AHRI Standard 921 (SI) with Addendum 1

2020 Standard for

Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units

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AHRI STANDARD 921-2020 WITH ADDENDUM 1

Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units

April – 2021

Addendum 1 of AHRI Standard 920-2020, is provided as follows. The following change has been incorporated (deletions are shown by ~~strikethroughs~~ and additions by shading) into the already published 2020 version of AHRI Standard 920 to avoid confusion:

The change includes the modification of Equation 20 description:

6.9.2 *Degradation Coefficient Method.* When the Supply Air dew-point temperature measured when operating the unit at its lowest-capacity compressor stage is lower than the target Supply Air dew-point temperature in excess of the specified test condition tolerance, perform additional tests in accordance with 6.9.2.1 and 6.9.2.2. Adjust the MRE and MRE_{70} by using a degradation coefficient, as show in Equations 18 through 27.

$$MRE_x = \frac{MRC_{Tgx}}{LF_x \cdot C_{D_x} \cdot (P_{CC_x} + P_{E,x} + WCoolPenalty_x) + P_{NCx}} \quad 18$$

$$MRE_{70,x} = \frac{MRC_{Tgx}}{LF_x \cdot C_{D_x} \cdot (P_{CC_x} + P_{E,x} + W\ CoolPenalty_x + W\ HeatPenalty_x) + P_{NCx}} \quad 19$$

For DX-DOAS ~~with~~ without VERS, with deactivated VERS (see Section 5.4.3), or with sensible-only VERS tested under Standard Rating Conditions other than D:

$$C_{D_x} = 1 + 0.35 \cdot (1 - LF_x) \quad 20$$

*Table of Contents updated to correct titles and page numbers.

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Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

IMPORTANT

SAFETY DISCLAIMER

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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 921 (SI)-2015.

For I-P ratings, see AHRI Standard 920 (I-P)-2020 with Addendum 1.

AHRI CERTIFICATION PROGRAM PROVISIONS

The current scope of the Direct Expansion – Dedicated Outdoor Air System Units (DX-DOAS) Units Certification Program can be found on AHRI's website at this link: http://www.ahrinet.org/Certification/AHRI-Certification-Programs/DX-Dedicated-Outdoor-Air-System-Units

Foreword:

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.

Price $10.00 (M) $20.00 (NM)
Printed in U.S.A.

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Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

SECTION **TABLE OF CONTENTS** **PAGE**

Section 1. Purpose....1

Section 2. Scope....1

Section 3. Definitions....1

Section 4. Classifications....5

Section 5. Test Requirements....6

Section 6. Rating Requirements....9

Section 7. Minimum Data Requirements for Published Ratings....23

Section 8. Operating Requirements....23

Section 9. Marking and Nameplate Data....25

Section 10. Conformance Requirements....25

Section 11. Symbols and Subscripts....25

TABLES

Table 1. Classification of DX- Dedicated Outdoor Air System Units....6

Table 2. Charging Hierarchy and Charging Test Condition Tolerance....8

Table 3. Multiples for Rated MRC....10

Table 4. Conditions for Standard Rating and Maximum Operating Tests for Classifications A, B, and W DX-DOAS Units....11

Table 5. Conditions for Standard Rating and Maximum Operation Tests for Classification H DX-DOAS Units....12

Table 6. Multiples for Rated Airflow....14

Table 7. External Static Pressures....15

Table 8. Basic Pumping Penalty (PP_B) vs. Liquid Flow Rate (WF)....16

Table 9. Test Operating and Test Condition Tolerances....17

Table 10. Heating Capacity Tests....20

Table 11. Supply Air Temperatures and W Penalty Used for Calculation of Heating Mode Ratings....21

FIGURES

Figure 1 DX-DOAS Unit Airflow Schematic....2

APPENDICES

Appendix A References – Normative....28

Appendix B References – Informative....29

AVA Documents Document Sharing Hub

Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

Appendix C ANSI/ASHRAE Standard 198 and ANSI/ASHRAE Standard 37 Additions Clarifications and Exceptions – Normative 30

Appendix D MRE and COP Weighted Average Calculations – Informative 46

Appendix E Typical Test Unit Installations – Informative 56

Appendix F Unit Configuration for Standard Efficiency Determination – Normative 63

Appendix G Verification Testing – Normative 66

TABLES FOR APPENDICES

Table C1 Outdoor Coil Entering Air Conditions for Air-Cooled and Evaporatively-Cooled DX-DOAS Units 30

Table C2 Temperature Measurement Requirements 34

Table C3 Criteria for Air Distribution and Control of Air Temperature 41

Table C4 Default VERS Performance Values 43

Table D1 MRE Weighted Average Calculation Example 1; Tested Values 46

Table D2 MRE Weighted Average Calculation Example 2; Tested Values 49

Table D3 COP Weighted Average Calculation Example 1; Tested Values 52

Table D4 COP Weighted Average Calculation Example 2; Tested Values 54

Table G1 Acceptance Criteria 66

FIGURES FOR APPENDICES

Figure C1 Non-Ducted Outlet Plenum 32

Figure C2 Non-Ducted Inlet Plenum (Without Ducting to Booster Fan) 33

Figure C3 Aspirating Psychrometer 34

Figure C4 Typical Air Sampling Tree 36

Figure C5 Determination of Measurement Rectangles and Required Number of Air Sampler Trees 37

Figure C6 Typical Test Setup Configurations 38

Figure E1 Single Package DX-DOAS Laboratory Schematic (No VERS) 56

Figure E2 Single Package DX-DOAS unit with Desiccant Wheel lLaboratory sSchematic (No VERS) 57

Figure E3 Single Package DX-DOAS unit with VERS (Option 1 - 2 Rooms) 58

Figure E4 Single Package DX-DOAS unit with VERS (Option 1 - , 3 Rooms) 59

Figure E5 Single Package DX-DOAS unit with Desiccant Wheel (Option 1 - , 3 Rooms) 60

Documents
Document Sharing Hub

Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

Figure E6 Single Package DX-DOAS with VERS (Option 2) 61
Figure E7 Relief-Air-Cooled DX-DOAS with or without VERS (Option 1) 62

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

PERFORMANCE RATING OF DIRECT EXPANSION-DEDICATED OUTDOOR AIR SYSTEM UNITS

Section 1. Purpose

1.1 *Purpose*. The purpose of this standard is to establish for Direct Expansion-Dedicated Outdoor Air System (DX-DOAS) 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-DOAS Units as defined in Section 3.

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

2.1.2 *Installation*. DX-DOAS Units are intended for ducted or non-ducted installation with field or factory supplied grilles.

2.2 *Exclusions.* This standard shall not apply to Sensible-only 100% Outdoor Air Units. Direct conversion of values from testing performed under AHRI Standard 921 (SI) 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 *Air Conditions.*

3.1.1 *Exhaust Air.* Air removed from the DX-DOAS Unit after use (a) for preconditioning Outdoor Air in a VERS, (b) as a heat sink or source for an Outdoor Coil, or (c) both, and discharged outside the building by means of mechanical ventilation systems. This is only applicable to DX-DOAS units with VERS and Relief-Air-Cooled DX-DOAS units.

3.1.2 *Outdoor Air*. Unconditioned air from outside a building taken from the external atmosphere.

