AHRI Standard 340/360-2022 (I-P)

2022 Standard for

Performance Rating of Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment

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Foreword:

AHRI Standard 340/360-2022 (I-P) includes additional provisions in Section D3 to cover Determinations of Fan and Motor Efficiency for Non-standard Indoor Fan and Motors with the addition of Appendix I to provide an example, and new provisions were included for Double-duct systems in sections 6.1.1.9, 6.1.3.6, 6.1.3.7 and Appendix I.

AHRI Standard 340/360-2022 (I-P) contains the following technical and administrative update(s) to the previous edition:

- Updated definitions of Indoor Single Package Air-conditioners, Single Package Heat Pumps, Split System Air-conditioners, Split System Heat Pumps, Staged Capacity Controlled Units, and Stepped Fan Control for clarity.
- Changed the defined term Proportionally Controlled Units to Proportionally Capacity Controlled Units throughout the document.
- Corrected instances that referred to Table 4 instead of Table 7 in Standard Rating definition and Section 6.1.3.3.1.
- Updated Section 6.5 to reflect that Standard Ratings can be based on simulation.
- Updated Table 3 to clarify that corrections apply when exceeding the minimum.
- Updated Section 5.8.1 to clarify that other charging metrics than listed may be used.
- Updated instances of “cfm” to “scfm” throughout.
- Updated section 6.1.1.8 for clarity.
- Updated Table 6 to restore the term “(max)” to the heating test wet-bulb requirements. Footnote 1 was clarified to correct the dew point for the 25 Percent Load test.
- Updated phrases to use the defined terms Full Load Rated Indoor Airflow and Part Load Rated Indoor Airflow throughout Section 6.1.3.
- Updated phrases of “part load cooling airflow rate” to “cooling indoor airflow rate” in Section 6.1.3.4.5.
- Corrected Table 9 to reference proper wet-bulb and make up water temperatures for evaporatively cooled products. Corrected Note 1 to reference Section 6.1.3.6.
- Updated phrases to use the defined term Percent Load and EER throughout Section 6.2.
- Removed references to “manual” means of adjustment from Section 6.2.5.
- Updated Section 6.2.6 to correctly reflect testing requirements and technology used in Proportionally Capacity Controlled Units.
- Updated Table 11 to include Make Up Water temperature requirements and corrected note 4.
- Corrected Section 6.4 by removing duplicate information about secondary capacity checks. Remaining information was moved to Section E6.4
- Corrected Section 6.5.3 to better reflect regulatory requirements.
- Corrected Section 7.2 to identify acceptable forms of publishing capacity.
- Updated references in Appendix A and B.
- Removed duplicate requirements from Table C2.
- Corrected Section E6.2 to refer to Section E6.4 instead of E6.3.
- Updated Section E6.5 to account for new Double-duct provisions.
- Updated Section E8.1 to reference Table 6.
- Included temperature requirements for Extra High Temperature Operating Requirement in Appendix F.
- Minor technical and grammatical changes to Appendix G

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PERFORMANCE RATING OF COMMERCIAL AND INDUSTRIAL UNITARY AIR-CONDITIONING AND HEAT PUMP EQUIPMENT

Section 1. Purpose

1.1 *Purpose*. The purpose of this standard is to establish for Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment: 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, federal and state regulations, and efficiency standards developed by ASHRAE, International Energy Conservation Code (IECC), Canadian Standards Association (CSA), Department of Energy (DOE), 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 Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment 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 following:

2.2.1 Rating and testing of individual assemblies, such as condensing units or coils, for separate use.

2.2.2 Air-cooled Unitary Air-conditioners and Unitary Heat Pumps as defined in AHRI Standard 210/240, with capacities less than 65,000 Btu/h.

2.2.3 Water-Source Heat Pumps as defined in ANSI/ASHRAE/AHRI/ISO Standard 13256-1.

2.2.4 Variable Refrigerant Flow Air-conditioners and Heat Pumps as defined in AHRI Standard 1230.

2.2.5 Rating of units equipped with desuperheater/water heating devices (as defined in ANSI/AHRI Standard 470) in operation.

2.2.6 Commercial and industrial unitary air-conditioning condensing units with a capacity greater than 135,000 Btu/h as defined in ANSI/AHRI Standard 365 (I-P).

2.3 *Other Applicable Standards.* Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment can be rated using the following standards:

2.3.1 Single vertical packaged air conditioners rated using ANSI/AHRI Standard 390.

2.3.2 Dedicated outdoor air systems rated with 100% outside air using ANSI/AHRI Standard 920 (I-P).

2.3.3 Air conditioners and condensing units serving computer rooms rated using AHRI Standard 1360.

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Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the *ASHRAE Terminology* website unless otherwise defined in this section.

3.1 *Air Sampling Device(s).* A combination of Air Sampling Tree(s), conduit, fan and Aspirating Psychrometer or Dew-point Hygrometer used to determine dry-bulb temperature and moisture content of an air sample from critical locations.

3.1.1 *Air Sampling Tree.* An assembly consisting of a manifold with branch tubes with multiple sampling holes that draws an air sample from a critical location from the unit under test (for example, indoor air inlet, indoor air outlet, outdoor air inlet).

3.1.2 *Aspirating Psychrometer.* An instrument used to determine the humidity of air by simultaneously measuring both the wet-bulb and dry-bulb temperatures. The difference between these temperatures is referred to as the wet-bulb depression.

3.1.3 *Dew-point Hygrometer.* An instrument used to determine the humidity of air by detecting visible condensation of moisture on a cooled surface.

3.2 *Basic Model*. All systems within a single equipment class, as defined in 10 CFR Part 431, that have the same or comparably performing compressor(s), heat exchangers, and air moving system(s) that have a common "nominal" Cooling Capacity.

3.3 *Coil-only Indoor Unit*. An indoor unit that is distributed in commerce without an indoor blower or separate designated air mover. A Coil-only Indoor Unit installed in the field relies on a separately installed furnace or modular blower for indoor air movement.

3.4 *Commercial and Industrial Unitary Air-conditioning Equipment.* One or more factory-made assemblies, that normally include a cooling coil, an air moving device, a compressor(s) and condenser combination, and can include a heating function as well. Where such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together, and the requirements of rating outlined in this standard shall be based upon the use of matched assemblies. The functions of Commercial and Industrial Unitary Air-conditioners, either alone or in combination with a heating plant, are to provide air-circulation, cooling, dehumidification, and can include the functions of heating, humidifying, outdoor air ventilation, and air cleaning.

3.5 *Commercial and Industrial Unitary Heat Pump.* One or more factory-made assemblies, that normally include an indoor conditioning coil, an air moving device, compressor(s), and an outdoor coil(s), including means to provide a heating function and can include a cooling function. When such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together, and the requirements of rating outlined in the standard shall be based upon the use of matched assemblies. Commercial and Industrial Unitary Heat Pumps shall provide the function of heating and can include the functions of air circulation, air cooling, dehumidifying or humidifying, outdoor air ventilation, and air cleaning.

3.6 *Cooling Capacity*. The net capacity associated with the change in air enthalpy between the air entering the unit and the air leaving the unit, that includes both the Latent and Sensible Capacities expressed in Btu/h and includes the heat of circulation fan(s) and motor(s).

3.6.1 *Standard Cooling Capacity*. Full load Cooling Capacity at Standard Rating Conditions for a unit configured in accordance with Appendix E, and when tested in accordance with the requirements of Appendix F, expressed in Btu/h.

3.6.2 *Latent Capacity*. Capacity associated with a change in humidity ratio, expressed in Btu/h.

3.6.3 *Sensible Capacity*. Capacity associated with a change in dry-bulb temperature, expressed in Btu/h.

3.7 *Double-duct System.* An air conditioner or heat pump that complies with all of the following:

1. Is either a horizontal single package or split-system unit; or a vertical unit that consists of two components that can be shipped or installed either connected or split; or a vertical single packaged unit that is not intended for exterior mounting on, adjacent interior to, or through an outside wall
2. Is intended for indoor installation with ducting of outdoor air from the building exterior to and from the unit, where the unit or its components are non-weatherized or both

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3. If it is a horizontal unit, the complete unit shall have a maximum height of 35 in or the unit shall have components that do not exceed a maximum height of 35 in. If it is a vertical unit, the complete (split, connected, or assembled) unit shall have components that do not exceed maximum depth of 35 in
4. Has a rated Cooling Capacity greater than and equal to 65,000 Btu/h and less than or equal to 300,000 Btu/h.

