ANSI/AHRI Standard 1350 (I-P) 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 1350 (I-P)-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 1350 (I-P)-2014, "*Changes to ANSI/AHRI Standard 1350 (I-P)-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 1350 (I-P) 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 18 in)~~ 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).

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°F	0.1°F	ANSI/ASHRAE Standard 41.1
Pressure	±0.01 in H_2O	±0.005 in H_2O	ANSI/ASHRAE Standard 41.3 Standard Method for Pressure Measurement
Length, width, and height	± 0.1 in	± 0.06 in	ISO/IEC 17025
Length, deflection	±0.002 in	±0.001 in	ISO/IEC 17025

Airflow	± 2.0% of the reading	1 cfm	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 and Potential Transformers 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, "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 ± 0.10 in H_2O, 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 ± ~~0.01 in 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 ± ~~0.01 in or~~ 5%~~, whichever is greater..~~

7) Updated Section C6.1.1.1.

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.; or

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 30°F higher average internal air temperature when compared to external ambient temperature but the internal temperature should not exceed 120° F. The manufacturer shall specify the maximum temperature for testing if the product has a lower maximum allowable internal temperature than 120° F. 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 500 ft/min coil face velocity.~~ The total airflow delivered by the circulating fan(s) in each unit section shall provide a minimum of 50 cfm per square foot 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 20 ft^2 cross-sectional area will require ~~at least 3~~ circulating fan(s) ~~each~~ delivering at least 1,000 ~~6,000-8,000~~ cfm ~~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.

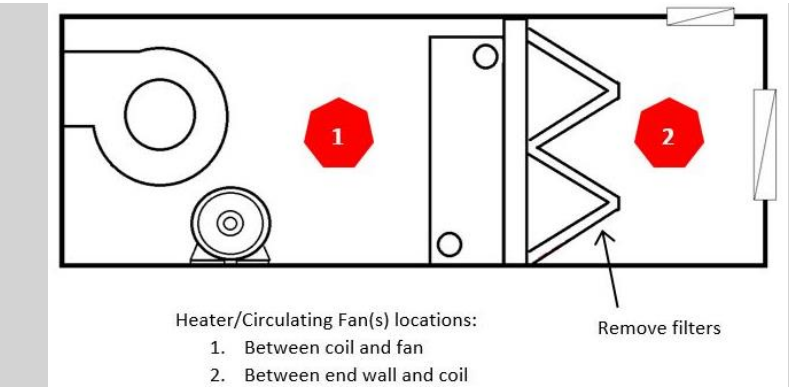

Figure C13. CSAHU with No Pressure Change Wall

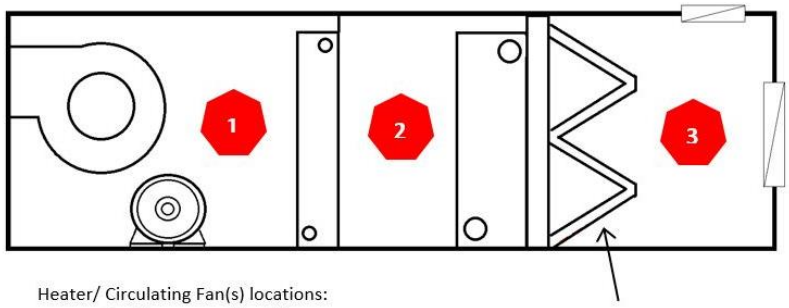

Figure C14. CSAHU with No Pressure Change Wall and Separate Coils

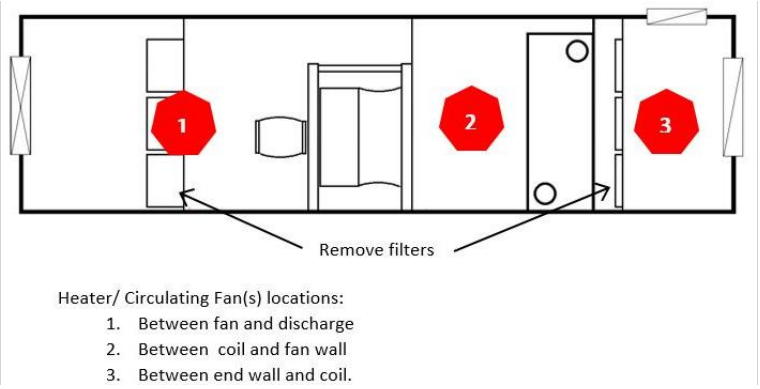

Figure C15. CSAHU with Pressure Change Wall

15) Updated Section C7.5.5.

C7.5.5 Calculate the Thermal Transmittance with leakage.

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

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

Where:

q_{tl} = total thermal energy with leakage, Btu/hr
U = Thermal Transmittance, Btu/hr/°F/ft^2

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, Btu/h
U = Thermal Transmittance, Btu/hr/°F/ft^2

17) Section C8.1.2 updated.

C8.1.2 The test shall be performed ~~at nominal 350 ± 50 ft/min calculated internal air velocity provided by the inside circulating fans~~ with the same circulating fans used for the thermal transmittance test.

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 SI ratings, see ANSI/AHRI Standard 1351 (SI)–2014.

AHRI CERTIFICATION PROGRAM PROVISIONS

Scope of Certification Program and Certified Ratings

Please refer to the most current version of the Central Station Air-handling Unit Casings Certification Program Operations Manual (OM) for the Scope of the Certification Program and Certified Ratings.

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 260 (I-P) 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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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

TABLES FOR APPENDICES

FIGURES FOR APPENDICES

MECHANICAL PERFORMANCE RATING OF CENTRAL STATION AIR-HANDLING UNIT CASINGS

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 factor 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 -1.0 in H_2O and 1.0 in H_2O.

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

3.2 *Casing Air Leakage Rate.* The air flow leaking through the casing of a Central Station Air-handling Unit (CSAHU) per 100 square feet of Casing Surface Area, cfm/100 ft^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 100 ft^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 casing, measured perpendicular to the plane of the casing surface, when the unit is subjected to a positive or negative internal air pressure, in.

3.4 *Casing Surface Area.* The total of all the exterior surface area, measured in ft^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, cfm/100 ft^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 casing 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, inches/inch.

3.11 *Maximum Rated Pressure for Leakage.* The absolute value of largest internal to external differential pressure across the casing at which the CSAHU casing is designed to operate. Ratings for Casing Air Leakage Rate shall include, at minimum, results at this pressure, inches H_2O.

3.12 *Negative Pressure.* Any point where the air pressure inside the CSAHU is less than the ambient air pressure, measured in inches H_2O and is always a negative value.

3.13 *Normalized Deflection*. The Casing Deflection divided by the Span, inches/inch.

3.14 *Positive Pressure.* Any point where the air pressure inside the CSAHU is greater than the ambient air pressure, measured in inches H_2O, 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.

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, in H_2O.

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 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 0.075 lb/ft^3 which approximates dry air at 70°F and at a barometric pressure of 29.92 in Hg.

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, $Btu/h/ft^2/°F$. (Also known as the U-value.)

3.27.1 *Thermal Transmittance without Leakage*. The rate at which thermal energy is transmitted through the casing, $Btu/h/ft^2/°F$.

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 1.0 in. H_2O, $Btu/h/ft^2/°F$.

3.28 *Thermal Transmittance Class.* The rating designation class that defines the maximum rate at which energy, $Btu/h/ft^2/°F$, 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.

3.28.1 *Thermal Transmittance Class without Leakage.* The rating designation class that defines the maximum rate at which energy, Btu/h/ft^2/°F, 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, Btu/h/ft^2/°F, 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 1 in H_2O and less or equal to than 4 in H_2O internal positive or negative pressure)
4.1.2.2 Medium pressure (greater than 4 in H_2O and less than 10 in H_2O internal positive or negative pressure)
4.1.2.3 High pressure (greater than or equal to 10 in H_2O 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 10 ft^2)
4.1.3.2 Medium (smallest internal cross-sectional area normal to the airflow direction is greater than 10 ft^2 and less than 60 ft^2)
4.1.3.3 Large (smallest internal cross-sectional area normal to the airflow direction is greater than or equal to 60 ft^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 CSHAU Casing 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 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 18 in)~~ 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)

6.1.3.1 One access point 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.

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 Casing 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 Casing Design Pressure. No Casing Air Leakage Class may be reported or published for Application Ratings. For Application Ratings, users shall report the measured leakage (cfm/100 ft^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, in H_2O	Maximum Normalized Deflection, in/in of Span
CD_1	10	0.0033 (1/300)
CD_2	8	0.0042 (1/240)
CD_3	6	0.0042 (1/240)
CD_4	4	0.0042 (1/240)
CD_5	1	$\geq$ 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 Casing Design Pressure and measured leakage. The Casing Air Leakage Rate shall be calculated per Equation 1 (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.

Table 2. Casing Air Leakage Rating Class[1,2]

Class - Leakage, CL_x	Maximum Casing Air Leakage Rate, CL_r, cfm/100 ft^2 (at P_r = 1 in H_2O)
CL_1	1
CL_2	2
CL_3	3
CL_6	6
CL_{12}	12
CL_{24}	24
CL_{100}	100

Notes:
1. Rating differential pressure for each CSAHU shall be determined according to the maximum unit operating conditions specified.
2. All values apply to positive or negative pressure conditions.

$$CL = CL_m \cdot \left(\frac{P_m}{P_r}\right)^{-0.65} \quad (1)$$

Where:

CL = Casing Air Leakage Rate, CFM/100ft^2
CL_m = Measured leakage, CFM/100ft^2 at P_m
P_m = Absolute value of test differential pressure, in. H_2O
P_r = Reference pressure, 1.0 in. H_2O

Note: Casing Air Leakage Rate must be equal or less than measured leakage (CL_m).

