BSR/ASHRAE Addendum q
to ANSI/ASHRAE Standard 15-2022

First Public Review Draft

Proposed Addendum q to Standard 15-2022, Safety Standard for Refrigeration Systems

First Public Review (August 2024)
(Draft shows Proposed Changes to Current Standard)

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FOREWORD

This proposed addendum addresses the use of the term "system" by clarifying the type of system in each use case. The most common update in the addendum is changing "system" to "refrigeration system". Changing "system" to "refrigeration system" references a defined term and is italicized. Additional changes include: "system" to "equipment" in some cases, "piping system" to "refrigeration system piping" and removing the word "refrigerating" when referring to a "machinery room".

Addendum c to ASHRAE 15-2022 will replace the defined term "refrigerating system" with "refrigeration system", therefore "refrigeration system" is italicized in this addendum.

Note: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.

Addendum q to Standard 15-2022

Modify Section 2 as follows. The remainder of Section 2 remains unchanged.

2. SCOPE

[…]

2.3 This standard *shall not* apply to refrigeration systems using ammonia (R-717) as the *refrigerant*.

Informative Note: See ANSI/IIAR 2 [1] for *refrigeration systems* ~~systems~~ using ammonia (R-717).

Modify Section 3 as follows. The remainder of Section 3 remains unchanged.

3. DEFINITIONS

[…]

companion valves (block valves): pairs of mating *stop valves* that allow sections of a *refrigeration system* ~~system~~ to be joined before opening these valves or separated after closing them.

[…]

limited charge system*:* a *refrigeration system* ~~system~~ in which, with the *compressor* idle, the *design pressure* will not be exceeded when the *refrigerant* charge has completely evaporated.

[…]

recovered refrigerants: refrigerants removed from a *refrigeration system* ~~system~~ in any condition without necessarily testing or processing them.

[…]

self-contained system: a complete, factory-assembled and factory-tested *refrigeration system* ~~system~~ that is shipped in one or more sections and has no *refrigerant*-containing parts that are joined in the field by other than *companion valves* or *block valves*.

[…]

system refrigerant charge (m_c): the total mass of *refrigerant* in an *independent circuit* of a *refrigeration system* ~~system~~, including both factory and field refrigerant charge.

[…]

three-way valve*:* a service valve for *dual pressure relief devices* that allows using one device while isolating the other from the *refrigeration system* ~~system~~, maintaining one valve in operation at all times.

[…]

Modify Section 5 as follows. The remainder of Section 5 remains unchanged.

5. REFRIGERATION SYSTEM CLASSIFICATION

[…]

5.2.1 High-Probability System. A *high-probability system* is any *refrigeration system* ~~system~~ in which the basic design or the location of components is such that a leakage of refrigerant from a failed connection, seal, or component will enter the occupied space.

[…]

5.2.2 Low-Probability System. A *low-probability system* is any *refrigeration system* ~~system~~ in which the basic design or the location of components is such that leakage of *refrigerant* from a failed connection, seal, or component cannot enter the *occupied space*.

[…]

5.3 Changing Refrigerant. Changes of *refrigerant* in an existing *refrigeration system* ~~system~~ to a *refrigerant* with a different *refrigerant designation shall* only be allowed where in accordance with Sections 5.3.1 through 5.3.4.

[…]

5.3.2 The change of *refrigerant shall* be in accordance with one of the following:
a. Written instructions of the original equipment manufacturer
b. An evaluation of the *refrigeration system* ~~system~~ by a registered design professional or by a *nationally recognized testing laboratory* that validates safety and suitability of the replacement *refrigerant*
c. Approval of the authority having jurisdiction (AHJ)

5.3.3 Where the replacement *refrigerant* is classified into the same safety group, requirements that were applicable to the existing *refrigeration system* ~~system~~ *shall* continue to apply.

5.3.4 Where the replacement *refrigerant* is classified into a different safety group, the *refrigeration system* ~~system~~ *shall* com- ply with the requirements of this standard for a new installation, and the change of *refrigerant shall* require AHJ approval.

[…]

Modify Section 7 as follows. The remainder of Section 7 remains unchanged.

7. RESTRICTIONS ON REFRIGERANT USE

[…]

7.2.1 General. The *effective dispersal volume* identified in Section 7.3 into which *refrigerant* will disperse in the event of a release *shall* be calculated in accordance with this section. Volume calculations *shall* evaluate each space or *connected spaces* relevant to each refrigeration system. The smallest volume into which *refrigerant* disperses *shall* be

used to determine the *refrigerant* quantity limit in the *refrigeration system* ~~system~~.

[…]

7.2.3.3 Connected Spaces via Ducted Air Distribution System. Where a refrigeration system or a part thereof is located within an air distribution duct system or in a space served by an air distribution duct system, the entire air distribution system shall be analyzed to determine the worst-case distribution of leaked refrigerant. The effective dispersal volume in which the leaked refrigerant disperses shall be used to determine the EDVC in the *refrigeration system* ~~system~~, subject to the criteria in the following subsections.

7.3.3 * **Industrial Occupancies and Refrigerated Rooms.** *Industrial occupancies* and refrigerated rooms *shall* comply with the following conditions:

[…]

g. Refrigerant-containing parts in *refrigeration systems* ~~systems~~ exceeding 100 *hp* (74.6 kW) *compressor* drive power, except *evaporators* used for refrigeration or dehumidification, *condensers* used for heating, control and *pressure relief valves* for either, *low-probability pumps*, and connecting *piping*, are located either in a *machinery room* or outdoors.

[…]

Figure 7-1 Refrigerant ~~system~~ charge limit compliance path—Part 1.

