

Air-Handling Unit Casings

Method of Test, Rating Standard, Certification Program
Why it matters



we make life better™

Learning Objectives

- **AHRI Standards 1350 (I-P) and 1351 (SI), *Mechanical Performance Rating of Central Station Air-handling Unit Casings***
 - Scope
 - Ratings
 - Method of Test
- **Central Station Air-handling Unit Casings (AHUC) Certification Program**
 - Annual testing
 - Real units
 - Optional thermal certification
 - Unit inspection

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Scope

- The enclosure which houses the fans, coils, filters, and other components of the CSAHU. Generally made of metal and lined, as necessary, with material for thermal insulation and/or acoustic attenuation. Contains the air that is being conditioned, is exposed to the fan pressure, and separates the conditioned air from the surrounding air. Also called the CSAHU cabinet.

➤ Scope Exclusions

- Unitary Small Equipment and Unitary Large Equipment
- Direct expansion dedicated outdoor air system units
- CSAHU's designed to only operate with internal casing pressure between -1 in. H₂O and 1 in. H₂O [-250 Pa and 250 Pa]

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Establishes:

- definitions;
- classifications;
- test requirements;
- rating requirements;
- minimum data requirements for Published Ratings;
- marking and nameplate data;

➤ Allows for equal comparisons of AHU Casings based on a standardized method of test.

➤ From a single tested unit, 5 ratings are derived

AHRI Standards 1350 (I-P) and 1351(SI)

➤ The 5 ratings derived:

- Casing Air Leakage Class
- Casing Deflection Rating Class
- Thermal Bridging Class
- Thermal Transmittance Class
 - With and Without Leakage

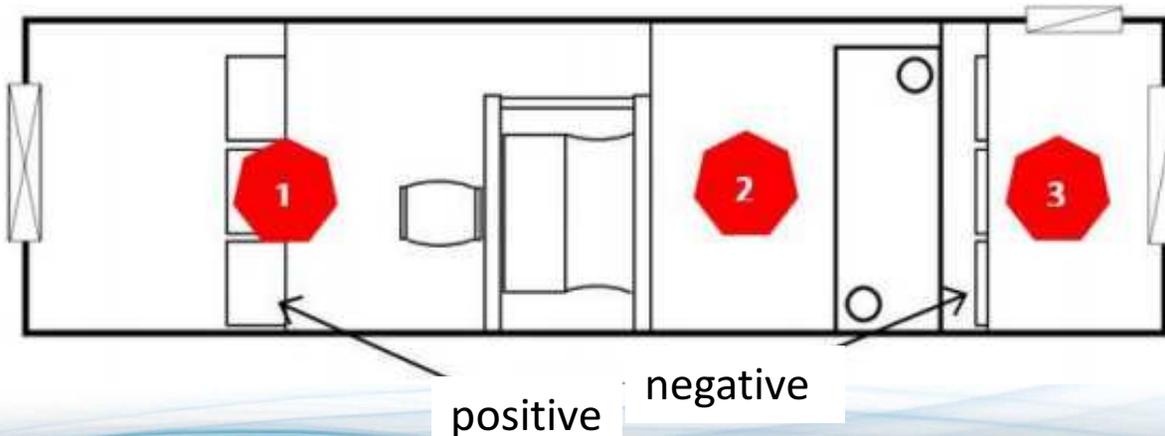
AHRI Standards 1350 (I-P) and 1351(SI)

➤ Casing Air Leakage Rate

- The air flow leaking through the casing of a Central Station Air-handling Unit per 100 square feet [10 m²] of Casing Surface Area, cfm/100 ft² [L/s/10 m²]

➤ Leakage Class

- The rating class designation that defines the maximum expected air flow leakage, cfm/100 ft² [L/s/10 m²], of the CSAHU casing operating within the interior pressure conditions specified for the total casing surface area
- Negative and positive



AHRI Standards 1350 (I-P) and 1351(SI)

