# CHAPTER 11
# REFRIGERATION

## SECTION 1101
## GENERAL

**1101.1 Scope.** This chapter shall govern the design, installation, construction and repair of refrigeration systems that vaporize and liquefy a fluid during the refrigerating cycle. Refrigerant piping design and installation, including pressure vessels and pressure relief devices, shall conform to this code. Permanently installed refrigerant storage systems and other components shall be considered as part of the refrigeration system to which they are attached.

**1101.2 Factory-built equipment and appliances.** Listed and labeled self-contained, factory-built equipment and appliances shall be tested in accordance with UL 207, 412, 471 or 1995. Such equipment and appliances are deemed to meet the design, manufacture and factory test requirements of this code if installed in accordance with their listing and the manufacturer's installation instructions.

**1101.3 Protection.** Any portion of a refrigeration system that is subject to physical damage shall be protected in an approved manner.

**1101.4 Water connection.** Water supply and discharge connections associated with refrigeration systems shall be made in accordance with this code and the ((~~*International*~~)) *Uniform Plumbing Code*.

**1101.5 Fuel gas connection.** Fuel gas devices, equipment and appliances used with refrigeration systems shall be installed in accordance with the *International Fuel Gas Code.*

**1101.6 General.** Refrigeration systems shall comply with the requirements of this code and, except as modified by this code, ASHRAE 15. Ammonia-refrigerating systems shall comply with this code and, except as modified by this code, ASHRAE 15 and IIAR 2.

**1101.7 Maintenance.** Mechanical refrigeration systems shall be maintained in proper operating condition, free from accumulations of oil, dirt, waste, excessive corrosion, other debris and leaks.

**1101.8 Change in refrigerant type.** The type of refrigerant in refrigeration systems having a refrigerant circuit containing more than 220 pounds of Group A1 or 30 pounds of any other group refrigerant shall not be changed without prior notification to the code official and compliance with the applicable code provisions for the new refrigerant type.

**[F] 1101.9 Refrigerant discharge.** Notification of refrigerant discharge shall be provided in accordance with the *International Fire Code*.

## SECTION 1102
## SYSTEM REQUIREMENTS

**1102.1 General.** The system classification, allowable refrigerants, maximum quantity, enclosure requirements, location limitations, and field pressure test requirements shall be determined as follows:

1. Determine the refrigeration system's classification, in accordance with Section 1103.3.
2. Determine the refrigerant classification in accordance with Section 1103.1.
3. Determine the maximum allowable quantity of refrigerant in accordance with Section 1104, based on type of refrigerant, system classification and occupancy.
4. Determine the system enclosure requirements in accordance with Section 1104.
5. Refrigeration equipment and appliance location and installation shall be subject to the limitations of Chapter 3.
6. Nonfactory-tested, field-erected equipment and appliances shall be pressure tested in accordance with Section 1108.

**1102.2 Refrigerants.** The refrigerant shall be that which the equipment or appliance was designed to utilize or converted to utilize. Refrigerants not identified in Table 1103.1 shall be approved before use.

**1102.2.1 Mixing.** Refrigerants, including refrigerant blends, with different designations in ASHRAE 34 shall not be mixed in a system.

**Exception:** Addition of a second refrigerant is allowed where permitted by the equipment or appliance manufacturer to improve oil return at low temperatures. The refrigerant and amount added shall be in accordance with the manufacturer's instructions.

**1102.2.2 Purity.** Refrigerants used in refrigeration systems shall be new, recovered or reclaimed refrigerants in accordance with Section 1102.2.2.1, 1102.2.2.2 or 1102.2.2.3. Where required by the equipment or appliance owner or the code official, the installer shall furnish a signed declaration that the refrigerant used meets the requirements of Section 1102.2.2.1, 1102.2.2.2 or 1102.2.2.3.

**Exception:** The refrigerant used shall meet the purity specifications set by the manufacturer of the equipment or appliance in which such refrigerant is used where such specifications are different from that specified in Sections 1102.2.2.1, 1102.2.2.2 and 1102.2.2.3.

**1102.2.2.1 New refrigerants.** Refrigerants shall be of a purity level specified by the equipment or appliance manufacturer.

**1102.2.2.2 Recovered refrigerants.** Refrigerants that are recovered from refrigeration and air-conditioning systems shall not be reused in other than the system from which they were recovered and in other systems of the same owner. Recovered refrigerants shall be filtered and dried before reuse. Recovered refrigerants that show clear signs of contamination shall not be reused unless reclaimed in accordance with Section 1102.2.2.3.

**1102.2.2.3 Reclaimed refrigerants.** Used refrigerants shall not be reused in a different owner's equipment or appliances unless tested and found to meet the purity requirements of ARI 700. Contaminated refrigerants shall not be used unless reclaimed and found to meet the purity requirements of ARI 700.

## SECTION 1103
## REFRIGERATION SYSTEM CLASSIFICATION

**1103.1 Refrigerant classification.** Refrigerants shall be classified in accordance with ASHRAE 34 as listed in Table 1103.1.

