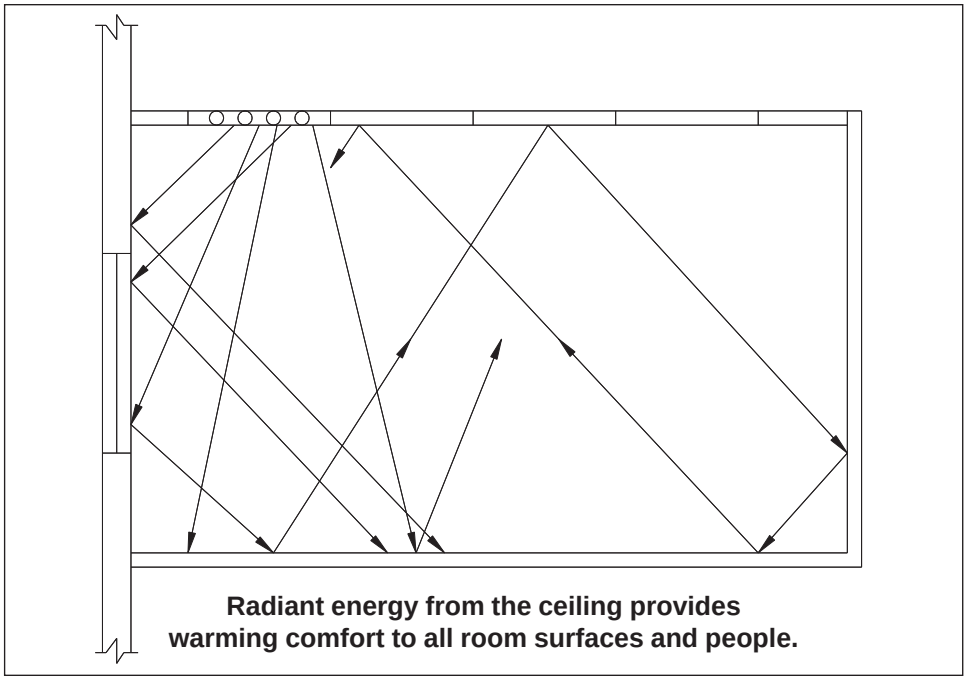
EngA ENGINEERED AIR

DESIGN
MANUAL

MODULAR HPH METAL RADIANT CEILING PANELS

EngA AIRTEX® RADIANT SYSTEMS

SYSTEM FUNDAMENTALS



Radiant energy from the ceiling provides warming comfort to all room surfaces and people.

Ceiling heating panels will produce floor surface temperatures equal to or greater than the ambient air temperature in the space, even to within 2 to 3" (51 to 76mm) of a cold glass wall, provided that the floor is properly designed to minimize direct conduction of heat to the cold ground or outside air.

No heating system is more amenable to integrated building design than an Airtex radiant ceiling system. The performance of the ceiling is related directly to the structure in which it is located. Actively involved in the continuous process of absorbing and reradiating energy from radiant panels, the structure and the objects within it are, in effect, functioning components of the system. Through this on-going transfer of energy, all surfaces within the space tend to assume an equilibrium temperature, resulting in a uniform, draftless thermal environment.

The critical design parameter for a radiant ceiling system is the difference between the mean panel temperature and the average unheated temperature of all surfaces within the space. If the average unheated surface temperature (AUST) and the temperature of the air in a room equal the mean panel temperature (MPT), there will be no net energy exchange.

When the AUST falls below the MPT, the panels radiate energy into the room. The energy radiated does not initially warm the air, it warms the glass areas, walls, furniture, floors, and people, and they, in turn, warm the air.

The radiant ceiling provides the energy source, but it is the spontaneous and dynamic interaction among the structure, the interior objects, the occupants, and the radiant panels that produces and maintains a uniform thermal environment.

The data and design information presented in this manual may be used for rooms with ceiling heights from 8 to 12ft. (2438 to 3658mm) although almost any ceiling height can be handled with radiant panels. Installations have been made with ceiling heights as great as 50ft. (15240mm) with outside walls of single glazing from floor to ceiling. For ceiling heights greater than 12ft. (3658mm) however, it is recommended that you consult your Airtex representative for specific design information.

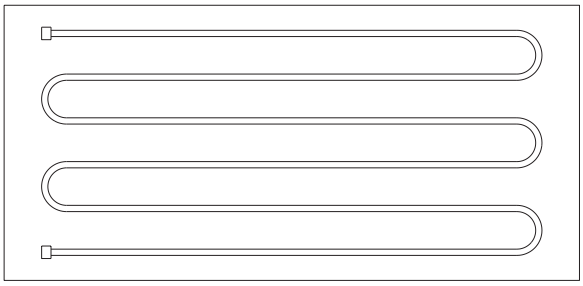
DESIGN CONSIDERATIONS

The design of a radiant ceiling perimeter system follows the usual design for recirculating water systems which incorporate remote terminals for space heating.