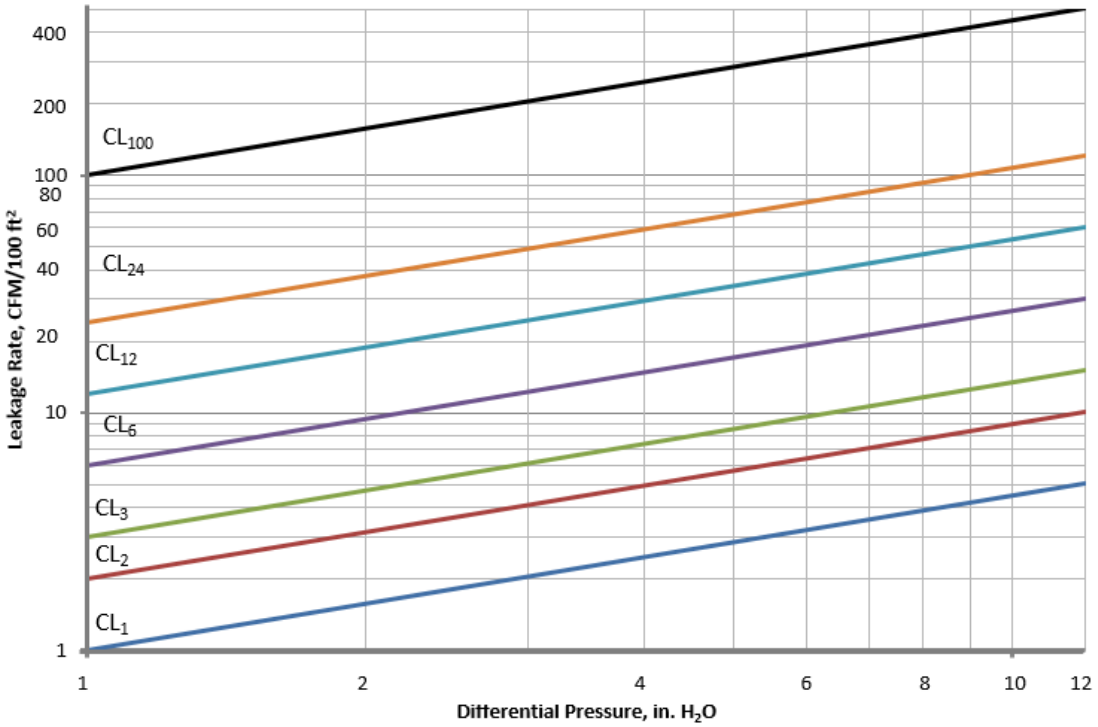


Figure 1. Casing Air Leakage Rating Class Chart

6.5.1 *Maximum Casing Rating Pressure.* Ratings shall be established at the Maximum Rated Pressure for Leakage. Air-handling units with sections operating under both positive and negative pressure shall, in all cases, have the positive and negative pressure sections tested separately.

6.6 *Thermal Transmittance*.

6.6.1 *Thermal Transmittance Class.* The Thermal Transmittance Class for the Central Station Air-handling Unit shall be determined from the test results, Section C7, and the thermal transmittances with and without leakage, U, shown in Table 3.

Table 3. Casing Thermal Transmittance Rating Class[1]

Class - Thermal Transmittance, CT_x	Thermal Transmittance without Leakage (U), Btu/hr/ft^2/°F	Thermal Transmittance with Leakage (U), Btu/hr/ft^2/°F
CT_1	$U \leq 0.14$	$U \leq 0.16$
CT_2	$0.14 > U \geq 0.23$	$0.16 > U \geq 0.26$
CT_3	$0.23 > U \geq 0.36$	$0.26 > U \geq 0.39$
CT_4	$0.36 > U \geq 0.55$	$0.39 > U \geq 0.61$
CT_5	$U > 0.55$	$U > 0.61$

Notes:
1. 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 Thermal Transmittance Class cannot be used to predict actual application Thermal Transmittance through the casing for any specific Central Station Air-handling Unit.

6.7 *Thermal Bridging Factor*.

6.7.1 *Thermal Bridging Class.* The Casing Thermal Bridging Rating Class shall be determined from the test results, Section C8, and the rating Thermal Bridging Factor as shown in Table 4 and calculated by Equation 2.

Table 4. Casing Thermal Bridging Rating Class[1,2,3]

Class - Thermal Bridging, CB_x	Thermal Bridging Factor, k_b
CB_0	$k_b \geq 0.8$
CB_1	$k_b \geq 0.8$
CB_2	$0.8 > k_b \geq 0.60$
CB_3	$0.60 > k_b \geq 0.40$
CB_4	$0.40 > k_b \geq 0.20$
CB_5	$k_b < 0.20$

Notes:
1. Meeting Thermal Bridging Class CB_0 requires screw heads (including any washers) and fasteners to be included as potential critical thermal bridging locations.
2. For Thermal Bridging Classes CB_1 through CB_5, screw heads (including any washers) and fasteners shall be excluded from consideration as long as their total area is less than 1% of the total unit surface area. However, any individual screw head (including any washer) or fastener larger than 0.5 in^2 shall be measured and shall not be excluded.
3. Thermal Bridging Factors are intended to be used only to compare the construction of different Central Station Air-handling Units. The numerical value associated with the Thermal Bridging Factor cannot be used to predict actual application risk of condensation for any specific Central Station Air-handling Unit.

$$k_b = \frac{T_{ai} - T_{so}}{T_{ai} - T_{ae}} \qquad 2$$

Where:
T_{ai} = Mean internal drybulb air temperature , °F
T_{ae} = Mean external (ambient) drybulb air temperature, °F
T_{so} = Casing external surface temperature at the location of Thermal Bridge , °F

6.8 *Standard Ratings and Conditions.* Standard Ratings for all CSAHUs shall be established at the Standard Rating Conditions.

6.8.1 *Deflection Class Rating Conditions.*

6.8.1.1 Ambient dry-bulb temperature, T_{ae}, $60°F < T_{ae} < 90°F$

6.8.2 *Leakage Rating Conditions.*

6.8.2.1 Ambient dry-bulb temperature, T_{ae}, $60°F < T_{ae} < 90°F$

6.8.3 *Thermal Transmittance Rating Conditions.*

6.8.3.1 Ambient dry-bulb temperature, T_{ae}, $60°F < T_{ae} < 90°F$
6.8.3.2 Differential dry-bulb temperature (internal to external), $40°F > (T_{ai} – T_{ae}) > 30°F$
6.8.3.3 Measured air velocity around the exterior of the unit, $V_{ae} < 100$ ft/min
6.8.3.4 Calculated air velocity inside the unit, V_{ai}, 350 ft/min ± 50 ft/min

6.8.4 *Thermal Bridging Factor Rating Conditions.*

6.8.4.1 Ambient dry-bulb temperature, T_{ae}, $60°F < T_{ae} <90°F$
6.8.4.2 Differential dry-bulb temperature (internal to external), $40°F > (T_{ai} – T_{ae}) > 30°F$
6.8.4.3 Measured air velocity around the exterior of the unit, $V_{ae} < 100$ ft/min
6.8.4.4 Calculated air velocity inside the unit, V_{ai}, 350 ft/min ± 50 ft/min

Section 7. Minimum Data Requirements for Published Ratings

7.1 *Minimum Data Requirements for Published Ratings*. As a minimum, Published Ratings shall include all Standard Ratings. All claims to ratings within the scope of this standard shall include the statement "Rated in accordance with ANSI/AHRI Standard 1350 (I-P)." If only portions of the standard have been used in the testing process, the claim to rating shall be adjusted accordingly. For example, if a unit has only been tested in accordance with ANSI/AHRI Standard 1350 (I-P) for Deflection Class and Leakage Class, the statement would say, "Rated in accordance with ANSI/AHRI Standard 1350 (I-P) for Deflection Class and Leakage Class." All claims to ratings outside the scope of this standard shall include the statement "Outside the scope of ANSI/AHRI Standard 1350 (I-P)." Wherever Application Ratings are published or printed, they shall include a statement of the conditions at which the ratings apply.

7.1.1 *Unit Description.*

7.1.1.1 Manufacturer name
7.1.1.2 Manufacturer model or brand name
7.1.1.3 Casing construction information

7.1.2 *Casing Deflection.*

7.1.2.1 Positive Pressure Section casing deflection class, CD_x, from Table 1 (+Class)
7.1.2.2 Negative Pressure Section casing deflection class, CD_x, from Table 1 (-Class)
7.1.2.3 Size range, if applicable

7.1.3 *Casing Air Leakage.*

7.1.3.1 Positive Pressure Section casing air leakage class, CL_x, from Table 2 (+Class)
7.1.3.2 Negative Pressure Section casing air leakage class, CL_x, from Table 2 (-Class)
7.1.3.3 Size range, if applicable

7.1.4 *Casing Thermal Transmittance.*

7.1.4.1 Thermal Transmittance Class (with leakage), CT_x, from Table 3.
7.1.4.2 Thermal Transmittance Class (without leakage), CT_x, from Table 3.

7.1.5 *Casing Thermal Bridging.*

7.1.5.1 Thermal Bridging Class, CB_x, from Table 4.

7.2 *Published Application Ratings.* Ratings at conditions other than those specified at Standard Rating Conditions may be published as Application Ratings and shall be based upon data determined by the method of test described in Appendix C.

7.3 *Publication of Ratings*. Wherever Application Ratings are published or printed, they shall include or be accompanied by the Standard Ratings, clearly designated as such, including a statement of the conditions at which the ratings apply.

7.4 *Tolerances*. To comply with this standard, Published Ratings shall be based on data obtained in accordance with the provisions of Sections 5, 6 and 7 of this standard and shall be such that any production unit, when tested, shall meet these ratings within the required tolerances. All instrumentation and measurements used during the testing shall comply with the uncertainty capabilities as defined in Appendix C.

Section 8. Marking and Nameplate Data

8.1 *Marking and Nameplate Data*. As a minimum, the nameplate shall display the manufacturer's name and model designation.

Section 9. Conformance Conditions

9.1 *Conformance.* While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims to meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all the requirements of the standard shall not reference, state, or acknowledge the standard in any written, oral, or electronic communication.

APPENDIX A. REFERENCES – NORMATIVE

A1 Listed here are all standards, handbooks and other publications essential to the formation and implementation of the standard. All references in this appendix are considered as part of the standard.

