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ADDENDA

ANSI/ASHRAE Addendum a to
ANSI/ASHRAE Standard 15-2019

Safety Standard for Refrigeration Systems

Approved by the ASHRAE Standards Committee on February 1, 2020; by the ASHRAE Board of Directors on February 5, 2020; and by the American National Standards Institute on February 6, 2020.

This addendum was approved by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

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FOREWORD

This addendum provides capacity factors for overpressure protection of pressure vessels and pressure equipment for a number of new refrigerants and expands the coverage of capacity factors for existing refrigerants based on the design pressure for the portion of the system being pressure protected. Because the capacity factors are now dependent on the equipment's design pressure, there will be cases where the revised capacity factors are larger than individual values for grouped refrigerants provided in previous editions to this standard. Such cases will not necessarily dictate a larger relief valve for a given piece of equipment, because many pressure vessels will have a relief device that has a modestly larger capacity compared to the calculated minimum required relief capacity for the pressure vessel. In addition, this addendum introduces a method for calculating pressure relief capacity factors for refrigerants not included in the standard or for design pressures for current refrigerants that are outside of the ranges of pressures listed in the pressure relief capacity factor tables.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum a to Standard 15-2019

Replace Section 9.7.5 as shown.

~~**9.7.5** The minimum required discharge capacity of the *pressure relief device* or *fusible plug* for each *pressure vessel shall* be determined by the following formula:~~

~~$C = fDL$~~

~~where~~

~~C = minimum required discharge capacity of the *pressure relief device* expressed as mass flow of air, lb/min (kg/s)~~

~~D = outside diameter of vessel, ft (m)~~

~~L = length of vessel, ft (m)~~

~~f = factor dependent upon type of *refrigerant* (see Table 9-1)~~

~~***Informative Notes:***~~

~~1. When combustible materials are used within 20 ft (6.1 m) of a *pressure vessel*, multiply the value of *f* by 2.5.~~

~~2. The formula is based on fire conditions. Other heat sources *shall* be calculated separately.~~

~~When one *pressure relief device* or *fusible plug* is used to protect more than one *pressure vessel*, the required capacity *shall* be the sum of the capacities required for each *pressure vessel*.~~

9.7.5 The minimum required discharge capacity (*C*) of the *pressure relief device* or *fusible plug* for each *pressure vessel* shall be determined using the methods in this section.

The minimum required discharge capacity (*C*) shall be the largest value determined by consideration of potential thermal exposure from both external heat sources in accordance with Section 9.7.5.1 and internal heat sources in accordance with Section 9.7.5.2, with each case calculated using Equation 9-AA. The calculated value of the minimum required relief device discharge capacity shall be rounded up to not less than two (2) significant figures.

When one *pressure relief device* or *fusible plug* is used to protect more than one *pressure vessel*, the required capacity shall be the sum of the capacities required for each *pressure vessel*.

The *pressure relief device* set pressure shall be in accordance with Section 9.5, and the relieving pressure for calculations in this section shall be 1.1 times the relief device set pressure.

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~~**Table 9-1 *Pressure Relief Devices* Capacity Factor**~~

~~***Refrigerant***~~	~~**Value of *f***~~
~~**When Used on the *Lowside* of a Limited-Charge *Cascade System***~~	
~~R-23, R-170, R-744, R-1150, R-508A, R-508B~~	~~1.0 (0.082)~~
~~R-13, R-13B1, R-503~~	~~2.0 (0.163)~~
~~R-14~~	~~2.5 (0.203)~~
~~**Other Applications**~~	
~~R-718~~	~~0.2 (0.016)~~
~~R-11, R-32, R-113, R-123, R-142b, R-152a, R-290, R-600, R-600a, R-764~~	~~1.0 (0.082)~~
~~R-12, R-22, R-114, R-124, R-134a, R-401A, R-401B, R-401C, R-405A, R-406A, R-407C, R-407D, R-407E, R-409A, R-409B, R-411A, R-411B, R-411C, R-412A, R-414A, R-414B, R-500, R-1270~~	~~1.6 (0.131)~~
~~R-143a, R-402B, R-403A, R-407A, R-408A, R-413A~~	~~2.0 (0.163)~~
~~R-115, R-402A, R-403B, R-404A, R-407B, R-410A, R-410B, R-502, R-507A, R-509A~~	~~2.5 (0.203)~~

