BSR/ASHRAE Addendum q
to ANSI/ASHRAE Standard 15-2024

______First Public Review Draft

Proposed Addendum q to Standard 15-2024, Safety Standard for Refrigeration Systems

First Public Review (October 2025)
(Draft shows Proposed Changes to Current Standard)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at https://www.ashrae.org/technical-resources/standards-and-guidelines/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

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(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

This proposed Addendum q is the product of an internal review of all symbols in this standard. Upon review, it was discovered that in many instances, the same symbol was being used for multiple purposes. This draft establishes unique symbols. It also creates an informative Appendix H, which lists all symbols, as well as their units of measure and where they appear in the standard. The intent of this addendum is not to change technical requirements, but rather to provide greater clarity of the standard. As such, most of these changes are editorial in nature.

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 15-2024

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

[…]

7.2.3.2.1 Natural Ventilation Opening for Group A1 Refrigerants. […]

$$A_{vent} = \frac{m_{rel} - m_{room}}{RCL \times 0.833} \times \sqrt{\frac{A_{room}}{g \times m_{room}} \times \frac{M_r}{M_r - M_a}} \quad \text{(7-1a [I-P])}$$

$$A_{vent} = \frac{m_{rel} - m_{room}}{RCL \times 208} \times 1000 \times \sqrt{\frac{A_{room}}{g \times m_{room}} \times \frac{M_r}{M_r - M_a}} \quad \text{(7-1b [SI])}$$

where
A_{vent} = minimum area of a permanent opening, ft^2 (m^2)
m_{rel} = *releasable refrigerant charge*, lb (kg)
m_{room} = allowable *refrigerant* charge of an individual room, lb (kg); (V_{eff}, used to calculate *EDVC*, is the volume of an individual room.)
RCL = *refrigerant concentration limit*, lb/1000 ft^3 (~~k~~g/m^3)
$A_{\underline{room}}$ = ~~actual~~ area of the individual room, ft^2 (m^2)
M_a = *relative molar mass* of air, 29.0, dimensionless
M_r = *relative molar mass* of the *refrigerant*, dimensionless
g = acceleration due to gravity, 32.2 ft/s^2 (9.81 m/s^2)
0.833 = I-P conversion factor
208 = SI conversion factor

Equations 7-1a and 7-1b are not applicable for *refrigerants* with a *relative molar mass* less than 42.

7.2.3.2.2 Natural Ventilation Opening for Group A2L, A2, or A3 Refrigerants. […]

$$A_{vent} = \frac{m_{rel} - m_{room}}{LFL \times 0.417} \times \sqrt{\frac{A_{room}}{g \times m_{room}} \times \frac{M_r}{M_r - M_a}} \qquad \text{(7-2a [I-P])}$$

$$A_{vent} = \frac{m_{rel} - m_{room}}{LFL \times 104} \times 1000 \times \sqrt{\frac{A_{room}}{g \times m_{room}} \times \frac{M_r}{M_r - M_a}} \qquad \text{(7-2b [SI])}$$

where
A_{vent} = minimum area of a permanent opening, ft^2 (m^2)
m_{rel} = *releasable refrigerant charge*, lb (kg)
m_{room} = allowable *refrigerant* charge of an individual room, lb (kg); (*Veff*, used to calculate *EDVC*, is the volume of an individual room.)
LFL = *lower flammability limit*, lb/1000 ft^3 (~~k~~g/m^3)
A_{room} = ~~actual~~ area of the individual room, ft^2 (m^2)
M_a = *relative molar mass* of air, 29.0, dimensionless
M_r = *relative molar mass* of the *refrigerant*, dimensionless
g = acceleration due to gravity, 32.2 ft/s^2 (9.81 m/s^2)
0.417 = I-P conversion factor
104 = SI conversion factor

Equations 7-2a and 7-2b ~~is~~ are not applicable for *refrigerants* with a *relative molar mass* less than 42.

[…]

7.3.1 EDVC Calculation. The maximum charge permitted for an *effective dispersal volume shall* be calculated using Equation ~~7-3a or 7-3b~~ 7-3, except for *refrigeration systems* covered by Section 7.3.1.1:

~~$EDVC = RCL \times V_{eff} \times F_{occ}$ (7-3a [I-P])~~
~~$EDVC = RCL \times V_{eff} \times F_{occ}/1000$ (7-3b [SI])~~
$EDVC = RCL \times V_{eff} \times F_{occ} / 1000$ (7-3)

where
EDVC = *effective dispersal volume charge*, lb (kg)
RCL = *refrigerant concentration limit*, lb/1000 ft^3 (g/m^3)
V_{eff} = *effective dispersal volume*, ft^3 (m^3), established using Sections 7.2.1 through 7.2.3
F_{occ} = *occupancy* adjustment factor (~~For all *occupancies* other than institutional, F_{occ} has a value of 1.~~ For *institutional occupancies*, F_{occ} has a value of 0.5. For all other *occupancies*, F_{occ} has a value of 1.)