[…]

Figure 7-2 Refrigerant ~~system~~ charge limit compliance path—Part 2.

[…]

7.3.4.1 Single Circuit. For single-circuit *refrigeration systems* ~~systems~~, the releasable refrigerant charge (mrel) shall be the system refrigerant charge, unless release mitigation controls are provided in accordance with Section 7.3.4.4. – same for next section

7.3.4.2 Multiple Independent Circuits. For *refrigeration systems* ~~systems~~ with multiple *independent circuits*, the *releasable refrigerant charges shall* be the *refrigerant charges* in each *independent circuit*, unless release mitigation controls are provided in accordance with Section 7.3.4.4.

[…]

7.5.1.4 Recovered Refrigerants. Recovered refrigerants shall not be reused except in the *refrigeration system* ~~system~~ from which they were removed, or as provided in Sections 7.5.1.5 or 7.5.1.6. When contamination is evident by discoloration, odor, acid test results, or *refrigeration system* ~~system~~ history, recovered refrigerants shall be reclaimed in accordance with Section 7.5.1.6 before reuse.

7.5.1.5 Recycled Refrigerants. Recycled refrigerants shall not be reused except in *refrigeration systems* ~~systems~~ using the same refrigerant and lubricant designation and belonging to the same owner as the *refrigeration systems* ~~systems~~ from which they were removed. When contamination is evident by discoloration, odor, acid test results, or *refrigeration system* ~~system~~ history, recycled refrigerants shall be reclaimed in accordance with Section 7.5.1.6.

[…]

7.5.1.7 Mixing of Refrigerants. Refrigerants with different refrigerant designations shall only be mixed in a *refrigeration system* ~~system~~ in accordance with both of the following:

7.5.1.8 Refrigerant or Lubricant Conversion. The type of refrigerant or lubricant in a *refrigeration system* ~~system~~ shall not be changed without evaluation for suitability, notification to the AHJ and the user, due observance of safety requirements, and replacement or addition of signs and identification as required in Section 10.1.2.

7.5.1.9 Addition of Doors to Open Refrigerated Display Cases Containing Flammable Refrigerants. It is acceptable for doors to be added to open display cases containing flammable *refrigerants* only when in accordance with all of the following:

[…]

c. Validation of safety and suitability of the addition of doors through one of the following:
   1. Written instructions of the original equipment *manufacturer* and approval of the AHJ
   2. Evaluation of the ~~system~~ equipment by a registered design professional and approval of the AHJ

[…]

7.7.1 Refrigerant Charge Limits. *Refrigerant* charge *shall* be limited as follows:

[…]

Exceptions to 7.7.1:

3. This restriction does not apply to *refrigeration systems* ~~systems~~ located in *machinery rooms* or outdoors.

[…]

7.8 Group A2 Refrigerants for Refrigeration Systems Other than Human Comfort. *High-probability systems* using Group A2 *refrigerants* for other than human comfort applications *shall* comply with this section. *Refrigeration systems* using Group A2 *refrigerants shall* be limited to *listed self-contained systems* containing no more than 0.459 × *LFL* (lb), where *LFL* is in lb/1000 ft^3 (13 × *LFL* [kg], where *LFL* is in kg/m^3), provided that the *refrigeration system* ~~system~~ is installed in accordance with the listing and the *manufacturer*'s installation instructions. Refrigeration systems containing more than 0.141 × *LFL* (lb), (4 × *LFL* [kg]) in an *independent circuit shall not* be installed within 20 ft (6 m) of an open flame.

[…]

Modify Section 8 as follows. The remainder of Section 8 remains unchanged.

8. INSTALLATION RESTRICTIONS

[…]

8.3 Safe Access. A clear and unobstructed approach and space *shall* be provided for inspection, service, and emergency shutdown of *condensing units*, *compressor units*, *condensers*, *stop valves*, and other serviceable

components of ~~refrigerating~~ *machinery*. Permanent ladders, platforms, or portable access equipment *shall* be provided in accordance with the requirements of the authority having jurisdiction (AHJ).

[...]

8.9 ~~Refrigerating~~ Machinery Room, General Requirements. When a *refrigerating system* is located indoors and a *machinery room* is required by Section 7.4, the *machinery room shall* be in accordance with the following provisions.

[...]

8.9.2 Each ~~refrigerating~~ *machinery room shall* have a tight-fitting door or doors opening outward, self-closing if they open into the building and adequate in number to ensure freedom for persons to escape in an emergency. With the exception of access doors and panels in *air ducts* and air-handling units conforming to Section 8.9.3, there *shall* be no openings that will permit passage of escaping *refrigerant* to other parts of the building.

[...]

8.9.4 Access. Access to the ~~refrigerating~~ *machinery room shall* be restricted to authorized personnel. Doors *shall* be clearly marked, or permanent signs *shall* be posted at each entrance to indicate this restriction.

8.9.5 Each ~~refrigerating~~ *machinery room shall* contain a detector, located in an area where *refrigerant* from a leak will concentrate, that actuates an alarm and mechanical ventilation in accordance with Section 8.9.7 at a set point not greater than the *occupational exposure limit* (*OEL*) value as published in ASHRAE Standard 34 3. For *refrigerants* that do not have a published *OEL* value in Standard 34, a set point determined in accordance with the *OEL* as defined by Standard 34 *shall* be *approved* by the AHJ. The alarm *shall* annunciate visual and audible alarms inside the ~~refrigerating~~ *machinery room* and outside each entrance to the ~~refrigerating~~ *machinery room*. The alarms required in this section *shall* be of the manual reset type with the reset located inside the ~~refrigerating~~ *machinery room*. Alarms set at other levels (such as *IDLH*) and automatic reset alarms are permitted in addition to those required by this section. The meaning of each alarm *shall* be clearly marked by signage near the annunciators.