When the relieving pressure exceeds 90% of the refrigerant's *critical pressure*, an engineering analysis shall determine the value of the pressure relief capacity factor (*f*)

$$C = f \times A \qquad \text{(9-AA)}$$

where

C = minimum required discharge capacity of the relief device expressed as mass flow of air, lb/min (kg/s)

f = pressure relief capacity factor that is dependent on type of refrigerant and vessel design pressure or protected equipment, lb/[ft^2·min] (kg/[m^2·s])

A = area of the pressure vessel or protected equipment (per Section 9.7.5.1 or 9.7.5.2), ft^2 (m^2)

Tables 9-1 through 9-6 provide values of pressure relief device capacity factors (*f*) for specific refrigerants and *pressure vessel* design pressures calculated in accordance with this section. The tables are arranged according to the *refrigerant designation* and the *design pressure* of the *pressure vessel* or protected equipment. Linear interpolation shall be used for determining capacity factors for intermediate *design pressure* values between tabulated values. Capacity factor values from Tables 9-1 through 9-6 shall not be extrapolated. Capacity factor values for other refrigerants or *design pressures* outside the range of the tables shall be calculated per the method in this section.

The area (*A*) shall be calculated in accordance with Section 9.7.5.1 and Section 9.7.5.2. The capacity factor (*f*) shall be calculated using Equation 9-BB when the relieving pressure of the vessel does not exceed 90% of the refrigerant *critical pressure*.

$$f = \frac{H}{h_{fg}} \times r_w \qquad \text{(9-BB)}$$

where

H = the heat flux from a thermal energy source originating from an external source or internal source in accordance with Sections 9.7.5.1 and 9.7.5.2, respectively, Btu/[ft^2·min] (kW/m^2)

h_{fg} = the refrigerant's latent heat of vaporization evaluated at the relieving pressure (1.1 times the component *design pressure*), Btu/lb (kJ/kg)

r_w = refrigerant to air mass flow rate conversion factor, dimensionless

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

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

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

where

C_a = 356, a dimensionless constant for air

T_r = the absolute dew-point temperature of refrigerant evaluated at a relieving pressure of 1.1 times the relief device set pressure, °R (K)

T_a = the absolute temperature of standard air, 520°R (289 K)

M_r = the relative molar mass of the refrigerant in accordance with ASHRAE Standard 34[1]

M_a = the relative molar mass of air, 28.97

k = the ratio of specific heats (c_p / c_v) for saturated refrigerant vapor evaluated at a relieving pressure of 1.1 times the relief device set pressure

9.7.5.1 External Heat Sources. The area (A) 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) shall be not less than 150 Btu/[min·ft^2] (28.4 kW/m^2). Where combustible materials are within 20 ft (6.1 m) of a pressure vessel, the value of heat flux (H) shall be not less than 375 Btu/[min·ft^2] (71.0 kW/m^2). Where a heat source other than an external fire has potential to generate a larger heat flux (H) 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.

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

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Table 9-1 Relief Device Refrigerant Capacity Factors, *f*, lb/[ft^2·min] (I-P)