3.1.3 *Outdoor Ventilation Air*. The Outdoor Air that passes through the conditioning coil and is supplied to the conditioned space.

3.1.4 *Regeneration Air.* Outdoor Air drawn into the DX-DOAS Unit that is used to remove moisture from the desiccant and is exhausted to the building exterior, rather than to the Conditioned Space.

3.1.5 *Return Air*. Air removed from the Conditioned Space and delivered to the DX-DOAS Unit by means of mechanical ventilation systems. This air is used to precondition Outdoor Air in a VERS or act as a heat sink or source for an Outdoor Coil.

3.1.6 *Simulated Ventilation Air*. Air that is representative of the pre-conditioned air leaving the Ventilation Energy Recovery System (VERS) when using test Option 2, as described in Section 5.4.

3.1.7 *Supply Air*. Conditioned air discharged from the DX-DOAS Unit and delivered to the Conditioned Space.

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Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

3.2 *Airflow*.

3.2.1 *Exhaust Airflow*. The moving volume of exhaust air discharged outside the building. Exhaust Airflow is expressed in m^3/s (see Figure 1).

3.2.2 *Outdoor Airflow*. The moving volume of Outdoor Air that enters and is conditioned by the DX-DOAS Unit. Outdoor Airflow is expressed in m^3/s (see Figure 1).

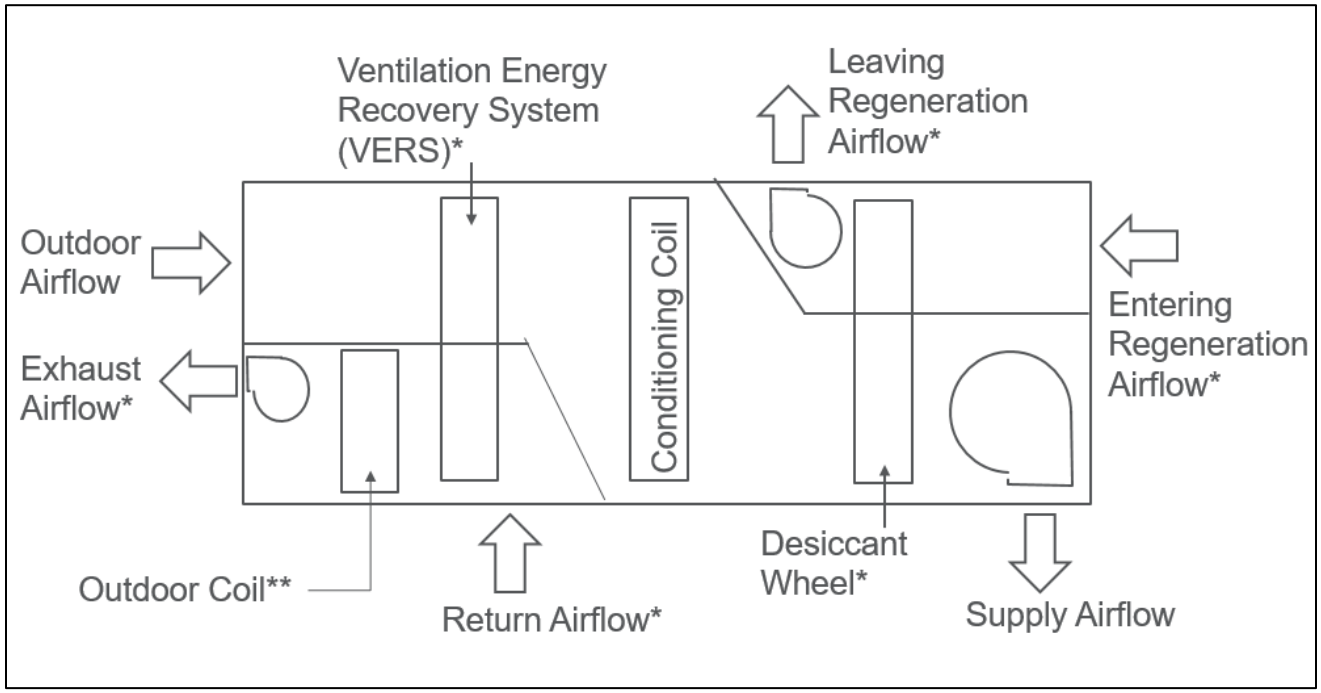
3.2.3 *Regeneration Airflow*. The moving volume of Outdoor Air that is drawn into the DX-DOAS Unit, is used to remove moisture from the desiccant, and is exhausted to the building exterior, rather than to the Conditioned Space.

3.2.4 *Return Airflow*. The moving volume of Return Air entering the DOAS. Return Airflow is expressed in m^3/s (see Figure 1).

3.2.5 *Simulated Ventilation Airflow*. The moving volume of Simulated Ventilation Air that is ducted to the Outdoor Air inlet and the Return Air inlet during Option 2 testing as described in Figure E6.

3.2.6 *Supply Airflow*. The moving volume of Supply Air delivered by the DX-DOAS Unit by the unit-mounted Supply Air fan or fans. Supply Airflow is expressed as m^3/s (see Figure 1).

3.2.6.1 *Rated Supply Airflow*. The Supply Airflow used when setting Airflow, as described in Section 6.1.5.



* - Denotes components of a DX-DOAS unit that may not be present in all testing arragements.
**- This outdoor coil location applicable only for a Relief-Air-Cooled DX DOAS arrangement. May be present in this location in a unit with or without VERS. Otherwise, the outdoor coil is in a separate location exposed to flow of outdoor air.

Figure 1. DX-DOAS Units Airflow Schematic.

3.3 *Coefficient of Performance (COP)*. 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.

3.3.1 $COP_{DOAS,x}$. The COP of the DX-DOAS Unit determined by the Total Heating Capacity – DOAS and the unit's electrical input power at the corresponding compressor capacity control that provides, or most closely provides, a Supply Air dry bulb temperature within the allowed Supply Air dry bulb temperature range (where x signifies the Standard Rating Condition).

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Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

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

3.5 *Conditioning Coil.* The coil that uses evaporating refrigerant to cool and dehumidify the Outdoor Ventilation Air in a DX-DOAS without a Ventilation Energy Recovery System (VERS) or to cool and dehumidify the air leaving the energy recovery device in a DX-DOAS with energy recovery.

3.6 *Direct Expansion-Dedicated Outdoor Air System Units (DX-DOAS or DX-DOAS Units)*. A type of air-cooled, evaporatively-cooled, or water-cooled air-conditioner, or an air-source or water source heat pump, that is a factory assembled product designed and marketed and sold to provide ventilation and dehumidification of 100 % Outdoor Air, is capable of dehumidifying air to a 12.8 °C dew point when operating under Standard Rating Condition A as specified in Table 4 or Table 5 of this test standard with a barometric pressure of 101.3 kPa, and may include Reheat. It may include pre-conditioning of Outdoor Air using an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes, or other heat or mass transfer apparatus. Heating components are optional and may include electrical resistance, steam, hot water, or gas heat. In addition, it may provide for air cleaning or may include mixing box or economizer dampers to allow Return Air to be intermittently used as allowed by the controls.