[…]

7.3.4.3 Calculating Releasable Refrigerant Charge. […]

$$m_{rel} = (t_{r1} \times 0.0062) + m_{r2} + m_{r3} \qquad \text{(7-4a [I-P])}$$
$$m_{rel} = (t_{r1} \times 0.0028) + m_{r2} + m_{r3} \qquad \text{(7-4b [SI])}$$

where
m_{rel} = *releasable refrigerant charge*, lb (kg)
t_{r1} = time before the leak is detected per Section 7.6.2.4, s
0.0062 = leakage rate in lb/s
0.0028 = leakage rate in kg/s
m_{r2} = leakage between the detection of the leak and the closing of the *safety shutoff valve*, lb (kg)
m_{r3} = leakage in the *piping* downstream of the *safety shutoff valve* after the valve is closed, lb (kg)

$$m_{r2} = t_{close} \times 0.0062 \qquad \text{(7-5a [I-P])}$$

$$m_{r2} = t_{close} \times 0.0028 \qquad \text{(7-5b [SI])}$$

where
t_{close} = time from when a leak is detected until the *safety shutoff valve* closes, s
0.0062 = leakage rate in lb/s
0.0028 = leakage rate in kg/s

[…]

7.5.1.2 Corridors and Lobbies. […]

c. *Refrigeration systems* containing Class 2L, 2, or 3 *refrigerants shall* be *listed*, and the *refrigerant* charge *shall* be limited for each *unit system*, calculated in accordance with Equation 7-7a or 7-7b:

$$m_s = 0.106 \times LFL \qquad \text{(7-7a [I-P])}$$
$$m_s = 3 \times LFL\ /1000 \qquad \text{(7-7b [SI])}$$

where
m_s = *system refrigerant charge*, lb (kg)
LFL = *lower flammability limit* per ASHRAE Standard 34,[3] lb/1000 ft^3 (~~k~~g/m^3)
0.106 = a constant with units of 1000 ft^3
3 = a constant with units of m^3

[…]

7.5.3 Higher-Flammability Refrigerants. […]

4. This restriction does not apply to equipment *listed* to UL 60335-2-89 [7]/CSA C22.2 No. 60335-2-89 [8] containing no more than 0.459 × *LFL* (lb), where *LFL* is in lb/1000 ft^3 (13 × *LFL* [~~k~~g], where *LFL* is in ~~k~~g/m^3) of Group A3 *refrigerant*, provided that the equipment is installed in accordance with the listing and the *manufacturer*'s installation instructions. *Refrigeration systems* containing more than 0.141 × *LFL* (lb) (4 × *LFL* [~~k~~g]) in an *independent circuit shall not* be installed within 20 ft (6 m) of an open flame.
5. This restriction does not apply to equipment *listed* to UL 60335-2-40 [5]/CSA C22.2 No. 60335-2-40 [6] containing no more than 0.106 × *LFL* (lb) (3 × *LFL* [~~k~~g]) of Group A3 *refrigerant*, provided that the equipment is installed in accordance with the listing and the *manufacturer*'s installation instructions.

[…]

7.6.1.1* Refrigeration Systems with Air Circulation. […]

$$EDVC = V_{eff} \times LFL \times \cancel{CF}\,CF \times F_{occ}\ /\ 1000 \qquad \text{(7-8)}$$

where
EDVC = *effective dispersal volume charge*, lb (kg)
V_{eff} = *effective dispersal volume*, ft^3 (m^3)
LFL = *lower flammability limit*, lb/1000 ft^3 (~~k~~g/m^3)
~~CF~~*CF* = concentration factor, value of 0.5
F_{occ} = *occupancy* adjustment factor; (~~For all *occupancies* other than institutional, *Focc* has a value of 1.~~ For *institutional occupancies*, *Focc* has a value of 0.5. For all other *occupancies*, *Focc* has a value of 1.)

[...]

7.6.1.2* Other Refrigeration Systems. […]

F_{occ} = *occupancy* adjustment factor; (~~For all *occupancies* other than institutional, *Focc* has a value of 1.~~ For *institutional occupancies*, *Focc* has a value of 0.5. For all other *occupancies*, *Focc* has a value of 1.)

[...]

7.6.4* Mechanical Ventilation. […]

$$Q_{req} = \frac{m_s - EDVC}{4 \times LFL} \times 1000 \times \cancel{SF} SF_{vent} \qquad \text{(7-11a [I-P])}$$

$$Q_{req} = \frac{m_s - EDVC}{4 \times LFL} \times 1000 \times \cancel{SF} SF_{vent} \times 60 \qquad \text{(7-11b [SI])}$$

where
Q_{req} = required minimum mechanical ventilation airflow rate, ft^3/min (m^3/h)
m_s = ~~largest~~ *system refrigerant charge* ~~from *independent circuit*~~, lb (kg)
EDVC = *effective dispersal volume charge*, lb (kg)
LFL = *lower flammability limit*, lb/1000 ft^3 (~~k~~g/m^3)
4 = assumed leak time (4 minutes)
~~SF~~ SF_{vent} = safety factor, value of 2
60 = conversion of minutes to hours

[…]

7.7.1 Refrigerant Charge Limits. *Refrigerant* charge *shall* be limited as follows:
a. *Refrigeration systems* containing more than 0.141 × *LFL* (lb) (4 × *LFL* [~~k~~g]) in an *independent circuit shall not* be installed within 20 ft (6 m) of an open flame.
b. *Refrigeration systems shall* contain a *releasable refrigerant charge* no more than 9.2 × *LFL* (lb), where *LFL* is in lb/1000 ft^3 (260 × *LFL* [~~k~~g], where *LFL* is in ~~k~~g/m^3) of Group A2L *refrigerant* per *independent circuit*.

[…]

7.7.3.3 A *refrigerant detector shall* be provided in accordance with Section 7.6.2.4 except where either of the following apply:
a. When the *refrigerant* charge of any *independent circuit* is less than or equal to 0.459 × *LFL* (lb), where *LFL* is in lb/1000 ft^3 (13 × *LFL* [~~k~~g], where *LFL* is in ~~k~~g/m^3)

[…]

7.8* High-Probability Commercial Refrigeration Systems Using Group A2 Refrigerants. *High-probability systems* using Group A2 *refrigerants* for commercial refrigeration applications within the scope of UL 60335-2-89 [7]/CSA C22.2 No. 60335-2-89 [8] *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* [~~k~~g], where *LFL* is in ~~k~~g/m^3), provided that the *refrigeration 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* [~~k~~g]) 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.