Informative Note: For equipment with a condenser fan/motor assembly designed for external ducting of condenser air that is not a Double-duct System (for example, if the unit does not meet the maximum height or width requirements, or if the unit has a rated Cooling Capacity greater than 300,000 Btu/h), provisions for testing at zero outdoor ESP are specified in Section 6.1.3.7.1. For such equipment, non-standard (for example, higher-static) ducted condenser fans are considered an optional feature per Section D2.18. See Sections D2 and D2.18 for further provisions regarding testing without this optional feature, as applicable.

3.8 *Energy Efficiency Ratio (EER).* A ratio of the Cooling Capacity in Btu/h to the power input values in watts at any given set of Rating Conditions, expressed in Btu/(W·h).

3.7.1 *Standard Energy Efficiency Ratio.* A ratio of the capacity to power input value obtained at Standard Rating Conditions.

3.9 *Fixed Capacity Controlled Units*. Products limited by the controls to a single stage of refrigeration capacity.

3.10 *Full Load Rated Indoor Airflow*. The Standard Airflow rate at 100% capacity as defined by the Manufacturer's Installation Instructions and at the external static pressure as listed in Table 6.

3.11 *Heating Capacity*. The capacity associated with the change in dry-bulb temperature between the air entering the unit and the air leaving the unit and includes the heat of circulation fan(s) and motor(s) but does not include supplementary heat, expressed in Btu/h.

3.12 *Heating Coefficient of Performance (COP_H).* 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. For COP_H, supplementary resistance heat shall be excluded.

3.13 *Independent Coil Manufacturer (ICM).* A company that manufactures indoor units but does not manufacture single package units or outdoor units.

3.14 *Integrated Energy Efficiency Ratio (IEER).* A weighted calculation of mechanical cooling efficiencies at full load and part-load Standard Rating Conditions, defined in Section 6.2, expressed in Btu/(W·h). See Appendix G for background and application.

3.15 *Indoor Single Package Air-conditioners*. Non-weatherized units with factory-made assemblies of one or more evaporator fans, evaporator coils, and condensing units having means for air cooling, cleaning, dehumidification, heating with factory or field installed electric strip heaters and forced air circulation through a duct system and that can have means for humidifying and control of temperature. These units do not have gas heat and are not heat pumps. Included are only those units that are assembled or designed to be assembled in a single unit (within a single factory-made enclosure).

3.16 *Manufacturer's Installation Instructions***.** 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 published recommendations," "manufacturer installation and operation manuals," "installation instructions" and other similar references means Manufacturer's Installation Instructions. This includes certification reports (information provided to authorities having jurisdiction) provided by the manufacturer. These certified parameters shall not deviate from the manufacturer's installation instructions.

3.16.1 *Supplemental Test Instructions (STI).* Additional instructions developed by the manufacturer and certified to the United States Department of Energy (DOE). STI shall include (a) all instructions that do not deviate from Manufacturer's Installation Instructions but provide additional specifications for test standard requirements allowing more than one option, and (b) all deviations from Manufacturer's Installation Instructions 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 Manufacturer's Installation Instructions. STI shall include no instructions that deviate from Manufacturer's Installation Instructions other than those described in (b) above.

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3.16.2 *Manufacturer-specified.* Information provided by the manufacturer through Manufacturer's Installation Instructions.

3.17 *Makeup Water (MW)*. The water supplied to an evaporative cooled condenser to compensate for the water evaporated.

3.18 *Multi Zone Variable Air Volume (MZVAV)*. Units with control systems designed to vary the indoor air volume and refrigeration capacity/staging at a controlled discharge air temperature and static pressure as a means of providing space temperature control to independent multiple spaces with independent thermostats.

3.19 *Outdoor Unit Manufacturer (OUM)*. A manufacturer of single package units, outdoor units, and indoor units. or outdoor units, or both.

3.20 *Part Load Rated Indoor Airflow*. The Standard Airflow at the part-load ratings conditions as defined by the Manufacturer's Installation Instructions and at the external static pressure as listed in Table 6 with modifications shown in Table 7. This can be different for each part-load rating point.

3.21 *Percent Load.* The ratio of the part-load Cooling Capacity over the measured full load Cooling Capacity at Standard Rating Conditions, expressed in units of percent, %.

3.22 *Proportionally Capacity Controlled Units.* Units incorporating one or more variable capacity compressors where the compressor capacity can be modulated continuously or in steps not more than 5% of the AHRI Standard 540, Table 2, rating test point A capacity (45/130/20/15). The modulating compressor or compressors shall be capable of modulating the unit capacity over a range of at least 50% to 100%. The unit can include combination of fixed capacity and variable capacity compressors.

3.23 *Published Rating.* A statement of the assigned values of those performance characteristics, under stated Rating Conditions, where a unit can be chosen to fit its application. These values apply to all units of like nominal size and type (identification) produced by the same manufacturer. As used herein, the term 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.

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

3.23.2 *Standard Rating.* A rating based on tests performed at Standard Rating Conditions as listed in Table 6.

3.23.3 *International Ratings*. A rating based on tests performed at International Rating Conditions as listed in Table F1.

3.24 *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.

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

3.24.2 *International Rating Conditions.* Rating Conditions used as the basis of comparison for performance characteristics for products sold outside North America.

3.25 *"Shall" or "shall not" and" should" or "should not"*

3.25.1 *"Shall" or "shall not."* indicate mandatory requirements to be strictly followed in order to conform to the standard and from which deviation is not permitted.

3.25.2 *"Should" or "should not."* Express recommendations rather than requirements. In the negative form, a recommendation is the expression that a suggested possible choice or course of action is not preferred but not prohibited.

3.26 *Single Package Air-conditioners*. Units with factory-made assemblies of one or more evaporator fans, evaporator coils, and condensing units having means for air cooling, cleaning, dehumidification, heating with factory or field installed electric

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strip heaters and forced air circulation through a duct system and that can have means for humidifying and control of temperature. These units do not have gas heat and are not heat pumps. Included are only those units that are assembled or designed to be assembled in a single unit (within a single factory-made enclosure). Single package (cooling only) roof top units are included in this category.

3.27 *Single Package Heat Pumps*. Units that can both cool and heat with the refrigeration system that can have provision for supplementary electric, hot water, steam or gas heat (dual fuel) that are factory-made assemblies of one or more evaporator fans, evaporator coils, and condensing units having means for air cooling, heating, cleaning, dehumidification, and forced air circulation through a duct system and that can have means for humidifying and control of temperature, with provision for modifying the performance so that either heating or cooling and dehumidification can be produced. Included are only those units that are assembled or designed to be assembled in a single unit (within a single factory-made enclosure).

3.28 *Single Zone Variable Air Volume (SZVAV)*. Units with a control system designed to vary the indoor air volume and refrigeration capacity/staging as a means to provide zone control to a single or common zones, The capacity, as well as the Supply Air shall be controlled either through modulation, discrete steps or combinations of modulation and step control based on the defined control logic.

3.29 *Split System Air-conditioners*. Air-conditioners designed with an air conditioning condensing unit that is installed remotely from the evaporator and requiring field connection by refrigerant lines.

3.30 *Split System Heat Pump*. Heat pumps designed with an outdoor unit that is installed remotely from the indoor coil, air handler, or fan coil and requiring field connection by refrigerant lines.

3.31 *Staged Capacity Controlled Units.* Units incorporating only fixed capacity or discrete steps of compression and limited by the controls to multiple stages of refrigeration capacity. Units that have multiple stages of refrigeration that do not meet the definition of Section 3.22, Proportionally Capacity Controlled Units, meet this definition.

3.32 *Standard Air*. Dry air having a mass density of 0.075 lb/ft^3.