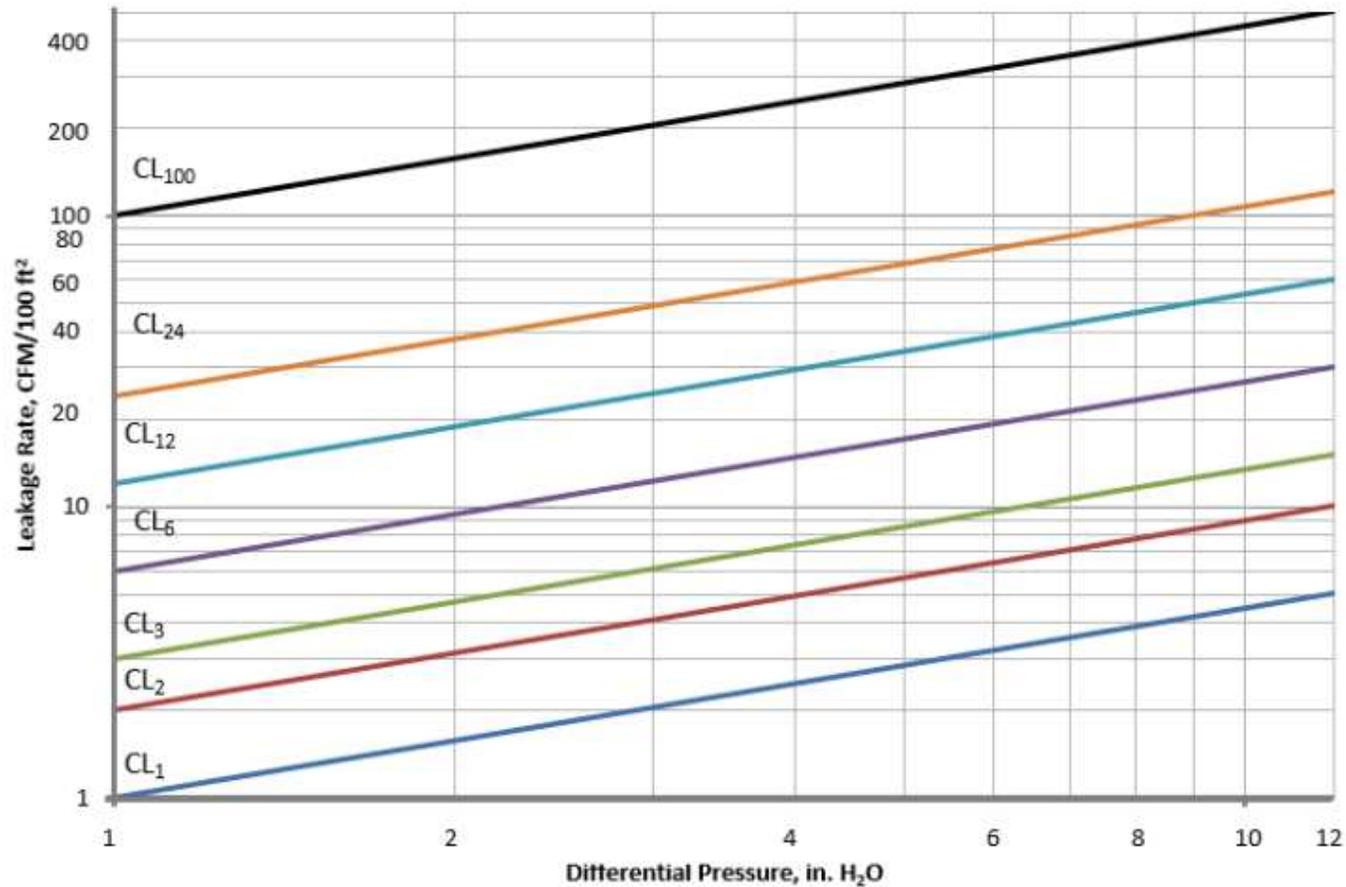
➤ Casing Air Leakage Rate

Class - Leakage, CL_x	Maximum Casing Air Leakage Rate, CL_r , cfm/100 ft ² (at $P_r = 1$ in H ₂ O)
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.

AHRI Standards 1350 (I-P) and 1351(SI)



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

Where:

CL = Casing Air Leakage Rate, CFM/100ft²

CL_m = Measured leakage, CFM/100ft² at P_m

P_m = Absolute value of test differential pressure, in. H₂O

P_r = Reference pressure, 1.0 in. H₂O

Figure 1. Casing Air Leakage Rating Class Chart

AHRI Standards 1350 (I-P) and 1351(SI)

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

Where:

Class - Leakage, CL _x	Maximum Casing Air Leakage Rate, CL _r , cfm/100 ft ² (at P _r = 1 in H ₂ O)
CL ₁	1
CL ₂	2
CL ₃	3
CL ₆	6
CL ₁₂	12
CL ₂₄	24
CL ₁₀₀	100

CL = Casing Air Leakage Rate, CFM/100ft²

CL_m = Measured leakage, CFM/100ft² at P_m

P_m = Absolute value of test differential pressure, in. H₂O

P_r = Reference pressure, 1.0 in. H₂O

$$CL = CL_m \cdot \frac{P_m^{-0.65}}{P_r} = 9 \cdot \left(\frac{4^{-0.65}}{1}\right) = 9 \cdot 0.406 = 3.65 = CL_6$$

$$CL = CL_m \cdot \frac{P_m^{-0.65}}{P_r} = 9 \cdot \left(\frac{6^{-0.65}}{1}\right) = 9 \cdot 0.312 = 2.81 = CL_3$$

