AHRI Standard 211/241-0B/1B-2021 (SI)

2021 Standard for

Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment

AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

we make life better®

2311 Wilson Boulevard, Suite 400
Arlington, VA 22201, USA
www.ahrinet.org
PH 703.524.8800
FX 703.562.1942

Documents
Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

IMPORTANT

SAFETY DISCLAIMER

AHRI does not set safety standards and does not certify or guarantee the safety of any products, components or systems designed, tested, rated, installed or operated in accordance with this standard/guideline. It is strongly recommended that products be designed, constructed, assembled, installed and operated in accordance with nationally recognized safety standards and code requirements appropriate for products covered by this standard/guideline.

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 is a new Standard

For I-P ratings, see AHRI Standard 210/240 (I-P)-2017 (with Addendum 1).

AHRI Certification Program Disclaimer

AHRI Standards are developed independently of AHRI Certification activities and may have scopes that include products that are not part of the AHRI Certification Program. The scope of the applicable AHRI Certification Program can be found on AHRI's website at www.ahrinet.org.

FOREWORD

The standard has been developed as an SI version of AHRI Standard 210/240 (I-P)-2017 (with Addendum 1) for application outside of the United States and Canada with the following major revisions:

- Update the Section 11 SEER calculation to support hot climate conditions. Additional global requirements may be added when required.
- Remove references to AHRI Certification and the U.S. Department of Energy.
- Remove evaporatively-cooled, water-cooled, and heating only equipment from the scope.
- Remove heating rating and heating testing conditions. Heat pump products remain because they can be tested in cooling mode.
- Convert all I-P units to SI.
- Remove reference to ASHRAE 116-2010 but retained information required to perform cyclic testing.

For informational purposes, in this standard "fan" and "blower" are used synonymously.

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

TABLE OF CONTENTS

SECTION		PAGE
Section 1.	Purpose	1
Section 2.	Scope	1
Section 3.	Definitions and Acronyms	2
Section 4.	Classifications	8
Section 5.	Test Requirements	10
Section 6.	Rating Requirements	17
Section 7.	Minimum Data Requirements for Published Ratings	27
Section 8.	Operating Requirements	28
Section 9.	Marking and Nameplate Data	30
Section 10.	Conformance Conditions	30
Section 11.	Calculations	31
Section 12.	Symbols and Subscripts	49

TABLES

Table 1.	Classification of Unitary Air-conditioners	8
Table 2.	Classification of Unitary Air-source Heat Pumps	9
Table 3.	Classification of Multi-split Systems	10
Table 4.	Refrigerant Line Length Correction Factors	11
Table 5.	Test Condition Tolerance for Charging Hierarchy	12
Table 6.	Test Operating and Test Condition Tolerances for Cyclic Dry Coil Cooling Mode Tests	15
Table 7.	Informative Guidance for Using AHRI Standard 211/241-0B/1B (SI)	18
Table 8.	Required Tests – T1 Climate	19
Table 9.	Required Tests – Hot Climates	20
Table 10.	Test Conditions for Air-cooled Products	21
Table 11.	Values of Standard Capacity Ratings	22
Table 12.	Minimum External Static Pressure for Ducted Systems	24
Table 13.	Fractional Bin Hours to Be Used in Calculation of $SEER_{T1}$ (T1 Example)	34
Table 14.	Fractional Bin Hours to Be Used in Calculation of $SEER_{T3}$ (T3 Example)	41
Table 15.	Fractional Bin Hours to Be Used in Calculation of $SEER_{T4}$ (T4 Example)	42

AVA Documents
Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

(Table of Contents Continued)

FIGURES

Figure 1. Voltage Tolerance Test Power Interrupt Procedure 29

Figure 2. Single-speed System Operation in the Cooling Mode – T1 Climate 35

Figure 3. Two-speed System Operation in the Cooling Mode – T1 Climate 36

Figure 4. Variable Speed System Operation in the Cooling Mode – T1 Climate 38

Figure 5. Single-speed System Operation in the Cooling Mode – Hot Climate 43

Figure 6. Two-speed System Operation in the Cooling Mode – Hot Climate 45

Figure 7. Variable Speed System Operation in the Cooling Mode – Hot Climate 48

APPENDICES

Appendix A. References – Normative 53

Appendix B. References – Informative 55

Appendix C. Secondary Capacity Check Requirements – Normative 57

Appendix D. ANSI/ASHRAE Standard 37 Clarifications/Exceptions – Normative 63

Appendix E. Unit Configuration for Standard Efficiency Determination – Normative 72

Appendix F. Verification Testing – Normative 75

FIGURES FOR APPENDICES

Figure D1. Configurations for Manifolding the Static Pressure Taps 65

Figure D2. Typical Air Sampling Tree 69

Figure D3. Aspirating Psychrometer 69

TABLES FOR APPENDICES

Table D1. Pressure Measurement Location 67

Table F1. Acceptance Criteria 75

Documents
Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

PERFORMANCE RATING OF UNITARY AIR-CONDITIONING AND AIR-SOURCE HEAT PUMP EQUIPMENT

Section 1. Purpose

1.1. *Purpose.* The purpose of this standard is to establish the following for Unitary Air-conditioners and Unitary Air-source Heat Pumps: definitions, classifications, test requirements, rating requirements, operating requirements, minimum data requirements for Published Ratings, marking and nameplate data, and conformance conditions.

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

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

Section 2. Scope

2.1. *Scope.* This standard applies to factory-made Unitary Air-conditioners and Unitary Air-source Heat Pumps with capacities less than 19 kW as defined in Section 3.

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

2.2. *Exclusions.* This standard does not apply to the rating and testing of:

a. Heating mode of heat pump equipment.
b. Packaged Terminal Air-conditioners/Heat Pumps, as defined in AHRI Standard 310/380 and CSA C744.
c. Room air-conditioners/heat pumps.
d. Water-source Heat Pumps, Ground Water-source Heat Pumps, or ground-source closed-loop Heat Pumps as defined in ISO/ANSI/ASHRAE/AHRI Standards 13256-1 and 13256-2.
e. Water heating heat pumps.
f. Units equipped with desuperheater/water heating devices in operation.
~~g.~~ Variable Refrigerant Flow Air Conditioners and Heat Pumps as defined in AHRI Standard 1230.
h. Single Packaged Vertical Units as defined in ANSI/AHRI Standard 390.
i. Evaporatively-cooled air-conditioning/heat pump equipment.
j. Water-cooled air-conditioning/heat pump equipment.
k. Heating only equipment.

AVA Documents
Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

Section 3. Definitions and Acronyms

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. Further definitions are found in Appendices C and D. Throughout the standard, defined terms are capitalized.

3.1. *Air Moving System* (AMS).

3.1.1. *Constant-torque AMS.* A fan system that maintains constant motor shaft torque over a broad range of loads.

3.1.2. C*onstant-volume AMS.* A fan system that varies its operating speed to provide a fixed air-volume-rate from a Ducted System.

3.1.3. *Permanent Split Capacitor Air Moving System (PSC AMS)*. A fan system connected to an induction motor that develops motor shaft torque proportional to the RPM slip from synchronous speed.

