AHRI Standard 1351 (SI)

2014 Standard for

Mechanical Performance Rating of Central Station Air-handling Unit Casings

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Note: This is a new standard.
For I-P ratings, see AHRI Standard 1350 (I-P) – 2014.

AHRI CERTIFICATION PROGRAM PROVISIONS

Scope of the Certification Program

There currently is no AHRI certification program for Mechanical Performance Rating of Central Station Air-handling Unit Casing for this Standard.

FOREWORD

This standard does not include acoustic testing or rating information for Central Station Air-handling Units (CSAHU). The unit must be tested in accordance with ANSI/AHRI Standard 261 (SI) in order to determine actual unit sound power levels, inlet, discharge and casing radiated..

CSAHU sound levels are dependent on many factors, for example, fan type, size, and operating conditions, casing construction and casing penetrations, etc. There is often a significant interaction between the fan and the unit casing which both generates and transmits sound. The prediction of unit sound power from fan-only sound power by applying effects such as casing noise reduction can easily result in errors as large as ± 15 decibels.

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MECHANICAL PERFORMANCE RATING OF CENTRAL STATION AIR-HANDLING UNIT CASING

Section 1. Purpose

1.1 *Purpose*. The purpose of this standard is to establish for Central Station Air-handling Unit Casings: definitions; classifications; test requirements; rating requirements; minimum data requirements for Published Ratings; operating requirements; marking and nameplate data; conformance conditions.

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

1.1.2 *Thermal Performance Rating Limitations.* Thermal performance ratings are intended to be used only to compare the construction of different Central Station Air-handling Units. The numerical value associated with the rating class cannot be used to predict actual application Thermal Transmittance through casing or the risk of condensation for any specific Central Station Air-handling Unit.

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

Section 2. Scope

2.1 *Scope*. This standard applies to Central Station Air-handling Units (CSAHU) as defined in Section 3.5.

2.2 *Exclusions.*

2.2.1 This standard does not apply to forced-circulation, free-delivery air-coolers for refrigeration, which are covered in ANSI/AHRI Standard 420.

2.2.2 This standard does not apply to unit heaters intended for free delivery of heated air or to room fan-coils as defined in ANSI/AHRI Standard 440.

2.2.3 This standard does not apply to units that have direct expansion coils incorporated by the manufacturer in a matched split system air-conditioner, or as otherwise defined in the product scope definition of the AHRI Unitary Small Equipment and Unitary Large Equipment Sections and covered in ANSI/AHRI Standard 210/240 or in ANSI/AHRI Standard 340/360.

2.2.4 This standard does not apply to unit ventilators as defined in ANSI/AHRI Standard 840.

2.2.5 This standard does not apply to variable refrigerant flow equipment as defined in ANSI/AHRI Standard 1230.

2.2.6 This standard does not apply to direct expansion (DX) dedicated outdoor air system units as defined in ANSI/AHRI Standard 920.

2.2.7 This standard does not apply to CSAHU's designed to only operate with internal casing pressure between -250 Pa and 250 Pa.

Section 3. Definitions

All terms in this document will follow the standard industry definitions in the ASHRAE Terminology website (https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology), and ANSI/AHRI Standard 430 unless otherwise defined in this section.

3.1 *Cabinet Design Pressure.* The Central Station Air-handling Unit manufacturer's stated maximum operating pressure.

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3.2 *Casing Air Leakage Rate.* The air flow leaking through the casing of a Central Station Air-handling Unit (CSAHU) per 10 square meters of Casing Surface Area, L/s/10 m^2. It is the ratio of the total air flow leaking through the casing measured at the Maximum Rated Pressure to the Casing Surface Area (per 10 m^2). Where a casing at design conditions has portions of the CSAHU operating in both positive and negative pressures, the Casing Air Leakage Rate shall be determined separately for casing sections applied under positive pressure from those applied under negative pressure.

3.3 *Casing Deflection.* The deformation of the external surface of the cabinet, measured perpendicular to the plane of the cabinet surface, when the unit is subjected to a positive or negative internal air pressure, m.

3.4 *Casing Surface Area.* The total of all the exterior surface area, measured in m^2, of the CSAHU casing calculated from the nominal external dimensions, excluding the area of the unit inlet and outlet airflow openings. The area of components which does not form part of the unit casing shall be excluded. These exclusions can include, both are not limited to: casing attachments such as base rails and/or ceiling mount structures, externally mounted devices such as dampers, louvers, hoods, and the area of the block-off plates on openings of separately tested unit sections.

3.5 *Central Station Air-handling Unit (CSAHU).* A factory-made encased assembly consisting of a fan or fans and other necessary equipment to perform one or more of the functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying and mixing of air. It shall not contain a source of mechanical cooling.

