**EngA** | **ENGINEERED AIR** ®

DESIGN
MANUAL

# LINEAR
# HEF-2 EXTRUDED
# RADIANT CEILING
# SYSTEM

**EngA** ®

**AIRTEX** ®
RADIANT SYSTEMS

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## AIRTEX LINEAR HEF-2 RADIANT CEILING SYSTEM

Airtex, HEF-2 linear radiant ceiling panels were developed as a specific response to the priorities and criteria expressed by the majority of architects and designers we've worked with over the years.

Linear ceiling panels are made of extruded aluminum. They are available in virtually any width and in lengths compatible with perimeter planning modules or the materials-handling limitations of each particular project up to a maximum of 16ft. (4877mm).

On the plenum side of each panel there is an innovative housing for copper tubes which form circulating coils. The unique design of this housing and the efficiency of the mechanical bonding technique provide the panels exceptionally high performance.

These highly efficient panels supply the heating requirements for a typical building while usually taking only 8 to 24in. (203 to 610mm) of perimeter ceiling plane. This innovative product affords not only the human comfort and efficiency long associated with radiant systems, but also unrestricted design freedom, outstanding aesthetics, space utility and flexibility, and economic feasibility.

The elimination of wall-mounted units creates an unobstructed perimeter wall that allows integration of glazed walls into the interior design. There are no unsightly perimeter baseboard or wall fin element units and consequently, there is no need for costly architectural covers. The heating source is concealed in the ceiling, allowing unlimited creativity in interior design.

The HEF-2 Linear radiant panels provide a narrow monolithic border that contrasts or compliments the most creative ceiling, and they naturally lend to creation of a perimeter soffit drop or continuous window pocket.

The uniform, draftless heating provided by the system allows utilization of the total interior, even at those locations where an occupant is seated adjacent to large areas of glass.

Re-allocation of space and occupant changes are easily accommodated when the open-office concept of floor-to-ceiling partitions are involved. Since the radiant panels can be furnished in lengths compatible with perimeter planning modules, zoning changes resulting from relocation of demising walls may be accomplished by simply adjusting terminal connections and adding thermostatic controls.

Sound transmission is not a problem because the HEF-2 Linear extruded panels have a higher STC rating than most acoustical ceiling systems.

It has long been recognized that radiant energy transfer is the most effective known method of transferring energy. Millions of square feet of radiant ceilings have been installed in various types of buildings but the convergence of today's high fuel costs and the technical developments that led to creation of HEF-2 Linear panels make the benefits of radiant ceiling systems economically advantageous for much broader applications, and especially for office buildings.

The HEF-2 Linear panels represent the production, application, and refinement of radiant heating ceiling systems since the early 1960's. We believe it epitomizes both functional and economic efficiency in heating today's buildings.

Radiant panels do not rely on the movement of air but rather transfer energy directly to any building surface the panel "sees" in much the same way that light energy from a light fixture illuminates the room. The uniformity of temperature long associated with radiant systems comes from the natural absorption and re-radiation of energy between all interior surfaces.

## SYSTEM FUNDAMENTALS

Radiant heat, like that from the sun, travels in straight lines, until it reaches a solid object. The heat warms that



object and is then re-radiated to a nearby colder object. Unlike convection heat, which is actually a current of warmed air, radiant heat does not rise. The floor is kept warm as all other absorbing surfaces. Through this silent, non-mechanical process, the HEF-2 Linear radiant ceiling system creates a thermal barrier at the perimeter of the building, providing a uniform, draftless, wall of warmth.

No heating system is more amenable to integrated building design than 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.

It has been well established that the mean radiant temperature within a space is one of the most important factors influencing occupant comfort. As Airtex radiant panels effect the mean radiant temperature directly by raising the surface temperatures in the space, they provide occupants superior control of comfort conditions.

The design of a radiant ceiling perimeter system follows the usual design for re-circulating water systems which incorporate remote terminals for space heating.
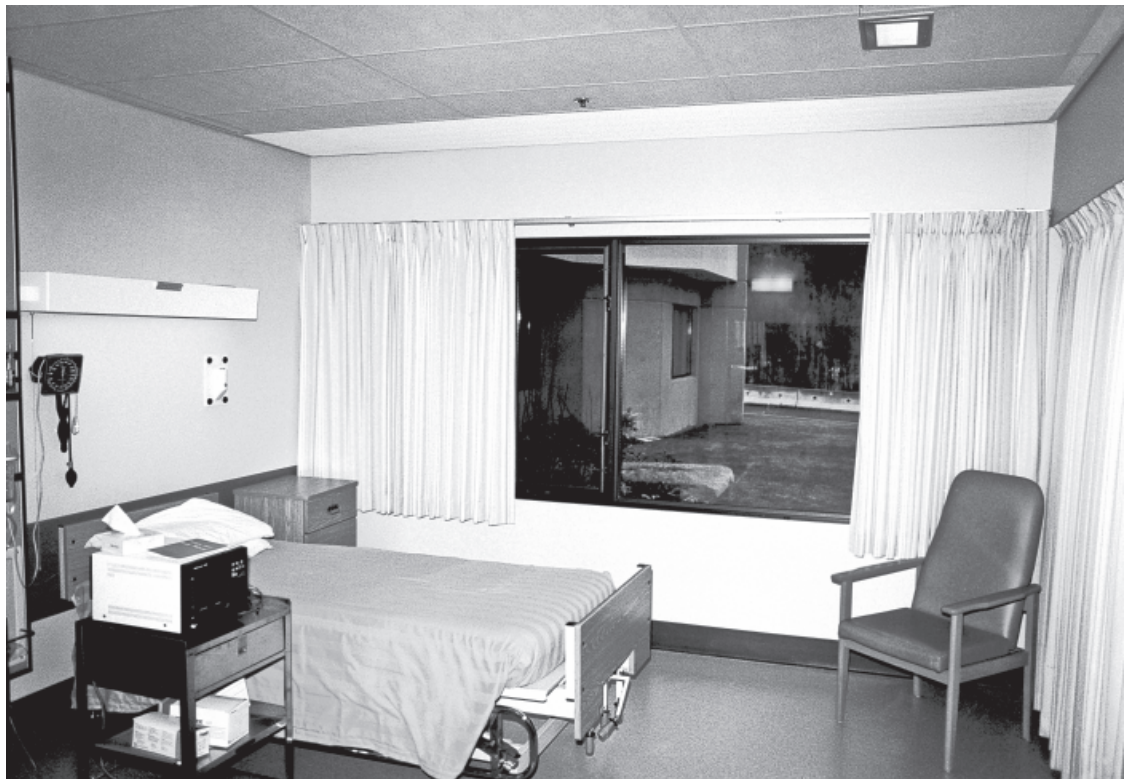
Standard controls govern the supply of heated water to the panels on demand from the room or zone thermostat. The light-weight panels respond almost instantaneously, and the space quickly receives the desired heat. The piping and controls are similar to those used with conventional perimeter hot-water systems, but all pipes are in the ceiling plenum where they are readily accessible.

## DESIGN CONSIDERATIONS

As Airtex radiant ceiling panels raise the mean radiant temperature in the space they 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.

## 1. CALCULATE THE PERIMETER HEAT LOSS PER LINEAL FOOT OF PANEL.

Initially, panel layout must be determined in order to make the correct performance selection. For example, the panels may be laid out as a continuous strip, between columns only, or in some other fashion. The BTUH per net lineal foot of panel required to meet the loads is calculated in order to use the performance tables in this design manual. See page 7.

# PANEL SELECTION PROCEDURE

Airtex recommends that for buildings employing Linear radiant panels at the perimeter, the width of the panels should be based on floor-to-floor heat loss calculations. The performance data developed since 1965 by Airtex are for total heat from the panel. Tabulated heating performance is therefore applied against total calculated heat loss.

Supply air heating requirements are dealt with by other conventional methods. During non-occupied periods, the ventilation system may be turned off and the radiant panels will maintain the desired temperature.

## 2. DETERMINE LENGTH OF THE INDIVIDUAL PANELS REQUIRED PER ZONE

Experience has shown that the most aesthetically pleasing panel arrangement is wall to wall. When panels are installed in a continuous band, select panel lengths in 2ft. (610mm), 4ft. (1219mm) or 5ft. (1524mm) increments to line up with acoustic ceiling grids. Reducing the number of panel joints helps to reduce installed costs. Costs are minimized when panel sizes and configurations are standardized for each application.

## 3. DETERMINE THE PANEL WIDTH

The basic equation for radiation exchange cited by ASHRAE, the Stefan-Boltzman equation, includes mean panel temperature (MPT) as one of the variables. The MPT is a function of the mean water temperature (MWT). Because MWT is more relevant to the design of other building systems, the Heating Performance Table and Design Examples presented in this manual are based upon MWT to facilitate calculations.