3.2. *Airflow-control Setting(s)*. Programmed or wired control system configurations that control a fan to achieve discrete, differing ranges of airflow—often designated for performing a specific function (e.g., cooling, heating, or constant circulation)—without manual adjustment other than interaction with a user-operable control (i.e., a thermostat) that meets the manufacturer specifications for installed-use. For the purposes of this standard, manufacturer specifications for installed-use are those found in the product literature shipped with the unit.

3.3. *Airflow Prevention Device.* A device that prevents airflow via natural convection by using mechanical means, such as an air Damper Box, or by means of changes in duct height, such as an upturned duct.

3.4. *Alternative Efficiency Determination Method (AEDM)*. As an alternative to testing a basic model, a simulated efficiency value may be acceptable if the alternative method complies with the following criteria:

a. The AEDM is derived from a mathematical model that estimates the energy efficiency or energy consumption characteristics of the basic model as measured by this test procedure.

b. The AEDM is based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of performance data.

3.5. *Approach Temperature*. The refrigerant temperature at the outdoor liquid service port minus the outdoor ambient temperature.

3.6. *Blower Coil System.* A Split System that includes one or more Blower Coil Indoor Units.

3.7. *Coil-only System.* A system that includes (one or more) coil-only Indoor Units.

3.8. *Cooling Load Factor (CLF)*. The ratio having as its numerator the total cooling delivered during a cyclic operating interval consisting of one ON period and one OFF period. The denominator is the total cooling that would be delivered, given the same ambient conditions, if the unit operated continuously at its steady-state space cooling capacity for the same total time (ON plus OFF) interval.

3.9. *Cyclic Test.* A test where the unit's compressor is cycled on and off for specific time intervals. A Cyclic Test provides half the information needed to calculate a Degradation Coefficient.

3.10. *Damper Box*. A short section of insulated duct having a means to block airflow during the off cycle of the Cyclic Test.

3.11. *Degradation Coefficient (C_D).* A parameter used in calculating the Part Load Factor, which is a measure of the efficiency loss due to the cycling of the units. The Degradation Coefficient for cooling is denoted by C_D^c.

3.12. *Double-duct System.* Double-duct Air-conditioner or Heat Pump means air-cooled commercial package air-conditioning and heating equipment that that is either a horizontal Single Package Unit or Split System; or a vertical unit that consists of two components that shall be shipped or installed either connected or split; is intended for indoor installation with ducting of outdoor air from the building exterior to and from the unit, where the unit and/or all of its components are non-weatherized and are not marked (or listed) as being in compliance with UL 1995/CSA C22.2 No.236 or equivalent requirements for outdoor use; or

AVA Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

is a horizontal unit, the complete unit shall have a maximum height of 89 cm or the unit shall have components that do not exceed a maximum height of 89 cm; if it is a vertical unit, the complete (split, connected, or assembled) unit shall have components that do not exceed maximum depth of 89 cm.

3.13. *Ducted System*. An air-conditioner or heat pump that is designed to be permanently installed and delivers all conditioned air through ductwork. The air-conditioner or heat pump may be either a Split System unit or a Single Package Unit.

3.14. *Energy Efficiency Ratio (EER)*. A ratio of the cooling capacity in watts to the Total Power in watts at any given set of Rating Conditions expressed in W/W.

3.14.1. $EER_{TI,Full}$. The EER at $T_{1,Full}$ test conditions.

3.15. *Gross Capacity*. The calculated system capacity that results when not accounting for the heat generated from an indoor supply fan.

3.16. *Indoor Unit*. A separate assembly of a Split System that includes both an arrangement of refrigerant-to-air heat transfer coil(s) for transfer of heat between the refrigerant and the indoor air and a condensate drain pan. An Indoor Unit may or may not include sheet metal or plastic parts not part of external cabinetry to direct/route airflow over the coil(s), a cooling mode expansion device, external cabinetry, air temperature sensing device and an integrated indoor blower (i.e. a device to move air including its associated motor). A separate designated air mover that may be a furnace or a Modular Blower may be considered to be part of the Indoor Unit. A Service Coil is not an Indoor Unit.

3.16.1. *Blower Coil Indoor Unit*. An Indoor Unit with either a) an indoor blower housed with the coil or b) a separate designated air mover such as a furnace or Modular Blower.

3.17. *Installation Instructions.* Manufacturer's documentation that come packaged with, or appear in, the labels applied to the unit. This does not include online manual.

3.18. *Latent Cooling Capacity*. The rate, expressed in KW, at which the equipment removes latent heat (reduces the moisture content) of the air passing through it under specified conditions of operation.

3.19. *Multiple-circuit (or Multi-circuit) System.* A Split System that has one Outdoor Unit and that has two or more Indoor Units installed on two or more refrigeration circuits such that each refrigeration circuit serves a compressor and one and only one Indoor Unit, and refrigerant is not shared from circuit to circuit.

3.20. *Multiple Capacity (Multiple Stage) Compressor*. A compressor having three or more pre-determined discrete stages of capacity or a group of compressors with three or more stages of capacity.

3.20.1. *Full Compressor Stage*. The staging of compressor(s) as specified by the manufacturer at which the unit operates at full load test conditions. The Full Compressor Stage for heating mode tests may be the same or different from the cooling mode value.

3.20.2. *Intermediate Compressor Stage*.

3.20.2.1 *Multi-split Systems*. The staging of compressor(s) as specified by the manufacturer that falls within one-fourth and three-fourths of the difference between the Low Compressor Stage and Full Compressor Stage for both cooling and heating, separately.

3.20.2.2 For all other Multiple Stage Compressors include the stage within a 5% tolerance of the Low Compressor Stage plus one-third of the difference between Low Compressor Stage and Full Compressor or the next higher stage.

3.20.3. *Low Compressor Stage*. The staging of compressor(s) as specified by the manufacturer at which the unit operates at low load test conditions. The Low Compressor Stage for heating mode tests may be the same or different from the cooling mode value.

3.21. *Net Capacity*. The calculated system capacity that results when accounting for the heat generated from an indoor supply fan.

AVA Documents
Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

3.22. *Nominal Capacity.* The capacity that is claimed by the manufacturer on the product name plate.

3.22.1. *Nominal Cooling Capacity*. A capacity approximately equal to the air conditioner cooling capacity tested at A or A2 condition.

3.23. *Non-ducted Indoor Unit*. An Indoor Unit designed to be permanently installed, mounted to/in ceilings and/or room walls, and/or to floors, and that directly heats or cools air within the conditioned space.

3.24. *Non-ducted System*. A Split System with one or more Non-ducted Indoor Units. The system components may be of a modular design.

3.25. *Non-tested Combination (NTC)*. Any manufacturer approved combination of an Outdoor Unit(s) with one or more Indoor Units whose Certified Ratings are based on an AEDM.

3.26. *Outdoor Coil.* A heat exchange surface that transfers heat between outdoor air and the refrigerant. The Outdoor Coil may be located internal or external to the building.

3.27. *Outdoor Unit.* A separate assembly of a Split System that transfers heat between the refrigerant and the outdoor air, and consists of an Outdoor Coil, compressor(s), an air moving device, and in addition for heat pumps, may include a heating mode expansion device, reversing valve, and/or defrost controls.

