

ANSI/AHRI Standard 921 (SI)

**2015 Standard for
Performance Rating of DX-
Dedicated Outdoor Air System
Units**



Approved by ANSI on November 6, 2015



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IMPORTANT

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AHRI uses its best efforts to develop standards/guidelines employing state-of-the-art and accepted industry practices. AHRI does not certify or guarantee that any tests conducted under its standards/guidelines will be non-hazardous or free from risk.

Note:

This standard supersedes ANSI/AHRI Standard 920-2012.

For I-P ratings, see ANSI/AHRI Standard 920 (I-P)-2015.

Foreword:

DX-Dedicated Outdoor Air Systems (DX-DOAS) condition outdoor ventilation air independently from the building HVAC system. This approach to handling ventilation air results in superior humidity control by limiting the primary source of humidity in most buildings – ambient humidity carried in by the ventilation air – directly at its source. When the DX-DOAS removes enough moisture from the ventilation air to match the building interior load, energy savings can be obtained by running the separate, sensible cooling only, interior cooling system at a higher evaporating temperature, thus improving the energy efficiency. Further energy savings may be realized by providing only the amount of ventilation air necessary and/or by using energy recovery from the building Exhaust Air to pre-treat the ventilation air. Alternate energy strategies may be employed to provide ventilation air at low or high dry-bulb temperatures to assist in building cooling and heating.

TABLE OF CONTENTS

SECTION		PAGE
Section 1.	Purpose.....	1
Section 2.	Scope.....	1
Section 3.	Definitions.....	1
Section 4.	Classifications	4
Section 5.	Test Requirements.....	4
Section 6.	Rating Requirements.....	7
Section 7.	Minimum Data Requirements for Published Ratings.....	10
Section 8.	Operating Requirements	11
Section 9.	Marking and Nameplate Data	12
Section 10.	Conformance Conditions	13

TABLES

Table 1.	Classification of DX-Dedicated Outdoor Air System Units	4
Table 2.	Operating Conditions for Standard Rating and Performance Tests for Classification A, B, and W DX-DOAS Units	5
Table 3.	Operating Conditions for Standard Rating and Performance Tests for Classification H DX-DOAS Units.....	6
Table 4.	External Static Pressure	7
Table 5.	Multiples for Rated Airflow	7
Table 6.	Basic Pumping Penalty (PP _B) vs. Liquid Flow Rate (WF).....	9

FIGURES

Figure 1.	DX-DOAS Units Airflow Schematic.....	2
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APPENDICES

Appendix A.	References - Normative	14
Appendix B.	References - Informative.....	14

PERFORMANCE RATING OF DX-DEDICATED OUTDOOR AIR SYSTEM UNITS

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish for DX-Dedicated Outdoor Air System Units: definitions; classifications; test requirements; rating requirements; minimum data requirements for Published Ratings; operating requirements; 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.

1.1.2 *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-assembled commercial or industrial DX-Dedicated Outdoor Air System Units as defined in Section 3.

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

2.1.2 *Installation.* DX-Dedicated Outdoor Air System Units are intended for ducted or non-ducted installation with field or factory supplied grilles.

2.2 *Exclusions.* This standard shall not apply to products covered under ANSI/AHRI Standard 210/240, ANSI/AHRI Standard 340/360, and ANSI/AHRI/ASHRAE ISO Standard 13256-1. Direct conversion of values from testing performed under ANSI/AHRI Standard 920 (I-P) shall not be used.

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 *Coefficient of Performance.* A ratio of the heating capacity in watts to the power input values in watts at any given set of Rating Conditions expressed in W/W, including Supplementary Heat if required to provide room neutral supply air temperature as listed in Table 3.

3.1.1 *Standard Coefficient of Performance (COP).* A ratio of the capacity to power input obtained at Standard Rating Conditions, heating.

3.2 *Conditioned Space.* That part of a building that is humidified or dehumidified; heated or cooled, or both, for the comfort of occupants.

3.3 *DX-Dedicated Outdoor Air System Units (DX-DOAS Units).* A type of air-cooled, water-cooled, or water source factory assembled product which dehumidifies 100% Outdoor Air to a low dew point, and includes reheat that is capable of controlling the supply dry-bulb temperature of the dehumidified air to the designed supply air temperature. This conditioned outdoor air is then delivered directly or indirectly to the Conditioned Space(s). It may pre-condition Outdoor Air by containing an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes, or other heat or mass transfer apparatus.

Note: DX-DOAS Units can operate in combination with a separate sensible cooling system to satisfy the entire building humidity load. The system is sized to maintain a prescribed ventilation rate under any load condition. The ventilation rate can be constant or varied based on the building operation or occupancy schedule or in response to the actual occupancy. It may pre-condition Outdoor Air by incorporating an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes or other heat or mass transfer apparatus. It shall reheat the ventilation air by containing a reheat refrigerant circuit, sensible wheel, heat pipe, or other heat or mass transfer apparatus. Cooling components may include chilled water coils. Heating

components are optional and may include electrical resistance, steam, hot water, or gas heat. In addition, it may provide for air cleaning.