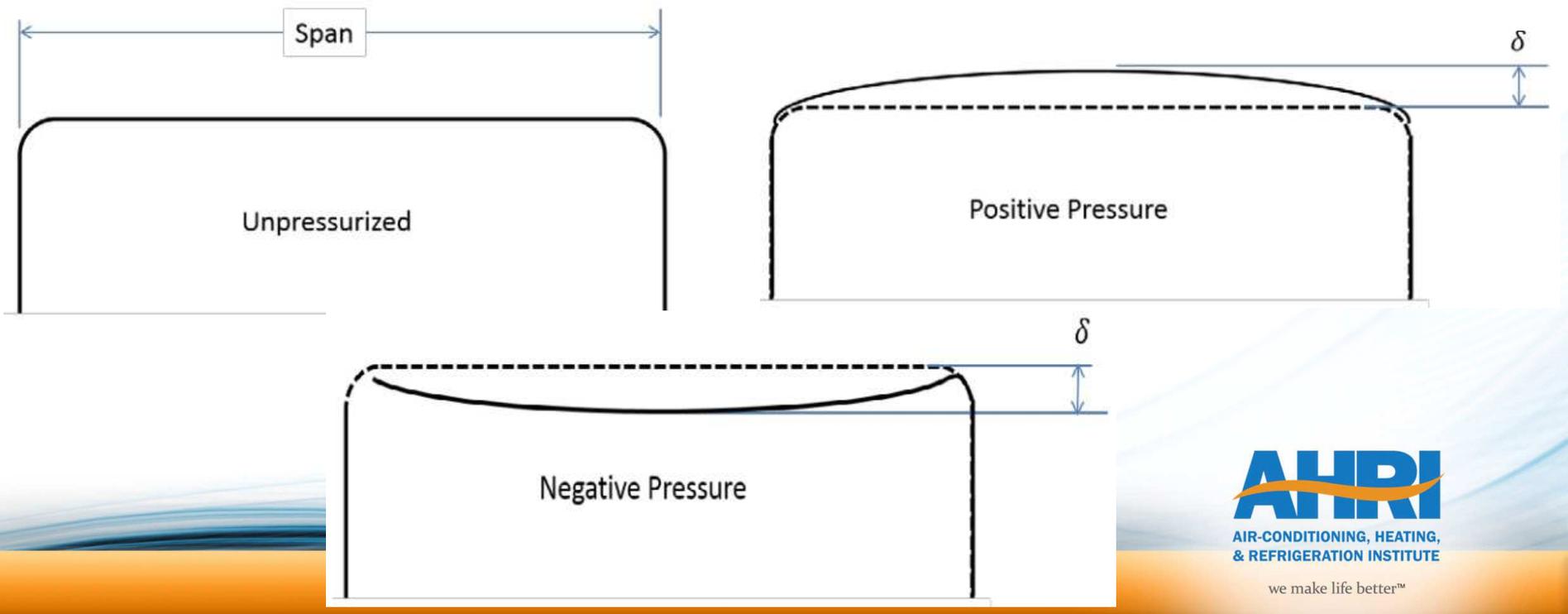
AHRI Standards 1350 (I-P) and 1351(SI)

➤ 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. [mm]

➤ Deflection Class

- The rating class designation defined by the CSAHU's Maximum Normalized Deflection at the corresponding Rating Differential Static Pressure.



AHRI Standards 1350 (I-P) and 1351(SI)

Table 1. Casing Deflection Rating Class

Class Deflection, CD _x	Rating Differential Static Pressure, in H ₂ O	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	≥ 0.0042 (1/240)

➤ Rating Differential Static Pressure

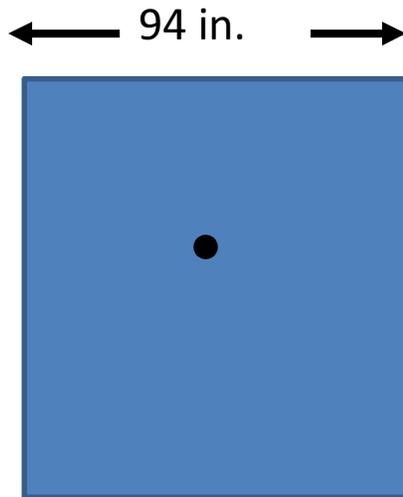
- The differential static pressure required for determining Deflection Class, in H₂O [Pa].

➤ 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.

AHRI Standards 1350 (I-P) and 1351(SI)

	0 min.	5 min.	10 min	15 min	Avg.
Pressure (P_i), in H ₂ O	8.02	8.03	8.01	8.03	8.02
Deflection at Maximum Deflection Point, inches	0.3857	0.3861	0.3862	0.3855	0.3859



$$\delta_{net} = \bar{\delta} - \delta_{baseline}$$

$$\bar{\delta} = \delta_{avg} = 0.3859$$

$$\delta_{baseline} = \frac{\delta_{start} + \delta_{final}}{2}$$

$$\delta_{baseline} = \frac{0.0045 + 0.0049}{2} = 0.0047$$

$$\delta_{net} = \bar{\delta} - \delta_{baseline} = 0.3859 - 0.0047 = 0.3812$$

$$\delta_{nd} = \frac{\delta_{net}}{l_{span}} = \frac{0.3812}{94} = .004055 \frac{in}{in}$$