Table 8-2 Calculation Method Equations [a] […]

where

$Q' = 646 \times P_{ref}^{0.62}$ (I-P)
$Q' = 6.67 \times P_{ref}^{0.62}$ (SI)
$G' = 21200 \times P_{ref}^{-0.72}$ (I-P)
$G' = 267 \times P_{ref}^{-0.72}$ (SI)
$P_{ref} = \cancel{DP}\,DP + 14.70$ (I-P)
$P_{ref} = \cancel{DP}\,DP + 0.1013$ (SI)
G = mass of *refrigerant* in the largest *refrigeration system* (*independent circuit*), any part of which is located in the *machinery room*, lb (kg)
G' = a threshold value where the airflow requirement changes, lb (kg)
Q = airflow rate, conversion to other units of measure is permitted, ft^3/min (m^3/s)
Q'= an airflow rate independent of charge quantity, ft^3/min (m^3/s)
Q_1 = Level 1 Ventilation in accordance with Section 8.11.11.2, ft^3/min (m^3/s)
P_{ref} = *refrigerant* pressure (absolute), psia (MPa)
$\cancel{DP}\,DP$ = *design pressure* (gage) of the *refrigeration system high side*, psi (MPa)

[…]

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

9.4.4 […]

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

where
V_1 = *low-side* volume, ft^3 (m^3)
V_2 = total volume of the *refrigeration system*, ft^3 (m^3)
~~W_1 = total weight of *refrigerant* in the *refrigeration system*, lb (kg)~~ m_s = *system refrigerant charge*, 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)

[…]

9.7.5.1 […]

$$C_{req} = f \times A_{proj} \quad (9\text{-}2)$$

where
C_{req} = minimum required ~~discharge capacity of the~~ relief device capacity expressed as mass flow of air, lb/min (kg/s)
f = pressure relief capacity factor (per Section 9.7.5.4 or, as applicable, per Section 9.7.5.5) that is dependent on type of *refrigerant* and relief device *relieving pressure*, lb/~~(~~[ft^2·min~~)~~] ~~[~~(kg/~~(~~[m^2·s~~)~~])
A_{proj} = projected area of the *pressure vessel* or protected equipment (per Section 9.7.5.6 or 9.7.5.7), ft^2 (m^2)

[…]

9.7.5.2.2 When the *pressure relief device set pressure* is less than the vessel's *design pressure*, the *relieving pressure shall* be calculated using Equation 9-4.

$$P_r = (P_s + P_b) \times 1.1 \quad (9\text{-}4)$$

where
~~P_b = *superimposed back pressure* standing at the outlet of the *pressure relief device*, psig (kPa gage)~~
P_r = *relieving pressure*, psig (kPa gage)
P_s = *pressure relief device set pressure*, which is equal to the vessel's *design pressure*, psig (kPa gage)
P_b = *superimposed back pressure* standing at the outlet of the *pressure relief device*, psig (kPa gage)

1.1 = allowed *overpressure*

9.7.5.2.3 For *fusible plugs*, the *relieving pressure shall* be determined using Equation 9-5a or 9-5b.

$$P_r = (P_{bp} - 14.70) \times 1.1 \quad \text{(9-5a [I-P])}$$
$$P_r = (P_{bp} - 101.3) \times 1.1 \quad \text{(9-5b [SI])}$$

where
P_{bp}= *bubble point* absolute pressure corresponding to the stamped melting temperature on the *fusible plug* for the applicable *refrigerant designation*, psia (kPa)
P_r = *relieving pressure*, psig (kPa gage)
1.1 = allowed *overpressure*

9.7.5.3 The area (A_{proj}) *shall* be calculated in accordance with Section 9.7.5.6 and Section 9.7.5.7.

9.7.5.4 Tables 9-1 through 9-6 provide values of *pressure relief device* capacity factors (*f*) for specific *refrigerants* and their corresponding *relieving pressures* calculated in accordance with this section and using the following basis: *set pressure* is equal to *design pressure*, the maximum heat flux (H_{flux}) is from an external source with the minimum permissible value, and combustible materials are not within 20 ft (6.1 m) of a *pressure vessel*. **[...]**

9.7.5.5 […]

$$f = \frac{H_{flux}}{h_{fg}} \times r_w \quad \text{(9-6)}$$

where
f = pressure relief capacity factor (per Section 9.7.5.4 or, as applicable, per Section 9.7.5.5) that is dependent on type of *refrigerant* and relief device *relieving pressure*, lb/[ft^2·min] (kg/[m^2·s])
H_{flux} = ~~the~~ heat flux from a thermal energy source originating from an external source or internal source in accordance with Section 9.7.5.6 and 9.7.5.7, respectively, Btu/[ft^2·min] (kW/m^2)
h_{fg} = ~~the~~ *refrigerant*~~'s~~ latent heat of vaporization evaluated at the *relieving pressure*, Btu/lb (kJ/kg)
r_w = *refrigerant* to air mass flow rate conversion factor, dimensionless

The *refrigerant* to air mass flow rate conversion factor (r_w) *shall* be calculated using Equations 9-7 and 9-8.