3.4 Exhaust Air. Air removed from the Conditioned Space and discharged to the outdoor area of the building by means of mechanical or natural ventilation systems.

3.5 Exhaust Air Transfer Ratio (EATR). A ratio of the tracer gas concentration difference between the Supply Airflow and the Outdoor Airflow and the tracer gas concentration difference between the Return Airflow and the Outdoor Airflow at the 100% rated airflows, expressed as a percentage.

3.5.1 Outdoor Airflow (OA). The outdoor airflow before passing through the unit indicated in Figure 1 as station 1.

3.5.2 Supply Airflow (SA). The outdoor airflow delivered after passing through the unit, indicated in Figure 1 as station 2.

3.5.3 Return Airflow (RA). The exhaust airstream (indoor airflow) before passing through the unit, indicated in Figure 1 as station 3. This is only applicable on units with energy recovery exhaust.

3.5.4 Exhaust Airflow (EA). The exhaust airflow (indoor airflow) after passing through the unit, indicated in Figure 1 as station 4. This is only applicable on units with energy recovery exhaust.

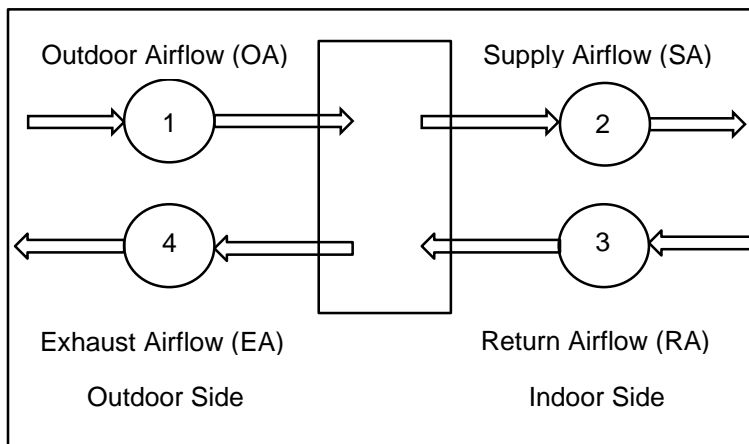


Figure 1. DX-DOAS Units Airflow Schematic

3.6 Ground Source Closed-loop Heat Pump. A heat pump that uses fluid circulated through a subsurface piping loop as a heat source/heat sink. The temperature of the fluid is related to climate and operating history conditions and usually varies from -4.0°C to 38.0°C .

3.7 Ground Source Heat Pump. A heat pump that uses water pumped from a well, lake or stream as a heat source/heat sink. The temperature of the water is related to climate conditions and usually ranges from 7.0°C to 24.0°C for deep wells.

3.8 Hot Gas Reheat. An air to refrigerant heat exchanger that uses energy from the cooling process to reheat cooled air.

3.9 Integrated Seasonal Coefficient of Performance (ISCOP). This seasonal efficiency number is a combined value based on Equation 5 listed in Section 6.4 of the two (2) COP values for the heating season of a DX-DOAS Unit Water Source Heat Pump expressed in W/W.

3.10 Integrated Seasonal Moisture Removal Efficiency (ISMRE). This seasonal efficiency number is a combined value based on Equation 6 listed in Section 6.5 of the four (4) dehumidification Moisture Removal Efficiency (MRE) ratings required in this standard for DX-DOAS Units expressed in kg of moisture/kWh.

3.11 Moisture Removal Capacity (MRC). The amount of moisture removed from the Outdoor Air at the DX-DOAS Unit rated airflow rate expressed in kg of moisture/h.

