



2024 I-Code A2L Refrigerant Related Changes

Based on the
2021 International Fire Code®
2021 International Building Code® and
2021 International Mechanical Code®

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2021 International Fire Code

CHAPTER 2: DEFINITIONS

FLAMMABLE GAS. A material that is a gas at 68°F (20°C) or less at 14.7 pounds per square inch atmosphere (psia) (101 kPa) of pressure [a material that has a *boiling point* of 68°F (20°C) or less at 14.7 psia (101 kPa)] ~~which is subdivided as follows:~~

1. ~~Category 1A.~~
1. A gas that is ignitable at 14.7 psia (101 kPa) when in a mixture of 13 percent or less by volume with air; or ~~has~~

2. A gas with a flammable range at 14.7 psia (101 kPa) with air of not less than 12 percent, regardless of the lower limit, unless data show compliance with Category 1B.
2. Category 1B.
A gas that meets the flammability criteria for Category 1A, is not pyrophoric or chemically unstable, and meets one of more of the following:

1. A lower flammability limit of more than 6 percent by volume of air; or

2. A fundamental burning velocity of less than 3.9 in/s (10 cm/s).

The limits specified shall be determined at 14.7 psia (101 kPa) of pressure and a temperature of 68°F (20°C) in accordance with ASTM E681.

Where not otherwise specified, the term "flammable gas" includes both Category 1A and Category 1B.

CHAPTER 6: BUILDING SERVICES AND SYSTEMS

[M] 608.17 Electrical equipment. Where refrigerant of Groups A2, A3, B2 and B3, as defined in the *International Mechanical Code*, are used, refrigeration machinery rooms shall conform to the Class I, Division 2, hazardous location classification requirements of NFPA 70.

~~Exceptions~~ Exception: Ammonia machinery rooms that are provided with ventilation in accordance with Section 1101.1.2, Exception 1, of the *International Mechanical Code*.

~~Machinery rooms for systems containing Group A2L refrigerants that are provided with ventilation in accordance with Section 608.18.~~

~~**[M] 608.18 Special requirements for Group A2L refrigerant machinery rooms.** Machinery rooms with systems containing Group A2L refrigerants that do not comply with the Class I, Division 2, hazardous location electrical requirements of NFPA 70, as permitted by Section 608.17, Exception 2, shall comply with Sections 608.18.1 through 608.18.2.~~

~~**608.18.1 Ventilation system activation.** Ventilation shall be activated by the refrigerant detection system in the machinery room. Refrigerant detection shall be in accordance with Section 608.9 and all of the following:~~

1. The detectors shall activate at or below a refrigerant concentration of 25 percent of the LFL.

2. Upon activation, the detection system shall activate the emergency ventilation system in Section 608.18.2.

3. The detection, signaling and control circuits shall be supervised.

~~**[M] 608.18.2 Emergency ventilation system.** An emergency ventilation system shall be provided at the minimum exhaust rate specified in ASHRAE 15 or Table 608.18.2. Shut down of the emergency ventilation system shall be by manual means.~~

~~**[M] 608.18.3 Emergency ventilation system discharge.** The point of discharge to the atmosphere shall be located outside of the structure at not less than 15 feet (4572 mm) above the adjoining grade level and not less than 20 feet (6096 mm) from any window, ventilation opening or exit.~~

~~**[M] 608.18 Group A2L and B2L Refrigerant.** Machinery rooms for Group A2L and B2L refrigerant shall comply with Sections 608.18.1 through Section 608.18.3.~~

~~**608.18.1 Elevated Temperatures.** Open flame-producing devices or continuously operating hot surfaces over 1290 °F (700 °C) shall not be permanently installed in the room.~~

~~**[M] 608.18.2 Refrigerant Detector.** In addition to the requirements of Section 1105.3 of the *International Mechanical Code*, refrigerant detectors shall signal an alarm and activate the ventilation system in accordance with the response time specified in Table 608.18.2.~~

~~**[M] 608.18.3 Mechanical Ventilation.** The machinery room shall have a mechanical ventilation system complying with ASHRAE 15.~~

[M] TABLE 608.18.2
GROUP A2L AND B2L DETECTOR ACTIVATION

Activation Level	Maximum Response Time (seconds)	ASHRAE 15 Ventilation Level	Alarm Reset	Alarm Type
Less than or equal to the OEL in Table 1103.1 of the <i>International Mechanical Code</i>	300	1	Automatic	Trouble
Less than or equal to the refrigerant concentration level in Table 1103.1 of the <i>International Mechanical Code</i>	15	2	Manual	Emergency

MINIMUM EXHAUST RATE

REFRIGERANT	Q (M ³ /SEC)	Q (CFM)
R32	15.4	32,600
R143A	13.6	28,700
R444A	6.46	13,700
R444B	10.6	22,400
R445A	7.83	16,600
R446A	23.9	50,700
R447A	23.8	50,400
R451A	7.04	15,000
R451B	7.05	15,000
R1234YF	7.80	16,600
R1234ZE(E)	5.92	12,600

CHAPTER 9: FIRE PROTECTION AND LIFE SAFETY SYSTEMS

TABLE 911.1
EXPLOSION CONTROL REQUIREMENTS^f

[Portions of table not shown remain unchanged.]

MATERIAL	CLASS	EXPLOSION CONTROL METHODS	
		Barricade construction	Explosion (deflagration) venting or explosion (deflagration) prevention systems
Hazard Category			
Flammable gas	Gaseous	Not required	Required ^h
	Liquefied	Not required	Required ^h

^h. Not required for Category 1B Flammable Gases having a burning velocity not exceeding 3.9 in/s (10 cm/s).

CHAPTER 33: FIRE SAFETY DURING CONSTRUCTION AND DEMOLITION

3307.2.1 Pipe cleaning and purging. The cleaning and purging of flammable gas piping systems, including cleaning new or existing piping systems, purging piping systems into service and purging piping systems out of service, shall comply with NFPA 56.

Exceptions:

1. Compressed gas piping systems other than fuel gas piping systems where in accordance with Chapter 53.
2. Piping systems regulated by the *International Fuel Gas Code*.
3. Liquefied petroleum gas systems in accordance with Chapter 61.
4. Cleaning and purging of refrigerant piping systems shall comply with the *International Mechanical Code*.

CHAPTER 50: HAZARDOUS MATERIALS – GENERAL PROVISIONS

TABLE 5003.1.1(1)
MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD^{a, i, m, n, p}

[Portions of table not shown remain unchanged.]

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE ^b			USE-CLOSED SYSTEMS ^b			USE-OPEN SYSTEMS ^b	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)
Flammable gas	Gaseous									
	<u>1A and 1B (High BV)</u> [†]	H-2	NA	NA	1,000 ^{d, e}	NA	NA	1,000 ^{d, e}	NA	NA
	<u>1B (Low BV)</u> [†]				<u>162,500^{d, e}</u>			<u>162,500^{d, e}</u>		
	Liquified									
	<u>1A and 1B (High BV)</u> [†]	H-2	NA	(150) ^{d, e}	NA	NA	(150) ^{d, e}	NA	NA	NA
	<u>1B (Low BV)</u> [†]			(10,000) ^{d, e}			(10,000) ^{d, e}			

- For use of control areas, see Section 5003.8.3.
- The aggregate quantity in use and storage shall not exceed the quantity listed for storage.
- The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies, the quantities of medicines, foodstuff or consumer products and cosmetics containing not more than 50 percent by volume of water-miscible liquids with the remainder of the solutions not being flammable shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.
- Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e applies, the increase for both notes shall be applied accumulatively.
- Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets, day boxes, gas cabinets, gas rooms, exhausted enclosures or in listed safety cans in accordance with Section 5003.9.10. Where Note d applies, the increase for both notes shall be applied accumulatively.
- Quantities shall not be limited in a building equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.
- Allowed only in buildings equipped throughout with an approved automatic sprinkler system.
- Containing not more than the maximum allowable quantity per control area of Class IA, Class IB or Class IC flammable liquids.
- The maximum allowable quantity shall not apply to fuel oil storage complying with Section 605.4.2.
- Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.
- A maximum quantity of 220 pounds of solid or 22 gallons of liquid Class 3 oxidizers is allowed where such materials are necessary for maintenance purposes, operation or sanitation of equipment where the storage containers and the manner of storage are approved.
- Net weight of pyrotechnic composition of the fireworks. Where the net weight of the pyrotechnic composition of the fireworks is not known, 25 percent of the gross weight of the fireworks including packaging shall be used.
- For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.
- For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 5003.11, see Table 5003.11.1.
- Densely-packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.
- The following shall not be included in determining the maximum allowable quantities:
 - Liquid or gaseous fuel in fuel tanks on vehicles.
 - Liquid or gaseous fuel in fuel tanks on motorized equipment operated in accordance with this code.
 - Gaseous fuels in piping systems and fixed appliances regulated by the *International Fuel Gas Code*.
 - Liquid fuels in piping systems and fixed appliances regulated by the *International Mechanical Code*.
 - Alcohol-based hand rubs classified as Class I or II liquids in dispensers that are installed in accordance with Sections 5705.5 and 5705.5.1. The location of the alcohol-based hand rub (ABHR) dispensers shall be provided in the construction documents.
- Where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 104.8.2.
- "High BV" Category 1B flammable gas has a burning velocity greater than 3.9 in/s (10cm/s). "Low BV" Category 1B flammable gas has a burning velocity of 3.9 in/s (10 cm/s) or less.

TABLE 5003.1.1(3)
MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD IN
AN OUTDOOR CONTROL AREA^{a, b, c, d}

[Portions of table not shown remain unchanged.]

Portions of table not shown remain unchanged.

MATERIAL	CLASS	STORAGE ^b			USE-CLOSED SYSTEMS ^b			USE-OPEN SYSTEMS ^b	
		Solid pounds (cubic feet)	Liquid gallons (pounds) ^d	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds) ^d	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds) ^d
Flammable gas	Gaseous								
	<u>1A and 1B (High BV)</u> ^ε	Not Applicable	Not Applicable	3,000	Not Applicable	Not Applicable	1,500	Not Applicable	Not Applicable
	<u>1B (Low BV)</u> ^ε			<u>195,000</u>			<u>97,500</u>		
	Liquified								
	<u>1A and 1B (High BV)</u> ^ε	Not Applicable	(300)	Not Applicable	Not Applicable	(150)	Not Applicable	Not Applicable	Not Applicable
	<u>1B (Low BV)</u> ^ε		<u>(20,000)</u>			<u>(10,000)</u>			

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 cubic foot = 0.02832 m³.