$$r_w = \frac{C_a}{C_r}\sqrt{\frac{T_r}{T_a}}\sqrt{\frac{M_a}{M_r}} \quad \text{(9-7)}$$

$$C_r = 520\sqrt{k\left(\frac{2}{k+1}\right)^{(k+1)/(k-1)}} \quad \text{(9-8)}$$

where
C_a = constant for air~~,~~ = 356
C_r = constant for *refrigerant* as determined from Equation 9-~~11~~8 (see also Equation C-4)
T_r = ~~the~~ absolute dew-point temperature of *refrigerant* evaluated at the *relieving pressure*, °R (K)
T_a = ~~the~~ absolute temperature of ~~standard~~air~~,~~ = 520°R (289 K)
M_r = *relative molar mass* of the *refrigerant*, dimensionless
M_a = *relative molar mass* of air, 29.0, dimensionless
k = ~~the~~ ratio of specific heats (~~cp/cv~~C_p/C_v) for saturated *refrigerant* vapor evaluated at the *relieving pressure*

[…]

Table 9-1 Relief Device Refrigerant Capacity Factors (~~f~~ *f*) lb/[ft²·min] (I-P)~~)~~

[…]

Table 9-2 Relief Device Refrigerant Capacity Factors (~~f~~ *f*) kg/[m²·s] (SI)

[…]

Table 9-3 Relief Device Refrigerant Capacity Factors (~~f~~ *f*) lb/[ft²·min] (I-P)

[…]

Table 9-4 Relief Device Refrigerant Capacity Factors (~~f~~ *f*) kg/[m²·s] (SI)

[…]

Table 9-5 Relief Device Refrigerant Capacity Factors (~~f~~ *f*) lb/[ft²·min] (I-P)

[…]

Table 9-6 Relief Device Refrigerant Capacity Factors (~~f~~ *f*) kg/[m²·s] (SI)

[…]

9.7.5.6 External Heat Sources. The area (A_{proj}) *shall* be the largest *refrigerant*-containing, projected external surface area of the *pressure vessel* when viewed from any orientation. See Figure 9-1 for examples. The value of heat flux (H_{flux}) *shall* be not less than 150 Btu/(min·ft²) (28.4 kW/m²). Where combustible materials are within 20 ft (6.1 m) of a *pressure vessel*, the value of heat flux (H_{flux}) *shall* be not less than 375 Btu/(min·ft²) (71.0 kW/m²). Where a heat source other than an external fire has potential to generate a larger heat flux (H_{flux}) during operating conditions and standby conditions as defined in Sections 9.2.1 and 9.2.1.2, or during other abnormal conditions, the *pressure relief device shall* be sized based on the other heat source.

9.7.5.7 Internal Heat Sources. The area (A_{proj}) *shall* be the applicable *refrigerant*-containing area for the *pressure vessel* or pressure-protected equipment that corresponds to the greatest internal heat flux (H_{flux}) expected during operating conditions or standby conditions as defined in Sections 9.2.1 and 9.2.1.2.

Informative Note: Tables 9-1 through 9-6 are based on H_{flux} = 150 Btu/(ft²·min) [kW/m²]. As stated in Section 9.7.5.4, the *relieving pressures* are based on the *pressure relief device set pressure* is equal to *design pressure*.

[…]

9.7.7 […]

$$C_{rd} = 0.64 P_1 d_{min}^2$$

$$d_{min} = 1.25(C_{rd}/P_1)^{0.5} \qquad \text{(9-9a[I-P])}$$

$$C_{rd} = 1.09 \times 10^{-6} P_1 d_{min}^2$$

$$d_{min} = 958.7(C_{rd}/P_1)^{0.5} \qquad \text{(9-9b[SI])}$$

where

C_{rd} = ~~rated~~ discharge capacity expressed as mass flow of air, lb/min (kg/s)

d_{min} = smallest of the internal diameter of the inlet pipe, retaining flanges, *fusible plug*, and *rupture member*, in. (mm)

where for *rupture members*,

~~P_1 = (rated pressure psig [kPa gage] × 1.1) + 14.7 (101.3)~~

P_1 = [rated gage pressure x 1.1] + 14.7, psia

P_1 = [rated gage pressure x 1.1] + 101.3, kPa

and where for *fusible plugs*,

P_1 = absolute *saturation pressure* corresponding to the stamped melting temperature of the *fusible plug* or the *critical pressure* of the applicable *refrigerant designation*, whichever is smaller, psia (kPa)

[…]

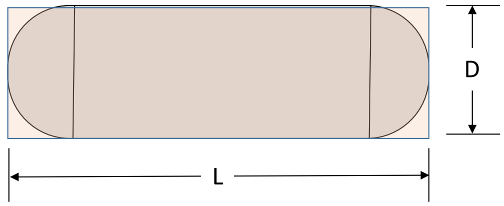
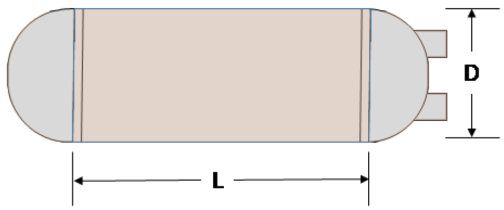
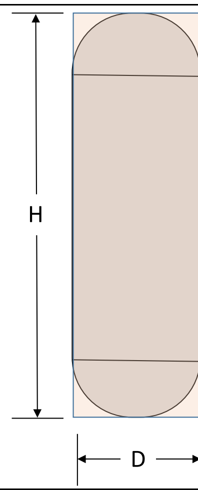
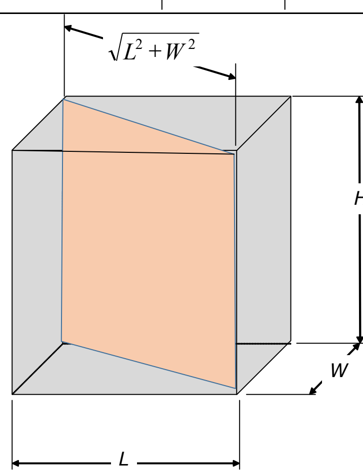
Component	Example	Area
Pressure vessel, horizontal, without waterboxes		$A_{proj} = D \cdot L$
Pressure vessel, horizontal, with waterboxes		$A_{proj} = D \cdot L$
Pressure vessel, vertical		$A_{proj} = D \cdot H$
Plate heat exchanger		$A_{proj} = \sqrt{L^2 + W^2} \cdot H$

Figure 9-1 External projected area examples for common pressure equipment.

