TABLE 1. THERMAL RESISTANCE OF PLASTER AND METAL CEILING PANELS

		Spacing in.	Thermal Resistance to Downward Heat Flow (r_d) (F deg)(hr)(sq ft) per Btu					
			Heat Flow Ratio, q_u/q_d					
			0	0.2	0.4	0.6	0.8	1.0[a]
Plaster Panels[b] Standard Gypsum Plaster, Three Coats	⅜ in. (nom.) non-ferrous tube or ½ in. (nom.) ferrous pipe *above* metal lath tied at 8-inch intervals with good tube embedment, or ⅜ in. (nom.) non-ferrous tube *below* metal or gypsum lath.	4½	0.30	0.34	0.38	0.42	0.46	0.50
		6	0.45	0.51	0.57	0.63	0.69	0.75
		9	0.75	0.85	0.95	1.05	1.15	1.25
		12	1.15	1.29	1.43	1.57	1.71	1.85
Aluminum Panel[c] ⅛ in. Minimum Thickness	pipe or tube installed so that excellent heat conduction to ceiling surface is obtained.	3	0.07	0.07	0.07	0.07	0.07	0.07

[a] Any ceiling panel also acts as a floor panel to the extent of its upward heat flow. If the upward heat flow is high and the space above is occupied, check floor surface temperature for possible foot discomfort (see *Reference 7*). Also check effect on heating requirements of the space above. It is not good practice to have the major portion of the upper room's heating requirements supplied by the upward heat flow of a ceiling panel below.

[b] Recommended maximum inlet water temperature (t_{max}) 140 F.

[c] Recommended maximum inlet water temperature (t_{max}) 220 F.

quired. Also in Table 1 find the resistance of each panel (r_d), using heat flow ratios calculated from the flow rates determined in Steps 2 and 4, interpolating as required.

Room	Spacing (Inches)	Heat Flow Ratio	Resistance (r_d)
A	4½	$\frac{12.5}{47.7} = 0.26$	0.35
B	9	$\frac{6}{19.7} = 0.30$	0.90
C	9	$\frac{5}{26.1} = 0.19$	0.85

Step 6. Mean Water Temperature

For the required panel output (q_d) found in Step 2, the panel resistance (r_d) found in Step 5, and the room air temperature (t_a), find the mean water temperature (t_{mw}) from Fig. 15. This use of Fig. 15 is illustrated in Fig. 15B.

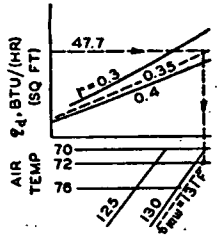

FIG. 15B. DETERMINATION OF MEAN WATER TEMPERATURE FOR ROOM A FROM FIG. A FROM FIG. 15

Values of t_{mw} for Rooms A, B and C as determined from Fig. 15 are as follows:

Room A t_{mw} = 131 F, Room B t_{mw} = 110.5 F, Room C t_{mw} = 119 F

Step 7. Design Mean Water Temperature

Select a single design mean water temperature (t_{dmw}) for each group of rooms which is to comprise a zone, choosing the highest mean water temperature (t_{mw}) of the group subject to the following:

a. If $t_{mw} + \frac{(t_i - t_o)}{2}$ is equal to or less than t_{max} (see Nomenclature and Table 1, this mean water temperature (t_{mw}) is an acceptable design mean water temperature (t_{dmw}). Proceed to Step 8.

b. If $t_{mw} + \frac{(t_i - t_o)}{2}$ is greater than t_{max}, go back to Step 5 and select a panel construction which has a lower panel resistance (r_d). This can be accomplished by either or both of the following:

1. Reducing the tube spacing,

2. Decreasing the upward heat flow (q_u) by providing additional insulation above the panel.

If the required mean water temperature is still too high apply either or both of the following:

1. Reduce the heat loss of the room,

2. Provide supplementary heating.

In Example 1, assume $t_i - t_o$ = 15 F deg and t_{max} = 140 F. Then since t_{mw} = 131 F, $t_{mw} + ½ (t_i - t_o)$ = 138.5 F and is less than t_{max}. Thus 131 F can be used as the design mean water temperature t_{dmw}.

Step 8. Design Panel Output

From Fig. 15, find the panel output (q_d) for design mean water temperature (t_{dmw}), room air temperature (t_a) and panel resistance (r_d). Fig. 15C shows how Fig. 15 is used to find q_d for Room B in this step.

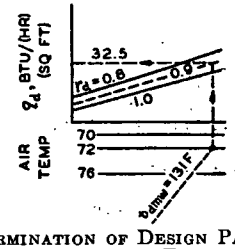

FIG. 15C. DETERMINATION OF DESIGN PANEL OUTPUT FOR ROOM B FROM FIG. 15

The mean water temperature (t_{mw}) found for Room A in Step 6 was used as the design mean water temperature (t_{dmw}). The panel output for Room A which was determined in Step 2 is therefore the design panel output for this room. Design panel outputs for Rooms B and C can be found from Fig. 15 using the design mean water temperature (t_{dmw}).

Room	Design Panel Output (q_d) BTU per (hr)(sq ft)
A	47.7
B	32.5
C	33.