ANSI/AHRI Standard 1351 (SI) with Addendum 1

2014 Standard for

Mechanical Performance Rating of Central Station Air-handling Unit Casings

Approved American National Standard
ANSI

Approved by ANSI on May 19, 2015

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ANSI/AHRI STANDARD 1351 (SI)-2014 WITH ADDENDUM 1

Mechanical Performance Rating of Central Station Air-handling Unit Casings

September 2015

Addendum 1 (dated September 2015) of ANSI/AHRI Standard 1351 (SI)-2014, "*Changes to* ANSI/*AHRI Standard 1351 (SI)-2014"* is provided as follows. The following changes have been incorporated (deletions are shown by ~~strikethroughs~~, additions are shown by shading) into the already published 2014 version of ANSI/AHRI Standard 1351 (SI) to avoid confusion:

Note: This addendum is not ANSI approved and is currently going through the process to become so.

The changes include:

1) Added Section 3.16. Updated all subsequent numbering.

> **3.16** *Pressure Section*. A section bounded by a Pressure Change Wall and/or the unit end(s) and is designed to operate entirely in Positive Pressure or Negative Pressure.

2) Updated Section 6.1.3.

> **6.1.3** All access points must be large enough ~~(minimum nominal width 450 mm)~~ for a person to enter or reach in to place instrumentation, including thermal sensors, heater(s), circulating fan(s), without damaging the test unit (i.e. by enlarging existing openings or creating new ones). One access point is required between end wall and first component (either fan or coil).

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3) Updated Table C1.

Table C1. Requirements for Test Instrumentation

Measurement	Measurement System Accuracy[1,2,3,4,5]	Display Resolution	Selected, Installed, Operated, Maintained in Accordance With
Air Temperature	±~~0.2~~1.0°C	0.1°C	ANSI/ASHRAE Standard 41.1
Pressure	±2.5 Pa	±1.25 Pa	ANSI/ASHRAE Standard 41.3 Standard Method for Pressure Measurement
Length, width, and height	± 2.5 mm	± 1.5 mm	ISO/IEC 17025
Length, deflection	±0.002	±0.001	ISO/IEC 17025
Airflow	± 2.0% of the reading	0.5 L/s	ANSI/ASHRAE Standard 41.2 Standard Method for Laboratory Airflow Measurement
Power	±1.0% of the quantity measured	1.0 W	ANSI/ASHRAE Standard 41.11 Standard Methods for Power Measurement

Notes:

1. Accuracy requirement also applies to volumetric type meters.
2. Measurement system accuracy shall apply over the range of use during testing, as indicated by the Turn Down Ratio determined during calibration, i.e. from full scale down to a value of full scale divided by the Turn Down Ratio. For many types of instruments and/or systems this may require exceeding the accuracy requirement at full scale. Percent of Reading = %RDG, %FS = percent of full scale for the measurement instrument or measurement system. If dual requirements are shown in the table, FS and RDG, then both requirements shall be met.
3. Current Transformers (CT's) and Potential Transformers (PT's) shall have a metering accuracy class of 0.3 or better, rated in accordance with IEEE C57.13.
4. Display resolution shown is the minimum requirement (most coarse resolution allowable). Better (finer) resolution is acceptable for instrument or panel displays, or computer screen displays. The display resolution shown is the preferred resolution for data reporting on test reports.
5. Significant figures (also known as significant digits) determined in accordance with Section 7.2 of NIST Special Publication 260-100-1993, "Handbook for SRM Users".

4) Updated third paragraph of Section C5.3.4.

All service access points including access doors and access panels used in lieu of an access door are included in the deflection measurement and shall be installed according to the manufacturer's instructions.

5) Updated Section C5.4.3.

C5.4.3 Record the location of the Maximum Deflection Point on the casing drawing. Several measurements may be necessary to locate the Maximum Deflection Point. Measure and record the deflection(s) ~~at the identified Maximum Deflection locations~~ and the casing pressure every 5 minutes for 15 minutes. See Figure C7.

6) Updated Section C5.5.1.