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Thermal Bridge

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



➤ Thermal Bridging Factor

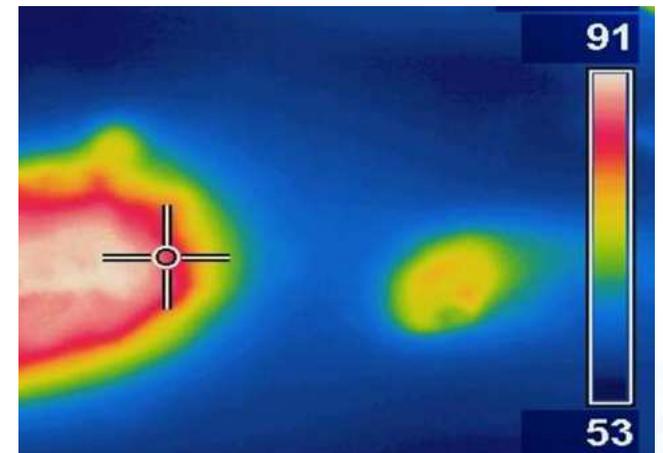
$$k_b = \frac{T_{ai} - T_{so}}{T_{ai} - T_{ae}}$$

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



➤ Thermal Bridging Class

- The rating designation class that defines the Thermal Bridging Factor.

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Thermal Bridging Class

Table 4. Casing Thermal Bridging Rating Class^{1,2,3}

Class - Thermal Bridging, CB _x	Thermal Bridging Factor, k _b
CB ₀	k _b ≥ 0.8
CB ₁	k _b ≥ 0.8
CB ₂	0.8 > k _b ≥ 0.60
CB ₃	0.60 > k _b ≥ 0.40
CB ₄	0.40 > k _b ≥ 0.20
CB ₅	k _b < 0.20