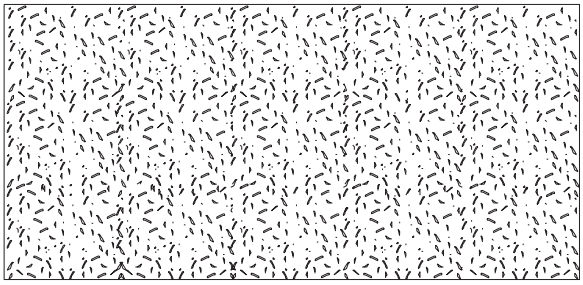
It has been found that radiant ceiling systems afford occupants greater thermal comfort at ambient temperatures lower than those required with convective systems. Accordingly, an inside dry bulb design temperature 3 to 4°F(1.7 to 2.2°C) below that normally used with convective systems is recommended.

Room loads should be calculated in the normal manner, using the procedures set forth in the ASHRAE Guide. Calculations based on overly safe room loads should not be used because such assumptions result in an excessive number of panels being specified. Using too many panels actually reduces both the effectiveness and efficiency of the system.

MODULAR HIGH PERFORMANCE HEATING PANELS



Reverse side showing copper tube 0.504”(12.8mm) I.D.



Silkscreen finish

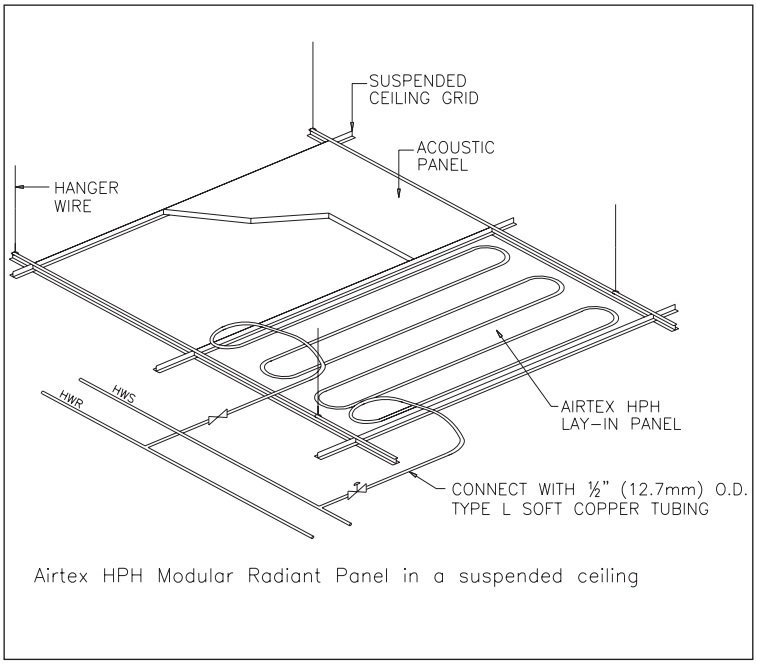
Panels are available in standard sizes of 2’ x 4’(610 x 1219mm) and 2’ x 2’(610 x 610mm).

THE MOST EFFICIENT USE OF THE ENERGY SOURCE

Lightweight radiant panels permit almost instant response to weather changes. Copper tubes are metallurgically bonded under pressure to the aluminum face sheet for maximum efficiency.

ARCHITECTURAL FEATURES

A standard exposed grid system hung by wires from the understructure forms the basic supporting structure for the panels.



Airtex HPH Modular Radiant Panel in a suspended ceiling

Modular panels are manufactured to suit imperial or metric ceiling grids with a standard square or tegular reveal edge. Panels in t-bar ceilings are often silk screen finished providing an architectural blend with adjacent acoustic tiles. Panels can be provided with aluminum frames for recessing or surface mounting to GWB ceilings.

Operating weight of the radiant ceiling panels including the suspension system is 1.5 lb/ft^2 (7.3 kg/m^2).

SIMPLE INSTALLATION

Airtex modular panels are sized to fit the ceiling grid selected by the architect, whether imperial or metric.

No fittings are required to connect to the panel coil – simply insert ½”(13mm) O.D. soft copper tubing and solder. Connection time is faster as joint cleaning and heating time is reduced.