The selected MWT is a correlation of panel width and performance. For a given performance, the narrower the panel, the higher the MWT must be. Refer to the Design Examples included in this manual for instructions on using the Heating Performance Table.

Airtex HEF-2 linear radiant panels are constructed from the aluminum extrusions shown on page 9. Any 1in. (25mm) incremental panel width from 8in. (203mm) to 48in. (1219mm) wide can be constructed from a combination of 4in. (102mm), 5in. (127mm) or 6in. (152mm) radiant extrusions.

## 4. DETERMINE THE WATER FLOW RATE PER ZONE

Water quantity should be based upon velocity and pressure drop considerations, and water temperature drop should be a consequence of quantity rather than a determinant. While the customary 20°F(11.1°C) WTD is often used in design calculations, higher temperature drops allow smaller pipe sizes and smaller pumps, providing both initial and operating cost savings. Any effect of WTD on performance over the length of a zone is eliminated by the serpentine circuitry of panel tubing.

5.  DETERMINE PIPING ARRANGEMENT AND WATER PRESSURE DROP
    PER CIRCUIT

One of the benefits of perimeter radiant ceiling systems is the minimized requirement for individual room controls. Long zones, even entire exposures may be regulated by a single control with no reduction of occupant comfort.

**PANEL SELECTION PROCEDURE (cont.)**

6.  ACOUSTICAL CONSIDERATIONS

In discontinuous applications when the panel is interrupted by a partition, the HEF-2 Linear radiant panel has a Class 46 STC rating. In a continuous application with a sound-sealing material between the panel and the partition, the rating is Class 38.

# PERIMETER HEATING PERFORMANCE

Heating Performance shown in **BTUH/Lineal Foot (W/m)** of Panel

Table Performance Values from Certified Curves

NOMINAL PANEL WIDTH (INCHES / MM)

MEAN WATER TEMPERATURE (DEG. F / DEG. C)

| MWT | 6 INCH (152mm) 1 TUBE | 8 INCH (203mm) 2 TUBE | 9 INCH (229mm) 2 TUBE | 10 INCH (254mm) 2 TUBE | 12 INCH (305mm) 2 TUBE | 16 INCH (406mm) 4 TUBE | 18 INCH (457mm) 3 TUBE | 18 INCH (457mm) 4 TUBE | 24 INCH (610mm) 4 TUBE | 30 INCH (762mm) 5 TUBE | 36 INCH (914mm) 6 TUBE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 120 (48.9) | 47 (45.2) | 60 (57.7) | 62 (59.6) | 64 (61.5) | 69 (66.3) | 89 (85.5) | 96 (92.3) | 117 (112.4) | 145 (139.4) | 153 (147.0) | 198 (190.3) |
| 125 (51.7) | 55 (52.9) | 70 (67.3) | 74 (71.1) | 77 (74.0) | 83 (79.8) | 107 (102.8) | 116 (111.5) | 136 (130.7) | 170 (163.4) | 183 (175.9) | 231 (222.0) |
| 130 (54.4 | 63 (60.5) | 81 (77.8) | 86 (82.7) | 90 (86.5) | 98 (94.2) | 125 (120.1) | 135 (129.7) | 154 (148.0) | 194 (186.4) | 212 (203.7) | 264 (253.7) |
| 135 (57.2) | 71 (68.2) | 91 (87.5) | 97 (93.2) | 102 (98.0) | 112 (107.6) | 143 (137.4) | 154 (148.0) | 173 (166.3) | 218 (209.5) | 241 (231.6) | 297 (285.4) |
| 140 (60.0) | 79 (76.0) | 101 (97.1) | 108 (103.8) | 114 (109.6) | 126 (121.1) | 161 (154.7) | 173 (166.3) | 192 (184.5) | 243 (233.5) | 270 (259.5) | 331 (318.1) |
| 145 (62.8) | 87 (83.6) | 111 (106.7) | 119 (114.4) | 126 (121.1) | 140 (134.5) | 179 (172.0) | 192 (184.5) | 210 (201.8) | 267 (256.6) | 299 (287.3) | 364 (349.8) |
| 150 (65.6) | 95 (91.3) | 121 (116.3) | 130 (124.9) | 138 (132.6) | 155 (149.0) | 198 (190.3) | 211 (202.8) | 229 (220.1) | 291 (279.7) | 329 (316.2) | 397 (381.5) |
| 155 (68.3) | 104 (99.9) | 131 (125.9) | 146 (140.3) | 150 (144.2) | 169 (162.4) | 216 (207.6) | 231 (222.0) | 248 (338.3) | 316 (303.7) | 358 (344.0) | 430 (413.2) |
| 160 (71.1) | 112 (107.6) | 141 (135.5) | 152 (146.1) | 162 (155.7) | 183 (175.9) | 234 (224.9) | 250 (240.3) | 266 (255.6) | 340 (326.7) | 387 (371.9) | 464 (445.9) |
| 165 (73.9) | 120 (115.3) | 151 (145.1) | 163 (156.6) | 175 (168.2) | 198 (190.3) | 252 (242.2) | 269 (258.5) | 285 (273.9) | 364 (349.8) | 416 (399.8) | 497 (477.6) |
| 170 (76.7) | 128 (123.0) | 161 (154.7) | 174 (167.2) | 187 (179.7) | 212 (203.7) | 270 (259.5) | 288 (276.8) | 303 (291.2) | 389 (373.8) | 446 (428.6) | 530 (509.3) |
| 175 (79.4) | 136 (131.7) | 171 (164.3) | 185 (177.8) | 199 (191.2) | 226 (217.2) | 288 (276.8) | 307 (295.0) | 322 (309.4) | 413 (396.9) | 475 (456.5) | 563 (541.0) |
| 180 (82.2) | 144 (138.4) | 181 (173.9) | 196 (188.4) | 211 (202.8) | 241 (231.6) | 307 (296.0) | 326 (313.3) | 341 (327.7) | 438 (420.9) | 504 (484.3) | 597 (573.7) |
| 185 (85.0) | 152 (146.1) | 191 (183.6) | 207 (198.9) | 223 (214.3) | 255 (245.1) | 325 (312.3) | 345 (331.6) | 359 (345.0) | 462 (444.0) | 533 (512.2) | 630 (605.4) |
| 190 (87.8) | 160 (153.8) | 201 (193.2) | 218 (209.5) | 235 (225.8) | 269 (258.5) | 343 (329.6) | 365 (350.8) | 378 (363.3) | 486 (467.1) | 562 (540.1) | 663 (637.1) |
| 195 (90.6) | 168 (161.5) | 211 (202.8) | 230 (221.0) | 248 (238.3) | 284 (272.9) | 361 (346.9) | 384 (369.0) | 397 (381.5) | 511 (491.1) | 592 (568.9) | 696 (668.9) |
| 200 (93.3) | 176 (169.1) | 221 (212.4) | 241 (231.6) | 260 (249.9) | 298 (286.4) | 379 (364.2) | 403 (387.3) | 415 (398.8) | 535 (514.1) | 621 (596.8) | 730 (701.5) |
| 205 (96.1) | 184 (176.8) | 231 (222.0) | 253 (243.1) | 272 (261.4) | 312 (299.8) | 397 (381.5) | 422 (405.5) | 434 (417.1) | 559 (537.2) | 650 (624.7) | 763 (733.2) |
| 210 (98.9) | 193 (185.5) | 241 (231.6) | 263 (252.7) | 284 (272.9) | 326 (313.3) | 416 (399.8) | 441 (423.8) | 453 (435.3) | 584 (561.2) | 679 (652.5) | 796 (765.0) |
| 215 (101.7) | 201 (193.2) | 252 (242.2) | 275 (264.3) | 297 (285.4) | 341 (327.7) | 434 (417.1) | 460 (442.1) | 471 (452.6) | 608 (584.3) | 708 (680.4) | 829 (796.7) |
| 220 (104.4) | 209 (200.9) | 262 (251.8) | 286 (274.9) | 309 (297.0) | 355 (341.2) | 452 (434.4) | 480 (461.3) | 490 (470.9) | 632 (607.4) | 738 (709.2) | 863 (829.3) |

Outputs for panel widths not shown may be interpolated from above table.

Performance based on 70°F (21.1°C) Air temperature, 67°F (19.4°C) AUST with natural convection. 1in. (25mm) thick ¾ lb/ft³ (12 kg/m³) fiberglass insulation was placed on the reverse side of the panels.

Select the most economical panel width which will satisfy the heat loss by adjusting the Mean Water Temperature (MWT).