A1.1 ANSI/AHRI Standard 210/240-2008 with Addendum 1 and 2, *Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment*, 2008, American National Standards Institute and Air-Conditioning & Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

A1.2 ANSI/AHRI Standard 260-2012 (I-P) , *Sound Rating of Ducted Air Moving and Conditioning Equipment*, 2012, American National Standards Institute and Air-Conditioning & Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

A1.3 ANSI/AHRI Standard 340/360-2008 with Addendum 2, *Performance Rating of Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment*, 2008, American National Standards Institute and Air-Conditioning & Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

A1.4 ANSI/AHRI Standard 420-2008, *Performance Rating of Forced-Circulation Free-Delivery Unit Coolers for Refrigeration*, 2008, American National Standards Institute and Air-Conditioning & Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

A1.5 ANSI/AHRI Standard 430-2009, *Performance Rating of Central Station Air-handling Units*, 2009, American National Standards Institute and Air-Conditioning & Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A**.**

A1.6 ANSI/AHRI Standard 440-2009 with Addendum 1, *Performance Rating of Room Fan-Coils*, 2009, American National Standards Institute and Air-Conditioning & Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A**.**

A1.7 ANSI/AHRI Standard 840-1998, *Standard for Unit Ventilators*, 2009, American National Standards Institute and Air-Conditioning & Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A**.**

A1.8 ANSI/AHRI Standard 920-2012, *Performance Rating of DX-Dedicated Outdoor Air System Units*, 2012, American National Standards Institute and Air-Conditioning & Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A**.**

A1.9 ANSI/AHRI Standard 1230-2010, *Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment*, 2010, American National Standards Institute and Air-Conditioning & Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A**.**

A1.10 ASHRAE Terminology website (https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology), 2014, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E. Atlanta, GA 30329, U.S.A.

A1.11 ANSI/ASHRAE Standard 41.1-2013, *Standard Method for Pressure Measurement*, 2013, American National Standards Institute/ American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 25 West 43rd Street, 4th Fl., New York, NY, 10036, U.S.A./1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.12 ANSI/ASHRAE Standard 41.2-1987 (RA 1992), *Standard Methods for Laboratory Air-Flow Measurement*, 1992, American National Standards Institute/ American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 25 West 43rd Street, 4th Fl., New York, NY, 10036, U.S.A./1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.13 ANSI/ASHRAE Standard 41.11-2014, *Standard Methods for Power Measurement*, 2014, American National Standards Institute/ American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 25 West 43rd Street, 4th Fl., New York, NY, 10036, U.S.A./1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.14 ANSI/ASHRAE Standard 111-2008, *Testing, Adjusting, and Balancing of Building HVAC Systems*, 2008, American National Standards Institute/ American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 25 West 43rd Street, 4th Fl., New York, NY, 10036, U.S.A./1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.15 ANSI/SMACNA 016, *HVAC Air Duct Leakage Test Manual*, 2012, Sheet Metal & Air Conditioning Contractor's National Association, 4201 Lafayette Center Drive Chantilly, Virginia 20151 U.S.A.

A1.16 IEEE C57.13, *IEEE Standard Requirements for Instrument Transformers*, 1993, Institute of Electrical and Electronics Engineers, 445 Hoes Lane Piscataway, NJ 08854-4141 U.S.A.

A1.17 ISO/IEC Standard 17025-2005, *General requirements for the competence of testing and calibration laboratories*, 2005, American National Standards Institute/International Organization for Standardization/ International Engineering Consortium, Case Postale 56, CH-1211, Geneva 20, Switzerland/ Two Prudential Plaza, 180 N. Stetson Suite 3500 Chicago, IL 60601 U.S.A..

A1.18 NIST Special Publication 260-100, *Standard Reference Materials Handbook for SRM users*, 1993, National Institute of Standards and Technology, Gaithersburg, MD 20899, U.S.A. .

APPENDIX B. REFERENCES – INFORMATIVE

B1 Listed here are all standards, handbooks, and other publications not essential to the formation and implementation of the standard and intended for referenced only.

None.

APPENDIX C. METHOD OF TESTING CENTRAL STATION AIR-HANDLING UNIT CASINGS - NORMATIVE

C1. *Purpose.* The purpose of this appendix is to prescribe a method of testing for the CSAHU casing and verify the deflection (Section C5), air leakage (Section C6), Thermal Transmittance (Section C7) and thermal bridging (Section C8) requirements at a specific set of conditions for the Standard Rating Unit as described in Section 6.2.

C1.1 Testing shall occur at a qualified test facility where instrumentation, as defined in Section C4, is available and test condition stability can be obtained.

C1.2 Testing shall not be conducted in field installations to the provisions of this standard. Steady state conditions and requirements for consistent, reliable measurement are difficult to achieve in field installations.

C2. *Scope.* The scope for this appendix is identical to that in Section 2 of ANSI/AHRI Standard 1350 (I-P).

C3. *Definitions.* Definitions for this appendix are identical to those in Section 3 ANSI/AHRI Standard 1350 (I-P).

C4. *Instrumentation.*

C4.1 Instruments shall be selected, installed, operated, and maintained according to the requirements listed in 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°F	0.1°F	ANSI/ASHRAE Standard 41.1
Pressure	±0.01 in H_2O	±0.005 in H_2O	ANSI/ASHRAE Standard 41.3 Standard Method for Pressure Measurement
Length, width, and height	± 0.1 in	± 0.06 in	ISO/IEC 17025
Length, deflection	±0.002 in	±0.001 in	ISO/IEC 17025
Airflow	± 2.0% of the reading	1 cfm	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:

6. Accuracy requirement also applies to volumetric type meters.
7. 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.
8. Current Transformers and Potential Transformers shall have a metering accuracy class of 0.3 or better, rated in accordance with IEEE C57.13.
9. 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.
10. Significant figures (also known as significant digits) determined in accordance with Section 7.2 of NIST Special Publication 260-100, “Handbook for SRM Users”.

C4.2 All instruments and measurement systems shall be calibrated over a range that meets or exceeds the range of test readings. Data acquisition systems shall be either calibrated as a system, or all individual component calibrations shall be documented in a manner that demonstrates the measurement system meets the accuracy requirements specified in Table C1. Calibrations shall include no less than four (4) points compared to a calibration standard. Calibration standards shall be traceable to NIST or equivalent laboratories that participate in inter-laboratory audits.

C4.3 *Certification of Instrument Calibration*. Test instrumentation calibration shall be traceable to national standards and shall be accompanied by a record of calibration, covering the range of its intended use, performed within 12 months of the test. The instrumentation calibration shall have been performed by a certified calibration laboratory per ISO/IEC Standard 17025.

C5. *CSAHU Casing Deflection Testing.*

C5.1 *Test Method.* The test will locate and measure the maximum Deflection of the CSAHU casing surface at a specific set of conditions.

C5.2 *Test Apparatus.*

C5.2.1 The test apparatus and set-up shall be as shown in Figures C1, C2 or C3 on the unit under test (test unit).

C5.2.2 Install block-off plates on inlets and outlets and, as required, block-off plates at pressure change wall locations inside the unit.

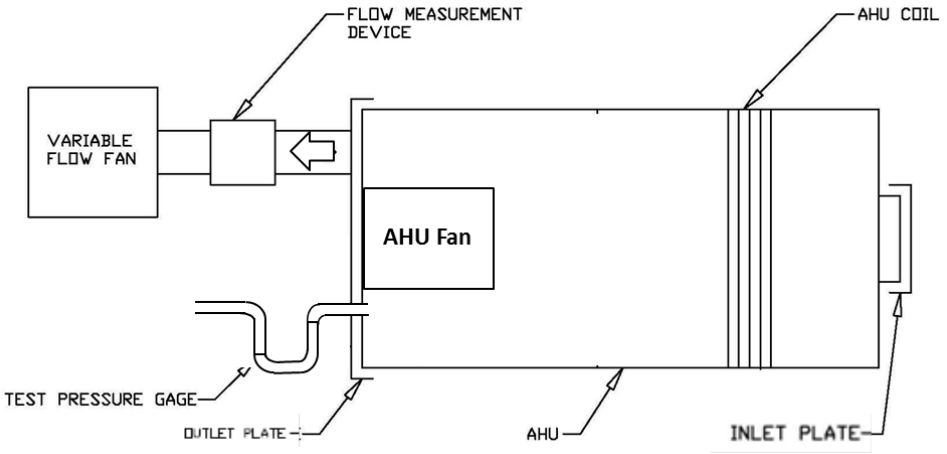


Figure C1. Negative Pressure CSAHU Test Apparatus

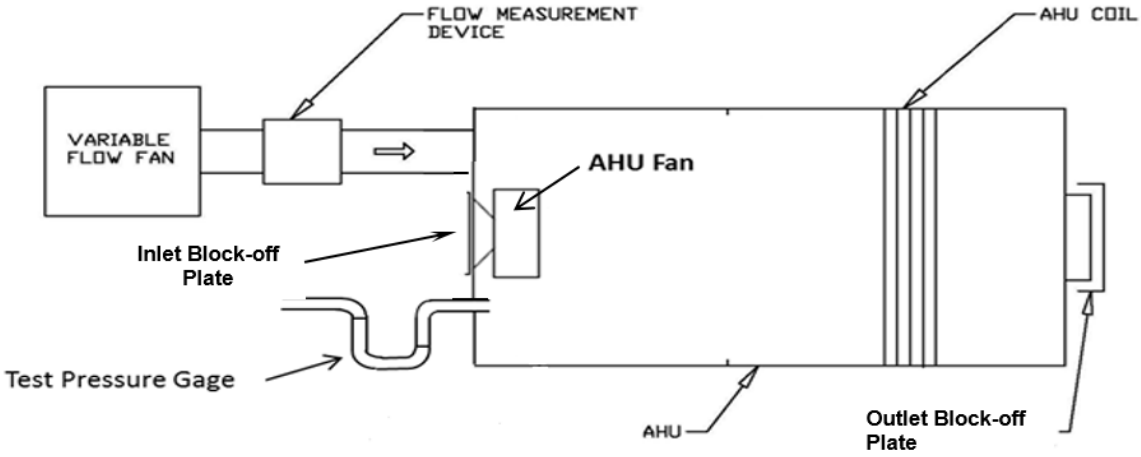


Figure C2. Positive Pressure CSAHU Test Apparatus

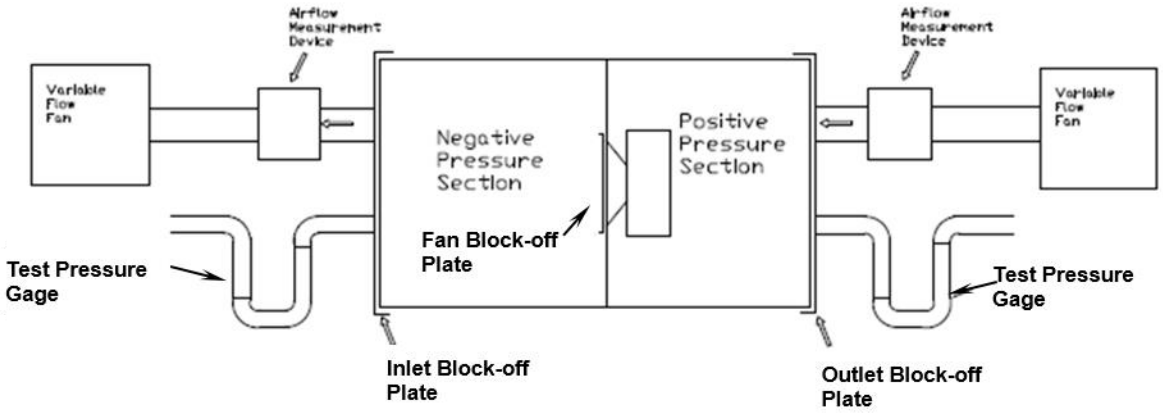


Figure C3. Positive and Negative Pressure CSAHU Test Apparatus.

