

Step 9. Design Panel Area

Divide the room heat loss found in Step 1 by the design panel output found in Step 8.

ROOM	DESIGN PANEL AREA (A_p) Sq ft
A	132 (Unchanged from Step 2)
B	77
C	242

Step 10. Total Panel Output

Add the heat flow upward (q_u) to the design panel output (q_d) and multiply by the design panel area to obtain the total panel output. If the design panel output is different from the panel output (q_d) used in Steps 3 and 4, the heat flow upward (q_u) should be redetermined.

ROOM	q_u	q_d	$q_u + q_d$	A_p	TOTAL PANEL OUTPUT $A_p(q_u + q_d)$ Btu/hr
A	12.5	47.7	60.2	132	7946
B	9.5†	32.5	42.	77	3234
C	5.5†	33	38.5	242	9317

† redetermined.

Step 11. Fluid Circuit

Design the fluid circuit (panel piping and mains) for a temperature drop of 10 to 20 F deg between the water inlet and outlet of the panel (See Chapter 21 Hot Water Heating Systems).

Step 12. Boiler Size

Size the boiler according to method contained in Chapter 16 Heating Boilers, Furnaces, and Space Heaters. The net Btu rating of the boiler should equal or exceed the total output of all panels plus any other loads on the boiler.

Procedure for Metal Ceiling Panels¹³

Follow the procedure for Hot-Water Plaster Ceiling Panels.

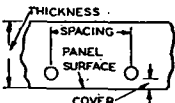
Procedure for Concrete Ceiling Panels¹³

Concrete ceiling panels are distinguished from concrete floor panels in intermediate floors by the position of the tubes in the concrete slabs (see Tables 2 and 3). Both types of panels have heat outputs in both directions in amounts determined by the thermal resistances and the temperature differences in the two directions. The effect of both outputs on heating requirements of the spaces and the comfort of the occupants should always be considered. (See section on Procedure for Concrete Floor Panels—Intermediate Slab.)

The procedure for hot-water plaster ceiling panels cannot be applied in its entirety to concrete ceiling panels because some of the simplifying assumptions regarding the upward heat flow from plaster panels are not

Panel Heating

TABLE 2. THERMAL RESISTANCE OF CONCRETE CEILING PANELS

PANEL CONSTRUCTION		SPACING in.	THERMAL RESISTANCE (F deg)(hr)(sq ft per Btu)					
			HEAT FLOW RATIO q_u/q_d					
			0		0.5 ^a		1.0 ^a	
			up	down	up	down	up	down
6 in. CONCRETE SLAB—1 in. COVER			r_{us}	r_d	r_u	r_d	r_u	r_d
½ in. (nom.) non-ferrous tube	9		3.6	0.30	0.9		0.7	0.45
	12		5.1	0.35	1.1		0.9	0.55
½ in. (nom.) ferrous pipe or ¾ in. (nom.) non-ferrous tube	9		2.6	0.25	0.7		0.6	0.35
	12		4.0	0.30	0.9		0.8	0.50
¾ in. (nom.) ferrous pipe or 1 in. (nom.) non-ferrous tube	9		2.1	0.20	0.6		0.6	0.30
	12		3.3	0.30	0.8		0.7	0.40
	15		4.5	0.35	1.0		0.8	0.55
1 inch (nom.) ferrous pipe	9		1.6	0.20	0.5		0.5	0.25
	12		2.6	0.25	0.7		0.6	0.35
	15		3.6	0.30	0.9		0.7	0.45
8 in. CONCRETE SLAB—1 in. COVER								
½ in. (nom.) non-ferrous tube	9		3.6	0.30	1.0		0.8	0.40
	12		5.2	0.35	1.2		1.0	0.55
½ in. (nom.) ferrous pipe or ¾ in. (nom.) non-ferrous tube	9		2.9	0.25	0.9		0.8	0.35
	12		4.0	0.30	1.1		0.9	0.45
¾ in. (nom.) ferrous pipe or 1 in. (nom.) non-ferrous tube	9		2.2	0.20	0.8		0.7	0.30
	12		3.3	0.30	1.0		0.8	0.40
	15		4.3	0.35	1.1		0.9	0.50
1 in. (nom.) ferrous pipe	9		1.7	0.20	0.7		0.7	0.25
	12		2.7	0.25	0.9		0.8	0.35
	15		3.7	0.30	1.0		0.9	0.45

^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.

valid for concrete panels. The necessary modification of the plaster ceiling panel procedure is as follows:

Step 1. Heat Loss

Follow the procedure for Plaster Ceiling Panels, Step 1.

Step 2. Required Panel Output

Follow the procedure for Plaster Ceiling Panels, Step 2.

Step 3. Panel Surface Temperature

Follow the procedure for Plaster Ceiling Panels, Step 3.

Step 4. Upward Heat Flow Estimate

- If the upper surface of the slab is exposed to form a floor, find the heat flow upward from Fig. 16, using the panel surface temperature (t_p) found in Step 3, and the air temperature of the space above.
- If the upper surface of the slab is not exposed, use the equation:

$$q_u = C_1(t_b - t_p) \quad (10)$$

Step 5. Upward and Downward Panel Resistance

Follow the procedure for Plaster Panels, Step 5, using Table 2 to find both resistances (r_{us} and r_{ds}).