- For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.
- The aggregate quantities in storage and use shall not exceed the quantity listed for storage.
- The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is allowed to exceed the maximum allowable quantity per control area where such storage is in accordance with Section 5003.11.
- Quantities in parentheses indicate quantity units in parentheses at the head of each column.
- "High BV" Category 1B flammable gas has a burning velocity greater than 3.9 in/s (10cm/s). "Low BV" Category 1B flammable gas has a burning velocity of 3.9 in/s (10 cm/s) or less.

5003.8.3.5 Hazardous materials in Group M display and storage areas and in Group S storage areas. Hazardous materials located in Group M and Group S occupancies shall be in accordance with Sections 5003.8.3.5.1 through ~~5003.8.3.5.3~~ **5003.8.3.5.4**.

5003.8.3.5.4 Flammable gas. The aggregate quantity of Category 1B flammable gas having a burning velocity of 3.9 in/s (10 cm/s) or less stored and displayed within a single control area of a Group M occupancy, or in an outdoor control area, or stored in a single control area of a Group S occupancy, is allowed to exceed the maximum allowable quantities per control area specified in Table 5003.1.1(1) without classifying the building or use as a Group H occupancy, provided the materials are stored and displayed in accordance with Section 5003.11.2.

5003.11 Maximum allowable quantity for Group M storage and display and Group S storage. The aggregate quantity of ~~nonflammable solid and nonflammable or noncombustible liquid~~ hazardous materials stored and displayed within a single control area of a Group M occupancy, or an outdoor control area, or stored in a single control area of a Group S occupancy, is allowed to exceed the maximum allowable quantity per control area indicated in Section 5003.1 where in accordance with Sections 5003.11.1 and 5003.11.2 through ~~5003.11.3.11~~.

5003.11.1 Nonflammable solid and nonflammable or noncombustible liquid hazardous materials ~~Maximum allowable quantity per outdoor control area in Group M or S occupancies.~~ The aggregate amount of nonflammable solid and nonflammable or noncombustible liquid hazardous materials stored and displayed within a single control area of a Group M occupancy, or an outdoor control area, or stored in a single control area of a Group S occupancy, shall not exceed the amounts set forth in Table 5003.11.1.

5003.11.2 Maximum allowable quantity per outdoor control area in Group M or S occupancies. The aggregate amount of nonflammable solid and nonflammable or noncombustible liquid hazardous materials stored and displayed within a single outdoor control area of a Group M occupancy shall not exceed the amounts set forth in Table 5003.11.1.

~~5003.11.3~~ **5003.11.1.1 Storage and display.** Storage and display shall be in accordance with Sections ~~5003.11.3.1~~ **5003.1.1.1** through ~~5003.11.3.11~~ **5003.11.1.1.1**.

~~5003.11.3.1~~ **5003.11.1.1.1 Density.** Storage and display of solids shall not exceed 200 pounds per square foot (976 kg/m²) of floor area actually occupied by solid merchandise. Storage and display of liquids shall not exceed 20 gallons per square foot (0.50 L/m²) of floor area actually occupied by liquid merchandise.

~~5003.11.3.2~~ **5003.11.1.1.2 Storage and display height.** Display height shall not exceed 6 feet (1829 mm) above the finished floor in display areas of Group M occupancies. Storage height shall not exceed 8 feet (2438 mm) above the finished floor in storage areas of Group M and Group S occupancies.

~~5003.11.3.3~~ **5003.11.1.1.3 Container location.** Individual containers less than 5 gallons (19 L) or less than 25 pounds (11 kg) shall be stored or displayed on pallets, racks or shelves.

~~5003.11.3.4~~ **5003.11.1.1.4 Racks and shelves.** Racks and shelves used for storage or display shall be in accordance with Section 5003.9.9.

~~5003.11.3.5~~ **5003.11.1.1.5 Container type.** Containers shall be *approved* for the intended use and identified as to their content.

~~5003.11.3.6~~ **5003.11.1.1.6 Container size.** Individual containers shall not exceed 100 pounds (45 kg) for solids or 10 gallons (38 L) for liquids in storage and display areas.

~~5003.11.3.7~~ **5003.11.1.1.7 Incompatible materials.** *Incompatible materials* shall be separated in accordance with Section 5003.9.8.

~~5003.11.3.8~~ **5003.11.1.1.8 Floors.** Floors shall be in accordance with Section 5004.12.

~~5003.11.3.9~~ **5003.11.1.1.9 Aisles.** Aisles 4 feet (1219 mm) in width shall be maintained on three sides of the storage or display area.

~~5003.11.3.10~~ **5003.11.1.1.10 Signs.** Hazard identification signs shall be provided in accordance with Section 5003.5.

~~5003.11.3.11~~ **5003.11.1.1.11 Storage plan.** A storage plan illustrating the intended storage arrangement, including the location and dimensions of aisles, and storage racks shall be provided.

5003.11.2 Category 1B flammable gas with low burning velocity. The aggregate quantity of Category 1B flammable gas having a burning velocity of 3.9 in/s (10 cm/s) or less stored and displayed within a single control area of a Group M occupancy, or an outdoor control area, or stored in a single control area of a Group S occupancy, shall not exceed the amounts set forth in Table 5003.11.2.

TABLE 5003.11.2

MAXIMUM ALLOWABLE QUANTITY OF LOW BURNING VELOCITY CATEGORY 1B FLAMMABLE GAS IN GROUP M AND S OCCUPANCIES PER CONTROL AREA ^a

FLAMMABLE GAS CATEGORY	MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA	
	Sprinklered in accordance with Note b	Nonsprinklered
Category 1B (Low BV) ^d		
Gaseous	390,000 cu. ft.	195,000 cu. ft
Liquefied	40,000 lbs. ^c	20,000 lbs.

For SI: 1 pound = 0.454 kg, 1 cubic foot = 0.02832 m³, 1 square foot = 0.093 m², 1 inch/second = 2.54 cm/s.

- Control areas shall be separated from each other by not less than a 1-hour fire barrier.
- The building shall be equipped throughout with an approved automatic sprinkler system with minimum sprinkler design density of Ordinary Hazard Group 2 in the area where flammable gases are stored or displayed.
- Where storage areas exceed 50,000 square feet in area, the maximum allowable quantities area allowed to be increased by 2 percent for each 1,000 square feet of area in excess of 50,000 square feet, up to not more than 100 percent of the table amounts. Separation of control areas is not required. The aggregate amount shall not exceed 80,000 pounds.
- "Low BV" Category 1B flammable gas has a burning velocity of 3.9 in/s (10 cm/s) or less.

5003.11.2.1 Fire protection and storage arrangements. Fire protection and container storage arrangements for quantities of Category 1B flammable gases permitted by Table 5003.11.2 shall be in accordance with the all of the following:

- Storage of the Category 1B flammable gases on shelves shall not exceed 6 feet (1829 mm) in height, and shelving shall be metal.
- Rack storage, pallet storage or piles of the Category 1B flammable gas greater than 6 feet 6 inches (1981 mm) in height shall be provided with an automatic sprinkler system with a minimum design of Extra Hazard Group 1.
- Combustible commodities shall not be stored above the Category 1B flammable gases.
- Flammable liquids shall be separated from the Category 1B flammable gases by a distance 20 feet (6096 mm). The separation is permitted to be reduced to 10 feet (3048 mm) where secondary containment or diking is provided to retain a flammable liquid spill at a distance of 10 feet (3048 mm) from the Category 1B flammable gas storage.

2021 International Building Code

CHAPTER 2: DEFINITIONS

[F] FLAMMABLE GAS. A material that is a gas at 68°F (20°C) or less at 14.7 pounds per square inch atmosphere (psia) (101 kPa) of pressure [a material that has a boiling point of 68°F (20°C) or less at 14.7 psia (101 kPa)], ~~which also meets one of the following subdivided as follows:~~

1. ~~Category 1A.~~

1. ~~A gas that is~~ ignitable at 14.7 psia (101 kPa) when in a mixture of 13 percent or less by volume with air. ~~has~~

2. ~~A gas with a flammable range at 14.7 psia (101 kPa) with air of at least 12 percent, regardless of the lower limit, unless data show compliance with Category 1B.~~

2. Category 1B.

A gas that meets the flammability criteria for Category 1A, is not pyrophoric or chemically unstable, and meets one or more of the following:

1. A lower flammability limit of more than 6 percent by volume in air; or

2. A fundamental burning velocity of less than 3.9 in/s (10 cm/s).

The limits specified shall be determined at 14.7 psi (101 kPa) of pressure and a temperature of 68°F (20°C) in accordance with ASTM E681.

Where not otherwise specified, the term "flammable gas" includes both Category 1A and Category 1B.

CHAPTER 3: OCCUPANCY CLASSIFICATION AND USE

TABLE 307.1(1)
MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD^{a, j, m, n, p}

[Portions of table not shown remain unchanged.]

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE ^b			USE-CLOSED SYSTEMS ^b			USE-OPEN SYSTEMS ^b	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)
Flammable gas	Gaseous									
	<u>1A and 1B (High BV)</u> [‡]	H-2	NA	NA	1,000 ^{d, e}	NA	NA	1,000 ^{d, e}	NA	NA
	<u>1B (Low BV)</u> [‡]				<u>162,500</u> ^{d, e}			<u>162,500</u> ^{d, e}		
	Liquified									
	<u>1A and 1B (High BV)</u> [‡]	H-2	NA	(150) ^{d, e}	NA	NA	(150) ^{d, e}	NA	NA	NA
	<u>1B (Low BV)</u> [‡]			(10,000) ^{d, e}			(10,000) ^{d, e}			

a. For use of control areas, see Section 414.2.

b. The aggregate quantity in use and storage shall not exceed the quantity specified for storage.

c. The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited provided the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs or consumer products, and cosmetics containing not more than 50 percent by volume of water-miscible liquids with the remainder of the solutions not being flammable, shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both notes shall be applied accumulatively.

e. Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, day boxes, gas cabinets, gas rooms or exhausted enclosures or in listed safety cans in accordance with Section 5003.9.10 of the International Fire Code. Where Note d also applies, the increase for both notes shall be applied accumulatively.

f. Quantities shall not be limited in a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

g. Allowed only in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

h. Containing not more than the maximum allowable quantity per control area of Class IA, IB or IC flammable liquids.

i. The maximum allowable quantity shall not apply to fuel oil storage complying with Section 605.4.2 of the *International Fire Code*.

j. Quantities in parentheses indicate quantity units in parentheses at the head of each column.

k. A maximum quantity of 220 pounds of solid or 22 gallons of liquid Class 3 oxidizers is allowed when such materials are necessary for maintenance purposes, operation or sanitation of equipment when the storage containers and the manner of storage are approved.