C5.3 *Casing Deflection Test Procedure.*

C5.3.1 The test unit for Casing Deflection (and Casing Air Leakage) shall be set up in the normal operating orientation with sections connected or joined per manufacturer's installation/assembly instructions. Manufacturer shall provide additional gasket, caulk, and fasteners as required to assemble unit sections. Internal and external dampers shall be dismounted or sealed. Unit access doors must remain operable. Inlet hoods, exhaust hoods, energy recovery wheels, and other similar appurtenances which are not part of the casing shall not be installed for this test.

C5.3.2 Casing deflection testing for positive and negative sections shall be performed independently, not concurrently.

C5.3.3 Floor-mounted units and units where ceiling suspended application is optional. Set up unit per manufacturer's installation instructions on the manufacturer recommended non-isolated, unrestrained, floor support structure such as base rails or feet.

Units that are only applied in ceiling suspended applications: Unit to be suspended per manufacturer's recommendations.

Deflection shall not be measured on the floor surface for all unit types.

C5.3.4 Seal external openings and isolate positive and negative sections of the CSAHU. Seal inlet and outlet openings. Seal external dampers, louvers, hoods, or other openings (including, but not limited to, electrical penetrations, coil connections, and drains) in the test unit. Install a block-off plate at any openings in the Pressure Change Wall as outlined in Section C5.2 and illustrated in Figure C3. Locate the Pressure Change Wall by measuring from the end of unit to the fan block-off plate inside the unit. Mark a line on exterior of unit at the same distance from the end of the unit. This location will be used in determining the Span.

Wall, roof, and/or end panel assemblies with inlet or discharge openings that are > 40% of that panel assemblies' surface area are exempt from deflection measurement. Wall, roof, and/or end panel assemblies with inlet or discharge openings that are ≤ 40% of that wall, roof, and/or assembly's surface area shall be included in the deflection measurement but the deflection measurement shall not be closer than 2 inches from the sealed off openings.

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.

Block-off plates shall be made from metal and sealed with gaskets, tape or caulk. The block-off plate shall not add significant stiffness or support to the unit under test.

Confirm air-tightness of the block-off plates and seals while unit is pressurized. Seal any leaks in all openings that were sealed for this test.

Connect unit to variable flow fan and measurement instrumentation as shown in Figures C1, C2 and C3.

C5.3.5 *Unit Break-in.* Pressurize the unit to the test pressure 3 times. Turn on variable flow fan test apparatus and adjust until the static pressure inside the test unit is within ± 0.10 in H_2O of the specified operating pressure. Run at the test pressure for a minimum of one minute. Turn off the variable flow fan and let the static pressure inside the unit return to zero. Rest the unit for a minimum of one minute. Repeat two more times in direct succession.

C5.3.6 *Measurement Locations.* Identify, number, and dimension each deflection measurement location on unit submittal drawing, also document Span length and direction on the drawing.

See Figures C4, C5, and C6 for examples of Span and for determining Span when crossing a Pressure Change Wall as described in Section C5.3.4.

Note: See Figure C4 for horizontal configuration, Figure C5 for vertical configuration and Figure C6 for pressure change wall examples.

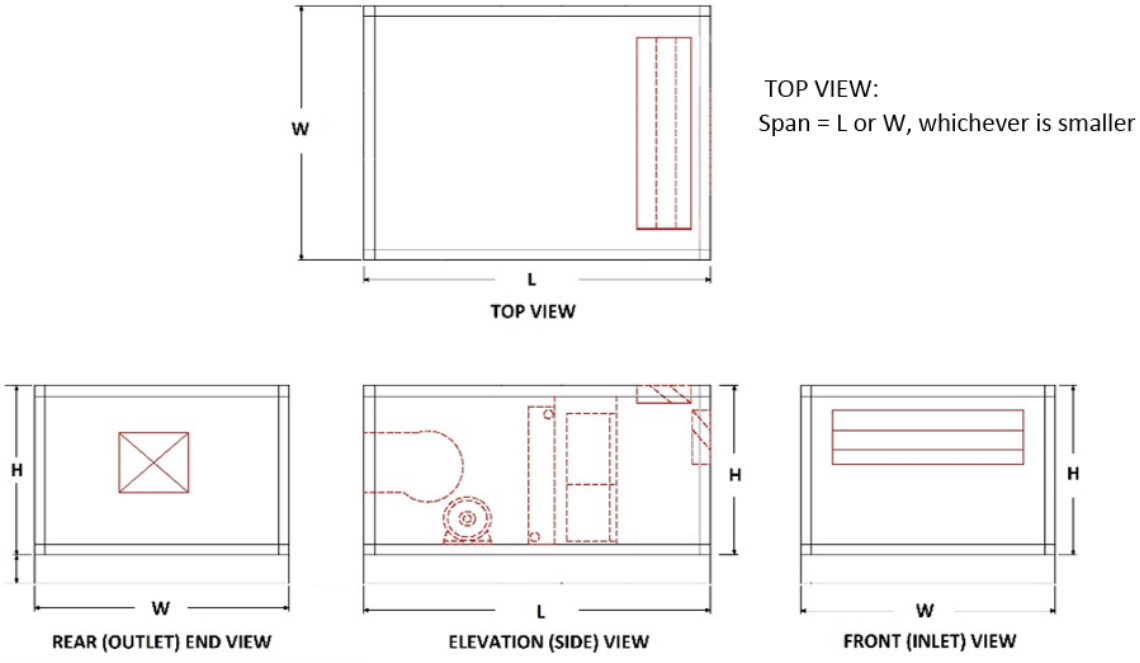
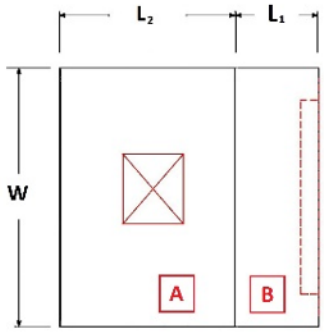


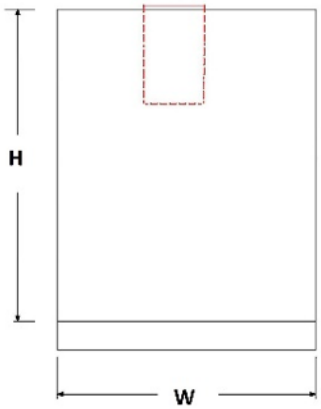
Figure C4- Span Measurement - Horizontal Unit



TOP VIEW

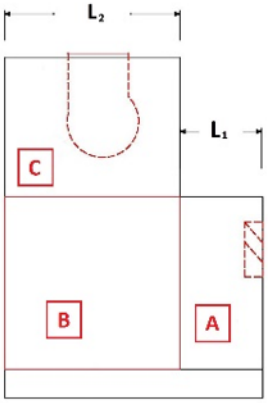
TOP VIEW (Area A):
Span = Smaller of L_2 and W