**1103.2 Occupancy classification.** Locations of refrigerating systems are described by occupancy classifications that consider the ability of people to respond to potential exposure to refrigerants. Where equipment or appliances, other than piping, are located outside a building and within 20 feet (6096 mm) of any building opening, such equipment or appliances shall be governed by the occupancy classification of the building. Occupancy classifications shall be defined as follows:

1. Institutional occupancy is that portion of premises from which, because they are disabled, debilitated or confined, occupants cannot readily leave without the assistance of others. Institutional occupancies include, among others, hospitals, nursing homes, asylums and spaces containing locked cells.
2. Public assembly occupancy is that portion of premises where large numbers of people congregate and from which occupants cannot quickly vacate the space. Public assembly occupancies include, among others, auditoriums, ballrooms, classrooms, passenger depots, restaurants and theaters.
3. Residential occupancy is that portion of premises that provides the occupants with complete independent living facilities, including permanent provisions for living, sleeping, eating, cooking and sanitation. Residential occupancies include, among others, dormitories, hotels, multiunit apartments and private residences.
4. Commercial occupancy is that portion of premises where people transact business, receive personal service or purchase food and other goods. Commercial occupancies include, among others, office and professional buildings, markets (but not large mercantile occupancies) and work or storage areas that do not qualify as industrial occupancies.
5. Large mercantile occupancy is that portion of premises where more than 100 persons congregate on levels above or below street level to purchase personal merchandise.
6. Industrial occupancy is that portion of premises that is not open to the public, where access by authorized persons is controlled, and that is used to manufacture, process or store goods such as chemicals, food, ice, meat or petroleum.
7. Mixed occupancy occurs when two or more occupancies are located within the same building. When each occupancy is isolated from the rest of the building by tight walls, floors and ceilings and by self-closing doors, the requirements for each occupancy shall apply to its portion of the building. When the various occupancies are not so isolated, the occupancy having the most stringent requirements shall be the governing occupancy.

**1103.3 System classification.** Refrigeration systems shall be classified according to the degree of probability that refrigerant leaked from a failed connection, seal, or component could enter an occupied area. The distinction is based on the basic design or location of the components.

**1103.3.1 Low-probability systems.** Double-indirect open-spray systems, indirect closed systems and indirect-vented closed systems shall be classified as low-probability systems, provided that all refrigerant-containing piping and fittings are isolated when the quantities in Table 1103.1 are exceeded.

**1103.3.2 High-probability systems.** Direct systems and indirect open-spray systems shall be classified as high-probability systems.

**Exception:** An indirect open-spray system shall not be required to be classified as a high-probability system if the pressure of the secondary coolant is at all times (operating and standby) greater than the pressure of the refrigerant.

## SECTION 1104
## SYSTEM APPLICATION REQUIREMENTS

**1104.1 General.** The refrigerant, occupancy and system classification cited in this section shall be determined in accordance with Sections 1103.1, 1103.2 and 1103.3, respectively. For refrigerant blends assigned dual classifications, as formulated and for the worst case of fractionation, the classifications for the worst case of fractionation shall be used.

