

AHRI Standard 871 (SI) - 2016

**2016 Standard for
Performance Rating of Direct
Geexchange Heat Pumps**



**Air-Conditioning, Heating,
and Refrigeration Institute**

2111 Wilson Boulevard, Suite 500
Arlington, VA 22201, USA
www.ahrinet.org

PH 703.524.8800
FX 703.562.1942

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Note:

This standard supersedes ANSI/AHRI Standard 870-2005 with Addendum 1.
For I-P ratings, see AHRI Standard 870 (I-P) -2016.

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PERFORMANCE RATING OF DIRECT GEOEXCHANGE HEAT PUMPS

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish for Direct Geexchange Heat Pumps: definitions; classification; test and rating requirements; minimum data requirements for Published Ratings; operating requirements; marking and nameplate data; and conformance conditions. For the remainder of this standard, the terms “heat pump” or “equipment” are also used to designate Direct Geexchange Heat Pumps.

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

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

Section 2. Scope

2.1 *Scope.* This standard applies to factory made residential, commercial and industrial Direct Geexchange Heat Pumps as defined in Section 3, and within the capacity range of 5,270 W through 52,700 W.

2.1.1 *Energy Source.* This standard applies only to electrically-driven, mechanical vapor-compression refrigeration systems.

2.1.2 *Alternative Applications.* Equipment designed for rating under this standard is not suitable for alternative applications covered in ANSI/AHRI/ASHRAE ISO Standards 13256-1 and 13256-2.

2.1.3 *Exclusions.* This standard applies to the rating and testing of complete refrigeration systems and does not apply to individual system components for separate use.

Section 3. Definitions

All terms in this document will follow the standard industry definitions in the *ASHRAE Terminology* website (<https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology>) unless otherwise defined in this section.

3.1 *Cooling Coefficient of Performance (COP_C).* The ratio of Cooling Capacity in watts to the power input values in watts at any given set of Rating Conditions expressed in watts/watt.

3.2 *Cooling Capacity.* The capacity associated with the change in air enthalpy which includes both the latent and sensible capacities, expressed in watts.

3.3 *Direct Geexchange Heat Exchanger.* A continuous sealed tube(s) heat exchanger with refrigerant supply and refrigerant return. This may be comprised of several tubes and may be supplied with each heat pump. The heat exchanger(s) may be factory or field assembled.

3.4 *Direct Geexchange Heat Pump(s) (DGX).* A heat pump consisting of (1) one or more factory made assemblies which normally include an indoor conditioning coil with air or water moving means, (2) compressor(s), and (3) a subsurface refrigerant piping loop system functioning as a Direct Geexchange Heat Exchanger, and may include means to provide a heating function, or a cooling function, or both. The separate system components shall be designed for use together. Models designated as “cooling only” need not include the heating function and models designated “heating only” need not include the cooling function. The four types of Direct Geexchange Heat Pumps within the scope of this standard are as follows.

3.4.1 *DGX-to-Air Split System* (Type 1). Compressor and indoor coil are in separate cabinets. Indoor coil is with or without a fan.

3.4.2 *DGX-to-Air Packaged System* (Type 2). Compressor and indoor coil are in one cabinet, with or without a fan.

3.4.3 *DGX-to-Water Split System* (Type 3). Compressor and Indoor Water-to-refrigerant heat exchanger are in separate cabinets. Indoor Water-to-refrigerant heat exchanger is with or without a pump.

3.4.4 *DGX-to-Water Packaged System* (Type 4). Compressor and Indoor Water-to-refrigerant heat exchanger are in one cabinet. Indoor heat exchanger is with or without a pump.

Note: ANSI/ASHRAE Standard 194 uses the term Direct-expansion Ground Source Heat Pump in lieu of Direct Geoechange Heat Pump.