For cooling performance data contact Engineered Air.

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# PRESSURE DROP TABLES

| 1/2" I.D. Panel Tubing | | | | | 12.7mm I.D. Panel Tubing | | | | | 1/2" O.D. Connecting Tubing | | | 12.7mm O.D. Connecting Tubing | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GPM / TUBE | FT PER 100 FT | GPM / TUBE | FT PER 100 FT | | L/SEC TUBE | Pa/m | L/SEC TUBE | Pa/m | | GPM/ TUBE | FT PER 100 FT | | L/SEC TUBE | kPa/m |
| **0.05** | **0.01** | 1.55 | 7.34 | | **0.003** | **0.98** | 0.098 | 719.8 | | **0.10** | **0.10** | | **0.006** | **0.01** |
| **0.10** | **0.05** | 1.60 | 7.78 | | **0.006** | **4.90** | 0.101 | 762.9 | | **0.20** | **0.36** | | **0.013** | **0.04** |
| **0.15** | **0.10** | 1.65 | 8.24 | | **0.009** | **9.81** | 0.104 | 808.0 | | **0.30** | **0.76** | | **0.019** | **0.07** |
| **0.20** | **0.17** | 1.70 | 8.71 | | **0.013** | **16.67** | 0.107 | 854.1 | | **0.40** | **1.30** | | **0.025** | **0.13** |
| **0.25** | **0.25** | 1.75 | 9.19 | | **0.016** | **24.52** | 0.110 | 901.2 | | 0.50 | 1.96 | | 0.032 | 0.19 |
| **0.30** | **0.35** | 1.80 | 9.68 | | **0.019** | **34.32** | 0.114 | 949.2 | | 0.60 | 2.75 | | 0.038 | 0.27 |
| **0.35** | **0.47** | 1.85 | 10.18 | | **0.022** | **46.09** | 0.117 | 998.3 | | 0.70 | 3.65 | | 0.044 | 0.36 |
| **0.40** | **0.60** | 1.90 | 10.70 | | **0.025** | **58.84** | 0.120 | 1049 | | 0.80 | 4.68 | | 0.050 | 0.46 |
| **0.45** | **0.74** | 1.95 | 11.22 | | **0.028** | **72.56** | 0.123 | 1100 | | 0.90 | 5.81 | | 0.057 | 0.57 |
| 0.50 | 0.91 | 2.00 | 11.76 | | 0.032 | 89.23 | 0.126 | 1153 | | 1.00 | 7.07 | | 0.063 | 0.69 |
| 0.55 | 1.08 | 2.05 | 12.31 | | 0.035 | 105.9 | 0.129 | 1207 | | 1.10 | 8.43 | | 0.069 | 0.83 |
| 0.60 | 1.27 | 2.10 | 12.87 | | 0.038 | 124.5 | 0.133 | 1262 | | 1.20 | 9.90 | | 0.076 | 0.97 |
| 0.65 | 1.47 | 2.15 | 13.45 | | 0.041 | 144.1 | 0.136 | 1319 | | 1.30 | 11.48 | | 0.082 | 1.13 |
| 0.70 | 1.69 | 2.20 | 14.03 | | 0.044 | 165.7 | 0.139 | 1376 | | 1.40 | 13.17 | | 0.088 | 1.29 |
| 0.75 | 1.92 | 2.25 | 14.63 | | 0.047 | 188.3 | 0.142 | 1435 | | 1.50 | 14.96 | | 0.095 | 1.47 |
| 0.80 | 2.16 | 2.30 | 15.23 | | 0.050 | 211.8 | 0.145 | 1493 | | 1.60 | 16.86 | | 0.101 | 1.65 |
| 0.85 | 2.42 | 2.35 | 15.85 | | 0.054 | 237.3 | 0.148 | 1554 | | 1.70 | 18.86 | | 0.107 | 1.85 |
| 0.90 | 2.68 | 2.40 | 16.48 | | 0.057 | 262.8 | 0.151 | 1616 | | 1.80 | 20.96 | | 0.114 | 2.06 |
| 0.95 | 2.97 | 2.45 | 17.12 | | 0.060 | 291.2 | 0.155 | 1679 | | 1.90 | 23.16 | | 0.120 | 2.27 |
| 1.00 | 3.26 | 2.50 | 17.77 | | 0.063 | 319.7 | 0.158 | 1743 | | 2.00 | 25.47 | | 0.126 | 2.50 |
| 1.05 | 3.57 | 2.55 | 18.44 | | 0.066 | 350.1 | 0.161 | 1808 | | 2.10 | 27.88 | | 0.133 | 2.73 |
| 1.10 | 3.89 | 2.60 | 19.11 | | 0.069 | 381.5 | 0.164 | 1874 | | 2.20 | 30.38 | | 0.139 | 2.98 |
| 1.15 | 4.23 | 2.65 | 19.80 | | 0.073 | 414.8 | 0.167 | 1942 | | 2.30 | 32.98 | | 0.145 | 3.23 |
| 1.20 | 4.57 | 2.70 | 20.49 | | 0.076 | 448.1 | 0.170 | 2009 | | 2.40 | 35.69 | | 0.151 | 3.50 |
| 1.25 | 4.93 | 2.75 | 21.20 | | 0.079 | 483.4 | 0.174 | 2079 | | 2.50 | 38.49 | | 0.158 | 3.77 |
| 1.30 | 5.30 | 2.80 | 21.92 | | 0.082 | 519.7 | 0.177 | 2149 | | 2.60 | 41.38 | | 0.164 | 4.06 |
| 1.35 | 5.68 | 2.85 | 22.65 | | 0.085 | 557.0 | 0.180 | 2221 | | 2.70 | 44.38 | | 0.170 | 4.35 |
| 1.40 | 6.08 | 2.90 | 23.99 | | 0.088 | 596.2 | 0.183 | 2352 | | 2.80 | 47.46 | | 0.177 | 4.65 |
| 1.45 | 6.49 | 2.95 | 24.14 | | 0.091 | 636.4 | 0.186 | 2367 | | 2.90 | 50.65 | | 0.183 | 4.97 |
| 1.50 | 6.91 | 3.00 | 24.90 | | 0.095 | 677.6 | 0.189 | 2442 | | 3.00 | 53.92 | | 0.189 | 5.29 |

NOTES:

1. **Design flow rates below 0.5 GPM (0.032 l/s) are not recommended.**

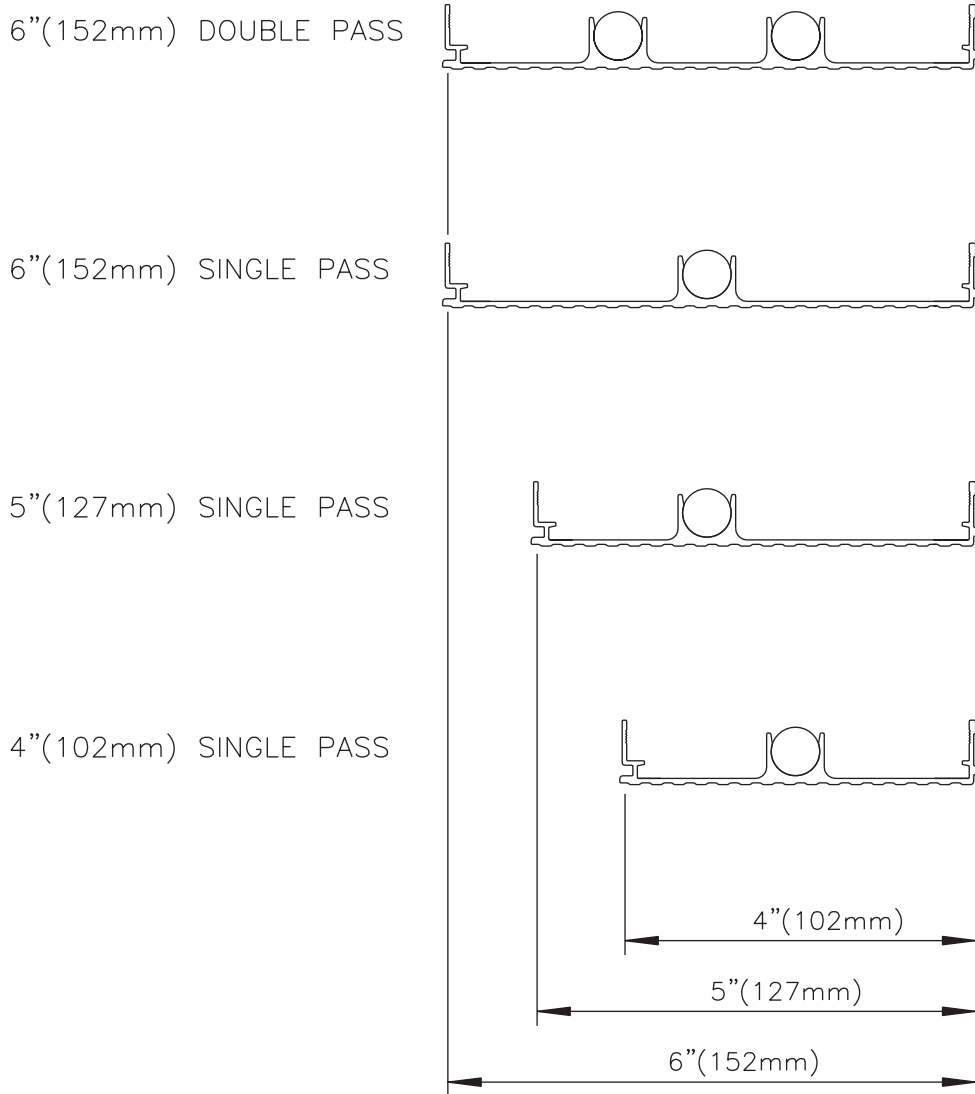2. For Airtex pigtail interconnects add 18in. (457mm) to tubing length.