Exception to 8.9.5: Detectors are not required when only *refrigeration systems* ~~systems~~ using R-718 (water) are located in the ~~refrigerating~~ *machinery room*.

[…]

8.9.7 Mechanical ventilation referred to in Section 8.9.6 *shall* be by one or more power-driven fans capable of exhausting air from the *machinery room* at least in the amount given in the formula in Section 8.9.8. To obtain a reduced airflow for normal ventilation, multiple fans or multispeed fans *shall* be used. Provision *shall* be made for inlet air to replace that being exhausted. Openings for inlet air *shall* be positioned to avoid recirculation. Air supply and exhaust *ducts* to the *machinery room shall* serve no other area. The discharge of the air *shall* be to the outdoors in such a manner so as not to cause a nuisance or danger. The mechanical exhaust inlets *shall* be located in an area where *refrigerant* from a leak is likely to concentrate, in consideration of the location of the replacement air paths, *refrigeration systems* ~~refrigerating machines~~, and the density of the *refrigerant*

relative to air.

[…]

8.9.8.1

[…]

A part of the ~~refrigerating~~ *machinery room* mechanical ventilation *shall* be

[...]

8.10 Machinery Room, Special Requirements. In cases *specified* in the rules of Section 7.4, a ~~refrigerating~~

machinery room shall meet the following special requirements in addition to those in Section 8.9:

[...]

c. Walls, floor, and ceiling *shall* be tight and of noncombustible construction. Walls, floor, and ceiling separating the ~~refrigerating~~ *machinery room* from other *occupied spaces shall* be of at least one-hour fire-resistive construction.

[...]

g. Remote control of the mechanical equipment in the ~~refrigerating~~ *machinery room shall* be provided immediately outside the *machinery room* door solely for the purpose of shutting down the equipment in an emergency. Ventilation fans *shall* be on a separate electrical circuit and have a control switch located immediately outside the *machinery room* door.

[...]

8.11.3 Walls, floor, and ceiling *shall* be tight and of noncombustible construction. Walls, floor, and ceiling separating the ~~refrigerating~~ *machinery room* from other *occupied spaces shall* be of at least one-hour fire-resistive construction.

[...]

8.11.7 Remote control of the mechanical equipment in the ~~refrigerating~~ *machinery room shall* be provided immediately outside the *machinery room* door solely for the purpose of shutting down the equipment in an emergency. Ventilation fans *shall* be on a separate electrical circuit and have a control switch located immediately outside the *machinery room* door.

8.11.8 Each ~~refrigerating~~ *machinery room* in accordance with Section 8.11 *shall* contain one or more *refrigerant detectors* in accordance with Section 8.11.9, with sensing element located in areas where *refrigerant* from a leak will concentrate, with one or more set points that activate responses in accordance with Section 8.11.10 for alarms and Section 8.11.11 for mechanical ventilation. Multiport-type devices *shall* be prohibited.

[...]

8.11.10.1 The alarm *shall* have visual and audible annunciation inside the ~~refrigerating~~ *machinery room* and outside each entrance to the ~~refrigerating~~ *machinery room*.

8.11.10.2 The *refrigerant detector* set points *shall* activate an alarm in accordance with the type of reset in Table 8-1. Manual reset type alarms *shall* have the reset located inside the ~~refrigerating~~ *machinery room*.

[...]

8.11.11.1 Mechanical ventilation referred to in Section 8.11.11 *shall* be in accordance with all of the following:

d. Inlets to the exhaust *ducts shall* be located in an area where *refrigerant* from a leak will concentrate, in consideration of the location of the replacement supply air paths, *refrigeration systems* ~~refrigerating machines~~, and the density of the *refrigerant* relative to air.

8.11.11.2 Level 1 Ventilation. The ~~refrigerating~~ *machinery room* mechanical ventilation in Section 8.11.11.1 *shall* exhaust at an airflow rate not less than shown in Table 8-2.

8.11.11.3 Level 2 Ventilation. A part of the ~~refrigerating~~ *machinery room* mechanical ventilation referred to in Section 8.11.11.1 *shall* exhaust an accumulation of *refrigerant* due to leaks or a rupture of a *refrigerating system*, or portion thereof, in the *machinery room*. The *refrigerant detectors* required in accordance with Section 8.11.8 *shall* activate ventilation at a set point and response time in accordance with Table 8-1, at an airflow rate not less than the

value determined in accordance with Section 8.11.11.4. When multiple *refrigerant designations* are in the *machinery room*, evaluate the required airflow according to each *refrigerating system*, and the highest airflow quantity *shall* apply. Ventilation reset *shall* be in accordance with the type of reset in Table 8-1. Manual-type ventilation reset *shall* have the reset located inside the ~~refrigerating~~ *machinery room*.

[...]

8.12

G = the mass of *refrigerant* in the largest *refrigeration system* ~~system~~, any part of which is located in the *machinery room*, lb (kg)

Modify Section 9 as follows. The remainder of Section 9 remains unchanged.