MAINTENANCE ECONOMY

Radiant ceiling panels are maintenance free as they are not subject to the physical abuse received by wall mounted units and require no more cleaning than regular acoustic ceilings.

PERFORMANCE AND PRESSURE DROP TABLES

WATER PRESSURE DROP TABLES							
WPD/PANEL						CONNECTING TUBING*	
GPM Flow per CIRCUIT	L/S Flow per CIRCUIT	HPH Panels 2' x 4' FT	HPH Panels 610 x 1219mm kPa	HPH Panels 2' x 2' FT	HPH Panels 610 x 610mm kPa	1/2" O.D. FT/100FT	12.7mm O.D kPa/m
0.2	0.013	0.04	0.12	0.02	0.06	0.36	0.04
0.3	0.019	0.09	0.27	0.05	0.15	0.76	0.07
0.4	0.025	0.15	0.45	0.08	0.24	1.30	0.13
0.5	0.032	0.23	0.69	0.12	0.36	1.96	0.19
0.6	0.038	0.32	0.96	0.17	0.51	2.75	0.27
0.7	0.044	0.42	1.26	0.22	0.66	3.62	0.35
0.8	0.050	0.54	1.61	0.28	0.84	4.68	0.46
0.9	0.057	0.67	2.00	0.35	1.05	5.81	0.57
1.0	0.063	0.82	2.45	0.42	1.26	7.07	0.69
1.1	0.069	0.97	2.90	0.51	1.52	8.43	0.83
1.2	0.076	1.14	3.41	0.59	1.76	9.90	0.97
1.3	0.082	1.33	3.98	0.69	2.06	11.48	1.13
1.4	0.088	1.52	4.54	0.79	2.36	13.17	1.29
1.5	0.095	1.73	5.17	0.90	2.69	14.96	1.47
1.6	0.101	1.95	5.83	1.01	3.02	16.86	1.65
1.7	0.107	2.18	6.52	1.13	3.38	18.86	1.85
1.8	0.114	2.42	7.23	1.26	3.77	20.96	2.06
1.9	0.120	2.68	8.01	1.39	4.15	23.16	2.27
2.0	0.126	2.94	8.79	1.53	4.57	25.47	2.50
2.1	0.133	3.22	9.62	1.67	4.99	27.88	2.73
2.2	0.139	3.51	10.49	1.82	5.44	30.38	2.98
2.3	0.145	3.81	11.39	1.98	5.92	32.98	3.23
2.4	0.151	4.12	12.31	2.14	6.40	35.69	3.50
2.5	0.158	4.44	13.27	2.31	6.90	38.49	3.77

HEATING PERFORMANCE					
MEAN WATER TEMPERATURE		PERIMETER LOCATION HPH2448		INTERIOR LOCATION HPH2448	
°F	°C	BTU/HR Panel	WATTS Panel	BTU/HR panel	WATTS Panel
120	48.9	600	175.80	560	164.08
125	51.7	690	202.17	615	180.19
130	54.5	780	228.54	675	197.77
135	57.3	870	254.91	730	213.89
140	60.0	960	281.28	790	231.47
145	62.8	1050	307.65	850	249.05
150	65.6	1140	334.02	905	265.16
155	68.4	1230	360.39	960	281.28
160	71.2	1320	386.76	1025	300.32
165	73.9	1410	413.13	1085	317.90
170	76.7	1500	439.50	1140	334.02
175	79.5	1590	465.87	1200	351.60
180	82.3	1680	492.24	1265	370.64
185	85.1	1770	518.61	1320	386.76
190	87.8	1860	544.98	1375	402.87
195	90.6	1950	571.34	1440	421.92
200	93.4	2040	597.71	1495	438.03
205	96.2	2130	624.08	1560	457.08
210	99.0	2220	650.45	1615	473.19

*Both panel and connecting tubing pressure drops must be included in the circuit pressure drop calculation.

Flow rates below 0.5 GPM (0.0315l/s) are not recommended.

Performance based on 70°F (21.1°C) air temperature, 67°F (19.4°C) AUST and natural convection. 1in. (25mm) of ¾ lb/ft^3 (12 kg/m^3) fiberglass insulation was placed on the back side of the panels.

Heating Performance for 2ft. x 2ft. (610 x 610mm) panels is half of the 2ft. x 4ft. (610 x 1219mm) output as shown above.

For cooling performance data contact your Airtex representative.

DESIGN PROCEDURE

DESIGN EXAMPLE NO. 1:

It is desirable to provide perimeter heat to offset the outside wall loss of a building 80 x 100 ft.(24384 x 30480mm) with a calculated perimeter heat loss of 143,000 btu/hr/floor (41.9 kW/floor).

