AHRI Standard 1410-2017 (R2024) (I-P)

Performance Rating of Commercial Finned Tube Radiation

AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

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Note:

This standard supersedes IBR Testing and Rating Standard for Finned Tube (Commercial) Radiation, Sixth Edition, July 2005

This standard was reaffirmed May 2024.

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PERFORMANCE RATING OF COMMERCIAL FINNED TUBE RADIATION

Section 1. Purpose

1.1 *Purpose*. The purpose of this standard is to establish for commercial finned tube radiation: definitions; test requirements; rating requirements; nomenclature; minimum data requirements for Published Ratings; marking and nameplate data; and conformance conditions.

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

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

Section 2. Scope

2.1 *Scope.* This standard applies to steam or water heated room heaters composed of a finned tube element fabricated from metallic tubing with a plurality of metallic fins attached to the tubing by means of a mechanical or other type bond. These heaters are designed for installation bare, or with Open Type Grilles, Covers, or Enclosures having top, front, or inclined outlets.

2.1.1 *Commercial Finned Tube Bare Element.* Commercial finned tube bare elements shall apply to elements fabricated from metallic tubing with a plurality of metallic fins attached to the tubing by means of a mechanical or other type bond.

2.1.2 *Commercial Finned Tube Assembly.* Commercial finned tube assembly shall apply to a steam or water heated commercial finned tube bare element with Open Type Grilles, Covers, or Enclosures having top, front or inclined outlets. These assemblies do not have a back panel that touches the floor.

2.1.3 *Exclusions.* This standard does not apply to the following:

2.1.3.1 Heaters that do not radiate their energy into a single measuring plane;

2.1.3.2 Residential baseboard radiation, covered by the I=B=R Testing and Rating Standard for Baseboard Radiation, and;

2.1.3.3 Convectors, which are designed only for installation in an Enclosure.

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) unless otherwise defined in this section.

3.1 *Active Length*. The length of the finned section of the finned tube element. It shall not include any piping or connections beyond the heating element.

3.2 *AHRI Steam Rating.* The Condensation Capacity of the finned tube at AHRI Standard Rating Conditions, plus an added Heating Effect, which is dependent on the installation height and type of installation. AHRI Steam Ratings are expressed in Btu per hour per linear foot of Active Length (Btu/h·ft), and also may be expressed in Square Feet of Steam per Linear Foot of Active Length.

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3.3 *Commercial Finned Tube Radiation*. A steam or water heated room heater composed of a finned tube element fabricated from metallic tubing with a plurality of metallic fins attached to the tubing by means of a mechanical or other type of bond. The Commercial Finned Tube is designed for bare installation, or with Open Type Grilles, covers, or enclosures having top, front or inclined outlets. A Commercial Finned Tube does not include room heaters having this type of heating element which are designed with Enclosures to replace baseboards covered by the AHRI Testing and Rating Standard for Baseboard Radiation. A Commercial Finned Tube does not include room heaters, commonly called "convectors", which are designed exclusively for installation in an Enclosure.

3.4 *Condensation Capacity*. The total heat output of the unit divided by the Active Length of the unit, expressed in Btu/h·ft.

3.5 *Cover*. A shield fabricated with at least a portion of the front skirt composed of non-perforated solid material, mounted on the finned tube element so that there is clearance between the wall and the Cover, and the rear of the finned tube element is not completely enclosed by the Cover. A Cover may have a top, front, or inclined outlet.

3.6 *Convector*. A heat-distributing unit that operates with gravity circulated air (natural convection). It has a heating element with a large amount of secondary surface and contains two or more tubes (at the same elevation) with headers at both ends. The heating element is surrounded by an Enclosure with an air inlet below and an air outlet above the heating element.

3.7 *Enclosure*. A shield fabricated of solid material installed so that the finned tube element is completely enclosed at both front and rear. An Enclosure may have an integral back and shall not touch the floor, or may be installed tightly against the wall so that the wall itself becomes the back. An Enclosure may have a top, front or inclined outlet.

3.8 *Heating Effect.* Reflects the ability of the unit to direct its heat output to the occupied zone of a room. The application of a Heating Effect factor implies that some units use less steam or hot water than others to produce an equal comfort effect in a room.

3.9 *Installed Height*. The vertical distance of the Commercial Finned Tube (Figure C6, Dimension E), as recommended by the manufacturer, measured at mid-length (at the middle of the Active Length), as defined in Figure C7.