Notes:

1. Meeting Thermal Bridging Class CB₀ requires screw heads (including any washers) and fasteners to be included as potential critical thermal bridging locations.
2. For Thermal Bridging Classes CB₁ through CB₅, 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 in² 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.

AHRI Standards 1350 (I-P) and 1351(SI)

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

Where:

T_{ai} = Mean internal drybulb air temperature , °F

T_{ae} = Mean external (ambient) drybulb air temperature, °F

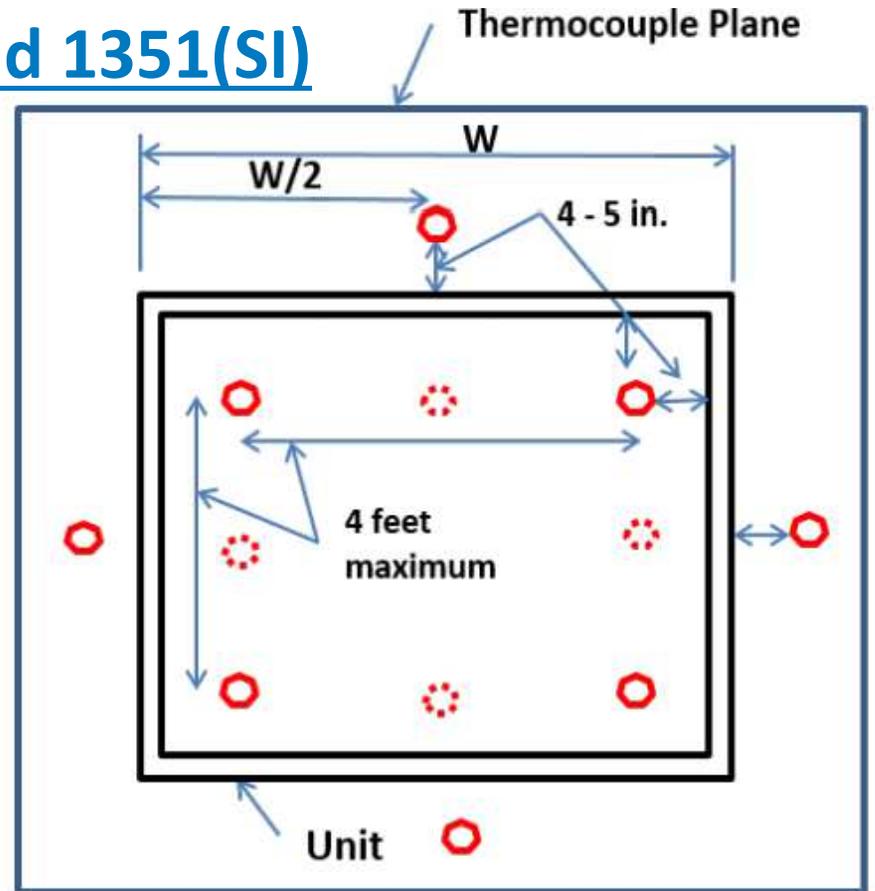
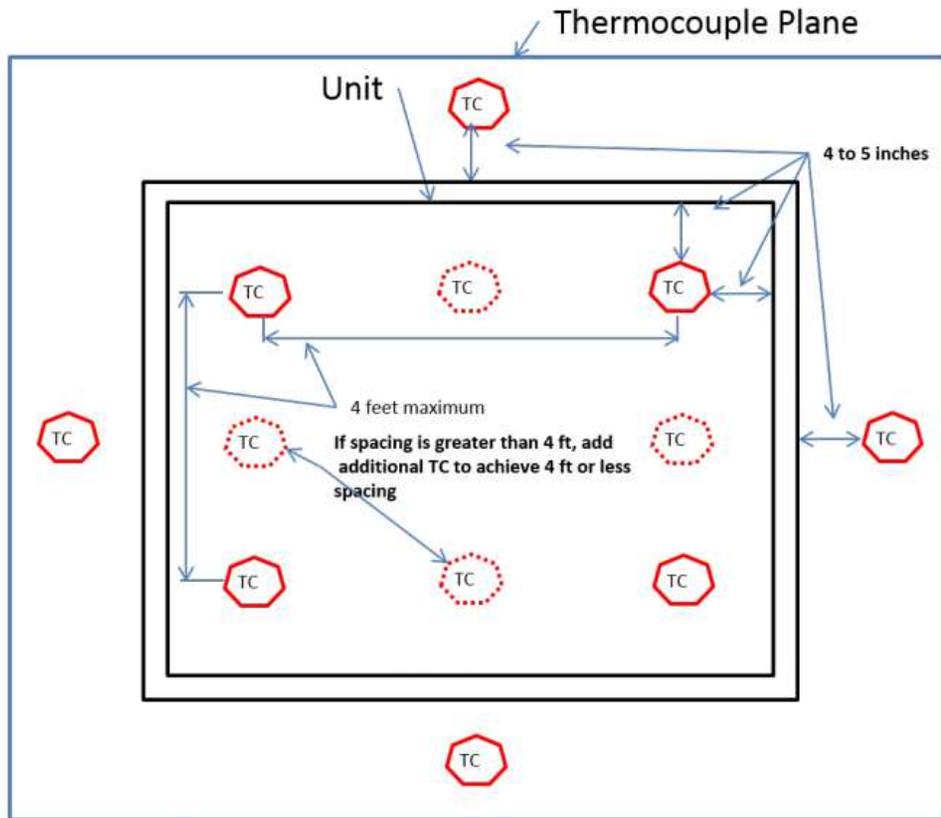
T_{so} = Casing external surface temperature at the location of Thermal Bridge , °F