3.6.1 *Outdoor-Air-Cooled DX-DOAS.* An air-cooled DX-DOAS unit which uses 100% outdoor air to cool the Outdoor Coil in dehumidification mode.

3.6.2 *Relief-Air-Cooled DX-DOAS.* An air-cooled DX-DOAS unit which cools or warms the outdoor coil using either (a) 100% Return Air, or (b) the air leaving a VERS after pre-conditioning the entering Outdoor Air.

3.7 *Energy Recovery Wheel.* A rotating-disk VERS having a porous matrix that transfers heat and may transfer moisture between air streams passing through opposite sides of the disk. It transfers energy between the air streams by alternately contacting one and then the other air stream as it rotates.

3.8 *Exhaust Air Transfer Ratio (EATR)*. The fraction of the flow of Standard Air leaving a VERS that leaked or transferred from the Return Air inlet rather than passing through the VERS from the Outdoor Air inlet.

3.9 *Full Capacity*. For compressors with Staged Capacity Control, all compressors on and are operating at maximum capacity. For compressors with Proportional Capacity Control, all compressors are on and operating at maximum capacity allowed by the factory mounted controls.

3.10 *Ground Source Closed-loop Heat Pump*. A heat pump that uses fluid circulated through a subsurface piping loop as a heat source/heat sink.

3.11 *Ground Source Heat Pump*. A heat pump that uses water pumped from a well, lake or stream as a heat source/heat sink.

3.12 *Integrated Seasonal Coefficient of Performance (ISCOP2)*. A seasonal efficiency rating. A combined heating efficiency rating of a DX-DOAS heat pump at operating points E and F, as defined in Tables 4 and 5, based on the formulas listed in Section 6.12. Expressed in W/W.

3.13 *Integrated Seasonal Moisture Removal Efficiency (ISMRE2)*. This seasonal efficiency rating is a combined MRE rating of a DX-DOAS Unit operating at standard rating conditions A, B, C and D as defined in Tables 4 and 5 and based on the formula listed in Section 6.13. Expressed in kg of moisture/kW·h.

3.13.1 *Integrated Seasonal Moisture Removal Efficiency 70 (ISMRE2$_{70}$)*. This seasonal efficiency rating is a combined MRE_{70} rating of a DX-DOAS Unit operating at standard rating conditions A, B, C and D, as defined in Tables 4 and 5, and based on the formula listed in Section 6.13.

3.14 *Manufacturer's Installation Instructions (MII)***.** Manufacturer's documents that come packaged with or appear in the labels applied to the unit(s). Online manuals are acceptable if referenced on the unit label or in the documents that come packaged with the unit. All references to "manufacturer's instructions," "manufacturer's published instructions," "manufacturer's installation instructions," "manufacturer's published recommendations," "manufacturer installation and operation manuals," "installation instructions" and other similar references means Manufacturer's Installation Instructions.

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Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

3.14.1 *Supplemental Test Instructions (STI).* Additional instructions provided by the manufacturer and certified to the United States Department of Energy (DOE). STI shall include (a) all instructions that do not deviate from MII but provide additional specifications for test standard requirements allowing more than one option, and (b) all deviations from MII necessary to comply with steady state requirements. STI shall provide steady operation that matches to the extent possible the average performance that would be obtained without deviating from the MII. STI shall include no instructions that deviate from MII other than those described in (b) above.

3.15 *Moisture Removal Capacity (MRC).* The rate of moisture removal from air delivered by the DX-DOAS Unit as Supply Air, expressed in kg of moisture/h at the Rated Supply Airflow rate.

3.16 *Moisture Removal Efficiency (MRE).* A ratio of the Moisture Removal Capacity to the total power input at any given set of Rating Conditions expressed in kg of moisture per kW·h.

3.16.1 *Moisture Removal Efficiency-70 (MRE_{70}).* The MRE of the DX-DOAS Unit including energy usage from any Supplementary Heat that is required to raise the temperature of the Supply Air to 21.1 °C.

3.17 *Outdoor Coil.* The heat exchanger that operates as a condenser to reject heat from the refrigeration circuit in dehumidification mode or (for heat pump DX-DOAS) operates as an evaporator to absorb heat into the refrigeration circuit during heating mode. For the purposes of this standard, most of the Outdoor Coils have Outdoor Air passing through them, except for Relief-Air-Cooled Dx-DOAS Units.

3.18 *Proportional Capacity Control.* Compressor capacity control that has at least one compressor with continuously modulating capacity or multiple capacity steps where the Total Cooling Capacity for each step is not more than 5% of the sum of all the ANSI/CAN/AHRI Standard 540 Table 1, rating test capacities for high temperature refrigeration.

3.19 *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.

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

3.19.2 *Standard Rating*. A rating based on tests performed at Standard Rating Conditions as listed in Table 4 or Table 5 and Table 7.

3.20 *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.

3.20.1 *Standard Rating Conditions.* Rating Conditions used as the basis of comparison for performance characteristics as listed in Table 4 or Table 5 and Table 7. Conditions A, B, C, D, E and F, are denoted throughout the standard using a subscript, x, in some cases.

3.21 *Reheat.* Sensible heat that the DX-DOAS Unit can input to the Supply Air in the dehumidification mode to raise its dry bulb temperature downstream of the conditioning coil.

3.21.1 *Cycle Reheat.* Heat that is used to increase the dry bulb temperature of dehumidified air leaving the evaporator that is supplied by a component that is either part of the vapor compression cycle, or a system that transfers heat from one part of the unit to the other (e.g., wrap-around heat pipe, wrap-around vapor compression cycle), or a system that transfers heat from outdoors, or air moving over the Outdoor Coil, to the dehumidified air. Cycle Reheat is not Supplementary Heat. Cycle Reheat is expressed in units of W.

3.21.2 *Supplementary Reheat.* Supplementary Heat used during dehumidification mode.

3.22 *"Shall" or "Should".* "Shall" or “should” shall be interpreted as follows:

3.22.1 *Shall.* Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance

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Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

with the standard is claimed.

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

3.23 *Staged Capacity Control.* Compressor capacity control that only uses discrete steps of compression or compressor on-off cycling. This type of control uses more than one stage and is not proportional control.

3.24 *Standard Air*. Air weighing 1.20 kg/m^3 which approximates dry air at 21.1 °C and at a barometric pressure of 101.3 kPa.

3.25 *Supplementary Heat.* All heat required to increase the dry bulb temperature of dehumidified or heat pump heated Supply Air (as applicable) to 21 °C per Section 6.3 that is not provided by the following sources: a**.** the vapor compression cycle, b. a system that transfers heat from one part of the unit to the other (e.g., wrap-around heat pipe, wrap-around vapor compression cycle), c. a system that transfers heat from the Outdoor Air to the Supply Air. Supplementary Heat is expressed in units of W.

3.26 *Total Cooling Capacity*. The capacity associated with the change in air enthalpy, which includes latent cooling, sensible cooling and any effects of a VERS, W.

3.27 *Total Heating Capacity*. Amount of heat the DX-DOAS Unit can input to the Supply Air in the heating mode. This includes the heat only from the vapor compression cycle, supply air fan heat, and the VERS, W.

3.27.1 *Total Heating Capacity - DOAS.* The Total Heating Capacity of the DX-DOAS Unit limited to a maximum supply air temperature of 24 °C if the unit capacity produces a Supply Air dry bulb temperature greater than 24 °C.