## [F] TABLE 1103.1
## REFRIGERANT CLASSIFICATION, AMOUNT AND TLV-TWA

| REFRIGERANT | CHEMICAL FORMULA | CHEMICAL NAME OR BLEND | HAZARD CATEGORIES[a] | REFRIGERANT CLASSIFICATION | DEGREES OF HAZARD[b] | [M] AMOUNT OF REFRIGERANT PER OCCUPIED SPACE | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Pounds per 1,000 cubic feet | ppm | $g/m^3$ | TLV-TWA[f] (ppm) |
| R-11[e] | $CCl_3F$ | Trichlorofluoromethane | OHH | A1 | 2-0-0[c] | 0.39 | 1,100 | 6.2 | C1,000 |
| R-12[e] | $CCl_2F_2$ | Dichlorodifluoromethane | CG,OHH | A1 | 2-0-0[c] | 5.6 | 18,000 | 90 | 1,000 |
| R-13[e] | $CClF_3$ | Chlorotrifluoromethane | CG,OHH | A1 | 2-0-0[c] | 18 | 67,000 | 290 | 1,000 |
| R-13B1[e] | $CBrF_3$ | Bromotrifluoromethane | CG,OHH | A1 | 2-0-0[c] | 22 | 57,000 | 350 | 1,000 |
| R-14 | $CF_4$ | Tetrafluoromethane (carbon tetrafluoride) | CG,OHH | A1 | 2-0-0[c] | 16 | 69,000 | 250 | 1,000 |
| R-22 | $CHClF_2$ | Chlorodifluoromethane | CG,OHH | A1 | 2-0-0[c] | 5.5 | 25,000 | 89 | 1,000 |
| R-23 | $CHF_3$ | Trifluoromethane (fluoroform) | CG,OHH | A1 | 2-0-0[c] | 7.3 | 41,000 | 120 | 1,000 |
| R-32 | $CH_2F_2$ | Difluoromethane (methylene fluoride) | CG,F,OHH | A2 | — | 4.2 | 32,000 | 68 | — |
| R-113[e] | $CCl_2FCClF_2$ | 1, 1,2-trichloro-1,2,2-trifluoroethane | OHH | A1 | 2-0-0[c] | 1.2 | 2,600 | 20 | 1,000 |
| R-114[e] | $CClF_2CClF_2$ | 1,2-dichloro-1,2,2-tetrafluoroethane | CG,OHH | A1 | 2-0-0[c] | 8.7 | 20,000 | 140 | 1,000 |
| R-116 | $CF_3CF_3$ | Hexafluoroethane | CH,OHH | A1 | 1-0-0 | 24 | 69,000 | 390 | — |
| R-123 | $CHCl_2CF_3$ | 2,2-dichloro-1,1,1-trifluoroethane | OHH | B1 | 2-0-0[c] | 3.5 | 9,100 | 57 | 50 |
| R-124 | $CHClFCF_3$ | 2-chloro-1,1,1,2-tetrafluoroethane | CG,OHH | A1 | 2-0-0[c] | 3.5 | 10,000 | 56 | 1,000 |
| R-125 | $CHF_2CF_3$ | Pentafluoroethane | CG,OHH | A1 | 2-0-0[c] | 21 | 69,000 | 340 | — |
| R-134a | $CH_2FCF_3$ | 1,1,1,2-tetrafluoroethane | CG,OHH | A1 | 2-0-0[c] | 13 | 50,000 | 210 | 1,000 |
| R-143a | $CH_3CF_3$ | 1,1,1-trifluoroethane | CG,F,OHH | A2 | 2-0-0[c] | 3.8 | 18,000 | 60 | — |
| R-152a | $CH_3CHF_2$ | 1,1-difluorethane | CG,F,OHH | A2 | 1-4-0 | 1.6 | 9,300 | 25 | — |
| R-170 | $CH_3CH_3$ | Ethane | CG,F,OHH | A3 | 2-4-0 | 0.54 | 7,000 | 8.7 | 1,000 |
| R-218 | $CF_3CF_2CF_3$ | Octafluoropropane | CG,OHH | A1 | 2-0-0[c] | 33 | 69,000 | 530 | — |
| R-236fa | $CF_3CH_2CF_3$ | 1,1,1,3,3,3-hexafluoropropane | CG,OHH | A1 | 2-0-0[c] | 21 | 55,000 | — | 1,000 |
| R-245fa | $CHF_2CH_2CF_3$ | 1,1,1,3,3-pentafluoropropane | CG,OHH | B1 | 2-0-0[c] | 12 | 34,000 | — | 300 |
| R-290 | $CH_3CH_2CH_3$ | Propane | CG,F,OHH | A3 | 2-4-0 | 0.56 | 5,000 | 9.0 | 2,500 |
| R400[e] | zeotrope | R-12/114 | CG,OHH | A1 | 2-0-0[c] | 9.3 | 26,000 | 150 | — |
| R-406A | zeotrope | R-22/600a/142b (55/4/41) | CG,F,OHH | A2 | — | — | — | — | — |
| R-401A | zeotrope | R-22/152a/124 (53/13/34) | CG,OHH | A1 | 2-0-0[c] | 4.8 | 20,000 | 77 | — |
| R-401B | zeotrope | R-22/152a/124 (61/11/28) | CG,OHH | A1 | 2-0-0[c] | 4.9 | 21,000 | 79 | — |
| R-401C | zeotrope | R-22/152a/124 (33/15/52) | CG,OHH | A1 | 2-0-0[c] | 4.4 | 17,000 | 71 | — |
| R-402A | zeotrope | R-125/290/22 (60/2/38) | CG,OHH | A1 | 2-0-0[c] | 10 | 39,000 | 160 | — |
| R-402B | zeotrope | R-125/290/22 (38/2/60) | CG,OHH | A1 | 2-0-0[c] | 7.8 | 32,000 | 120 | — |

*(continued)*

[F] TABLE 1103.1—continued
REFRIGERANT CLASSIFICATION, AMOUNT AND TLV-TWA

| REFRIGERANT | CHEMICAL FORMULA | CHEMICAL NAME OR BLEND | HAZARD CATEGORIES[a] | REFRIGERANT CLASSIFICATION | DEGREES OF HAZARD[b] | [M] AMOUNT OF REFRIGERANT PER OCCUPIED SPACE | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Pounds per 1,000 cubic feet | ppm | $g/m^3$ | TLV-TWA[f] (ppm) |
| R-403A | zeotrope | R-290/22/218 (5/75/20) | CG,OHH | A1 | 2-0-0[c] | — | — | — | — |
| R-403B | zeotrope | R-290/22/218 (5/56/39) | CG,OHH | A1 | 2-0-0[c] | — | — | — | — |
| R-404A | zeotrope | R-125/143a/134a (44/52/4) | CG,OHH | A1 | 2-0-0[c] | 17 | 69,000 | 280 | — |
| R-407A | zeotrope | R-32/125/134a (20/40/40) | CG,OHH | A1 | 2-0-0[c] | 16 | 69,000 | 260 | — |
| R-407B | zeotrope | R-32/125/134a (10/70/20) | CG,OHH | A1 | 2-0-0[c] | 18 | 69,000 | 290 | — |
| R-407C | zeotrope | R-32/125/134a (23/25/52) | CG,OHH | A1 | 2-0-0[c] | 15 | 69,000 | 240 | — |
| R-407D | zeotrope | R-32/125/134a (15/15/70) | CG,OHH | A1 | 2-0-0[c] | 15 | 65,000 | 240 | — |
| R-407E | zeotrope | R-32/125/134a (25/15/60) | CG,OHH | A1 | 2-0-0[c] | 15 | 69,000 | 240 | — |
| R-408A | zeotrope | R-125/143a/22 (7/46/47) | CG,OHH | A1 | 2-0-0[c] | 10 | 47,000 | 170 | — |
| R-409A | zeotrope | R-22/124/142b (60/25/15) | CG,OHH | A1 | 2-0-0[c] | 4.9 | 20,000 | 79 | — |
| R-409B | zeotrope | R-22/124/142b (65/25/10) | CG,OHH | A1 | 2-0-0[c] | 4.9 | 20,000 | 78 | — |
| R410A | zeotrope | R-32/125 (50/50) | CG,OHH | A1 | 2-0-0[c] | 10 | 55,000 | 160 | — |
| R-410B | zeotrope | R-32/125 (45/55) | CG,OHH | A1 | 2-0-0[c] | 11 | 58,000 | 180 | — |
| R-411A | zeotrope | R-127/22/152a (1.5/87.5/11.0) | CG,F,OHH | A2 | — | — | — | — | — |
| R-411B | zeotrope | R-1270/22/152a (3/94/3) | CG,F,OHH | A2 | — | — | — | — | — |
| R-507A | azeotrope | R-125/143a (50/50) | CG,OHH | A1 | 2-0-0[c] | 17 | 69,000 | 280 | — |
| R-508A | azeotrope | R-23/116 (39/61) | CG,OHH | A1 | 2-0-0[c] | 14 | 55,000 | 220 | — |
| R-508B | azeotrope | R-23/116 (46/54) | CG,OHH | A1 | 2-0-0[c] | 13 | 52,000 | 200 | — |
| R-509A | zeotrope | R-22/218 (44/56) | CG,OHH | A1 | 2-0-0[c] | 12 | 38,000 | 190 | — |
| R-600 | $CH_3CH_2CH_2CH_3$ | Butane | CG,F,OHH | A3 | 1-4-0 | — | — | — | — |
| R-600a | $CH(CH_3)_2$-$CH_3$ | Isobutane (2-methyl propane) | CG,F,OHH | A3 | 2-4-0 | 0.51 | 2,500 | 6.0 | 800 |