3.6 *Central Station Air-handling Unit (CSAHU) Casing.* The enclosure which houses the fans, coils, filters, and other components of the CSAHU. It is generally made of metal and lined, where necessary, with material for thermal insulation and/or acoustic attenuation. It is the portion of CSAHU containing the air that is being conditioned, is exposed to the fan pressure, and separates the conditioned air from the surrounding air. This may also be referred to as the CSAHU cabinet.

3.7 *Deflection Class.* The rating class designation defined by the CSAHU's Maximum Normalized Deflection at the corresponding Rating Differential Static Pressure, specified in Table 1.

3.8 *Leakage Class.* The rating class designation that defines the maximum expected air flow leakage, L/s/10 m^2, of the CSAHU casing operating within the interior pressure conditions specified for the total casing surface area.

3.9 *Maximum Deflection Point.* The location on the unit cabinet surface that has the largest Casing Deflection.

3.10 *Maximum Normalized Deflection*. The largest value of Normalized Deflection found on the Central Station Air-handling Unit, millimeters/millimeter.

3.11 *Maximum Rated Pressure for Leakage.* The absolute value of largest internal to external differential pressure across the cabinet at which the CSAHU casing is designed to operate. Ratings for Casing Air Leakage Rate shall include, at minimum, results at this pressure, Pa.

3.12 *Negative Pressure.* Any point where the air pressure inside the CSAHU is less than the ambient air pressure, measured in Pa and is always a negative value.

3.13 *Normalized Deflection*. The Casing Deflection divided by the Span, millimeters/millimeter.

3.14 *Positive Pressure.* Any point where the air pressure inside the CSAHU is greater than the ambient air pressure, measured in Pascals, and is always a positive value.

3.15 *Pressure Change Wall*. The plane in the CSAHU where the internal pressure changes from negative to positive.

3.16 *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. For Casing Air Leakage Rate and Casing Deflection, these values apply to all units of similar casing construction and type (identification) produced by the same manufacturer. For thermal performance ratings, these values only apply to the casing construction of the Standard Rating Unit. 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.

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

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

3.17 *Rating Conditions.* Any set of ambient and operating conditions under which a single level of performance results are defined.

3.17.1 *Application Rating Conditions.* Rating conditions that are not the standard rating conditions as specified in Section 6.

3.17.2 *Standard Rating Conditions.* Rating conditions used as the basis of comparison for performance characteristics as specified in Section 6.

3.18 *Rating Differential Static Pressure.* The differential static pressure required for determining Deflection Class, Pa.

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

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

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

3.20 *Span.* The shortest linear dimension of the CSAHU pressure vessel casing, width, height or depth, to be used in calculating the relative deflection of the corresponding surface. (Span does not transverse across a negative to positive pressure change wall. Refer to Section C5.3.6 and Figures C4, C5, and C6 for further definition of Span.)

3.21 *Standard Air.* Air weighing 1.20 kg/m^3 which approximates dry air at 21°**C** and at a barometric pressure of 101.3 kPa.

3.22 *Standard Rating Unit.* Configuration of the Standard Rating Unit is specifically defined in Section 6.1.

3.23 *Thermal Bridge.* The minimum temperature difference between the dry-bulb air temperature inside the unit and the exterior surface temperature of the CSAHU.

3.24 *Thermal Bridging Class.* The rating designation class that defines the Thermal Bridging Factor.

3.25 *Thermal Bridging Factor.* The ratio of the difference between the mean internal dry-bulb and the external casing temperature to the difference between the mean external dry-bulb air temperature and mean interior air dry-bulb temperature at the location of the Thermal Bridge. The ratio is calculated using Equation 2 in Section 6.7.

3.26 *Thermal Transmittance.* The rate at which thermal energy is transmitted through the casing with or without air leakage, W/m$^{2\cdot}$K. (Also known as the U-value.)

3.26.1 *Thermal Transmittance without Leakage*. The rate at which thermal energy is transmitted through the casing, W/m$^{2\cdot}$K.

3.26.2 *Thermal Transmittance with Leakage.* The rate at which thermal energy is transmitted through the casing plus the calculated rate of energy lost through air leakage at 250 Pa, W/m$^{2\cdot}$K.

3.27 *Thermal Transmittance Class.* The rating designation class that defines the maximum rate at which energy, W/m$^{2\cdot}$K, will be transmitted through the CSAHU casing as a function of total casing surface area and temperature difference from interior to exterior of the unit with or without the calculated rate of energy lost through air leakage at Standard Rating Conditions.

Note: Thermal Transmittance Class may also be referred to as Thermal Transmission Class.

3.27.1 *Thermal Transmittance Class without Leakage.* The rating designation class that defines the maximum rate at which energy, W/m$^{2\cdot}$K, will be transmitted through the CSAHU casing as a function of total casing surface area and temperature difference from interior to exterior of the unit at Standard Rating Conditions.