3.33 *Standard Airflow*. The volumetric flowrate of air converted to Standard Air conditions expressed in scfm.

3.34 *Standard Filter*. The filter with the lowest level of filtration that is distributed in commerce with a model. If the manufacturer does not specify what filter option has the lowest level of filtration in Manufacturer's Installation Instructions or marketing materials for the model, then the Standard Filter shall be the filter designated as the "default" or "standard" filter in the marketing materials for the model. If the manufacturer does not specify a default filter option or the filter option that has the lowest filtration level, then the Standard Filter shall be any filter shipped by the manufacturer.

3.35 *Supply Air*. Air delivered by a unit to the conditioned space expressed as Standard Air.

3.36 *Year Round Single Package Air-conditioners*. Gas and oil Single Package Air-conditioners that are factory-made assemblies of one or more evaporator fans, evaporator coils, and condensing units and equipped with gas or oil-fired heating sections and means for air cooling, cleaning, dehumidification, heating and forced air circulation through a duct system and that can have means for humidifying and control of temperature. Included are only those units that are assembled or designed to be assembled in a single unit (within a single factory-made enclosure).

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Section 4. Classifications

4.1 Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment within the scope of this standard shall be classified as shown in Table 1 and Table 2.

Table 1. Classification of Commercial and Industrial Unitary Air-conditioning Equipment

Designation	AHRI Type[1,2]	Arrangement – Indoor (ID)	Arrangement – Outdoor (OD)
Single Package and Indoor Package Air-conditioners	SP-A[3, 4] SP-E[3, 4] SP-W[4, 7]	--	ELECTRIC HEAT[5] ID FAN EVAPORATOR OD FAN or PUMP COMPRESSOR CONDENSER
Year Round Single Package Air-conditioners	SPY-A[3, 4] SPY-E[3, 4] SPY-W[4, 7]	--	GAS HEAT[6] ID FAN EVAPORATOR OD FAN or PUMP COMPRESSOR CONDENSER
Air-conditioner with Remote Condenser	RC-A[3] RC-E[3] RC-W[7]	ID FAN EVAPORATOR ELECTRIC HEAT[5]	OD FAN or PUMP COMPRESSOR[8] CONDENSER
Split System Air-conditioners: Condensing Unit, Coil Alone	RCU-A-C[3] RCU-E-C[3] RCU-W-C[7]	EVAPORATOR	OD FAN or PUMP COMPRESSOR CONDENSER
Split System Air-conditioners: Condensing Unit, Coil and Fan	RCU-A-CB[3] RCU-E-CB[3] RCU-W-CB[7]	ID FAN EVAPORATOR ELECTRIC HEAT[5]	OD FAN or PUMP COMPRESSOR CONDENSER
Year Round Split System Condensing Unit, Coil and Fan	RCUY-A-CB[3] RCUY-E-CB[3] RCUY-W-CB[7]	GAS HEAT[6] ID FAN EVAPORATOR	OD FAN or PUMP COMPRESSOR CONDENSER

Notes:

1. A suffix of "-O" following any of the above classifications indicates equipment not intended for use with field-installed duct systems.
2. "-A" indicates air-cooled condenser, "-E" indicates evaporatively-cooled (does not apply to evaporative pre-cooled) condenser and "-W" indicates water-cooled condenser.
3. For Double-duct Systems, insert “-DD” at the end, and outdoor arrangement moves from outdoor side to indoor side.
4. Components can be installed indoors as well in accordance with Manufacturer’s Installation Instructions.
5. Optional component.
6. May be any other heat source except for electric strip heat.
7. For water-cooled products, outdoor arrangement can move from outdoor side to indoor side.
8. May be installed with either the indoor or the outdoor unit.

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Table 2. Classification of Commercial and Industrial Unitary Heat Pump Equipment

Designation	AHRI Type[1,2]	Arrangement - Indoor (ID)	Arrangement – Outdoor (OD)
Single Package Heat Pumps	HSP-A[3]	--	ELECTRIC HEAT[4] ID FAN EVAPORATOR OD FAN or PUMP COMPRESSOR CONDENSER
Year Round Single Package Heat Pump	HSPY-A	--	GAS HEAT[5] ID FAN EVAPORATOR OD FAN or PUMP COMPRESSOR CONDENSER
Heat Pump with Remote Outdoor Coil	HRC-A-CB[3]	ID FAN EVAPORATOR COMPRESSOR	OD FAN or PUMP CONDENSER
Split System Heat Pump with Remote Outdoor Coil with no Indoor Fan	HRC-A-C[3]	EVAPORATOR COMPRESSOR	OD FAN or PUMP CONDENSER
Split System Heat Pump with Coil Blower	HRCU-A-CB[3]	ELECTRIC HEAT[4] ID FAN EVAPORATOR	OD FAN or PUMP COMPRESSOR CONDENSER

Notes:

1. A suffix of "-O" following any of the above classifications indicates equipment not intended for use with field-installed duct systems.
2. For heating only, change the initial “H” to “HO”.
3. For Double-duct Systems, append “-DD”, and outdoor arrangement moves from outdoor side to indoor side.
4. Optional component.
5. Can be other heat sources.

Section 5. Test Requirements

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

5.1.1 Units shall be tested in accordance with ANSI/ASHRAE Standard 37 as amended by this section and Appendix E.

5.2 *Instruction Priority.* Units shall be installed per Manufacturer’s Installation Instructions. In the event of conflicting instructions regarding the set-up of the unit under test (excluding charging instructions for split systems, see 5.2.1), priority shall be given to installation instructions that appear on the unit’s label over installation instructions that are shipped with the unit.

5.2.1 *Instructions for Split Systems.* In the event of conflicting charging instructions for split systems, priority shall be given to the installation instructions that are shipped with the unit over the installation instructions that appear on the unit’s label. For split systems other than mix-matched systems (see section 5.2.1.1), if the Manufacturer’s Installation Instructions for the components conflict, priority shall be given to the outdoor unit instructions over the indoor unit instructions, except for provisions regarding setting indoor airflow and external static pressure (ESP). For setting indoor airflow and ESP for such a split system, priority shall be given to the indoor unit instructions over the outdoor unit instructions.

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5.2.1.1 *Mix-Matched Systems*. The following provisions apply for systems consisting of an OUM outdoor unit and an ICM indoor unit. If instructions for the two units differ, priority shall be given to the ICM Manufacturer's Installation Instructions. If instructions are provided only with the outdoor unit or are provided only with an ICM indoor unit, then use the provided instructions.

5.3 *Break-in.* Conduct a compressor break-in period prior to conducting the test if there is a Manufacturer-specified break-in period. Conduct the break-in period using the Manufacturer-specified duration and conditions; however, the duration shall not exceed 20 hours and the outdoor temperature shall not exceed 115°F. When there is a Manufacturer-specified break-in period, each compressor of the unit shall undergo this break-in period. No testing shall commence until the Manufacturer-specified break-in period is completed.

5.4 *Test Unit Duct Installation Requirements*. ANSI/ASHRAE Standard 37 duct requirements shall be followed. Furthermore, the test apparatus including the interconnecting ductwork shall be insulated to have a minimum R-value of 13 $ft^2 \cdot °F \cdot hr/Btu$. Duct losses can be calculated using conduction factors, inside air and outside ambient temperature difference, and the total duct surface area between the unit and the temperature measurement location. Ducts that are exposed to multiple ambient temperatures shall be divided into zones and each zone calculated separately.

5.5 *Defrost Controls*. Defrost controls shall be left at manufacturer's factory settings if the Manufacturer's Installation Instructions provided with the equipment do not specify otherwise. To facilitate testing of any unit, the manufacturer shall provide information and any necessary hardware to manually initiate a defrost cycle.

5.6 *Head Pressure Control*. For units with condenser head pressure controls, the head pressure controls shall be enabled and operated in automatic mode. Set head pressure controls as specified by the Manufacturer's Installation Instructions. If there are no such instructions, use the as-shipped setting. If this results in unstable operation (outside test tolerances in Table 11) and testing requirements cannot be met then the procedures in Appendix E Section E7 shall be used.