C5.5.1 The test is valid if any measured pressure, P_i, does not vary from the mean pressure, P_a, more than ± 25 Pa, or ±2%, whichever is greater, if any measured deflection, $\delta_{1,2,3,4}$, during the test does not vary from the average deflection, $\bar{\delta}$, by more than ~~± 0.25 mm or~~ ± 5%~~, whichever is greater,~~ and if the difference between the unpressurized final deflection, δ_{final}, and the unpressurized starting deflection, δ_{start}, test does not vary by more than ~~± 0.25 mm or~~ ± 5%~~, which is greater~~.

7) Updated Section C6.1.1.1.

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C6.1.1.1 Method 1: As an assembled unit with the entire unit under ~~negative or positive~~ pressure. ~~For negative pressure units, inward swinging doors shall be completely sealed and outward swinging doors shall not be sealed.~~ In a negative pressure test, seal off all of the access points on the positive pressure side. ~~For positive pressure units, outward swinging doors shall be completely sealed and inward swinging doors shall not be sealed~~ In a positive pressure test, seal off all of the access points on the negative pressure side.;

8) Added Section C6.5.1.1.

C6.5.1.1 If the unit has a Pressure Change Wall, there will be two Casing Air Leakage Ratings, one for the positive pressure section and one for the negative pressure section.

9) Updated Section C6.6.1.

C6.6.1 Use the Casing Air Leakage Rate, CL_x, to determine rating class. Refer to Table 2, Section 6.4. ~~If the unit has a Pressure Change Wall, there will be 2 Casing Air Leakage Ratings, one for the positive pressure section and one for the negative pressure section.~~

10) Updated Section C7.1.1.

C7.1.1 The test shall be performed with distributed internal heat sources and circulating fans as needed to provide uniform internal temperatures. The heat source will be energized to provide a minimum of 17°C higher average internal air temperature when compared to external ambient temperature but the internal temperature should not exceed 50° C. The manufacturer shall specify the maximum temperature for testing if the product has a lower maximum allowable internal temperature than 50°C. Steady state is defined in Section C7.3.3. See Figures C13, C14, and C15 for some example thermal set-ups.

11) Updated Section C7.2.3

C7.2.3 ~~A minimum of 3~~ Circulating fans shall be installed inside the ~~unit~~ CSAHU to help ~~achieve and maintain a uniform temperature distribution inside the unit~~ provide adequate air mixing to achieve uniform temperature distribution and convection inside the CSAHU. At a minimum, one fan shall be located in each Pressure Section and/or in each section divided by a coil so that circulating air is obtained throughout the entire unit. ~~At minimum, one fan shall be located in each unit section bounded by any pressure change wall, coil, and/or unit end so that circulating air is obtained throughout the entire unit and provides adequate air mixing to achieve uniform temperature distribution inside the unit and simulate unit internal airflow velocities based on 2.5 m/s coil face velocity.~~ The total airflow delivered by the circulating fan(s) in each unit section shall provide a minimum of 25 L/s per square meter of unit cross-sectional area. Multiple fans may be used to produce the required airflow.

12) Updated Section C7.2.3.1.

C7.2.3.1 For example, a unit with a 2 m^2 cross-sectional area will require ~~at least 3~~ circulating fan(s) ~~each~~ delivering ~~2850-3775~~ at least 500 L/s ~~at free delivery~~ per pressure section bounded by any pressure change wall, coil, and/or unit end.

13) Changed “thermocouple” to “temperature measuring device” throughout document. Ex;

C7.2.5 ~~Thermocouples~~ Temperature measuring devices shall be distributed inside the unit to measure and verify the uniformity of the internal air temperature. ~~Thermocouples~~ Temperature measuring devices shall be distributed outside the unit to measure and verify the uniformity of the external air temperature.

14) Added Figures C13, C14 and C15.

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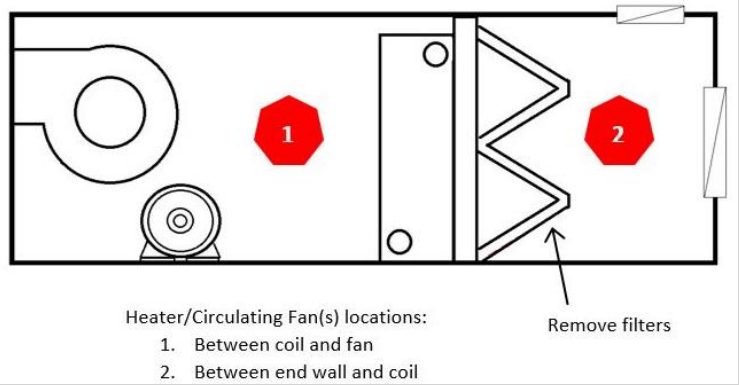