3.10 *Open Type Grille*. The shield fabricated of expanded metal or perforated materials, which covers the top and front of the finned tube element. It does not apply to any Cover or Enclosure which has a solid front panel, or skirt, which provides a stack effect for the air flowing over the element.

3.11 *Output Heating Capacity*. The rate of useful heat output when operating under steady-state conditions.

3.12 *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. These values apply to all units of like nominal size and type (identification) produced by the same manufacturer. 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.

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

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

3.13 *Rating Conditions.* Any set of operating conditions under which a single level of performance results and which causes only that level of performance to occur.

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

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3.14 *Square Feet of Steam per Linear Foot of Active Length.* Is a unit of measurement of power or heat flow rate based on the Active Length of the radiator.

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

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

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

3.16 *Total Length*. Total Length is the overall length of the Commercial Finned Tube or Enclosure, excluding boxes added to the ends of the unit to conceal pipe connections and valves.

Section 4. Test Requirements

4.1 *Test Requirements.* Published Ratings shall be verified by tests conducted in accordance with the test method described in Appendix C and in accordance with the rating requirements of Section 5.

Section 5. Rating Requirements

5.1 *Standard Ratings*. Standard Ratings shall be established at the Standard Rating Conditions specified in Section 5.2.

5.2 *Standard Rating Conditions.* The conditions of test for Standard Ratings shall be established at the Standard Rating Conditions specified in Table 1.

Table 1. Conditions for Standard Rating Tests

Unit Rating	Air Temperature, °F	Saturated Steam Temperature, °F
Steam Output Heating Capacity, Btu/h·ft	65	215

5.2.1 *Barometric Pressure.* All tested ratings shall be corrected to standard atmospheric pressure of 29.92 in Hg.

5.3 *Rounding Requirements.* The Published Rating shall be rounded to the nearest 10 Btu/h·ft of the Output Heating Capacity calculated in accordance with Appendix C.

5.4 *Heating Effect*. A Heating Effect (HE) shall be added to the steam output heating capacity. The Heating Effect shall be calculated as follows:

5.4.1 *Heating Effect for Installed Height Less than 36 in.* If the Installed Height of a finned tube unit is less than 36 in, the following maximum percentages may be added to the Condensation Capacity For Standard Rating Conditions (H_s).

5.4.1.1 *Bare Elements, Open Type Grille or Cover Heating Effect.* For a finned tube unit installed bare or in an Open Type Grille or a Cover, the maximum percentages which may be added shall be taken from Table 2.

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Table 2. Heating Effect (HE) Calculation Table of Maximum Addition to Capacity Percentages	
Installed Height, in	**Maximum Addition to Capacity Percentages, %**
36 or more	0
34	1
32	2
30	3
29	4
28	5
27	6
26	7
25	8
24	9
23	10
22	11
21	12
20	13
19	14
18 or less	15

5.4.1.2 *Front Outlet Enclosure Heating Effect.* For a front outlet Enclosure, the maximum percentages which may be added shall be determined per Table 2.

5.4.1.3 *Inclined Outlet Enclosure Heating Effect.* For an inclined outlet Enclosure, the maximum percentage shall be the percentage shown in Table 2, multiplied by x, where:

$$x = \frac{Angle\ of\ outlet\ to\ horizontal}{90} \quad (1)$$

where:

x = Maximum Heating Effect Percentage, %

5.4.1.2 *Top Outlet Enclosure Installations.* For a top outlet Enclosure, no additions shall be made to the Condensation Capacity.

5.4.2 *Heating Effect for Installed Height 36 in or Greater.* If the Installed Height of a finned tube unit is 36 in or greater, no addition shall be made to the Condensation Capacity for standard rating conditions (H_s).

5.4.3 *Output Heating Capacity.* The Output Heating Capacity (H_{out}) is determined by adding the Heating Effect to the Condensation Capacity for standard rating conditions (H_s).

$$H_{Out} = H_s\ (1 + HE) \quad (2)$$

where:

HE = Heating Effect, %
H_{out} = Output Heating Capacity, Btu/h·ft
H_s = Condensation capacity for standard rating conditions, Btu/h·ft

Section 6. Nomenclature

6.1 *Nomenclature*. All symbols and variables used in the standard are defined as shown in Table 3.