TOP VIEW (Area B):
Span = Smaller of L_1 and W



REAR VIEW

REAR VIEW:
Span = Smaller of H and W

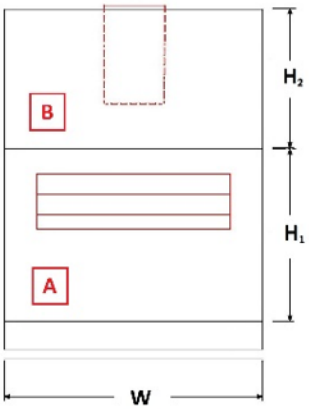


ELEVATION (SIDE) VIEW

ELEVATION VIEW (Area A):
Span = Smaller of L_1 and H_1

ELEVATION VIEW (Area B):
Span = Smaller of L_2 and H_1

ELEVATION VIEW (Area C):
Span = Smaller of L_2 and H_2



FRONT VIEW

FRONT VIEW (Area A):
Span = Smaller of H_1 and W

FRONT VIEW (Area B):
Span = Smaller of H_2 and W

Figure C5 - Span Measurement -Vertical Unit

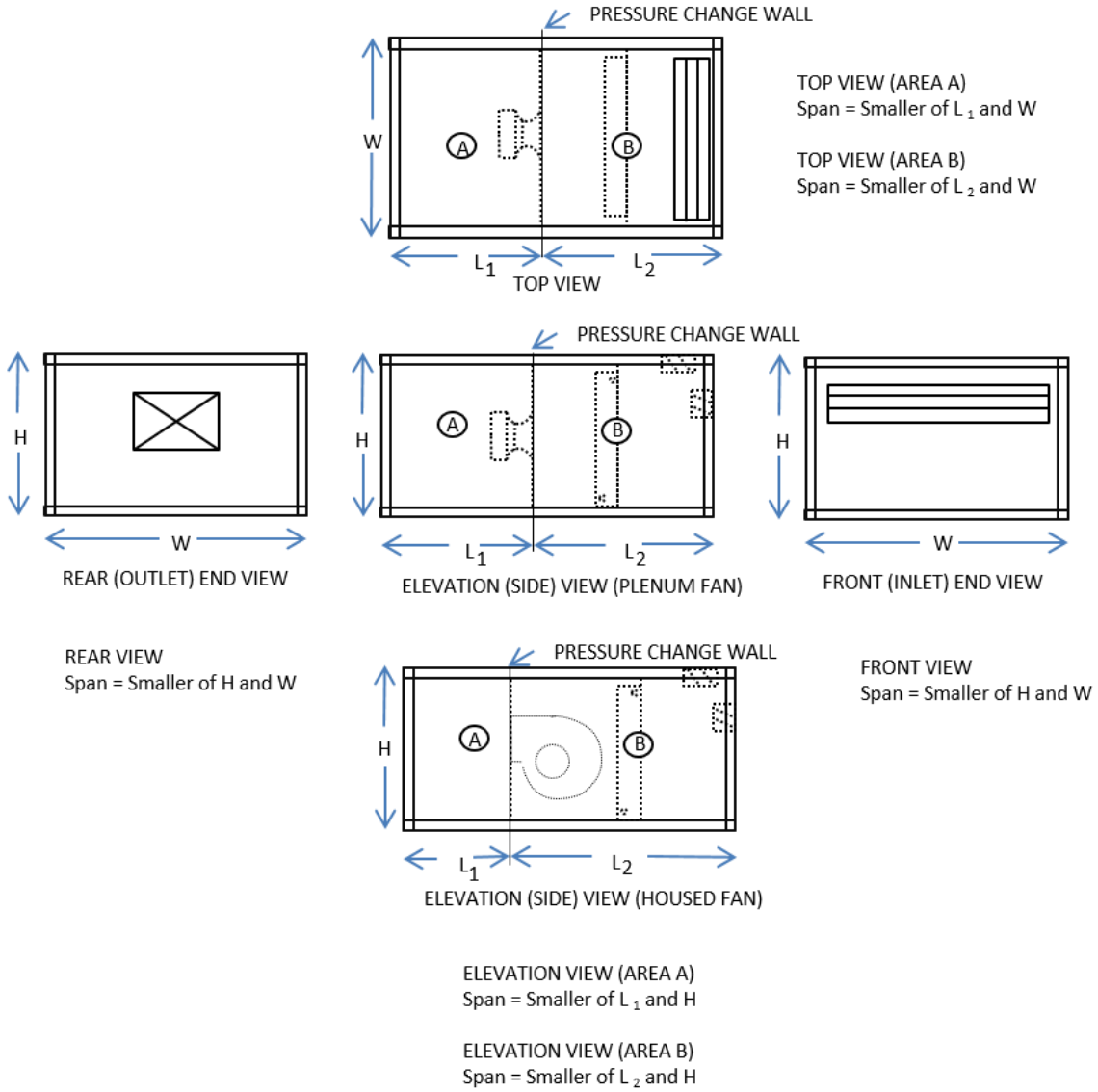


Figure C6. Span Measurement - Pressure Change Wall Unit

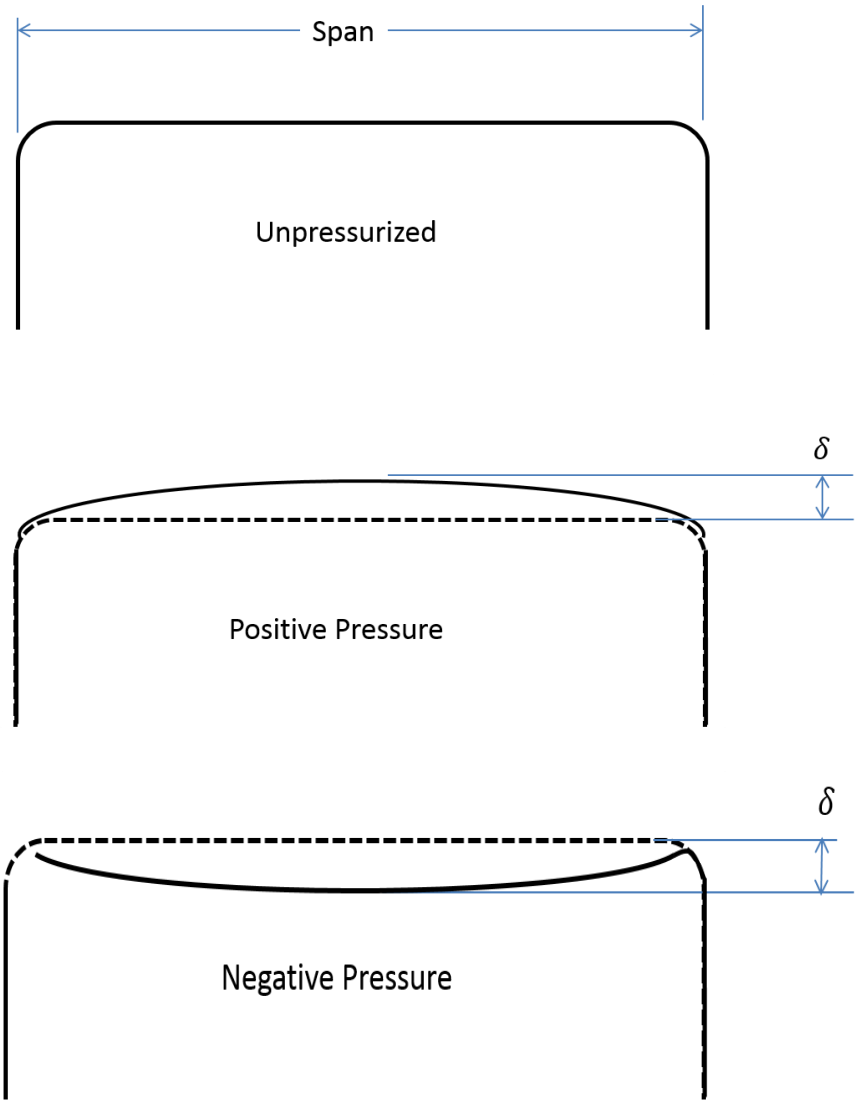


Figure C7. Deflection Measurement

C5.3.8 Record the unpressurized base deflection readings.
Note: They do not need to be zeroed out.

C5.3.9 Pressurize unit to the Rating Differential Static Pressure, Section 6.3, Table 1. The Rating Differential Static Pressure shall be less than or equal to the Maximum Casing Design Pressure. The test pressure shall not exceed the manufacturer's maximum stated limit. The static pressure inside the test unit shall not deviate from the rating pressure more than ± 0.10 in H_2O, or ±2%, whichever is greater.

C5.3.10 Conditions are considered to be stable when the individual readings of internal static pressures do not vary from the rated pressure more than ± 0.10 in H_2O, or ±2%, whichever is greater, when measurements are taken every 5 minutes for a total of 15 minutes.

C5.4 *Measurements.*

C5.4.1 Measure and record the initial unpressurized base deflections.

C5.4.2 Record the initial test pressure (in H_2O), P_i.

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.

C5.4.4 Depressurize the unit and record the final base deflection readings

C5.4.5 Measure the corresponding Spans. See Figures C4, C5, and C6.

C5.5 *Calculation of Results.*

C5.5.1 The test is valid if any measured pressure, P_i, does not vary from the mean pressure, P_a, more than ± 0.10 in H_2O, 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 ± ~~0.01 in 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 ± ~~0.01 in or~~ 5%~~, whichever is greater.~~

C5.5.2 Calculate the deflection for each measurement location. For all measurement locations, the deflection is equal to the average pressurized deflection reading less that location's average reading when not pressurized. Figure C7.

Use the following procedure:

Calculate the average of the pressurized deflection measurements recorded every 5 minutes for 15 minutes (per Section C5.4.3) for the measurement locations (the max deflection points):

$$\bar{\delta} = \frac{\delta_1+\delta_2+\delta_3+\delta_4}{4} \quad \text{C1}$$

Where:

$\bar{\delta} = 4$ measurement average deflection, in
$\delta_{1,2,3,4} =$ Individual deflection measurements, in

Calculate the baseline unpressurized deflection values at the maximum deflection point:

$$\delta_{baseline} = \frac{(\delta_{final}+\delta_{start})}{2} \quad \text{C2}$$

Where:

$\delta_{baseline} =$ Baseline unpressurized deflection, in
$\delta_{start} =$ Initial unpressurized deflection, in
$\delta_{final} =$ Final unpressurized deflection, in

Calculate the net deflection for the maximum deflection point.

$$\delta_{net} = \bar{\delta} - \delta_{baseline} \quad \text{C3}$$

Calculate the normalized net deflection:

$$\delta_{nd} = \frac{\delta_{net}}{l_{span}} \quad \text{C4}$$

Where:

$\delta_{net} =$ maximum deflection along Span, in

δ_{nd} = normalized net deflection, in/in of Span
l_{span} = Span, (in)

C5.6 *Rating Class.*

C5.6.1 The largest calculated normalized net deflection value determines the test unit's Deflection Class. Refer to Table 1, Section 6.3.

C5.6.2 For units applied in both positive and negative pressure, there will be two ratings, one for positive and one for negative pressure.

C6 *Air-handling Unit Case Air Leakage Testing.*

C6.1 *Test Method.*

C6.1.1 The test will measure the CSAHU Casing air leakage rate at a specific set of conditions for the unit under test (test unit).

If the unit has a Pressure Change Wall, the negative and positive pressure sections shall be tested by either Method 1 or Method 2. The manufacturer shall indicate in their Published Literature which rating method is used.

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.; or

C6.1.1.2 Method 2: As a disassembled or assembled unit with the Pressure Change Wall completely sealed.

C6.1.2 The measured leakage rate, cfm, and unit casing surface area, ft^2, shall be used to calculate the Casing Air Leakage Rate (cfm/100 ft^2)

C6.1.3 The unit test setup is identical to the setup used for the deflection testing defined in Section C5.

C6.2 *Test Apparatus.* The test apparatus shall be as shown in Figures C1, C2 and C3.

C6.3 *Test Procedure.*

C6.3.1 If no deflection testing has been performed, break-in the unit in accordance with Section C5.3.2 before performing the leakage testing.

C6.3.2 Perform the pre-test air leakage tester duct and unit connection leakage test. Block off the leakage test apparatus where it connects to the test unit. Energize the tester to each of the test pressures to be run and measure the test apparatus and duct/connection to the unit leakage airflow rate.