- l. Net weight of the pyrotechnic composition of the fireworks. Where the net weight of the pyrotechnic composition of the fireworks is not known, 25 percent of the gross weight of the fireworks, including packaging, shall be used.
- m. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2 of the *International Fire Code*.
- n. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 414.2.5, see Tables 414.2.5(1) and 414.2.5(2).
- o. Densely packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.
- p. The following shall not be included in determining the maximum allowable quantities:
 - 1. Liquid or gaseous fuel in fuel tanks on vehicles.
 - 2. Liquid or gaseous fuel in fuel tanks on motorized equipment operated in accordance with the *International Fire Code*.
 - 3. Gaseous fuels in piping systems and fixed appliances regulated by the *International Fuel Gas Code*.
 - 4. Liquid fuels in piping systems and fixed appliances regulated by the *International Mechanical Code*.
 - 5. Alcohol-based hand rubs classified as Class I or II liquids in dispensers that are installed in accordance with Sections 5705.5 and 5705.5.1 of the *International Fire Code*. The location of the alcohol-based hand rub (ABHR) dispensers shall be provided in the construction
- q. Where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 414.1.3.
- r. "High BV" Category 1B flammable gas has a burning velocity greater than 3.9 in/s (10 cm/s). "Low BV" Category 1B flammable gas has a burning velocity of 3.9 in/s (10 cm/s) or less.

[F] 307.4 High-hazard Group H-2. Buildings and structures containing materials that pose a deflagration hazard or a hazard from accelerated burning shall be classified as Group H-2. Such materials shall include, but not be limited to, the following:

Class I, II or IIIA *flammable or combustible liquids* that are used or stored in normally open containers or systems, or in closed containers or systems pressurized at more than 15 pounds per square inch gauge (103.4 kPa).
Combustible dusts where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 414.1.3.
Cryogenic fluids, flammable.
Category 1A Flammable gases.
Category 1B Flammable gases having a burning velocity greater than 3.9 inches per second (10 cm/s).
Organic peroxides, Class I.
Oxidizers, Class 3, that are used or stored in normally open containers or systems, or in closed containers or systems pressurized at more than 15 pounds per square inch gauge (103 kPa).
Pyrophoric liquids, solids and gases, nondetonable.
Unstable (reactive) materials, Class 3, nondetonable.
Water-reactive materials, Class 3.

[F] 307.5 High-hazard Group H-3. Buildings and structures containing materials that readily support combustion or that pose a *physical hazard* shall be classified as Group H-3. Such materials shall include, but not be limited to, the following:

Class I, II or IIIA *flammable or combustible liquids* that are used or stored in normally closed containers or systems pressurized at 15 pounds per square inch gauge (103.4 kPa) or less.
Combustible fibers, other than densely packed *baled cotton*, where manufactured, generated or used in such a manner that the concentration and conditions create a fire or *explosion* hazard based on information prepared in accordance with Section 414.1.3.
 Consumer *fireworks*, 1.4G (Class C, Common).
Cryogenic fluids, oxidizing.
Category 1B flammable gases having a burning velocity of 3.9 inches per second (10 cm/s) or less.
Flammable solids.
Organic peroxides, Class II and III.
Oxidizers, Class 2.
Oxidizers, Class 3, that are used or stored in normally closed containers or systems pressurized at 15 pounds per square inch gauge (103 kPa) or less.
Oxidizing gases.
Unstable (reactive) materials, Class 2.
Water-reactive materials, Class 2.

CHAPTER 4: SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

[F] 414.2.5 Hazardous materials in Group M display and storage areas and in Group S storage areas. *Hazardous materials* located in Group M and Group S occupancies shall be in accordance with Sections 414.2.5.1 through ~~414.2.5.3~~ 414.2.5.4.

414.2.5.4 Flammable gas.

The aggregate quantity of Category 1B flammable gas having a burning velocity of 3.9 in/s (10 cm/s) or less stored and displayed within a single *control area* of a Group M occupancy or stored in a single *control area* of a Group S occupancy is allowed to exceed the *maximum allowable quantities per control area* specified in Table 307.1(1) without classifying the building or use as a Group H occupancy, provided the materials are stored and displayed in accordance with the *International Fire Code* and quantities do not exceed the amounts specified in Table 414.2.5(3).

TABLE 414.2.5(3) MAXIMUM ALLOWABLE QUANTITY OF LOW BURNING VELOCITY CATEGORY 1B FLAMMABLE GAS IN GROUP M AND S OCCUPANCIES PER CONTROL AREA ^a

FLAMMABLE GAS CATEGORY	MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA	
	Sprinklered in Accordance with Note b	Nonsprinklered
Category 1B (Low BV) ^e		
Gaseous	390,000 cu. ft.	195,000 cu. ft.
Liquefied	40,000 lbs. ^c	20,000 lbs.

For SI: 1 pound = 0.454 kg, 1 cubic foot = 0.02832 m³, 1 square foot = 0.093 m², 1 inch/second = 2.54 cm/s.

- a. Control areas shall be separated from each other by not less than a 1-hour fire barrier.
- b. The building shall be equipped throughout with an approved automatic sprinkler system with minimum sprinkler design density of Ordinary Hazard Group 2 in the area where flammable gases are stored or displayed.
- c. Where storage areas exceed 50,000 square feet in area, the maximum allowable quantities area allowed to be increased by 2 percent for each 1,000 square feet of area in excess of 50,000 square feet, up to not more than 100 percent of the table amounts. Separation of control areas is not required. The aggregate amount shall not exceed 80,000 pounds.
- d. "Low BV" Category 1B flammable gas has a burning velocity of 3.9 in/s (10 cm/s) or less.

[F] TABLE 414.5.1 EXPLOSION CONTROL REQUIREMENTS^{a, h}

MATERIAL	CLASS	EXPLOSION CONTROL METHODS	
		Barricade construction	Explosion (deflagration) venting or explosion (deflagration) prevention systems ^b
HAZARD CATEGORY			
Combustible dusts ^c	—	Not Required	Required
Cryogenic flammables	—	Not Required	Required
Explosives	Division 1.1	Required	Not Required
	Division 1.2	Required	Not Required
	Division 1.3	Not Required	Required
	Division 1.4	Not Required	Required
	Division 1.5	Required	Not Required
	Division 1.6	Required	Not Required
Flammable gas	Gaseous	Not Required	Required ^j
	Liquefied	Not Required	Required ^j
Flammable liquid	IA ^d	Not Required	Required
	IB ^e	Not Required	Required
Organic peroxides	U	Required	Not Permitted
	I	Required	Not Permitted
Oxidizer liquids and solids	4	Required	Not Permitted
Pyrophoric gas	—	Not Required	Required
Unstable (reactive)	4	Required	Not Permitted
	3 Detonable	Required	Not Permitted
	3 Nondetonable	Not Required	Required
Water-reactive liquids and solids	3	Not Required	Required
	2 ^g	Not Required	Required

SPECIAL USES			
Acetylene generator rooms	—	Not Required	Required
Electrochemical energy storage system ⁱ	—	Not Required	Required
Energy storage system ⁱ	—	Not Required	Required
Grain processing	—	Not Required	Required
Liquefied petroleum gas-distribution facilities	—	Not Required	Required
Where explosion hazards exist ^f	Detonation	Required	Not Permitted
	Deflagration	Not Required	Required

- a. See Section 414.1.3.
- b. See the *International Fire Code*.
- c. Combustible dusts where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 104.8.2 of the *International Fire Code*. See definition of "Combustible dust" in Chapter 2.
- d. Storage or use.
- e. In open use or dispensing.
- f. Rooms containing dispensing and use of hazardous materials where an explosive environment can occur because of the characteristics or nature of the hazardous materials or as a result of the dispensing or use process.
- g. A method of explosion control shall be provided where Class 2 water-reactive materials can form potentially explosive mixtures.
- h. Explosion venting is not required for Group H-5 fabrication areas complying with Section 415.11.1 and the *International Fire Code*.
- i. Where explosion control is required in Section 1207 of the *International Fire Code*.
- j. Not required for Category 1B Flammable Gases having a burning velocity not exceeding 3.9 in/s (10 cm/s).

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CHAPTER 11: REFRIGERATION

1101.2.1 Group A2L, A2, A3 and B1 high-probability equipment.

High-probability equipment using Group A2L, A2, A3, or B1 refrigerant shall comply with UL 484, UL/CSA 60335-2-40, or UL/CSA 60335-2-89.