***Design Pressure* (psi, gage)**								
Refrigerant	**50**	**100**	**150**	**200**	**300**	**400**	**500**	**600**
R12	1.24	1.38	1.51	1.64	1.91	2.3	—	—
R22	0.98	1.09	1.18	1.26	1.43	1.62	1.88	—
R23	0.95	1.05	1.13	1.21	1.38	1.56	1.84	—
R32	0.73	0.80	0.86	0.91	1.02	1.13	1.26	1.45
R115	1.48	1.69	1.89	2.2	2.7	—	—	—
R134a	1.05	1.18	1.29	1.40	1.65	1.97	—	—
R143a	1.05	1.18	1.30	1.42	1.69	2.1	—	—
R152a	0.84	0.94	1.02	1.10	1.27	1.47	1.79	—
R170	0.70	0.77	0.83	0.89	1.01	1.14	1.33	—
R290	0.78	0.87	0.95	1.03	1.20	1.41	—	—
R401A	1.01	1.12	1.22	1.31	1.51	1.75	2.2	—
R401B	1.00	1.11	1.21	1.30	1.49	1.72	2.1	—
R401C	1.04	1.16	1.27	1.37	1.60	1.88	2.5	—
R402A	1.11	1.25	1.36	1.48	1.73	2.1	—	—
R402B	1.06	1.18	1.28	1.39	1.60	1.86	2.3	—
R403A	1.05	1.18	1.28	1.38	1.60	1.86	2.4	—
R403B	1.16	1.30	1.42	1.55	1.82	2.2	—	—
R404A	1.12	1.26	1.38	1.51	1.80	2.3	—	—
R405A	1.10	1.22	1.34	1.45	1.70	2.1	—	—
R406A	0.98	1.09	1.19	1.28	1.47	1.70	2.1	—
R407A	0.98	1.09	1.19	1.28	1.48	1.72	2.2	—
R407B	1.08	1.21	1.33	1.44	1.69	2.1	—	—
R407C	0.95	1.05	1.15	1.23	1.41	1.63	1.99	—
R407D	0.97	1.08	1.18	1.27	1.46	1.71	2.2	—
R407E	0.93	1.03	1.12	1.20	1.38	1.58	1.90	—
R407F	0.93	1.03	1.12	1.20	1.37	1.58	1.89	—
R407G	1.03	1.15	1.26	1.37	1.60	1.90	—	—
R407H	0.91	1.00	1.09	1.16	1.33	1.51	1.79	—
R408A	1.03	1.15	1.25	1.36	1.57	1.84	—	—
R409A	1.02	1.13	1.23	1.32	1.52	1.75	2.2	—
R409B	1.02	1.13	1.23	1.32	1.51	1.74	2.1	—
R410A	0.90	0.99	1.07	1.15	1.31	1.48	1.74	—
R410B	0.92	1.02	1.10	1.18	1.35	1.54	1.82	—
R411A	0.95	1.05	1.14	1.22	1.39	1.58	1.84	—
R411B	0.97	1.07	1.16	1.24	1.41	1.60	1.86	—
R412A	1.00	1.10	1.20	1.28	1.47	1.68	1.99	—

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Table 9-1 Relief Device Refrigerant Capacity Factors, *f*, lb/[ft^2·min] (I-P) *(Continued)*

Design Pressure **(psi, gage)**								
Refrigerant	**50**	**100**	**150**	**200**	**300**	**400**	**500**	**600**
R413A	1.07	1.20	1.32	1.44	1.71	2.1	—	—
R414A	1.03	1.14	1.25	1.34	1.55	1.81	2.3	—
R414B	1.05	1.17	1.27	1.37	1.58	1.85	2.3	—
R415A	0.94	1.04	1.13	1.21	1.38	1.57	1.83	—
R415B	0.87	0.96	1.05	1.13	1.29	1.49	1.79	—
R416A	1.11	1.25	1.37	1.49	1.77	2.2	—	—
R417A	1.10	1.24	1.36	1.49	1.77	2.2	—	—
R417B	1.17	1.32	1.45	1.59	1.90	2.4	—	—
R417C	1.06	1.19	1.31	1.43	1.69	2.1	—	—
R418A	0.97	1.08	1.17	1.25	1.42	1.61	1.87	—
R419A	1.11	1.24	1.37	1.49	1.76	2.2	—	—
R419B	1.07	1.20	1.32	1.43	1.68	2.1	—	—
R420A	1.05	1.18	1.29	1.40	1.64	1.97	—	—
R421A	1.12	1.26	1.39	1.51	1.80	2.3	—	—
R421B	1.19	1.34	1.48	1.61	1.93	2.5	—	—
R422A	1.19	1.34	1.48	1.62	1.95	2.5	—	—
R422B	1.11	1.26	1.38	1.51	1.80	2.3	—	—
R422C	1.16	1.31	1.45	1.59	1.91	2.5	—	—
R422D	1.14	1.28	1.41	1.54	1.85	2.3	—	—
R422E	1.12	1.26	1.39	1.52	1.81	2.3	—	—
R423A	1.19	1.35	1.50	1.65	1.99	2.6	—	—
R424A	1.11	1.24	1.37	1.49	1.78	2.2	—	—
R425A	0.97	1.07	1.17	1.26	1.45	1.69	2.1	—
R426A	1.05	1.18	1.30	1.41	1.66	2.00	—	—
R427A	0.99	1.10	1.20	1.29	1.50	1.75	2.3	—
R428A	1.18	1.33	1.47	1.61	1.93	2.5	—	—
R429A	0.77	0.86	0.93	1.00	1.15	1.33	1.60	—
R430A	0.87	0.98	1.07	1.16	1.36	1.62	—	—
R431A	0.81	0.91	0.99	1.07	1.25	1.48	—	—
R432A	0.74	0.82	0.89	0.96	1.10	1.27	1.51	—
R433A	0.77	0.86	0.94	1.01	1.18	1.38	1.75	—
R433B	0.78	0.87	0.95	1.03	1.19	1.41	—	—
R433C	0.77	0.86	0.94	1.02	1.18	1.38	1.76	—
R434A	1.14	1.29	1.42	1.55	1.86	2.4	—	—
R435A	0.74	0.82	0.88	0.95	1.08	1.22	1.40	1.77
R436A	0.79	0.88	0.96	1.05	1.23	1.48	—	—