C6.3.3 Pressurize the unit to the manufacturer's maximum rated pressure per Section 6.4.1.

C6.3.4 Confirm stability of test pressure per Section C5.3.10.

C6.4 *Measurements.*

C6.4.1 Record the leakage flow rate (cfm) and the casing differential test pressure (in H_2O) every 5 minutes for a total of 15 minutes.

C6.4.2 Perform the post-test leakage tester duct and unit connection air leakage test per Section C6.3.2. If the leakage tester leakage rate has not changed more than 5%, the test is valid. If the leakage tester air

leakage has changed more than 5% from pre to post-test then the test apparatus and unit connections shall be modified to meet these requirements and the air leakage testing rerun.

C6.4.3 Record the casing's length, width and height.

C6.4.4 Record the name and dimensions of each component to be excluded from the calculation of net external casing surface area as described in Section C6.5.

C6.5 *Calculation of Results*

C6.5.1 The test is valid if any measured pressure, P_i, does not vary from the mean pressure, P_a, more than ± 0.10 in H_2O, or ±2%, whichever is greater and if any measured gross air leakage rate does not vary from the mean gross leakage more than 5%.

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.

C6.5.2. Calculate net external casing surface area less any block off plates.

$$A_{gross} = 2(H \cdot W) + 2(H \cdot L) + 2(W \cdot L) \quad \text{C5}$$

$$A_{net} = A_{gross} - A_{block\ off} \quad \text{C6}$$

Where:

$A_{block\ off}$ = total CSAHU inlet & outlet block − offs surface area, ft^2
A_{gross} = total CSAHU surface area, ft^2
A_{net} = difference between total CSAHU surface area and inlet & outlet block − off surface area, ft^2
H = CSAHU casing height, ft
L = CSAHU casing length, ft
W = CSAHU casing width, ft

C6.5.3 Calculate the mean leakage tester duct and unit connection air leakage using pre and post-test values. Subtract the mean tester leakage value (tare) from the average gross leakage measured during the pressurized test. This will be the net unit leakage to be used in the air leakage rate calculations in Section C6.5.4.

$$Q_{net} = Q_{gross} - Q_{tare} \quad \text{C7}$$

Where:

Q_{gross} = Measured average leakage at test pressure, cfm
Q_{net} = Average net unit leakage, cfm
Q_{tare} = Average leakage tester leakage, pre to post − test, cfm

C6.5.4 Calculate the leakage rate, CL_m (cfm/100 ft^2), at the rating pressure, P_m. Then calculate the Rating Leakage Factor, CL.

$$CL = CL_m \cdot \left(\frac{P_m}{P_r}\right)^{-0.65} \quad \text{C8}$$

C6.6 *Rating Class.*

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.~~

C7. *Air-handling Unit Case Thermal Transmittance Testing.*

C7.1 *Test Method.* The test will measure the thermal energy transmitted through the casing of the test unit to determine the Thermal Transmittance Rate without Leakage and measure the Casing Air Leakage Rate to determine the Thermal Transmittance Rate with Leakage.

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 30°F higher average internal air temperature when compared to external ambient temperature but the internal temperature should not exceed 120° F. The manufacturer shall specify the maximum temperature for testing if the product has a lower maximum allowable internal temperature than 120° F. Steady state is defined in Section C7.3.3. See Figures C13, C14, and C15 for some example thermal set-ups.

C7.1.2 All openings shall be sealed and blocked off with insulating material with a minimum thermal resistance of R-50, (U value = 0.020 Btu/h /ft^2/° F). The surface area of the block offs shall be subtracted from the unit casing surface area in the calculations. Any filters shall be removed prior to the test.

C7.1.3 The input energy to the heat sources and recirculating fans will be measured as well as the inside and outside the unit air dry bulb temperature.

C7.1.4 A leakage test shall be performed on the thermal test unit at the Casing Design Pressure per leakage testing defined in Section C6 to determine the amount of net calculated leakage cfm to be used in the determination of total Thermal Transmittance with Leakage.

C7.2 *Test Apparatus.*

C7.2.1 Support the unit 12 to 16 inches above the floor on thermally isolated blocks (i.e., wood blocks, cinder blocks, other materials with low thermal transmission, etc.) of adequate size and number to safely support the unit. The thermally isolated blocks shall not cover more than 5% of the bottom surface area and shall not inhibit external airflow below the unit.

C7.2.2 Install adjustable electric heaters inside the unit. The heaters shall be capable of increasing the internal air temperature to a minimum of 30ºF above the external ambient air temperature. The heaters shall be adjusted to a constant heat input, not cycled on and off, to achieve uniform internal temperatures at a constant electrical energy input.

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 500 ft/min coil face velocity.~~ The total airflow delivered by the circulating fan(s) in each unit section shall provide a minimum of 50 cfm per square foot of unit cross-sectional area. Multiple fans may be used to produce the required airflow.

C7.2.3.1 For example, a unit with a 20 ft^2 cross-sectional area will require ~~at least 3~~ circulating fan(s) ~~each~~ delivering at least 1,000 ~~6,000 8,000~~ cfm ~~at free delivery~~ per pressure section bounded by any pressure change wall, coil, and/or unit end.

C7.2.4 External velocities shall be no greater than 100 ft/min within one foot of the test sample for the duration of the test.

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.

C7.2.6 ~~Thermocouples~~ Temperature measuring devices mounted internally shall be mounted 4 to 5 inches from the nearest internal wall. External ~~thermocouples~~ temperature measuring devices shall be mounted 4 to 5 inches from the outside surface of the unit.

C7.2.7 Locate ~~thermocouples~~ temperature measuring devices inside the unit as defined below and shown in Figures C8-C12.

C7.2.7.1 Determine the number of ~~thermocouple~~ temperature measuring device planes needed. Minimum of two planes per inside section bounded by one end of the unit and an internal airflow barrier (i.e. coil, fan, Pressure Change Wall), two interior airflow barriers or an interior airflow barrier and the other end of the unit.

C7.2.7.2 Locate the first and last ~~thermocouple~~ temperature measuring device planes 4 to 5 inches from the ends of the unit.

C7.2.7.3 Distribute intermediate ~~thermocouple~~ temperature measuring device planes evenly to maintain a maximum of 4 feet between planes.

C7.2.7.4 Maintain 4 to 5 inches from ~~thermocouple~~ temperature measuring device planes to any internal airflow barrier (i.e. coil, fan, Pressure Change Wall)

C7.2.7.5 Install a minimum of 4 ~~thermocouples~~ temperature measuring devices inside the unit on each ~~thermocouple~~ temperature measuring device plane, one in each corner 4 to 5 inches away from each wall.

C7.2.7.6 ~~Thermocouples~~ Temperature measuring devices shall be supported with brackets or other supporting structure in such a way to prevent significant ~~thermocouple~~ Temperature measuring device movement during the test. See Figure C11 for typical mounting/supporting example.

C7.2.7.7 Avoid locating internal heaters near ~~thermocouples~~ Temperature measuring devices where air temperatures may be non-uniform or radiation from the heater may influence the ~~thermocouple~~ Temperature measuring device measurement. Shielding of the ~~thermocouple~~ Temperature measuring device is allowed but may affect the time constant for stability of measurement. Care should be exercised to verify stability and meet the required uniformity of the temperature measurements. See Figure C12 for typical shielding example.

C7.2.8 Locate ~~thermocouples~~ Temperature measuring devices outside the unit as defined below and shown in Figures C8 through C10.

C7.2.8.1 Install one ~~thermocouple~~ Temperature measuring device at the center of each unit side, 4 to 5 inches away from the unit surface.

C7.2.8.2 Install one ~~thermocouple~~ Temperature measuring device at the center of each unit side at each unit end plane located 4 to 5 inches from the end of the unit. ~~Thermocouples~~ Temperature measuring devices shall be mounted 4 to 5 inches from the unit surface.

C7.2.8.3 Install one ~~thermocouple~~ Temperature measuring device at the center of the end panels of the unit, 4 to 5 inches away from the unit end walls.

C7.2.8.4 ~~Thermocouples~~ Temperature measuring devices shall be supported with brackets or other supporting structure in such a way to prevent significant ~~thermocouple~~ Temperature measuring device movement during the test. See Figure C11 for typical mounting/supporting example.