TABLE 1103.1
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

CHEMICAL REFRIGERANT	FORMULA	CHEMICAL NAME OF BLEND	REFRIGERANT SAFETY GROUP CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE							[F] DEGREES OF HAZARD°
				RCL			LFL			OEL°	
				Pounds per 1,000 cubic feet lb/MCf	ppm	g/m ³	lb/MCf	ppm	g/m ³	OEL° ppm	
R-11 ^d ^ε	CCl ₃ F	trichlorofluoromethane	A1	0.39	1,100	6.2 6.1				≤1,000	2-0-0 ^b
R-12 ^d ^ε	CCl ₂ F ₂	dichlorodifluoromethane	A1	5.6	18,000	90				1,000	2-0-0 ^b
R-13 ^d ^ε	CClF ₃	chlorotrifluoromethane	A1	—	—	—				1,000	2-0-0 ^b
R-13B1 ^d ^ε	CBrF ₃	bromotrifluoromethane	A1	—	—	—				1,000	2-0-0 ^b
<u>R-13I1</u>	<u>CF₃I</u>	<u>trifluoroiodomethane</u>	<u>A1</u>	<u>1.0</u>	<u>2,000</u>	<u>16</u>				<u>500</u>	
R-14	CF ₄	tetrafluoromethane (carbon tetrafluoride)	A1	25	110,000	400				1,000	2-0-0 ^b
R-22	CHClF ₂	chlorodifluoromethane	A1	13	59,000	210				1,000	2-0-0 ^b
R-23	CHF ₃	trifluoromethane (fluoroform)	A1	7.3	41,000	120				1,000	2-0-0 ^b
R-30	CH ₂ Cl ₂	dichloromethane (methylene chloride)	B1	—	—	—				—	—
<u>R-31</u>	<u>CH₂ClF</u>	<u>Chlorofluoromethane</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>				<u>—</u>	<u>—</u>
R-32	CH ₂ F ₂	difluoromethane (methylene fluoride)	A2 ^ε <u>A2L</u>	4.8	36,000	77	<u>19.1</u>	<u>144,000</u>	<u>306</u>	1,000	1-4-0
R-40	CH ₃ Cl	chloromethane (methyl chloride)	B2	—	—	—				—	—
<u>R-41</u>	<u>CH₃F</u>	<u>Fluoromethane (methyl fluoride)</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>				<u>—</u>	
R-50	CH ₄	methane	A3	—	—	—		<u>50,000</u>		1,000	—
R-113 ^d ^ε	CCl ₂ FCClF ₂	1,1,2-trichloro-1,2,2-trifluoroethane	A1	1.2	2,600	20				1,000	2-0-0 ^b
R-114 ^d ^ε	CClF ₂ CClF ₂	1,2-dichloro-1,1,2,2-tetrafluoroethane	A1	8.7	20,000	140				1,000	2-0-0 ^b
R-115	CClF ₂ CF ₃	chloropentafluoroethane	A1	47	120,000	760				1,000	—
R-116	CF ₃ CF ₃	hexafluoroethane	A1	34	97,000	550				1,000	1-0-0

R-123	CHCl ₂ CF ₃	2,2-dichloro-1,1,1-trifluoroethane	B1	3.5	9,100	57				50	2-0-0 ^b
R-124	CHClFCF ₃	2-chloro-1,1,1,2-tetrafluoroethane	A1	3.5	10,000	56				1,000	2-0-0 ^b
R-125	CHF ₂ CF ₃	pentafluoroethane	A1	23	75,000	370				1,000	2-0-0 ^b
R-134a	CH ₂ FCF ₃	1,1,1,2-tetrafluoroethane	A1	13	50,000	210				1,000	2-0-0 ^b
R-141b	CH ₃ CCl ₂ F	1,1-dichloro-1-fluoroethane	—	0.78	2,600	12	<u>17.8</u>	<u>60,000</u>	<u>287</u>	500	2-1-0
R-142b	CH ₃ CClF ₂	1-chloro-1, 1-difluoroethane	A2	5.1	20,000	83 <u>82</u>	<u>20.4</u>	<u>80,000</u>	<u>329</u>	1,000	2-4-0
R-143a	CH ₃ CF ₃	1,1,1-trifluoroethane	A2* <u>A2L</u>	4.5 <u>4.4</u>	21,000	70	<u>17.5</u>	<u>82,000</u>	<u>282</u>	1,000	2-0-0 ^b
R-152a	CH ₃ CHF ₂	1,1-difluoroethane	A2	2.0	12,000	32	<u>8.1</u>	<u>48,000</u>	<u>130</u>	1,000	1-4-0
R-170	CH ₃ CH ₃	ethane	A3	0.54	7,000	8.7 <u>8.6</u>	<u>2.4</u>	<u>31,000</u>	<u>38</u>	1,000	2-4-0
R-E170	CH ₃ OCH ₃	Methoxymethane (dimethyl ether)	A3	1.0	8,500	16	<u>4.0</u>	<u>34,000</u>	<u>64</u>	1,000	—
R-218	CF ₃ CF ₂ CF ₃	octafluoropropane	A1	43	90,000	690				1,000	2-0-0 ^b
R-227ea	CF ₃ CHFCF ₃	1,1,1,2,3,3,3-heptafluoropropane	A1	36	84,000	580				1,000	—
R-236fa	CF ₃ CH ₂ CF ₃	1,1,1,3,3,3-hexafluoropropane	A1	21	55,000	340				1,000	2-0-0 ^b
R-245fa	CHF ₂ CH ₂ CF ₃	1,1,1,3,3-pentafluoropropane	B1	12	34,000	190				300	2-0-0 ^b
R-290	CH ₃ CH ₂ CH ₃	propane	A3	0.56 <u>0.59</u>	5,300	9.5	<u>2.4</u>	<u>21,000</u>	<u>38</u>	1,000	2-4-0
R-C318	-(CF ₂) ₄ -	octafluorocyclobutane	A1	41	80,000	660 <u>650</u>				1,000	—
R-400 ^d ^ε	zeotrope	R-12/114 (50.0/50.0)	A1	10	28,000	160				1,000	2-0-0 ^b
R-400 ^d ^ε	zeotrope	R-12/114 (60.0/40.0)	A1	11	30,000	170				1,000	—
R-401A	zeotrope	R-22/152a/124 (53.0/13.0/34.0)	A1	6.6	27,000	110				1,000	2-0-0 ^b
R-401B	zeotrope	R-22/152a/124 (61.0/11.0/28.0)	A1	7.2	30,000	120				1,000	2-0-0 ^b
R-401C	zeotrope	R-22/152a/124 (33.0/15.0/52.0)	A1	5.2	20,000	84				1,000	2-0-0 ^b
R-402A	zeotrope	R-125/290/22 (60.0/2.0/38.0)	A1	17	66,000	270				1,000	2-0-0 ^b
R-402B	zeotrope	R-125/290/22 (38.0/2.0/60.0)	A1	15	63,000	240				1,000	2-0-0 ^b
R-403A	zeotrope	R-290/22/218 (5.0/75.0/20.0)	A2	7.6	33,000	120				1,000	2-0-0 ^b
R-403B	zeotrope	R-290/22/218 (5.0/56.0/39.0)	A1	18	70,000 <u>68,000</u>	290				1,000	2-0-0 ^b
R-404A	zeotrope	R-125/143a/134a (44.0/52.0/4.0)	A1	31	130,000	500				1,000	2-0-0 ^b
R-405A	zeotrope	R-22/152a/142b/C318 (45.0/7.0/5.5/2.5)	—	16	57,000	260				1,000	—

R-406A	zeotrope	R-22/600a/142b (55.0/4.0/41.0)	A2	4.7	21,000	25 <u>75</u>	<u>18.8</u>	<u>82,000</u>	<u>301.9</u>	1,000	—
R-407A	zeotrope	R-32/125/134a (20.0/40.0/40.0)	A1	19	83,000	300				1,000	2-0-0 ^b
R-407B	zeotrope	R-32/125/134a (10.0/70.0/20.0)	A1	21	79,000	330				1,000	2-0-0 ^b
R-407C	zeotrope	R-32/125/134a (23.0/25.0/52.0)	A1	18	81,000	290				1,000	2-0-0 ^b
R-407D	zeotrope	R-32/125/134a (15.0/15.0/70.0)	A1	16	68,000	250				1,000	2-0-0 ^b
R-407E	zeotrope	R-32/125/134a (25.0/15.0/60.0)	A1	17	80,000	280				1,000	2-0-0 ^b
R-407F	zeotrope	R-32/125/134a (30.0/30.0/40.0)	A1	20	95,000	320				1,000	—
R-407G	zeotrope	R-32/125/134a (2.5/2.5/95.0)	A1	13	52,000	210				1,000	—
R-407H	zeotrope	R-32/125/134a (32.5/15.0/52.5)	A1	19	92,000	300				1,000	—
R-407I	zeotrope	R-32/125/124a (19.5/8.5/72.0)	A1	16	71,100	250				1,000	
R-408A	zeotrope	R-125/143a/22 (7.0/46.0/47.0)	A1	21	95,000 <u>94,000</u>	340 <u>330</u>				1,000	2-0-0 ^b
R-409A	zeotrope	R-22/124/142b (60.0/25.0/15.0)	A1	7.1	29,000	110				1,000	2-0-0 ^b
R-409B	zeotrope	R-22/124/142b (65.0/25.0/10.0)	A1	7.3	30,000	120				1,000	2-0-0 ^b
R-410A	zeotrope	R-32/125 (50.0/50.0)	A1	26	140,000	420				1,000	2-0-0 ^b
R-410B	zeotrope	R-32/125 (45.0/55.0)	A1	27	140,000	430				1,000	2-0-0 ^b
R-411A	zeotrope	R-127/22/152a (1.5/87.5/11.0)	A2	2.9	14,000	46	<u>11.6</u>	<u>55,000</u>	<u>185.6</u>	990 <u>970</u>	—
R-411B	zeotrope	R-1270/22/152a (3.0/94.0/3.0)	A2	2.8	13,000	45	<u>14.8</u>	<u>70,000</u>	<u>238.3</u>	980 <u>940</u>	—
R-412A	zeotrope	R-22/218/142b (70.0/5.0/25.0)	A2	5.1	22,000	82	<u>20.5</u>	<u>87,000</u>	<u>328.6</u>	1,000	—
R-413A	zeotrope	R-218/134a/600a (9.0/88.0/3.0)	A2	5.8	22,000	94 <u>93</u>	<u>23.4</u>	<u>88,000</u>	<u>374.9</u>	1,000	—
R-414A	zeotrope	R-22/124/600a/142b (51.0/28.5/4.0/16.5)	A1	6.4	26,000	100				1,000	—
R-414B	zeotrope	R-22/124/600a/142b (50.0/39.0/1.5/9.5)	A1	6.0	23,000	95 <u>96</u>				1,000	—
R-415A	zeotrope	R-22/152a (82.0/18.0)	A2	2.9	14,000	47	<u>11.7</u>	<u>56,000</u>	<u>187.9</u>	1,000	—
R-415B	zeotrope	R-22/152a (25.0/75.0)	A2	2.1	12,000	34	<u>8.4</u>	<u>47,000</u>	<u>135.1</u>	1,000	—
R-416A	zeotrope	R-134a/124/600 (59.0/39.5/1.5)	A1	3.9	14,000	62				1,000	2-0-0 ^b
R-417A	zeotrope	R-125/134a/600 (46.6/50.0/3.4)	A1	3.5	13,000	56 <u>55</u>				1,000	2-0-0 ^b
R-417B	zeotrope	R-125/134a/600 (79.0/18.3/2.7)	A1	4.3	15,000	70 <u>69</u>				1,000	—
R-417C	zeotrope	R-125/134a/600 (19.5/78.8/1.7)	A1	5.4	21,000	87				1,000	—
R-418A	zeotrope	R-290/22/152a (1.5/96.0/2.5)	A2	4.8	22,000	77	<u>19.2</u>	<u>89,000</u>	<u>308.4</u>	1,000	—
R-419A	zeotrope	R-125/134a/E170 (77.0/19.0/4.0)	A2	4.2	15,000	67	<u>16.7</u>	<u>60,000</u>	<u>268.6</u>	1,000	—