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Table 9-1 Relief Device Refrigerant Capacity Factors, *f*, lb/[ft^2·min] (I-P) *(Continued)*

***Design Pressure* (psi, gage)**

Refrigerant	50	100	150	200	300	400	500	600
R436B	0.79	0.88	0.97	1.05	1.24	1.49	—	—
R437A	1.06	1.19	1.31	1.43	1.68	2.1	—	—
R438A	1.04	1.17	1.28	1.38	1.62	1.93	—	—
R439A	0.90	0.99	1.08	1.15	1.31	1.50	1.77	—
R440A	0.84	0.94	1.02	1.10	1.27	1.47	1.80	—
R441A	0.73	0.82	0.89	0.96	1.12	1.33	1.71	—
R442A	0.93	1.03	1.12	1.20	1.38	1.58	1.90	—
R443A	0.76	0.85	0.92	1.00	1.15	1.34	1.67	—
R444A	1.00	1.11	1.22	1.32	1.54	1.83	2.4	—
R444B	0.87	0.96	1.04	1.11	1.26	1.43	1.66	2.1
R445A	0.95	1.06	1.16	1.26	1.46	1.73	2.3	—
R446A	0.81	0.89	0.96	1.02	1.15	1.29	1.46	1.73
R447A	0.82	0.90	0.97	1.03	1.16	1.29	1.47	1.74
R447B	0.82	0.90	0.97	1.03	1.16	1.30	1.48	1.76
R448A	0.97	1.08	1.18	1.27	1.46	1.70	2.1	—
R449A	0.98	1.09	1.19	1.28	1.48	1.73	2.2	—
R449B	0.97	1.08	1.18	1.27	1.46	1.70	2.2	—
R449C	1.00	1.11	1.21	1.31	1.52	1.79	2.4	—
R450A	1.10	1.24	1.36	1.49	1.77	2.2	—	—
R451A	1.19	1.35	1.50	1.65	2.1	—	—	—
R451B	1.19	1.35	1.50	1.65	2.1	—	—	—
R452A	1.11	1.24	1.36	1.48	1.74	2.2	—	—
R452B	0.83	0.92	0.99	1.06	1.20	1.35	1.55	1.96
R452C	1.10	1.23	1.35	1.46	1.72	2.1	—	—
R453A	0.97	1.07	1.17	1.26	1.45	1.69	2.1	—
R454A	0.96	1.07	1.16	1.25	1.44	1.68	2.1	—
R454B	0.83	0.91	0.99	1.05	1.19	1.34	1.54	1.92
R454C	1.02	1.14	1.24	1.35	1.57	1.88	—	—
R455A	0.98	1.09	1.19	1.28	1.48	1.74	2.2	—
R456A	1.04	1.16	1.27	1.38	1.62	1.94	—	—
R457A	1.00	1.11	1.22	1.32	1.53	1.83	—	—
R458A	0.96	1.07	1.17	1.26	1.45	1.68	2.1	—
R459A	0.83	0.91	0.99	1.05	1.19	1.33	1.53	1.90
R459B	1.02	1.14	1.24	1.34	1.57	1.87	2.6	—
R460A	1.05	1.17	1.28	1.38	1.61	1.91	2.6	—
R460B	0.95	1.05	1.14	1.22	1.40	1.61	1.93	—

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Table 9-1 Relief Device Refrigerant Capacity Factors, *f*, lb/[ft^2·min] (I-P) *(Continued)*