3.28. *Overspeeding.* A temporary-basis speed of an indoor blower above design operating speed.

3.29. *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 Capacity and type (identification) produced by the same manufacturer. As used herein, 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.

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

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

3.30. *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.

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

3.31. *Seasonal Energy Efficiency Ratio ($SEER_{Tx}$).* The total heat removed from the conditioned space during the annual cooling season divided by the total electrical energy consumed by the air-conditioner or heat pump during the same season, expressed in W/W.

3.32. *Sensible Cooling Capacity*. The rate, expressed in kW, at which the equipment lowers the dry-bulb temperature (removes sensible heat) of the air passing through it under specified conditions of operation.

3.33. *"Shall" or "Should".* "Shall" or "should" shall be interpreted as follows:

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

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

3.34. *Single Unit (Single Package Air-conditioner or Single Package Heat Pump)*. Any central air-conditioner or heat pump that has all major assemblies enclosed in one cabinet.

3.35. *Single System (Single Stage Air-conditioner or Single Stage Heat Pump).* An air-conditioner or heat pump that has a single, fixed capacity compressor.

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

3.36. *Small-duct, High-velocity System.* A Split System for which all Indoor Units are Blower Coil Indoor Units that produce at least 0.30 kPa of external static pressure when operated at the full-load air volume rate certified by the manufacturer of at least 106 m^3/h (Standard Air) per rated kW of cooling.

3.37. *Space Constrained Product.* A central air-conditioner or heat pump that has (1) rated cooling capacities no greater than 8.8 kW, and (2) an Outdoor Unit or Indoor Unit having at least two overall exterior dimensions or an overall displacement that:

a. is substantially smaller than those of other units that are currently usually installed in site built single family homes, of a similar cooling, and, if a heat pump, heating capacity; and

b. if increased, would certainly result in a considerable increase in the usual cost of installation or would certainly result in a significant loss in the utility of the product to the consumer.

3.38. *Split System (Split System Air-conditioner or Split System Heat Pump)*. Any air-conditioner or heat pump that has at least two separate assemblies that are connected with refrigerant piping when installed. At least one of these assemblies is an Indoor Unit and at least one of these assemblies is an Outdoor Unit. Split Systems may be either Blower Coil System or Coil-only Systems.

3.38.1. *Multi-head Mini-split System*. A Split System that has one Outdoor Unit and that has two or more Indoor Units connected with a single refrigeration circuit. The Indoor Units operate in unison in response to a single indoor thermostat.

3.38.2. *Multi-split System (Multi-split Air-conditioner or Multi-split Heat Pump)*. A Split System that has one Outdoor Unit and having two or more Indoor Units connected with a single refrigeration circuit. The Indoor Units operate independently and can be used to condition multiple zones in response to at least two indoor thermostats or temperature sensors. The Outdoor Unit operates in response to independent operation of the Indoor Units based on control input of at least two indoor thermostats or temperature sensors, and/or based on refrigeration circuit sensor input.

3.38.3. *Single-split System (Single-split Air-conditioner or Single-split Heat Pump)*. A Split System that has one Outdoor Unit and one Indoor Unit connected with a single refrigeration circuit.

3.39. *Standard Air.* Dry air having a mass density of 1.2 kg/m^3.

3.40. *Steady-state Test*. A test where the controlled test parameters are regulated to remain constant within the specified tolerances while the unit operates continuously in the same mode.

3.41. *System Controls.* These devices may include but are not limited to:

a. An integral network operations and communications system with sensors to monitor the status of items such as temperature, pressure, oil, refrigerant levels, and fan speed.

b. A micro-processor, algorithm-based control scheme to: (1) communicate with a managed variable capacity compressor, fan speed of Indoor Units, fan speed of the Outdoor Unit, solenoids, various accessories; (2) manage metering devices; and (3) concurrently operate various parts of the system.

c. Regulate system efficiency and refrigerant flow through an engineered distributed refrigerant system to conduct zoning operations, matching capacity to the load in each of the zones.

3.42. *Temperature Bin*. The temperature (°C) increments used to partition the outdoor dry-bulb temperature ranges of the cooling season.

3.43. *Test Condition Tolerance.* The maximum permissible difference between the average value of the measured test parameter and the specified test condition.

3.44. *Test Operating Tolerance.* The maximum permissible range a measurement may vary over the specified test interval. When expressed as a percentage, the maximum allowable variation is the specified percentage of the average value. The difference between the maximum and minimum sampled values shall be less than or equal to the specified Test Operating Tolerance.

AVA Documents
Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

3.45. Tested Combination. A specific combination of an Outdoor Unit(s) with one or more Indoor Units having measured performance in a laboratory psychrometric facility.

3.45.1. *Multi-split Tested Combination.* A specific combination of an Outdoor Unit with between two and five Indoor Units.

3.45.2. *Single-split Tested Combination.* A specific combination of an Outdoor Unit with either one Indoor Unit or multiple Indoor Units which operate in unison.

3.46. *Total Cooling Capacity*. The sum of Sensible and Latent Capacity the equipment can remove from the conditioned space in a defined interval of time in kW (Net Capacity in the cooling mode).

3.47. *Total Power*. The sum of the power consumed by all components of a system, including the power consumed by the compressor(s), indoor supply fan motor(s), outdoor condenser fan motor(s), System Controls, factory installed condensate pumps and other devices required for normal operating modes.

3.48. *Two-capacity (or Two-stage) Compressor*. A compressor or group of compressors operating with only two stages of capacity.

3.48.1. *Full Compressor Stage*. The staging of compressor(s) as specified by the manufacturer at which the unit operates at full load test conditions.

3.48.2. *Low Compressor Stage*. The staging of compressor(s) as specified by the manufacturer at which the unit operates at low load test conditions. The Low Compressor Stage for heating mode tests may be the same or different from the cooling mode value.

3.49. *Two-capacity (or Two-stage) System (Two-stage Air-conditioner or Two-stage Heat Pump)*. An air -conditioner(s) or heat pump(s) that use a Two-capacity Compressor, or two single stage Outdoor Units connected to a single Indoor Unit, where each Outdoor Unit can operate independently or jointly.

3.50. *Unitary Air-conditioner (Air-conditioner).* One or more factory-made assemblies which normally include an indoor coil(s), compressor(s), Outdoor Coil(s), indoor fan(s), outdoor fan(s), and expansion device(s). When such equipment is provided in more than one assembly, the separated assemblies shall be designed to be used together, and the requirements of rating outlined in the standard are based upon the use of matched assemblies. Air-conditioners shall provide the function of air-circulation, air cleaning, cooling with controlled temperature and dehumidification, and may optionally include the function of heating and/or humidifying.

3.51. Unitary Air-source Heat Pump (Heat Pump). One or more factory-made assemblies which normally include an indoor coil(s), compressor(s), Outdoor Coil(s), indoor fan(s), outdoor fan(s), and expansion device(s) including means to provide a heating function. When such equipment is provided in more than one assembly, the separated assemblies shall be designed to be used together, and the requirements of rating outlined in the standard are based upon the use of matched assemblies. Heat Pumps shall provide the function of air heating with controlled temperature, and may include the functions of air-cooling, air-circulating, air-cleaning, dehumidifying or humidifying.