3. For range in tables, pressure drop in Airtex return bends may be ignored.

4. 1/2in. (13mm) O.D. tubing is used for supply and return connections as well as interconnection through or around perimeter obstructions when Airtex pigtails are unsuitable.
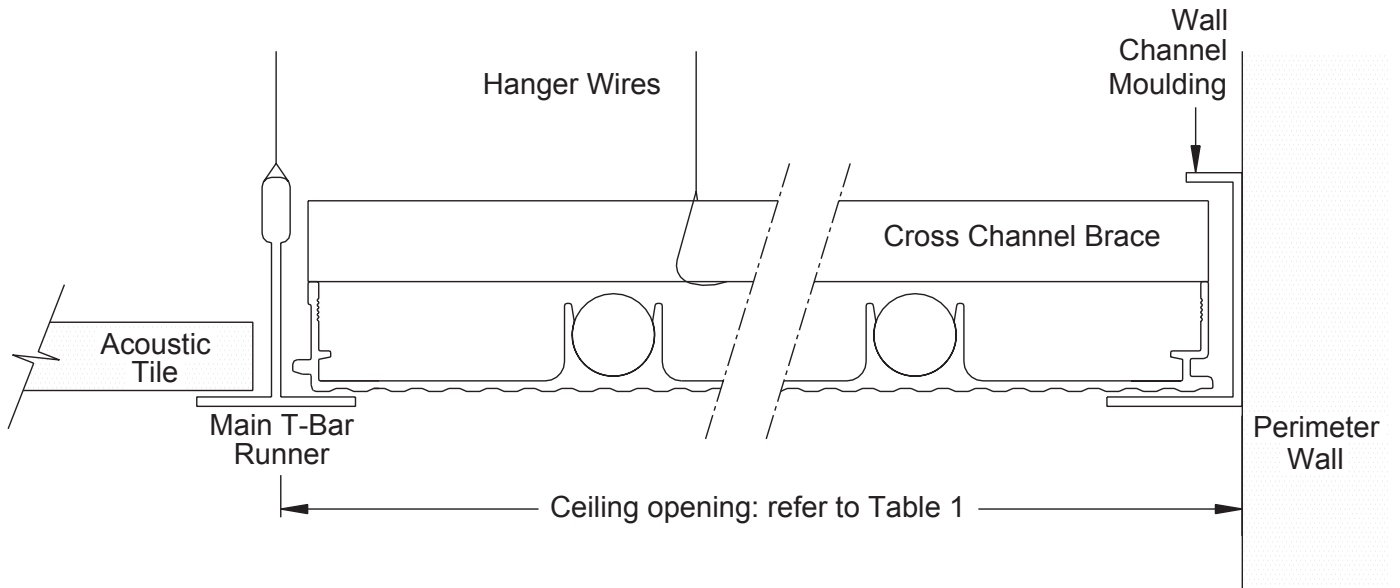
5. Adjust flow for Glycol solutions compensating for specific heat and specific gravity.
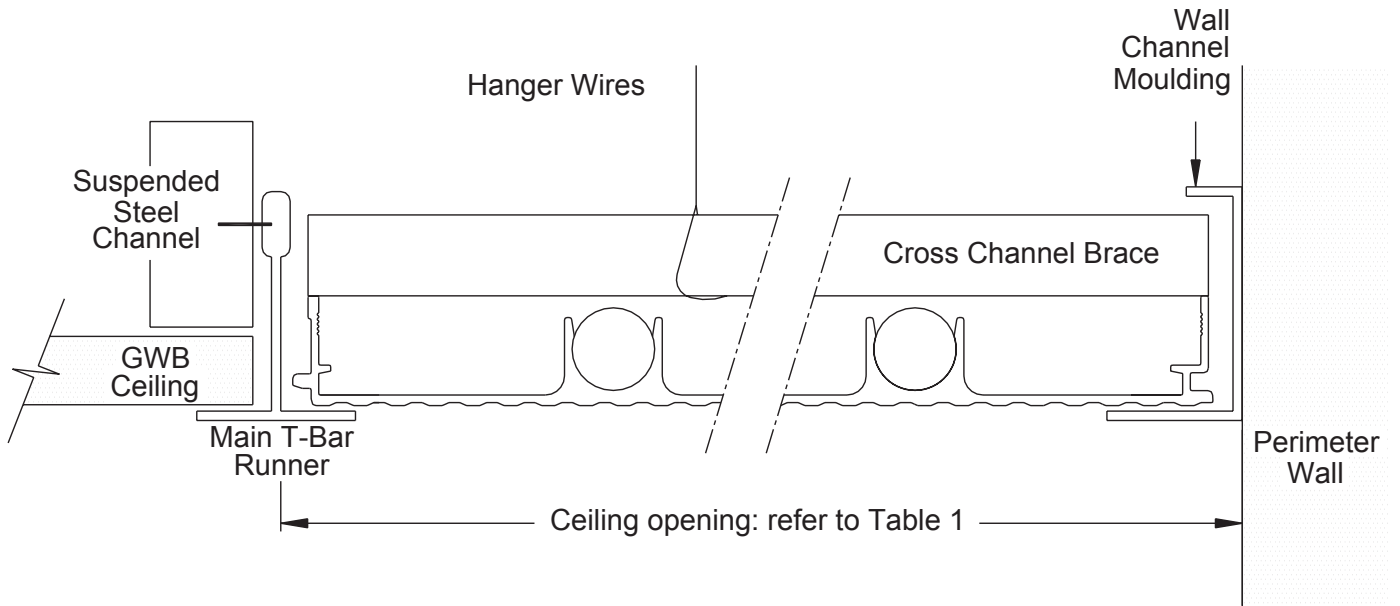
# HEF-2 EXTRUDED SECTIONS

6"(152mm)  DOUBLE  PASS

6"(152mm)  SINGLE  PASS

5"(127mm)  SINGLE  PASS

4"(102mm)  SINGLE  PASS

4"(102mm)

5"(127mm)

6"(152mm)

Airtex HEF-2 Linear Radiant Panels are constructed from the aluminum extrusions shown above. Any 1"(25mm) incremental panel width from 8"(203mm) to 48"(1219mm) wide can be constructed from a combination of 4"(102mm), 5"(127mm) or 6"(152mm) radiant extrusions. Splice lines between extrusions are hidden from view when male edge is installed toward perimeter wall. Panel lengths can be provided to suit perimeter planning modules up to 16' (4870mm) long. For additional custom extruded sections, see LM-2 or contact Engineered Air.