Design Pressure **(psi, gage)**								
Refrigerant	**50**	**100**	**150**	**200**	**300**	**400**	**500**	**600**
R500	1.11	1.24	1.35	1.47	1.71	2.1	—	—
R501	1.04	1.15	1.25	1.34	1.53	1.75	2.1	—
R502	1.20	1.34	1.47	1.60	1.87	2.3	—	—
R503	1.14	1.27	1.38	1.49	1.72	2.00	—	—
R504	0.99	1.10	1.20	1.29	1.48	1.72	2.2	—
R507A	1.13	1.27	1.40	1.53	1.83	2.3	—	—
R508A	1.25	1.41	1.55	1.69	2.1	2.6	—	—
R508B	1.21	1.36	1.49	1.62	1.91	2.4	—	—
R509A	1.29	1.46	1.62	1.77	2.2	2.8	—	—
R510A	0.73	0.81	0.88	0.94	1.07	1.22	1.41	—
R511A	0.77	0.87	0.95	1.02	1.19	1.40	—	—
R512A	0.85	0.95	1.03	1.11	1.28	1.49	1.82	—
R513A	1.14	1.29	1.42	1.56	1.87	2.4	—	—
R513B	1.14	1.29	1.43	1.57	1.88	2.4	—	—
R515A	1.16	1.32	1.46	1.60	1.94	2.5	—	—
R1150	0.69	0.76	0.81	0.87	0.98	1.10	1.27	—
R1234yf	1.21	1.37	1.53	1.69	2.1	—	—	—
R1234ze(E)	1.14	1.29	1.42	1.56	1.87	2.4	—	—
R1270	0.75	0.84	0.91	0.98	1.13	1.31	1.58	—

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

***Design Pressure* (kPa, gage)**								
Refrigerant	**350**	**700**	**1000**	**1500**	**2000**	**2500**	**3000**	**4000**
R12	0.101	0.113	0.122	0.137	0.153	0.173	0.199	—
R22	0.080	0.089	0.095	0.105	0.115	0.126	0.138	—
R23	0.078	0.086	0.092	0.101	0.111	0.121	0.134	—
R32	0.060	0.066	0.070	0.076	0.082	0.088	0.095	0.114
R115	0.121	0.138	0.152	0.178	0.22	—	—	—
R134a	0.086	0.096	0.104	0.118	0.132	0.149	0.174	—
R143a	0.086	0.097	0.105	0.119	0.135	0.155	—	—
R152a	0.069	0.077	0.083	0.092	0.102	0.113	0.127	—
R170	0.057	0.063	0.067	0.074	0.081	0.089	0.098	—
R290	0.063	0.071	0.077	0.086	0.096	0.108	0.123	—
R401A	0.082	0.092	0.099	0.110	0.121	0.134	0.151	—
R401B	0.082	0.091	0.098	0.108	0.120	0.132	0.148	—
R401C	0.085	0.095	0.103	0.115	0.128	0.143	0.164	—
R402A	0.091	0.102	0.110	0.124	0.138	0.156	0.180	—
R402B	0.086	0.096	0.104	0.116	0.128	0.143	0.161	—
R403A	0.086	0.096	0.103	0.116	0.128	0.143	0.161	—
R403B	0.094	0.106	0.115	0.130	0.146	0.166	0.196	—
R404A	0.091	0.103	0.112	0.127	0.144	0.167	—	—
R405A	0.090	0.100	0.108	0.122	0.136	0.153	0.178	—
R406A	0.080	0.089	0.096	0.107	0.118	0.130	0.146	—
R407A	0.080	0.089	0.096	0.107	0.119	0.132	0.149	—
R407B	0.089	0.099	0.107	0.121	0.135	0.153	0.178	—
R407C	0.078	0.086	0.093	0.103	0.114	0.126	0.141	—
R407D	0.079	0.088	0.095	0.106	0.118	0.131	0.148	—
R407E	0.076	0.084	0.091	0.100	0.111	0.122	0.136	—
R407F	0.076	0.084	0.091	0.100	0.110	0.122	0.136	—
R407G	0.084	0.094	0.102	0.115	0.128	0.145	0.168	—
R407H	0.074	0.082	0.088	0.097	0.107	0.117	0.130	—
R408A	0.084	0.094	0.101	0.113	0.126	0.141	0.161	—
R409A	0.083	0.093	0.099	0.110	0.122	0.135	0.151	—
R409B	0.083	0.092	0.099	0.110	0.121	0.134	0.150	—
R410A	0.073	0.081	0.087	0.096	0.105	0.115	0.127	—
R410B	0.075	0.083	0.089	0.099	0.108	0.119	0.132	—
R411A	0.078	0.086	0.092	0.102	0.112	0.123	0.135	—
R411B	0.079	0.087	0.094	0.103	0.113	0.124	0.137	—
R412A	0.081	0.090	0.097	0.107	0.118	0.130	0.144	—

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Table 9-2 Relief Device Refrigerant Capacity Factors, *f*, kg/[m^2·s] (SI) *(Continued)*