3.52. *Variable Capacity (or Variable Stage or Variable Speed) System (Variable Stage Air-conditioner or Variable Stage Heat Pump).* Air-conditioner(s) or heat pump(s) that has either a Variable Speed Compressor or a Multiple Capacity Compressor.

3.53. *Variable Refrigerant Flow (VRF) System.* A Multi-split System with at least three compressor capacity stages, distributing refrigerant through a piping network to multiple indoor blower coil units each capable of individual zone temperature control, through proprietary zone temperature control devices and a common communications network. Single-phase VRF systems less than 19 kW are central air-conditioners and central air conditioning heat pumps, also referred to as Unitary Air-conditioners and Unitary Air-source Heat Pumps.

3.54. *Variable Speed Compressor.* A compressor that has capability of varying its rotational speed in non-discrete stages or steps from low to full using an inverter or variable frequency drive.

3.54.1. *Full Compressor Speed (Full)*. The speed as specified by the manufacturer at which the unit operates at full load test conditions.

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

3.54.2. *Intermediate Compressor Speed*

3.54.2.1 *For Multi-split Systems.* The speed as specified by the manufacturer that falls within one-fourth and three-fourths of the difference between the Low Compressor Speed and Full Compressor Speed for both cooling and heating, separately.

3.54.2.2 *For all other Variable Stage Systems.* Low Compressor Speed plus one-third of the difference between Low Compressor Speed and Full Compressor Speed with a tolerance of plus 5% or the next higher inverter frequency step.

3.54.3. *Low Compressor Speed (Low)*. The speed as specified by the manufacturer at which the unit operates at low load test conditions.

3.55. *Wet-coil Test.* A test conducted at test conditions that typically cause water vapor to condense on the test unit evaporator coil.

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

Section 4. Classifications

4.1. *Classifications*. Equipment covered within the scope of this standard shall be classified as shown in Tables 1, 2 and 3.

Table 1. Classification of Unitary Air-conditioners

Designation	AHRI Type [1,2]	Arrangement – ID	Arrangement – OD
Single Package Unit	SP-A [7]		ELEC HEAT [3,8] ID FAN EVAP OD FAN or PUMP COMP COND
Year-Round Single Package Unit	SPY-A [5,7]		GAS HEAT [4,8] ID FAN EVAP OD FAN or PUMP COMP COND
Remote Condenser	RC-A	ID FAN EVAP COMP	OD FAN or PUMP COND
Split System Air-conditioner with Coil-only		EVAP	OD FAN or PUMP COMP COND
Split System Air-conditioner with Coil Blower	RCU-A-CB [6,7]	ID FAN EVAP	OD FAN or PUMP COMP COND
Year-Round Split System Air-conditioner with Coil Blower	RCUY-A-CB [5,6,7]	GAS HEAT [4,8] ID FAN EVAP	OD FAN or PUMP COMP COND

Notes:

1. A suffix of "-O" following any of the above classifications indicates a Non-ducted System.
2. "-A" indicates air-cooled condenser, "-E" indicates evaporatively cooled condenser and "-W" indicates water-cooled condenser.
3. Optional component.
4. May also be other heat source except for electric strip heat.
5. For Space Constrained Products, insert "SCP-" at the beginning.
6. For Small-duct, High-velocity System, insert "SDHV-" at the beginning.
7. For Double-duct System, append "-DD", and outdoor arrangement moves from outdoor side to indoor side.
8. System components intended for heating operation are included, however, the standard only covers cooling performance of these systems.

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

Table 2. Classification of Unitary Air-source Heat Pumps

Designation	AHRI Type [1]	Arrangement – ID	Arrangement – OD
Single Package Unit	HSP-A [4,6]		ELEC HEAT [2,7] ID FAN EVAP OD FAN or PUMP COMP COND
Year-Round Single Package Unit	HSPY-A [4,6]		GAS HEAT [3,7] ID FAN EVAP OD FAN or PUMP COMP COND
Remote Outdoor Coil	HRC-A-CB [6]	ID FAN EVAP COMP	OD FAN or PUMP COND
Remote Outdoor Coil, Coil-only	HRC-A-C [6]	EVAP COMP	OD FAN or PUMP COND
Year Round Split System Heat Pump with Coil Blower	HRCUY-A-CB	ELEC HEAT [3,7] ID FAN EVAP	OD FAN or PUMP COMP COND
Split System Heat Pump with Coil Blower	HRCU-A-CB [5,6]	ELEC HEAT [2,7] ID FAN EVAP	OD FAN or PUMP COMP COND
Split System Heat Pump with Coil-only	HRCU-A-C [5,6]	EVAP	OD FAN or PUMP COMP COND

Notes:

1. A suffix of "-O" following any of the above classifications indicates a Non-ducted System.
2. Optional component
3. May also be other heat source except for electric strip heat.
4. For Space Constrained Products, insert "SCP-" at the beginning.
5. For Small-duct, High-velocity System, insert "SDHV-" at the beginning.
6. For Double-duct System, append "-DD", and outdoor arrangement moves from outdoor side to indoor side.
7. System components intended for heating operation are included, however, the standard only covers cooling performance of these systems.

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

Table 3. Classification of Multi-split Systems			
System Identification / Attribute		Multi-split	Heat Recovery Multi-split
Refrigerant Circuits		One shared to all Indoor Units	One shared to all Indoor Units
Compressors		One or more variable speed or alternative method resulting in three or more steps of capacity	One or more variable speed or alternative method resulting in three or more steps of capacity
Indoor Units	Quantity	Greater than one Indoor Unit	Greater than one Indoor Unit
	Operation	Individual Zones/Temperature	Individual Zones/Temperature
Outdoor Unit/s	Quantity	One Outdoor Unit or multiple manifolded Outdoor Units with a specific model number.	One Outdoor Unit or multiple manifolded Outdoor Units with a specific model number.
	Steps of Control	Three or More	Three or More
	Mode of Operation	Cooling, Heating	Cooling, Heating, Heat Recovery
	Heat Exchanger	One or more circuits of shared refrigerant flow	One or more circuits of shared refrigerant flow
Classification [1,2]	Air-conditioner (air-to-air)	MSV-A-CB	
	Heat Pump (air-to-air)	HMSV-A-CB	HMSR-A-CB
Notes: 1. A suffix of "-O" following any of the above classifications indicates a Non-ducted System. 2. "-A" indicates air-cooled condenser			

Section 5. Test Requirements

5.1. All testing for Standard Ratings shall be conducted in accordance with the test methods and procedures as described in this standard and its appendices.

5.1.1. Air-cooled units shall be tested in accordance with ANSI/ASHRAE Standard 37 as amended by Appendix C and Appendix D. In ANSI/ASHRAE Standards 37, wherever terms "may" or "should" are used, they shall be taken to be mandatory requirements.

5.1.2. *Variable Speed Equipment*. A means to override the controls of the Variable Speed System under test shall be provided by the manufacturer that claims the performance of the particular system, when needed, prior to initial set-up during laboratory testing.