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Table 3. Nomenclature		
Symbol	**Title**	**Unit**
C_b	Correction Factor for Barometric Pressure	-
C_{exp}	Expanded Metal Cover Factor	-
C_s	Correction Factor for Steam and Air Temperature	-
G_{area}	Free area of the grille	in^2/ft
H_c	Condensation Capacity	Btu/h·ft
HE	Heating Effect	%
H_{exp}	Heating Capacity of an Expanded Metal Cover	Btu/h·ft
h_{fg}	Latent Heat of Steam	Btu/lb
H_{out}	Output Heating Capacity	Btu/h·ft
H_s	Condensation Capacity for Standard Rating Conditions	Btu/h·ft
L_a	Active Length of Finned Tube Unit	ft
L_c	Length of Permanent Condensate Piping	in
L_{sp}	Length of Substitute Piping	in
P_b	Barometric pressure	in Hg
P_s	Absolute Steam Pressure	in Hg or psia
R_1	Ratio of free area of the grille to the projected area of the fins	-
R_g	Gross Condensation Rate	lb/h
R_{net}	Net Condensation Rate	lb/h
R_{nl}	Condensation Rate under No-Load Correction	lb/h
t	Duration of Test	h
T_a	Air Temperature	°F
T_{s1}	Saturated Steam Temperature Corresponding to Pressure	°F
T_{s2}	Supply Steam Superheat Temperature	°F
T_{s3}	Steam Supply Temperature	°F
W_c	Total Weight of Condensate During Test	lb

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 AHRI Standard 1410". All claims to ratings outside the scope of this standard shall include the statement "Outside the scope of AHRI Standard 1410". Wherever Application Ratings are published or printed, they shall include a statement of the conditions at which the ratings apply.

The following shall be reported for each appropriate model(s):

7.1.1 Model number
7.1.2 Fin size
7.1.3 Fin thickness
7.1.4 Fin finish

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7.1.5 Fin material
7.1.6 Fins per foot
7.1.7 Nominal tube diameter
7.1.8 Tube material
7.1.9 Installed height

Section 8. Marking and Nameplate Data

8.1 *Marking and Nameplate Data*. This product does not carry a nameplate.

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 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.

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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 this standard.

A1.1 ASHRAE Terminology, https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology, 2017, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, USA

APPENDIX B. REFERENCES – INFORMATIVE

B1 Listed here are standards, handbooks and other publications which may provide useful information and background but are not considered essential. References in this appendix are not considered part of the standard.

B1.1 *ASHRAE Systems and Equipment Handbook, Chapter 46, Pipes, Tubes and Fittings*, 2016, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, USA.

B1.2 *ASHRAE Systems and Equipment Handbook, Chapter 36, Hydronic Heat-Distributing Units and Radiators*, 2016, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, USA.

B1.3 J. H. Keenan, F. G. Keyes, P. G. Hill, and J. G. Moore, *Steam Tables — Thermodynamic Properties of Water Including Vapor, Liquid, and Solid Phases*, Wiley, New York, 1969.

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APPENDIX C. METHOD OF TESTING FOR PERFORMANCE RATING OF COMMERCIAL FINNED TUBE RADIATION - NORMATIVE

C1 *Purpose*. The purpose of this appendix is to provide a method of testing for obtaining the steam output heating capacity of a Commercial Finned Tube under Standard Rating Conditions.

C2 *Scope.* Refer to Section 2 of the standard.

C3 *Test Equipment.*

C3.1 *Test Room.* Tests shall be conducted in a warm-wall booth.

C3.1.1 *Test Room Types.* Tests shall be conducted in a warm-wall booth as described below.

C3.1.1.1 *Warm-Wall Booth.* A warm-wall booth shall have one side open and is located in a larger room. The open side of the booth shall have a shield projecting down vertically one foot from the ceiling. The test booth shall be shielded from the radiant effects of any auxiliary heating or cooling equipment. The air in the booth shall be free from draft, except that created by the finned tube unit under test in the course of its normal operation.

Note: The larger room may be provided with a controlled means of maintaining desired temperatures.

C3.1.2 *Test Room Requirements.* The test room shall have the following characteristics.

C3.1.2.1 *Size*. The floor area of the test room or booth shall not be less than 100 ft^2 and not more than 300 ft^2. No side wall shall be less than 9 ft long. The ceiling height shall be not less than 8 ft or more than 10 ft.

C3.1.2.2 *Floor*. The floor shall be tight and constructed of commercial wood flooring. The floor of a warm-wall booth shall be at least 1 ft and not more than 4 ft above the floor of the larger room.