3.28 *Ventilation Energy Recovery System (VERS).* A system that preconditions Outdoor Air entering the DX-DOAS Unit through direct or indirect thermal and/or moisture exchange with the Exhaust Air. Figures showing suggested DX-DOAS with VERS laboratory schematics include Figures E3, E4, E5, and E6. Figures showing a DX-DOAS without VERS laboratory schematics include Figures E1 and E2.

3.28.1 *Test Option 1*. DX-DOAS unit with VERS where the Outdoor Air and Return Air conditions during the test are the same as the Standard Rating Conditions specified in Tables 4 and 5 of this standard. This option will have a VERS attached and operating. Suggested lab schematics for Option 1 can be found in Appendix E, specifically Figures E3, E4, and E5.

3.28.2 *Test Option 2*. DX-DOAS unit with VERS with Simulated Ventilation Air, adjusted to account for VERS pre-conditioning performance based on AHRI Standard 1061 (SI) ratings, entering the Outdoor Air inlet and Return Air inlet of the conditioning unit. This option will have a VERS attached and operating per Section C4. Suggested lab schematics for Option 2 testing can be found in Appendix E, specifically Figure E6.

3.29 *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.

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

Table 1. Classification of DX-Dedicated Outdoor Air System Units

Designation	AHRI Type[1,2,3]	Typical Arrangement
Remote Condenser with Cycle Reheat	RC-A-R RC-B-R RC-W-R RC-H-R	EVAP CYCLE REHEAT FAN HEAT COND COMP
Remote Condenser with VERS and Cycle Reheat	RC-A-P-R RC-B-P-R RC-W-P-R RC-H-P-R	VERS CYCLE REHEAT FAN HEAT EVAP COMP COND
Single Package with Cycle Reheat	SP-A-R SP-B-R SP-W-R SP-H-R	EVAP CYCLE REHEAT FAN HEAT COMP COND
Single Package with VERS and Cycle Reheat	SP-A-P-R SP-B-P-R SP-W-P-R SP-H-P-R	VERS EVAP CYCLE REHEAT FAN HEAT COMP COND

Notes:
1. "-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-source or water-cooled condenser.
2. "-A," "-B," "-H," and "-W" are referenced in Tables 4 and 5.
3. "-P" indicates energy recovery pre-conditioning and "-R" indicates Reheat. These are applicable to " -A", "-B," "-H," or "-W."

Section 5. Test Requirements

5.1 *Test Requirements*. All Standard Ratings shall be verified by tests conducted in accordance with the test methods and procedures as described in this standard and its appendices. Units shall be tested in accordance with ANSI/ASHRAE Standard 198 as amended by this standard and Appendix C.

5.2 *Equipment Installation.* Units shall be installed per MII. In the event of conflicting instructions regarding the set-up of the unit under test, priority shall be given to MII that appear on the unit's label over MII that are shipped with the unit. If the unit is a split system and the components' MII conflict, priority shall be given to the indoor unit MII over the outdoor unit MII unless indicated otherwise by the STI.

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

5.3 *Steady State Requirements and Measurement Intervals.* Requirements for achieving equilibrium prior to testing (including when setting of airflow under Standard Rating Condition A), test duration, and recording of measurements shall be as described in Sections 8.2 and 8.4 of ANSI/ASHRAE Standard 198. Equilibrium, which means achievement of steady-state conditions meeting the tolerances of Section 6.6 of this standard, shall also be maintained during recording of measurements.

5.3.1 At least three consecutive sets of measurements made every five minutes shall be recorded to confirm the setting of airflow in Section 6.1.5. The measurements shall be made during steady operation meeting the applicable tolerances of Section 6.6 of this standard. When setting airflow under Standard Rating Condition A as described in Section 6.1.5.3, the equilibrium and measurement recording requirements described in the above paragraph shall be met.

5.4 *Testing Requirements for DX-DOAS Equipped with VERS.*

5.4.1 *VERS Standard Rating Options*. DX-DOAS equipped with VERS, can be tested using either one of the options described under Section 5.4.1.1 or Section 5.4.1.2.

5.4.1.1 *Option 1*. The Outdoor Ventilation Air and Return Air conditions are the same as the Standard Rating Conditions specified in Tables 4 and 5 of this standard.

5.4.1.2 *Option 2*. The Simulated Ventilation Airflow temperature and humidity shall be adjusted to account for VERS conditioning per Appendix C, Section C4. Option 2 shall not be used for Relief-air-cooled DX-DOAS.

5.4.2 *Energy Recovery Wheel Rotational Speed.* For DX-DOAS models with energy recovery wheels, if the DX-DOAS manufacturer uses an energy recovery wheel rotational speed different from the speed used to determine the EATR and effectiveness values, the default EATR and effectiveness values provided in Section C4 and Table C4 of Appendix C shall be used to determine performance.

5.4.3 *Deactivation of VERS*. If the VERS is capable of being deactivated and if the VERS deactivation is also specified by the manufacturer, the operation of the VERS may be deactivated for Standard Rating Condition C or D. This is allowed for testing either using Option 1 (Section 5.4.1.1) or Option 2 (Section 5.4.1.2). The air surrounding the unit and entering the Outdoor Coil for both Option 1 and 2 shall be equal to the Outdoor Air conditions specified in Tables 4 and 5 of this standard, except as outlined in Sections C2.1 and C2.1.2 of Appendix C.

Informative Note: Although other methods of deactivation can exist, the following examples are three commons methods for VERS deactivation: a) the rotation of an energy recovery wheel can be stopped. b) Controlled shut off valves can be added to a heat pipe to prevent energy transfer between Outdoor Air and Return Air. c) Bypass dampers can allow most air to bypass any energy recovery device.

5.4.3.1 When using Option 1, if the deactivation is achieved by switching the position of face/bypass dampers, airflow shall first be reset for the bypass mode and airflow shall be reset as described in Section 6.1.5.5 using dry bulb air conditions of Standard Rating Condition D. If airflows had initially been set using the procedures of Section 6.1.5.3, match within required tolerances of Table 10.

5.4.3.2 When using Option 2, deactivation shall be simulated by substituting Outdoor Air conditions for Simulated Ventilation Air conditions and de-energizing VERS powered components (e.g. Energy Recovery Wheel rotation motors) as they would be during deactivation in field operation. If specified by the manufacturer, the position of the face/bypass dampers shall be switched and the airflow shall be reset as specified in Section 6.1.5.5 using dry bulb air conditions of Standard Rating Condition D.

5.5 *Defrost Controls for Air-Source Heat Pump during Heating Mode.* Defrost controls shall be left at manufacturer's factory settings if the published installation instructions provided with the equipment do not specify otherwise. Any defrost control settings specified by the manufacturer in installation instructions and that can be achieved through methods outlined in the MII may be used to achieve steady state. To facilitate testing, the manufacturer shall provide information and any necessary hardware to manually initiate a defrost cycle. If the defrost settings require defrost during the heating mode tests, the manufacturer shall submit a petition for a waiver from test procedure to obtain an alternative method of test, pursuant to 10 CFR §431.401. The Standard Rating F condition test is optional. If the Standard Rating F condition test is not conducted, a default value of 1.0 shall be assigned for $COP_{DOAS,F}$, in order to complete the ISCOP2 calculation.