5.1.2.1 The means for overriding the controls of the test unit shall necessitate ability to control the compressor, outdoor fan, indoor blower and expansion device(s) such that the compressor(s) operates at the specified speed or capacity, the outdoor fan operates per the manufacturer specification, the indoor blower operates at the specified speed or delivers the specified air volume rate, and the expansions device(s) operate per manufacturer specification.

5.1.2.2 Power used for any override controls that would not normally be installed in the field shall not be included in Total Power.

5.1.3. *Break-in.* 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 specified break-in period is completed.

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

5.1.4. *Test Unit Installation Requirements*. For units designed for both horizontal and vertical installation or for both up-flow and down-flow vertical installations, the manufacturer shall specify the orientation used for testing. Conduct testing with the following installed:

5.1.4.1 Factory installed supplementary resistance heat; and

5.1.4.2 Other equipment specified as part of the unit. For Small-duct, High-velocity Systems, configure all balance dampers or restrictor devices on or inside the unit to fully open or lowest restriction.

5.1.5. *Requirements for Separated Assemblies*. All Standard Ratings for Split Systems shall be determined with at least 7.6 m of interconnecting tubing on each line of the size recommended by the manufacturer. Equipment in which the interconnecting tubing is furnished as an integral part of the system not recommended for cutting to length shall be tested with the complete length of tubing furnished, or with 7.6 m of tubing, whichever is greater. At least 3.0 m of the interconnecting tubing shall be exposed to the outside conditions. The line sizes, insulation, and details of installation shall be in accordance with the manufacturer's published recommendation.

5.1.5.1 When testing Multi-split Systems, connect each indoor fan-coil to the Outdoor Unit using: (a) 7.6 m of tubing, or (b) tubing furnished by the manufacturer, whichever is longer, per Indoor Unit. If a branching device is used, the common piping between the Outdoor Unit and the branching device shall be included in the overall length between indoor and outdoor sections.

5.1.5.1.1. *Multi-split Line Length Correction*. For test setups where the laboratory's physical limitations require use of more than the required line length, refer to Table 4 for Cooling Capacity correction factors that shall be used when the refrigerant line length exceeds the minimum as specified in Section 5.1.5.1. Cooling capacity correction factor, F_{CCC}, is used in Section 11.1 to adjust cooling capacity.

Table 4. Refrigerant Line Length Correction Factors[1, 2, 3, 4]

Piping length beyond the requirement (X), m	Cooling Capacity Correction Factor, F_{CCC}
$1 < X \leq 6$	1.01
$6 < X \leq 12$	1.02
$12 < X \leq 18$	1.03
$18 < X \leq 24$	1.04
$24 < X \leq 30$	1.05
$30 < X \leq 37$	1.06

Note:
1. Due to the refrigerant line lengths required in the test setup as determined by laboratory personnel, a correction factor shall be applied to normalize the measured cooling capacity
2. The piping length X is the additional refrigerant piping length above the minimum described in Section 5.1.5.1 that has been applied to at least 33% (minimum of 2) of the Indoor Units in the testing configuration.
3. In all cases, the absolute minimum length necessary to physically connect the system shall be used.
4. Average piping length in addition to the minimum in Table 4 (X), m for at least 33% (minimum of 2) of the Indoor Units. (The length (X) is the differential distance between the actual piping length between the Outdoor Unit and the Indoor Unit and the minimum requirement).

5.1.6. *Refrigerant Charging.* All test samples shall be charged at Standard Rating Conditions (or condition at which the manufacturer indicates in the Installation Instructions) in accordance with the Installation Instructions or labels applied to the unit. If the Installation Instructions 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.

AVA Documents Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

If there are no Installation Instructions and/or the Installation Instructions do not provide parameters and target values, set superheat to a target value of 6.7°C for fixed orifice systems or set subcooling to a target value of 5.6°C for expansion valve systems.

5.1.6.1 *Charging Hierarchy Instructions*. In the event of conflicting information between charging instructions, the Outdoor Unit label prevails, followed by Installation Instructions of the Outdoor Unit, followed by the Installation Instructions of the Indoor Unit. For Multi-split Systems, the hierarchy is Outdoor Unit installation instructions prevail, followed by the Outdoor Unit label, followed by the Indoor Units' installation instructions. Conflicting information is defined as multiple conditions given for charge adjustment where all conditions specified cannot be met. In such instances of conflicting information, follow the hierarchy in Table 5 for priority. Unless the manufacturer specifies a different charging tolerance, the tolerances specified in Table 5 shall be used for all products.

Table 5. Test Condition Tolerance for Charging Hierarchy

Fixed Orifice			Expansion Valve		
Priority	Method	Tolerance	Priority	Method	Tolerance
1	Super-heat	± 1.1°C	1	Sub-cooling	10% of the Target Value; No less than ± 0. 0.28°C, No more than ± 1.1°C
2	High Side Pressure or Saturation Temperature	± 28 kPa or ± 0.56°C	2	High Side Pressure or Saturation Temperature	± 28 kPa or ± 0.56°C
3	Low Side Pressure or Saturation Temperature	± 14 kPa or ± 0.44°C	3	Low Side Pressure or Saturation Temperature	± 14 kPa or ± 0.44°C
4	Low Side Temperature	± 1.1°C	4	Approach Temperature	± 0.56°C
5	High Side Temperature	± 1.1°C	5	Charge Weight	0.5% or 28 g, whichever is greater
6	Charge Weight	± 57 g			

The refrigerant charge obtained at the Standard Rating Condition shall then be used to conduct all cooling cycle and heating cycle tests unless an adjustment is required based on the sections below. Once the correct refrigerant charge is determined, all tests shall run until completion without further modification.

Note: After completion of all required tests, it is good laboratory practice to achieve $T_{1,Full}$ test conditions for 30 continuous minutes and compare results to the previous set of $T_{1,Full}$ tests. When comparing results, measured charge parameters outside of those listed in Table 5 is an indication refrigerant charge or other parameters may have changed and analysis should be performed, and corrective actions should be made.

5.1.6.2 *Heat Pumps.* Refrigerant charge shall be set at the $T_{1,Full}$ conditions or as specified by the manufacturer.

5.1.6.3 *Single Package Unit.* Unless otherwise directed by the Installation Instructions, install one or more refrigerant line pressure gauges during the setup of the unit, located depending on the parameters used to verify or set charge, as described in this section. Use methods for installing pressure gauge(s) at the required location(s) as indicated in Installation Instructions if specified.

5.1.6.3.1. Install a pressure gauge at the location of the service valve on the liquid line if charging is on the basis of subcooling, or high side pressure or corresponding saturation or dew point temperature;

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

AVA Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

5.2. *Cyclic Test Requirements*. For tests utilizing the Degradation Coefficient, the following procedure shall be followed in addition to the requirements of ASHRAE Standard 37.

Test set up, temperature and electrical measurements methods shall be identical for both the dry steady state and their corresponding Cyclic Tests (e.g. "C" and "D" tests) in order to minimize errors in the cyclic Degradation Coefficient.