5.7 *Line Length for Split Systems*. All Standard Ratings for equipment where the outdoor section is separated from the indoor section, shall be determined with at least 25 ft of interconnection tubing on each line of the size specified in the Manufacturer's Installation Instructions. Such equipment where the interconnection tubing is furnished as an integral part of the machine and not intended to be cut to length per the Manufacturer's Installation Instructions, shall be tested with the complete length of tubing furnished, or with 25 ft of tubing, whichever is greater. At least 10 ft of the interconnection tubing shall be exposed to the outside conditions. The line sizes, insulation, and details of installation shall be in accordance with the Manufacturer's Installation Instructions. Refer to Table 3 for Cooling Capacity correction factors that shall be applied to the full load Cooling Capacity when the tested refrigerant line length exceeds the minimum values.

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

Piping length beyond the requirement (X), ft	Cooling Capacity Correction Factor
$3.3 < X \leq 20$	1.01
$20 < X \leq 40$	1.02
$40 < X \leq 60$	1.03

Note:
1. If the refrigerant line lengths required in the test setup exceed the minimum specified length, the tested capacity shall be multiplied by the correction factor to yield the final capacity result.
2. The piping length X is the cumulative additional line length above the minimum.
3. The absolute minimum length necessary to physically connect the system shall be used subject to the minimum specified length.
4. Cooling Capacity Correction Factor shall only be applied to full load test results.

5.8 *Refrigerant Charging.* Unless the unit does not require charging (per Section 5.8.5) use the test or operating conditions specified in the Manufacturer's Installation Instructions for charging. If the Manufacturer's Installation Instructions do not specify a test or operating conditions for charging or there are no Manufacturer's Installation Instructions, charging shall be conducted at Standard Rating Conditions in cooling mode. If the Manufacturer's Installation Instructions contain two sets of refrigerant charging criteria, one for field installation and one for lab testing, use the field installation criteria. Perform charging of refrigerant blends only with refrigerant in the liquid state.

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5.8.1 If the Manufacturer's Installation Instructions give a Manufacturer-specified range for a charging parameter (for example, superheat, subcooling, or refrigerant pressure) the average of the range shall be used to determine the refrigerant charge.

5.8.2 If there are no Manufacturer's Installation Instructions or the Manufacturer's Installation Instructions do not provide parameters and target values, or both, set superheat to a target value of 12°F for fixed orifice systems or set subcooling to a target value of 10°F for expansion valve systems.

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 Manufacturer-specified conditions given for charge adjustment where all Manufacturer-specified conditions cannot be met. If such instances of conflicting information occur within the highest-ranking set of instructions where refrigerant charging instructions are provided, follow the hierarchy in Table 4, as appropriate, unless the manufacturer specifies a different priority in the outdoor unit installation instructions. Unless the Manufacturer's Installation Instructions specify a tighter charging tolerance, the tolerances specified in Table 4 shall be used.

Table 4. Tolerances for Charging Hierarchy

Fixed Orifice			**Expansion Valve**		
Priority	**Parameter**	**Tolerance**	**Priority**	**Parameter**	**Tolerance**
1	Superheat	± 2.0°F	1	Subcooling	± 2.0°F
2	High Side Pressure or Saturation Temperature	± 4.0 psi or ± 1.0°F	2	High Side Pressure or Saturation Temperature	± 4.0 psi or ± 1.0°F
3	Low Side Pressure or Saturation Temperature	± 4.0 psi or ± 1.0°F	3	Low Side Pressure or Saturation Temperature	± 2.0 psi or ± 0.8°F
4	Low Side Temperature	± 2.0°F	4	Approach Temperature[1]	± 1.0°F
5	High Side Temperature	± 2.0°F	5	Charge Weight	± 2.0 oz
6	Charge Weight	± 1% of nominal charge or 2.0 oz, whichever is greater	--	--	--

Notes:

1. Approach temperature means the refrigerant temperature at the outdoor liquid service port minus the outdoor ambient temperature.

5.8.4 *Single Package Unit.* Install one or more refrigerant line pressure gauges during the setup of the unit unless either of the following conditions are met: (1) the Manufacturer's Installation Instructions indicate that pressure gauges shall not be installed; or (2) charging is based only on parameters, such as charge weight, that do not require measurement of refrigerant pressure. Use methods for installing pressure gauge(s) at the required location(s) as indicated in Manufacturer's Installation Instructions if specified. Install pressure gauges depending on the parameters used to verify or set charge, as described in the following paragraphs.

5.8.4.1 Install a pressure gauge at the location of the service connections on the liquid line if charging is based on subcooling, or high side pressure or corresponding saturation or dew point temperature.

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

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5.8.5 The refrigerant charge obtained as described in this section shall then be used to conduct all tests used to 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*

5.9.1 *Air-Cooled and Evaporatively-Cooled Equipment*. For testing split systems, the indoor unit shall be located in the indoor test room (in other words, the test chamber maintained at the air conditions specified for return indoor air). A remote condenser or condensing unit shall be located in the outdoor test room (in other words, the test chamber maintained at the air conditions specified for outdoor ambient air), unless the remote condenser or condensing unit is designed and marketed for indoor installation (for example, Double-duct Systems), then the indoor remote condenser or condensing unit shall be located in the indoor test room. For testing single package units, the unit shall be located in the outdoor test room unless the unit is designed and marketed for indoor installation (for example, Double-duct Systems), then the unit shall be located in the indoor test room.

5.9.2 *Water-Cooled Equipment*. The unit (including both units for split systems) shall be located in the indoor test room.

5.10 When testing air conditioners and heat pumps having a variable speed drive, an induction watt-hour meter shall not be used.

5.11 If the Outdoor Unit or the outdoor portion of a Single Package Unit has a drain pan heater to prevent freezing of defrost water, the heater shall be energized, subject to control to de-energize it when not needed by the heater's thermostat or the unit's control system, for all tests.

5.12 *Instrumentation Accuracy*. In addition to the instrument accuracy requirements specified in section 5 of ASHRAE Standard 37, measurements shall be made in accordance with the following provisions.

5.12.1 *Atmospheric pressure*. Atmospheric pressure measuring instruments shall be accurate to within ± 0.5% of the reading.

5.12.2 *Electrical Frequency*. Measurement devices used to measure electrical frequency shall be accurate to within ± 0.2 Hz.

Section 6. Rating Requirements

6.1 *Standard Ratings*

6.1.1 Standard Ratings shall meet the following criteria:

6.1.1.1 Standard ratings shall be established at the Standard Rating Conditions specified in Table 5, Table 6, and Table 8 for North American Ratings, or Appendix F for International Ratings.

6.1.1.2 Standard Ratings related to Cooling or Heating Capacities shall be net values, including the effects of circulating fan heat, but not including supplementary heat.

6.1.1.3 Standard Ratings shall be based on the total power input (see appendix D regarding features to be included and activated during the test). Power used for any override controls only used for laboratory testing shall not be included in total power.

6.1.1.4 Standard Ratings shall be based on 100% recirculated indoor air.

6.1.1.5 Standard Ratings tests shall not include operation of any heating components other than the reverse cycle heat pump functionality.

6.1.1.6 Standard Ratings of Coil-Only Indoor Units shall be established by subtracting 1,250 Btu/h per 1,000 scfm from the total Cooling Capacity, and by adding the same amount to the Heating Capacity. Total power

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input for both heating and cooling shall be increased by 365 W per 1,000 scfm of indoor air circulated.

6.1.1.7 Standard Ratings of water-cooled units from less than 135,000 Btu/h shall include a total allowance for cooling tower fan motor and circulating water pump motor power inputs to be added in the amount of 10.0 W per 1,000 Btu/h Cooling Capacity.

6.1.1.8 Standard ratings for water cooled equipment shall be based on a fouling factor of 0.0000 $hr \cdot ft^{2} \cdot {}^{o}F/Btu$

6.1.1.9 Standard ratings for Double-duct Systems shall be established in accordance with Section 6.1.3.7.

6.1.2 *Standard Rating Values*

6.1.2.1 *Values of Standard Capacity Ratings.* These ratings shall be expressed in terms of Btu/h in multiples shown in Table 5.