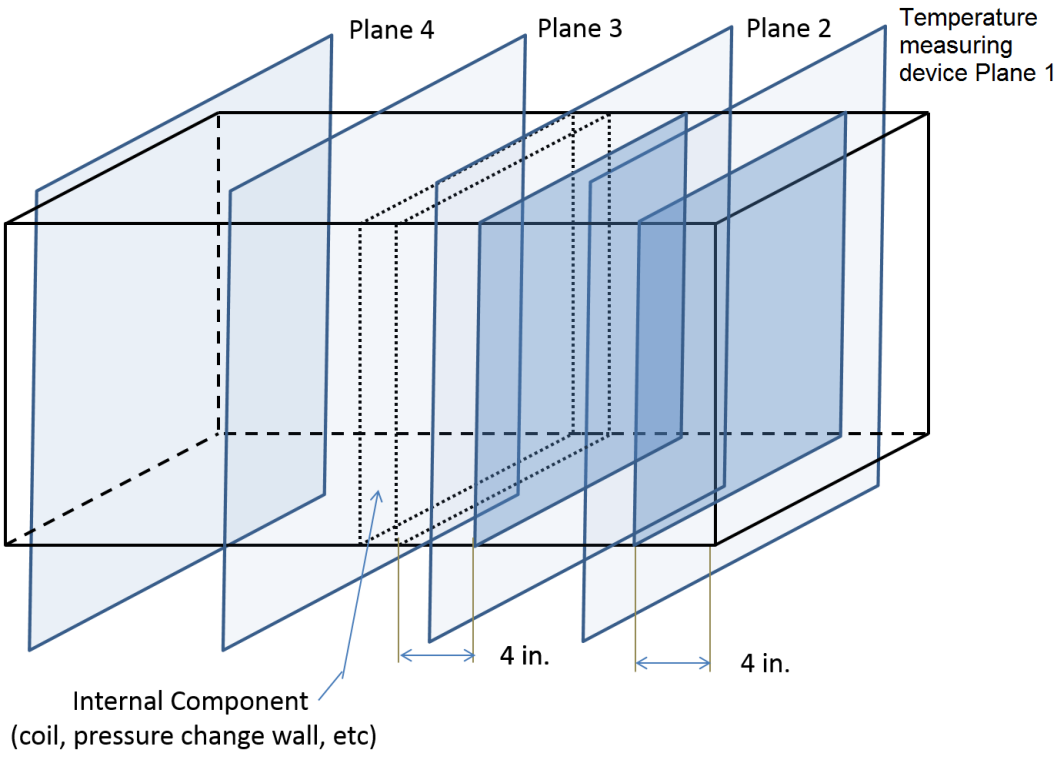


Figure C8. ~~Thermocouple~~ Temperature Measuring Device Planes

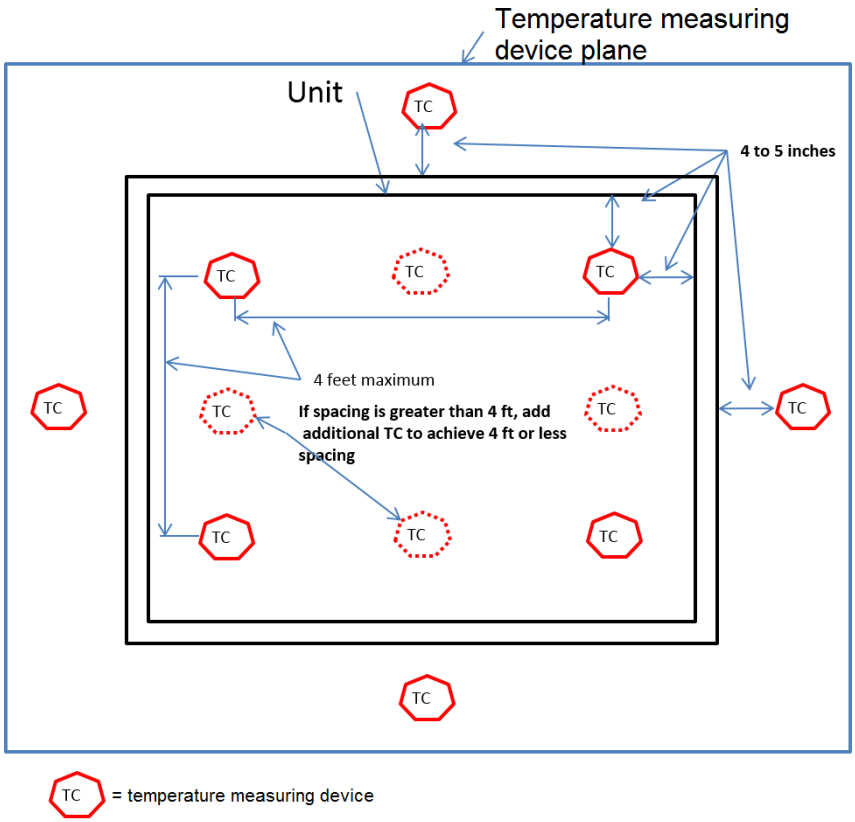


Figure C9. ~~Thermocouple~~ Temperature Measuring Device Locations – Side View

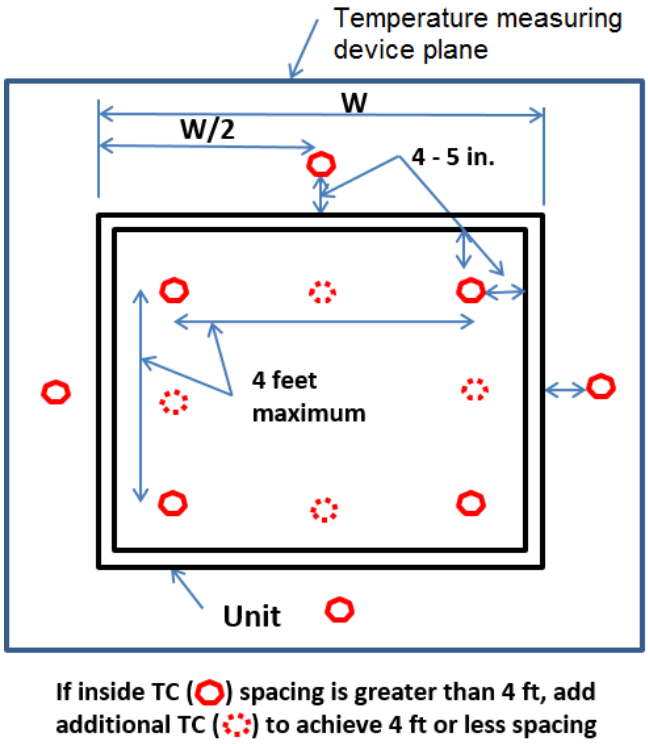


Figure C10. ~~Thermocouple~~ Temperature Measuring Device Locations – End View

Figure C11. Typical ~~Thermocouple~~ Temperature Measuring Device Mounting

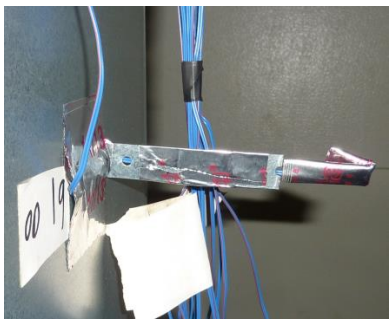
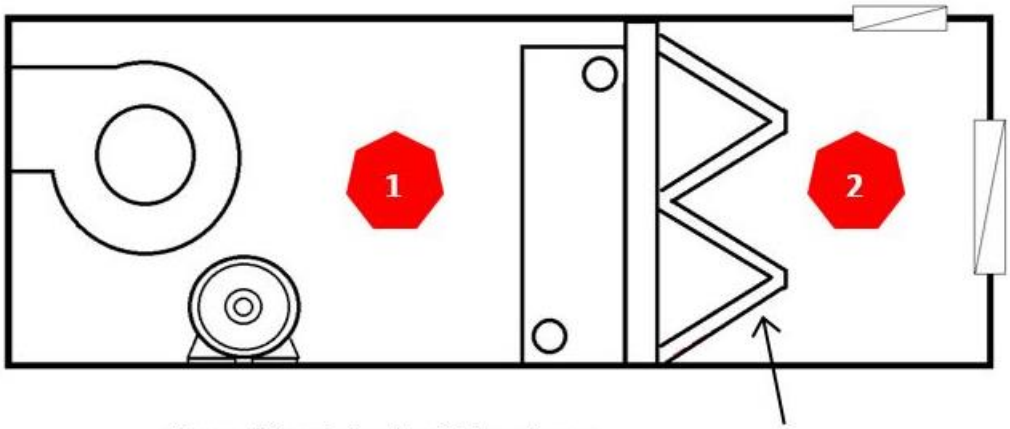


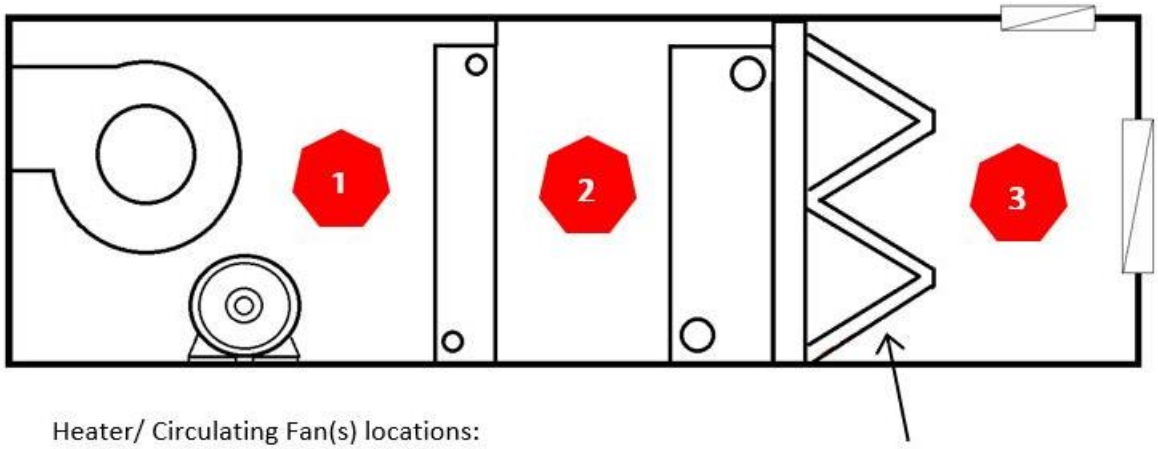
Figure C12. Typical ~~Thermocouple~~ Temperature Measuring Device Shielding



Heater/Circulating Fan(s) locations:

1. Between coil and fan
2. Between end wall and coil

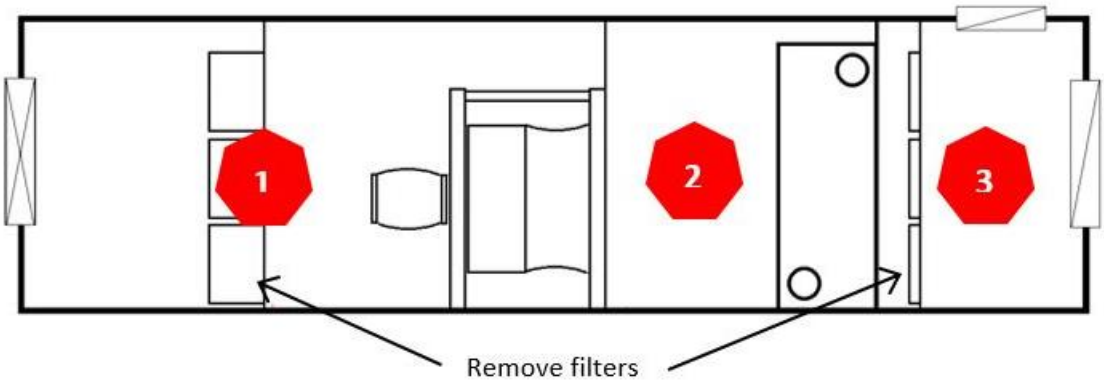
Figure C13. CSAHU with No Pressure Change Wall



Heater/ Circulating Fan(s) locations:

1. Between coil and fan
2. Between separated coils
3. Between end wall and coil

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



Heater/ Circulating Fan(s) locations:

1. Between fan and discharge
2. Between coil and fan wall
3. Between end wall and coil.

Figure C15. CSAHU with Pressure Change Wall

C7.3 *Test Procedure.*

C7.3.1 Verify test room velocities outside the unit are no greater than 100 ft/min within one foot of the test sample.