C3.1.2.3 *Ceiling.* A non-metallic ceiling shall be used. The inside ceiling shall be painted sheetrock. The ceiling of a warm-wall booth shall be not less than 1 ft from the ceiling of the larger room.

C3.1.2.4 *Walls.* Non-metallic walls shall be used. The inside walls shall be painted sheetrock or plaster. The distance between any wall of a warm-wall booth and the wall of the surrounding room shall be not less than 2 ft.

C3.1.2.5 *Wall Against Which Test Unit Is Placed*. The wall against which the finned tube unit is placed for test shall be the wall opposite the open side in a warm wall booth and shall have an inside surface composed of sheetrock or plaster on gypsum lath or metal lath. The thickness of the sheetrock or plaster shall not be less than ⅜ in.

The bottom ground for the sheetrock shall consist of a wood board not more than 3 ⅝ in wide, nailed to the studs at the floor level. In order to prevent destruction of the plaster wall when installing the test unit mounting brackets, a ⅜ (minimum) x 1 ½ x 36 in wood slat should be installed vertically on studs as shown in Figure C1. These wood slats should be used to fasten the test unit mounting brackets and can be replaced without damaging the

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plaster wall. Use a mold release agent for easy removal and replacement on the three surfaces.

The room side of the ground and sheetrock shall be flush and there shall be no air leakage through or around the bottom ground.

The lower part of the wall shall be insulated with 3 ⅝ in thick blanket insulation or equivalent, laid between the studs and in contact with the sheetrock and extending from the floor to at least 12 in above the top of the highest unit to be tested as shown in Figure C1.

Note: It is permissible to build an interior false wall inside the test room or booth, with the construction of the front surface complying with the provisions of this standard and with 3 ⅝ in thick blanket insulation, or equivalent, between the permanent wall and the false wall. The height of this false wall shall be at least 12 in higher than the top of the highest unit to be tested.

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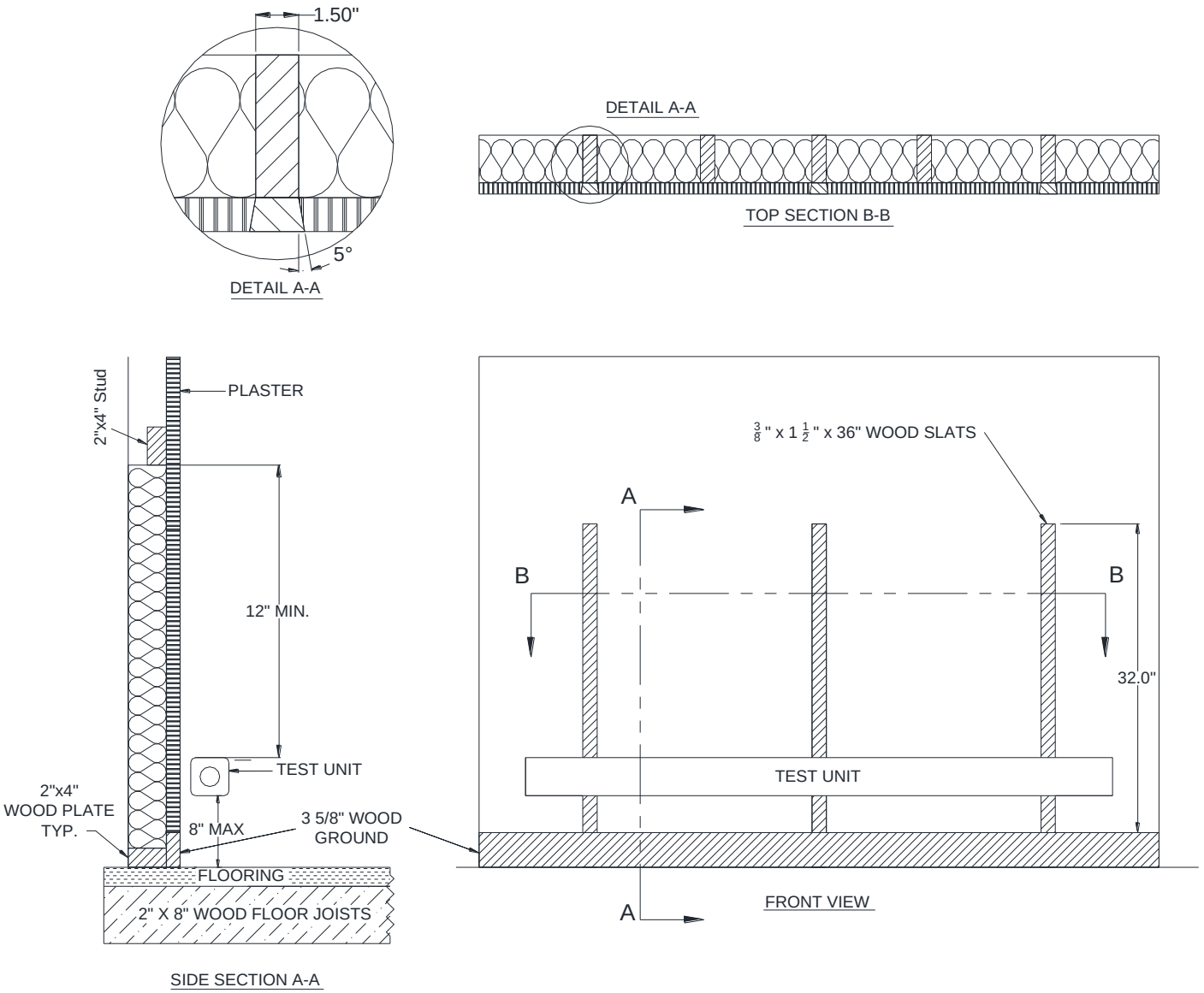