[…]

9.7.9.3.1 […]

$$L_{eq} = \frac{0.2146 d^5 (P_0^2 - P_2^2)}{f_{ff} C_{rc}^2} - \frac{d \times \ln(\frac{P_0}{P_2})}{6 f_{ff}} \quad \text{(9-10a [I-P])}$$

$$L_{eq} = \frac{7.4381 \times 10^{-15} d^5 (P_0^2 - P_2^2)}{f_{ff} C_{rc}^2} - \frac{d \times \ln(\frac{P_0}{P_2})}{500 f_{ff}} \quad \text{(9-10b [SI])}$$

where
L_{eq} = equivalent length of discharge *piping*, ft (m)
C_{rc} = rated capacity as stamped on the *pressure relief device* in lb/min (kg/s), or in standard cubic feet per minute multiplied by 0.0764, or as calculated in Section 9.7.7 for a *rupture member* or *fusible plug*, or as adjusted for reduced capacity due to *piping* as *specified* by the *manufacturer* of the device, or as adjusted for reduced capacity due to *piping* as estimated by an *approved* method
f_{ff} = Moody friction factor in fully turbulent flow (***Informative Note:*** See typical values in Informative Appendix D.)
d = inside diameter of pipe or tube, in. (mm)
~~ln = natural logarithm~~
P_2 = absolute pressure at outlet of discharge *piping*, psia (kPa)
P_0 = allowed *back pressure* (absolute) at the outlet of *pressure relief device* (see Section 9.7.9.3.2), psia (kPa)

9.7.9.3.2 Unless the maximum allowable *back pressure* (P_0), psia (kPa), is *specified* by the relief valve *manufacturer*, the following maximum allowable *back pressure* values *shall* be used for P_0, where P_{set} is the *set pressure* and P_a is atmospheric pressure at the nominal elevation of the installation (Informative Table 9-7):

a. For conventional relief valves: 15% of *set pressure*

$$P_0 = (0.15 \times P_{set}) + P_a \quad \text{(9-11)}$$

b. For *balanced relief valves*: 25% of *set pressure*

$$P_0 = (0.25 \times P_{set}) + P_a \quad \text{(9-12)}$$

c. For rupture disks alone, *fusible plugs*, or pilot-operated *pressure relief devices*: 50% of *set pressure*

$$P_0 = (0.5 \times P_{set}) + P_a \quad \text{(9-13)}$$

For *fusible plugs*, P_{set} *shall* be the ~~absolute~~ *saturation pressure* (gage) corresponding to the stamped melting temperature of the *fusible plug* or the *critical pressure* (gage) of the applicable *refrigerant designation*, whichever is smaller, psi~~a~~g (kPa gage).

[…]

Table 9-12 Shaft Ventilation Velocity

Shaft Cross-Sectional Area, A_{shaft}		Minimum Ventilation Velocity, V	
in.²	**m²**	**ft/min**	**m/min**
$A_{shaft} \leq 20$	$A_{shaft} \leq 0.0129$	$100 \leq V$	$30.5 \leq V$
$20 < A_{shaft} \leq 250$	$0.0129 < A_{shaft} \leq 0.161$	$200 \leq V$	$61 \leq V$
$250 < A_{shaft} \leq 1250$	$0.161 < A_{shaft} \leq 0.806$	$300 \leq V$	$91 \leq V$
$1250 < A_{shaft}$	$0.806 < A_{shaft}$	$400 \leq V$	$122 \leq V$

[…]

Table 9-13 Duration of Leak Test

	Pipe Length, L_p		Maximum Nominal Pipe Size		Minimum Period of Test
Leak Test	**ft**	**m**	**NPS, in.**	**DN, mm**	**hours**
Pressure test	$L_p \leq 100$	$L_p \leq 30$	NPS ≤ 3/4	DN ≤ 20	0.25
			3/4 < NPS ≤ 3	20 < DN ≤ 75	1.0
			3 < NPS	75 < DN	24
	$100 < L_p \leq 200$	$30 < L_p \leq 61$	NPS ≤ 3	DN ≤ 75	1.0
			3 < NPS	75 < DN	24
	$200 < L_p$	$61 < L_p$	Any	Any	24
Vacuum test	$L_p \leq 100$	$L_p \leq 30$	NPS ≤ 3/4	DN ≤ 20	1.0
			3/4 < NPS ≤ 3	20 < DN ≤ 75	8.0
			3 < NPS	75 < DN	24
	$100 < L_p \leq 200$	$30 < L_p \leq 61$	NPS ≤ 3	DN ≤ 75	8.0
			3 < NPS	75 < DN	24
	$200 < L_p$	$61 < L_p$	Any	Any	24

Informative Note: The maximum nominal pipe size is the largest interconnecting field *piping* installed.

[…]

Modify Informative Appendix C as follows. The remainder of Informative Appendix C remains unchanged.