C7.3.2 Energize heaters and circulating fans. Monitor air temperatures at all ~~thermocouples~~ temperature measuring devices and adjust the heaters until the mean internal temperature is, at minimum, 30ºF higher than the mean external air temperature. The mean internal temperature should not exceed 120°F. The manufacturer shall specify the maximum temperature for testing if the product has a lower maximum allowable internal temperature than 120° F.

C7.3.3 The test condition is stable when the following conditions are met for 30 minutes of continuous data taken at intervals of no more than 10 seconds:

C7.3.3.1 The internal air temperature is uniform when the standard deviation is ≤ 2°F and no individual ~~thermocouple~~ temperature measuring device temperature is ≥ ± 3°F from the average throughout the unit
C7.3.3.2 The mean internal air temperature is ≥ 30°F higher than the external air temperature
C7.3.3.3 The mean internal air temperature remains stable within ± 2°F
C7.3.3.4 The external air temperature is uniform when the standard deviation is ≤ 2°F and no individual ~~thermocouple~~ temperature measuring device temperature is ≥ ± 3°F from the average
C7.3.3.5 The mean external air temperature remains stable within ± 2°F.
C7.3.3.6 At any test point, the electrical input power to heater(s) and fan(s) shall be within 3% of the mean input power calculated during the test and the standard deviation is ≤ 2%.

Note: Do not place heaters close to or directly under ~~thermocouples~~ temperature measuring devices as they can influence that ~~thermocouples~~ temperature measuring devices' measurement and may not be representative of the internal air temperature. For example, install baffles and/or relocate heaters/fans, as necessary, to achieve uniform and stable conditions.

C7.4 *Measurements.*

C7.4.1 Prior to C7.3.2, record the following:

C7.4.1.1 ~~Thermocouple~~ Temperature measuring device locations
C7.4.1.2 Outside dimensions of the unit
C7.4.1.3 Outside dimensions and locations of all insulated block off plates
C7.4.1.4 Test room air velocity outside the unit

C7.4.2 Continually record the following data for 30 minutes after test conditions are stable, at intervals no greater than 10 seconds:

C7.4.2.1 ~~Thermocouple~~ Temperature measuring device temperatures
C7.4.2.2 Electrical energy input to the heater(s)
C7.4.2.3 Electrical energy input to the circulating fan(s)

C7.5 *Calculation of Results.*

C7.5.1 Calculate gross unit surface area, total surface area of any insulated block off plates and net area.

$$A_{gross} = 2(H \cdot W) + 2(H \cdot L) + 2(W \cdot L) \quad \text{C9}$$

$$A_{net} = A_{gross} - A_{block\ off} \quad \text{C10}$$

C7.5.2 Calculate energy input from the circulating fan(s) and inside the unit heater(s) and convert the electrical energy to thermal energy Btu/hr.

$$kW_{in} = kW_{heater(s)} + kW_{circulating\ fan(s)} \quad \text{C11}$$

$q_{in} = 3412.14 \times kW_{in}$ C11a

Where:

kW_{in} = Overall electrical energy, kW
$kW_{heaters(s)}$ = Electrical energy input of the heaters, kW
$kW_{circulating\ fans(s)}$ = Electrical energy input of the circulating fans, kW
q_{in} = Thermal energy, Btu/hr

C7.5.3 Calculate the net unit leakage air flow by subtracting the mean pre and post-test tester leakage from the test measured gross leakage per C6.5.3. Calculate the adjusted net leakage.

$$Q_{net} = Q_{gross} - Q_{tare} \quad \text{C12}$$

$$Q_{anet} = Q_{net} \cdot \left(\frac{P_m}{P_r}\right)^{-0.65} \quad \text{C13}$$

Where:

Q_{anet} = adjusted net unit leakage(normalized to 1.0 in. H_2O) , cfm

C7.5.4 Calculate the net leakage air energy content, Btu/hr.

$$q_l = 60 \cdot \rho \cdot C_p \cdot Q_{anet} \cdot (T_{ae}T_{ai} - T_{ai}T_{ae}) \quad \text{C14}$$

Where:

q_l = energy content of the net leakage air, Btu/hr
ρ= Air density at test conditions, lbm/ft^3
C_p = Heat capacity of air at test conditions, Btu/lbm/°F
T_{ae} = mean external dry bulb Air Temperature, °F
T_{ai} = mean internal dry bulb Air Temperature, °F

C7.5.5 Calculate the Thermal Transmittance with leakage.

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

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

Where:

q_{tl} = total thermal energy with leakage, Btu/hr
U = Thermal Transmittance, Btu/hr/°F/ft^2

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, Btu/hr
U = Thermal Transmittance, Btu/hr/°F/ft^2

C7.6 *Rating Class.* Use the calculated U from the testing to determine the rating class. Refer to Table 3, Section 6.5.

C8. *Air-handling Unit Case Thermal Bridging Testing.*

C8.1 *Test Method.*

C8.1.1 This test will measure the inside air temperature, the external air temperature and the unit exterior surface temperature downstream of the cooling coil, in order to determine the value and location of the minimum temperature difference between the casing exterior surface downstream of the coil and the mean inside unit air temperature.

C8.1.2 The test shall be performed ~~at nominal 350 ± 50 ft/min calculated internal air velocity provided by the inside circulating fans~~ with the same circulating fans used for the thermal transmittance test.

C8.1.3 The mean internal air temperature shall be a minimum of 30°F higher than the mean external air temperature but should not exceed 120 ° F. The manufacturer shall specify the maximum temperature for testing if the product has a lower maximum temperature than 120°F.

C8.2 *Test Apparatus.* The test apparatus is the same as defined in section C7.2.

C8.2.1 Identify potential areas where thermal bridging occurs (critical thermal bridging locations). Location(s) of potential thermal bridging may be identified during/after completion of the Thermal Transmittance testing. Suggested methods to locate critical thermal bridging areas include:

C8.2.1.1 Dry method - Operate the test set-up with internal air temperature elevated above the external air temperature (suggest 30°F minimum) and survey the unit using thermal imaging or other temperature survey methodology.

C8.2.1.2 Wet method – Operate the test set-up with reduced internal air temperature and warm, humid external air (internal temperature lower than external air dew point temperature) to achieve condensation formation on the exterior of the unit.

Notes: If using the wet method, dry off unit before installing ~~thermocouples~~ temperature measuring devices and conducting hot thermal bridging test.

C8.2.2 Meeting class CB_0 requires screw head (including any washer) and fasteners to be included as potential critical thermal bridging locations. For Thermal Bridging Classes CB1 through CB5, screw heads (including any washer) and fasteners shall be excluded from consideration as long as their total area is less than 1% of the total unit surface area. However, any individual screw head (including any washer) or fastener larger than 0.5 in^2 shall be measured and shall not be excluded.

C8.2.3 Internal and external air temperatures shall be determined using the same ~~thermocouple~~ temperature measuring device arrangement as used for the thermal transmittance testing as defined in Section C7.2 and Figure C6. Verify that the ~~thermocouples~~ temperature measuring devices are securely installed so that any impinging airflow does not appreciably change their location or function.

C8.2.4 Install surface mounted ~~thermocouples~~ temperature measuring devices on the external surface of the unit at all the identified potential thermal bridging locations.

C8.3 *Test Procedure.*

C8.3.1 Verify test room velocities outside the unit are no greater than 100 ft/min within one foot of the test sample.

C8.3.2 Energize heaters and circulating fans. Monitor air temperatures at all ~~thermocouples~~ temperature measuring devices and adjust the heaters input and fan locations, if needed, until the mean internal temperature is, at minimum, 30ºF higher than the mean external air temperature but the internal temperature should not exceed 120°F. The manufacturer shall specify the maximum temperature for testing if the product has a lower maximum allowable internal temperature than 120°F.

C8.3.3 The test condition is stable when the following conditions are met for 30 minutes of continuous data taken at intervals of no more than 10 seconds:

C8.3.3.1 The internal air temperature is uniform when the standard deviation is ≤ 2°F and no individual ~~thermocouple~~ temperature measuring device temperature is ≥ ± 3°F from the average throughout the unit
C8.3.3.2 The mean internal air temperature is ≥ 30°F higher than the external air temperature
C8.3.3.3 The mean internal air temperature remains stable within ±2°F
C8.3.3.4 The external air temperature is uniform when the standard deviation is ≤ 2°F and no individual ~~thermocouple~~ temperature measuring device temperature is ≥ ± 3°F from the average
C8.3.3.5 The mean external air temperature remains stable within ± 2°F.
C8.3.3.6 The thermal bridging temperatures remain stable within ± 2°F.
C8.3.3.7 At any test point, the electrical input power to heater(s) and fan(s) shall be within 3% of the mean input power calculated during the test and the standard deviation is ≥ 2%.

C8.4 *Measurements.*

C8.4.1 Prior to energizing the circulating fans and internal heaters, record the following:

C8.4.1.1 Thermal bridging surface ~~thermocouple~~ temperature measuring device locations
C8.4.1.2 Test room air velocity outside the unit

C8.4.2 Continually record the following for 30 minutes after test conditions are stable, at intervals no greater than 10 seconds:

C8.4.2.1 ~~Thermocouple~~ Temperature measuring device temperatures

C8.5 *Calculation of Results.*

C8.5.1 Calculate mean internal and external air temperatures.

C8.5.2 Calculate thermal bridging factor, k_b.

$$k_b = \frac{T_{ai} - T_{so}}{T_{ai} - T_{ae}} \qquad \text{C17}$$

Where:

T_{ai} = mean internal dry − bulb air temperature , °F
T_{ae} = mean external dry − bulb air temperature, °F
T_{so} = casing external surface temperature at bridging location , °F

C8.6 *Rating Class.* Use the minimum calculated k_b from the testing to determine the rating class. Refer to Table 4, Section 6.6.