- 3.12** *Moisture Removal Efficiency (MRE)*. A ratio of the Moisture Removal Capacity expressed in kg/h to the total power input in kW at any given set of Rating Conditions expressed in kg of moisture/kWh, including any additional auxiliary energy required to raise the temperature to the supply airflow design condition.
- 3.13** *Net Sensible Cooling Capacity*. The amount of sensible cooling remaining after the air has been cooled to remove moisture and that can contribute to the building sensible load with the reheat disabled and the conditioned space at 24°C.
- 3.14** *Outdoor Air*. Ambient air that enters the DX-DOAS Unit.
- 3.15** *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.
- 3.15.1** *Application Rating*. A rating based on tests performed at application Rating Conditions (other than Standard Rating Conditions).
- 3.15.2** *Standard Rating*. A rating based on tests performed at Standard Rating Conditions as listed in Table 2.
- 3.16** *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.
- 3.16.1** *Standard Rating Conditions*. Rating Conditions used as the basis of comparison for performance characteristics as listed in Table 2.
- 3.17** *"Shall" or "Should"*. "Shall" or "should" shall be interpreted as follows:
- 3.17.1** *Shall*. Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.
- 3.17.2** *Should*. "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.
- 3.18** *Standard Air*. Air weighing 1.2 kg/m³, which is approximately dry air at 21°C and at a barometric pressure of 101.3 kPa.
- 3.19** *Supplementary Cooling*. A cooling source that is not part of the vapor compression cycle.
- 3.20** *Supplementary Heat Thermal Efficiency*. Heating output per heating input, %.
- 3.21** *Supplementary Heat*. A heating input value converted to watts that is not part of the vapor compression cycle, W.
- 3.22** *Total Cooling Capacity*. The capacity associated with the change in air enthalpy which includes latent cooling, sensible cooling and any effects of an energy recovery device, W.
- 3.23** *Tracer Gas Test*. The marking of air with a gas to monitor its presence, to monitor concentration, and to identify if any leaks are present in a system.
- 3.24** *Unit Total Heating Capacity*. Amount of heat the DX-DOAS Unit can input to the supply air in the heating mode, including the heat from the vapor compression cycle, air-to-air heat exchanger, and Supplementary Heat, kW.
- 3.25** *Unit Total Reheat Capacity*. Amount of heat the DX-DOAS Unit can input to the supply air in the dehumidification mode, including recovered heat from the vapor compression cycle and/or air-to-air heat exchanger or other heat or mass transfer apparatus, kW. This does not include Supplementary Heat.
- 3.26** *Water Source Heat Pump*. A heat pump that uses fluid circulated in a common piping loop as a heat source/heat sink. The temperature of the piping loop fluid is usually mechanically controlled within a moderate temperature range of 16.0°C to 32.0°C.

Section 4. Classifications

4.1 Classification. DX-DOAS Units within the scope of this standard shall be classified as shown in Table 1.

Table 1. Classification of DX-Dedicated Outdoor Air System Units^{4,5,6}			
Designation	AHRI Type ¹	Arrangement	
Remote Condenser Rejection with Hot Gas Reheat	RC-A-R RC-B-R RC-W-R	FAN	HEAT ² COND
		EVAP	
		HOT GAS REHEAT ³	
		SUP HEAT ⁴	
		COMP	
Remote Condenser Rejection with Energy Recovery and Hot Gas Reheat	RC-A-P-R RC-B-P-R RC-W-P-R	FAN	HEAT ²
		EVAP	COND
		HOT GAS REHEAT ³	ENERGY RECOVERY
		SUP HEAT ⁴	
		COMP	
Single Package with Hot Gas Reheat	SP-A-R SP-B-R SP-W-R SP-H-R	FAN	HEAT ² COND
		SUP HEAT ⁴	
		HOT GAS REHEAT ³	COND
		EVAP	COMP
		FAN	COND
Single Package with Energy Recovery and Hot Gas Reheat	SP-A-P-R SP-B-P-R SP-W-P-R SP-H-P-R	SUP HEAT ⁴	ENERGY RECOVERY
		HOT GAS REHEAT ³	COMP
		EVAP	HEAT ²
		FAN	COND

Notes:

1. A suffix of “-A” indicates air-cooled condenser, “B” indicates air-cooled heat pump condenser”, “-H” indicates Ground Source Closed-loop Heat Pump, Ground Source Heat Pump or Water Source Heat Pump, and “-W” indicates water-cooled condenser.
2. Heating for heat pump units
3. Hot Gas Reheat is optional if an alternate internal heat recovery system is used.
4. Supplementary Heat is optional.
5. Suffixes A, B, and W are referenced in Table 2. Suffix H is referenced in Table 3.
6. A suffix of “-P” indicates energy recovery pre-conditioning and “-R” indicates reheat. These are applicable to suffix A, B, H, or W.

Section 5. Test Requirements

5.1 Test Requirements. All Standard Ratings shall be established at the Standard Rating Conditions specified in Section 5.2 and shall be verified by tests conducted in accordance with the test method and procedures described in ASHRAE Standard 198. Tracer gas test measurements shall be conducted according to ASHRAE Standard 84, Section 8.4.

5.2 Standard Rating Tests. Tables 2 and 3 indicate the tests and test conditions which are required to determine values of standard Unit Total Heating Capacity, Unit Total Reheat Capacity, Moisture Removal Capacity, Moisture Removal Efficiency, and Coefficient of Performance.

5.2.1 Electrical Conditions. Standard rating tests shall be performed at the nameplate rated voltage and frequency unless otherwise specified in this standard.