***Design Pressure* (kPa, gage)**								
Refrigerant	**350**	**700**	**1000**	**1500**	**2000**	**2500**	**3000**	**4000**
R413A	0.087	0.098	0.107	0.121	0.137	0.157	0.189	—
R414A	0.084	0.093	0.101	0.112	0.125	0.139	0.157	—
R414B	0.086	0.095	0.103	0.114	0.127	0.141	0.160	—
R415A	0.077	0.085	0.091	0.101	0.111	0.121	0.134	—
R415B	0.071	0.079	0.085	0.094	0.104	0.115	0.128	—
R416A	0.091	0.102	0.111	0.125	0.142	0.162	0.195	—
R417A	0.090	0.101	0.110	0.125	0.141	0.162	0.197	—
R417B	0.095	0.108	0.117	0.134	0.152	0.176	—	—
R417C	0.087	0.098	0.106	0.120	0.135	0.154	0.182	—
R418A	0.079	0.088	0.094	0.104	0.114	0.125	0.138	—
R419A	0.091	0.102	0.110	0.125	0.141	0.160	0.191	—
R419B	0.087	0.098	0.106	0.120	0.135	0.153	0.180	—
R420A	0.086	0.096	0.104	0.117	0.132	0.149	0.174	—
R421A	0.091	0.103	0.112	0.127	0.144	0.165	0.200	—
R421B	0.097	0.109	0.119	0.136	0.154	0.179	—	—
R422A	0.097	0.110	0.120	0.136	0.156	0.181	—	—
R422B	0.091	0.103	0.112	0.127	0.144	0.166	0.21	—
R422C	0.095	0.107	0.117	0.134	0.152	0.177	—	—
R422D	0.093	0.105	0.114	0.130	0.148	0.171	0.22	—
R422E	0.091	0.103	0.112	0.128	0.145	0.167	0.21	—
R423A	0.098	0.111	0.121	0.139	0.159	0.188	—	—
R424A	0.090	0.102	0.111	0.125	0.142	0.163	0.199	—
R425A	0.079	0.088	0.095	0.105	0.117	0.130	0.147	—
R426A	0.086	0.096	0.105	0.118	0.133	0.151	0.178	—
R427A	0.080	0.090	0.097	0.108	0.120	0.134	0.153	—
R428A	0.096	0.108	0.118	0.135	0.154	0.179	—	—
R429A	0.063	0.070	0.075	0.084	0.093	0.103	0.115	—
R430A	0.071	0.080	0.086	0.097	0.109	0.123	0.143	—
R431A	0.066	0.074	0.080	0.090	0.100	0.113	0.130	—
R432A	0.060	0.067	0.072	0.080	0.089	0.098	0.109	—
R433A	0.063	0.070	0.076	0.085	0.094	0.105	0.120	—
R433B	0.063	0.071	0.076	0.086	0.096	0.107	0.123	—
R433C	0.063	0.070	0.076	0.085	0.095	0.106	0.120	—
R434A	0.093	0.105	0.115	0.130	0.148	0.172	—	—
R435A	0.060	0.067	0.071	0.079	0.087	0.095	0.104	0.135
R436A	0.064	0.072	0.078	0.088	0.098	0.112	0.130	—

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Table 9-2 Relief Device Refrigerant Capacity Factors, *f*, kg/[m^2·s] (SI) *(Continued)*

