

ANSI/AHRI Standard 510-2006
(Formerly ARI Standard 510-2006)

Standard for 2006

Performance Rating Of Positive Displacement Ammonia Compressors and Compressor Units



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Note:

This standard supersedes ARI Standard 510-93.

TABLE OF CONTENTS

SECTION	PAGE
Section 1. Purpose.....	1
Section 2. Scope.....	1
Section 3. Definitions	1
Section 4. Test Requirements	2
Section 5. Rating Requirements.....	3
Section 6. Minimum Data Requirements for Published Ratings	4
Section 7. Marking and Nameplate Data	4
Section 8. Conformance Conditions	4

TABLES

Table 1. ARI Standard Rating Conditions for Ammonia Compressors and Compressor Units (Based on 90.0°F [32.2°C] Ambient Temperature and No Liquid Subcooling Except for Booster and Compound Units)	3
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APPENDICES

Appendix A. References – Normative	5
Appendix B. References – Informative	5

PERFORMANCE RATING OF POSITIVE DISPLACEMENT AMMONIA COMPRESSORS AND COMPRESSOR UNITS

Section 1. Purpose

1.1 Purpose. The purpose of this standard is to establish for Positive Displacement Ammonia Compressors and Compressor Units: definitions; test requirements; rating requirements; minimum data requirements for Published Ratings; marking and nameplate data and conformance conditions.

1.1.1 Intent. This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

1.2 Review and Amendment. This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 Scope. This standard applies to Positive Displacement Ammonia Compressors (Ammonia Compressors) and Compressor Units (Ammonia Compressor Units) for use in commercial and industrial refrigeration applications.

2.1.1 Refrigerant. This standard applies to compressors and compressor units using ammonia (R717), as defined in ANSI/ASHRAE Standard 34 with Addenda.

Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the current edition of ASHRAE *Terminology of Heating, Ventilation, Air-Conditioning, and Refrigeration* unless otherwise defined in this section.

3.1 Efficiency. The Efficiency of an Ammonia Compressor shall be expressed in one of two ways:

3.1.1 Brake horsepower per ton of refrigeration (BHP/TR). A ratio of the shaft horsepower consumption to the Refrigerating Capacity, expressed in BHP/TR

$$\text{BHP/ton} = \frac{\text{BHP input}}{\text{tons refrigeration effect}} \quad 1$$

3.1.2 Coefficient of Performance (COP). A ratio of cooling capacity in kilowatts [kW] to the brake power input value in brake kilowatts [BkW] at any given set of Rating Conditions expressed in kilowatts/brake kilowatts [kW/BkW].

$$\text{COP} = \frac{\text{kW refrigeration effect}}{\text{BkW input}} \quad 2$$

3.2 Manufacturer. For the purpose of this standard, the company or organization which evidences its responsibility by affixing its name or its nationally registered trademark or trade name to the Ammonia Compressor or Ammonia Compressor Unit.

3.3 Positive Displacement Ammonia Compressor (Ammonia Compressor). A compressor in which an increase in ammonia vapor pressure is attained by changing the internal volume of the compression chamber. The compressor may have service valves supplied by the manufacturers.

3.3.1 Booster Compressor. A compressor applied to the low stage(s) of a multi-stage refrigeration system.

STANDARD 510-2006

3.3.2 *Internally Compounded Compressor.* A compressor in which compression is accomplished in two or more stages within the same compressor body.

3.3.3 *Reciprocating Piston Compressor.* A compressor in which pistons are moved in cylinders by means of rods connected to a crankshaft with a fully-enclosed crankcase subjected to refrigerant pressure.

3.3.4 *Rotary Screw Compressor.* A compressor in which mating screws or a single screw with gate rotor(s) are used for displacement purposes.

3.3.5 *Rotary Vane Compressor.* A compressor in which an eccentrically located rotor with a vane or vanes is used for displacement purposes.

3.4 *Positive Displacement Ammonia Compressor Unit (Ammonia Compressor Unit).* A combination of any of the above Positive Displacement Ammonia Compressors with or without prime mover(s) mounted on a structural base with accessories, such as strainers, service valves, check valves, suction filters, oil separators, etc., as supplied or specified by the Manufacturer.