INFORMATIVE APPENDIX C
METHOD FOR CALCULATING DISCHARGE CAPACITY OF POSITIVE DISPLACEMENT COMPRESSOR PRESSURE RELIEF DEVICE

{Note to reviewers: Addendum o revises Informative Appendix C but those changes are not reflected here, the revisions proposed in Addendum q would be merged with the other changes in Addendum o.}

[...]

$$W_{\cancel{v}r} = \frac{Q_{comp} \times \cancel{PL}PL \times \eta_v}{v_g} \quad \text{(C-1)}$$

where
W_r = mass flow of *refrigerant*, lb/min (kg/s)
Q_{comp} = swept volume flow rate of *compressor*, ft^3/min (m^3/s)
~~PL~~*PL* = fraction of *compressor* capacity at minimum regulated flow
η_v = volumetric efficiency (assume 0.9 unless actual volumetric efficiency at *relieving pressure* is known)
v_g = specific volume of *refrigerant* vapor as *specified* in Section 9.8, ft^3/lb (m^3/kg)

Next, find the relieving capacity in mass flow of air W_a for an ASME-rated [15] *pressure relief device*:

$$W_a = W_r \times r_{\cancel{w}comp} \quad \text{(C-2)}$$

$$r_{\cancel{w}comp} = \frac{C_a}{C_r}\sqrt{\frac{T_{\cancel{r}comp}}{T_a}}\sqrt{\frac{M_a}{M_r}} \quad \text{(C-3)}$$

where
W_a = relieving capacity in mass flow of air for an ASME-rated *pressure relief device*, lb/min (kg/s)
W_r = mass flow of *refrigerant*, lb/min (kg/s)
$r_{\cancel{w}comp}$ = *refrigerant*-to-~~standard~~ air-mass-flow conversion factor, dimensionless (see Table C-1)
M_a = *relative molar mass* of air, 29.0, dimensionless
M_r = *relative molar mass* of the *refrigerant*, dimensionless (see Table C-1)
T_a = absolute temperature of the air = 520°R (289 K)
$T_{\cancel{r}comp}$ = absolute temperature of the *refrigerant* = 510°R (283 K)
C_a = constant for air = 356
C_r = constant for *refrigerant* as determined from Equation 9-8 (see also Equation C-4)

$$C_r = 520\sqrt{k_{comp}\left(\frac{2}{k_{comp}+1}\right)^{\frac{k_{comp}+1}{k_{comp}-1}}} \quad \text{(C-4)}$$

where
k_{comp} = ratio of specific heats (C_p/C_v), dimensionless
C_p = constant-pressure specific heat of *refrigerant* at a *refrigerant* quality of 1 at 50°F (10°C), Btu/[lb·°R] (J/[kg·K])
C_v = constant-volume specific heat of *refrigerant* at a *refrigerant* quality of 1 at 50°F (10°C), Btu/[lb·°R] (J/[kg·K])

Constants for several *refrigerants* are listed in Table C-1.

Example

Determine the flow capacity of a *pressure relief device* for a R-410A *compressor* with a swept volume (Q_{comp}) of 341 ft³/min (0.1609 m³/s). The *compressor* is equipped with capacity control that is actuated at 90% of the *pressure relief device set pressure* and has a minimum regulated flow of 10%.

Q_{comp} = 341 ft³/min

Q_{comp} = 0.16095 m³/s

η_v = 0.90, assumed

~~PL~~ PL = 0.1

[…]

$$W_a = W_r \times r_{\cancel{w}comp} = 25.62 \times 0.62 = 15.88\ \frac{\text{lb}}{\text{min}}\ \text{of air} \qquad \text{(I-P [see C-2])}$$

$$W_a = W_r \times r_{\cancel{w}comp} = 0.1936 \times 0.62 = 0.12\ \frac{\text{kg}}{\text{s}}\ \text{of air} \qquad \text{(SI [see C-2])}$$

[…]

Table C-1 Constants for Calculating Discharge Capacity

Refrigerant	k_{comp} [a]	Relative Molar Mass	C_r	$r_{\cancel{w}comp}$
R-11	1.137	137.4	330.7	0.49
R-12	1.205	120.9	337.7	0.51
R-13	2.053	104.5	403.6	0.46
R-22	1.319	86.5	348.8	0.59
R-23	2.742	70.0	439.3	0.52
R-113	1.081	187.4	324.7	0.43
R-114	1.094	170.9	326.1	0.45
R-123	1.104	153.0	327.1	0.47
R-134a	1.196	102.0	336.8	0.56
R-236fa	1.101	152.0	326.8	0.47
R-245fa	1.107	134.0	327.5	0.50
R-290	1.235	44.0	340.8	0.84
R-404A	1.279	97.6	345.0	0.56
R-407C	1.270	86.2	344.1	0.59
R-410A	1.434	72.6	359.0	0.62
R-500	1.236	99.3	340.8	0.56
R-502	1.264	112.0	343.6	0.52

R-507A	1.284	98.9	345.5	0.55
R-600	1.122	58.1	329.2	0.76
R-718	1.328	18.0	349.6	1.28
R-744	2.690	44.0	437.0	0.65

a. Source: NIST REFPROP, Standard Reference Database, v9.1, 2013 [67]

Modify Informative Appendix D as follows. The remainder of Informative Appendix D remains unchanged.

INFORMATIVE APPENDIX D
TYPICAL MOODY FRICTION FACTORS FOR USE IN RELIEF PIPING LINE LENGTH LIMIT

Table D-1 Typical Moody Friction Factors (~~f~~ f_{ff}) for Fully Turbulent Flow

[...]