# SUSPENSION DETAILS

Wall
Channel
Moulding

Hanger Wires

Cross Channel Brace

Acoustic
Tile

Perimeter
Wall

Main T-Bar
Runner

Ceiling opening: refer to Table 1

Typical suspension. Panel supported by wall channel and main T-bar
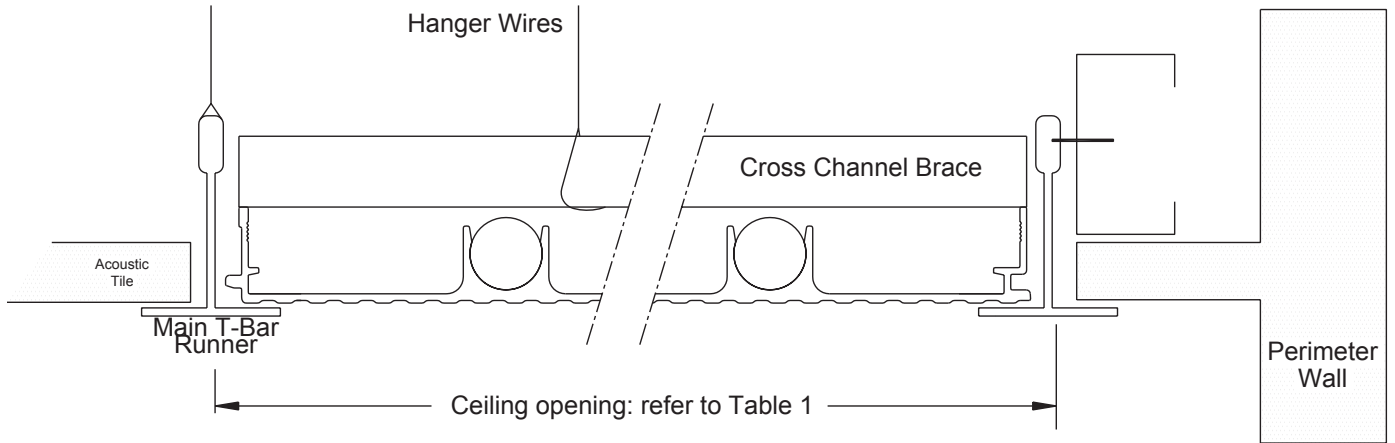Allow expansion space between wall and balance of ceiling as per Table 1, page 11

Wall
Channel
Moulding

Hanger Wires

Suspended
Steel
Channel

Cross Channel Brace

GWB
Ceiling

Perimeter
Wall

Main T-Bar
Runner

Ceiling opening: refer to Table 1

**TABLE 1**

**AIRTEX HEF-2 LINEAR PANEL CEILING OPENING SCHEDULE**

| NOMINAL PANEL WIDTH inches (mm) | CEILING OPENING: Add dimension below to nominal width | |
|---|---|---|
| | (inches) | (mm) |
| Less than 15" (381) | 1/4" | 6 |
| 15" to 19" (381 to 483) | 3/16" | 5 |
| 20" to 24" (508 to 610) | 1/8" | 3 |
| 25" to 29" (635 to 737) | 1/16" | 2 |
| 30" to 36" (762 to 914) | 0 | 0 |

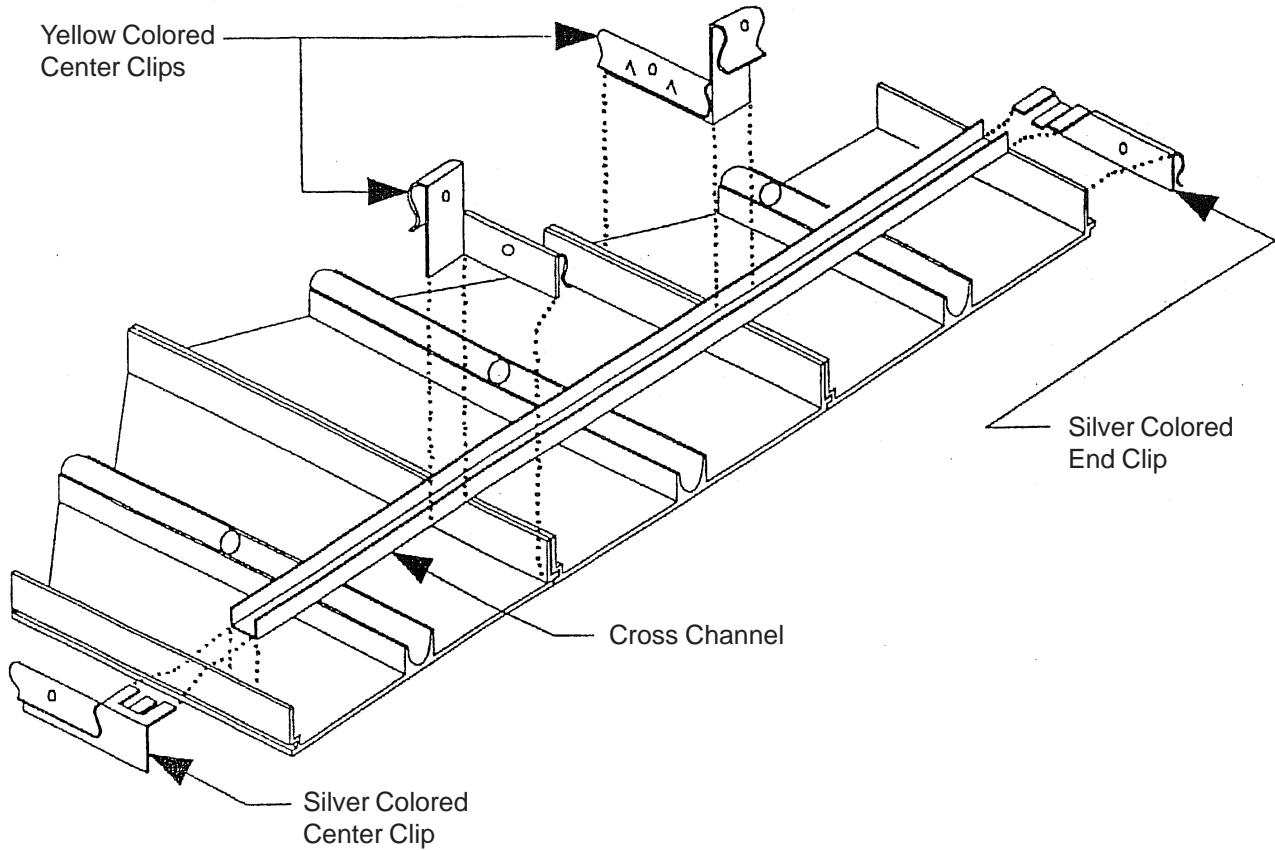*Note: For panels wider than 36"(914mm), contact Engineered Air.*

# SUSPENSION DETAILS (cont.)



Hanger Wires

Cross Channel Brace

Acoustic Tile

Main T-Bar Runner

Perimeter Wall

Ceiling opening: refer to Table 1

This detail compensates for an uneven outer wall or perimeter obstructions
and permits a better view factor of the glass by the panel



Wall Angle Moulding

Hanger Wire

Wall Channel Moulding

Cross Channel Brace

Drop Soffit or Bulkhead

Perimeter Wall

Ceiling opening: refer to Table 1

Typical window pocket installation where panel is higher than ceiling.
Channel moulding on one side and angle wall moulding on the other.
Similarly, this detail may be used for a drop soffit where panel is
lower than balance of ceiling.

# PANEL ASSEMBLY

Yellow Colored Center Clips

Silver Colored End Clip

Cross Channel

Silver Colored Center Clip

Install correct number of cross channel braces as per Table 2. Place one channel within 2" (51mm) of each end of panel. Slip end clips onto channel. Hammer clips onto edge of panel. Then install centre clips to secure channel and male/female joint as illustrated in Fig. 1. Alternate direction of centre clips.
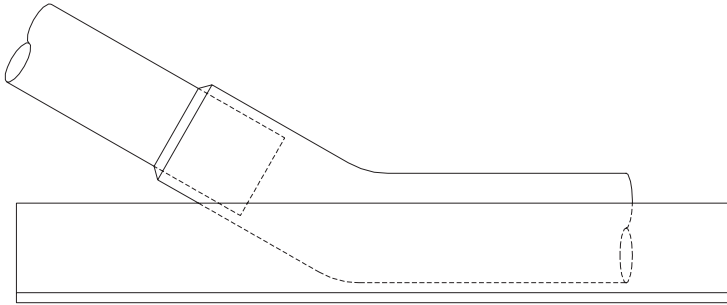
### TABLE 2

| Number of Cross Channels required for Panel Widths 24" (610mm) or less | |
| --- | --- |
| Panel Length | Minimum no. of Channels |
| Less than 10'(3048mm) | 3 |
| 10' to 13' (3048 to 3962mm) | 4 |
| Over 13' to 16' (3962 to 4877mm) | 5 |

Note: For 30" (762mm) and 36" (914mm) wide panels add one or more additional cross channels.
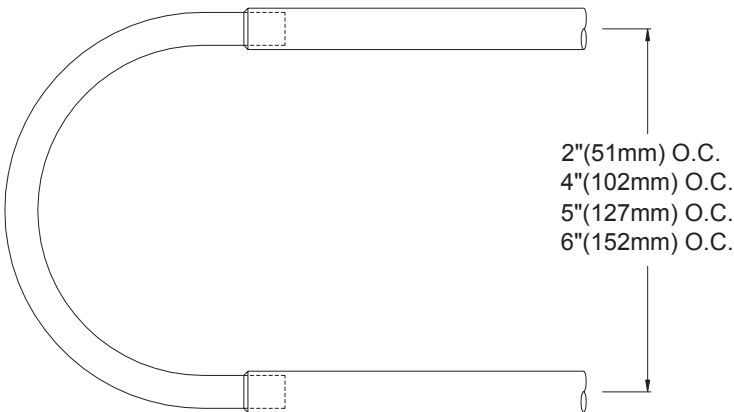
Figure 1

# PIPING COMPONENTS REFERENCE

**Typical connection for supply, return and trimmed panels.**

Connect with type L or M 3/8" (9.5mm) nominal (1/2" (12.7mm) O.D.) soft copper tubing.