Table 5. Rounding of Standard Rating Capacities

Standard Cooling Capacity Ratings, Btu/h	Multiples, Btu/h for both Heating and Cooling
From 65,000 to 135,000	1000
From 135,000 to ≤ 400,000	2000
400,000 and greater	5000

6.1.2.2 *Values of Energy Efficiency Ratios and Heating Coefficients of Performance.* Energy Efficiency Ratio (EER, EER_{DD}) and Integrated Energy Efficiency Ratio (IEER, $IEER_{DD}$) for cooling, whenever published, shall be expressed in multiples of 0.1, and expressed in Btu/(W·h) for a unit configured in accordance with Appendix D, and when tested in accordance with the requirements of Appendix E. Heating Coefficients of Performance (COP_{H}, $COP_{H,DD}$), whenever published, shall be expressed in multiples of 0.01.

6.1.3 *Standard Rating Tests*. Table 6 and Table 7 indicate the tests and test conditions that are required to determine values of standard full load capacity ratings and values of energy efficiency. Standard cooling ratings are not applicable for heating-only heat pumps.

6.1.3.1 *Voltage and Frequency*. Standard Rating tests shall be performed at the nameplate rated voltage(s) and frequency.

For air-conditioners and heat pumps with dual nameplate voltage ratings, 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.

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Table 6. Conditions for Standard Rating and Operating Tests

Test		Indoor Section[4] Air Entering		Outdoor Section[6] Test Conditions based on Condenser Type						
				Air Cooled		Evaporative			Water Cooled	
		Dry-bulb, °F	Wet-bulb, °F	Dry-bulb, °F	Wet-bulb, °F	Dry-bulb, °F	Wet-bulb, °F	Makeup Water, °F	Inlet, °F	Outlet, °F
Cooling	Standard Rating Conditions Cooling[3, 5]	80.0	67.0	95.0	75.0[1,7]	95.0	75.0	85.0	85.0	95.0
	Low Temperature Operating Cooling[3, 5]	67.0	57.0	67.0	57.0	67.0	57.0	67.0	--	70.0[2]
	Maximum Operating Conditions[3, 5]	80.0	67.0	115	--	100	80.0[4]	90.0	90.0[2]	--
	Standard Rating Part-Load Conditions (IEER)[3, 5]	80.0	67.0	Varies with load per Table 9	Varies with load per Table 9[1,7]	Varies with load per Table 9	Varies with load per Table 9	77.0	Varies with load per Table 9[2]	Varies with load per Table 9
	Insulation Efficiency[3, 5]	80.0	75.0	80.0	75.0	80.0	75.0	85.0	--	80.0
	Condensate Disposal[3, 5]	80.0	75.0	80.0	75.0	80.0	75.0	85.0	--	80.0
Heating	Standard Rating Conditions (High Temperature Steady State Heating)[5]	70.0	60.0 (max)	47.0	43.0	--	--	--	--	--
	Standard Rating Conditions (Low Temperature Steady State Heating)[5]	70.0	60.0 (max)	17.0	15.0	--	--	--	--	--
	Maximum Operating Conditions[5]	80.0	--	75.0	65.0	--	--	--	--	--

Footnotes:
1. Only required if unit rejects condensate to Outdoor Coil.
2. Water flow rate as determined from Standard Rating Conditions test.
3. Cooling rating and operating tests are not required for heating only heat pumps.
4. Indoor fan system external static pressure shall be set per Table 7.
5. Tests are only valid when the atmospheric pressure is greater than 13.700 psia.
6. For some product classifications, the outdoor section can be located indoors per section 5.9.
7. For Single Package Units that do not reject condensate to the Outdoor Coil, where all or part of the indoor section of the equipment is located in the outdoor room, maintain an outdoor room dew point temperature of 60.5°F for 100, 75, and 50 Percent Load tests and 58.7°F for 25 Percent Load tests.

6.1.3.2 *Atmospheric Pressures.* Cooling and Heating Capacity, EER, IEER and COP_H measurements obtained during test are only valid when atmospheric pressure is greater than 13.700 psia. The test shall not be conducted if the atmospheric pressure is below 13.700 psia.

6.1.3.3 *Minimum Indoor Air External Static Pressure for Testing*

6.1.3.3.1 Test at the external static pressure specified in Table 7 for full-load cooling tests for all units (except for Coil-only Indoor Units and heating-only units) and high temperature Heating Capacity tests for heating-only units.

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Table 7. External Static Pressure

Rated Cooling Capacity, Btu/h·1000[1]	External Static Pressure, in H_2O[2]
From 0 to 28.8[3]	0.10
From 29 to 42.5[3]	0.15
From 43 to 64.5[3]	0.20
From 65 to 70	0.20
From 71 to 105	0.25
From 106 to 134	0.30
From 135 to 210	0.35
From 211 to 280	0.40
From 281 to 350	0.45
From 351 to 400	0.55
From 401 to 500	0.65
501 and greater	0.75

Footnotes:
1. Rated full load Cooling Capacity for units with cooling function; high temperature Heating Capacity for heating-only units.
2. Standard Ratings shall be determined and tested with the Standard Filter for that model. For units distributed in commerce without filters, refer to Section 6.1.3.3.3
3. Only applicable for evaporatively and water-cooled units.

6.1.3.3.2 Heating and Part Load Cooling Tests that do not use the full-load cooling airflow (except for Coil-only Indoor Units). When conducting heating or part-load cooling tests where the Manufacturer-specified fan control settings, or rated airflow rates are different than for the full-load cooling test, or both, calculate adjusted ESP requirements using equation 1.

$$ESP_{adj} = ESP_{FL}\left(\frac{Q_{dif}}{Q_{FL}}\right)^2 \quad \textbf{1}$$

Where:
ESP_{adj} = Adjusted ESP requirement at heating airflow or part-load cooling airflow, in H_2O
ESP_{FL} = ESP requirement at full-load cooling airflow specified in Table 7, in H_2O
Q_{dif} = Measured part-load cooling airflow or Manufacturer-specified heating airflow, scfm
Q_{FL} = Measured full-load cooling airflow, scfm

6.1.3.3.3 For units distributed in commerce without a filter (except for Coil-only Indoor Units), an additional static pressure allowance shall be added to the minimum static pressure shown in Table 7. The additional static pressure shall be based on the filter face area, as defined in the Manufacturer's Installation Instructions, and the rated full-load cooling airflow rate. For units that do not specify a filter face area or units where a 2 in filter rack is not an option, the face area of the evaporator shall be used. For heating tests and part load tests, the additional static pressure allowance shall be reduced per equation 1.

$$ESP_{filter} = 0.000108\left(\frac{Q_{FL}}{A_{ft}}\right)^{1.3} \quad \textbf{2}$$

Where:
ESP_{filter} = additional static pressure allowance, in H_2O
Q_{FL} = Rated full-load cooling airflow, scfm
A_{ft} = Filter face area, ft^2.

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6.1.3.3.4 For Coil-only Indoor Units, the pressure drop across the indoor assembly shall not exceed 0.30 in H_2O for the full-load cooling test. If this pressure drop is exceeded, reduce the airflow rate until the measured pressure drop equals the specified maximum. Test Coil-only Indoor Units without a filter.

6.1.3.4 *Indoor Airflow Target Values*

6.1.3.4.1 All airflow rates, including those used for determining capacity, shall be expressed in terms of Standard Airflow. When converting measured airflow to Standard Air, the conversion shall be based on the air density at the airflow test measurement station.

6.1.3.4.2 For the full-load cooling test (except for Coil-only Indoor Units), use the cooling Full Load Rated Indoor Airflow. If there is no cooling Full Load Rated Indoor Airflow, use a value of 400 scfm per ton (in other words, per 12,000 Btu/h) of rated Cooling Capacity.

6.1.3.4.3 For the heating tests (except for Coil-only Indoor Units), use the heating Full Load Rated Indoor Airflow. If there is no heating Full Load Rated Indoor Airflow, use the airflow that results from using the Manufacturer-specified heating fan control settings at the adjusted ESP requirement determined per Section 6.1.3.3. If there is no heating Full Load Rated Indoor Airflow and no Manufacturer-specified heating fan control settings but the Manufacturer's Installation Instructions describe how to obtain steady-state heating operation (for example, using thermostat or other control system input) that results in an automatic adjustment to airflow, use those instructions. If none of this information is accessible, use the cooling Full Load Rated Indoor Airflow for the heating tests.