Figure C1. Test Unit Wall Construction

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C3.2 *Thermocouple Locations for Temperature Measurements*.

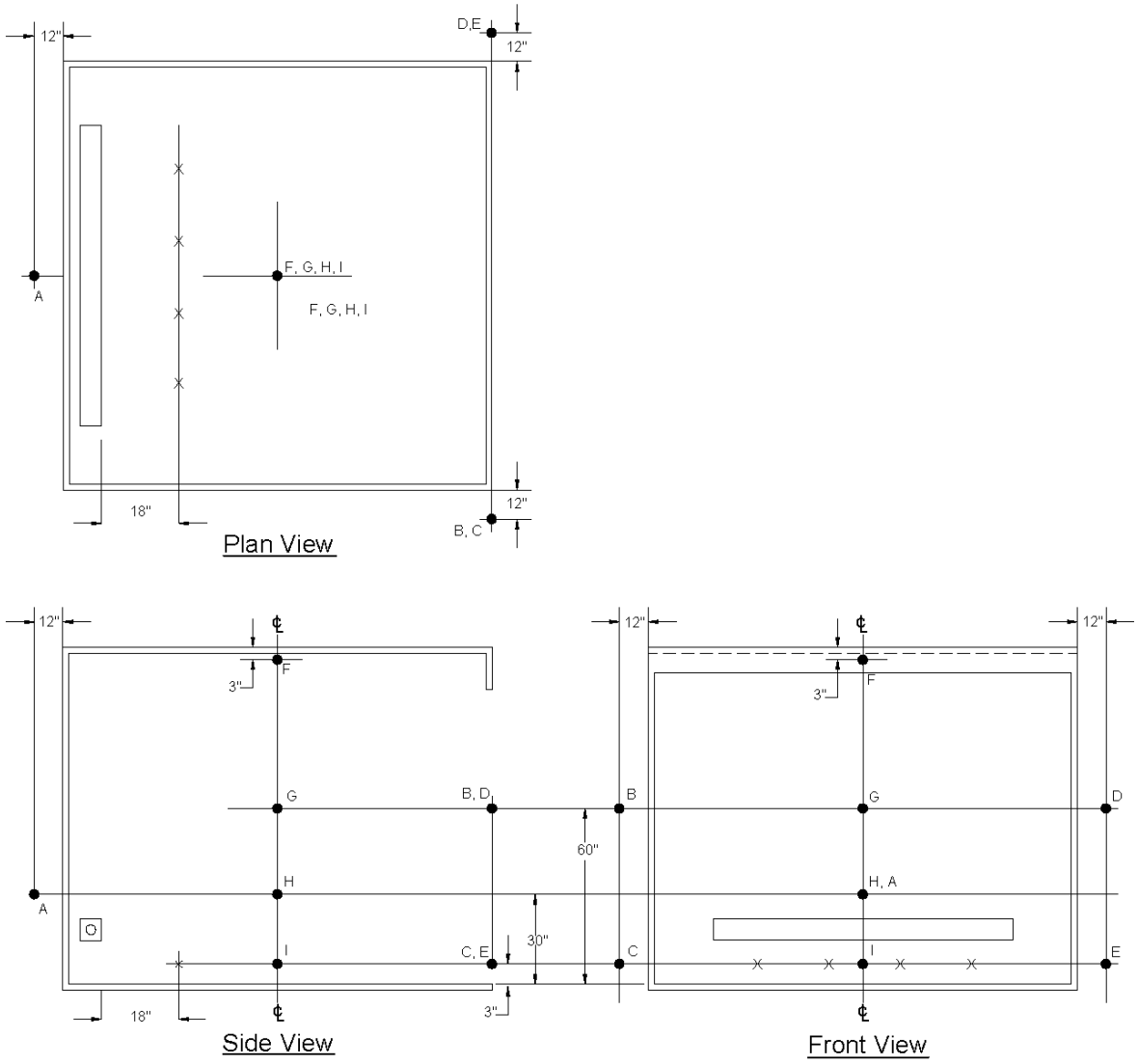
C3.2.1 *Air Temperature Surrounding the Test Booth.* The air temperature measurements in the space surrounding the test booth shall be taken as specified in Section C3.2.1.1 and C3.2.1.2. Temperatures taken at each point shall not show a variation in excess of ± 3 ºF during the course of a test. All temperatures shall be recorded on the test log sheet, CFTR-TR3.

