ANSI/ASHRAE Addendum c to
ANSI/ASHRAE Standard 15-2004

ASHRAE STANDARD

Safety Standard for Refrigeration Systems

Approved by the ASHRAE Standards Committee on June 24, 2006; by the ASHRAE Board of Directors on June 29, 2006; and by the American National Standards Institute on March 3, 2007.

This standard is under continuous maintenance 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. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada).

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SPECIAL NOTE

This American National Standard (ANS) is a national voluntary consensus standard developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Consensus is defined by the American National Standards Institute (ANSI), of which ASHRAE is a member and which has approved this standard as an ANS, as "substantial agreement reached by directly and materially affected interest categories. This signifies the concurrence of more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that an effort be made toward their resolution." Compliance with this standard is voluntary until and unless a legal jurisdiction makes compliance mandatory through legislation.

ASHRAE obtains consensus through participation of its national and international members, associated societies, and public review.

ASHRAE Standards are prepared by a Project Committee appointed specifically for the purpose of writing the Standard. The Project Committee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Standard. Every effort is made to balance the concerned interests on all Project Committees.

The Manager of Standards of ASHRAE should be contacted for:

a. interpretation of the contents of this Standard,
b. participation in the next review of the Standard,
c. offering constructive criticism for improving the Standard,

(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

The current version of ANSI/ASHRAE Standard 15-2004 includes an informative appendix, Appendix F, for determining the required relief capacity for positive displacement compressors. This revision of Appendix F expands the list of refrigerants and their corresponding properties for determining relief capacity. In addition, the methodology has been revised to more clearly demonstrate relief valve capacity calculations for positive displacement compressors equipped with capacity modulation.

Addendum c to 15-2004

Delete the current Appendix F in Standard 15-2004 and replace it with the following revised version of the appendix:

(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.)

APPENDIX F
METHOD FOR CALCULATING DISCHARGE CAPACITY OF POSITIVE DISPLACEMENT COMPRESSOR PRESSURE-RELIEF DEVICE

The following calculation method provides the required discharge capacity of the compressor pressure-relief device in Section 9.8:[1]

$$W_r = \frac{Q \cdot PL \cdot \eta_v}{v_g} \qquad \text{(F-1)}$$

where

W_r = mass flow of refrigerant, lb_m/min (kg/s)
Q = swept volume flow rate of compressor, ft^3/min (m^3/s)
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 (m^3/kg)

[1] Section 9.8 permits the discharge capacity of the relief device to be the minimum regulated flow rate of the compressor when the following conditions are met: (a) the compressor is equipped with capacity regulation, (b) capacity regulation actuates to minimum flow at 90% of the pressure-relief device setting, and (c) the pressure-limiting device is installed and set in accordance with the requirements of Section 9.9.

Next, find the relieving capacity in mass flow of air, W_a, for an ASME-rated (Reference 5 in Appendix E) pressure-relief device:

$$W_a = W_r \cdot r_w \qquad \text{(F-2)}$$

$$r_w = \frac{C_a}{C_r}\sqrt{\frac{T_r}{T_a}}\sqrt{\frac{M_a}{M_r}} \qquad \text{(F-2a)}$$

where

r_w = refrigerant-to-standard-air-mass-flow conversion factor
M_r = molar mass of refrigerant (see table below)
M_a = molar mass of air = 28.97
T_a = absolute temperature of the air = 520 R (289 K)
C_a = constant for air = 356
C_r = constant for refrigerant (as determined from Equation F-2b)
T_r = absolute temperature of refrigerant = 510 R (283 K)

$$C_r = 520\sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}} \qquad \text{(F-2b)}$$

where

k = ratio of specific heats (C_p/C_v)
C_p = constant-pressure specific heat of refrigerant at a refrigerant quality of 1 at 50°F (10°C)
C_v = constant-volume specific heat of refrigerant at a refrigerant quality of 1 at 50°F (10°C)

Constants for several refrigerants are listed in the following table.

Refrigerant	k^*	Molar Mass†	C_r	r_w
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	152.9	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	44.1	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	111.6	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-717	1.422	17.0	358.0	1.28
R-718	1.328	18.0	349.6	1.28
R-744	2.690	44.0	437.0	0.65

* Source: *NIST Refprop, Standard Reference Database 23*, Version 7, 2002.
† Source: *IUPAC Atomic Weights*, 2003.

Example: Determine the flow capacity of a relief device for an ammonia (R-717) screw compressor with a swept volume, Q, of 1,665 ft^3/min (0.7858 m^3/s). The compressor is equipped with capacity control that is actuated at 90% of the pressure relief device set pressure to its minimum regulated flow of 10%.

$$Q = 1{,}665 \text{ ft}^3/\text{min } (0.7858 \text{ m}^3/\text{s})$$

$$\eta_v = 0.90, \text{ assumed}$$

$$PL = 0.1$$

$$v_g = 3.2997 \text{ ft}^3/\text{lb}_\text{m } (0.206 \text{ m}^3/\text{kg})$$

$$W_r = \frac{1665\frac{\text{ft}^3}{\text{min}} \cdot 0.1 \cdot 0.9}{3.2997\frac{\text{ft}^3}{\text{lb}_\text{m}}} = 45.4\frac{\text{lb}_\text{m}}{\text{min}} \qquad \text{(see F-1)}$$

$$\left[W_r = \frac{0.7858\frac{\text{m}^3}{\text{s}} \cdot 0.1 \cdot 0.9}{0.206\frac{\text{m}^3}{\text{kg}}} = 0.343\frac{\text{kg}}{\text{s}} \right]$$

$$W_a = W_r \cdot r_w = 45.4 \cdot 1.28 = 58.1\frac{\text{lb}_\text{m}}{\text{min}} \text{ of air} \qquad \text{(see F-2)}$$

$$\left[W_a = W_r \cdot r_w = 0.343 \cdot 1.28 = 0.439\frac{\text{kg}}{\text{s}} \text{ of air} \right]$$

Converting to standard cubic feet per minute (SCFM), where V_a = specific volume of air = 13.1 ft^3/lb_m (0.818 m^3/kg) for dry air at 60°F (15.6°C),

$$\text{SCFM} = 13.1(58.1) = 761 \text{ ft}^3/\text{min}$$

$$[\text{SCFM} = 0.818(0.439) = 0.359 \text{ m}^3/\text{s}].$$

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

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.