$$k_b = \frac{T_{ai} - T_{so}}{T_{ai} - T_{ae}} = \frac{106 - 83}{106 - 70} = 0.6388 = CB_2$$

$$k_b = \frac{T_{ai} - T_{so}}{T_{ai} - T_{ae}} = \frac{106 - 77}{106 - 70} = 0.8055 = CB_1 \text{ or } CB_0$$

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Thermal Testing – Test-set-up

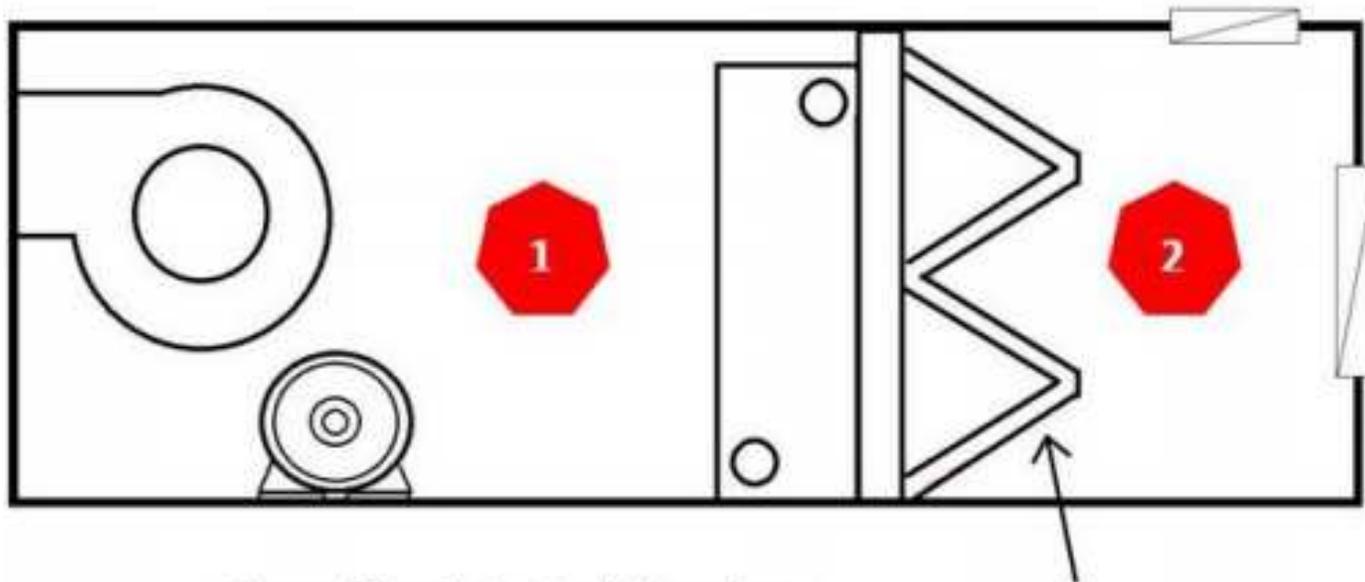


If inside TC (○) spacing is greater than 4 ft, add additional TC (⊙) to achieve 4 ft or less spacing

Figure C10. Thermocouple locations – End View

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Thermal Testing – Test-set-up



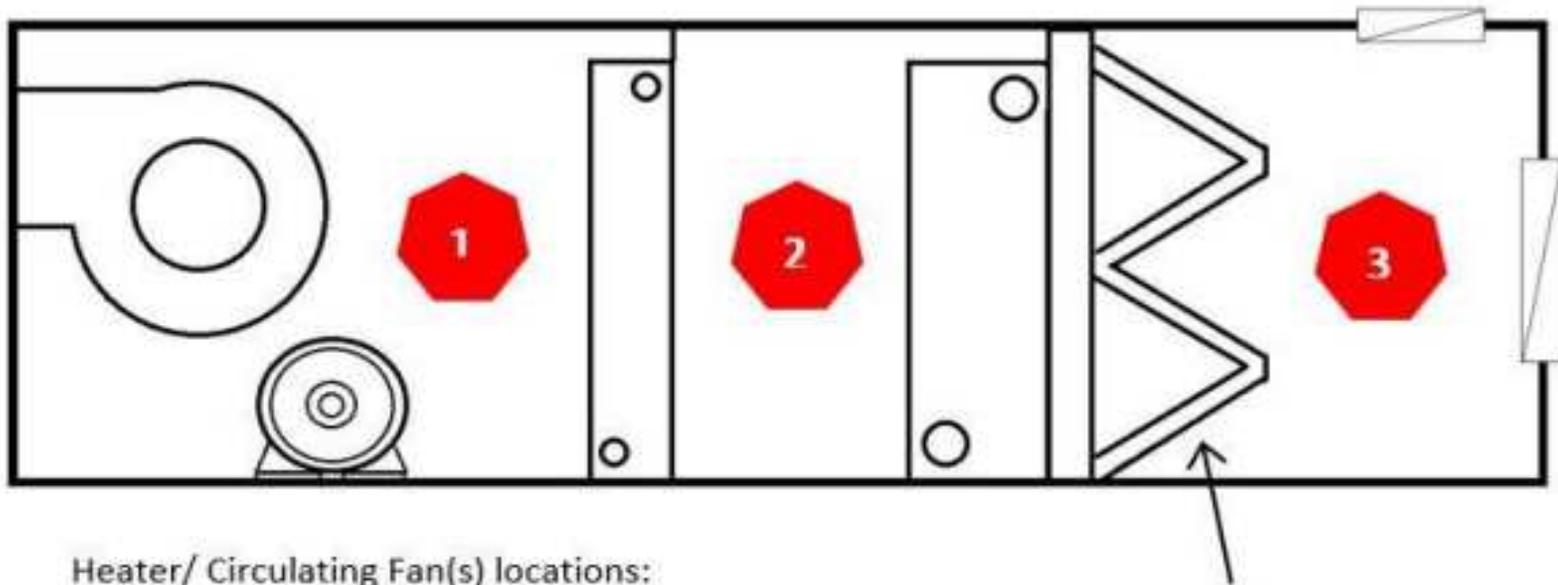
Heater/Circulating Fan(s) locations:

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

Remove filters

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Thermal Testing – Test-set-up