6.1.3.4.4 For part-load cooling tests for units other than MZVAV units and Coil-only Indoor Units, use the cooling Part Load Rated Indoor Airflow. If there is no cooling Part Load Rated Indoor Airflow, use the airflow that results from using the Manufacturer-specified part-load cooling fan control settings at the ESP requirement determined per Section 6.1.3.3. If there is no cooling Part Load Rated Indoor Airflow and no Manufacturer-specified part-load cooling fan control settings for the test point but the Manufacturer's Installation Instructions describe how to obtain steady-state part-load cooling operation (for example, using thermostat or other control system input) that results in an automatic adjustment to airflow, use those instructions. If none of this information is accessible, use the cooling Full Load Rate Indoor Airflow for the part-load cooling tests.

6.1.3.4.5 For part-load cooling tests for MZVAV units, adjust the cooling indoor airflow rate to achieve an indoor air leaving dry-bulb temperature equal to the average value measured over the course of the full-load cooling test, within a tolerance of ± 0.5°F.

6.1.3.4.6 For full-load cooling tests of Coil-only Indoor Units, the indoor airflow rate shall be the lesser of: the cooling Full Load Rated Indoor Airflow; or the airflow equal to 450 scfm per ton of rated Cooling Capacity. If there is no Full Load Rated Indoor Airflow, use a value of 400 scfm per ton of rated Cooling Capacity. Maintain the airflow within ± 3% of the target airflow throughout the test.

6.1.3.4.7 For heating tests and part-load cooling tests of Coil-only Indoor Units, the indoor airflow rate shall be the lesser of: the Manufacturer-specified airflow rate for that test; or the measured full-load cooling airflow. If there is no heating Full Load Rated Indoor Airflow or cooling Part Load Rated Indoor Airflow, use the measured full-load cooling airflow for the heating test or part-load cooling test. Maintain the airflow within ± 3% of the target airflow throughout the test.

6.1.3.5 *Indoor External Static Pressure and Airflow Tolerances and Set-Up (except for Coil-only Indoor Units)*

6.1.3.5.1 *General*. For each test, set indoor airflow while operating the unit at the rating conditions specified in Table 6 and Table 9 for the test. After setting the airflow, no adjustments can be made to the fan control settings during the test.

6.1.3.5.1.1 *Tolerances*. All tolerances for airflow and ESP specified in Section 6.1.3.5 for

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setting airflow and ESP are condition tolerances that apply for each test. Specifically, the average value of a parameter measured over the course of the test shall vary from the target value by no more than the condition tolerance. Operating tolerances for ESP and nozzle pressure drop are specified in Table 11.

6.1.3.5.2 *Full-load Cooling Test*

6.1.3.5.2.1 Operate the unit using the Manufacturer-specified fan control settings. If there are no Manufacturer-specified fan control settings, use the as-shipped fan control settings. Adjust the airflow-measuring apparatus to maintain ESP within -0.00/+0.05 in H_2O of the requirement specified in Table 7 and to maintain the airflow within ± 3% of the cooling Full Load Rated Indoor Airflow.

6.1.3.5.2.2 If ESP or airflow are higher than the tolerance range, adjust the fan control settings (for example, lower fan speed) to maintain both ESP and airflow within tolerance. If ESP or airflow are higher than the tolerance range at the lowest fan control setting (for example lowest fan speed), adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with an ESP as close as possible to the minimum requirement specified in Table 7.

6.1.3.5.2.3 If ESP or airflow are lower than the tolerance range, adjust the fan control settings (for example, higher fan speed) to maintain both ESP and airflow within tolerance. If ESP or airflow are lower than the tolerance range at the maximum fan control setting (for example, highest fan speed), adjust the airflow-measuring apparatus to maintain ESP within tolerance and operate with an airflow as close as possible to the Manufacturer-specified value. Use the measured lower airflow as the target airflow for all subsequent tests that call for the cooling Full Load Rated Indoor Airflow.

6.1.3.5.2.4 For two adjacent fan control settings, if the lower setting is too low (such as ESP or airflow are lower than the tolerance range) and the higher setting is too high (such as ESP or airflow are higher than the tolerance range), use the higher fan control setting. At this higher fan control setting, adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with an ESP as close as possible to the minimum requirement specified in Table 7.

6.1.3.5.2.5 If the ESP measured after setting airflow exceeds the minimum ESP requirement by more than 0.05 in H_2O (because the ESP and airflow requirements cannot be simultaneously met, see Section 6.1.3.5.2.2), there is no condition tolerance for ESP. If an airflow less than 97% of the cooling Full Load Rated Indoor Airflow is used for the full-load cooling test (because the airflow and ESP requirements cannot be simultaneously met, see Section 6.1.3.5.2.3), there is no condition tolerance for airflow.

6.1.3.5.3 *Heating Test and Part-load Cooling for Units other than MZVAV Units*

6.1.3.5.3.1 For tests where the cooling Part Load Rated Indoor Airflow or the heating Full Load Rated Indoor Airflow is the same as the cooling Full Load Rated Indoor Airflow (and for heating tests and part-load cooling tests where there is no Manufacturer-specified airflow, and the cooling Full Load Rated Indoor Airflow is used as the airflow for the test), use the fan control settings used for the full-load cooling test. Adjust the airflow-measuring apparatus to maintain the airflow within ± 3% of the measured full-load cooling airflow without regard to the resulting ESP. No changes are to be made to the fan control settings for the test.

6.1.3.5.3.2 For tests where the cooling Part Load Rated Indoor Airflow or the heating Full Load Rated Indoor Airflow differs from the cooling Full Load Rated Indoor Airflow, use the following provisions.

6.1.3.5.3.2.1 Operate the system using the Manufacturer-specified fan control settings for that test condition. If there are no Manufacturer-specified fan control

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settings for the heating test or part-load cooling test, use the fan control settings for the full-load cooling test. If there are no Manufacturer-specified fan control settings for any tests, use the as-shipped fan control settings.

6.1.3.5.3.2.2 Adjust the airflow-measuring apparatus to maintain ESP within -0.00/+0.05 in H_2O of the adjusted ESP requirement determined per Section 6.1.3.3 and maintain airflow within ± 3% of the Manufacturer-specified airflow for the heating or part-load cooling test. If ESP or airflow are higher than the tolerance range, adjust the fan control settings (for example, lower fan speed) to maintain both ESP and airflow within tolerance, if possible. If ESP or airflow are higher than the tolerance range at the lowest fan control setting, adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with an ESP as close as possible to the adjusted ESP requirement. If ESP or airflow are lower than the tolerance range, adjust the fan control settings (for example, higher fan speed) to maintain both ESP and airflow within tolerance (if possible, but without adjusting sheaves and without exceeding the final fan control settings used for the full-load cooling test). If this is not possible, adjust the airflow-measuring apparatus to maintain ESP within tolerance and operate with an airflow as close as possible to the Manufacturer-specified value.

6.1.3.5.3.2.3 For two adjacent fan control settings, if the lower setting is too low (such as ESP or airflow are lower than the tolerance range) and the higher setting is too high (such as ESP or airflow are higher than the tolerance range), use the higher fan control setting. At this higher fan control setting, adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with an ESP as close as possible to the minimum requirement specified in Table 7.

6.1.3.5.3.2.4 If the ESP measured after setting airflow exceeds the adjusted ESP requirement determined per Section 6.1.3.3 by more than 0.05 in H_2O (because the ESP and airflow requirements cannot be simultaneously met, see Section 6.1.3.5.3.2.2), there is no condition tolerance for ESP. If an airflow less than 97% of the Manufacturer-specified airflow is used for a test (because the airflow and ESP requirements cannot be simultaneously met, see Section 6.1.3.5.3.2.2), there is no condition tolerance for airflow.

