unducted opening in a wall, a spot-type detector listed for releasing service shall be installed within 5 feet (1524 mm) horizontally of the damper.
4. Where a damper is installed in a corridor wall, the damper shall be permitted to be controlled by a smoke detection system installed in the corridor.
5. Where a total-coverage smoke detector system is provided within all areas served by an HVAC system, dampers shall be permitted to be controlled by the smoke detection system.

607.5.5 Shaft enclosures. Ducts and air transfer openings shall not penetrate a shaft serving as an exit enclosure except as permitted by Section 1005.3.4.1 of the *International Building Code*.

607.5.5.1 Penetrations of shaft enclosures. Shaft enclosures that are permitted to be penetrated by ducts and air transfer openings shall be protected with approved fire and smoke dampers installed in accordance with their listing.

Exceptions: Fire dampers are not required at penetrations of shafts where:

1. Steel exhaust subducts extend at least 22 inches (559 mm) vertically in exhaust provided there is a continuous airflow upward to the outside.
2. Penetrations are tested in accordance with ASTM E 119 as part of the fire-resistance rated assembly.
3. Ducts are used as part of an approved smoke-control system in accordance with Section 909 of the *International Building Code*.
4. The penetrations are in parking garage exhaust or supply shafts that are separated from other buildings shafts by not less than 2-hour fire-resistance-rated construction.

607.6 Horizontal assemblies. Penetrations by air ducts of a floor, floor/ceiling assembly or the ceiling membrane of a

roof/ceiling assembly shall be protected by a shaft enclosure that complies with the *International Building Code* or shall comply with this section.

607.6.1 Through penetrations. In occupancies other than Groups I-2 and I-3, a duct and air transfer opening system constructed of approved materials in accordance with this code that penetrates a fire-resistance-rated floor/ceiling assembly that connects not more than two stories is permitted without shaft enclosure protection provided a fire damper is installed at the floor line.

607.6.2 Membrane penetrations. Where duct systems constructed of approved materials in accordance with this code penetrate a ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly, shaft enclosure protection is not required provided an approved ceiling radiation damper is installed at the ceiling line. Where a duct is not attached to a diffuser that penetrates a ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly, shaft enclosure protection is not required provided an approved ceiling radiation damper is installed at the ceiling line. Ceiling radiation dampers shall be installed in accordance with UL 555C and constructed in accordance with the details listed in a fire-resistance-rated assembly or shall be labeled to function as a heat barrier for air-handling outlet/inlet penetrations in the ceiling of a fire-resistance-rated assembly. Ceiling radiation dampers shall not be required where ASTM E 119 fire tests have shown that ceiling radiation dampers are not necessary in order to maintain the fire-resistance rating of the assembly.

607.6.3 Nonfire-resistance-rated assemblies. Duct systems constructed of approved materials in accordance with this code that penetrate nonfire-resistance-rated floor assemblies that connect not more than two stories are permitted without shaft enclosure protection provided that the annular space between the assembly and the penetrating duct is filled with an approved noncombustible material to resist the free passage of flame and the products of combustion. Duct systems constructed of approved materials in accordance with this code that penetrate non-rated floor assemblies that connect not more than three stories are permitted without shaft enclosure protection provided that the annular space between the assembly and the penetrating duct is filled with an approved noncombustible material to resist the free passage of flame and the products of combustion, and a fire damper is installed at each floor line.

Exception: Fire dampers are not required in ducts within individual residential dwelling units.

607.7 Flexible ducts and air connectors. Flexible ducts and air connectors shall not pass through any fire-resistance-rated assembly. Flexible air connectors shall not pass through any wall, floor or ceiling.