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3.27.2 *Thermal Transmittance Class with Leakage.* The rating designation class that defines the maximum rate at which energy, W/m^2K, will be transmitted through the CSAHU casing as a function of total casing surface area and temperature difference from interior to exterior of the unit plus the calculated rate of energy lost through air leakage at Standard Rating Conditions.

Section 4. Classifications

4.1 *Classifications.* Equipment included within the scope of this standard shall be classified as follows:

4.1.1 *Application Type.*

4.1.1.1 Indoor
4.1.1.2 Outdoor

4.1.2 *Casing Structure.*

4.1.2.1 Low pressure (greater than 250 Pa and less or equal to than 1,000 Pa internal positive or negative pressure)
4.1.2.2 Medium pressure (greater than 1,000 Pa and less than 25,000 Pa internal positive or negative pressure)
4.1.2.3 High pressure (greater than or equal to 25,000 Pa internal positive or negative pressure)

4.1.3 *Casing Size.*

4.1.3.1 Small (smallest internal cross-sectional area normal to the airflow direction is less than or equal to 1 m^2)
4.1.3.2 Medium (smallest internal cross-sectional area normal to the airflow direction is greater than 1 m^2 and less than 5.5 m^2)
4.1.3.3 Large (smallest internal cross-sectional area normal to the airflow direction is greater than or equal to 5.5 m^2)

Section 5. Test Requirements

5.1 *Test Requirements*. Published Ratings for Casing Deflection, Casing Air Leakage Rate, Thermal Transmittance, and Thermal Bridging shall be verified by tests conducted in accordance with the test method described in Appendix C and at the Rating Conditions in Section 6.

5.1.1 Testing shall be performed on assembled units at a site where instrumentation is in place and test condition stability can be obtained.

5.2 *Casing Deflection.* The deflection for each section of the assembled air-handling unit casing shall be determined by testing according to the test method prescribed in Section C5.

5.2.1 The location of maximum deflection of the Pressure Vessel shall be determined and the deflection measured relative to the unpressurized condition. This test shall be performed at the standard rating pressure. The pressure shall be stable within the bounds specified in Section C5.

5.2.2 The Casing Deflection Rating shall be determined and reported using methodology outlined in Section 6.3 and Section C5.

5.3 *Casing Air Leakage Rate.* The Casing Air Leakage Rate for each section of the assembled air-handling unit shall be determined by testing according to the test method prescribed in Section C6.

5.3.1 The amount of Casing Air Leakage Rate shall be measured. This test shall be performed at the standard rating pressure. The pressure shall be stable within the bounds specified in Section C6.

5.3.2 The Casing Air Leakage Rate shall be determined and reported using methodology outlined in Section 6.3

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and Section C6.

5.4 *Thermal Transmittance.* The casing thermal heat transfer energy transmission and leakage air energy content for the assembled CSAHU shall be determined by testing according to the test method and calculations prescribed in Section C7.

5.4.1 The inside and outside the unit mean air dry-bulb temperatures shall be measured. The amount of Thermal Transmittance due to heat transfer through the unit casing walls shall be calculated based on the thermal energy input from the heaters and circulating fans inside the assembled unit and the temperature difference between inside the unit and outside the unit. The energy transfer due to airflow leakage shall be determined by measuring the leakage air flow rate and calculating the leakage air heat capacity energy content. The total energy transmittance shall be the sum of the heat transfer through the casing walls and the leakage air heat capacity. Thermal Transmittance, U, shall be calculated per the methodology outlined in Section C7.

5.4.2 Both Thermal Transmittance Classes (with and without leakage) shall be determined and reported using methodology prescribed in Section 6.4 and Section C7.

5.5 *Thermal Bridging.* The Thermal Bridging Factor shall be based on the minimum casing temperature difference between the casing exterior surface and the mean inside air temperature as determined by testing according to the test method prescribed in Section C8.

5.5.1 The Thermal Bridge location, unit exterior surface temperature, inside unit mean air temperature and the outside unit mean air temperature shall be determined per the methodology prescribed in Section C8.

5.5.2 The Thermal Bridging Factor shall be determined and reported using the methodology prescribed in Section 6.5 and Section C8.

Section 6. Rating Requirements

6.1 *Standard Rating Unit.* The Standard Rating Unit configuration shall meet the following:

6.1.1 Central Station Air-handling Unit inlet(s) and/or outlet(s):

6.1.1.1 Build unit without inlet and outlet duct openings if this is available as a standard construction option. Do not subtract any area from total exterior surface area.

6.1.1.2 If the standard unit configuration does not include an option for no duct openings, the unit shall include standard single inlet and outlet openings.