6.1.3.5.3.3 For heating tests and part-load cooling tests where there is no Manufacturer-specified airflow and the cooling Full Load Rated Indoor Airflow is not used as the airflow for the test (because there are Manufacturer-specified fan control settings or instructions to obtain steady-state operation for the test, per the provisions of Section 6.1.3.4), use the Manufacturer-specified fan control setting for that test condition or allow the system to automatically adjust airflow, as specified in the Manufacturer's Installation Instructions. Adjust the airflow-measuring apparatus to meet the adjusted ESP requirement determined per Section 6.1.3.3 with a condition tolerance of -0.00/+0.05 in H_2O, using the measured heating or part-load cooling airflow in the ESP calculation.

6.1.3.5.4 *Heating Test for MZVAV Units*

6.1.3.5.4.1 For tests where the heating Full Load Rated Indoor Airflow is the same as the cooling Full Load Rated Indoor Airflow (and for heating tests where there is no heating Full Load Rated Indoor Airflow and the cooling Full Load Rated Indoor Airflow is used as the airflow for the test), use the fan control settings used for the full-load cooling test. Adjust the airflow-measuring apparatus to maintain the airflow within ± 3% of the airflow measured during the full-load cooling test without regard to the resulting ESP. No changes are to be made to the fan control settings for the test.

6.1.3.5.4.2 For tests where the heating Full Load Rated Indoor Airflow differs from the cooling Full Load Rated Indoor Airflow, use the following provisions.

6.1.3.5.4.2.1 Operate the system using the Manufacturer-specified fan control

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settings for the heating test. If there are no Manufacturer-specified fan control settings for the heating test, use the fan control settings for the full-load cooling test. If there are no Manufacturer-specified fan control settings for any tests, use the as-shipped fan control settings.

6.1.3.5.4.2.2 Adjust the airflow-measuring apparatus to maintain ESP within -0.00/+0.05 in H_2O of the adjusted ESP requirement determined per Section 6.1.3.3 and maintain airflow within ± 3% of the heating Full Load Rated Indoor Airflow. If ESP or airflow are higher than the tolerance range, adjust the fan control settings (for example, lower fan speed) to maintain both ESP and airflow within tolerance, if possible. If ESP or airflow are higher than the tolerance range at the lowest fan control setting, adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with the lowest ESP that meets the adjusted ESP requirement. If ESP or airflow are lower than the tolerance range, adjust the fan control settings (for example, lower fan speed) to maintain both ESP and airflow within tolerance (if possible, but without adjusting sheaves and without exceeding the final fan control settings used for the full-load cooling test). If this is not possible, adjust the airflow-measuring apparatus to maintain ESP within tolerance and operate with an airflow as close as possible to the Manufacturer-specified value.

6.1.3.5.4.2.3 For two adjacent fan control settings, if the lower setting is too low (such as ESP or airflow are lower than the tolerance range) and the higher setting is too high (such as ESP or airflow are higher than the tolerance range), use the higher fan control setting. At this higher fan control setting, adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with an ESP as close as possible to the minimum requirement specified in Table 7.

6.1.3.5.4.2.4 If the ESP measured after setting airflow exceeds the adjusted ESP requirement determined per Section 6.1.3.3 by more than 0.05 in H_2O (because the ESP and airflow requirements cannot be simultaneously met, see Section 6.1.3.5.4.2.2), there is no condition tolerance for ESP. If an airflow less than 97% of the Manufacturer-specified airflow is used for a test (because the airflow and ESP requirements cannot be simultaneously met, see Section 6.1.3.5.4.2.2), there is no condition tolerance for airflow

6.1.3.5.4.3 If there is no heating Full Load Rated Indoor Airflow and the cooling Full Load Rated Indoor Airflow is not used as the airflow for the heating test (because there are Manufacturer-specified fan control settings or instructions to obtain steady-state operation for the heating test, per the provisions of Section 6.1.3.4), use the Manufacturer-specified fan control setting for the heating test or allow the system to automatically adjust airflow, as specified in the Manufacturer's Installation Instructions. Adjust the airflow-measuring apparatus to meet the adjusted ESP requirement determined per Section 6.1.3.3 with a condition tolerance of -0.00/+0.05 in H_2O, using the measured heating airflow in the ESP calculation.

6.1.3.5.5 *Part-Load Cooling Tests for MZVAV Units*. For each part-load cooling test point, the unit fan control settings shall be adjusted to achieve an average indoor air leaving dry-bulb temperature for the test period equal to the average value measured over the course of the full-load cooling test, within a tolerance of ± 0.5 ºF. The airflow-measuring apparatus shall be adjusted to meet the adjusted ESP requirement determined per Section 6.1.3.3 with a condition tolerance of -0.00/+0.05 in H_2O, using the measured part-load cooling airflow in the ESP calculation. If the indoor air leaving dry-bulb temperature is greater than the full-load average by more than the allowable tolerance and airflow cannot be reduced while simultaneously meeting the adjusted ESP requirement, adjust the fan control settings and airflow-measuring apparatus to run at the minimum fan speed allowed by the controls while maintaining ESP within tolerance of the adjusted ESP requirement per Section 6.1.3.3. If the indoor air leaving dry bulb temperature is less than the full-load average by more than the allowable tolerance and the temperature tolerance cannot be met while simultaneously meeting the adjusted ESP requirement, adjust the fan control settings and airflow-measuring apparatus to achieve an indoor air leaving dry bulb temperature as close to meeting the tolerance as possible while

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maintaining ESP within tolerance of the adjusted ESP requirement per Section 6.1.3.3. The test report shall indicate when indoor leaving dry bulb temperature is not in tolerance.

6.1.3.6 *Outdoor Airflow Rate for units with Free Air Discharge Condensers.* All Standard Ratings shall be determined at the outdoor airflow rate obtained with no condenser ducting. Where the fan drive is non-adjustable, the Standard Ratings shall be determined at the outdoor airflow rate inherent in the equipment. For adjustable speed fans, the outdoor fan speed shall be set as specified in the Manufacturer's Installation Instructions or as determined by automatic controls. Once established, no changes affecting outdoor airflow shall be made unless automatically adjusted by unit controls, unless adjusted to achieve stability as described in Sections E7.3 or E7.4. Outdoor airflow rate does not need to be measured unless using the outdoor air enthalpy method per Section E6.5.

6.1.3.7 *Outdoor Airflow Rate and External Static Pressure for Units with Ducted Condensers*. For rating Double-duct Systems to EER_{DD}, $IEER_{DD}$, or $COP_{H,DD}$ (based on non-zero condenser ESP), follow the provisions of Appendix I. For rating units with condensers intended for ducting of outdoor air to EER, IEER, or COP (based on zero condenser ESP), follow the provisions of this section.

6.1.3.7.1. Install the unit with outdoor coil ductwork and external static pressure measurements made in accordance with Section 6.4 and Section 6.5 of ANSI/ASHRAE Standard 37 and manufacturer's instructions as applicable. The unit shall operate at 0.0 in H_2O external static pressure with a condition tolerance of -0.00/+0.05 in H_2O. If manufacturer's instructions provide guidance for setting outdoor airflow (for example, outdoor fan control settings), set the outdoor airflow per manufacturer's instructions while maintaining the outdoor air ESP within -0.00/+0.05 in H_2O of 0.0 in H_2O. If manufacturer's instructions do not provide any guidance for setting outdoor airflow, test using the as-shipped outdoor fan setting while maintaining the outdoor air ESP within -0.00/+0.05 in H_2O of 0.0 in H_2O. If the outdoor air ESP cannot be maintained within -0.00/+0.05 in H_2O of 0.0 in H_2O at the Manufacturer-specified or as-shipped fan setting (as applicable), operate with a fan setting as close as possible to the target fan setting (such as Manufacturer-specified or as-shipped) that allows for meeting this outdoor air ESP requirement. Outdoor airflow rate does not need to be measured unless using the outdoor air enthalpy method per Section E6.5.

6.1.3.7.2 *Outdoor Air ESP Tolerance*. The outdoor air ESP tolerance of -0.00/+0.05 in H_2O is a condition tolerance that applies throughout the test. Specifically, the average value of the outdoor air ESP measured over the course of the test shall vary from the target value by no more than the condition tolerance. An operating tolerance for ESP is specified in Table 11.