3.5 *Power Input.* The compressor shaft power, brake horsepower BHP [brake kilowatts BkW].

3.6 *Published Rating.* A statement of the assigned values of those performance characteristics, under stated Rating Conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal size and type (identification) produced by the same Manufacturer. The term Published Rating includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the Manufacturer, at stated Rating Conditions.

3.6.1 *Application Rating.* A rating based on tests performed at application Rating Conditions (other than Standard Rating Conditions).

3.6.2 *Standard Rating.* A rating based on tests performed at Standard Rating Conditions.

3.7 *Rating Conditions.* Any set of operating conditions under which a single level of performance results and which causes only that level of performance to occur.

3.7.1 *Standard Rating Conditions.* Rating Conditions used as the basis of comparison for performance characteristics.

3.8 *Refrigerating Capacity.* The capacity associated with the increase in total enthalpy between the liquid refrigerant entering the expansion valve and superheated return gas multiplied by the mass flow rate of the refrigerant. tons [kW]

3.9 *"Shall" or "Should,"* shall be interpreted as follows:

3.9.1 *Shall.* Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.9.2 *Should.* "Should" is used to indicate provisions which are not mandatory, but which are desirable as good practice.

3.10 *Subcooling.* The reduction in temperature of refrigerant liquid below its saturation temperature.

3.11 *Superheat.* Additional heat in a vapor when at a temperature higher than the saturation temperature corresponding to its pressure.

Section 4. Test Requirements

4.1 *Test requirements.* All Published Ratings shall be verified by tests conducted in accordance with ANSI/ASHRAE Standard 23.

Section 5. Rating Requirements

5.1 Standard Rating of an Ammonia Compressor. A Standard Rating of an Ammonia Compressor, with stop valves if supplied by the Manufacturer, consists of a Refrigerating Capacity, shaft Power Input and Efficiency, identified at its ARI Standard Rating Condition and group designation from Table 1. The actual compressor speed (rpm) [rev/s] at Rating Conditions shall be stated.

5.2 Application Rating of an Ammonia Compressor. An Application Rating of an Ammonia Compressor, with stop valves if supplied by the Manufacturer, consists of a Refrigerating Capacity, shaft Power Input and Efficiency at completely stated conditions other than those presented in Table 1. The actual compressor speed (rpm) [rev/s] at Rating Conditions shall be stated.

5.3 Standard Rating of an Ammonia Compressor Unit. A Standard Rating of an Ammonia Compressor Unit with all mounted accessories supplied by the Manufacturer consists of a Refrigerating Capacity, shaft Power Input and Efficiency, identified at its ARI Standard Rating Condition and group designation from Table 1. The actual compressor speed (rpm) [rev/s] at Rating Conditions shall be stated.

5.4 Application Rating of an Ammonia Compressor Unit. An Application Rating of an Ammonia Compressor Unit with all mounted accessories supplied by the Manufacturer consists of a Refrigerating Capacity, shaft Power Input and Efficiency at completely stated conditions other than those presented in Table 1. The actual compressor speed (rpm) [rev/s] at Rating Conditions shall be stated.

Table 1. ARI Standard Rating Conditions for Ammonia Compressors and Compressor Units (Based on 90.0°F [32.2°C] Ambient Temperature and No Liquid Subcooling Except for Booster and Compound Units)

Group Designation	Saturated Suction Temperature		Return Gas Temperature		Saturated Discharge Temperature		Liquid Temperature Above Interstage Saturation Temperature (Temperature Difference)	
	°F	°C	°F	°C	°F	°C	°F	°C
A	20.0	-6.70	30.0	-1.11	95.0	35.0	Not Applicable	Not Applicable
B	5.00	-15.0	15.0	-9.44	95.0	35.0	Not Applicable	Not Applicable
C	-10.0	-23.3	0.00	-17.8	95.0	35.0	Not Applicable	Not Applicable
*D	-40.0	-40.0	-30.0	-34.4	95.0	35.0	10.0	5.56
**E	-40.0	-40.0	-30.0	-34.4	10.0	-12.2	10.0	5.56

*Compound Compressor Unit

**Booster Compressor Unit

5.5 Refrigerating Capacity shall be calculated using the following:

$$q = \dot{m} \cdot c \cdot (h_1 - h_2) \tag{3}$$

where:

q = Refrigerating Capacity, tons [kW]

\dot{m} = Mass flow rate, lbm/min [kg/min]

If Superheat is not applied at the compressor suction, the mass flow rate shall be determined by using the corresponding saturated suction gas density at the compressor or unit suction flange.