R-419B	zeotrope	R-125/134a/E170 (48.5/48.0/3.5)	A2	4.6	17,000	74	<u>18.5</u>	<u>69,000</u>	<u>297.3</u>	1,000	—
R-420A	zeotrope	R-134a/142b (88.0/12.0)	A1	12	45,000 <u>44,000</u>	190 <u>180</u>				1,000	2-0-0 ^b
R-421A	zeotrope	R-125/134a (58.0/42.0)	A1	17	61,000	280				1,000	2-0-0 ^b
R-421B	zeotrope	R-125/134a (85.0/15.0)	A1	21	69,000	330				1,000	2-0-0 ^b
R-422A	zeotrope	R-125/134a/600a (85.1/11.5/3.4)	A1	18	63,000	290				1,000	2-0-0 ^b
R-422B	zeotrope	R-125/134a/600a (55.0/42.0/3.0)	A1	16	56,000	250				1,000	2-0-0 ^b
R-422C	zeotrope	R-125/134a/600a (82.0/15.0/3.0)	A1	18	62,000	290				1,000	2-0-0 ^b
R-422D	zeotrope	R-125/134a/600a (65.1/31.5/3.4)	A1	16	58,000	260				1,000	2-0-0 ^b
R-422E	zeotrope	R-125/134a/600a (58.0/39.3/2.7)	A1	16	57,000	260				1,000	—
R-423A	zeotrope	R-134a/227ea (52.5/47.5)	A1	19	59,000	310 <u>300</u>				1,000	2-0-0 ^c
R-424A	zeotrope	R-125/134a/600a/600/601a (50.5/47.0/0.9/1.0/0.6)	A1	6.2	23,000	100				970 <u>990</u>	2-0-0 ^b
R-425A	zeotrope	R-32/134a/227ea (18.5/69.5/12.0)	A1	16	72,000	260				1,000	2-0-0 ^b
R-426A	zeotrope	R-125/134a/600a/601a (5.1/93.0/1.3/0.6)	A1	5.2	20,000	83				990	—
R-427A	zeotrope	R-32/125/143a/134a (15.0/25.0/10.0/50.0)	A1	18	79,000	290				1,000	2-1-0
R-428A	zeotrope	R-125/143a/290/600a (77.5/20.0/0.6/1.9)	A1	23	83,000 <u>84,000</u>	370				1,000	—
R-429A	zeotrope	R-E170/152a/600a (60.0/10.0/30.0)	A3	0.81	6,300	13	<u>3.2</u>	<u>25,000</u>	<u>83.8</u>	1,000	—
R-430A	zeotrope	R-152a/600a (76.0/24.0)	A3	1.3	8,000	21	<u>5.2</u>	<u>32,000</u>	<u>44.0</u>	1,000	—
R-431A	zeotrope	R-290/152a (71.0/29.0)	A3	0.69 <u>0.68</u>	5,500	11	<u>2.7</u>	<u>22,000</u>	<u>38.6</u>	1,000	—
R-432A	zeotrope	R-1270/E170 (80.0/20.0)	A3	0.13	1,200	2.1	<u>2.4</u>	<u>22,000</u>	<u>39.2</u>	700 <u>550</u>	—
R-433A	zeotrope	R-1270/290 (30.0/70.0)	A3	0.34	3,100	5.5	<u>2.4</u>	<u>20,000</u>	<u>32.4</u>	880 <u>760</u>	—
R-433B	zeotrope	R-1270/290 (5.0-95.0)	A3	0.51 <u>0.39</u>	4,500 <u>3,500</u>	8.1 <u>6.3</u>	<u>2.0</u>	<u>18,000</u>	<u>32.1</u>	950	—
R-433C	zeotrope	R-1270/290 (25.0-75.0)	A3	0.41	2,600 <u>3,700</u>	6.6 <u>6.5</u>	<u>2.0</u>	<u>18,000</u>	<u>83.8</u>	790	—
R-434A	zeotrope	R-125/143a/600a (63.2/18.0/16.0/2.8)	A1	20	73,000	320				1,000	—
R-435A	zeotrope	R-E170/152a (80.0/20.0)	A3	1.1	8,500	17	<u>4.3</u>	<u>34,000</u>	<u>68.2</u>	1,000	—
R-436A	zeotrope	R-290/600a (56.0/44.0)	A3	0.50	4,000	8.1	<u>2.0</u>	<u>16,000</u>	<u>32.3</u>	1,000	—
R-436B	zeotrope	R-290/600a (52.0/48.0)	A3	0.51	4,000	8.1 <u>8.2</u>	<u>2.0</u>	<u>16,000</u>	<u>32.7</u>	1,000	—
<u>R-436C</u>	<u>zeotrope</u>	<u>R-290/600a (95.0/5.0)</u>	<u>A3</u>	<u>0.57</u>	<u>5,000</u>	<u>9.1</u>	<u>2.3</u>	<u>20,000</u>	<u>36.5</u>	<u>1,000</u>	
R-437A	zeotrope	R-125/134a/600/601 (19.5/78.5/1.4/0.6)	A1	5.0 <u>5.1</u>	19,000	82				990	—
R-438A	zeotrope	R-32/125/134a/600/601a (8.5/45.0/44.2/1.7/0.6)	A1	4.9	20,000	79				990	—

R-439A	zeotrope	R-32/125/600a (50.0/47.0/3.0)	A2	4.7	26,000	76	<u>18.9</u>	<u>104,000</u>	<u>303.3</u>	<u>990</u> <u>1,000</u>	—
R-440A	zeotrope	R-290/134a/152a (0.6/1.6/97.8)	A2	1.9	12,000	31	<u>7.8</u>	<u>46,000</u>	<u>124.7</u>	1,000	—
R-441A	zeotrope	R-170/290/600a/600 (3.1/54.8/6.0/36.1)	A3	0.39	3,200	6.3	<u>2.0</u>	<u>16,000</u>	<u>31.7</u>	1,000	—
R-442A	zeotrope	R-32/125/134a/152a/227ea (31.0/31.0/30.0/3.0/5.0)	A1	21	100,000	330				1,000	—
R-443A	zeotrope	R-1270/290/600a (55.0/40.0/5.0)	A3	0.19	1,700	3.1	<u>2.2</u>	<u>20,000</u>	<u>35.6</u>	<u>580</u> <u>640</u>	—
R-444A	zeotrope	R-32/152a/1234ze(E) (12.0/5.0/83.0)	A2* <u>A2L</u>	5.1	21,000	81	<u>19.9</u>	<u>82,000</u>	<u>324.8</u>	850	—
R-444B	zeotrope	R-32/152a/1234ze(E) (41.5/10.0/48.5)	A2* <u>A2L</u>	4.3	23,000	69	<u>17.3</u>	<u>93,000</u>	<u>277.3</u>	<u>890</u> <u>930</u>	—
R-445A	zeotrope	R-744/134a/1234ze(E) (6.0/9.0/85.0)	A2* <u>A2L</u>	4.2	16,000	67	<u>2.7</u>	<u>63,000</u>	<u>347.4</u>	930	—
R-446A	zeotrope	R-32/1234ze(E)/600 (68.0/29.0/3.0)	A2* <u>A2L</u>	2.5	16,000	39	<u>13.5</u>	<u>62,000</u>	<u>217.4</u>	960	—
R-447A	zeotrope	R-32/125/1234ze(E) (68.0/3.5/28.5)	A2* <u>A2L</u>	2.6	16,000	42	<u>18.9</u>	<u>65,000</u>	<u>303.5</u>	<u>900</u> <u>960</u>	—
R-447B	zeotrope	R-32/125/1234ze(E) (68.0/8.0/24.0)	A2* <u>A2L</u>	<u>23</u> <u>2.6</u>	<u>30,000</u> <u>16,000</u>	<u>360</u> <u>42</u>	<u>20.6</u>	<u>121,000</u>	<u>312.7</u>	970	
R-448A	zeotrope	R-32/125/1234yf/134a/1234ze(E) (26.0/26.0/20.0/21.0/7.0)	A1	24	110,000	390				<u>890</u> <u>860</u>	—
R-449A	zeotrope	R-32/125/1234yf/134a (24.3/24.7/25.3/25.7)	A1	23	100,000	370				<u>830</u> <u>840</u>	—
R-449B	zeotrope	R-32/125/1234yf/134a (25.2/24.3/23.2/27.3)	A1	23	100,000	370				850	
R-449C	zeotrope	R-32/125/1234yf/134a (20.0/20.0/31.0/29.0)	A1	23	98,000	<u>360</u>				800	
R-450A	zeotrope	R-134a/1234ze(E) (42.0/58.0)	A1	20	72,000	320				880	—
R-451A	zeotrope	R-1234yf/134a (89.8/10.2)	A2* <u>A2L</u>	<u>5.3</u> <u>5.0</u>	18,000	81	<u>20.3</u>	<u>70,000</u>	<u>326.6</u>	<u>520</u> <u>530</u>	—
R-451B	zeotrope	R-1234yf/134a (88.8/11.2)	A2* <u>A2L</u>	<u>5.3</u> <u>5.0</u>	18,000	81	<u>20.3</u>	<u>70,000</u>	<u>326.6</u>	530	—
R-452A	zeotrope	R-32/125/1234yf (11.0/59.0/30.0)	A1	27	<u>40,000</u> <u>100,000</u>	440				<u>780</u> <u>790</u>	—
R-452B	zeotrope	R-32/125/1234yf (67.0/7.0/26.0)	A2* <u>A2L</u>	<u>23</u> <u>4.8</u>	30,000	<u>260</u> <u>77</u>	<u>19.3</u>	<u>119,000</u>	<u>310.5</u>	870	—
R-452C	zeotrope	R-32/125/1234yf (12.5/61.0/26.5)	A1	27	100,000	430				<u>800</u> <u>810</u>	
R-453A	zeotrope	R-32/125/134a/227ea/600/601a (20.0/20.0/53.8/5.0/0.6/0.6)	A1	7.8	34,000	120				1,000	
R-454A	zeotrope	R-32/1234yf (35.0/65.0)	A2* <u>A2L</u>	<u>28</u> <u>3.2</u>	16,000	<u>450</u> <u>52</u>	<u>18.3</u>	<u>63,000</u>	<u>293.9</u>	690	
R-454B	zeotrope	R-32/1234yf (68.9/31.1)	A2* <u>A2L</u>	<u>22</u> <u>3.1</u>	19,000	<u>360</u> <u>49</u>	<u>22.0</u>	<u>77,000</u>	<u>352.6</u>	850	
R-454C	zeotrope	R-32/1234yf (21.5/78.5)	A2* <u>A2L</u>	<u>29</u> <u>4.4</u>	19,000	<u>460</u> <u>71</u>	<u>18.0</u>	<u>62,000</u>	<u>289.5</u>	620	
R-455A	zeotrope	R-744/32/1234yf (3.0/21.5/75.5)	A2* <u>A2L</u>	<u>23</u> <u>4.9</u>	<u>30,000</u> <u>22,000</u>	<u>380</u> <u>79</u>	<u>26.9</u>	<u>118,000</u>	<u>432.1</u>	650	
R-456A	zeotrope	R-32/134a/1234ze(E) (6.0/45.0/49.0)	A1	20	77,000	320				900	
R-457A	zeotrope	R-32/1234yf/152a (18.0/70.0/12.0)	A2* <u>A2L</u>	<u>25</u> <u>3.4</u>	15,000	<u>400</u> <u>54</u>	<u>13.5</u>	<u>60,000</u>	<u>216.3</u>	650	
R-457B	zeotrope	R-32/1234yf/152a (35.0/55.0/10.0)	A2L	3.7	19,000	59	14.9	76,000	239	730	
R-458A	zeotrope	R-32/125/134a/227ea/236fa (20.5/4.0/61.4/13.5/0.6)	A1	18	76,000	280				1,000	