For equipment that is rated with 208-230V dual nameplate voltages, standard rating tests shall be performed at 230V. For all other dual nameplate voltage equipment covered by this standard, the standard rating tests shall be performed at both voltages or at the lower of the two voltages if only a single Standard Rating is to be published.

Table 2. Operating Conditions for Standard Rating and Performance Tests for Classification A, B, and W DX-DOAS Units⁴

Rating Condition		Outdoor Airflow (OA) Temperature		Return Airflow (RA) Temperature ¹		Cooling Tower Condenser Water Entering Temperature	Chilled Water Entering Condenser Temperature	Ambient Air Temperature
		Dry-bulb, °C	Wet-bulb, °C	Dry-bulb, °C	Wet-bulb, °C	°C	°C	°C
DEHUMIDIFICATION	Standard Rating A Conditions ^{3,5}	35.0	26.0	24.0	17.0	29.0	7.0	35.0
	Standard Rating B Conditions ^{3,5}	27.0	23.0	24.0	17.0	27.0	7.0	27.0
	Standard Rating C Conditions ^{3,5}	20.0	19.0	24.0	17.0	19.0	7.0	20.0
	Standard Rating D Conditions ^{3,5}	15.5	14.5	24.0	15.0	11.0	7.0	15.5
	Manufacturer Application Condition	35.0	26.0	Min 16.0 Max 24.0	Min 10.0 Max 17.0	29.0	7.0	35.0
	Insulation Efficiency ^{2,3}	27.0	24.0	24.0	17.0	29.0	7.0	27.0
	Maximum Operating Conditions ³	46.0	24.0	24.0	17.0	32.0	24.0	46.0
HEATING	Part Load Standard Rating E Conditions ³	1.5	-1.5	21.0	14.5	NA	NA	1.5
	Standard Rating F Conditions ³	-9.0	-11.0	21.0	14.5	NA	NA	-9.0
	Maximum Operating Conditions ³	21.0	N/A	21.0	14.5	NA	NA	21.0

Notes:

1. Applies to units with energy recovery at balanced airflow.
2. Conditions surrounding the unit are the same as the outdoor air entering conditions.
3. All Rating Conditions shall include performance with a minimum Supply Airflow (SA) temperature of 21.0°C.
4. Air-cooled, air-cooled heat pump, and water-cooled condenser type units do not require supplementary heat testing. Supplementary Heat is not tested under this standard.
5. The maximum dew-point for Standard Rating Conditions A through D shall be 13.0°C.

Table 3. Operating Conditions for Standard Rating and Performance Tests for Classification H and W DX-DOAS Units⁵

Rating Condition		Outdoor Airflow (OA) Temperature		Return Airflow (RA) Temperature ¹		Inlet Fluid Temperature		
		Dry-bulb, °C	Wet-bulb, °C	Dry-bulb, °C	Wet-bulb, °C	Ground Source Closed-loop Heat Pumps, °C ⁵	Ground-water Source Heat Pumps, °C	Water Source Heat Pumps, °C
DEHUMIDIFICATION	Standard Rating A Conditions ^{3,6}	35.0	26.0	24.0	17.0	25.0	21.0	29.0
	Standard Rating B Conditions ^{3,6}	27.0	23.0	24.0	17.0	25.0	21.0	29.0
	Standard Rating C Conditions ^{3,6}	20.0	19.0	24.0	17.0	21.0	10.0	24.0
	Standard Rating D Conditions ^{3,6}	15.5	14.5	24.0	15.0	21.0	10.0	24.0
	Manufacturer Application Condition	35.0	26.0	Min 16.0 Max 24.0	Min 10.0 Max 17.0	29.0	7.0	35.0
	Insulation Efficiency ^{2,3}	27.0	24.0	24.0	17.0	25.0	21.0	29.0
	Maximum Operating Conditions ³	46.0	24.0	24.0	17.0	38.0	24.0	35.0
HEATING	Part Load Standard Rating E Conditions ³	2.0	-2.0	21.0	15.0	5.0	21.0	24.0
	Standard Rating F Conditions ³	-9.0	-11.0	21.0	15.0	0.0	10.0	21.0
	Maximum Operating Conditions ³	21.0	-	21.0	15.0	24.0	24.0	32.0

Notes:

1. Applies to units with energy recovery at balanced airflow.
2. Conditions surrounding the unit are the same as the outdoor air entering conditions.
3. All Rating Conditions shall include performance with a minimum supply air temperature of 21.0°C.
4. Water Source Heat Pump units do not require supplementary heat testing. Supplementary Heat is not tested under this standard.
5. 15% methanol is used during closed-loop water source heap pump testing.
6. The maximum dew-point for Standard Rating Conditions A through D shall be 13.0°C

5.2.2 *Supply Airflow Rate.* All Standard Ratings shall be determined at a Supply Airflow rate and a minimum external static pressure as specified in Table 4. All airflow rates shall be expressed in m³/hr of Standard Air.

