joist spaces and an uninsulated attic space with a combined U value of 0.05 from room C to outdoor air.

*Step 1. Heat Loss*

Calculate the heat loss of each room by methods outlined in Chapter 12 Heating Load, but do not include any heat loss through the area covered by the panel.

Room dimensions and calculated heat losses are as follows:

| Room | Dimensions Feet | Heat Loss Btu per hour |
|---|---|---|
| Room A | 11 x 12 x 8 | 6300 |
| Room B | 11 x 12 x 8 | 2500 |
| Room C | 15 x 21 x 8 | 8000 |

*Step 2. Required Panel Output*

Divide the heat loss of each room by the maximum ceiling area in the room which can be used as a heating panel. The result is the minimum heat output per square foot of panel that will satisfy the requirements of the room. The panel that requires the highest output per square foot will generally control the design, because the temperature of the fluid in the system must be high enough to produce the required output from that panel. The required panel output is given in the following table.

| Available Panel Area Sq Ft | Required Panel Output, $q_d$ Btu/(hr) (sq ft) |
|---|---|
| Room A 132 sq ft | $\frac{6300}{132} = 47.7$ |
| Room B 127 sq ft | $\frac{2500}{127} = 19.7$ |
| Room C 306 sq ft | $\frac{8000}{306} = 26.1$ |

*Step 3. Panel Surface Temperature*

From Fig. 15 find the panel surface temperature needed to yield the required heat output to each room, using the output determined in Step 2 and the design room air temperature. This use of Fig. 15 for Room A is illustrated in Fig. 15A.

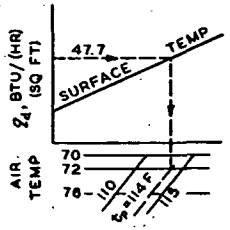



Fig. 15A. Determination of Panel Surface Temperature for Room A from Fig. 15

The values of $t_p$ determined for Rooms A, B and C are as follows:

Room A $t_p$ = 114 F
Room B $t_p$ = 92 F
Room C $t_p$ = 97 F



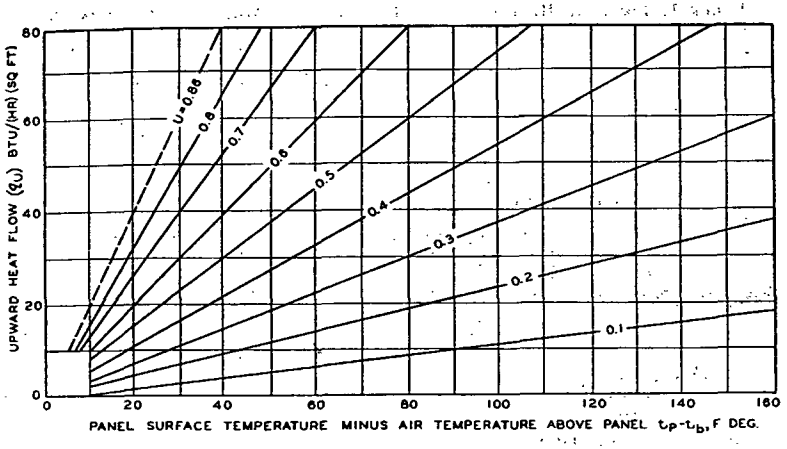



Fig. 18. Upward Heat Flow from Plaster Ceiling Panel

*Step 4. Upward Heat Flow*

Determine the upward heat flow from each panel using Fig. 18. The upward heat flow must be determined in order to obtain the downward panel resistance and to select the proper size of boiler. The use of Fig. 18 is illustrated for Room A in Fig. 18A. Note that the $U$ values shown on Fig. 18 are those for the entire struc-

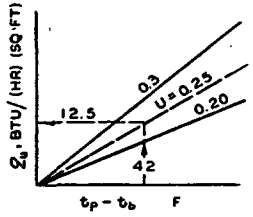



Fig. 18A. Determination of Upward Heat Flow for Room A from Fig. 18

ture of which the panel is a part and are taken from room air (temperature, $t_a$) to air above the panel (temperature, $t_b$) and for that reason $q_u \neq U(t_p - t_b)$. $U$ values may be obtained from Chapter 9 Heat Transmission Coefficients of Building Materials.

The values of $q_u$ for Rooms A, B and C as determined from Fig. 18 are as follows:

| Room | $U$ | $t_p - t_b$ F Deg | $q_u$ Btu/(hr) (sq ft) |
|---|---|---|---|
| A | 0.25 | 42 | 12.5 |
| B | 0.25 | 20 | 6 |
| C | 0.05 | 97 | 5 |

*Step 5. Downward Panel Resistance*

Assume tentative pipe or tube spacings for the panel construction to be used from those listed in Table 1, choosing the closer spacings when higher outputs are re-