R-459A	zeotrope	R-32/1234yf/1234ze(E) (68.0/26.0/6.0)	A2 ^e A2L	23 4.3	27,000	360 69	17.4	107,000	278.7	870	
R-459B	zeotrope	R-32/1234yf/1234ze(E) (21.0/69.0/10.0)	A2 ^e A2L	30	16,000 25,000	470 92	23.3	99,000	373.5	640	
R-460A	zeotrope	R-32/125/134a/1234ze(E) (12.0/52.0/14.0/22.0)	A1	24	92,000	380				650 950	
R-460B	zeotrope	R-32/125/134a/1234ze(E) (28.0/25.0/20.0/27.0)	A1	25	120,000	400				950	
R-460C	zeotrope	<u>R-32/125/134a/1234ze(E)</u> <u>(2.5/2.5/46.0/49.0)</u>	<u>A1</u>	<u>20</u>	<u>73,000</u>	<u>310</u>				<u>900</u>	
R-461A	zeotrope	R-32/125/134a/1234ze(E) (2.5/2.5/46.0/49.0)	A1	17	61,000	270				1,000	
R-462A	zeotrope	R-125/143a/134a/227ea/600a (55.0/5.0/32.0/5.0/3.0)	A2	3.9	16,000	62	<u>16.6</u>	<u>105,000</u>	<u>265.8</u>	1,000	
R-463A	zeotrope	R-744/32/125/1234yf/134a (6.0/36.0/30.0/14.0/14.0)	A1	19	98,000	300				990	
R-464A	zeotrope	<u>R-32/125/1234ze(E)/227ea</u> <u>(27.0/27.0/40.0/6.0)</u>	<u>A1</u>	<u>27</u>	<u>120,000</u>	<u>430</u>				<u>930</u>	
R-465A	zeotrope	R-32/290/1234yf <u>(21.0/7.9/71.1)</u>	A2	<u>2.5</u>	<u>12,000</u>	<u>40</u>	<u>10.0</u>	<u>98,000</u>	<u>160.9</u>	<u>660</u>	
R-466A	zeotrope	<u>R-32/125/131i (49.0/11.5/39.5)</u>	<u>A1</u>	<u>6.2</u>	<u>30,000</u>	<u>99</u>				<u>860</u>	
R-467A	zeotrope	<u>R-32/125/134a/600a</u> <u>(22.0/5.0/72.4/0.6)</u>	<u>A2L</u>	<u>6.7</u>	<u>31,000</u>	<u>110</u>				<u>1,000</u>	
R-468A	zeotrope	<u>R-1132a/32/1234yf (3.5/21.5/75.0)</u>	<u>A2L</u>	<u>4.1</u>	<u>18,000</u>	<u>66</u>				<u>610</u>	
R-469A	zeotrope	<u>R-744/R-32/R-125 (35.0/32.5/32.5)</u>	<u>A1</u>	<u>8</u>	<u>53,000</u>	<u>130</u>				<u>1,600</u>	
R-470A	zeotrope	<u>R-</u> <u>744/32/125/134a/1234ze(E)/227ea</u> <u>(10.0/17.0/19.0/7.0/44.0/3.0)</u>	<u>A1</u>	<u>17</u>	<u>77,000</u>	<u>270</u>				<u>1,100</u>	
R-470B	zeotrope	<u>R-</u> <u>744/32/125/134a/1234ze(E)/227ea</u> <u>(10.0/11.5/11.5/3.0/57.0/7.0)</u>	<u>A1</u>	<u>16</u>	<u>72,000</u>	<u>260</u>				<u>1,100</u>	
R-471A	zeotrope	<u>R-1234ze(E)/227ea/1336mzz(E)</u> <u>(78.7/4.3/17.0)</u>	<u>A1</u>	<u>9.7</u>	<u>31,000</u>	<u>160</u>				<u>710</u>	
R-472A	zeotrope	<u>R-744/32/134a (69.0/12.0/19.0)</u>	<u>A1</u>	<u>4.5</u>	<u>35,000</u>	<u>72</u>				<u>2,700</u>	
R-500 ^{e, d}	azeotrope	R-744/32/125/1234yf/134a (6.0/36.0/30.0/14.0/14.0)	A1	7.6 7.4	30,000 29,000	120				1,000	2-0-0 ^b
R-501 ^{d, c}	azeotrope	R-22/12 (75.0/25.0)	A1	13	54,000	210				1,000	—
R-502 ^{e, d}	azeotrope	R-22/115 (48.8/51.2)	A1	21	73,000	330				1,000	2-0-0 ^b
R-503 ^{e, d}	azeotrope	R-23/13 (40.1/59.9)	—	—	—	—				1,000	2-0-0 ^b
R-504 ^{d, c}	azeotrope	R-32/115 (48.2/51.8)	—	28	140,000	450				1,000	—
R-507A	azeotrope	R-125/143a (50.0/50.0)	A1	32	130,000	520 510				1,000	2-0-0 ^b
R-508A	azeotrope	R-23/116 (39.0/61.0)	A1	14	55,000	220				1,000	2-0-0 ^b
R-508B	azeotrope	R-23/116 (46.0/54.0)	A1	13	52,000	200				1,000	2-0-0 ^b
R-509A	azeotrope	R-22/218 (44.0/56.0)	A1	24	75,000	390 380				1,000	2-0-0 ^b
R-510A	azeotrope	R-E170/600a (88.0/12.0)	A3	0.87	7,300	14	<u>3.5</u>	<u>29,000</u>	<u>56.1</u>	1,000	—
R-511A	azeotrope	R-290/E170 (95.0/5.0)	A3	0.59	5,300	9.5	<u>2.4</u>	<u>21,000</u>	<u>38.0</u>	1,000	—