*(continued)*

**[F] TABLE 1103.1—continued**
**REFRIGERANT CLASSIFICATION, AMOUNT AND TLV-TWA**

| REFRIGERANT | CHEMICAL FORMULA | CHEMICAL NAME OR BLEND | HAZARD CATEGORIES[a] | REFRIGERANT CLASSIFICATION | DEGREES OF HAZARD[b] | [M] AMOUNT OF REFRIGERANT PER OCCUPIED SPACE | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Pounds per 1,000 cubic feet | ppm | $g/m^3$ | TLV-TWA[f] (ppm) |
| R-412A | zeotrope | R-22/318/142b (70/5/25) | CG,F,OHH | A2 | — | — | — | — | — |
| R-413A | zeotrope | R-218/134a/600a (9/88/3) | CG,F,OHH | A2 | — | — | — | — | — |
| R-414A | zeotrope | R-22/124/600a/142b (51/28.5/4/16.5) | CG,OHH | A1 | — | — | — | — | — |
| R-414B | zeotrope | R-22/124/600a/142b (50/39/1.5/9.5) | CG,OHH | A1 | — | — | — | — | — |
| R-416A | zeotrope | R-134a/124/600 (59/39.5/1.5) | CG,OHH | A1 | 2-0-0[c] | 6 | 21,000 | 96 | — |
| R-417A | zeotrope | R-125/134a/600 (45.5/50/3.5) | CG,OHH | A1 | 2-0-0[c] | — | — | — | — |
| R-500[e] | azeotrope | R-12/152a (73.8/26.2) | CG,OHH | A1 | 2-0-0[c] | 7.4 | 29,000 | 120 | 1,000 |
| R-502[e] | azeotrope | R-22/115 (48.8/51.2) | CG,OHH | A1 | 2-0-0[c] | 10 | 35,000 | 160 | 1,000 |
| R-503[e] | azeotrope | R-23/13 (40.1/59.9) | CG,OHH | A1 | 2-0-0[c] | 15 | 67,000 | 240 | 1,000 |
| R-717 | $NH_3$ | Ammonia | CG,C,F,OHH | B2 | 3-3-0[d] | 0.022 | 500 | 0.35 | 25 |
| R-718 | $H_2O$ | Water | — | A1 | 0-0-0 | — | — | — | — |
| R-744 | $CO_2$ | Carbon dioxide | CG,OHH | A1 | 2-0-0[c] | 4.5 | 40,000 | 72 | 5,000 |
| R-1150 | $CH_2{=}CH_2$ | Ethene (ethylene) | CG,F,OHH | A3 | 1-4-2 | 0.38 | 5,200 | 6.0 | 1,000 |
| R-1270 | $CH_3CH{=}CH_2$ | Propene (propylene) | CG,F,OHH | B3 | 1-4-1 | 0.37 | 3,400 | 5.0 | 660 |

For SI: 1 pound = 0.454 kg, 1 cubic foot = 0.0283 $m^3$.

a. CG = Compressed gas; C = Corrosive; F = Flammable; OHH = Other Health Hazard.

b. Degrees of hazard are for health, fire, and reactivity, respectively, in accordance with NFPA 704.

c. 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.

d. For installations that are entirely outdoors, use 3-1-0.

e. Class I ozone depleting substance; prohibited for new installations.

f. PEL or consistent occupational exposure limit on a time-weighted average (TWA) basis (unless noted C for ceiling) for an 8 hr/d and 40 hr/wk.