5.2.2.1 Equipment with leaving air fans intended for use with field installed duct systems shall be rated at the airflow rate delivered when operating against the minimum external static pressure as shown in Table 4, or at a higher external static pressure and lower leaving airflow rate if so specified by the manufacturer.

5.2.2.2 Equipment with leaving air fans not intended for use with field installed duct systems (free discharge) shall be rated at the leaving airflow rate delivered when operating at 0 Pa external pressure as specified by the manufacturer.

5.2.2.3 The manufacturer shall specify a single airflow rate for all tests required in this part of the standard.

5.2.2.4 The refrigeration system and energy recovery (if applicable) shall not be in operation during the setup of all fans for rating purposes at the outdoor air entering temperature and return air temperature (if applicable) of Standard Rating Condition C. No fan speeds shall be adjusted for the remaining Standard Rating Conditions.

Supply Airflow Rate, m ³ /h	Minimum External Static Pressure, Pa
≤ 1,400	25
> 1,400 and ≤ 2,500	37
> 2,500 and ≤ 4,000	50
> 4,000 and ≤ 6,100	62
> 6,100 and ≤ 7,600	75
> 7,600 and ≤ 11,900	87
> 11,900 and ≤ 15,800	100
> 15,800 and ≤ 19,800	112
> 19,800 and ≤ 22,700	137
> 22,700 and ≤ 28,100	162
> 28,100	187

Section 6. Rating Requirements

6.1 *Rating Requirements.*

6.1.1 *Rating Requirements.* Standard Ratings shall be expressed as follows:

6.1.1.1 *Airflow Rate.* The supply airflow rate and return airflow rate (if applicable) at Standard Rating Condition C shall be expressed in terms of m³/hr of Standard Air as indicated in Table 5.

Rated Airflow for Units, m ³ /s	Multiples, m ³ /s
< 0.12	0.005
≥ 0.12 and < 0.24	0.01
≥ 0.24 and < 0.47	0.02
≥ 0.47	0.05

6.1.1.2 *Ambient Conditions.* Ambient conditions shall be expressed in terms of °C db/wb as stated in Tables 2 and 3.

6.1.1.3 *Coefficient of Performance.* COP shall be expressed in terms of W/W and stated to the nearest 0.05 W/W.

6.1.1.4 Electrical Power Input. Electrical power input shall be expressed in terms of kW and stated to the nearest 0.1 kW.

6.1.1.5 Integrated Seasonal Coefficient of Performance. ISCOP shall be expressed in terms of W/W and stated to the nearest 0.05 W/W.

6.1.1.6 Integrated Seasonal Moisture Removal Efficiency. ISMRE shall be expressed in terms of kg of moisture/kWh and stated to the nearest 0.05 kg of moisture/kWh.

6.1.1.7 Power Input of Supplementary Heat and Supplementary Cooling. Power input of Supplementary Heat and Supplementary Cooling shall be expressed in kW stated to the nearest increments of 0.03 kW.

6.1.1.8 Moisture Removal Capacity. MRC shall be expressed in terms of kg of moisture/h and stated to the nearest 0.05 kg of moisture/h.

6.1.1.9 Moisture Removal Efficiency. MRE shall be expressed in terms of kg of moisture/kWh and stated to the nearest 0.05 kg of moisture/kWh.

6.1.1.10 Net Sensible Cooling Capacity. Net Sensible Cooling Capacity shall be expressed in terms of kW stated to the nearest 0.03 kW.

6.1.1.11 Total Cooling Capacity. Total Cooling Capacity shall be expressed in terms of kW stated to the nearest 0.03 kW.

6.1.1.12 Unit Minimum Leaving Air Temperature in Cooling Mode. Net minimum Supply Air temperature in cooling mode conditions shall be expressed in terms of °C db stated to the nearest 0.05°C.

6.1.1.13 Unit Total Heating Capacity. Unit Total Heating Capacity shall be expressed in terms of kW and stated to the nearest 0.03 kW.

6.1.1.14 Unit Total Reheat Capacity. Unit Total Reheat Capacity shall be expressed in terms of kW and stated to the nearest 0.03 kW.

6.1.1.15 Water Flow Rate. Water flow rate shall be expressed in terms of L/s and stated to the nearest 0.005 L/s.

6.1.1.16 EATR. The EATR shall be expressed as a percentage, %.

6.1.1.17 Tracer Gas Test. The Tracer Gas Tests shall be performed at the 100% rated airflow rate listed in Tables 2 and 3. The tracer gas used shall be sulfur hexafluoride (SF₆). Tests shall be conducted at laboratory ambient temperature conditions with no psychrometric changes. Relative humidity shall be maintained between 20% and 60% for the duration of the test.