R-512A	azeotrope	R-134a/152a (5.0/95.0)	A2	1.9	11,000	31	<u>7.7</u>	<u>45,000</u>	<u>123.9</u>	1,000	—
R-513A	azeotrope	R-1234yf/134a (56.0/44.0)	A1	20	72,000	320				650	—
R-513B	azeotrope	R-1234yf/134a (58.5/41.5)	A1	21	74,000	330				640	
R-514A	azeotrope	R-1336mzz(Z)/1130 (E) (74.7/25.3)	B1	0.86	2,400	14				320	
R-515A	azeotrope	R-1234ze(E)/227ea (88.0/12.0)	A1	19	62,000 <u>63,000</u>	300				810	
R-515B	azeotrope	R-1234ze(E)/227ea (91.1/8.9)	A1	18	61,000	290				<u>810</u>	
R-516A	azeotrope	R-1234yf/134a/152a (77.5/8.5/14.0)	A2	7.0 <u>3.2</u>	27,000 <u>13,000</u>	110 <u>52</u>	<u>13.1</u>	<u>50,000</u>	<u>210.1</u>	590	
R-600	CH ₃ CH ₂ CH ₂ CH ₃	butane	A3	0.15	1,000	2.4	<u>3.0</u>	<u>20,000</u>	<u>48</u>	1,000	1-4-0
R-600a	CH(CH ₃) ₂ CH ₃	2-methylpropane (isobutane)	A3	0.59	4,000	9.6 <u>9.5</u>	<u>2.4</u>	<u>16,000</u>	<u>38</u>	1,000	2-4-0
R-601	CH ₃ CH ₂ CH ₂ CH ₂ CH ₃	pentane	A3	0.18	1,000	2.9	<u>2.2</u>	<u>12,000</u>	<u>35</u>	600	—
R-601a	(CH ₃) ₂ CHCH ₂ CH ₃	2-methylbutane (isopentane)	A3	0.18	1,000	2.9	<u>2.4</u>	<u>13,000</u>	<u>38</u>	600	—
R-610	ethoxyethane (ethyl ether)	CH ₃ CH ₂ OCH ₂ CH ₃	—	—	—	—				400	—
R-611	methylformate	HCOOCH ₃	B2	—	—	—				100	—
R-718	H ₂ O	water	A1	—	—	—				—	0-0-0
R-744	CO ₂	carbon dioxide	A1	4.5	40,000	72				5,000	2-0-0 ^b
R-1130(E)	CHCl=CHCl	Trans-1,2-dichloroethene	B1B2	0.25	1,000	4	<u>16</u>	<u>65,000</u>	<u>258</u>	200	
R-1132a	CF ₂ = CH ₂	1, 1-difluoroethylene	A2	2.0	13,000	33	<u>8.1</u>	<u>50,000</u>	<u>131</u>	500	
R-1150	CH ₂ =CH ₂	ethene (ethylene)	A3	—	—	—	<u>2.2</u>	<u>31,000</u>	<u>36</u>	200	1-4-2
R-1224yd(Z)	CF ₃ CF=CHCl	(Z)-1-chloro-2,3,3,3-tetrafluoropropene	A1	23	60,000	260 <u>370</u>				1,000	
R-1233zd(E)	CF ₃ CH=CHCl	trans-1-chloro-3,3,3-trifluoro- 1-propene	A1	5.3	16,000	85				800	—
R-1234yf	CF ₃ CF=CH ₂	2,3,3,3-tetrafluoro-1 propene	A2* <u>A2L</u>	4.7 <u>4.5</u>	16,000	75	<u>18.0</u>	<u>62,000</u>	<u>289</u>	500	—
R-1234ze(E)	CF₃CH=CHF CF ₃ CH=CFH	trans-1,3,3,3-tetrafluoro-1 - propene	A2* <u>A2L</u>	4.7	16,000	75 <u>76</u>	<u>18.8</u>	<u>65,000</u>	<u>303</u>	800	—
R-1270	CH ₃ CH=CH ₂	Propene (propylene)	A3	0.1	1,000	1.7				500	1-4-1
R-1336mzz(E)	CF ₃ CH=CHCF ₃	trans 1,1,1,4,4,4-hexafluoro-2- butene	A1	<u>3.0</u>	<u>7,200</u>	<u>48</u>				<u>400</u>	
R-1336mzz(Z)	CF ₃ CH=CHCF ₃	Cis-1,1,1,4,4,4-hexafluoro-2-butene	A1	5.4 <u>5.2</u>	13,000	87 <u>84</u>				500	

SI: 1 pound = 0.454 kg, 1 cubic foot = 0.02832 m³

- Degrees of hazard are for health, fire, and reactivity, respectively, in accordance with NFPA 704.
- Reduction to 1-0-0 is allowed if analysis satisfactory to the code official shows that the maximum concentration for a rupture or full loss of refrigerant charge would not exceed the IDLH, considering both the refrigerant quantity and room volume.
- ~~The ASHRAE Standard 34 flammability classification for this refrigerant is 2L, which is a subclass of Class 2.~~
- ~~c.~~ Class I ozone depleting substance; prohibited for new installations.
- ~~e.~~ d. Occupational Exposure Limit based on the OSHA PEL, ACGIH TLV-TWA, the TERA WEEL or consistent value on a time-weighted average (TWA) basis (unless noted C for ceiling) for an 8 hr/d and 40 hr/wk.

1104.3.1 Air conditioning for human comfort. In other than industrial occupancies where the quantity in a single independent circuit does not exceed the amount in Table 1103.1, Group B1, B2 and B3 refrigerants shall not be used in high-probability systems for air conditioning for human comfort. High-probability systems used for human comfort shall use Group A1 or A2L refrigerant.

Exceptions:

1. Equipment listed for and used in residential occupancies containing a maximum of 6.6 pounds (3 kg) of refrigerant.
2. Equipment listed for and used in commercial occupancies containing a maximum of 22 pounds (10 kg) of refrigerant.
3. Industrial occupancies.

1104.3.2 Nonindustrial occupancies Group A2, A3, B2 and B3 refrigerants. Group A2 and B2 refrigerants shall not be used in high-probability systems where the quantity of refrigerant in any independent refrigerant circuit exceeds the amount shown in Table 1104.3.2. Group A2 and B2 refrigerants shall not be used in high-probability systems. Group A3 and B3 refrigerants shall not be used except where approved.

Exceptions: This section does not apply to laboratories:

1. Laboratories where the floor area per occupant is not less than 100 square feet (9.3 m²).
2. Listed self-contained systems having a maximum of 0.331 pounds (150 g) of Group A3 refrigerant.
3. Industrial occupancies.
4. Equipment listed for and used in residential occupancies containing a maximum of 6.6 pounds (3 kg) of Group A2 or B2 refrigerant.
5. Equipment listed for and used in commercial occupancies containing a maximum of 22 pounds (10 kg) of Group A2 or B2 refrigerant.

TABLE 1104.3.2
MAXIMUM PERMISSIBLE QUANTITIES OF REFRIGERANTS

TYPE OF REFRIGERATION SYSTEM	MAXIMUM POUNDS FOR VARIOUS OCCUPANCIES			
	Institutional	Public assembly	Residential	All other occupancies
Sealed absorption system				
In exit access	0	0	3.3	3.3
In adjacent outdoor locations	0	0	22	22
In other than exit access	0	6.6	6.6	6.6
Unit systems				
In other than exit access	0	0	6.6	6.6

For SI: 1 pound = 0.454 kg.

1106.3 Flammable Class 2 and 3 refrigerants. Where refrigerants of Groups A2, A3, B2 and B3 are used, the machinery room shall conform to the Class I, Division 2, hazardous location classification requirements of NFPA 70.

Exception: Machinery rooms for systems containing Group A2L refrigerants that are provided with ventilation in accordance with Section 1106.4.

1106.4 Special requirements for Group A2L refrigerant machinery rooms. Machinery rooms with systems containing Group A2L refrigerants that do not conform to the Class I, Division 2, hazardous location electrical requirements of NFPA 70, as permitted by the exception to Section 1106.3, shall comply with Sections 1106.4.1 through 1106.4.3.

Exception: Machinery rooms conforming to the Class I, Division 2, hazardous location classification requirements of NFPA 70 are not required to comply with Sections 1106.4.1 and 1106.4.2.

1106.4 Group A2L and B2L refrigerant. Machinery rooms for Group A2L and B2L refrigerant shall comply with Sections 1106.4.1 through Section 1106.4.3.

1106.4.1 Elevated temperatures. Open flame-producing devices or continuously operating hot surfaces over 1290 °F (700 °C) shall not be permanently installed in the room.

[F] 1106.4.1 Ventilation system activation. Ventilation shall be activated by the refrigerant detection system in the machinery room. Refrigerant detection systems shall be in accordance with Section 605.8 of the International Fire Code and all of the following:

1. The detectors shall activate at or below a refrigerant concentration of 25 percent of the LFL.
2. Upon activation, the detection system shall activate the emergency ventilation system required by Section 1106.4.2.
3. The detection, signaling and control circuits shall be supervised.

1106.4.2 Emergency ventilation system. An emergency ventilation system shall be provided at the minimum exhaust rate specified in ASHRAE 15 or Table 1106.4.2. Shutdown of the emergency ventilation system shall be by manual means.

1106.4.2 Refrigerant detector. In addition to the requirements of Section 1105.3, refrigerant detectors shall signal an alarm and activate the ventilation system in accordance with the response time specified in Table 1106.4.2.

TABLE 1106.4.2 GROUP A2L and B2L DETECTOR ACTIVATION

Activation Level	Maximum Response Time (seconds)	ASHRAE 15 Ventilation Level	Alarm Reset	Alarm Type
Less than or equal to the OEL in Table 1103.1	300	1	Automatic	Trouble
Less than or equal to the refrigerant concentration level in Table 1103.1	15	2	Manual	Emergency

TABLE 1106.4.2 MINIMUM EXHAUST RATES

REFRIGERANT	Q(m/sec)	Q(cfm)
R32	15.4	32,600
R143	13.6	28,700
R444A	6.46	13,700
R444B	10.6	22,400
R445A	7.83	16,600
R446A	23.9	50,700
R447A	23.8	50,400
R451A	7.04	15,000
R451B	7.05	15,000
R1234yf	7.80	16,600
R1234ze(E)	5.92	12,600

1106.4.3 Emergency ventilation system discharge.

The emergency ventilation system point of discharge to the atmosphere shall be located outside of the structure at not less than 15 feet (4572 mm) above the adjoining grade level and not less than 20 feet (6096 mm) from any window, ventilation opening or exit.

1106.4.3 Mechanical ventilation.

The machinery room shall have a mechanical ventilation system complying with ASHRAE 15.

TABLE 1107.4 REFRIGERANT PIPE

PIPING MATERIAL	STANDARD
Aluminum tube	ASTM B210/ASTM B210M, ASTM B491/B491M
Brass (copper alloy) pipe	ASTM B43
Copper linesets	ASTM B280, ASTM B1003
Copper pipe	ASTM B42, ASTM B302
Copper tube ^a	ASTM B68, ASTM B75, ASTM B88, ASTM B280, ASTM B819
Steel pipe ^b	ASTM A53, ASTM A106, ASTM A333
Steel tube	ASTM A254, ASTM A334

- Soft annealed copper tubing larger than 1³/₈-inch (35 mm) O.D. shall not be used for field-assembled refrigerant piping unless it is protected from mechanical damage.
- ASTM A53, Type F steel pipe shall not be used for refrigerant lines having an operating temperature less than -20°F (-29°C). only be permitted for discharge lines in pressure relief systems.