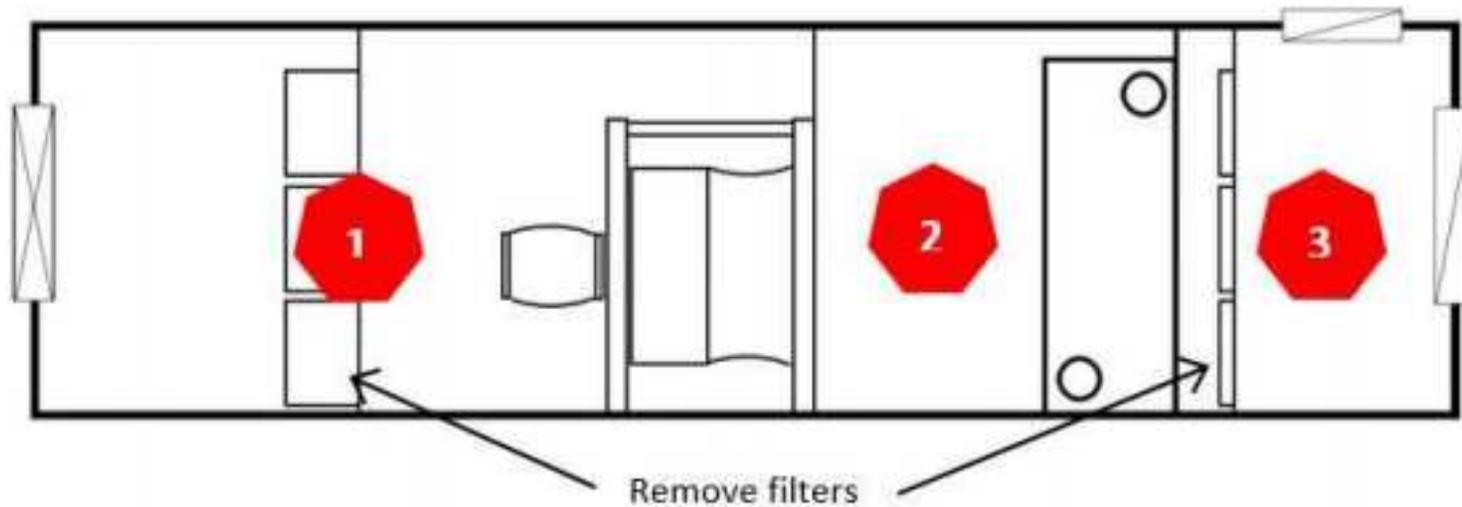
Heater/ Circulating Fan(s) locations:

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

Remove filters

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Thermal Testing – Test-set-up



Heater/ Circulating Fan(s) locations:

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

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Thermal Transmittance

- The rate at which thermal energy is transmitted through the casing with or without air leakage, Btu/h/ft²/°F [W/m²·K]. (Also known as the U-value.)

➤ Thermal Transmittance Class

- The rating designation class that defines the maximum rate at which energy, Btu/h/ft²/°F [W/m²·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.

AHRI Standards 1350 (I-P) and 1351(SI)

➤ Thermal Transmittance

Table 3. Casing Thermal Transmittance Rating Class¹

Class - Thermal Transmittance, CT_x	Thermal Transmittance without Leakage (U), Btu/hr/ft ² /°F	Thermal Transmittance with Leakage (U), Btu/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.

AHRI Standards 1350 (I-P) and 1351(SI)

The unit has a total surface area (excluding block-off panels) of 140 ft² (A_{net}) and the measured leakage is 17.1 cfm (Q_{anet}) and the power input for the heaters is 0.19 kW and 0.37 kW for the circulating fans.

$$q_{in} = 3412.14 \cdot kW_{in} = 3412.14 \cdot (kW_{heaters} + kW_{circ. fan(s)}) = 3412.14 \cdot (0.19 + .37) = 1910.7984$$

$$q_l = 60 \cdot \rho \cdot C_p \cdot Q_{anet} \cdot (T_{ai} - T_{ae}) = 60 \cdot 0.076 \cdot 0.241 \cdot 17.1 \cdot (106 - 68) = 741.104$$

$$q_{tl} = q_{in} + q_l = 1910.7984 + 741.104 = 2651.9024$$

$$U_{with\ leakage} = \frac{q_{tl}}{A_{net}(T_{ai} - T_{ae})} = \frac{2651.9024}{140(113 - 66)} = 0.40302 = CT_4$$

$$U_{without\ leakage} = \frac{q_{in}}{A_{net}(T_{ai} - T_{ae})} = \frac{1910.7984}{140(113 - 66)} = 0.2904 = CT_3$$

AHRI Standards 1350 (I-P) and 1351(SI)

➤ 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.

AHRI Standards 1350 (I-P) and 1351(SI)

- **AHRI Standards 1350 and 1351 are available on AHRI's website**
 - As with all AHRI standards, they are available to download at no cost
 - The download of 1350 or 1351 includes the entire method of test

Rated

- Conforms to standard
- Subject to rigorous and continuous testing
- Manufacturers' performance ratings independently measured
- Third-party verified
- All products within program scope certified
- Provides marketplace clarity

AHRI-Certified®

- Conforms to standard
- Subject to rigorous and continuous testing
- Manufacturers' performance ratings independently measured
- Third-party verified
- All products within program scope certified
- Provides marketplace clarity

Why Choose AHRI-Certified Products

- **Foremost globally recognized HVACR & water heating certification program**
- **Voluntary program**
- **Qualification is lengthy and rigorous**
- **400+ participants across all program**
 - 600 Licensees
 - Including 58 International Licensees from 16 countries
- **2,500 independent laboratory tests annually**
- **Accredited by Standards Council of Canada (SCC)**



we make life better™

Why You Can Trust AHRI

- **AHRI contracts with a third-party lab to conduct all tests**
- **Products are randomly selected for testing**
- **Operation Manuals dictate strict procedure for administration of the certification program**
- **AHRI Directory is recognized by government agencies**
 - EPA (Environmental Protection Agency)
 - DOE (U.S. Department of Energy)
 - FTC (Federal Trade Commission)
 - NRCan (Natural Resources Canada)
 - CEC (California Energy Commission)