6.1.2 Values of Water Flow and Water Pressure Drop Ratings. Water flow rate and water pressure drop values shall be determined at each Standard Rating Condition specified in Tables 2 and 3. Water flow rate shall be expressed in terms of L/s and stated to the nearest 0.005 L/s. Water pressure drop through the unit for the rated standard flow rate(s) shall be expressed in multiples of 3.5 kPa.

6.1.3 Values of Moisture Removal Efficiency. In calculating MRE, an addition for the water pump effect, PE, shall be added to the measured power input (including total power input to the compressor(s), fan(s), controls and other items included as part of the model number) and determined using Equation 1. Table 6 shall apply to all units that include a refrigerant to liquid heat recovery device.

$$PE = WF [(PP_B \cdot \Delta P) + C]$$

1

Where:

- ΔP = Unit water pressure drop, kPa
- C = Constant pump energy 400 W per L/s based on a column of 6.0 m
- PE = Total pumping effect, W
- PP_B = Basic pumping penalty (Table 6), W/(kPa·L/s)
- WF = Water flow rate, L/s

Water Flow Rate, WF	Basic Pumping Penalty, PP _B
L/s	W/(kPa·L/s)
.06 - .25	11.50
.26 - .49	8.92
.50 - .75	6.19
.76 - 1.00	5.34
1.01 - 1.25	4.92
1.26 and above	4.65

6.1.3.1 Supplemental Heat Penalty. An additional kilowatt penalty is required if site recovered energy is not adequate to produce a leaving air temperature of 21.0°C. The penalty for each Standard Rating Condition A through F shall be calculated using Equation 2 through 4 when applicable.

$$\text{kW Penalty}_x = \frac{Q_{th,x}}{1,000} \tag{2}$$

$$Q_{th,x} = \frac{c_p \cdot (MSAT - LAT_x)}{v' \cdot (1+W)} \tag{3}$$

$$c_p = 1,005 + 1,859 \cdot W \tag{4}$$

Where:

- 1,000 = Conversion factor from watts to kilowatts, W/kW
- 1,005 = Specific heat of air, J/(Kg · °C)
- 1,859 = Specific heat of water vapor, J/(Kg · °C)
- c_p = The specific heat of leaving air, J/(Kg · °C)
- kW Penalty_x = Supplemental heat penalty at Standard Rating Condition x, where x is the Standard Rating Condition A, B, C, D, E, or F, W, kW
- LAT_x = Supply Airflow temperature at Standard Rating Condition x, where x is the Standard Rating Condition A, B, C, D, E, or F, °C
- MSAT = Minimum supply air temperature is 21.0 for each calculation, °C
- Q_{th,x} = Heating capacity required to achieve minimum supply air temperature, where x is the calculated value at Standard Rating Condition A, B, C, D, E, or F, W
- v' = Specific volume of leaving air and water mixture, m³/kg
- W = Leaving air humidity ratio, kg moisture/kg dry air

6.1.4 Liquid Flow Rates.

6.1.4.1 For DX-DOAS Units with integral liquid pumps, ratings shall be determined at a liquid flow rate specified by the manufacturer.

6.1.4.2 For DX-DOAS Units without integral liquid pumps, ratings shall be determined at a liquid flow rate specified by the manufacturer.

6.1.4.3 The manufacturer shall specify a single liquid flow rate for all of the tests required in this part of the standard unless automatic adjustment of the liquid flow rate is provided by the equipment. A separate control signal output for each step of liquid flow rate will be considered as an automatic adjustment.

6.1.5 *Test Liquid.* The test liquid for DX-DOAS Units shall be water and it shall be sufficiently free of gas to ensure that the measured result is not influenced by its presence.

6.2 *Application Ratings.* Ratings at conditions other than those specified in Tables 2 and 3 may be published as Application Ratings, and shall be based on data determined by the methods prescribed in Section 6.1.

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

6.4 *Calculation of Integrated Seasonal Coefficient of Performance.* ISCOP is calculated using Equation 5. The weighted values are derived from bin hour data and represent a year of operation.

$$\text{ISCOP} = (\text{COP}_E \cdot 0.77) + (\text{COP}_F \cdot 0.23) \quad 5$$

Where:

COP_E = Coefficient of Performance at Standard Rating Condition E, W/W

COP_F = Coefficient of Performance at Standard Rating Condition F, W/W

6.5 *Calculation of Integrated Seasonal Moisture Removal Efficiency.* ISMRE is calculated using Equation 6. The weighted values are derived from bin hour data and represent a year of operation.

$$\text{ISMRE} = (\text{MRE}_A \cdot 0.12) + (\text{MRE}_B \cdot 0.28) + (\text{MRE}_C \cdot 0.36) + (\text{MRE}_D \cdot 0.24) \quad 6$$