9. DESIGN AND CONSTRUCTION OF REFRIGERATION EQUIPMENT AND SYSTEMS

9.2 Refrigeration System Design Pressure

[…]

9.2.1

[…]

a. *Low sides* of all *refrigeration systems* ~~systems~~: 80°F (26.7°C)
b. *High sides* of all water-cooled or evaporatively cooled *refrigeration systems* ~~systems~~: 30°F (16.7°C) higher than the summer 1% wet-bulb temperature for the location, as applicable, or 15°F (8.3°C) higher than the highest design leaving condensing water temperature, or 104°F (40°C), whichever is greatest
c. *High sides* of all air-cooled *refrigeration systems* ~~systems~~: 30°F (16.7°C) higher than the summer 1% design dry-bulb temperature for the location but not lower than 122°F (50°C)

[…]

9.2.1.2 Standby conditions are intended to include normal conditions that are capable of being attained when the *refrigeration system* ~~system~~ is not in operation (e.g., maintenance, shutdown, power failure). Selection of the *design pressure* for *low-side* components *shall* also consider pressure developed in the *low side* of the *refrigeration system* ~~system~~ from equalization, or heating due to changes in ambient temperature, after the *refrigeration system* ~~system~~ has stopped.

[…]

9.2.6

[…]

c. Defrost, for *refrigeration systems* ~~systems~~ designed with defrost capability

[…]

9.2.6.4

[…]

a. A pressure-relieving connection that will relieve excess pressure to a lower pressure part of

the *refrigeration system* ~~system~~

[…]

9.4.3.1

[…]

a. *pressure relief device* to relieve hydrostatic pressure to another part of the *refrigeration system* ~~system~~ and

[…]

9.4.4 *Heat exchanger coils* located downstream, or upstream within 18 in. (460 mm), of a heating source and capable of being isolated *shall* be fitted with a *pressure relief device* that discharges to another part of the *refrigeration system* ~~system~~ in accordance with Section 9.4.3 or outside any enclosed space in accordance with Section 9.7.8. The *pressure relief device shall* be connected at the highest possible location of the heat exchanger or *piping* between the heat exchanger and its manual isolation valves.

Exceptions to 9.4.4:

2. A relief valve *shall not* be required on ~~self-contained~~ *self-contained systems* or *unit systems* if the volume of the *low side* of the *refrigeration system* ~~system~~, which is shut off by valves, is greater than the specific volume of the *refrigerant* at critical conditions of temperature and pressure as determined Equation 9-1:

$$V_1/[W_1 - (V_2 - V_1)/V_{gt}] \text{ shall be greater than } V_{gc} \quad (9\text{-}1)$$

where

V_1 = *low-side* volume, ft^3 (m^3)

V_2 = total volume of the *refrigeration system* ~~system~~, ft^3 (m^3)

W_1 = total weight of *refrigerant* in the *refrigeration system* ~~system~~, lb (kg)

V_{gt} = specific volume of *refrigerant* vapor at 110°F (43.5°C), ft^3/lb (m^3/kg)

V_{gc} = specific volume at *critical temperature* and *critical pressure*, ft^3/lb (m^3/kg)

[…]

9.4.6 Stop valves shall not be located between a pressure relief device and parts of the *refrigeration system* ~~system~~ protected thereby. A three-way valve, used in conjunction with the dual relief valve requirements of Section 9.7.2.3, is not considered a stop valve.

9.4.7

a. A parallel relief valve is installed that protects the *refrigeration system* ~~system~~ or vessels.

b. The *refrigeration system* ~~system~~ or vessels being protected have been depressurized and are vented to the atmosphere.

9.4.8 *Pressure relief devices shall* be connected directly to the *pressure vessel* or other parts of the *refrigeration system* ~~system~~ protected thereby. These devices *shall* be connected above the liquid *refrigerant* level and installed so that they are accessible for inspection and repair and so that they cannot be readily rendered inoperative

[…]

9.5.1 Pressure Relief Valve Setting. Pressure relief valves shall start to function at a pressure not to exceed the design pressure of the parts of the *refrigeration system* ~~system~~ protected.

Exception to 9.5.1: See Section 9.7.8.3 for relief valves that discharge into other parts of the *refrigeration system* ~~system~~.

9.5.2 Rupture Member Setting. *Rupture members* used in lieu of, or in series with, a relief valve *shall* have a nominal rated rupture pressure not to exceed the *design pressure* of the parts of the *refrigeration system* ~~system~~ protected. The conditions of application *shall* conform to the requirements of *ASME Boiler and Pressure Vessel Code* [15], Section VIII, Division 1, paragraph UG-127. The size of *rupture members* installed ahead of relief valves *shall not* be less than the relief valve inlet.

9.6 Marking of Relief Devices and Fusible Plugs

Exception to 9.6.1: Relief valves for *refrigeration systems* ~~systems~~ with *design pressures* of 15 psig (103.4 kPa gage) or less *shall* be marked by the *manufacturer* with the pressure setting capacity.

[…]

Exceptions to 9.7.2.3: A single relief valve is permitted on *pressure vessels* of 10 ft^3 (0.285 m^3) or more *internal gross volume* when all of the following conditions are met:

1. The relief valves are located on the *low side* of the *refrigeration system* ~~system~~.
2. The vessel is provided with shutoff valves designed to allow pumpdown of the *refrigerant* charge of the *pressure vessel*.
3. Other *pressure vessels* in the *refrigeration system* ~~system~~ are separately protected in accordance with Section 9.7.2.

[…]

9.7.3 For *pressure relief valves* discharging into the *low side* of the *refrigeration system* ~~system~~, a single relief valve (not *rupture member*) of the required relieving capacity *shall not* be used on vessels of 10 ft^3 (0.283 m^3) or more *internal gross volume* except under the conditions permitted in Section 9.7.8.3.

[…]

9.7.6 The rated discharge capacity of a *pressure relief device* expressed in lb of air/min (kg of air/s) *shall* be determined in accordance with *ASME Boiler and Pressure Vessel Code* [15], Section VIII, Division 1, para- graph UG-131. All pipe and fittings between the *pressure relief valve* and the parts of the *refrigeration system* ~~system~~ it protects *shall* have at least the area of the *pressure relief valve* inlet area.