C3.2.1.1 *Air Temperature Surrounding the Test Booth at the Rear Wall.* The air temperature at the rear wall shall be measured at the midpoint of the rear wall of the test booth, at a level of 30 in above the floor of the test booth, at a distance of 12 in from the rear wall (see Figure C2, Point A). The temperature at the rear wall shall be not less than 50 ºF at any time during the test.

C3.2.1.2 *Air Temperature Surrounding the Test Booth at the Front Edge.* The air temperature shall be taken at the front edge of each side wall at a distance of 12 in from the wall and at two heights: 3 in and 60 in above the floor of the test booth (see Figure C2, Points B, C, D, E). The air temperatures at the front edge shall be taken at a distance of 3 in above the floor (see Figure C2, Points C and E) and at all times must be between T_a and (T_a minus 10 ºF).

C3.2.2 *Air Temperature at the Center of the Room or Booth.* Temperature readings shall be taken in the center of the room or booth at levels of 3 in above the floor, as shown in Figure C2 at Points I, H, and G, respectively. Temperature readings shall also be measured at 3 in below the ceiling as shown in Figure C2, Point F.

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Section Reference	Measurement Description	Measurement Location(s)
C3.2.1.1	Air temperature surrounding the test booth at the rear wall.	Point A
C3.2.1.2	Air temperature surrounding the test booth at the front edge	Points B, C, D, and E
C3.2.2	Air temperature at the center of the room or booth.	Points F, G, H, and I
C3.2.3	Air temperature in front of the test unit.	Points X

Figure C2. Location of Thermometers/Thermocouples for Measuring Air Temperature

C3.2.3. *Air Temperature in Front of the Test Unit*. The air temperature in front of the test unit shall be measured 3 in above the floor at four or more points, spaced not more than 24 in apart throughout the length of the unit and 18 in in front of the unit, as shown in Figure C3. The end thermocouple or thermometer shall be 12 in from the ends of the unit, as shown in Figure C3.

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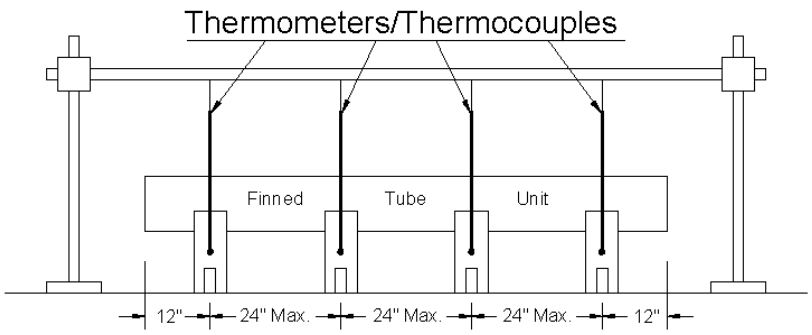


Figure C3. Location of Thermometers/Thermocouples in Front of the Test Unit

C3.2.3.1 *Additional Requirements for Measuring Air Temperature in Front of the Test Unit.* The thermocouple or thermometer used in the test shall be accurate within ± 0.5 ºF. The sensitive end of thermocouple or thermometer shall not have a diameter greater than $^{5}/_{16}$ in. The last 2 in of the temperature sensitive end shall be shielded against radiation by bright metal shields of such construction as not to interfere with the airflow (see Figure C4 for suggested constructions).