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

5.6 *Break-in.* Manufacturers may optionally specify a "break-in" period to operate the equipment under test prior to conducting the test. If an initial break-in period is required to achieve performance, the break-in conditions and duration shall be specified by the manufacturer, but shall not exceed 20 hours in length. No testing per Section 6 shall commence until the manufacturer-specified break-in period is completed. Each compressor of the unit shall undergo this "break-in" period.

5.7 *Condenser Head Pressure Controls*. If modulation or cycling of air-cooled condenser fan(s) or water-cooled flow control valve(s) occurs that prevents the DX-DOAS unit from maintaining the test tolerances shown in Table 9, the STI document provided by the manufacturer shall be referenced to determine the settings required to stabilize the operation. The STI shall result in condensing (liquid outlet) pressure corresponding to a bubble point temperature between 24 °C and 54 °C. Should no STI documentation be provided, the operation without intervention should first be observed. For the test, the fan(s) or valve(s) causing the instability shall be set manually at a speed, operating state (on/off) or position to achieve stable condensing (liquid outlet) pressure corresponding to a bubble point temperature as close to 29 °C as possible while remaining no lower than 29 °C. If there is a discharge pressure port but no liquid pressure port, the STI settings or manual intervention shall achieve a stable discharge pressure corresponding to a bubble point temperature at least 1.7 °C higher than the minimum values indicated above.

5.8 *Refrigerant Charging*. All test samples shall be charged at Standard Rating Condition A (or condition at which the manufacturer indicates in the MII) in accordance with the MII. If the MII contain two sets of refrigerant charging criteria, one for field installation and one for lab testing, use the field installation criteria. Unless the MII specifies a tighter charging tolerance, the test condition tolerances specified in Table 2 shall be used for the criterion specified by the MII.

5.8.1 If the MII give a specified range for superheat, sub-cooling, or refrigerant pressure, the average of the range shall be used to determine the refrigerant charge. Perform charging of near-azeotropic and zeotropic refrigerants only with refrigerant in the liquid state.

5.8.2 If there are no MII and/or the MII do not provide parameters and specified values, set superheat to a value of -11 °C for fixed orifice systems or set sub-cooling to a value of -12 °C for expansion valve systems, with test condition tolerance as specified in Table 2.

5.8.3 In the event of conflicting information between charging instructions, use the instruction priority order indicated in Section 5.2. Conflicting information is defined as multiple conditions given for charge adjustment where all conditions specified cannot be met. If such instances of conflicting information occur within the highest ranking set of instructions for which refrigerant charging instructions are provided, follow the hierarchy in Table 2 for priority.

Table 2. Charging Hierarchy and Charging Test Condition Tolerance

Fixed Orifice			Expansion Valve		
Priority	Method	Tolerance	Priority	Method	Tolerance
1	Super-heat	± 1.1 °C	1	Sub-cooling	± 1.1 °C
2	High Side Pressure or Saturation Temperature	± 28.0 kPa or ± 0.6 °C	2	High Side Pressure or Saturation Temperature	± 28.0 kPa or ± 0.6 °C
3	Low Side Pressure or Saturation Temperature	± 28.0 kPa or ± 0.6 °C	3	Low Side Pressure or Saturation Temperature	± 14.0 kPa or ± 0.4 °C
4	Low Side Temperature	± 1.1 °C	4	Approach Temperature	± 0.6 °C
5	High Side Temperature	± 1.1 °C	5	Charge Weight	± 57.0 g
6	Charge Weight	± 57.0 g			

5.8.4 *Single Package Unit.* Install one or more refrigerant line pressure gauges during the setup of the unit, as described in Section 5.8.4.1 or 5.8.4.2, located depending on the parameters used to verify or set charge, unless the MII instructions say not to verify refrigerant charge.

5.8.4.1 Install a pressure gauge at the location of the service valve on the liquid line if charging is on the basis of sub-cooling, high side pressure, corresponding saturation, or dew point temperature.

5.8.4.2 Install a pressure gauge at the location of the service valve on the suction line if charging is on the basis of superheat, high side pressure, corresponding saturation, or dew point temperature

5.8.5 The refrigerant charge obtained as described in Section 5.8 shall then be used to conduct all tests used to

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

determine performance. All tests shall run until completion without further modification. If measurements indicate that refrigerant charge has leaked during the test, repair the refrigerant leak, repeat any necessary set-up steps, and repeat all tests.

5.9 Test *Unit Location.* Install the unit under test in accordance with Sections 6.1, 6.6 and 7.2 of ANSI/ASHRAE Standard 198 (with modifications outlined in Appendix C of this standard).

5.10 *Atmospheric Pressure*. Tests shall be conducted at an atmospheric pressure of at least 94.5 kPa.

5.11 *Supplementary Heat*. All Supplementary Heat sources, including electric resistance heat, shall be turned off or disconnected from power during the test.

5.12 *Instrumentation and Apparatus*. Use instruments and apparatus that meet the applicable requirements specifications in the following standards (see Sections 5.12.1 through 5.12.10).

5.12.1 *Airflow Measurement*. Sections 5.3, 6.2, 6.3, and 7.7 (not including Sections 7.7.1.2, 7.7.3, and 7.7.4) of ANSI/ASHRAE Standard 37.

5.12.2 *Refrigerant and Liquid Pressure Measurement*. Section 5.2 of ANSI/ASHRAE Standard 37.

5.12.3 *Duct Static Pressure and Pressure Difference*. Sections 5.1.3, 5.3.2, 6.4, and 6.5 of ANSI/ASHRAE Standard 37.

5.12.4 *Temperature Measurements*. Temperature measurements other than those used to determine air conditions (dry bulb temperature and water vapor content), shall follow Section 4.4 of ANSI/ASHRAE Standard 198. For air condition measurements, see Section C3 of Appendix C.

5.12.5 *Electrical Measurements.* Section 4.5 of ANSI/ASHRAE Standard 198.

5.12.5.1 Modulating compressors require an integrated measurement or an indicated reading of no more than one second.

5.12.6 *Liquid Flow Measurement*. Section 4.6 of ANSI/ASHRAE Standard 198.

5.12.7 *Time and Mass Measurements*. Section 4.7 of ANSI/ASHRAE Standard 198.

5.12.8 *Test Room and Room Conditioning System Requirements*. Section 7.1 of ANSI/ASHRAE Standard 198.

5.12.9 *Volatile Refrigerant Flow Measurement*. Section 5.5 of ANSI/ASHRAE Standard 37.

5.12.10 *Atmospheric pressure measurement.* See Section 5.2 of ANSI/ASHRAE Standard 37, except the atmospheric pressure measuring instruments shall be accurate to within ± 0.5% of the reading.

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

5.13.1 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.

Section 6. Rating Requirements

6.1 *Standard Ratings*. Standard Ratings shall be at the Standard Rating Conditions specified in Tables 4 and 5 and in this Section.

6.1.1 All Standard Ratings shall be determined by tests in accordance with Section 5.

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

6.1.2 Ratings shall include the following performance metrics.

6.1.2.1 *COP_{DOAS} (heat pump only).* COP_{DOAS} shall be expressed in terms of W/W and stated to the nearest 0.05 W/W.