Where:

MRE_A = Moisture Removal Efficiency at Standard Rating Condition A, kg of moisture/kWh

MRE_B = Moisture Removal Efficiency at Standard Rating Condition B, kg of moisture/kWh

MRE_C = Moisture Removal Efficiency at Standard Rating Condition C, kg of moisture/kWh

MRE_D = Moisture Removal Efficiency at Standard Rating Condition D, kg of moisture/kWh

Section 7. Minimum Data Requirements for Published Ratings

7.1 *Minimum Data Required for Published Ratings.* As a minimum, Published Ratings shall consist of the following information:

- 7.1.1** Airflow rate, m³/h
- 7.1.2** Input of all supplementary heating and cooling sources, at all Standard Rating Conditions (dehumidification and heating), kW
- 7.1.3** Supplementary Heat Thermal Efficiency when applicable for internal gas heating, %
- 7.1.4** Leaving air temperature with reheat on and with reheat off, Standard Rating Conditions, dehumidification, °C
- 7.1.5** Leaving air temperature without Supplementary Heat, Standard Rating Conditions, heating, °C
- 7.1.6** MRC, at all Standard Rating Conditions, dehumidification, kg of moisture/h
- 7.1.7** MRE, at all Standard Rating Conditions, dehumidification, kg of moisture/kWh
- 7.1.8** ISCOP, W/W
- 7.1.9** ISMRE, kg of moisture/kWh
- 7.1.10** Unit Total Heating Capacity, at all Standard Rating Conditions, heating, kW
- 7.1.11** Unit Total Reheat Capacity, at all Standard Rating Conditions, dehumidification, kW
- 7.1.12** Water flow rate (where water is used for heat rejection), L/s
- 7.1.13** Leaving air dew point temperature at each rated condition as listed in Tables 2 and 3, °C
- 7.1.14** Total Cooling Capacity, kW
- 7.1.15** Net Sensible Cooling Capacity, kW
- 7.1.16** COP (for Water-Source Heat Pumps), at all Standard Rating Conditions, heating, W/W
- 7.1.17** Exhaust Air Transfer Ratio, %
- 7.1.18** Power frequency, Hz
- 7.1.19** Voltage/phase, V/(ph)

As a minimum, Published Ratings shall include all Standard Rating Conditions. All claims to ratings within the scope of this standard shall include the statement “Rated in accordance with AHRI Standard 921 (SI)”. All claims to ratings outside the scope of this standard shall include the statement “Outside the scope of AHRI Standard 921 (SI)”. Wherever Application Ratings are published or printed, they shall include a statement of the conditions at which the ratings apply.

Section 8. Operating Requirements

8.1 *Operating Requirements.* DX-DOAS Units shall comply with the provisions of this section such that any production unit will meet the requirements detailed herein.

8.2 *Maximum Operating Conditions Test.* DX-DOAS Units shall pass the following maximum dehumidification and heating operating conditions test with a leaving airflow rate as specified by the manufacturer.

8.2.1 *Temperature Conditions.* Temperature conditions shall be maintained as shown in Tables 2 and 3.

8.2.2 *Voltages.* Tests shall be run at the minimum and maximum utilization voltages as shown in ANSI/AHRI Standard 110 at the unit's service connection and rated frequency.

8.2.3 *Procedure.*

8.2.3.1 DX-DOAS Units shall be operated continuously for one hour at the temperature conditions and voltage(s) specified.

8.2.3.2 All power to the equipment shall be interrupted for a period sufficient to cause the compressor to stop (not to exceed five seconds) and then be restored.

8.2.4 *Requirements.*

8.2.4.1 During both tests, the equipment shall operate without failure of any of its parts.

8.2.4.2 The unit shall resume continuous operation within one hour of restoration of power and shall then operate continuously for one hour. Operation and resetting of safety devices prior to establishment of continuous operation is permitted.

8.3 *Dehumidification Low Temperature Operation Test.* DX-DOAS Units shall pass the following low-temperature operation test when operating with initial airflow rates as specified by the manufacturer with controls and dampers set to produce the maximum tendency to frost or ice the indoor coil, provided such settings are not contrary to the manufacturer's instructions to the user.

8.3.1 *Temperature Conditions.* Temperature conditions shall be maintained at the Standard Rating D Conditions as shown in Tables 2 and 3.

8.3.2 *Voltage and Frequency.* The test shall be performed at nameplate rated voltage and frequency. For DX-DOAS Units with dual nameplate voltage ratings, tests shall be performed at the lower of the two voltages.

8.3.3 *Procedure.* The test shall be continuous with the DX-DOAS Units in the dehumidification cycle for not less than four hours after establishment of the specified temperature conditions. The unit will be permitted to start and stop under control of an automatic limit device, if provided.