Add new Informative Appendix H as follows.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX H

Table H-1 ASHRAE Standard 15 Symbols

Symbol	Description	Units	Sections Appearing
A_{proj}	projected area of the *pressure vessel* or protected equipment (per Section 9.7.5.6 or 9.7.5.7)	ft^2 (m^2)	9.7.5.1, 9.7.5.3, 9.7.5.6, 9.7.5.7, Figure 9-1
A_{room}	area of the individual room	ft^2 (m^2)	7.2.3.2.1, 7.2.3.2.2
A_{shaft}	Shaft Cross-Sectional Area	in.^{2} (m^2)	Table 9-12
A_{vent}	minimum area of a permanent opening	ft^2 (m^2)	7.2.3.2.1, 7.2.3.2.2
C_a	constant for air = 356	dimensionless	9.7.5.5, Appendix C
CF	Concentration factor	dimensionless	7.6.1.1
C_{LFL}	*lower flammability limit* conversion factor as determined from Table 7-5	dimensionless	7.6.4
C_p	constant-pressure specific heat of *refrigerant* at a *refrigerant* quality of 1 at 50°F (10°C)	Btu/[lb·°R] (J/[kg·K])	Appendix C
C_r	constant for *refrigerant* as determined from Equation 9-8 (see also C-4)	dimensionless	9.7.5.5, Appendix C, Table C-1
C_{rc}	rated capacity as stamped on the *pressure relief device* in lb/min (kg/s), or in standard cubic feet per minute multiplied by 0.0764, or as calculated in Section 9.7.7 for a *rupture member* or *fusible plug*, or as adjusted for reduced capacity due to *piping* as *specified* by the *manufacturer* of the device, or as adjusted for reduced capacity due to *piping* as estimated by an *approved* method	lb/min (kg/s)	9.7.9.3.1
C_{rd}	discharge capacity expressed as mass flow of air	lb/min (kg/s)	9.7.7
C_{req}	minimum required relief device capacity expressed as mass flow of air	lb/min (kg/s)	9.7.5.1
C_v	constant-volume specific heat of *refrigerant* at a *refrigerant* quality of 1 at 50°F (10°C)	Btu/[lb·°R] (J/[kg·K])	Appendix C
D	diameter	ft (m)	Figure 9-1
d	inside diameter of pipe or tube	in. (mm)	9.7.9.3.1
d_{min}	smallest of the internal diameter of the inlet pipe, retaining flanges, *fusible plug*, and *rupture member*	in. (mm)	9.7.7
DP	*design pressure* (gage) of the *refrigeration system high side*	psi (MPa)	Table 8-2
$EDVC$	*effective dispersal volume charge*	lb (kg)	7.3.1, 7.6.1.1, 7.6.1.2, 7.6.4
F	the free opening area	ft^2 (m^2)	8.12

Table H-1 ASHRAE Standard 15 Symbols *[Continued]*

Symbol	**Description**	**Units**	**Sections Appearing**
f	pressure relief capacity factor (per Section 9.7.5.4 or, as applicable, per Section 9.7.5.5) that is dependent on type of *refrigerant* and relief device *relieving pressure*	lb/[ft^2·min] (kg/[m^2·s])	9.7.5.1, 9.7.5.4, 9.7.5.5, Table 9-1, Table 9-2, Table 9-3, Table 9-4, Table 9-5, Table 9-6
f_{ff}	Moody friction factor in fully turbulent flow	dimensionless	9.7.9.3.1, Table D-1
F_{LFL}	*LFL* conversion factor	dimensionless	7.6.1.2
F_{occ}	occupancy adjustment factor	dimensionless	7.3.1, 7.6.1.1, 7.6.1.2
G	mass of *refrigerant* in the largest *refrigeration system* (*independent circuit*), any part of which is located in the *machinery room*	lb (kg)	8.9.8.2, Table 8-2, 8.12
G'	a threshold value where the airflow requirement changes	lb (kg)	Table 8-2
H	height	ft (m)	Figure 9-1
h_{fg}	*refrigerant* latent heat of vaporization evaluated at the *relieving pressure*	Btu/lb (kJ/kg)	9.7.5.4
H_{flux}	heat flux from a thermal energy source originating from an external source or internal source in accordance with Section 9.7.5.6 and 9.7.5.7, respectively	Btu/[ft^2·min] (kW/m^2)	9.7.5.4, 9.7.5.5, 9.7.5.6, 9.7.5.7
k	ratio of specific heats (C_p/C_v) for saturated *refrigerant* vapor evaluated at the *relieving pressure*	dimensionless	9.7.5.5
k_{comp}	ratio of specific heats (C_p/C_v)	dimensionless	Appendix C, Table C-1
L	length	ft (m)	Figure 9-1
L_{eq}	equivalent length of discharge *piping*	ft (m)	9.7.9.3.1
LFL	*lower flammability limit*	lb/1000 ft^3 (g/m^3)	7.2.3.2.2, 7.5.1.2, 7.5.3, 7.6.1.1, 7.6.1.2, 7.6.4, 7.7.1, 7.7.3.3, 7.8
$LFL_{R\text{-}32}$	*lower flammability limit of R-32*	lb/1000 ft^3 (g/m^3)	7.6.1.2
L_p	Pipe Length	ft (m)	Table 9-13
M_a	relative molar mass of air, 29.0	dimensionless	7.2.3.2.1, 7.2.3.2.2, 9.7.5.5, Appendix C
M_{def}	*refrigerant* charge from Table 7-1 or Table 7-2	lb (kg)	7.6.1.2
M_r	relative molar mass of the *refrigerant*	dimensionless	7.2.3.2.1, 7.2.3.2.2, 9.7.5.5, Appendix C, Table C-1
m_{r2}	leakage between the detection of the leak and the closing of the *safety shutoff valve*	lb (kg)	7.3.4.3
m_{r3}	leakage in the *piping* downstream of the *safety shutoff valve* after the valve is closed	lb (kg)	7.3.4.3
m_{rel}	*releasable refrigerant charge*	lb (kg)	7.2.3.2.1, 7.2.3.2.2 7.3.4.3