6.1.2 The entire interior of the unit must be accessible for installing instrumentation via standard service doors or standard service access panels.

6.1.3 All access points must be large enough (minimum nominal width 450 mm) for person to enter and place instrumentation, including thermal sensors, heater(s), circulating fan(s).

6.1.3.1 One access oint between first and second component or other end wall

6.1.3.2 If required, additional access points between additional components and last component and other end wall

6.1.4 Unit shall contain shipping split (if an option in the product line being rated). Additional gasket material, caulk, fasteners and other required assembly parts shall be shipped with the split unit. A copy of the assembly instructions shall be provided with the split unit.

6.1.5 Unit shall include, at minimum, a fan and a coil:

6.1.5.1 A standard size and arrangement fan(s) shall be installed, the motor(s) and drive components are not necessary if not needed for the mechanical support of the fan(s) installation.

6.1.5.2 A standard size cooling coil (minimum of 65% of unit cross-section area) and drain pan. If no standard catalog selectable coil meets the minimum 65% area, use the largest standard catalog coil available for the unit.

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6.2 *Standard Ratings*. Standard ratings shall be established at the Standard Rating Conditions specified in Section 6.3 for Casing Deflection, Section 6.4 for Casing Air Leakage Rate, Section 6.5 for Casing Thermal Transmittance and Section 6.6 for Thermal Bridging Factor.

6.2.1 *Casing Deflection.* Once established, ratings for Casing Deflection shall be representative of the casing construction of a range of models within a model line. For a model line which includes very small to very large units, with different panel sizes, ratings of a test unit shall only be extended to units (1) with the same casing construction as the test unit; (2) with panel Spans nominally equal to or smaller than the test unit; and (3) which are also capable of operating at the same Rating Differential Static Pressure as the test unit.

6.2.2 *Casing Air Leakage Rate.* Once established, ratings for Casing Air Leakage Rate shall be representative of the casing construction of a range of models within a model line. For a model line which includes units with a range of Casing Surface Areas, ratings of a test unit shall only be extended to units (1) with the same casing construction as the test unit; (2) with a Casing Surface Area equal to or larger than the test unit; (3) which are also capable of operating at the same Maximum Cabinet Design Pressure as the test unit.

6.2.3 *Thermal Performance.* Standard Ratings for Thermal Performance, Thermal Transmittance and Thermal Bridging, shall be representative of the casing construction being rated.

6.3 *Application Ratings.*

6.3.1 *Casing Deflection.* Application Ratings shall be established for Casing Deflection for pressures other than the Rating Differential Static Pressure. No Deflection Class may be reported or published for Application Ratings. For Application Ratings, users shall report the measured deflection at the tested pressure.

6.3.2 *Casing Air Leakage Rate.* Application Ratings shall be established for Casing Air Leakage for pressures other than the Cabinet Design Pressure. No Casing Air Leakage Class may be reported or published for Application Ratings. For Application Ratings, users shall report the measured leakage (L/s/10 m^2) at the tested pressure.

6.3.3 *Thermal Transmittance.* Application Ratings shall be established for Thermal Transmittance. No Thermal Transmittance Class with Leakage or Transmittance Class without Leakage may be reported or published for Application Ratings. For Application Ratings, users shall report the measured thermal transmittance, U-value, at the tested conditions.

6.3.4 *Thermal Bridging.* Application Ratings shall be established for Thermal Bridging. No Thermal Bridging Class may be reported or published for Application Ratings. For Application Ratings, users shall report the measured thermal bridging factor, k_b at the tested conditions.

6.4 *Casing Deflection Rating*. The Deflection Class shall be determined from the test results, Section C5, and the Maximum Normalized Deflection at the Rating Differential Static Pressures in Table 1. For units applied in both positive and negative pressure there will be two ratings, one for positive and one for negative pressure.

Table 1. Casing Deflection Rating Class

Class - Deflection, CD_x	Rating Differential Static Pressure, Pa	Maximum Normalized Deflection, mm/mm of Span
CD_1	2,500	0.0033 (1/300)
CD_2	2,000	0.0042 (1/240)
CD_3	1,500	0.0042 (1/240)
CD_4	1,000	0.0042 (1/240)
CD_5	250	$\geq$ 0.0042 (1/240)

6.5 *Casing Air Leakage Rate.* The leakage class for Casing Air Leakage Rate shall be determined from the test results, Section C6, at the maximum Cabinet Design Pressure and measured leakage. The Casing Air Leakage Rate shall be calculated per Equation 2 (per ASHRAE 111/SMACNA 016) and the leakage class shall be equal or greater than the Casing Air Leakage Rate, CL. The leakage class can also be determined by plotting the measured leakage at the absolute value of the test pressure on the chart in Figure 1.

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