8.3.4 *Requirements.*

8.3.4.1 During the entire test, the equipment shall operate without damage.

8.3.4.2 During the entire test, the airflow rate shall not drop more than 5% from that specified for the Standard Rating test.

8.3.4.3 During all phases of the test and during the defrosting period after the completion of the test, all ice or meltage must be caught and removed by the drain provisions.

8.4 *Insulation Efficiency Test (Dehumidification).* DX-DOAS Units shall pass the following insulation efficiency test when operating with airflow rates as specified by the manufacturer with controls, fans, dampers, and grills set to produce the maximum tendency to sweat, provided such settings are not contrary to the manufacturer's instructions to the user.

8.4.1 *Temperature Conditions.* Temperature conditions shall be maintained as shown in Tables 2 and 3.

8.4.2 *Procedure.* After establishment of the specified temperature conditions, the unit shall be operated continuously for a period of four hours.

8.4.3 *Requirements.* During the test, no condensed water shall drop, run, or blow off from the unit casing.

8.5 *Voltage Tolerance Test.* DX-DOAS Units shall pass the following voltage tolerance test with a leaving airflow rate as specified by the manufacturer.

8.5.1 *Temperature Conditions.* Temperature conditions shall be maintained at the standard dehumidification (and/or standard heating, as required) steady state conditions as shown in Tables 2 and 3.

8.5.2 *Voltages.*

8.5.2.1 Tests shall be run at the minimum and maximum utilization voltages from ANSI/AHRI Standard 110 based upon the unit's nameplate rated voltage(s). These voltages shall be supplied at the unit's service connection and at rated frequency. A lower minimum or a higher maximum voltage shall be used, if listed on the nameplate.

8.5.2.2 The power supplied to single-phase equipment shall be adjusted just prior to the shutdown period so that the resulting voltage at the unit's service connection is 86% of nameplate rated voltage when the compressor motor is on locked-rotor. (For 200V or 208V nameplate rated equipment, the restart voltage shall be set at a minimum of 180V when the compressor motor is on locked rotor). Open circuit voltage for three-phase equipment shall not be greater than 90% of nameplate rated voltage.

8.5.2.3 Within one minute after the equipment has resumed continuous operation (Section 8.5.4.3), the voltage shall be restored to the values specified in Section 8.5.2.1.

8.5.3 *Procedure.*

8.5.3.1 The equipment shall be operated for one hour at the temperature conditions and voltage(s) specified.

8.5.3.2 All power to the equipment shall be interrupted for a period sufficient to cause the compressor to stop (not to exceed five seconds) and then be restored.

8.5.4 *Requirements.*

8.5.4.1 During both tests, the equipment shall operate without failure of any of its parts.

8.5.4.2 The equipment shall operate continuously without interruption for any reason for the one hour period preceding the power interruption.

8.5.4.3 The unit shall resume continuous operation within two hours of restoration of power and shall then operate continuously for one half hour. Operation and resetting of safety devices prior to establishment of continuous operation is permitted.

Section 9. Marking and Nameplate Data

9.1 *Marking and Nameplate Data.* As a minimum, the nameplate shall display the manufacturer's name, model designation, electrical characteristics, MRC and MRE at Standard Rating point A, and COP at Standard Rating Point F, if applicable.

Nameplate voltages shall include one or more of the equipment nameplate voltage ratings shown in ANSI/AHRI Standard 110.

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 shall not 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 110-2012, *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/AHRI Standard 210/240-2008 with Addenda 1 and 2, *Unitary Air-Conditioning and Air-Source Heat Pump Equipment*, 2008, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd. Suite 500, Arlington, VA 22201, U.S.A.

A1.3 ANSI/AHRI Standard 340/360-2007, with Addendum 1, *Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment*, 2007, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd. Suite 500, Arlington, VA 22201, U.S.A.

A1.4 ANSI/AHRI Standard 920 (I-P)-2015, *Performance Rating of DX-Dedicated Outdoor Air System Units*, 2015, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd. Suite 500, Arlington, VA 22201, U.S.A.

A1.5 ANSI/AHRI/ASHRAE/ISO 13256-1 (2012), *Water-Source Heat Pumps – Testing and Rating for Performance – Part 1: Water-to Air and Brine-to-Air Heat Pumps*, 2012, International Organization for Standardization, Case Postale 56, CH-1211, Geneva 21, Switzerland.

A1.6 ANSI/ASHRAE Standard 84-2013, *Method of Testing Air-to-Air Heat Exchangers*, 2008, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

A1.7 ANSI/ASHRAE Standard 198-2013, *Method of Test for Rating DX-Dedicated Outdoor Air System (DX-DOAS) Units*, 2013, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.8 *ASHRAE Terminology*, <https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology>, 2014, 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

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.

None.