Figure C13. CSAHU with No Pressure Change Wall

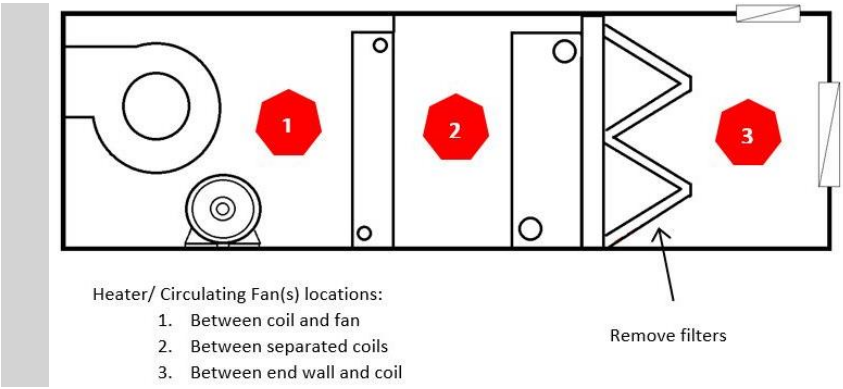


Figure C14. CSAHU with No Pressure Change Wall and Separate Coils

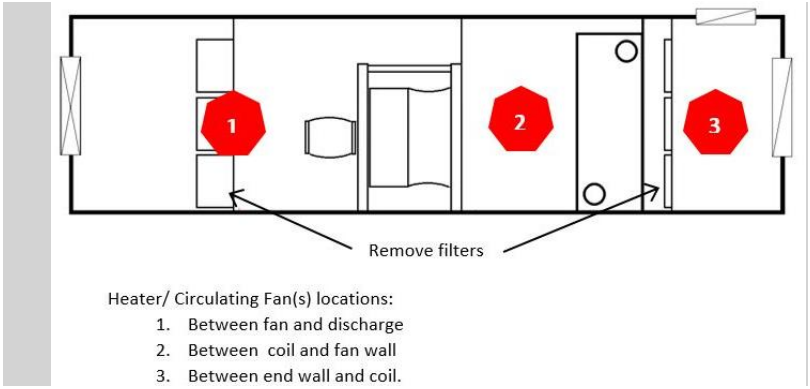


Figure C15. CSAHU with Pressure Change Wall

15) Updated Section C7.5.5.

C7.5.5 Calculate the Thermal Transmittance with leakage.

$$q_{tl} = q_{in} + q_l \qquad \text{C15}$$

$$U = \frac{q_{tl}}{A_{net}(T_{ae}-T_{ai})} \qquad \text{C16}$$

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Where:

q_{tl} = total thermal energy with leakage, W
U = Thermal Transmittance, W/m·K

16) Added Section C7.5.6.

C7.5.6 Calculate the Thermal Transmittance without leakage.

$$q_t = q_{in} \quad \text{C17}$$

$$U = \frac{q_t}{A_{net}(T_{ai} - T_{ae})} \quad \text{C18}$$

Where:

q_t = total thermal energy without leakage, W
U = Thermal Transmittance, W/m·K

17) Section C8.1.2 updated.

C8.1.2 The test shall be performed ~~at nominal 1.8 ± 0.25 m/s calculated internal air velocity provided by the inside circulating fans~~ with the same circulating fans used for the thermal transmittance test.

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IMPORTANT

SAFETY DISCLAIMER

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

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

Note: This is a new standard.
For I-P ratings, see ANSI/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 *Pressure Section*. A section bounded by a Pressure Change Wall and/or the unit end(s) and is designed to operate entirely in Positive Pressure or Negative Pressure.

3.17 *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.

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

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

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

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

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

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

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

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

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

3.21 *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.)

3.22 *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.

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

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

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

3.26 *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.

3.27 *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.)

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

3.27.2 *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.

3.28 *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.

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3.28.1 *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.

3.28.2 *Thermal Transmittance Class with 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 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.

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