[…]

9.7.8.1 Discharging Location Interior to Building. Pressure relief devices, including fusible plugs, serving refrigeration systems shall be permitted to discharge to the interior of a building only when all of the following apply:

a. The *refrigeration system* ~~system~~ contains less than 110 lb (50 kg) of a Group A1 or A2L refrigerant.
b. The *refrigeration system* ~~system~~ contains less than 6.6 lb (3 kg) of a Group A2, B1, B2L, or B2 refrigerant.
c. The *refrigeration system* ~~system~~ does not contain any quantity of a Group A3 or B3 refrigerant.
d. The *refrigeration system* ~~system~~ is to be installed in a machinery room as required by Section 7.4.

9.7.8.2 Discharging Location Exterior to Building.

[…]

a. The point of vent discharge shall be located not less than 15 ft (4.57 m) above the adjoining ground level. Exception to (a): Outdoor *refrigeration systems* ~~systems~~ containing Group A1 refrigerant shall be permitted to discharge at any elevation where the point of discharge is located in an access controlled area accessible to authorized personnel only.

b. The point of vent discharge shall be located not less than 20 ft (6.1 m) from windows, building ventilation openings, pedestrian walkways, or building exits.

c. For heavier-than-air refrigerants, the point of vent discharge shall be located not less than 20 ft (6.1 m) horizontally from below-grade walkways, entrances, pits, or ramps if a release of the entire *refrigeration system* ~~system~~ charge into such a space would yield a concentration of refrigerant in excess of the refrigerant concentration limit (RCL). The direct discharge of a relief vent into enclosed outdoor spaces, such as a courtyard with walls on all sides, shall not be permitted if a release of the entire *refrigeration system* ~~system~~ charge into such a space would yield a concentration of refrigerant in excess of the RCL. The volume for the refrigerant concentration calculation shall be determined using the gross area of the space and a height of 8.2 ft (2.5 m), regardless of the actual height of the enclosed space.

9.7.8.3 Internal Relief. Pressure relief valves designed to discharge from a higher-pressure vessel into a lower-pressure vessel internal to the *refrigeration system* ~~system~~ shall comply with all of the following:

[…]

b. The capacity of the pressure relief valve protecting the part of the *refrigeration system* ~~system~~ receiving a discharge from a pressure relief valve protecting a higher-pressure vessel shall be at least the sum of the capacity required in Section 9.7.5 plus the mass flow capacity of the pressure relief valve discharging into that part of the *refrigeration system* ~~system~~.

[…]

9.8 Positive Displacement Compressor Protection. Every *positive displacement compressor* with a *stop valve* in the discharge connection *shall* be equipped with a *pressure relief device* of adequate size and pressure setting, as *specified* by the *compressor manufacturer*, to prevent rupture of the *compressor* or to prevent the pressure from increasing to more than 10% above the maximum allowable working pressure of any other component located in the discharge line between the *compressor* and the *stop valve* or in accordance with Section 9.7.5, whichever is larger. The *pressure relief device shall* discharge into the low-pressure side of the *refrigeration system* ~~system~~ or in accordance with Section 9.7.8.

The relief devices *shall* be sized based on *compressor* flow at the following conditions:

a. *Compressors* in single-stage *refrigeration systems* ~~systems~~ and high-stage *compressors* of other *refrigeration systems* ~~systems~~. Flow *shall* be calcu- lated based on 50°F (10°C) saturated suction temperature at the *compressor* suction.

[…]

b. Low-stage *compressors* in ~~*cascade systems*~~ *cascade refrigeration systems*. For those *compressors* that are located in the lower-temperature stages of ~~*cascade systems*~~ *cascade refrigeration systems*, flow *shall* be calculated based on the suction pressure being equal to the pressure setpoint of the pressure relieving devices that protect the

low side of the stage against overpressure.

[…]

9.9.1 When Required. Pressure limiting devices complying with Section 9.9 shall be provided for compressors on all *refrigeration systems* ~~systems~~ operating above atmospheric pressure.

Exception to 9.9.1: *Pressure limiting devices* are not required for *listed* factory-sealed *refrigeration systems* ~~systems~~ containing less than 22 lb (10 kg) of Group A1 *refrigerant*.

9.9.2 Setting. *Pressure limiting devices shall* be set in accordance with one the following:

a. For *positive displacement compressors*:

1. When *refrigeration systems* ~~systems~~ are protected by a *high-side pressure relief device*, the *compressor*'s *pressure limiting device shall* be set at or below 90% of the operating pressure for the *high-side pressure relief device*.
2. When *refrigeration systems* ~~systems~~ are not protected by a *high-side pressure relief device*, the *compressor*'s *pressure limiting device shall* be set at or below the *refrigeration systems'* ~~systems'~~ *high-side design pressure*.

b. For *nonpositive displacement compressors*:

1. When *refrigeration systems* ~~systems~~ are protected by a *high-side pressure relief device*, the *compressor*'s *pressure limiting device shall* be set at or below 90% of the operating pressure for the *high-side pressure relief device.*
2. When *refrigeration systems* ~~systems~~ are protected by a *low-side pressure relief device* that is only subject to *low-side* pressure and is provided with a permanent relief path between the *refrigeration systems'* ~~systems'~~ *high side* and *low side*, with- out intervening valves, the *compressor*'s *pressure limiting device shall* be set at or below the *refrigeration systems'* ~~systems'~~ *high-side design pressure*.

[…]

9.10.1.1 *Refrigerant piping*, valves, fittings, and related parts having a maximum internal or external *design pressure* greater than 15 psig (103.4 kPa gage) *shall* be *listed* either individually or as part of an assembly or a *refrigeration system* ~~system~~ by a *nationally recognized testing laboratory*, or *shall* comply with ASME B31.5 [17] where applicable.