If Superheat is applied at the compressor suction, the mass flow rate shall be determined by using the corresponding superheated gas density at the compressor or unit suction flange.

STANDARD 510-2006

$$c = 1/200 \text{ tons/ (btu/min) [1/60 kW/ (kJ/min)]}$$

$$h_1 = \text{Enthalpy of ammonia vapor, btu/lbm [kJ/kg]}$$

If Superheat is not applied, h_1 is the saturated vapor enthalpy that corresponds to the Ammonia Compressor or Compressor Unit suction pressure.

If Superheat is applied, h_1 is the superheated vapor enthalpy that corresponds to the Ammonia Compressor or Compressor Unit suction pressure and temperature.

$$h_2 = \text{Enthalpy of saturated ammonia liquid, btu/lbm [kJ/kg]}$$

If Subcooling is not applied, h_2 is the saturated liquid enthalpy that corresponds to the Ammonia Compressor or Compressor Unit discharge pressure.

If Subcooling is applied, h_2 is the saturated liquid enthalpy that corresponds to the Ammonia Compressor or Compressor Unit discharge pressure at the reduced temperature.

5.6 Tolerances. To comply with this standard, measured test results shall not be less than 95% of Published Ratings for Refrigerating Capacity and Efficiency, and shall be no more than 105% of the rated Power Input.

Section 6. Minimum Data Requirements for Published Ratings

6.1 Minimum Data Requirements for Published Ratings. As a minimum, Published Ratings shall include all Standard Ratings. All claims to ratings within the scope of this standard shall include the statement “Rated in accordance with ARI Standard 510.” All claims to ratings outside the scope of this standard shall include the statement “Outside the scope of ARI Standard 510.” Wherever Application Ratings are published or printed, they shall include a statement of the conditions at which the ratings apply.

Section 7. Marking and Nameplate Data

7.1 Marking and Nameplate Data. As a minimum, the nameplate shall include:

- a. Manufacturer’s name and/or symbol
- b. Manufacturer’s model number
- c. Manufacturer’s identification number (serial number)
- d. Refrigerant
- e. Maximum design working pressure
- f. Maximum permissible speed

Section 8. Conformance Conditions

8.1 Conformance Conditions. While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard’s *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all the requirements of the standard shall not reference, state, or acknowledge the standard in any written, oral, or electronic communication.

APPENDIX A. REFERENCES – NORMATIVE

A.1 Listed here are all standards, handbooks, and other publications essential to the formation and implementation of the standard. All references in this appendix are considered as part of the standard.

A.1.1 ANSI/ASHRAE Standard 23-2005, *Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units*, 2005, American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers, 11 West 42nd Street, New York, NY 10036, U.S.A./1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

A.1.2 ANSI/ASHRAE Standard 34-2004, *Designation and Safety Classification of Refrigerants*, 2004, with Addenda, American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers, 25 West 43rd Street, New York, NY 10036, U.S.A./1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

A.1.3 ASHRAE *Terminology of Heating, Ventilation, Air Conditioning and Refrigeration*, 1991, Second Edition, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

APPENDIX B. REFERENCES – INFORMATIVE

B.1 Listed here are standards, handbooks, and other publications which may provide useful information and background but are not considered essential. References in this appendix are not considered part of the standard.

B.1.1 ISO 917: 1989, *Testing of Refrigerant Compressors*, 1989, International Organization for Standardization, Case Postale 56, CH-1211, Geneva 21 Switzerland.

B.1.2 AHRI Standard 540-2004 (formerly ARI Standard 540-2004), *Performance Rating Of Positive Displacement Refrigerant Compressors And Compressor Units, 2004*, Air-Conditioning Heating and Refrigeration Institute, 2111 Wilson Blvd., 500, Arlington, VA 22201, U.S.A.