**1104.2 Machinery room.** Except as provided in Sections 1104.2.1 and 1104.2.2, all components containing the refrigerant shall be located either outdoors or in a machinery room where the quantity of refrigerant in an independent circuit of a system exceeds the amounts shown in Table 1103.1. For refrigerant blends not listed in Table 1103.1, the same requirement shall apply when the amount for any blend component exceeds that indicated in Table 1103.1 for that component. This requirement shall also apply when the combined amount of the blend components exceeds a limit of 69,100 parts per million (ppm) by volume. Machinery rooms required by this section shall be constructed and maintained in accordance with Section 1105 for Group A1 and B1 refrigerants and in accordance with Sections 1105 and 1106 for Group A2, B2, A3 and B3 refrigerants.

**Exceptions:**

1. Machinery rooms are not required for listed equipment and appliances containing not more than 6.6 pounds (3 kg) of refrigerant, regardless of the refrigerant's safety classification, where installed in accordance with the equipment's or appliance's listing and the equipment or appliance manufacturer's installation instructions.
2. Piping in conformance with Section 1107 is allowed in other locations to connect components installed in a machinery room with those installed outdoors.

**1104.2.1 Institutional occupancies.** The amounts shown in Table 1103.1 shall be reduced by 50 percent for all areas of institutional occupancies except kitchens, laboratories, and mortuaries. The total of all Group A2, B2, A3 and B3 refrigerants shall not exceed 550 pounds (250 kg) in occupied areas or machinery rooms.

**1104.2.2 Industrial occupancies and refrigerated rooms.** This section applies only to industrial occupancies and refrigerated rooms for manufacturing, food and beverage preparation, meat cutting, other processes and storage. Machinery rooms are not required where all of the following conditions are met:

1. The space containing the machinery is separated from other occupancies by tight construction with tight-fitting doors.
2. Access is restricted to authorized personnel.
3. The floor area per occupant is not less than 100 square feet (9.3 $m^2$) where machinery is located on floor levels with exits more than 6.6 feet (2012 mm) above the ground. Where provided with egress directly to the outdoors or into approved building exits, the minimum floor area shall not apply.
4. Refrigerant detectors are installed as required for machinery rooms in accordance with Section 1105.3.
5. Surfaces having temperatures exceeding 800°F (427°C) and open flames are not present where any Group A2, B2, A3 or B3 refrigerant is used (see Section 1104.3.4).
6. All electrical equipment and appliances conform to Class 1, Division 2, hazardous location classification requirements of NFPA 70 where the quantity of any Group A2, B2, A3 or B3 refrigerant in a single independent circuit would exceed 25 percent of the lower flammability limit (LFL) upon release to the space.
7. All refrigerant-containing parts in systems exceeding 100 hp (74.6 kW) drive power, except evaporators used for refrigeration or dehumidification; condensers used for heating; control and pressure relief valves for either; and connecting piping, shall be located either outdoors or in a machinery room.

**1104.3 Refrigerant restrictions.** Refrigerant applications, maximum quantities and use shall be restricted in accordance with Sections 1104.3.1 through 1104.3.4.

**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.

**1104.3.2 Nonindustrial occupancies.** 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 A3 and B3 refrigerants shall not be used except where approved.

**Exception:** This section does not apply to laboratories where the floor area per occupant is not less than 100 square feet (9.3 $m^2$).

**TABLE 1104.3.2**
**MAXIMUM PERMISSIBLE QUANTITIES OF REFRIGERANTS**

| TYPE OF REFRIGERATION SYSTEM | MAXIMUM POUNDS FOR VARIOUS OCCUPANCIES | | | |
|---|---|---|---|---|
| | Institutional | 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.

**1104.3.3 All occupancies.** The total of all Group A2, B2, A3 and B3 refrigerants other than R-717, ammonia, shall not exceed 1,100 pounds (499 kg) except where approved.

**1104.3.4 Protection from refrigerant decomposition.** Where any device having an open flame or surface temperature greater than 800°F (427°C) is used in a room containing more than 6.6 pounds (3 kg) of refrigerant in a single independent circuit, a hood and exhaust system shall be provided in accordance with Section 510. Such exhaust system shall exhaust combustion products to the outdoors.

**Exception:** A hood and exhaust system shall not be required:

1. Where the refrigerant is R-717, R-718, or R-744;
2. Where the combustion air is ducted from the outdoors in a manner that prevents leaked refrigerant from being combusted; or
3. Where a refrigerant detector is used to stop the combustion in the event of a refrigerant leak (see Sections 1105.3 and 1105.5).

**1104.4 Volume calculations.** Volume calculations shall be in accordance with Sections 1104.4.1 through 1104.4.3.

**1104.4.1 Noncommunicating spaces.** Where the refrigerant-containing parts of a system are located in one or more spaces that do not communicate through permanent openings or HVAC ducts, the volume of the smallest, enclosed occupied space shall be used to determine the permissible quantity of refrigerant in the system.

**1104.4.2 Communicating spaces.** Where an evaporator or condenser is located in an air duct system, the volume of the smallest, enclosed occupied space served by the duct system shall be used to determine the maximum allowable quantity of refrigerant in the system.

**Exception:** If airflow to any enclosed space cannot be reduced below one-quarter of its maximum, the entire space served by the air duct system shall be used to determine the maximum allowable quantity of refrigerant in the system.

**1104.4.3 Plenums.** Where the space above a suspended ceiling is continuous and part of the supply or return air plenum system, this space shall be included in calculating the volume of the enclosed space.

## SECTION 1105
## MACHINERY ROOM, GENERAL REQUIREMENTS

**[B] 1105.1 Design and construction.** Machinery rooms shall be designed and constructed in accordance with the *International Building Code* and this section.