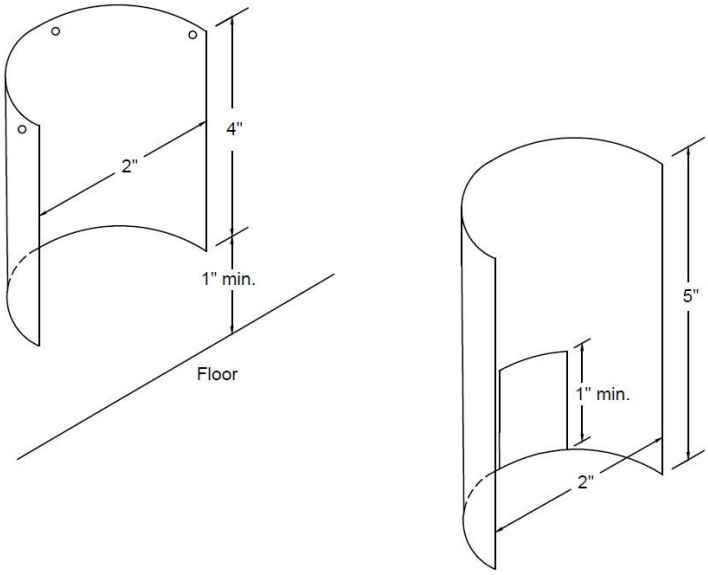


Figure C4. Suggested Construction of Thermometer/Thermocouple Shield of Bright Metal

C3.3 *Test Equipment.* Instruments which meet the minimum requirements shown in Table C1 shall be used.

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Table C1. Equipment Accuracy Requirements			
Item	**Minimum Instrument Accuracy**	**Minimum Instrument Resolution**	**Measurement Description**
Resistance Temperature Detector (RTD)	± 0.25 °F	1°F	Steam Supply Temperature
Precision Thermocouple	± 1 °F	1°F	Air Temperature in front of the test unit
Thermocouple (Standard)	± 1 °F	1°F	Air Temperature except in front of the test unit
Thermometer	± 1 °F	1°F	Air Temperature in front of the test unit
Pressure Transducer or Gauge	± 0.01 psi	0.01 psi	Steam Pressure
Caliper	± 0.001 in	0.001 in	Fin Thickness, Nominal Tube Diameter
Measuring Tape	± 0.5%	1/32 in	Fin Height
Measuring Tape	± 0.25 in	0.25 in	Active Tube Length
Weighing Scale	± 0.5%	0.1 lb	Weight of Condensate

C3.3.1 *Calibration.* Instruments shall be calibrated to a recognized standard at regular intervals.

C4 *Test Setup*

C4.1 *Installation of Test Unit and Piping.* The Commercial Finned Tube shall be installed in accordance with the following requirements.

C4.1.1 *Length of Test Units*. Tests shall be run on finned tube elements having an Active Length not less than 7 ft. If the Active Length is different from the Total Length, the relationship between them shall be the same as specified in the manufacturer's product literature.

C4.1.2 *Location.* The finned tube unit shall be installed along the wall of the test room that is insulated in accordance with Section C3.1.2.5. The distance from the end of the finned tube unit and the adjacent side walls of the room shall be at least 6 in.

C4.1.3 *Mounting.* The finned tube unit shall be mounted or hung in accordance with the manufacturer's instructions. Hangers, brackets, and supports regularly furnished with the element shall be used. The distance from the floor to the top of the lowest element shall be not more than 12 in (see Figure C1), unless the manufacturer intends to specifically recommend a higher dimension, in which case the recommended height shall be used for the test.

C4.1.3.1 *Pitch*. The bare element or the finned tube unit shall be pitched down towards the condensate collection side at 1 in per 8 ft (See Figure C5).

C4.1.4 *Supply Piping.* The supply piping shall be insulated with a minimum insulation equivalent to a value of R-4 and of such size as to cause only a negligible pressure drop between pressure measuring device and the finned tube unit. The piping inside the test shall be kept to a minimum. (Figure C5 illustrates a suitable piping arrangement and the required pitch.)

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