3.5 *Effective Power Input*. The average electrical power input in watts, supplied to the equipment within a defined interval of time. This is the sum of the following, as appropriate:

3.5.1 The power input for the operation of the compressor, excluding supplemental electric heat, W

3.5.2 The power input of all control and safety devices of the equipment, W

3.5.3 The proportional power input of the conveying devices for the transport of heat transfer media through the heat pump only (e.g., fans, pumps, whether internal or external, whether provided with heat pump or not), W

3.6 *Heating Capacity*. For DGX-to-Air systems, the rate at which the equipment adds heat to the air passing through the indoor coil under specified conditions of operation, including the fan power adjustment. For DGX-to-Water systems, the rate at which the equipment adds heat to the Indoor Water passing through the indoor heat exchanger under specified conditions of operation, including the pump power in watts, W.

3.7 *Heating Coefficient of Performance (COP_h)*. The ratio of the Heating Capacity in watts to the Effective Power Input in watts at any given set of Rating Conditions expressed in watts/watt, W/W. Supplementary resistance heat shall be excluded.

3.8 *Indoor Water*. The liquid used in the indoor side water-to-refrigerant heat exchanger. This is not the same working fluid as the Test Liquid.

3.9 *Published Rating*. A statement of the assigned values of those performance characteristics, under stated Rating Conditions, by which a heat pump 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 heat pump or published in its specifications, advertising or other literature controlled by the manufacturer, at stated Rating Conditions.

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

3.9.2 *Part-load Rating*. A rating based on tests performed at part-load Rating Conditions.

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

3.10 *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.

3.10.1 *Standard Rating Conditions*. Rating Conditions used as the basis of comparison for performance characteristics as listed in Table 3.

3.11 “*Shall*” or “*Should*”. “Shall” or “Should” shall be interpreted as follows:

3.11.1 Shall. Where “Shall” or “Shall not” is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.11.2 Should. “Should” is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.12 Test Liquid. An antifreeze mixture used in the refrigerant-to-test liquid heat exchanger (ground loop simulator) consisting of water and 15% methanol, by mass.

Section 4. Classification

4.1 Classification. Direct Geoexchange Heat Pumps (DGX) within the scope of this standard shall be classified as shown in Table 1.

Table 1. Classification of Direct Geoexchange Heat Pumps					
Designation	AHRI Type ³			Arrangement ¹	
	Heating & Cooling	Heating Only	Cooling Only		
DGX-to-Air Split System (Type 1) with Indoor Fan	HRCU-DGX-CB	HORCU-DGX-CB	HCRCU-DGX-CB	FAN HEAT ² INDOOR COIL	COMP GROUND LOOP
DGX-to-Air Split System (Type 1) without Indoor Fan	HRCU-DGX-C	HORCU-DGX-C	HCRCU-DGX-C	HEAT ² INDOOR COIL	COMP GROUND LOOP
DGX-to-Air Packaged System (Type 2) with Indoor Fan	HSP-DGX-CB	HOSP-DGX-CB	HCSP-DGX-CB	FAN HEAT ² INDOOR COIL	COMP GROUND LOOP
DGX-to-Air Packaged System (Type 2) without Indoor Fan	HSP-DGX-C	HOSP-DGX-C	HCSP-DGX-C	HEAT ² INDOOR COIL	COMP GROUND LOOP
DGX-to-Water Split System (Type 3) with Circulating Pump	HRCU-DGX-CWP	HORCU-DGX-CWP	HCRCU-DGX-CWP	CIRC PUMP HEAT ² INDOOR HX	COMP GROUND LOOP
DGX-to-Water Split System (Type 3) without Circulating Pump	HRCU-DGX-CW	HORCU-DGX-CW	HCRCU-DGX-CW	HEAT ² INDOOR HX	COMP GROUND LOOP
DGX-to-Water Packaged System (Type 4) with Circulating Pump	HSP-DGX-CWP	HOSP-DGX-CWP	HCSP-DGX-CWP	CIRC PUMP HEAT ² INDOOR HX	COMP GROUND LOOP
DGX-to-Water Packaged System (Type 4) without Circulating Pump	HSP-DGX-CW	HOSP-DGX-CW	HCSP-DGX-CW	HEAT ² INDOOR HX	COMP GROUND LOOP
Notes:	1) Arrangement denotes Heating & Cooling and Heating Only mode functions. Separated enclosures indicate a remote condensing unit (RCU) and adjoining enclosures indicate a single package (SP). 2) “HEAT” denotes supplemental heating options such as electric resistance heat. 3) For AHRI Types XXXX-YYY-ZZZ, XXXX is Segment 1, YYY is Segment 2, and ZZZ is Segment 3.				
Legend First Segment: H = Heat Pump (Heating and Cooling, unless followed by an “O” or “C”) O = Heating Only C = Cooling Only R = Remote CU = Condensing Unit SP = Single Package Second Segment: DGX = Direct Geoexchange System Third Segment: C = Outdoor Coil (Ground Loop) B = Indoor Fan W = Indoor Water Heat Exchanger P = Indoor Circulating Pump					