Outside Design at 10°F(-12.2°C) dry bulb
Inside Design at 70°F(21.1°C) dry bulb

Supply Hot Water at 200°F(93.3°C) with a 20°F(11.1°C) WTD provides a MWT of 190°F(87.8°C).

STEP 1:

From the Performance Table on page 3, with 190°F(87.8°C) MWT the HPH Panel will produce 1860 btu/hr/panel (0.55kW/panel).

STEP 2:

Divide the calculated heat loss by the panel performance to determine the total number of panels required.

$$\frac{143{,}000}{1860} \text{ or } \frac{41.9}{0.55} = 77 \text{ panels}$$

Thus 77 panels/floor will be required to offset the calculated heat loss. These 77 panels, 4ft. (1219mm) long will cover 308 lineal ft. (93878mm) of perimeter.

A continuous strip of 2ft. x 4ft. (610 x 1219mm) panels should be used with 77 active radiant panels (specify AIRTEX HPH2448) distributed evenly and the remaining panels in the 2ft. (610mm) wide strip could be acoustic tile or matching inactive panels. The remainder of the ceiling can be designed as specified by the architect and owner.

STEP 3:

Determine flow rate of water required for this ceiling area:

$$\text{GPM} = \frac{143{,}000 \text{ btu/hr}}{500 \times 20°\text{F}} = 14.3$$

$$\text{l/s} = \frac{41.9 \text{ kw}}{4.19 \times 11.1°\text{C}} = 0.9$$

Thus 14.3 GPM (0.9 l/s) of water at 190°F(87.8°C) MWT will be required for this floor. This translates to 0.186 GPM (0.012 l/s) per panel.

STEP 4:

Determine the number of radiant panels that can be connected in one circuit for the design pressure drop. Note: In any given circuit the panel nearest the return line will have a lower output. Thus the number of panels on a specific control should be considered to assure comfort in addition to the usual concerns about greater pressure drops in larger circuits.

For this example, let's try 6 panels per circuit.

Determine the flow per circuit:

6 panels/circuit x 0.186 GPM (0.012 l/s)/panel

= 1.12 GPM (0.072 l/s)/circuit

Estimate interconnecting tubing length as 40ft. (12192mm) (see fig. 1). Refer to the Pressure Drop Tables on page 3 and interpolate for 1.12 GPM (0.072 l/s)/circuit.

Panel WPD :
1.0ft. (3.0kPa)/panel x 6 panel / circuit = 6.0ft. (18.0kPa)

Connecting tubing WPD :

8.72 ft./100 ft. x 40 ft.100 ft. = 3.5 ft.

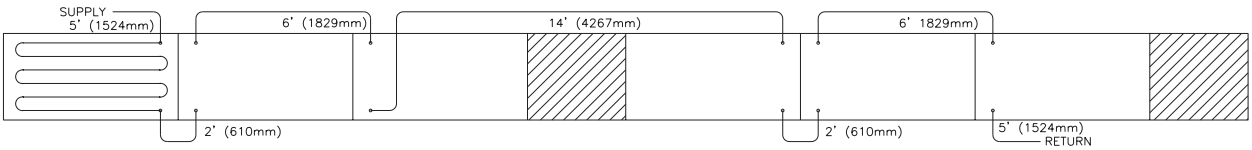
0.86 kPa/m x 12.19m = 10.5 kPa

Total WPD/6 panel circuit = 9.5 ft. (28.5kPa).

Figure 1: Design Example 1

As calculated, 77 panels 2ft. x 4ft. (610x1219mm) filling 308 lineal feet(91440mm) of the 360 foot(109728mm) perimeter.

A uniform layout would be a repeating sequence of three 2ft. x 4ft. (610x1219mm) radiant panels and one 2ft. x 2ft. (610x610mm) non-radiant panel. Two such sequences are shown below piped as a single circuit. The hatched areas represent matching non-radiant panels, or acoustic tile.



Piping for a 6 panel circuit over 28'(8534mm) of exposure with estimated connecting tubing lengths.

DESIGN PROCEDURE (cont.)

DESIGN EXAMPLE NO. 2:

The same as Design Example No. 1 except: calculated loss is 185,300 BTUH/floor (54.3kW/floor).

STEP 1:

Panel performance is still 1860 BTUH/panel (0.55kW/panel).