5.2.1. *Damper Box.* A damper shall be installed on the inlet and outlet of the test unit capable of being completely opened or completely closed within a time period not to exceed 5 seconds for each action. Airflow through the equipment being tested should stop within 5 seconds after the airflow measuring device is de-energized.

For the outlet air Damper Box, install it within the interconnecting duct at a location upstream of the location where air from the sampling device is reintroduced or upstream of the in-duct sensor that measures water vapor content of the outlet air.

5.2.1.1 *Leakage.* The leakage rate from the combination of the outlet plenum, the closed damper, and the duct section that connects these two components shall not exceed 34 m^3/h when a negative pressure of 0.25 kPa is maintained at the outlet of the outlet air damper.

5.2.1.2 *Non-Ducted Systems.* Inlet dampers shall not be used on Non-ducted Systems.

5.2.1.3 *Arrangement and Size.* Components may be altered to meet the physical requirements of the unit to be tested. Dampers shall have a cross-sectional flow area of the Damper Box that shall be equal to or greater than the flow area of the inlet plenum.

5.2.1.4 *Airflow Prevention Device.* For space constrained testing, an alternative to the inlet damper system may be used as defined in this section.

When using an upturned duct Airflow Prevention Device, place a dry bulb temperature sensor near the inlet opening of the indoor duct at a centerline location not higher than the lowest elevation of the duct edges at the inlet, and ensure that the variation of the dry bulb temperature at this location, measured at least every minute during the compressor OFF period of the Cyclic Test, does not exceed 0.56°C.

Construct the Airflow Prevention Device having a cross-sectional flow area equal to or greater than the flow area of the inlet plenum. Install the Airflow Prevention Device immediately upstream of the inlet plenum (if installed, otherwise immediately upstream of the Indoor Unit) and construct ductwork connecting it to the inlet plenum. If needed, use an adaptor plate or a transition duct section to connect the Airflow Prevention Device with the inlet plenum. If an inlet plenum is not used, add static pressure taps at the center of each face of a rectangular Airflow Prevention Device Insulate the ductwork and inlet plenum with thermal insulation that has a nominal overall resistance (R-value) of at least 3.3 $m^2 \cdot K/W$.

5.2.2. *Temperature Measurement.* The temperature difference between inlet air and outlet air shall be measured by a thermopile, two thermocouple grids or other temperature measuring device with a response time of 10 seconds or less.

The outlet plenum, minimum of 9 individual dry bulb temperature sensors, shall not exceed a difference of 0.83 °C during any ON cycle. Use of mixers and/or perforated screen shall be used to meet this requirement.

5.2.2.1 *Grid Differential Temperature*.

5.2.2.1.1. While conducting the steady state test associated with the Cyclic Test, observe the difference between the entering dry bulb and leaving dry bulb temperature using both the grid/thermopile and the primary psychrometer sensors.

Determine the value of F_{CD} from Equations 5.1 or 5.2. When sample rates are less than 1 minute apart, Equation 5.1 shall be used to integrate results. When sample rates are 1 minute or more apart, Equation 5.2 shall be used.

$$F_{CD} = \int_0^6 \frac{\Delta T_{RTD}}{\Delta T_{TC}} \qquad 5.1$$

$$F_{CD} = \frac{1}{7}\sum_{i-6}^{i} \frac{\Delta T_{RTD}}{\Delta T_{TC}}$$

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

ΔT_{RTD} shall be the temperature differential between inlet air stream and outlet air stream as measured by Resistance Temperature Devices (RTDs), or equivalent, meeting the accuracy requirements for steady state testing. ΔT_{TC} shall be the temperature differential between inlet air stream and outlet air stream as measured by thermocouple grid, thermocouple thermopile, or equivalent, meeting the response requirements for cyclic testing.

5.2.2.1.2. If any F_{CD} calculated throughout the steady state test (total of 5 values) is outside the range of 0.94 to 1.06 then stop the test and recalibrate the temperature sensors.

5.2.2.1.3. The final value of the F_{CD} ratio shall be set to F_{CD}^{*}. Use F_{CD}^{*} as a correction factor applied to the grid or thermopile measurement during the Cyclic Test. If the temperature sensors used to provide the primary measurement of the indoor-side dry bulb temperature difference during the steady-state dry-coil test and the subsequent cyclic dry-coil test are the same, set F_{CD}^{*}= 1.

5.2.3. *Electrical Voltage, Power and Energy Measurement*.

5.2.3.1 *Supply Voltage.* The supply voltage at the terminals on the test unit shall be measured by using a voltage meter that provides a reading that is accurate to within ±1.0% of the measured quantity. During the ON and OFF cycle, the voltage total observed range, excluding the 30 seconds after compressor startup and shutdown, shall not exceed 2.0% and the set-point average error shall not exceed 1.5%.

5.2.3.2 *Integrated Power.* Use an integrating power (watt-hour) measuring system to determine the electrical energy or average electrical power supplied to all components of the air-conditioner or heat pump (including auxiliary components such as controls, transformers, crankcase heater, integral condensate pump on Non-ducted Indoor Units, etc.). Activate the scale or meter having the lower power rating within 15 seconds after beginning an OFF cycle. Activate the scale or meter having the higher power rating active within 15 seconds prior to beginning an ON cycle. When testing air-conditioners and heat pumps having a Variable Speed Compressor, do not use an induction watt/watt-hour meter.

Watt-hour measurement system shall be accurate within ±0.5% or 0.5 W•h, whichever is greater, for both ON and OFF cycles. If two measurement systems are used, then the meters shall be switched within 15 seconds of the start of the OFF cycle and switched within 15 seconds prior to the start of the ON cycle.

5.2.3.3 *Non-Ducted System Tests.* When performing Cyclic Tests on Non-ducted Systems, provide instrumentation to determine the average electrical power consumption of the indoor fan motor to within ±1.0%. This same instrumentation requirement applies when testing air-conditioners and heat pumps having a Constant-torque AMS or a Constant-volume AMS."

When performing test that are not Steady State Tests on Non-ducted Systems, provide instrumentation to determine the average electrical power consumption of the indoor blower motor to within ±1.0%.

5.2.4. *Cycle Stability Requirements*. Conduct three complete compressor OFF/ON cycles with the test tolerances given in Table 6 satisfied. Calculate the Degradation Coefficient C_D for each complete cycle using Equation 5.3.

$$C_D = \frac{1-\frac{EER_{cyc}}{EER_{ss}}}{1-CLF^{x}} \quad (5.3)$$

Where:

$$EER_{cyc} = \frac{q_{cyc,x}}{E_{cyc,x}} \quad (5.4)$$

$$EER_{ss} = \frac{\dot{q}_{tci,x}}{E_{m,x}} \quad (5.5)$$

$$CLF^{x} = \frac{q_{cyc,x}}{\dot{q}_{tci,x} \cdot \theta_{cyc}} \quad (5.6)$$

$$q_{cyc,x} = q'_{cyc,x} + q_{ts} \quad (5.7)$$

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

$$q'_{cyc,x} = \frac{60\dot{Q}_{mi}c_{pa}\Gamma}{v'_{n(1+W_n)}} \quad 5.8$$

$$\Gamma = \int_{\theta_2}^{\theta_1}[t_{a1}(\theta) - t_{a2}(\theta)]\,d\theta \quad 5.9$$

$$q_{ts} = m_{ts}c_{pm}(t_{m1} - t_{m2}) \quad 5.10$$

Table 6. Test Operating and Test Condition Tolerances for Cyclic Dry Coil Cooling Mode Tests