Slip into tubing 0.504" (12.8) I.D. elevated to the connected position by factory supplied Airtex bending tool.

Typical soldered joint. No fittings required.

2"(51mm) O.C.
4"(102mm) O.C.
5"(127mm) O.C.
6"(152mm) O.C.

**Airtex Return Bends.**

Factory supplied in sizes indicated. No fittings required.

Install, and solder in place, factory supplied Airtex return bends as illustrated. No fittings required.

Connect panel to supply and return using 1/2" (12.7mm) O.D. soft copper tubing. No fittings required.
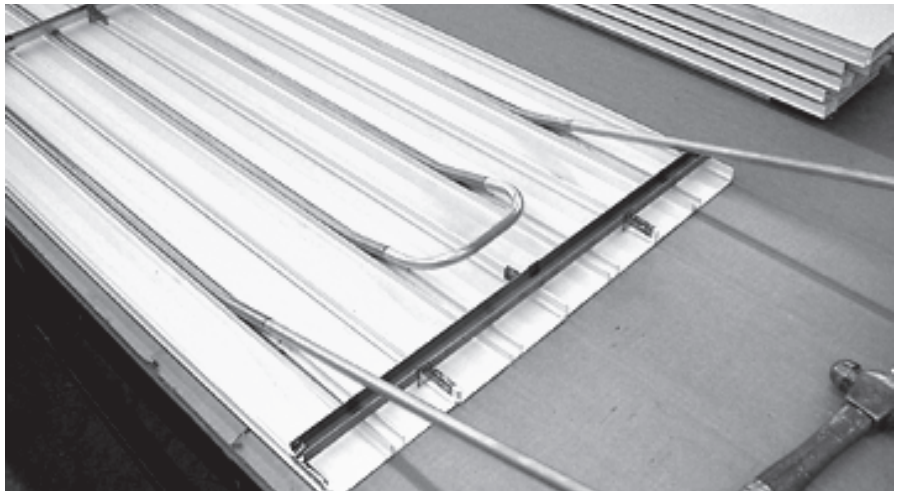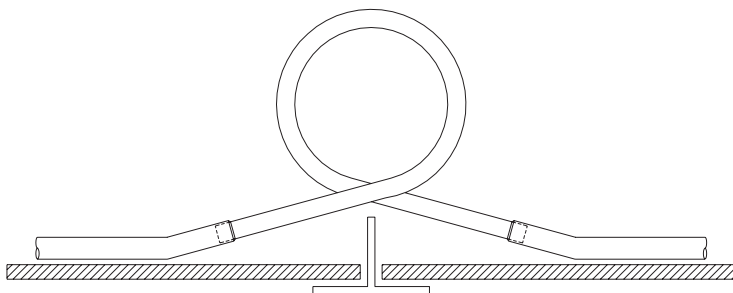
Figure 2

**Airtex Interconnects.**

Interconnect ends are sized to accept panel tubes with no fittings. No panel tubing adjustment is required if the panels have not been trimmed.

# PIPING COMPONENTS (cont.)

When panels are to be connected in series, factory supplied Airtex interconnects are to be installed as illustrated. No fittings required.
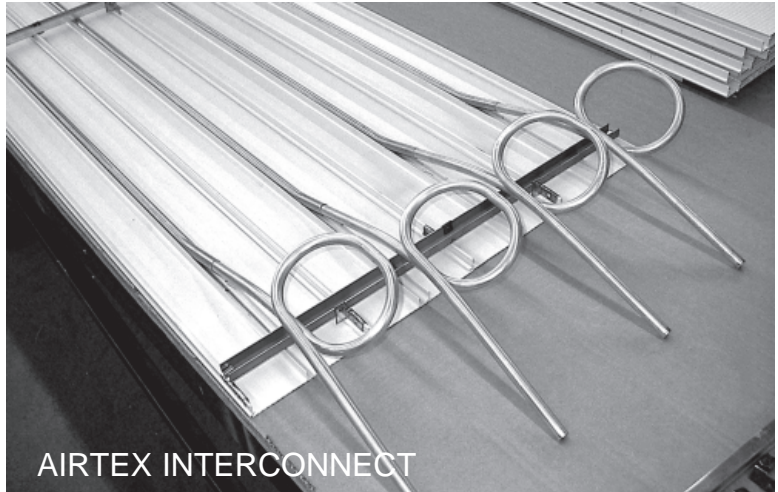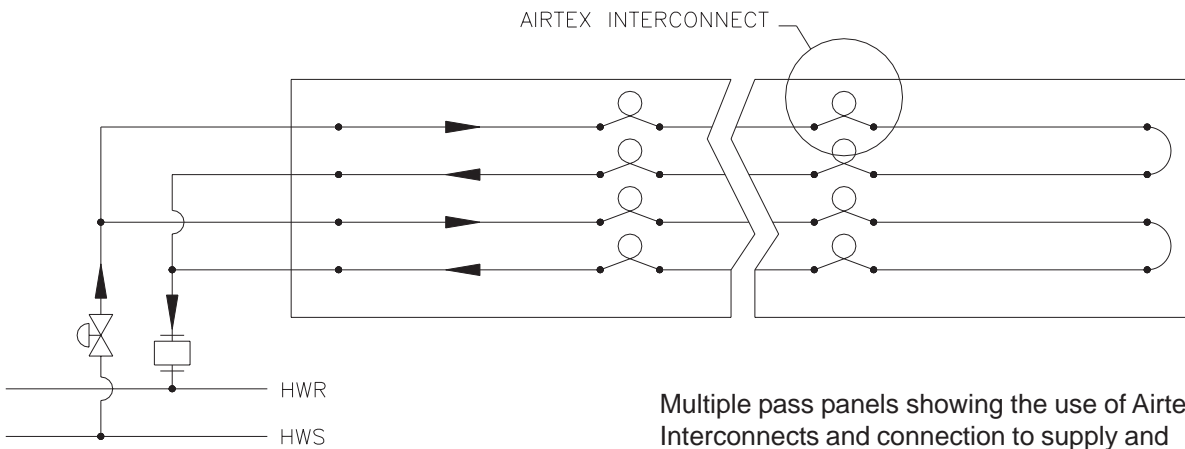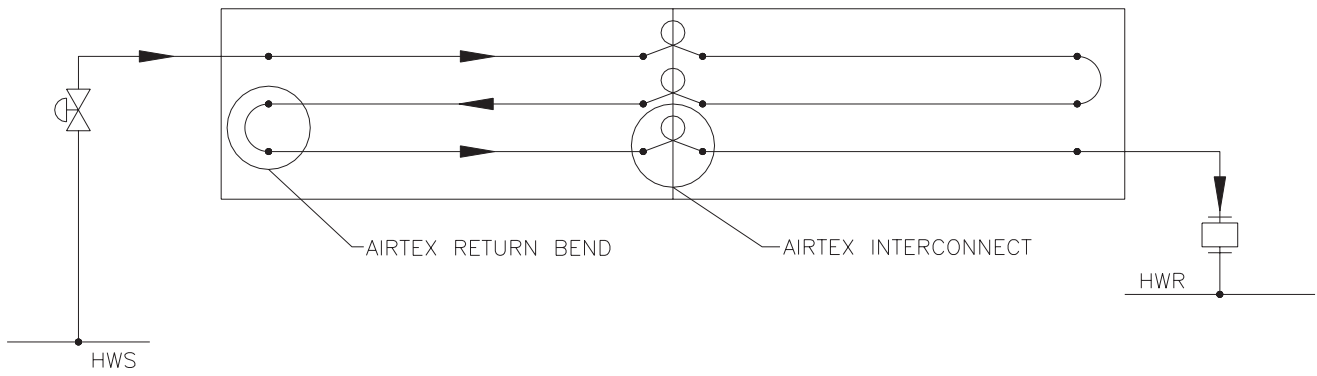


AIRTEX INTERCONNECT

Figure 3



AIRTEX RETURN BEND          AIRTEX INTERCONNECT

HWR

HWS



AIRTEX INTERCONNECT

HWR

HWS

Multiple pass panels showing the use of Airtex Interconnects and connection to supply and return lines. Parallel flow can be used to reduce pressure drop for long zones.