STEP 2:

Determine the number of panels required.

$$\frac{185{,}300}{1860} \text{ or } \frac{54.3}{0.55} = 100 \text{ Panels}$$

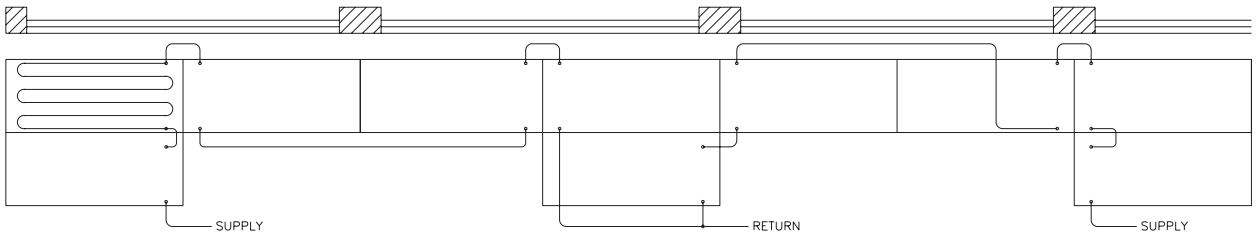
At the performance specified, 100 panels, 4ft. (1219mm) long require 400 lineal feet(121920mm), but the perimeter of the building is only 360 lineal ft (109728mm). Therefore, the panel performance must be increased or more radiant panels must be used.

Possible Solutions:

1. Increase design MWT to 200°F (93.3°C) with HPH panel.
2. Use the AIRTEX Linear Extruded Radiant Panel found in a separate design manual.
3. Install additional 2ft. x 4ft. (610 x 1219mm) panels as required in addition to the 2ft. (610mm) wide band of HPH panels (see below).

Figure 2: Design Example 2

If the heat loss is greater than the output of a 2ft. (610mm) wide band of panels, then consider additional 2ft. x2ft. (610x610) or 2ft. x4ft. (610x1219mm) panels as needed to offset the additional loss from the building. These panels would be inboard from the original perimeter band.



Piping for a 10 panel layout over a 28' (8534mm) exposure with 5 panels per circuit.

MODULAR HPH PANEL SPECIFICATIONS

AIRTEX MODULAR RADIANT CEILING PANELS

The contractor for this section of the specifications shall furnish all labour, materials, tools, equipment, and services necessary to deliver and install a complete radiant ceiling system.

SCOPE OF WORK

Provide a complete AIRTEX modular radiant ceiling system as shown on the architectural and mechanical drawings in all areas, as scheduled and as herein specified. The radiant panels shall be installed as per the manufacturer's recommendations, complete and satisfactory to the consultant.

MODULAR RADIANT CEILING PANELS

Radiant panels shall be AIRTEX Modular HPH radiant panels, as manufactured by ENGINEERED AIR, consisting of 0.040in. (1mm) aluminum face plate, 0.504in. (12.8mm) I.D. copper six-pass serpentine coil, metallurgically bonded to face plate. The panels shall weigh no more than 1.5 lbs/ft^2 (7.3 kg/m^2) when operating.

All panels in t-bar ceiling shall be silk screen finished to match adjacent acoustic tile.

Where panels are mounted into or onto gypsum board ceilings, the panels shall be supplied with a one piece AIRTEX extruded aluminum frame. Model ARF for recessed installation or ASF for surface mounting.

HEATING PERFORMANCE

The AIRTEX Modular HPH panels shall produce a minimum heating output of ____Btuh/ft^2 (____W/m^2) at ____ °F (____ °C) mean water temperature (MWT), in a room with 70°F(21°C) air temperature with natural convection.

INSTALLATION & TESTING

1. The mechanical contractor shall cooperate with other trades working in the ceiling to achieve a neat, well coordinated overall installation.

2. When the AIRTEX Modular HPH panels are to lay in a suspended t-bar ceiling grid, coordinate metric or imperial sizing, standard or fineline grid flange.

3. Run-out piping shall terminate at the supply and return points, as detailed on the drawings, or within 2ft. (610 mm) of panel tube connections.

4. No installation of finished ceiling radiant panels shall begin until all glazing has been completed and all exterior openings closed in.

5. All radiant panels shall be installed by personnel wearing clean white gloves to avoid soiling the panel face.

6. All interconnecting of radiant panels by mechanical contractor shall consist of ½in. (12.7mm) O.D. soft copper tubing.

7. All system piping shall be thoroughly cleaned, flushed, drained and refilled before radiant panels are connected to the system.

8. The mechanical contractor shall give each zone of interconnected radiant panels a pressure test, in accordance with procedures specified elsewhere.

9. All active panels shall be covered with a minimum of 25 mm(1") thick insulation (refer to the insulation specification).

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