6.1.2.2 *Electrical Power Input.* Electrical power input shall be expressed in terms of W and stated to the nearest 100 W.

6.1.2.3 *ISCOP2 (heat pump only).* ISCOP2 shall be expressed in terms of W/W and stated to the nearest 0.1 W/W.

6.1.2.4 *ISMRE2.* ISMRE2 shall be expressed in terms of kg/kW·h and stated to the nearest 0.05 kg/kW·h.

6.1.2.5 *MRC.* MRC shall be expressed in terms of kg/h and stated to the nearest multiple, as shown in Table 3.

Table 3. Multiples for Rated MRC

Rated MRC For Units (kg/h)	Multiples (kg/hr)
$0 < MRC \leq 14$	0.1
$14 < MRC \leq 27$	0.2
$27 < MRC \leq 82$	0.5
$82 < MRC$	1

6.1.2.6 *MRE.* MRE shall be expressed in terms of kg/kW·h and stated to the nearest 0.05 kg/kW·h.

6.1.2.7 *Total Heating Capacity (heat pump only).* Total heating capacity shall be expressed in terms of W and stated to the nearest 25 W.

6.1.2.8 *Supply Air Temperature and Dew Point.* Supply Air dry bulb, wet bulb and dew point (dew point is only required in the dehumidification mode of operation) shall be expressed in terms of °C and stated to the nearest 0.1°C.

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

Table 4. Conditions for Standard Rating and Maximum Operating Tests for Classifications A, B, and W DX-DOAS Units[1]

	Rating Condition	Outdoor Air (OA) Temperature, °C		Condenser Water Entering Temperature, Cooling Tower Water, °C[2]	Condenser Water Entering Temperature, Chilled Water, °C[2,3]	Ambient Air Temperature[2], °C
		Dry bulb	Wet bulb			
DEHUMIDIFICATION	Standard Rating A Conditions[5]	35.0	26.0	30.0	7.0	35.0
	Standard Rating B Conditions[5]	27.0	23.0	27.0	7.0	27.0
	Standard Rating C Conditions[5]	21.0	19.0	23.0	7.0	21.0
	Standard Rating D Conditions[5]	17.0	15.0	19.0	7.0	17.0
	Maximum Operating Conditions	46.0	24.0	32.0	N/A	46.0
HEATING	Part Load Standard Rating E Conditions[6,7]	8.0	6.0	N/A	N/A	8.0
	Standard Rating F Conditions[6,7,8]	-8.0	-9.0	N/A	N/A	-8.0
	Maximum Operating Conditions	21.0	N/A	N/A	N/A	21.0

Notes:
1. Supplementary Heat is not tested under this standard.
2. See Section 6.1.6.5 for test liquid requirements.
3. Informative note: While many configurations of a chilled water-cooled condenser may exist, typically this system would apply when a water-cooled DX-DOAS unit is connected to a chilled water loop to provide lower dew point air than would be possible with that chilled water and a water coil, the "Condenser Water Entering Temperature, Chilled Water" temperature condition may be used to provide the heat rejection capability for a DX-DOAS unit
4. Conditions surrounding the unit and entering the condenser (outdoor) coil are the same as the Outdoor Air entering conditions, except as described in Section C2.1.2 of Appendix C.
5. Return Air for Standard Rating Conditions A, B, C and D shall be 23.9 °C dry bulb temperature and 16.9 °C wet bulb temperature, except as described in Section C4 of Appendix C.
6. Return Air for Standard Rating Conditions E and F shall be 21.1 °C dry bulb temperature, except as described in Section C4 of Appendix C.
7. For Standard Rating Conditions E and F, Return Air wet bulb conditions of 14.7 °C is required for Relief Air-Cooled DX-DOAS. Otherwise, control of Return Air water vapor content is not required for Standard Rating Conditions E and F.
8. Standard Rating F Condition test is optional. If Standard Rating F Condition test is not conducted, a default value of 1 shall be assigned for $COP_{DOAS,F}$.

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

Table 5. Conditions for Standard Rating and Maximum Operation Tests for Classification H DX-DOAS Units[1]

Rating Condition		Outdoor Airflow (OA) Temperature[2], °C		Inlet Fluid Temperature, °C	
		Dry bulb	Wet bulb	Water-Source Heat Pumps[3]	Water-Source Heat Pump, Ground-Source Closed Loop (Optional)[3,4]
DEHUMIDIFICATION	Standard Rating A Conditions[5]	35.0	26.0	30.0	25.0
	Standard Rating B Conditions[5]	27.0	23.0	27.0	25.0
	Standard Rating C Conditions[5]	21.0	19.0	23.0	20.0
	Standard Rating D Conditions[5]	17.0	15.0	19.0	20.0
	Maximum Operating Conditions	46.0	24.0	40.0	40.0
HEATING	Part Load Standard Rating E Conditions[6,7]	8.0	6.0	20.0	5.0
	Standard Rating F Conditions[6,7,8]	-8.0	-9.0	20.0	0.0
	Maximum Operating Conditions	21.0	N/A	30.0	25.0

Notes:
1. Supplementary Heat is not tested under this standard.
2. Conditions surrounding the unit are the same as the Outdoor Air entering conditions.
3. See Section 6.1.6.5 for test liquid requirements.
4. Manufacturer may recommend antifreeze type and concentration at the optional conditions.
5. Return Air for Standard Rating Conditions A, B, C and D shall be 24.0 °C dry bulb temperature and 17.0 °C wet bulb temperature dry bulb temperature, except as described in Section C4 of Appendix C.
6. Return Air for Standard Rating Conditions E and F shall be 21.0 °C dry bulb temperature, except as described in Section C4 of appendix C.
7. Control of return air water vapor content is not required for Standard Rating Conditions E and F.
8. Standard Rating F Condition test is optional. If Standard Rating F Condition test is not conducted, a default value of 1 shall be assigned for $COP_{DOAS,F.}$

6.1.3 *Supply Air Dew Point Temperature*. After establishing Standard Airflow per Section 6.1.5, Supply Air dew point temperature in °C shall be $12.8 + 0.186 \times (101.3 - P_{bar})$ or below for all Standard Rating Conditions A through D where barometric pressure P_{bar} is measured in kPa. Supply Air dew point temperature for tests conducted for Standard Rating Conditions B, C, and D shall be within ± 0.2 °C of the average Supply Air dew point temperature measured for Standard Rating Condition A. If the Supply Air dew point temperature cannot be controlled within ± 0.2 °C for a given unloading point (e.g. because the unit has Staged Capacity Control), but tests can be conducted for which the Supply Air

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

dew point temperatures are above and below the target, steady state tests shall be conducted above and below the target. If the lowest capacity stage results in a dew point temperature lower than the target, either (a) conduct two tests, the first using the lowest-capacity stage, and the second with compressors turned off, or (b) conduct one test for which the power input and electric energy use of the compressor and the condenser fans are separately measured. (Refer to Section 6.9 of this standard for MRE calculations) There are no Supply Air dew point temperature requirements for heating mode tests.