Measurements	Test operating tolerance	Test condition tolerance
Indoor entering dry-bulb temperature,[1] °C	1.0	0.3
Indoor entering wet-bulb temperature, °C		See Note 2
Outdoor entering dry-bulb temperature,[1] °C	1.0	0.3
External pressure resistance to airflow,[1] Pa	12.5	
Airflow nozzle pressure difference or velocity pressure,[1]% of reading	2.0	2.0[3]
Electrical voltage,[4] % of reading	2.0	1.5

1. Applies during the interval that air flows through the indoor (outdoor) coil except for the first 30 seconds after flow initiation. For units having a variable-speed indoor blower that ramps, the tolerances listed for the external pressure resistance to airflow apply from 30 seconds after achieving full speed until ramp down begins.
2. Shall at no time exceed a wet-bulb temperature that results in condensate forming on the indoor coil.
3. The test condition must be the average nozzle pressure difference or velocity pressure measured during the steady-state dry coil test.
4. Applies during the interval when at least one of the following—the compressor, the outdoor fan, or, if applicable, the indoor blower—are operating except for the first 30 seconds after compressor start-up.

If all three C_D values are within 0.02 of the average C_D then stability has been achieved, and the highest C_D value of these three shall be used. If stability has not been achieved, conduct additional cycles, up to a maximum of eight cycles total, until stability has been achieved between three consecutive cycles. Once stability has been achieved, use the highest C_D value of the three consecutive cycles that establish stability. If stability has not been achieved after eight cycles, use the highest C_D from cycle one through cycle eight, or the default C_D, whichever is lower.

5.2.4.2 *Optional Cycle Tests.* If optional Cyclic Tests are conducted, they shall follow immediately after the Steady-state Test that requires the same test conditions. When testing heat pumps during the compressor OFF cycles, leave the reversing valve in the same position as used for the compressor ON cycles, unless automatically changed by the controls of the unit.

5.2.4.3 *ON Cycle Length.* For Blower Coil Systems or Coil-only Systems rated with an indoor fan time delay, the ON cycle lasts from compressor ON to indoor fan OFF. For Ducted Systems tested without an indoor fan time delay, the ON cycle lasts from compressor ON to compressor OFF. For Non-ducted Systems, the ON cycle lasts from indoor fan ON to indoor fan OFF.

5.2.4.4 *Artificial Loads.* Inside the indoor and outdoor psychrometric rooms, use artificial loads during Cyclic Tests, if needed, to produce stabilized room air temperatures. For the outdoor psychrometric room, select an electric resistance heater(s) having a heating capacity that is approximately equal to the heating capacity of the test unit's condenser. For the indoor psychrometric room, select a heater(s) having a capacity that is close to

AVA Documents Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

the Sensible Cooling Capacity of the test unit's evaporator. When applied, cycle the heater located in the same room as the test unit evaporator coil ON and OFF when the test unit cycles ON and OFF. Cycle the heater located in the same room as the test unit condensing coil ON and OFF when the test unit cycles OFF and ON.

5.2.4.5 *Indoor Fan Control.* For units having a Constant-volume AMS or Constant-torque AMS, the manufacturer has the option of electing at the outset whether to conduct the Cyclic Test with the indoor fan enabled or disabled. Conduct the cyclic dry coil test using the draw-through approach described below if any of the following occur when testing with the fan operating:

5.2.4.5.1. The test unit automatically cycles off;
5.2.4.5.2. Its blower motor reverses; or
5.2.4.5.3. The unit operates for more than 30 seconds at an external static pressure that is 0.025 kPa or more, higher than the value measured during the prior Steady-state Test.

For the draw-through approach, disable the indoor fan and use the exhaust fan of the airflow measuring apparatus to generate the specified flow nozzles static pressure difference or velocity pressure. If the exhaust fan cannot deliver the required pressure difference because of resistance created by the unpowered blower, temporarily remove the blower.

5.2.4.6 *Additional Measurement Requirements.* Continuously record the dry-bulb temperature of the air entering both the Indoor Coil and Outdoor Coils during periods when air flows through the respective coils. Sample the water vapor content of the indoor coil inlet air at least every 2 minutes during periods when air flows through the coil. Record external static pressure and the air volume rate indicator (either nozzle pressure difference or velocity pressure) at least every minute during the interval that air flows through the indoor coil. (These regular measurements of the airflow rate indicator are in addition to the required measurement at 15 seconds after flow initiation.) Sample the electrical voltage at least every 10 seconds beginning 30 seconds after compressor start-up. Continue until the compressor, the outdoor fan, and the indoor fan (if it is installed and operating) cycle off.

For Ducted Systems, continuously record the dry-bulb temperature of the air entering leaving the indoor coil. Or if using a thermopile, continuously record the difference between these two temperatures during the interval that air flows through the Indoor Coil. For Non-ducted Systems, make the same dry-bulb temperature measurements beginning when the compressor cycles on and ending when indoor coil airflow ceases.

Integrate each complete cycle as follows:

5.2.4.6.1. For Blower Coil Systems tested with an indoor fan installed and operating or Coil-only Systems rated with an indoor fan time delay, integrate electrical power from indoor fan OFF to indoor fan OFF.

5.2.4.6.2. For all other Ducted Systems and for Non-ducted Systems, integrate electrical power from compressor OFF to compressor OFF.

5.2.4.6.3. Capacity integration of all systems is from indoor fan ON to indoor fan OFF.

5.2.4.7 *Ducted system procedures for the optional cyclic dry-coil cooling-mode tests (D_{Full}, D_{Low}, and I_{Low}).* The automatic controls that are normally installed with the test unit shall govern the OFF/ON cycling of the air moving equipment on the indoor side (exhaust fan of the airflow measuring apparatus and, if installed, the indoor fan of the test unit). For Coil-only Systems rated based on using a fan time delay, the indoor coil airflow shall be controlled according to the rated ON and/or OFF delays provided by the fan time delay. For Ducted Systems having a Constant-volume AMS or Constant-torque AMS that has been disabled (and possibly removed), the indoor airflow shall be started and stopped at the same instances as if the fan were enabled. For all other Ducted Systems tested without an indoor fan installed, the indoor coil airflow shall be cycled in unison with the cycling of the compressor. Air dampers shall be closed on the inlet and outlet side the OFF period.

Blower Coil Systems with Constant-volume AMS or Constant-torque AMS which has the blower disabled for Cyclic Test, adjust energy based on Equation 5.11 and capacity per Equation 5.12

$$Ec_{adj,x} = E_{fan,x} \cdot [\theta_2 - \theta_1] \quad 5.11$$

AVA Documents Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

$$qc_{adj,x} = P_{fan,x} \cdot [\theta_2 - \theta_1] \quad 5.12$$

The following algorithm shall be used to calculate $Ec_{adj,x}$ and $qc_{adj,x}$ in lieu of Equations 5.11 and 5.12, at the manufacturer's discretion, if the indoor fan ramps its speed when cycling.