***Design Pressure* (kPa, gage)**								
Refrigerant	**350**	**700**	**1000**	**1500**	**2000**	**2500**	**3000**	**4000**
R436B	0.064	0.072	0.078	0.088	0.099	0.112	0.132	—
R437A	0.087	0.098	0.106	0.120	0.135	0.154	0.182	—
R438A	0.085	0.095	0.103	0.116	0.130	0.146	0.170	—
R439A	0.073	0.081	0.087	0.096	0.106	0.116	0.128	—
R440A	0.069	0.077	0.083	0.092	0.102	0.113	0.127	—
R441A	0.060	0.067	0.072	0.080	0.090	0.101	0.116	—
R442A	0.076	0.084	0.091	0.100	0.111	0.122	0.136	—
R443A	0.062	0.069	0.075	0.083	0.092	0.103	0.117	—
R444A	0.081	0.091	0.098	0.111	0.124	0.139	0.160	—
R444B	0.071	0.079	0.084	0.093	0.101	0.111	0.122	0.160
R445A	0.077	0.087	0.094	0.105	0.117	0.132	0.152	—
R446A	0.066	0.073	0.078	0.085	0.093	0.100	0.109	0.135
R447A	0.067	0.073	0.078	0.086	0.093	0.101	0.110	0.136
R447B	0.067	0.074	0.079	0.086	0.094	0.101	0.110	0.137
R448A	0.079	0.088	0.095	0.106	0.117	0.130	0.147	—
R449A	0.080	0.089	0.096	0.107	0.119	0.132	0.150	—
R449B	0.080	0.089	0.095	0.106	0.118	0.131	0.148	—
R449C	0.082	0.091	0.098	0.110	0.122	0.136	0.156	—
R450A	0.090	0.101	0.110	0.125	0.141	0.162	0.198	—
R451A	0.097	0.111	0.121	0.139	0.161	0.192	—	—
R451B	0.097	0.110	0.121	0.139	0.161	0.191	—	—
R452A	0.090	0.101	0.110	0.124	0.139	0.159	0.189	—
R452B	0.068	0.075	0.080	0.088	0.096	0.105	0.115	0.150
R452C	0.090	0.101	0.109	0.123	0.138	0.156	0.185	—
R453A	0.079	0.088	0.094	0.105	0.116	0.129	0.146	—
R454A	0.078	0.087	0.094	0.104	0.116	0.129	0.146	—
R454B	0.068	0.075	0.080	0.088	0.096	0.104	0.114	0.147
R454C	0.083	0.093	0.101	0.113	0.126	0.142	0.166	—
R455A	0.080	0.089	0.096	0.107	0.119	0.133	0.152	—
R456A	0.085	0.095	0.103	0.116	0.130	0.147	0.172	—
R457A	0.081	0.091	0.098	0.110	0.123	0.139	0.161	—
R458A	0.079	0.088	0.094	0.105	0.116	0.129	0.146	—
R459A	0.068	0.075	0.080	0.088	0.095	0.104	0.114	0.146
R459B	0.083	0.093	0.100	0.112	0.126	0.142	0.165	—
R460A	0.086	0.096	0.103	0.116	0.129	0.145	0.168	—
R460B	0.077	0.086	0.092	0.102	0.113	0.124	0.139	—

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Table 9-2 Relief Device Refrigerant Capacity Factors, *f*, kg/[m^2·s] (SI) *(Continued)*

Design Pressure **(kPa, gage)**								
Refrigerant	**350**	**700**	**1000**	**1500**	**2000**	**2500**	**3000**	**4000**
R500	0.090	0.101	0.109	0.123	0.137	0.154	0.177	—
R501	0.085	0.094	0.101	0.112	0.123	0.135	0.150	—
R502	0.098	0.110	0.119	0.134	0.150	0.169	0.198	—
R503	0.093	0.104	0.112	0.124	0.138	0.153	0.174	—
R504	0.081	0.090	0.097	0.108	0.119	0.132	0.149	—
R507A	0.092	0.104	0.113	0.129	0.146	0.169	—	—
R508A	0.102	0.115	0.125	0.142	0.161	0.187	—	—
R508B	0.099	0.111	0.120	0.136	0.153	0.176	—	—
R509A	0.105	0.119	0.130	0.149	0.171	0.21	—	—
R510A	0.060	0.066	0.071	0.079	0.086	0.095	0.104	0.138
R511A	0.063	0.071	0.076	0.086	0.096	0.107	0.122	—
R512A	0.069	0.077	0.083	0.093	0.103	0.114	0.129	—
R513A	0.093	0.105	0.115	0.131	0.149	0.174	—	—
R513B	0.093	0.106	0.115	0.132	0.150	0.175	—	—
R515A	0.095	0.108	0.118	0.135	0.155	0.181	—	—
R1150	0.056	0.062	0.066	0.072	0.079	0.085	0.094	0.125
R1234yf	0.099	0.112	0.123	0.142	0.165	0.198	—	—
R1234ze(E)	0.093	0.105	0.115	0.131	0.150	0.174	—	—
R1270	0.061	0.068	0.074	0.082	0.091	0.101	0.113	—

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Table 9-3 Relief Device Refrigerant Capacity Factors, *f*, lb/[ft^2·min] (I-P)