6.1.3.1 *Initial Standard Rating Condition A Dehumidification Test.* For Standard Rating Condition A, operate the unit within a test condition tolerance of ± 0.2 °C of the dew point that would result in matching the certified Moisture Removal Capacity (reported per Section 6.1.2.5) to the certified supply airflow at the measured barometric pressure. If there is no rated airflow, use the full capacity settings and follow the provisions in Section 6.1.5.3 for setting airflow.

6.1.4 *Supply Air Dry Bulb Temperature.*

6.1.4.1 *$ISMRE2_{70}$/MRE_{70}.* Attempt to set the Supply Air dry bulb temperature within a temperature range of 21 ºC to 24 °C for all Standard Rating Conditions used to calculate MRE_{70} or $ISMRE2_{70}$. If Cycle Reheat cannot be adjusted in sufficiently small increments to obtain Supply Air dry bulb temperature (adjusted for duct losses) in the range from 21 ºC to 24 °C for dehumidification tests or does not attain 21 ºC at its maximum reheat setting, adjust it to provide the maximum achievable temperature lower than this target range. If Cycle Reheat overshoots 24 °C at its minimum reheat setting, test using the minimum setting. The supplemental heating penalty and the supplemental cooling penalty apply to this rating, as described in Sections 6.3 and 6.4.

6.1.4.2 *ISMRE2/MRE*. Supply Air dry bulb temperatures shall be set using the STI, and should be below 24 °C (adjusted for duct losses) . If an approach for setting the Supply Air dry bulb temperatures is not indicated in the STI and Supply Air Temperatures are not otherwise reported, the temperature shall be set following Section 6.1.4.1. If Cycle Reheat overshoots 24 °C at its minimum reheat setting, test using the minimum setting. The supplemental cooling penalty applies to this rating, as described in Sections 6.4.

6.1.4.3 *Heating Mode Tests.* For heat pump units in heating mode, attempt to set the Supply Air dry bulb temperature within a temperature range of 21 ºC to 24 °C. If the Supply Air dry bulb temperature (adjusted for duct losses) cannot be controlled within this target range for a given Standard Rating condition (e.g. because the unit has Staged Capacity Control), two steady state tests shall be conducted above and below the target range (i.e., Supply Air dry bulb temperature is above 24 °C for one test and below 21 ºC for the other). For a DX-DOAS without VERS, the lower of these capacity stages must include some non-zero level of compressor operation—for a DX-DOAS with VERS, the lower of these stages may include operation of the VERS without compressor operation. If the lowest compressor capacity stage of a DX-DOAS unit without VERS delivers Supply Air dry bulb temperature greater than 24 °C, test the unit at this lowest compressor capacity stage. If a DX-DOAS unit with VERS delivers a Supply Air dry bulb temperature greater than 24 °C without operating the compressor, test the unit without operating the compressor

6.1.4.4 *Duct Losses.* The Supply Air dry bulb temperature shall be adjusted for duct losses for ductwork between the unit's supply duct connection and the air condition measurement location using Equations 1 and 2 prior to comparison with the target. Use the adjusted value wherever T_{SA} is called for in ANSI/ASHRAE Standard 198 and in this test standard.

Note: If the Supply Air duct passes through a chamber dividing wall, separately calculate and add duct loss q_{loss} for the duct exposed to different chamber temperatures

$$T_{SA} = T_{SA,measured} + \frac{q_{loss}}{Q_{SA} \cdot c_{pSA}} \quad (1)$$

$$q_{loss} = U \cdot A_{duct}\left(T_{SA,measured} - T_{OA}\right) \quad (2)$$

6.1.5 *Supply and Return Airflow Rates*. Standard ratings shall be determined after setting up Supply Airflow (and Return Airflow rate for units with VERS or Relief-Air-Cooling) as specified in this section.

6.1.5.1 *Representation of Airflow.*

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

6.1.5.1.1 Airflow specifications and measured airflow to be compared to specifications shall be expressed in m^3/s, calculated as shown in Equation 3.

$$Q_{SA} = \frac{Q_{mSA}}{1.20 \cdot v_{SA}} = \frac{Q_{mSA}}{1.20 \cdot v'_{SA}(1+W_{SA})} \quad (3)$$

Where, 1.20 kg/m^3 is the density of air at 20°C and 101.3 kPa.

6.1.5.1.2 Rated Supply Airflow rate shall be rounded as indicated in Table 6.

Table 6. Multiples for Rated Airflow

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

6.1.5.2 If there is no Supply Airflow specification, refer to Section 6.1.5.3 for unspecified Supply Airflow. Otherwise, set up Airflow as indicated below. If the STI includes equipment settings for Airflow, start with those settings. Otherwise, make no unit adjustments. Control the test chamber(s) at Point C dry bulb conditions per Table 4 and Table 5. When building a plenum to duct outdoor air to an air intake hood, consider the requirements of Section C2.5.1 when setting airflows. The unit's compressors shall be off but optional VERS shall be active. Adjust the unit and the airflow measurement apparatus fans to obtain the Table 7 ESP levels corresponding to the specified Supply Airflow, a measured Supply Airflow within a +/- 3% test condition tolerance of its specified value, and a measured Return Airflow (for units with VERS or Relief-Air-Cooling) within +/- 3% test condition tolerance of the measured Supply Airflow. If successful, preliminary airflows are established—refer to Section 6.1.5.4. If not, make adjustments as described in Sections 6.1.5.2.1-5.

6.1.5.2.1 For belt-drive fans without variable motor speed control (e.g. a variable-frequency drive) or belt-drive fans with variable motor speed control already at maximum or minimum settings, change sheaves using compatible off-the-shelf sheaves and re-start the above adjustment procedure.

6.1.5.2.2 For direct-drive fans with step-adjustable motor speed control at an intermediate speed setting (not the maximum or minimum speed), change to the next higher or lower speed setting as appropriate and re-start the above set-up procedure. If, for two adjacent speed steps for such a fan, the lower speed is too low and the higher speed is too high, use the higher speed. Set the airflow measurement apparatus fans to obtain a measured Supply Airflow within a +/- 3% test condition tolerance of its specified value, and a measured Return Airflow (for units with VERS or Relief-Air-Cooling) within +/- 3% test condition tolerance of the measured Supply Airflow.

6.1.5.2.3 If a fan's maximum speed is too low to satisfy the Airflow and ESP requirements within tolerance (i.e. the motor speed is at the highest setting, a larger compatible off-the-shelf sheave is not available, or increased speed would overload the motor or motor drive) and the motor is not a non-standard low-static motor, use the maximum speed and adjust the airflow measurement apparatus fan to achieve an airflow and ESP satisfying Table 7.

6.1.5.2.4 If the motor is a non-standard low-static motor, use the maximum available speed that does not overload the motor or motor drive and adjust the airflow measurement apparatus fan to achieve the specified Supply Airflow within +/-3% test condition tolerance (for Supply Air fans) or to set the Return Airflow within +/- 3% test condition tolerance of the measured Supply Airflow.

6.1.5.2.5 If a fan's minimum speed is too high to satisfy the Airflow and ESP requirements within tolerance (i.e. the motor speed is at the lowest setting, or a smaller compatible off-the-shelf sheave is not available), use the minimum speed setting and adjust the airflow measurement apparatus fan to achieve the specified Supply Airflow within +/-3% test condition tolerance (for Supply Air fans) or to

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Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

set the Return Airflow within +/- 3% test condition tolerance of the measured Supply Airflow.