Third-party Verification

- **Manufacturer performance ratings verified by a third-party laboratory**
- **Holds manufacturers accountable**
- **Provides consumers with confidence in performance of the product**

AHUC Certification Program

- **A Participant's listing shall be grouped by BMG. At a minimum, a BMG is a regular range of units having the construction and similar geometry parameters and no more than two (2) classes in any singular rating class (i.e. CD1 and CD2) as stated below:**
- **Similar wall construction**
 - Single Wall
 - Frame and/or Panel construction variations (i.e. 2' center to center distances)
 - Double Wall
 - Frame and/or Panel construction variations
 - Similar insulation thickness and type (i.e. 2" fiberglass or 4" foam)
 - Similar assembly method (i.e. similar Seam Construction, seam treatments, bracing, caulking, gasketing, etc.)

Qualification Process

➤ **Application Submittals**

- Application is separately applied to each Certification Program
- Ratings provided for all models (Certify All)

➤ **Testing**

- 20% Basic Model Groups are tested
- Conducted by a 3rd party lab (not AHRI)
- Laboratories in the US and Asia

Qualification Process

➤ Sample Inspection

In Compliance? Y/N	Description	Comments
	All test sample piece parts match the documents including material and thickness.	
	All test sample gaskets and caulking are shown on the documents, as applicable.	
	Fastener center to center distances are within the range shown on the documents.	
	All test sample welds, supports and stiffeners are shown on the documents, as applicable.	
	All test sample door hinges, latches and gaskets match the documents, as applicable.	
	All test sample thermal breaks are shown on the documents, if applicable.	
	The material type and thickness of the casing matches the documents.	
	The insulation type and thickness matches the documents.	

How to Join the Central Station Air-handling Unit Casings (AHUC) Certification Program

➤ **Step 1: Certification Application Package**

- A. AHRI sends Interest Letter to OEM:
 - Application for AHRI Certification (certification & billing contact form)
 - Annual Sales Volume form
 - Product-specific data submittal sheets
 - One test report for every BMG or Basic Model subject to certification.
 - Witness Facility Approval paperwork (if applicable)
 - Selection software programs (in lieu of paper catalog)
- B. AHRI receives completed documentation within 60 calendar days and sends confirmation.

➤ **Step 2: Processing Application Package**

- A. AHRI sends Participation and License Agreement for OEMs
- B. AHRI sends Participation and License Fee Invoice



we make life better™

How to Join the Central Station Air-handling Unit Casings (AHUC) Certification Program

➤ **Step 3: Selection and Qualification Testing**

- A. AHRI sends Qualification Selection Letter
 - Acquisition of qualification test samples
 - Witness test program provisions
- B. Qualification Test Results:
 - IF QUALIFICATION TESTS PASS:
 - Proceed to step 4
 - IF QUALIFICATION TESTS FAIL:
 - AHRI will send a Manufacturer's Decision Form (MDF).
 - The applicant will have 7 calendar days to respond to AHRI with one of the following decisions:
 - » 2nd sample
 - » Re-rate
 - » Discontinue the qualification process

How to Join the Central Station Air-handling Unit Casings (AHUC) Certification Program

➤ **Step 4: Acceptance into the program**

- A. AHRI sends Welcome Letter and executed Agreement to the applicant
- B. Applicant's data will be uploaded to the AHRI Directory of Certified Product Performance

Central Station Air-handling Unit Casings (AHUC) Certification Program Participants

- **GD Midea Heating & Ventilating Equipment Co., Ltd.**



we make life better™

Central Station Air-handling Unit Casings (AHUC) Certification Program Annual Testing

- **Once the qualification process has completed, a Participant is subject to annual testing.**
 - 10% of a Participant's BMGs shall be tested annually, with a minimum of two (2) models.
 - 25% of a Participant's Annual Testing samples shall have a Sample Inspection with at least one sample verified every 2 testing years.



Importance of AHRI-certified AHU Casings

- **Third-party verification of published ratings**
- **Voluntary**
- **Failures are noted for one year**
 - Re-rates are required to consistent with tested results and must be approved by AHRI in the Participant's software/catalog.
- **Allows for equal comparisons of AHU Casings based on a standardized method of test through the AHRI Directory.**

How to Incorporate AHRI Certified Ratings

➤ Example specifications

- “Each unit shall have an AHRI-certified casing with a minimum rating class of CD₂ for deflection, CT₂ for thermal transmittance, CL₂ for leakage, and CB₂ for thermal bridging.”

Questions?



AHRI

AIR-CONDITIONING, HEATING,
& REFRIGERATION INSTITUTE

we make life better™