5.2.4.7.1. Measure the electrical power consumed by the Constant-volume AMS or Constant-torque AMS at a minimum of three operating conditions: at the speed/air volume rate/external static pressure that was measured during the Steady-state Test, at operating conditions associated with the midpoint of the ramp-up interval, and at conditions associated with the midpoint of the ramp-down interval. For these measurements, the tolerances on the airflow volume or the external static pressure are the same as required for the Steady-state Test.

5.2.4.7.2. For each case, determine the indoor fan power from the average of measurements made over a minimum of 5 minutes.

5.2.4.7.3. Approximate the electrical energy consumption of the indoor fan if it had operated during the Cyclic Test using all three power measurements. Assume a linear profile during the ramp intervals. The manufacturer shall provide the durations of the ramp-up and ramp-down intervals. If a manufacturer-supplied ramp interval exceeds 45 seconds, use a 45-second ramp interval nonetheless when estimating the fan energy.

5.2.4.8 *Non-ducted System procedures for the optional cyclic dry-coil cooling-mode tests (D_{Full}, D_{Low}, and I_{Low}).* Do not use dampers when conducting Cyclic Tests on Non-ducted Systems. Until the last OFF/ON compressor cycle, airflow through the Indoor Coil must cycle off and on in unison with the compressor. For the last OFF/ON compressor cycle—the one used to determine energy and capacity—use the exhaust fan of the airflow measuring apparatus and the indoor fan of the test unit to have indoor airflow start 3 minutes prior to compressor cut-on and end three minutes after compressor cutoff. Subtract the electrical energy used by the indoor fan during the 3 minutes prior to compressor cut-on from the integrated electrical energy. Add the electrical energy used by the indoor fan during the 3 minutes after compressor cutoff to the integrated cooling capacity. For the case where the Non-ducted System uses a variable-speed indoor fan which is disabled during the Cyclic Test, correct $E_{cyc,dry}$ and $q_{cyc,dry}$ using the same approach as prescribed for Blower Coil Systems with Constant-volume AMS or Constant-torque AMS which has the blower disabled for Cyclic Test."

5.2.4.9 *Outdoor Equipment Cycling.* The outdoor air-moving equipment (on the condenser side) shall cycle ON and OFF when the compressor cycles ON and OFF unless controls supplied with the product preclude this.

5.3. For reference purposes only, Table 7 summarizes the various sections of this standard that are applicable to different types of equipment.

Section 6. Rating Requirements

6.1. *Standard Ratings.* Standard Ratings shall be established at the Standard Rating Conditions specified per Tables 8, 9, and 10. Standard Ratings shall be established for all refrigerants listed on the nameplate of product.

Standard Ratings relating to cooling capacities shall be net values, including the effects of circulating-fan heat, but not including supplementary electric heat. Power input used for calculating efficiency shall be the Total Power.

Standard Ratings of units which do not have indoor air-circulating fans furnished as part of the model, i.e., Coil-only System, shall be established by subtracting from the total cooling capacity 365 W per 1700 m^3/h. Total Power for cooling shall be increased by 365 W per 1700 m^3/h of indoor air circulated.

Documents
Document Sharing Hub

Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

Table 7. Informative Guidance for Using AHRI Standard 211/241-0B/1B (SI)						
			General Testing and Set-up Issues	Rating Procedure Issues		Calculations
				General	Cooling	Cooling
Requirements for all units			5.1.1, 5.1.3, 5.1.4, 5.1.6, 5.2, Section 5, Section 6, Appendix C, Appendix D, D1, D3, D4, D7, D8, D9, D11, D13, D14, D15.2, D16, D17, F1	5.1.1, 6.1, Table 8, Table 9, 6.1.1, 6.1.2, 6.1.3, 6.1.4, 6.1.5.1, Table 12, 6.1.8, 6.5, 6.5.4, 6.5.5	6.1.5	11.1.1 to 11.1.6, 11.2.1
Requirements for all Heat Pumps			5.1.5, 5.1.6.2	6.1.6, 6.1.7		
Additional Requirements	System Configurations (more than one may	Blower Coil System	5.1.5, D5, C4.5, C5.1.1, C7.1.2.1			
		Non-ducted System	D12		6.1.5.1.4, 6.1.5.3.4	
		Single-package	5.1.6.3, D5, C5.2.1	6.1.8.5		
		SDHV	D6			
		Multi-split	5.1.5.1, D10	6.1.8.4		
	Modulation	Single speed compressor		6.1.8.1	6.1.3.1.1	11.2.1.1
		Two-capacity compressor		6.1.8.2	6.1.3.1.2, 6.1.5.3	11.2.1.2
		Variable Speed Compressor	5.1.2, D2		6.1.3.1.3, 6.1.5.4	11.2.1.3
	Special	Units with a Multi-speed Outdoor Fan	D15.1			

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

Table 7. Required Tests[1] – T1 Climate			
Test Name	Air-cooled Product Type		
	Single Stage System	Two-stage System	Variable Stage System
Cooling Mode			
$T_{1,Full}$	R	R	R
B_{Full}	R	R	R
B_{Low}		R	R
C_{Full}	O [2]	O [2]	
C_{Low}		O [2]	
D_{Full}	O [2]	O [2]	
D_{Low}		O [2]	
E_{Int}			R
F_{Low}		R	R
G_{Low}			O [2]
I_{Low}			O [2]
Cooling Mode Operation Tests			
Voltage Tolerance	R	R	R
Low Temperature Cooling	R	R	R
Insulation Efficiency	R	R	R
Condensate Disposal	R	R	R
Maximum Operating Conditions	R	R	R

Notes:
1. "R" means Required, "O" means Optional, and a blank cell indicates test is not applicable for the given product type.
2. Refer to Section 6.1.3.1.

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...

Table 8. Required Tests[1] – Hot Climate			
Test Name	Air-cooled Product Type		
	Single Stage System	Two-stage System	Variable Stage System
Cooling Mode			
$T_{3,Full}$ or $T_{4,Full}$ [2]	R	R	R
$T_{1,Full}$	R	R	R
$T_{1,Int}$			R
$T_{1,Low}$		R	R
B_{Full}	R		
B_{Low}		R	R
C_{Full}	O [3]	O [3]	
C_{Low}		O [3]	
D_{Full}	O [3]	O [3]	
D_{Low}		O [3]	
F_{Low}		O [3]	O [3]
G_{Low}			O [3]
I_{Low}			O [3]
Cooling Mode Operation Tests			
Voltage Tolerance	R	R	R
Low Temperature Cooling	R	R	R
Insulation Efficiency	R	R	R
Condensate Disposal	R	R	R
Maximum Operating Conditions	R	R	R
Extra High Maximum Operating Conditions	O[4]	O[4]	O[4]

Notes:
1. "R" means Required, "O" means Optional, and a blank cell indicates test is not applicable for the given product type.
2. Where required, depending on climate zone.
3. Refer to Section 6.1.3.1.
4. May be required in some regions

Documents
Document Sharing Hub
Full document details: AHRI Standard 211-241-0B-1B-2021 (SI) - Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment - Addend...