[…]

9.10.2 Reuse of Piping Materials on Existing Refrigeration Systems. Reused pipe, fittings, valves, or other materials on existing ~~*refrigerant* systems~~ *refrigeration systems* being renovated or modified *shall* be clean and free of foreign materials and *shall* comply with the requirements of Section 9.10.

[…]

9.11.4.3 Soldered Joints. Joint surfaces *shall* be cleaned. A flux conforming to ASTM B813 [57] *shall* be applied. The joint *shall* be soldered with a solder conforming to ASTM B32 [58]. Solder joints *shall* be limited to ~~*refrigerant* systems~~ *refrigeration systems* using Group A1 *refrigerant* and *shall* not exceed the pressure rating *specified* in Appendix I of ASME B16.22 [45]

9.12.2.2 Shaft Ventilation. Refrigerant pipe shafts with *refrigeration systems* ~~systems~~ using only Group A2L or B2L refrigerants *shall* be naturally or mechanically ventilated. *Refrigerant* pipe shafts with one or more *refrigeration systems* ~~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 the discharge location require-

ment *specified* in Section 9.7.8.2.

[…]

b.When active, mechanically ventilated shafts *shall* have a minimum air velocity in accordance with Table 9-12. *Makeup air shall* be provided at the inlet to the shaft for mechanically ventilated shafts. The mechanical ventilation *shall* either be continuously operated or, for pipe shafts containing only *refrigeration systems* ~~systems~~ using Group A2L or B2L *refrigerants*, activated by a *refrigerant detector*. *Refrigerant* pipe shafts utilizing a *refrigerant detector shall* have a set point not exceeding the *occupational exposure limit* (*OEL*) 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.

[…]

9.12.5 Stop Valves. *Stop valves shall* be installed in *specified* locations when required in accordance with Section 9.12.5.1 and 9.12.5.2. *Stop valves shall* be identified in accordance with Section 9.12.5.3. This requirement *shall not* apply to the following:

a. *Refrigeration systems* ~~systems~~ that have a *refrigerant* pump-out function capable of storing the entire *refrigerant* charge in a receiver or heat exchanger
b. *Refrigeration systems* ~~systems~~ that are equipped with provisions for pump out of the *refrigerant* using either portable or permanently installed *refrigerant* recovery equipment
c. ~~*Self-contained listed systems*~~ *Listed self-contained systems*

[…]

9.12.5.2 Refrigerating Systems Containing More Than 110 lb (50 kg) of Refrigerant. In addition to *stop valves* required by Section 9.12.5.1, *refrigeration systems* ~~systems~~ containing more than 110 lb (50 kg) of *refrigerant shall* have *stop valves* installed in the following locations:

[…]

Stop valves shall not be required on the inlet of a receiver in a *condensing unit* or on the inlet of a receiver that is an integral part of the *condenser* or *refrigeration systems* ~~systems~~ utilizing *nonpositive displacement compressors*.

[…]

9.13.1General. *Refrigerating systems* fabricated, assembled, or erected on the *premises shall* be tested to the applicable requirements of this section. Tests *shall* include both the *high sides* and *low sides* of each *refrigeration system* ~~system~~. *Refrigeration system* ~~system~~ components that have been strength tested under pressure by the component *manufacturer*, fabricator, or assembler are not required to be strength tested again on the *premises* unless modified or repaired. *Listed* equipment not modified or repaired *shall not* be required to be strength tested on the *premises*. After installation and before being placed in operation, *refrigeration system* ~~system~~ components not previously strength tested *shall* be strength tested under pressure in accordance with Section 9.13.5. After successful completion of the required strength tests and before being placed in operation, *refrigeration system* ~~system~~ components and field installed connections *shall* be leak tested for tightness in accordance with Section 9.13.6.

Informative Note: *Refrigeration system* ~~system~~ components that are strength tested prior to field assembly include (but are not limited to), compressors, *condensers*, precharged linesets, *pressure vessels*, *evaporators*, *refrigerant* bulk storage tanks, safety devices, pressure gages, and control mechanisms

9.13.2* Exposure of Refrigerant Piping ~~System~~. *Refrigerant piping* and joints installed on the *premises* *shall* be exposed for visual inspection and testing prior to being covered or enclosed.

9.13.3 Test Gases. The medium used for pressure testing the ~~*refrigerant system*~~ *refrigeration system* *shall* be one of the following inert gases: oxygen-free nitrogen, helium, argon, or premixed nonflammable oxygen-free nitrogen with a tracer gas of hydrogen or helium. For R-744 ~~*refrigerant system*~~ *refrigeration systems*, carbon dioxide *shall* be allowed as the test medium. For R-718 ~~*refrigerant system*~~ *refrigeration systems*, water *shall* be allowed as the test medium.

9.13.4 Field Test Apparatus. The means used to pressurize the *refrigeration system piping* ~~*refrigerant piping system*~~ shall have either a pressure limiting device or a pressure reducing device and a test pressure measuring device on the outlet side. The test pressure measuring device shall have an accuracy of ±3% or less of the test pressure and shall have a resolution of 3% or less of the test pressure

9.13.5 Refrigerant Piping ~~System~~ Strength Test. *Refrigerating system* components and *refrigerant piping* shall be tested in accordance with ASME B31.5 17 or this section. Separate tests for isolated portions of the *refrigeration system* ~~system~~ are permitted, provided that all required portions are tested at least once. Pressurize with test gas for a minimum of ten (10) minutes to not less than the lower of (a) the lowest design pressure for any *refrigeration system* ~~system~~ component or (b) the lowest value of set pressure for any pressure relief devices in the *refrigeration system* ~~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 *refrigeration system* ~~system~~ component with a nameplate. A passing test result shall have no rupture or structural failure of any *refrigeration system* ~~system~~ component or refrigerant piping.