**1105.2 Openings.** Ducts and air handlers in the machinery room that operate at a lower pressure than the room shall be sealed to prevent any refrigerant leakage from entering the airstream.

**[F] 1105.3 Refrigerant detector.** Refrigerant detectors ((~~in machinery rooms~~)) shall be provided as follows: ((~~required by Section 606.8 of the *International Fire Code*~~)).

**[F] 1105.3.1 Within machinery rooms.** Machinery rooms shall contain a refrigerant detector connected to an alarm system utilizing listed and labeled fire alarm signaling devices capable of generating a sound level, distinctive from other alarm signals, of at least 15 dB above the operating ambient sound pressure level of the space in which they are installed and initiating an approved distinctive visual alarm.

Where continuous mechanical ventilation is provided, failure of the ventilation system shall activate an audible and visual alarm.

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 alarm shall be actuated at a value not greater than the corresponding TLV-TWA values shown in the *International Mechanical Code* for the refrigerant classification.

**Exception:** Machinery room vapor detectors for ammonia system shall actuate an alarm at a detection level not to exceed 1,000 ppm and shall automatically exhaust air from the machinery room in accordance with Section 1105.6.4 for emergency conditions.

Detectors and alarms shall be placed in approved locations.

**[F] 1105.3.2 Outside of machinery rooms.** Where evaporators and piping containing refrigerants are located within rooms or spaces used exclusively for processing or storage of materials under refrigerated conditions, the refrigerated room or space shall be equipped with a refrigerant-vapor detector and alarm system complying with Section 1105.3.1.

Activation of the refrigerant detector shall also automatically stop the flow of refrigerant to evaporators within the space and stop the flow of refrigerant in all supply lines leaving a machinery room whenever the refrigerant vapor concentration is detected at or above 50 percent of the IDLH or 25 percent of the LFL, whichever is lower.

**1105.4 Tests.** Periodic tests of the mechanical ventilating system shall be performed in accordance with manufacturer's specifications and as required by the code official.

**1105.5 Fuel-burning appliances.** Fuel-burning appliances and equipment having open flames and that use combustion air from the machinery room shall not be installed in a machinery room.

**Exceptions:**

1. Where the refrigerant is carbon dioxide or water.
2. Fuel-burning appliances shall not be prohibited in the same machinery room with refrigerant-containing equipment or appliances where combustion air is ducted from outside the machinery room and sealed in such a manner as to prevent any refrigerant leakage from entering the combustion chamber, or where a refrigerant vapor detector is employed to automatically shut off the combustion process in the event of refrigerant leakage.

**1105.6 Ventilation.** Machinery rooms shall have continuous mechanical ventilation ((~~be mechanically ventilated~~)) to the outdoors. Mechanical ventilation shall be capable of exhausting the minimum quantity of air both at normal operating and emergency conditions. Multiple fans or multispeed fans shall be allowed in order to produce the emergency ventilation rate and to obtain a reduced airflow for normal ventilation.

**Interpretation:** The requirement for continuous mechanical ventilation to the outdoors means that fire dampers are not allowed on machinery room ventilation ducts.

**Exception:** Where a refrigerating system is located outdoors more than 20 feet (6096 mm) from any building opening and is enclosed by a penthouse, lean-to or other open structure, natural or mechanical ventilation shall be provided. Location of the openings shall be based on the relative density of the refrigerant to air. The free-aperture cross section for the ventilation of the machinery room shall be not less than:

$$F = \sqrt{G} \qquad \textbf{(Equation 11-1)}$$

For SI: $F = 0.138\sqrt{G}$

where:

$F$ = The free opening area in square feet ($m^2$).

$G$ = The mass of refrigerant in pounds (kg) in the largest system, any part of which is located in the machinery room.

**1105.6.1 Discharge location.** The discharge of the air shall be to the outdoors in accordance with Chapter 5. Exhaust from mechanical ventilation systems shall be discharged not less than 20 feet (6096 mm) from a property line or openings into buildings.

**1105.6.2 Makeup air.** Provisions shall be made for makeup air to be drawn from the outside to replace that being exhausted. Openings for makeup air shall be located to avoid intake of exhaust air. Supply and exhaust ducts to the machinery room shall serve no other area, shall be constructed in accordance with Chapter 5 and shall be covered with corrosion-resistant screen of not less than $^1/_4$-inch (6.4 mm) mesh.

**1105.6.3 Quantity—normal ventilation.** ((~~During occupied conditions, t~~)) The mechanical ventilation system shall exhaust the larger of the following:

1. Not less than 0.5 cfm per square foot (0.0025 $m^3/s \cdot m^2$) of machinery room area or 20 cfm (0.009 $m^3/s$) per person; or
2. A volume required to limit the room temperature rise to 18°F (10°C) taking into account the ambient heating effect of all machinery in the room.

**1105.6.4 Quantity—emergency conditions.** Upon actuation of the refrigerant detector required in Section 1105.3, the mechanical ventilation system shall exhaust air from the machinery room in the following quantity:

$$Q = 100 \times \sqrt{G} \qquad \textbf{(Equation 11-2)}$$

For SI: $Q = 0.07 \times \sqrt{G}$

where:

$Q$ = The airflow in cubic feet per minute ($m^3/s$).

$G$ = The design mass of refrigerant in pounds (kg) in the largest system, any part of which is located in the machinery room.