6.2 *Part Load Rating.* All equipment rated in accordance with this standard shall include an Integrated Energy Efficiency Ratio (IEER) Rating, even if there is one stage of Cooling Capacity control.

6.2.1. *IEER Requirements.* The equations used for calculation of the IEER are defined in Section 6.2.2.

To help in the application of the general equations specific step by step procedures have been included in the following sections for various product classifications in Table 8.

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Table 8. Section References for Different Product Classifications	
Product Classifications	**Section Reference**
IEER for Fixed Capacity Controlled Units	6.2.4
IEER for Staged Capacity Controlled Units	6.2.5
IEER for Proportionally Capacity Controlled Units	6.2.6

For calculation examples showing the procedures for calculating the IEER see Appendix G.

6.2.2 *General IEER Equations*. For units covered by this standard, the IEER shall be calculated using test derived data and the Equation 3.

$$IEER = (0.020 \cdot A) + (0.617 \cdot B) + (0.238 \cdot C) + (0.125 \cdot D) \quad \textbf{3}$$

Where:

A = EER, (Btu/h)/W, at 100% Capacity at AHRI Standard Rating Conditions (see Table 6)
B = EER, (Btu/h)/W, at 75% Capacity and reduced condenser temperature (see Table 9)
C = EER, (Btu/h)/W, at 50% Capacity and reduced condenser temperature (see Table 9)
D = EER, (Btu/h)/W, at 25% Capacity and reduced condenser temperature (see Table 9)

The IEER rating requires that the unit efficiency be determined at 100, 75, 50, and 25 Percent Load at the conditions specified in Table 9 and at the part-load rated airflow, if different than the Full Load Rated Indoor Airflow.

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Table 9. IEER Part-Load Rating Conditions

Conditions	Condition
Indoor Air	
Return Air Dry-bulb Temperature	80.0°F
Return Air Wet-bulb Temperature	67.0°F
Part Load Rated Indoor Airflow	See note 1
Condenser (Air Cooled)	100 Percent Load = 95.0ºF[4,5]
Entering Dry-bulb Temperature (OAT)	75 Percent Load = 81.5ºF[4,5]
	50 Percent Load = 68.0ºF[4,5]
	25 Percent Load = 65.0ºF[4,5]
Condenser Airflow Rate, cfm	See note 2
Condenser (Water Cooled)	100 Percent Load = 85.0ºF
Entering Condenser Water Temperature (EWT)	75 Percent Load = 73.5ºF
	50 Percent Load = 62.0ºF
	25 Percent Load = 55.0ºF
Condenser Water Flow Rate, gpm	See note 3
Condenser (Evaporatively Cooled)	100 Percent Load = 75.0ºF/95.0ºF/85.0ºF
Entering Air Wet-bulb/Air Dry-bulb/Makeup Water Temperature (EWB/DB/MW)	75 Percent Load = 66.2ºF/81.5ºF/77.0ºF
	50 Percent Load = 57.5ºF/68.0ºF/77.0ºF
	25 Percent Load = 52.8ºF/65.0ºF/77.0ºF

Notes:
1. Refer to Section 6.1.3 for indoor airflow and external static pressure.
2. Condenser airflow shall be adjusted, if required per Section 6.1.3.6 or 6.1.3.7.
3. At 100 Percent Load, the condenser water flow rate shall be equal to the flow rate determined for the Standard Rating Condition for cooling, described in Table 6. Except as noted in Section E7, at 75, 50, and 25 Percent Load, the supplemental testing instructions (10 CFR §429.43) shall describe the conditions to run the unit.
4. For testing Air-cooled units that reject condensate to the condenser coil, the condenser air wet bulb temperature requirements specified for evaporatively cooled products apply.
5. For Single Package Units that do not reject condensate to the Outdoor Coil, where all or part of the indoor section of the equipment is located in the outdoor room, maintain an outdoor room dew point temperature of 60.5ºF for 100, 75, and 50 Percent Load and 58.7°F for 25 Percent Load.

6.2.3 *Rating Adjustments.* Testing shall be performed at the four load points and condenser conditions as defined in Table 9. If the unit is not capable of running at any of the 75, 50, or 25 Percent Load points then Section 6.2.3.1 or Section 6.2.3.2 shall be followed to determine the EER rating at the required load.

6.2.3.1 *Interpolation.* If the units cannot run at any of the 75, 50 or 25 Percent Load points within a tolerance of ± 3% but is capable of running at load above and below the Percent Load of 75, 50 or 25 interpolation of the test points shall be used to determine the EER at the required load.

6.2.3.2 *Degradation*. If the unit cannot be unloaded to the 75, 50, or 25 Percent Load then the unit shall be run at the minimum step of unloading and the rated indoor airflow at the condenser conditions defined for each of the percent load points listed in Table 9 and then the part-load EER shall be adjusted for cyclic performance using Equation 4.

$$EER = \frac{LF \cdot q}{LF[C_D \cdot (P_C + P_{CD})] + P_{IF} + P_{CT}} \quad \textbf{4}$$

Where:

C_D = Degradation coefficient, (Btu/h)/(Btu/h)
P_C = Compressor power at the lowest machine unloading point operating at the applicable part-load Rating Condition, W
P_{CD} = Condenser Section power, at the applicable part-load Rating Condition, W
P_{CT} = Control circuit power and any auxiliary loads, W

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P_{IF} = Indoor Fan power, W
q = Cooling Capacity at the lowest machine unloading point operating at the applicable part-load Rating Condition, Btu/h

P_{CD} for air-cooled and evaporatively cooled units is the power of the fans and pumps. P_{CD} for water cooled units with a capacity of 65,000 Btu/h to less than 135,000 Btu/h shall be the cooling tower power allowance per Section 6.1. For capacities above 135,000 Btu/h, P_{CD} shall be 0.

The degradation coefficient, to account for cycling of the compressor for capacity less than the minimum step of capacity, shall be calculated per Equation 5.

$$C_D = (-0.13 \cdot LF) + 1.13 \quad \textbf{5}$$

Where:

LF = Fractional "on" time for last stage at the tested load point, noted in Equation 6.

$$LF = \frac{(PL/_{100}) \cdot \dot{q}_{A,Full}}{\dot{q}_{i,x}} \quad \textbf{6}$$

Where:

PL = Percent Load
$\dot{q}_{A,Full}$ = Full load Net Capacity, Btu/h
$\dot{q}_{i,x}$ = Part load Net Capacity, Btu/h

6.2.4 Procedure for *IEER Calculations for Fixed Capacity Control Units.* For Fixed Capacity Controlled Units (single stage), the IEER shall be calculated using data and the Equation 4 and the following procedures.

The following sequential steps shall be followed.

6.2.4.1 *Step 1.* Each of the three percent load EER rating-points for 75, 50 and 25 Percent Load shall be determined at the Percent Load-condenser entering temperatures defined in Table 9 within tolerances defined in Section 6.3.

Note: Because the unit only has a single stage of capacity, the three percent load capacities will be greater than the required Percent Load and the cyclic performance will be adjusted using the degradation calculations as per step 2.

6.2.4.2 *Step 2.* The EER shall be adjusted for cyclic degradation using the procedures in Section 6.2.3.

6.2.4.3 *Step 3.* The test results including adjustments for cyclic degradation from step 2 shall then be used to calculate the IEER using the procedures defined in Section 6.2.2. For example calculations, see Appendix G.

6.2.5 *IEER for Staged Capacity Controlled Units.* For Staged Capacity Controlled Units, the IEER shall be calculated using Equation 3 and the following procedures.

Staged Capacity Controlled Units, for test purposes, shall be provided with means to adjust the stages of refrigeration capacity and the indoor fan speed to obtain the rated airflow with the tolerance specified in Section 6.1.

The following sequential steps shall be followed.

6.2.5.1 *Step 1.* For part-load tests, the unit shall be configured per the Manufacturer's Installation Instructions, including setting of stages of refrigeration for each part-load point. The stages of refrigeration that result in capacity closest to the tested part-load point shall be used.

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