[…]

9.13.6.1 Leak Testing Protocol. After the time to complete the strength test, continue to pressure test in accordance with Section 9.13.5 for a minimum period as *specified* in Table 9-13. The *refrigeration system* ~~system~~ *shall* show no loss in pressure on the pressure measuring device during the pressure test. Calculation of the pressure differential based on a change in ambient temperature *shall* be permitted. A vacuum of 0.0097 psi (67 Pa) absolute or lower *shall* be achieved (0.0197. in Hg [32°F]; 500 microns Hg [0°C]; 500 microns). After achieving a vacuum, the *refrigeration system* ~~system~~ *shall* be isolated from the vacuum pump. The *refrigeration system* ~~system~~ pressure *shall not* rise above 0.029 psi (200 Pa) absolute (0.059 in. Hg [32°F]; 1500 microns Hg [0°C]; 1500 microns) for a minimum period as *specified* in Table 9-13.

Informative Note: The vacuum pump should gradually create a vacuum to avoid freezing of any moisture in the *refrigeration system piping* ~~system~~.

9.13.7 Contractor or Engineer Declaration. The installing contractor or registered design professional of record *shall* issue a certificate of test, verifying strength test in accordance with Section 9.13.5 and leak- age test in accordance with Section 9.13.6, to the AHJ for all *refrigeration systems* ~~system~~ containing 55 lb (25 kg) or more of *refrigerant*. The certificate *shall* give the test date, photograph of the pressure gage at the test pressure, *refrigerant designation*, test medium, and the field test pressure applied to the *high side* and the *low side* of the *refrigeration system* ~~system~~. The certification of test *shall* be signed by the installing contractor or registered design professional and *shall* be made part of the public record.

[…]

9.14.4 Liquid receivers, if used, or parts of a *refrigeration system* ~~system~~ designed to receive the refrigerant charge during pumpdown *shall* have sufficient capacity to receive the *pumpdown charge*. The liquid *shall not* occupy more than 90% of the volume when the temperature of the *refrigerant* is 90°F (32°C).

Informative Note: The receiver volume is not required to contain the total *refrigeration system* ~~system~~ charge but is required to contain the amount being transferred. If the environmental temperature is expected to rise above 122°F (50°C), the designer *shall* account

for the specific expansion characteristics of the *refrigerant*.

[…]

9.15.3 All *refrigeration systems* ~~systems~~ shall have provisions to handle the refrigerant charge for service purposes. When required, there *shall* be liquid and vapor transfer valves, a transfer *compressor* or pump, and *refrigerant* storage tanks or appropriate valved connections for removal by a reclaim, recycle, or recovery device.

9.16.1.1 Testing Procedure. Tests *shall* be performed with dry nitrogen or another nonflammable, non- reactive, dried gas. Oxygen, air, or mixtures containing them *shall not* be used. The means used to build up the test pressure *shall* have either a *pressure limiting device* or a pressure reducing device and a gage on the outlet side. The *pressure relief device shall* be set above the test pressure but low enough to prevent permanent deformation of the *refrigeration system's* ~~system's~~ components.

Exceptions to 9.16.1.1:

[…]

3. Compressed air without added *refrigerant* is allowed for factory tests, provided the *refrigeration system* ~~system~~ is sub- sequently evacuated to less than 1000 microns (132 Pa) before charging with *refrigerant*. The required evacuation level is atmospheric pressure for *refrigeration systems* ~~systems~~ using R-718 (water) or R-744 (car- bon dioxide) as the *refrigerant*.

[…]

Modify Section 10 as follows. The remainder of Section 10 remains unchanged.

10.1.3 Each entrance to a ~~refrigerating~~ *machinery room shall* be provided with a legible permanent sign, securely attached and easily accessible, reading "Machinery Room—Authorized Personnel Only." The sign *shall* further communicate that entry is forbidden except by those personnel trained in the emergency procedures required by Section 10.6 when the *refrigerant* alarm, required by Section 8.9.5, has been activated.

[…]

10.2 Charging, Withdrawal, and Disposition of Refrigerants. No service containers shall be left connected to *refrigeration systems* ~~systems~~ except while charging or withdrawing refrigerant.

[…]

10.6 Responsibility for Operation and Emergency Shutdown. It *shall* be the duty of the person in charge of the *premises* on which a *refrigerating system* containing more than 55 lb (25 kg) of *refrigerant* is installed to provide a schematic drawing or panel giving directions for the operation of the ~~system~~ equipment at a location that is convenient to the operators ~~of the equipment~~.

Emergency shutdown procedures, including precautions to be observed in case of a breakdown or leak, *shall* be displayed on a conspicuous card located as near as possible to the *refrigerant compressor*. These precautions *shall* address

a. instructions for shutting down the ~~system~~ equipment in case of emergency;

b. the name, address, and day and night telephone numbers for obtaining service; and
c. the names, addresses, and telephone numbers of all corporate, local, state, and federal agencies to be contacted as required in the event of a reportable incident.

When a ~~refrigerating~~ *machinery room* is used, the emergency procedures *shall* be posted outside the room, immediately adjacent to each door.
The emergency procedures *shall* forbid entry into the ~~refrigerating~~ *machinery room* when the *refrigerant* alarm required by Section 8.9.5 has been activated, except by persons provided with the appropriate respiratory and other protective equipment and trained in accordance with jurisdictional requirements.

[…]

Modify Appendix F as follows. The remainder of Appendix F remains unchanged.