**[F] 1105.6.5 Standby source of power required.** Where treatment, detection, continuous ventilation or alarm systems are required, such systems shall be connected to a standby source of power to supply electrical power in the event of loss of power from the primary source. See the *International Fire Code* Section 606 and Chapter 27 and *Seattle Electrical Code* Article 701.

**1105.7 Termination of relief devices.** Pressure relief devices, fusible plugs and purge systems located within the machinery room shall terminate outside of the structure at a location 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.

[F] For additional requirements regarding termination of relief devices for flammable refrigerants, toxic and highly toxic refrigerants, ammonia refrigerant, treatment systems, flaring systems and ammonia diffusion systems, see Section 606.11 of the *International Fire Code*.

**1105.8 Ammonia discharge.** Pressure relief valves for ammonia systems shall discharge in accordance with ASHRAE 15.

**[F] 1105.9 Emergency pressure control system.** Refrigeration systems containing more than 6.6 pounds (3 kg) of flammable, toxic or highly toxic refrigerant or ammonia shall be provided with an emergency pressure control system in accordance with Section 606.10 of the *International Fire Code*.

## SECTION 1106
## MACHINERY ROOM, SPECIAL REQUIREMENTS

**1106.1 General.** Where required by Section 1104.2, the machinery room shall meet the requirements of this section in addition to the requirements of Section 1105.

**1106.2 Elevated temperature.** There shall not be an open flame-producing device or continuously operating hot surface over 800°F (427°C) permanently installed in the room.

**1106.3 Ammonia room ventilation.** Ventilation systems in ammonia machinery rooms shall be operated continuously at the ((~~emergency~~)) normal ventilation rate determined in accordance with Section ((~~1105.6.4~~)) 1105.6.3.

**Exception((s)):**

((~~1. Machinery rooms equipped with a vapor detector that will automatically start the ventilation system at the emergency rate determined in accordance with Section 1105.6.4, and that will actuate an alarm at a detection level not to exceed 1,000 ppm; or~~

2.)) Machinery rooms conforming to the Class 1, Division 2, hazardous location classification requirements of the ((~~*International Code Council Electrical Code Administrative Provisions*~~)) *Seattle Electrical Code*.

**1106.4 Flammable refrigerants.** Where refrigerants of Groups A2, A3, B2 and B3 are used, the machinery room shall conform to the Class 1, Division 2, hazardous location classification requirements of the ((~~*International Code Council Electrical Code Administrative Provisions*~~)) *Seattle Electrical Code*.

**Exception:** Ammonia machinery rooms, but not including ventilation fan motors.

**[F] 1106.5 Remote controls.** Remote control of the mechanical equipment and appliances located in the machinery room shall be provided as required by Section 606.9 of the *International Fire Code*.

**[F] 1106.5.1 Refrigeration system.** A clearly identified switch of the break-glass type shall provide off-only control of electrically energized equipment and appliances in the machinery room, other than refrigerant leak detectors and machinery room ventilation.

**Exception:** In machinery rooms where only nonflammable refrigerants are used, electrical equipment and appliances, other than compressors, are not required to be provided with a cutoff switch.

**[F] 1106.5.2 Ventilation system.** A clearly identified switch of the break-glass type shall provide on-only control of the machinery room ventilation fans.

**[F] 1106.6 Emergency signs and labels.** Refrigeration units and systems shall be provided with approved emergency signs, charts, and labels in accordance with the *International Fire Code*.

**[F] 1106.7 Alarm activation.** Where continuous ventilation is provided, failure of the ventilation system shall automatically activate an audible and visual alarm.

## SECTION 1107
## REFRIGERANT PIPING

**1107.1 General.** All refrigerant piping shall be installed, tested and placed in operation in accordance with this chapter.

**1107.2 Pipe enclosures.** Rigid or flexible metal enclosures or pipe ducts shall be provided for soft, annealed copper tubing and used for refrigerant piping erected on the premises and containing other than Group A1 or B1 refrigerants. Enclosures shall not be required for connections between condensing units and the nearest riser box(es), provided such connections do not exceed 6 feet (1829 mm) in length.

**1107.3 Condensation.** All refrigerating piping and fittings, brine 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 will cause a safety hazard to the building occupants, structure, electrical equipment or any other equipment or appliances, shall be protected in an approved manner to prevent such damage.

**1107.4 Materials for refrigerant pipe and tubing.** Piping materials shall be as set forth in Sections 1107.4.1 through 1107.4.5.

**1107.4.1 Steel pipe.** Carbon steel pipe with a wall thickness not less than Schedule 80 shall be used for Group A2, A3, B2 or B3 refrigerant liquid lines for sizes 1.5 inches (38 mm) and smaller. Carbon steel pipe with a wall thickness not less than Schedule 40 shall be used for Group A1 or B1 refrigerant liquid lines 6 inches (152 mm) and smaller, Group A2, A3, B2 or B3 refrigerant liquid lines sizes 2 inches (51 mm) through 6 inches (152 mm) and all refrigerant suction and discharge lines 6 inches (152 mm) and smaller. ((~~Type F steel pipe shall not be used for r~~)) Refrigerant lines having an operating temperature less than -20°F (-29°C) shall be designed to meet the requirements of ASME B31.5-2001, *Refrigeration Piping and Heat Transfer*.

**1107.4.2 Copper and brass pipe.** Standard iron-pipe size, copper and red brass (not less than 80-percent copper) pipe shall conform to ASTM B 42 and ASTM B 43.