TABLE 1107.5 REFRIGERANT PIPE FITTINGS

FITTING MATERIAL	STANDARD
Aluminum	ASTM B361
Brass (copper alloy)	ASME B16.15, ASME B16.24
Copper and Copper Alloy (Brass)	ASME B16.15, ASME B16.18, ASME B16.22, ASME B16.24, ASME B16.26, ASME B16.50
Steel	ASTM A105, ASTM A181, ASTM A193, ASTM A234, ASTM A420, ASTM A707

1107.7 Flexible connectors, expansion and vibration compensators. Flexible connectors and expansion and vibration control devices shall be listed and labeled for use in refrigerant systems and pressures for which the components are installed.

1109.2.2 Refrigerant pipe enclosure. Refrigerant piping shall be protected by locating it within the building elements or within protective enclosures.

Exception: Piping protection within the building elements or protective enclosure shall not be required in any of the following locations:

1. Where installed without ready access or located more than 7 feet 3 inches (2210 mm) above the finished floor.
2. Where located within 6 feet (1829 mm) of the refrigerant unit or *appliance*.
3. Where located in a *machinery room* complying with Section 1105.
4. Outside the building:
 - 4.1 Protected from damage from the weather, including, but not limited to, hail, ice, and snow loads and
 - 4.2 Protected from damage within the expected foot or traffic path or
 - 4.3 Outside, underground, installed not less than 8 inches (200 mm) below finished grade and protected against corrosion.

1109.2.3 Prohibited locations. Refrigerant piping shall not be installed in any of the following locations:

1. Exposed within a fire-resistance-rated exit access corridor.
2. Exposed wWithin an interior exit stairway.
3. Within an interior exit ramp.
4. Within an exit passageway.
5. Within an elevator, dumbwaiter or other shaft containing a moving object.

1109.2.6 Exposed piping surface temperature. Exposed piping with ready access to nonauthorized personnel having surface temperatures greater than 120°F (49°C) or less than 5°F (-15°C) shall be protected from contact or shall have thermal insulation that limits the exposed insulation surface temperature to a range of 5°F (-15°C) to 120°F (49°C).

1109.2.7 Pipe identification. Refrigerant pipe located in areas other than the room or space where the refrigerating *equipment* is located shall be identified. The pipe identification shall be located at intervals not exceeding 20 feet (6096 mm) on the refrigerant piping or pipe insulation. The minimum height of lettering of the identification label shall be 1/2 inch (12.7 mm). The identification shall indicate the refrigerant designation and safety group classification of refrigerant used in the piping system. For Group A2L and B2L refrigerants, the identification shall also include the following statement: "WARNING – Risk of Fire. Flammable Refrigerant." For Group A2, A3, B2 and B3 refrigerants, the identification shall also include the following statement: "DANGER—Risk of Fire or Explosion. Flammable Refrigerant." For any Group B refrigerant, the identification shall also include the following statement: "DANGER—Toxic Refrigerant."

1109.3 Installation requirements for Group A2L, ~~A2, A3, or B2L~~, B2, or B3 refrigerant. Piping systems using Group A2L, A2, A3, or B2L, B2, or B3 refrigerant shall comply with the requirements of Sections 1109.3.1 and 1109.3.2.

1109.3.1 Pipe protection. In addition to the requirements of Section 305.5, aluminum, copper and steel tube used for Group ~~A2L, A2, A3, and B2L~~, A2L, A2, A3, and B2L, B2, and B3 refrigerants and located in concealed locations where tubing is installed in studs, joists, rafters or similar member spaces, and located less than 1 1/2 inches (38 mm) from the nearest edge of the member, shall be continuously protected by shield plates. Protective steel shield plates having a minimum thickness of 0.0575 inch (1.46 mm) (No. 16 gage) shall cover the area of the tube plus the area extending not less than 2 inches (51 mm) beyond both sides of the tube.

1109.3.2 Shaft ventilation. Refrigerant pipe shafts with systems using Group A2L or B2L refrigerant shall be naturally or mechanically ventilated. Refrigerant pipe shafts with one or more systems using any Group A2, A3, B2, or B3 refrigerant shall be continuously mechanically ventilated and shall include a refrigerant detector. The shaft ventilation exhaust outlet shall comply with Section 501.3.1. Naturally ventilated shafts shall have a pipe, duct or conduit not less than 4 inches (102 mm) in diameter that connects to the lowest point of the shaft and extends to the outdoors. The pipe, duct or conduit shall be level or pitched downward to the outdoors. Mechanically ventilated shafts shall have a minimum airflow velocity in accordance with Table 1109.3.2. The mechanical ventilation shall be continuously operated or activated by a refrigerant detector. Systems utilizing a refrigerant detector shall activate the mechanical ventilation at a maximum refrigerant concentration of 25 percent of the lower flammable limit of the refrigerant. The detector, or a sampling tube that draws air to the detector, shall be located in an area where refrigerant from a leak will concentrate. The shaft shall not be required to be ventilated for double-wall refrigerant pipe where the interstitial space of the double-wall pipe is vented to the outdoors.

1109.4 Installation requirements for Group A2, A3, B2 or B3 refrigerant. Piping systems using Group A2, A3, B2 or B3 refrigerant shall comply with the requirements of Sections 1109.4.1 and 1109.4.2.

1109.4.1 Piping material. Piping material for Group A2, A3, B2 or B3 refrigerant located inside the building, except for *machinery rooms*, shall be copper pipe, brass pipe or steel pipe. Pipe joints located in areas other than the *machinery room* shall be welded. Self-contained *listed and labeled equipment or appliances* shall have piping material based on the listing requirements.

1109.4.2 Shaft ventilation. Refrigerant pipe shafts with systems using Group A2, A3, B2 or B3 refrigerant shall be continuously mechanically ventilated. The shaft ventilation exhaust outlet shall comply with Section 501.3.1. Mechanically ventilated shafts shall have a minimum airflow velocity as specified in Table 1109.3.2. The shaft shall not be required to be ventilated for double-wall refrigerant pipe where the interstitial space of the double-wall pipe is vented to the outdoors.

1109.7 Condensate control. Refrigerating piping and fittings that, during normal operation, will reach a surface temperature below the dew point of the surrounding air, and are located in spaces or areas where condensation has the potential to cause a safety hazard to the building occupants, structure, electrical equipment or any other equipment or appliances, shall be insulated or protected in an approved manner to prevent damage from condensation.

1110.3 Test gases. The medium used for pressure testing the refrigerant system shall be one of the following inert gases: oxygen-free nitrogen, helium, ~~or argon~~ or premixed nonflammable oxygen-free nitrogen with a tracer gas of hydrogen or helium. For R-744 refrigerant systems, carbon dioxide shall be allowed as the test medium. For R-718 refrigerant systems, water shall be allowed as the test medium. Oxygen, air, combustible gases and mixtures containing such gases shall not be used as a test medium. Systems erected on the premises with tubing not exceeding 5/8 inch (15.9 mm) outside diameter shall be allowed to use the refrigerant identified on the nameplate label or marking as the test medium.

1110.3.1 Test gases not permitted.

Oxygen, air, refrigerants other than those identified in Section 1110.3, combustible gases and mixtures containing such gases shall not be used as the pressure test medium.

1110.5 Piping system strength test pressure test and leak test. Refrigerating system components and refrigerant piping shall be tested in accordance with ASME B31.5 or this section. Separate tests for isolated portions of the system are permitted provided that all required portions are tested at least once. Pressurize with test gas for a minimum of 10 minutes to not less than the lower of (a) the lowest design pressure for any system component, or (b) the lowest value of set pressure for any pressure relief devices in the system. The design pressures for determination of test pressure shall be the pressure identified on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel, or other system component with a nameplate. A passing test result shall have no rupture or structural failure of any system component or refrigerant piping. Refrigerant piping and tubing greater than 3/4 inches in diameter shall be tested in accordance with ASHRAE 15.

The refrigerant piping system shall be tested as a whole or separate tests shall be conducted for the low pressure side and high pressure side of the piping system. The refrigerant piping system shall be tested in accordance with both of the following methods:

1. The system shall be pressurized for a period of not less than 60 minutes to not less than the lower of the design pressures or the setting of the pressure relief device(s). The design pressures for testing shall be the pressure listed on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. Additional test gas shall not be added to the system after the start of the pressure test. The system shall not show loss of pressure on the test pressure measuring device during the pressure test. Where using refrigerant as a test medium in accordance with Section 1110.3, the test pressure shall be not less than the saturation dew point pressure at 77°F (25°C).
2. A vacuum of 500 microns shall be achieved. After achieving a vacuum, the system shall be isolated from the vacuum pump. The system pressure shall not rise above 1,500 microns for a period of not less than 10 minutes.

1110.5.2 Limited charge systems. Limited charge systems with a pressure relief device, erected on the premises, shall be tested at a pressure not less than one and one-half times the pressure setting of the relief device. Listed and labeled limited charge systems shall be tested at the equipment or appliance design pressure.

1110.5.1 Joints and refrigerant containing parts in air ducts. Joints and all refrigerant containing parts of a refrigerating system located in an air duct of an air conditioning system that conveys conditioned air to and from human occupied spaces shall be tested at a pressure of 150 percent of the higher of the design pressure or pressure relief device setting.

1110.6 Booster compressor. Where a compressor protected by a pressure relief device is used as a booster to obtain an intermediate pressure, and such compressor discharges into the suction side of another compressor, the booster compressor shall be considered to be a part of the low pressure side of the system.

1110.7 Centrifugal/nonpositive displacement compressors. Where testing systems using centrifugal or other nonpositive displacement compressors, the entire system shall be considered to be the low pressure side for test purposes.

CHAPTER 15: REFERENCED STANDARDS

ASHRAE

ASHRAE
1791 Tullie Circle NE
Atlanta, GA 30329

15-2022

Safety Standard for Refrigeration Systems

34-2022

Designation and Safety Classification of Refrigerants

ASTM

ASTM International
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428

A333-18

Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and other Applications with required Notch Toughness

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

UL/CSA 60335-2-40—17 2022

Household and Similar Electrical Appliances—Safety—Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers

UL/CSA 60335-2-89—17 2021

Household and Similar Electrical Appliances—Safety—Part 2-89: Particular Requirements for Commercial Refrigerating Appliances with an Incorporated or Remote Refrigerant Unit or Compressor