Section 5. Test Requirements

5.1 *Test Methods.* All tests shall be conducted in accordance with ANSI/ASHRAE Standard 194.

Section 6 Rating Requirements

6.1 *Standard Rating.* Standard Ratings shall be established at the Standard Rating Conditions specified in Section 6.1.3, using test procedures described in ANSI/ASHRAE Standard 194. Standard Ratings relating to Cooling and Heating Capacities shall be net values, including the effects of circulating fan and circulating pump heat, but not including supplementary heat. Standard efficiency ratings shall be based on Effective Power Input as defined in Section 3.6.

6.1.1 *Values of Standard Capacity Ratings.* Capacity ratings shall be expressed only in terms of watts in multiples shown in Table 2.

Capacity Ratings, W	Multiples, W
< 5,270	25
≥ 5,270 and <11,000	50
≥11,000 and <19,000	150
≥19,000 and < 39,600	300
≥39,600 and < 52,700	600

6.1.2 *Values of Standard Coefficients of Performance.* Standard Coefficients of Performance for heating and cooling, whenever published, shall be expressed in multiples of the nearest 0.1 watt/watt.

6.1.3 *Standard Rating Conditions.* Equipment with dual rated frequencies shall be tested at each frequency. The test conditions for Standard Ratings shall include the following.

6.1.3.1 *Standard Rating Conditions.* Standard Rating Conditions for all types are described in Table 3. For each test, the heat pump shall be operated and readings taken in accordance with ANSI/ASHRAE Standard 194.

6.1.3.2 *Electrical Conditions.* Standard rating tests shall be performed at the nameplate rated voltage and frequency.

Table 3. Standard Rating Conditions						
Equipment Classification	Rating Conditions	Operating Mode	Entering Air Temperature dry bulb/wet bulb, °C	Entering Water Temperature, °C	Surrounding Air Temperature, °C	Saturated Refrigerant Temperature ¹ , (Evaporating) (Condensing) °C
DGX-to-Air (Types 1 & 2)	Standard	Heat	20.0/15.0	N/A	20.0	0.0 (Evap)
		Cool	27.0/19.0	N/A	27.0	25.0 (Cond)
	Part-load	Heat	20.0/15.0	N/A	20.0	5.0 (Evap)
		Cool	27.0/19.0	N/A	27.0	20.0 (Cond)
DGX-to-Water (Types 3 & 4)	Standard	Heat	N/A	40	15.0-30.0	0.0 (Evap)
		Cool	N/A	12	15.0-30.0	25.0 (Cond)
	Part-load	Heat	N/A	40	15.0-30.0	5.0 (Evap)
		Cool	N/A	12	15.0-30.0	20.0 (Cond)
Note: 1. Refrigerant pressure and temperature are measured at the inlet to the heat pump being tested. Increasing superheat will increase the equipment entering refrigerant temperature and increasing sub-cooling will decrease the equipment leaving refrigerant temperature.						

6.2 Part-load Rating. Heat pumps which are capable of capacity control shall be rated at each step of capacity reduction provided by the heat pump and allowed by the controls.

6.2.1 Part-load Rating Conditions. The conditions of test for Part-load Ratings are the same as for the Standard Ratings in Section 5.3 except for the values listed in Table 3.