**1107.4.3 Copper tube.** Copper tube used for refrigerant piping erected on the premises shall be seamless copper tube of Type ACR (hard or annealed) complying with ASTM B 280. Where approved, copper tube for refrigerant piping erected on the premises shall be seamless copper tube of Type K, L or M (drawn or annealed) in accordance with ASTM B 88. Annealed temper copper tube shall not be used in sizes larger than a 2-inch (51 mm) nominal size. Mechanical joints shall not be used on annealed temper copper tube in sizes larger than 7/8-inch (22.2 mm) OD size.

**1107.4.4 Copper tubing joints.** Copper tubing joints used in refrigerating systems containing Group A2, A3, B2 or B3 refrigerants shall be brazed. Soldered joints shall not be used in such refrigerating systems.

**1107.4.5 Aluminum tube.** Type 3003-0 aluminum tubing with high-pressure fittings shall not be used with methyl chloride and other refrigerants known to attack aluminum.

**1107.5 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 carrying conditioned air to and from human-occupied space shall be constructed to withstand, without leakage, a pressure of 150 percent of the higher of the design pressure or pressure relief device setting.

**1107.6 Exposure of refrigerant pipe joints.** Refrigerant pipe joints erected on the premises shall be exposed for visual inspection prior to being covered or enclosed.

**1107.7 Stop valves.** All systems containing more than 6.6 pounds (3 kg) of a refrigerant in systems using positive-displacement compressors shall have stop valves installed as follows:

1. At the inlet of each compressor, compressor unit or condensing unit.

2. At the discharge outlet of each compressor, compressor unit or condensing unit and of each liquid receiver.

**Exceptions:**

1. Systems that have a refrigerant pumpout function capable of storing the entire refrigerant charge in a receiver or heat exchanger.
2. Systems that are equipped with provisions for pumpout of the refrigerant using either portable or permanently installed recovery equipment.
3. Self-contained systems.

**1107.7.1 Liquid receivers.** All systems containing 100 pounds (45 kg) or more of a refrigerant, other than systems utilizing nonpositive displacement compressors, shall have stop valves, in addition to those required by Section 1107.7, on each inlet of each liquid receiver. Stop valves shall not be required on the inlet of a receiver in a condensing unit, nor on the inlet of a receiver which is an integral part of the condenser.

Ammonia systems shall be provided with liquid receivers designed for pumpdown that have sufficient capacity to assure that the liquid does not occupy more than 90 percent of the volume of the receiver at 90°F (32°C).

**1107.7.2 Copper tubing.** Stop valves used with soft annealed copper tubing or hard-drawn copper tubing 7/8-inch (22.2 mm) OD standard size or smaller shall be securely mounted, independent of tubing fastenings or supports.

**1107.7.3 Identification.** Stop valves shall be identified where their intended purpose is not obvious. Numbers shall not be used to label the valves, unless a key to the numbers is located near the valves.

## SECTION 1108
## FIELD TEST

**1108.1 General.** Every refrigerant-containing part of every system that is erected on the premises, except compressors, condensers, vessels, evaporators, safety devices, pressure gauges and control mechanisms that are listed and factory tested, shall be tested and proved tight after complete installation, and before operation. Tests shall include both the high- and low-pressure sides of each system at 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 those listed on the condensing unit, compressor or compressor unit name-plate, as required by ASHRAE 15.

**Exceptions:**

1. Gas bulk storage tanks that are not permanently connected to a refrigeration system.
2. Systems erected on the premises with copper tubing not exceeding $^5/_8$-inch (15.8 mm) OD, with wall thickness as required by ASHRAE 15, shall be tested in accordance with Section 1108.1, or by means of refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 70°F (21°C) or higher.
3. Limited-charge systems equipped 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. If the equipment or appliance has been tested by the manufacturer at one and one-half times the design pressure, the test after erection on the premises shall be conducted at the design pressure.

**1108.1.1 Booster compressor.** Where a compressor is used as a booster to obtain an intermediate pressure and discharges into the suction side of another compressor, the booster compressor shall be considered a part of the low side, provided that it is protected by a pressure relief device.

**1108.1.2 Centrifugal/nonpositive displacement compressors.** In field-testing systems using centrifugal or other nonpositive displacement compressors, the entire system shall be considered as the low-side pressure for field test purposes.

**1108.2 Test gases.** Tests shall be performed with an inert dried gas including, but not limited to, nitrogen and carbon dioxide. Oxygen, air, combustible gases and mixtures containing such gases shall not be used.

**Exception:** The use of air is allowed to test R-717, ammonia, systems provided that they are subsequently evacuated before charging with refrigerant.

**1108.3 Test apparatus.** The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gauge on the outlet side.

**1108.4 Declaration.** A certificate of test shall be provided for all systems containing 55 pounds (25 kg) or more of refrigerant. The certificate shall give the name of the refrigerant and the field test pressure applied to the high side and the low side of the system. The certification of test shall be signed by the installer and shall be made part of the public record.

## [F] SECTION 1109
## PERIODIC TESTING

**1109.1 Testing required.** The following emergency devices and systems shall be periodically tested in accordance with the manufacturer's instructions and as required by the code official:

1. Treatment and flaring systems.
2. Valves and appurtenances necessary to the operation of emergency refrigeration control boxes.
3. Fans and associated equipment intended to operate emergency pure ventilation systems.
4. Detection and alarm systems.