6.1.5.3 *Unspecified Supply Airflow.* If Supply Airflow is not specified then it must be determined by testing at Condition A and adjusting Supply Airflow such that the Supply Air dew point temperature is $12.8 + 0.186 \times (101.3 - P_{bar})$ within a test condition tolerance of -0.3/+0.0 °C. Set up Airflow as described in Section 6.1.5.2, except that achieving a Supply Airflow within +/- 3 % of the specified Supply Airflow shall be replaced with achieving the above Supply Air dew point requirement. Return Airflow shall still be set within +/- 3 % of measured Supply Airflow. After setting airflow, do not make any further adjustments of the supply fan, return fan or airflow measurement apparatus fan (except as indicated for optional VERS bypass for Standard Rating Condition D described in Section 6.1.5.5), and proceed with performance testing without rechecking the Supply dew point temperature as described in Section 6.1.5.4.

6.1.5.4 *Confirmation of Sufficient Dehumidification for Preliminary Airflows*. Operate the unit at Standard Rating Condition A. If Supply Air dew point temperature is less than or equal to $12.8 + 0.186 \times (101.3 - P_{bar})$ then Airflow settings are confirmed. Do not make any further adjustments of the supply fan, return fan or airflow measurement apparatus fan (except as indicated for optional VERS bypass for Standard Rating Condition D described in Section 6.1.5.7), and proceed with performance testing. If the Supply Air dew point temperature is high, reset Airflow(s) as described in Section 6.1.5.3.

6.1.5.5 *Airflow for VERS Bypass*. If VERS bypass is specified in the STI for Standard Rating Condition D, reset Airflows prior to conducting performance testing for this condition. Open the VERS bypass and deactivate the VERS. If there was no Supply Airflow specification, use the Supply Airflow measured for Standard Rating Condition A as the specified Supply Airflow. Follow the steps in Section 6.1.5.2 to set Airflows. When complete, proceed with performance testing for Standard Rating Condition D.

6.1.5.6 *External Static Pressure.* When setting airflow in accordance with Section 6.1.5.2 or 6.1.5.3, the minimum external static pressures shall be as specified in Table 7 or the certified external static pressure, whichever is greater. All pressures shall be expressed in Pa.

Table 7. External Static Pressures

Supply Airflow Rate, m^3/h	Minimum Supply Airflow External Static Pressure, Pa	Minimum Return Airflow External Static Pressure, Pa
≤ 1500	159	187
> 1,500 and ≤ 2,400	214	212
> 2,400 and ≤ 3,900	241	231
> 3,900 and ≤ 6,000	266	251
> 6,000 and ≤ 7,600	286	266
> 7,600 and ≤ 11,900	309	281
> 11,900 and ≤ 15,800	328	296
> 15,800	336	304

6.1.6 *Liquid Flow Rates for Water-Cooled, Water-Source Heat Pump, and Ground-Source Heat Pump.*

6.1.6.1 For DX-DOAS Units with or without integral liquid pumps, ratings shall be determined at a liquid flow rate specified by the manufacturer. The liquid flow rate specified by the manufacturer for Standard Rating Conditions and Max Operating Conditions shall result in a liquid temperature rise greater than or equal to 4 °C at Standard Rating Condition A. Manufacturers may specify a liquid flow rate for Manufacturer Application Conditions that results in a liquid temperature change greater than or equal to 2 °C.

6.1.6.2 A single liquid flow rate shall be used 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. In no case shall the liquid flow rate for any of the other Standard Rating condition tests (i.e., B, C, and D) exceed the value as determined as described in Section 6.1.5.1.

Documents
Document Sharing Hub
Full document details: AHRI Standard 921-2020 (SI) - Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units - Addendum 1

6.1.6.3 *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 4 and 5. Water flow rate shall be expressed in terms of L/s and stated to the nearest 0.01 L/s. Water pressure drop through the unit for the rated standard flow rate(s) shall be expressed in multiples of 1 kPa.

6.1.6.4 *Values of Water Pump Effect*. In calculating MRE and COP, an addition for the water pump effect, $P_{E,x}$, applicable for Standard Rating Condition x (see Sections 6.9 and 6.11), shall be added to the measured power input, which is represented as P_T in ANSI/ASHARE 198 (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 4. Table 8 shall apply to all water-cooled and water-source units.

$$P_{E,x} = WF\ [(PP_B \cdot \Delta P) + C] \qquad 4$$

Table 8. Basic Pumping Penalty (PP_B) vs. Liquid Flow Rate (WF)

Liquid Flow Rate (WF), L/s	Basic Pumping Penalty (PP_B), W/(L/s·kPa)
0.06 – 0.25	11.50
0.26 – 0.50	8.93
0.51 – 0.75	6.19
0.76 – 1.00	5.34
1.01 – 1.25	4.92
1.26 and above	4.65

6.1.6.5 *Test Liquid.* The test liquid for DX-DOAS Units shall be water, except for ground-source closed-loop DX-DOAS, which shall use a manufacturer-specified fluid (see note 7 of Table 5), and it shall be purged of all gas, as required in ISO Standard 13256-1 Section 4.1.9.3.

6.2 *Application Ratings.* Ratings at conditions other than those specified in Tables 4 and 5 may be published as Application Ratings, and shall be based on data determined by the methods prescribed in Section 6.1. Application Ratings shall not include integrated performance ratings (e.g. ISMRE2 and ISCOP2).

6.3 *Supplementary Heat Penalty*. Calculate the Supplementary Heat penalty for the determination of MRE_{70} and $COP_{ISCOP,x}$ (where x represents the Standard Rating Condition) when the Supply Air dry bulb temperature, adjusted as described in Section 6.1.4, is less than 21 °C.

6.3.1 When two dehumidification mode tests are conducted for a staged-capacity DX-DOAS for a single Standard Rating Condition, calculate and apply the heating penalty for each test prior to calculating the weighted average MRE_{70} values, per Section 6.9.1.

6.3.2 Calculate the Supplementary Heat penalty, $\mathbf{W\ HeatPenalty}_x$, expressed in W, as described in Section C6 of this standard.

6.4 *Supplementary Cooling Penalty*. For dehumidification mode, calculate the supplementary cooling penalty for the determination of MRE_x and $MRE_{70,x}$ (where x represents the Standard Rating Condition) when the Supply Air dry bulb temperature, adjusted as described in Section 6.1.4, is greater than 24 °C.

6.4.1 When two dehumidification mode tests are conducted for a staged-capacity DX-DOAS for a single Standard Rating Condition, calculate and apply the supplementary cooling penalty for each test prior to calculating the weighted average MRE and MRE_{70} values.

6.4.2 Calculate the supplementary cooling penalty, $W\ CoolPenalty_x$, expressed in W, as described in Section C6 of this standard.

6.5 *Determination of EATR.*

6.5.1 For DX-DOAS units equipped with a VERS, where the VERS is not an Energy Recovery Wheel, $EATR_{DOAS}$ equals zero.

6.5.2 For DX-DOAS units equipped with an Energy Recovery Wheel, adjust the $EATR_{DOAS}$ to DX-DOAS Supply

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