6.2.1.1 Capacity Reduction Means May be Adjusted to Obtain the Specified Step of Unloading. No manual adjustment of indoor air quantities or water flow rates from those of Standard Rating Conditions shall be made. Automatic adjustment of the quantities by system function is permissible provided it is by means of a control system which is an integral part of the equipment to be tested and the control is configured to function in accordance with the manufacturer’s published instructions. The manufacturer must provide a schematic and sequence of operation for providing control of the system during test.

Section 7. Minimum Data Requirements for Published Ratings

7.1 Minimum Data Requirements for Published Ratings. As a minimum, Published Ratings shall include Standard Ratings and, as applicable, Part-load Ratings. All claims to ratings within the scope of this standard shall include the statement “Rated in accordance with AHRI Standard 871 (SI)”. All claims to ratings outside the scope of this standard shall include the statement “Outside the scope of AHRI Standard 871 (SI)”. Wherever Application Ratings are published or printed, they shall include a statement of the conditions at which the ratings apply. Calculations for the Published Ratings shall be in accordance with ANSI/ASHRAE Standard 194.

7.1.1 Published Ratings shall consist of the following information at Standard Rating Conditions and part-load Rating Conditions, as appropriate:

7.1.1.1 Cooling Capacity, W

7.1.1.2 Cooling Coefficient of Performance, COP_c, W/W

7.1.1.3 Heating Capacity, W

7.1.1.4 Heating Coefficient of Performance, COP_h, W/W

7.2 Tolerances. To comply with this standard, measured test results shall not be less than 95% of Published Ratings for performance ratios and capacities

Section 8. Operating Requirements

8.1 *Operating Requirements.* To comply with this standard, Direct Geothermal Heat Pumps shall be designed and produced in such a manner that any production units shall meet the operating requirements of ANSI/ASHRAE Standard 194. This shall include an insulation effectiveness test, a low-temperature start and operating test, and maximum operating conditions test.

Section 9. Marking and Nameplate Data

9.1 *Nameplate Data.* As a minimum, the nameplate shall display the manufacturer's name, model designation and electrical characteristics.

Nameplate voltages for 60 Hertz systems shall include one or more of the equipment nameplate voltages shown in Table 1 of ANSI/AHRI Standard 110. Nameplate voltages for 50 Hertz systems shall include one or more of the utilization voltages shown in Table 1 of IEC Standard 60038.

Section 10. Conformance Conditions

10.1 *Conformance.* 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 cannot reference, state, or acknowledge the standard in any written, oral, or electronic communication.

APPENDIX A. REFERENCES – NORMATIVE

A1 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.

A1.1 ANSI/AHRI Standard 110-2016, *Air-Conditioning, Heating, and Refrigerating Equipment Nameplate Voltages*, 2012, Air-Conditioning Heating and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, U.S.A.

A1.2 ANSI/ASHRAE Standard 194-2012, *Method of Test for Direct-expansion Ground Source Heat Pumps*, 2012. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.3 AHRI Standard 871(SI)-2016, *Performance Rating of Direct Geexchange Heat Pumps, 2015*, Air-Conditioning Heating and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, U.S.A.

A1.4 ANSI/AHRI/ASHRAE ISO Standard 13256-1:2012, *Water-source heat pumps-testing and rating for performance- Part I: Water-to-air and brine-to-air heat pumps*, 2012. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tillie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.5 ANSI/AHRI/ASHRAE ISO Standard 13256-2:2012, *Water-source heat pumps-testing and rating for performance- Part II: Water-to-water and brine-to-water heat pumps*, 2012. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tillie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.6 *ASHRAE, Terminology*, <https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology>, 2016, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.7 IEC Standard 60038-2009, *IEC Standard Voltages*, 2009, International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland.

APPENDIX B. REFERENCES – INFORMATIVE

B1 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.

B1.1 ANSI/AHRI Standard 210/240-2008 with Addenda 1 and 2, *Unitary Air-Conditioning and Air- Source Heat Pump Equipment*, Air-Conditioning, Heating, and Refrigeration Institute, 2008, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, U.S.A.

B1.2 ANSI/ASHRAE Standard 34-2013 with addenda, *Number Designation and Safety Classification of Refrigerants*, 2015, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.