Table H-1 ASHRAE Standard 15 Symbols *[Continued]*

Symbol	Description	Units	Sections Appearing
m_{room}	allowable *refrigerant charge* of an individual room	lb (kg)	7.2.3.2.1, 7.2.3.2.2
m_s	*system refrigerant charge*	lb (kg)	7.5.1.2, 7.6.4, 9.4.4
P_0	allowed *back pressure* (absolute) at the outlet of *pressure relief device* (see Section 9.7.9.3.2)	psia (kPa)	9.7.9.3.1, 9.7.9.3.2
P_1	for *rupture members*, P_1 = [rated gage pressure x 1.1] + 14.7, psia, P_1 = [rated gage pressure x 1.1] + 101.3, kPa for fusible plugs, P_1 = absolute *saturation pressure* corresponding to the stamped melting temperature of the *fusible plug* or the *critical pressure* of the applicable *refrigerant designation*, whichever is smaller	psia (kPa)	9.7.7
P_2	absolute pressure at outlet of discharge *piping*	psia (kPa)	9.7.9.3.1
P_a	atmospheric pressure at the nominal elevation of the installation (see Informative Table 9-7)	psia (kPa)	9.7.9.3.2, Table 9-7
P_b	*superimposed back pressure* standing at the outlet of the *pressure relief device*	psig (kPa gage)	9.7.5.2.2
P_{bp}	*bubble point* absolute pressure corresponding to the stamped melting temperature on the *fusible plug* for the applicable *refrigerant designation*	psia (kPa)	9.7.5.2.3
PL	fraction of *compressor* capacity at minimum regulated flow	dimensionless	Appendix C
P_r	*relieving pressure*	psig (kPa gage)	9.7.5.2.1, 9.7.5.2.2, 9.7.5.2.3
P_{ref}	*refrigerant* pressure (absolute)	psia (MPa)	Table 8-2
P_s	*pressure relief device set pressure*, which is equal to the vessel's *design pressure*	psig (kPa gage)	9.7.5.2.1, 9.7.5.2.2
P_{set}	*set pressure*	psig (kPa gage)	9.7.9.3.2
Q	airflow	ft^3/min (m^3/s)	8.9.8.2, Table 8-2
Q'	an airflow rate independent of charge quantity	ft^3/min (m^3/s)	Table 8-2
Q_1	Level 1 Ventilation in accordance with Section 8.11.11.2	ft^3/min (m^3/s)	Table 8-2
Q_{comp}	swept volume flow rate of *compressor*	ft^3/min (m^3/s)	Appendix C
Q_{min}	minimum mechanical ventilation airflow rate	ft^3/min (m^3/h)	7.6.4
Q_{req}	required ventilation as determined from Table 7-4	ft^3/min (m^3/h)	7.6.4
RCL	*refrigerant concentration limit*	lb/1000 ft^3 (g/m^3)	7.2.3.2.1, 7.3.1
r_{comp}	*refrigerant*-to-air-mass-flow conversion factor (see Table C-1)	dimensionless	Appendix C, Table C-1
r_w	*refrigerant* to air mass flow rate conversion factor	dimensionless	9.7.5.5
SF_{vent}	safety factor, value of 2	dimensionless	7.6.4
T_a	absolute temperature of the air = 520°R (289 K)	°R (K)	9.7.5.5, Appendix C
t_{close}	time from when a leak is detected until the *safety shutoff valve* closes	s	7.3.4.3
T_{comp}	absolute temperature of the *refrigerant* = 510°R (283 K)	°R (K)	Appendix C
T_r	absolute dew-point temperature of *refrigerant* evaluated at the *relieving pressure*	°R (K)	9.7.5.5
t_{r1}	time before leak is detected per Section 7.6.2.4	s	7.3.4.3
V	Minimum Ventilation Velocity	ft/min (m/min)	Table 9-12
V_1	*low-side* volume	ft^3 (m^3)	9.4.4

Table H-1 ASHRAE Standard 15 Symbols *[Continued]*

Symbol	**Description**	**Units**	**Sections Appearing**
V_2	total volume of the *refrigeration system*	ft^3 (m^3)	9.4.4
V_a	specific volume of air = 13.1 ft^3/lb (0.818 m^3/kg) for dry air at 60°F (15.6°C)	ft^3/lb (m^3/kg)	Appendix C
V_{eff}	*effective dispersal volume*	ft^3 (m^3)	7.3.1, 7.6.1.1
V_{gt}	specific volume of *refrigerant* vapor at 110°F (43.5°C)	ft^3/lb (m^3/kg)	9.4.4
V_{gc}	specific volume at *critical temperature* and *critical pressure*	ft^3/lb (m^3/kg)	9.4.4
V_{pipe}	internal volume of each section of the *piping* and *heat exchanger coil* downstream of the *safety shutoff valve*	ft^3 (m^3)	7.3.4.3
W	width	ft (m)	Figure 9-1
W_a	relieving capacity in mass flow of air for an ASME-rated *pressure relief device*	lb/min (kg/s)	Appendix C
W_r	mass flow of *refrigerant*	lb/min (kg/s)	Appendix C
η_v	volumetric efficiency (assume 0.9 unless actual volumetric efficiency at *relieving pressure* is known)	dimensionless	Appendix C
v_g	specific volume of *refrigerant* vapor as *specified* in Section 9.8	ft^3/lb (m^3/kg)	Appendix C
ρ_{ref}	density of the *refrigerant* in each section of pipe downstream of the *safety shutoff valve*	lb/ft^3 (kg/m^3)	7.3.4.3