INFORMATIVE APPENDIX F
EMERGENCIES IN ~~REFRIGERATING~~ MACHINERY ROOMS

This standard specifies ~~refrigerating~~ *machinery rooms* under some conditions to reduce risks from large *refrigerating systems* and large amounts of *refrigerant*. One purpose of the requirements is to warn of emergencies in the ~~refrigerating~~ *machinery room*. The *refrigerant detector* required by Section 8.9.5 or 8.11.8 triggers alarms inside and outside the ~~refrigerating~~ *machinery room*. Signage warns refrigeration technicians and bystanders not to enter when the alarm has activated.
This appendix provides guidance on integrating the minimum emergency warning and training requirements of this standard with measures often taken in occupational health and safety programs.
The requirements in the standard provide minimum protection to help prevent injury from ~~refrigerating~~ *machinery room* accidents. Minimal conformance to the standard's specifications does not necessarily facilitate the convenient handling of incidents in the room. For example, if only the minimum protective steps are taken, refrigeration technicians may not reenter the *machinery room* after an alarm has sounded (to silence the alarm and repair any damage) without calling on the services of emergency responders (generally the local hazardous materials team). Many other approaches are possible, especially in facilities that prepare sophisticated emergency response plans.

F1. ALARM LEVELS

A *refrigerant* level above the *occupational exposure limit* (*OEL*) activates the alarms required by Section 8.9.5 or 8.11.10. If personnel working in the ~~refrigerating~~ *machinery room* are not provided with and trained to use respiratory protection equipment appropriate for the *refrigerant* (such as canister respirators or self-contained breathing apparatus), they must leave the room immediately. Presence of *refrigerant* above the *OEL* does not by itself signal an emergency. Many routine service operations can create such levels. Local or national regulations often prescribe that steps be taken to protect the health and safety of personnel working in the *machinery room* when *refrigerant* concentrations rise above the *OEL*.

[…]

F2. ALTERNATE REFRIGERANT LEVEL MEASUREMENTS

The required alarms signal only that *refrigerant* was detected at concentrations above the *OEL*. Some facilities may find it useful to have multiple levels of alarm or to provide an instrument that indicates the actual *refrigerant* level (digital readout in parts per million of *refrigerant*). Selecting proper respiratory protection for technicians or other responders, as mentioned above, is one reason. This is perfectly acceptable, provided that the additional alarms or indicators are clearly distinguished from the main alarm. Bystanders should not be confused by the alarm arrangements.
The main alarm must be a manual-reset type as required per Section 8.9.5 or 8.11.10.2. It is unwise to rely on automatic detectors to announce that an event is over. A technician could not distinguish between an alarm

that reset when the *refrigerant* concentration dropped (e.g., because ventilation fans controlled the incident) and one that reset because the *refrigerant detector* was damaged. In the latter case, anyone entering the ~~refrigerating~~ *machinery room* might be entering a hazardous area. Alarms or indicators intended to communicate current conditions inside the refrigeration *machinery room* may, of course, be automatically resetting.

F3. REENTRY INTO ~~REFRIGERATING~~ MACHINERY ROOMS

Reentering an area during an emergency requires sophisticated equipment and training; many national and local regulations govern such activities. Prepositioning emergency response equipment (e.g., self-contained breathing apparatus) should be done only by arrangement with emergency responders, and any prepositioned equipment should be clearly labeled for use by trained personnel only. Doing otherwise invites unauthorized use (or vandalism) by untrained personnel, with dangerous consequences.

Facilities should note, however, that the alarms required in this standard annunciate not that an emergency is occurring but that an abnormal situation is occurring. It may be acceptable for trained personnel to enter the ~~refrigerating~~ *machinery room* to investigate the situation, repair minor leaks, reset alarms tripped in error, etc. Any personnel required to enter should be provided with appropriate personal protective equipment (especially respiratory protection, if needed) and should be trained to recognize an emergency situation requiring professional emergency response.

F4. EXAMPLE EMERGENCY PROCEDURES

As an example (and there are many other possibilities), consider a facility that wishes to use its own technicians to handle minor problems in the ~~refrigerating~~ *machinery room*. The facility

a. provides the *refrigerant* alarm required by Section 8.9.5 or 8.11.10, along with signage warning "Authorized Personnel Only. Stay Out When Refrigerant Alarm Sounds; Call Facilities Management Immediately." This alarm triggers at the *OEL*.

b. provides a digital readout of the current *refrigerant detector* reading outside the ~~refrigerating~~ *machinery room*. A sign distinguishes the current-reading indicator from the alarm-activation indicator required by Section 8.9.5 or 8.11.10.

c. provides the refrigeration technicians with appropriate respiratory protection suitable for use in an atmosphere containing *refrigerant* in concentrations below the *IDLH*, in accordance with all applicable national and local regulations.

d. defines as "incidental" any *refrigerant* release that is not producing levels above the *IDLH* in the *machinery room*. (The ventilating system will render many potential releases incidental.)

e. trains the technicians to leave the ~~refrigerating~~ *machinery room* when the *refrigerant* alarm sounds. After donning appropriate respiratory protection (if necessary), they may reenter the *machinery room* to close valves, fix leaks, shut off alarms, etc., if and only if the current *refrigerant* level is below the *IDLH*. That is, technicians may reenter the room if the *refrigerant* release is incidental. If the level exceeds the *IDLH*, or the problem seems uncontrolled in the sense that it may unpredictably worsen or require a team of technicians to fix, they are to leave and call for emergency responders.

f. coordinates emergency procedures with the local emergency response agencies in advance.

None of these steps contradicts the requirements of the standard, but the additional procedures significantly aid the facility's efforts to handle minor maintenance problems safely.