	Design Pressure **(psi, gage)**			
Refrigerant	**15**	**50**	**100**	**150**
R11	1.05	1.18	1.32	1.44
R113	1.21	1.38	1.57	1.75
R114	1.25	1.42	1.62	1.81
R123	1.09	1.24	1.40	1.55
R124	1.10	1.25	1.41	1.56
R142b	0.94	1.07	1.20	1.31
R245fa	0.99	1.12	1.27	1.41
R600	0.74	0.84	0.94	1.04
R600a	0.76	0.87	0.98	1.09
R718	0.24	0.26	0.28	0.29
R764	0.64	0.70	0.76	0.81
R1224yd(Z)	1.09	1.25	1.43	1.59
R1233zd(E)	1.02	1.16	1.31	1.45
R1336mzz(Z)	1.12	1.29	1.49	1.68

Table 9-4 Relief Device Refrigerant Capacity Factors, *f*, kg/[m^2·s] (SI)

	Design Pressure **(kPa, gage)**			
Refrigerant	**100**	**350**	**700**	**1000**
R11	0.086	0.096	0.107	0.116
R113	0.098	0.112	0.128	0.141
R114	0.101	0.116	0.133	0.146
R123	0.089	0.101	0.115	0.125
R124	0.089	0.102	0.115	0.126
R142b	0.077	0.087	0.098	0.106
R245fa	0.080	0.092	0.104	0.114
R600	0.060	0.068	0.077	0.084
R600a	0.062	0.071	0.080	0.088
R718	0.0195	0.021	0.023	0.023
R764	0.052	0.057	0.062	0.066
R1224yd(Z)	0.089	0.102	0.117	0.128
R1233zd(E)	0.083	0.094	0.107	0.117
R1336mzz(Z)	0.091	0.105	0.121	0.135

Table 9-5 Relief Device Refrigerant Capacity Factors, *f*, lb/[ft^2·min] (I-P)

	Design Pressure **(psi, gage)**							
Refrigerant	**100**	**300**	**400**	**500**	**600**	**700**	**800**	**850**
R744	0.75	0.93	1.01	1.09	1.18	1.30	1.48	1.63

Table 9-6 Relief Device Refrigerant Capacity Factors, *f*, kg/[m^2·s] (SI)

	Design Pressure **(kPa, gage)**											
Refrigerant	**700**	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**	**5500**	**5900**
R744	0.061	0.065	0.070	0.075	0.080	0.084	0.089	0.095	0.101	0.109	0.120	0.134

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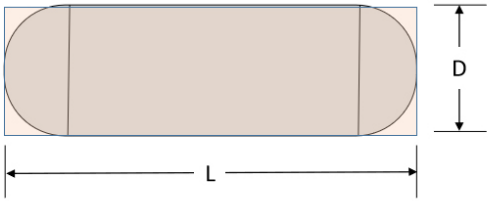
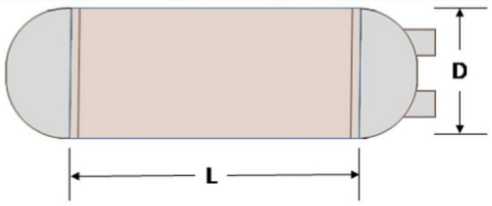
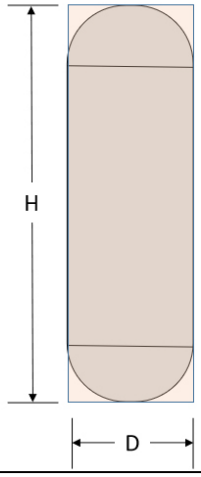
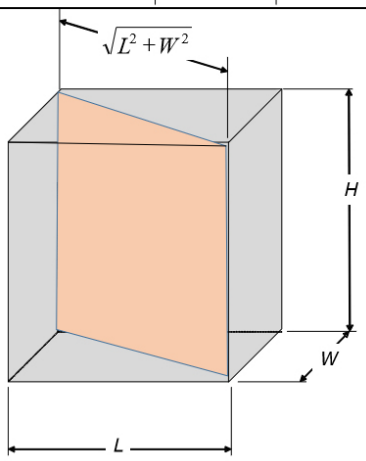
Component	Example	Area
Pressure vessel, horizontal, without waterboxes		$A = D \cdot L$
Pressure vessel, horizontal, with waterboxes		$A = D \cdot L$
Pressure vessel, vertical		$A = D \cdot H$
Plate heat exchanger		$A = \sqrt{L^2 + W^2} \cdot H$

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

Informative Table ~~9-2~~ 9-7 Atmospheric Pressure at Nominal Installation Elevation (Pa)

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ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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