**DESIGN EXAMPLE #1**

The following criteria apply to this design example. The building is multi-story, and the example is calculated for a typical intermediate floor.

> 150ft. (45720mm) x 150ft. (45720mm) Square Building
> 12ft. (3658mm) floor-to-floor
> Inside Design = 70°F (21.1°C) Dry Bulb
> Supply Hot Water = 200°F (93.3°C)
> Heat loss for Each Floor = 160,000 BTUH (46.9kW)
> Owner requires 1 zone per 30ft. (9144mm) bay.

**Step #1**
CALCULATE THE HEAT LOSS PER LINEAL FOOT OF THE OUTSIDE WALL

$$\frac{\text{Total Load}}{\text{Floor Perimeter}} \quad \frac{160,000 \text{ BTUH}}{600 \text{ ft.}} = 267 \text{ BTUH/L.ft.}$$

$$\frac{\text{Total Load}}{\text{Floor Perimeter}} \quad \frac{46.9\text{kW}}{182.880 \text{ m}} = 257 \text{ W/m}$$

**Step #2**
DETERMINE THE LENGTH OF THE INDIVIDUAL PANELS TO BE USED IN EACH PART OF THE ZONE

(Actual panel lengths are 3/8in. (9.5mm) less than nominal. Use 12ft. to 16ft. (3658 to 4877mm) lengths for lowest first cost. Use the same size and configuration where possible). For this project we would use two 15ft. (4572mm) panels on each 30ft. (9144mm) zone. With 20 zones per floor there will be 40 panels for each floor of the building.

**Step #3**
DETERMINE THE PANEL WIDTH REQUIRED

The Performance Table for the linear panel on page 7 shows that a MWT of 190°F(87.8°C) produces 269 BTUH/L.ft (259W/m) of 12in. (305mm) wide panel. The 190°F(87.8°C) MWT suggests a 20°F (11.1°C) WTD. A 12in. (305mm) panel has two copper tubes which will provide supply and return passes. Airtex interconnects will be used between panels. Supply and return connections will be at one end of the zone, with an Airtex return bend at the other end. (See page 14).

**Step #4**
DETERMINE THE FLOW RATE REQUIRED PER ZONE

$$\text{Gallons/min} = \frac{\text{Total BTUH / zone}}{500 \times \text{water temp. drop deg. F}}$$

$$\text{GPM} = \frac{30 \times 267 \text{ BTUH / L.ft.}}{500 \times 20 \text{ deg. F}} = 0.8 \text{ GPM}$$

$$\text{Liter/sec.} = \frac{\text{Total W/zone}}{4190 \times \text{water temp. drop deg. C}}$$

$$\text{l/s} = \frac{9.14 \times 257 \text{ W/m}}{4190 \times 11.1 \text{ deg. C}} = 0.05 \text{ l/s}$$

Thus: 0.8 GPM(0.05 l/s) at 190°F (87.8°C) MWT will be required for each zone.

**Step #5**

DETERMINE THE PIPING ARRANGEMENT AND WATER PRESSURE DROP PER CIRCUIT

For this example we selected two (2) panels per 30ft. (9144mm) zone. The panel has two tubes. One tube will be a supply and the other tube a return.

Determine the length of the tube per circuit.
Equivalent length of ½in. (12.7mm) I.D. copper tube
30ft. (9144mm) zone x 2 passes (supply & return) = 60ft. (18288mm)

2 interconnects at 1.5ft. (457mm) = 3ft. (914mm)

(The Airtex return bends may be ignored).

Total equivalent ft. = 60ft. (18288mm) + 3ft. (914mm) = 63ft. (19202mm)

Since we have 0.8 GPM (0.05 l/s) per Circuit the Water Pressure Drop Table on page 8 shows 2.16 ft per 100ft. (211.8Pa per m) of water pressure drop. Total pressure drop this circuit:

$$\frac{63 \times 2.16}{100} = 1.36 \text{ ft. of water} \left( \frac{19.2 \times 0.212}{m} = 4.07\text{kPa of water} \right)$$

**DESIGN EXAMPLE #2**

The following criteria apply to this design example. The building is multi-story, and the example is calculated for a typical intermediate floor.

- 100ft.(30480mm) x 200ft. (60960mm) rectangular building, 12ft.(3658mm) floor-to-floor
- Inside design 70°F(21.1°C) dry bulb
- Supply hot water available 200°F(93.3°C)
- Heat loss for each floor 225,000 BTUH (65.9kW)
- Bay length 33ft. 4in. (10160mm)
- Column size 2ft. (610mm) x 2ft.(610mm)
- Owner required 1 zone per 3 bays

**Step #1**

CALCULATE THE HEAT LOSS PER LINEAL FOOT OF OUTSIDE WALL

For this example, the panels will be installed from the column face to column face. Because the finished column size is 2ft. (610mm) x 2ft. (610mm), the panel required per bay is 33ft. 4in. (10160mm) − 2ft.(610mm) = 31ft. 4in. (9550mm).

$$\text{Output} = \frac{225,000 \text{ BTUH}}{(18 \text{ bays}) (31.33\text{ft.})} = 399 \text{ BTUH/L.ft.}$$

$$\text{Output} = \frac{65900\text{W}}{(18 \text{ bays}) (9.55\text{m})} = 383 \text{ W/m}$$

**Step #2**

DETERMINE THE LENGTH OF THE INDIVIDUAL PANELS REQUIRED PER ZONE

Since column face to column face spacing is 31ft. 4in. (9550mm), we will use two (2) 16ft. (4877mm) panels cut to length. The zone size will be 100ft. (30480mm) perimeter, however total panel length is 3 x 31ft. 4in. (9550mm) or 94ft. (28651mm).

**Step #3**

DETERMINE THE PANEL WIDTH REQUIRED

Based on 399 BTUH/linear foot (383 W/m) output needed, the panel width required is 24in. (610mm) using a MWT of 172°F(77.8°C). The 24in. (610mm) panel is composed of (4) 6in. (152mm) wide extrusions, each housing one copper tube. We will use (2) tubes for supply and (2) tubes for return water (see page 15).

**Step #4**

DETERMINE THE FLOW RATE REQUIRED PER ZONE

In order to minimize flow rate and water pressure drop, a 40°F(22.2°C) WTD will be selected. (This would require 192°F(88.9°C) supply water).

$$\text{GPM} = \frac{94 \text{ ft x 399 BTUH/ft}}{500 \text{ x } 40} = 1.9 \text{ GPM per zone}$$

**Step #5**

$$\text{l/s} = \frac{28.65\text{m x 383 W/m}}{419 \text{ x } 22.2} = 0.12 \text{ l/s per zone}$$

DETERMINE THE PIPING ARRANGEMENT AND WATER PRESSURE DROP PER CIRCUIT

Since the zone is composed of 2 circuits, each circuit will require 0.95 GPM (1.9/2)(0.06 l/s(0.12/2)). Water pressure drop includes pressure drop through both panel and interconnects.

Equivalent length of ½in. (12.7mm) I.D. copper tube:

94ft. (28651mm) of panel x 2 passes (supply & return) = 188ft. (57302mm)
Pigtail interconnects 3 x 2 passes x 1.5ft. (457mm) = 9ft. (2743mm)
Total equivalent length = 188ft.(57302mm) + 9ft. (2743mm) = 197ft. (60046mm)

Equivalent length of ½in. (12.7mm) O.D. tubing copper interconnects around columns
= 2 interconnects x 2 passes x 10ft. (3048mm) each = 40ft. (12192mm)

From the Water Pressure Drop table on page 8 the pressure drop for ½in. (12.7mm) I.D. copper tube at 0.95 GPM(0.06 l/s) is 2.97 ft./100 ft. (291.2 Pa/m). The pressure drop for ½in. (12.7mm) O.D. connecting tubing at 0.95 GPM    (0.06 l/s) is approx. 6.4 ft./100 ft. (0.63kPa/m).

$$\text{Pressure Drop} = \frac{197 \text{ x } 2.97}{100} + \frac{40 \text{ x } 6.4}{100} = 8.4 \text{ ft. of water}$$

$$\text{Pressure Drop} = \frac{60.05 \text{ x } .291}{m} + \frac{12.19 \text{ x } .63}{m} = 25.1 \text{ kPa of water}$$

18

SECTION 15XXX

**LINEAR RADIANT PANELS**

**1.0 GENERAL**

1.1 SCOPE

   .1 Linear Radiant Panels

**LINEAR HEF-2 PANEL SPECIFICATIONS**

1.2 QUALITY ASSURANCE

   .1 Panels should be manufactured by a company regularly engaged in the manufacture of radiant panels and having catalogue performance data and certified test data.

1.3 SUBMITTALS

   .1 Manufacturer shall submit complete scale shop drawings showing layouts and complete details of all areas where radiant panels are indicated. These drawings shall be co-ordinated with and interference shall be cleared with other trades.

   .2 Shop drawings shall indicate location of supply and return hook-ups in addition to interconnection details for each zone.

2.0 LINEAR RADIANT CEILING PANELS

2.1 .1 Contractor shall refer to architectural reflected ceiling plans and room finish schedule in addition to mechanical drawings to determine location, quantity and finish of radiant panels.

   .2 This panel specification is based on the AIRTEX HEF-2 Linear radiant ceiling panel design. Refer to the contract drawings for the details and dimensions. Panels shall run continuously from wall to wall and specified widths are minimum allowable.

   .3 The AIRTEX HEF-2 radiant ceiling extrusions shall be manufactured by ENGINEERED AIR, and shall consist of extruded aluminum with copper tubing of 0.504in.(12.8 mm) I.D. mechanically attached to the aluminum face plate. The copper tube shall be held in place by an aluminum saddle which extends more than half way around the diameter of the tube. A non-hardening heat conductive paste shall be placed between the copper tubing and the aluminum face plate. Panels shall weigh no more than 2.15 lb/ft$^2$ (10.5 kg/m$^2$) when operating. The use of adhesive and/or clips to attach the copper tube to the extrusion will not be acceptable.

   .4 Panels shall be finished in the manufacturer's standard white colour (or as selected by the consultant).

3.0 EXECUTION

3.1 INSTALLATION

   .1 The Mechanical Contractor shall co-operate with other trades working in the ceiling to achieve a neat, well co-ordinated overall installation. Refer to Architectural and Mechanical Details for installation requirements.

   .2 All interconnecting of radiant panels by the mechanical contractor shall consist of 3/8in. (9.0mm) nominal, 0.5in. (12.8mm) O.D. soft copper tubing or AIRTEX

accessories as recommended by ENGINEERED AIR, i.e. factory supplied 360 degree inter-connecting loops and 180 degree return U-bends. Supply first to panel tubing pass closest to perimeter wall. Multiple panels shall be circuited to ensure serpentine flow over complete length of zone. Individual serpentine panel coils connected in series is unacceptable for multiple panel zones.

.3  All radiant panels shall run continuous from wall-to-wall and shall be field trimmed to length ensuring adequate expansion allowance while maintaining panel end coverage by architectural mouldings. Inactive filler panels will be permitted only where indicated on drawings.

.4  Ceiling support mouldings for radiant panels to be supplied and installed by Division 9. Ensure ceiling openings and wall mouldings are installed as per radiant panel shop drawings.

.5  All radiant panels shall be installed by personnel wearing clean white gloves, to avoid soiling of panel face. Hanger wires for safety and seismic restraint shall be installed at 4ft. (1220mm) o.c. or as recommended by the manufacturer.

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

.7  Each group or zone of coils shall be given a pressure test in accordance with procedures specified elsewhere.

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

.9  All active panels shall be covered with a minimum of 1in.(25mm) thick batt insulation (refer to insulation specifications).


**MECHANICAL EQUIPMENT SCHEDULE**

LINEAR RADIANT PANELS

Description:

All radiant panels to be of single manufacture, Airtex Linear HEF-2.

| | |
|---|---|
| Designation | (Consultant's Designation) |
| Manufacturer | Airtex by Engineered Air |
| Model | Linear HEF-2 |
| Performance | (BTUH/Lin.ft.) (W/Lin.m.) |
| Minimum Width | (Specify) |

Notes:

.1  Output based on ___ °F( ___°C) supply, ___ °F ( ___ °C) return, with 70°F (21°C) ambient air temperature and 67°F (19.5°C) AUST with natural convection.

.2  Panel lengths and widths to be obtained from drawings.

.3  Panels to be finished to suit Architectural requirements.

## HISTORICAL NOTES

Testing of radiant transfer between surfaces of different temperatures has taken place over many years. These studies of panel heating and cooling have been continued to both determine the effect of asymmetric radiant fields on occupant comfort, and better methods for designing radiant panel heating and cooling systems.

The first lightweight metal ceilings through which heated or cooled water was passed were introduced into the United States in the early 1950's under a license to the Burgess-Manning Company. At that time Airtex became involved as the Midwest distributor and installer for Burgess-Manning Systems. In the late 50's Airtex developed a snap-on radiant panel system which was used at the O=Hare International Airport terminals. Airtex built a full size mock-up of a perimeter section of the O=Hare Terminal building. The perimeter wall was 25 ft. (7.6m) high, 1/2in. (13mm) thick single pane glass. The panels were the standard AIRTEX snap-on with pipe 6in. (152mm) on center for the first 7ft. (2.1m) and pipe 12in. (305mm) on center for the next 12ft. (3.7m) parallel to the glass perimeter. (There were radiant panels throughout the complex, for heating and cooling). The initial radiant ceiling at O=Hare Airport was completed in 1961 and covered more than 200,000 square feet (18,580m$^2$), much of which is still in operation. Additional areas have been added since the early 1960's.

In the early 1960's Airtex developed modular panels consisting of aluminum sheet to which copper tubing was soldered. This type of panel was designated as modular high performance panel because the cooling performance was more than double the snap-on system.

In the early 1970's Airtex developed an extruded aluminum radiant panel with a mechanically attached copper tube. This panel was called the Architectural Space Mastery Series and was the culmination of a five year research and developmental effort. The panel was introduced in 1977 and the first installation was completed in 1978.

In the mid 1980's research and development began to improve the Airtex extruded aluminum radiant panel. This second generation HEF-2 Linear Radiant panel was introduced in 1987. This panel incorporates new design features reducing manufacturing and installation costs and improving appearance and efficiency.

The performance testing and final development of this new HEF-2 Series panel was accomplished in a new modern research and development facility at the Airtex Laboratory in Chicago, Illinois.

## RESEARCH AND DEVELOPMENT FACILITY

Airtex Radiant Panels have been independently tested. The Airtex testing facility used to test our panels incorporated state of the art technology. The test room was designed to simulate an exterior room in a multi-story building. The floor of the test room, the floor above the ceiling plenum, and three interior walls were surrounded by a temperature-controlled environment. The temperature and the humidity of the perimeter space was controlled to meet test requirements. One wall was an outside wall. It simulated typical construction of about 50% glass with a 58in.x138in. (1473mmx3505mm) double-glazed thermal pane window. The test room interior dimensions were 12ft. x 12ft. x 10ft. (3658mm x 3658mm x 3048mm) high. A moveable finished ceiling was installed, usually between 8ft. and 9ft. (2438mm and 2743mm) above the finished floor, for testing. A cold room outside one wall simulated outside air conditions throughout the year, and could provide a 15 MPH (24 KMH) wind across the wall to simulate winter design conditions. Solar simulation was incorporated in the outside room to correspond to real life design situations.

A hydronic system supplied hot or cold water to the ceiling panels. Water flow rate was measured, as were supply and return water temperatures. Floor temperatures were measured at various distances from the outside wall. Room air temperatures were measured at one-foot increments from the floor to the ceiling.

All test work has been conducted by **Airtex** personnel and personnel from the Armour Research Institute or its successor, the Illinois Institute of Technology. Performance curves have been certified by professors from Illinois Institute of Technology and the University of Illinois in Chicago.

The performance of the perimeter panel heating system was measured with no mechanical air supply to the room, simulating conditions when a building is unoccupied with supply and return air systems turned off to save energy. The perimeter heating system maintains the temperature of the building. This type of testing provides true panel output with no mechanical supply air in the occupied space. With no air motion, stratification may increase between the floor and the ceiling of the room. The test conditions are "worst case" and do not represent true comfort conditions. When the building is occupied there is ventilation air being supplied to the space and people movement to break up the stratification. Therefore, when the space is occupied there is practically no stratification and comfort levels are superior to other types of perimeter heating systems.

Maintaining the mean radiant temperature of surfaces is one of the most important factors in controlling occupant comfort. The highest degree of comfort can be achieved with a combination of narrow radiant perimeter ceiling panels located within the first few feet of space as measured from the outside wall, with a mechanical air system for ventilation. Like any system, the designer should make use of manufacturer's recommendations for a given building, since the façade of the building is varied on most buildings for architectural effect. The placement of the radiant panels in relationship to the outside wall, the type and location of supply and return air devices, the type of building (i.e. multi-story or single-story), and the plenum area between the ceiling and floor above, all affect recommended design of the radiant panel heating system.

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