peratures of these walls, therefore, cannot be lower than 68 F and must actually be higher than 68 F because, in addition to their contact with 68 F air and their contact with the heated ceiling, they are exposed to the heat radiation from the ceiling.

In the following example, *70 F will be selected as the mean surface temperature of the inside walls.*

For the two outside walls, the mean inside surface temperature can be calculated with fair accuracy. For a heat transmission coefficient of 0.25 and a temperature difference of 68 deg, heat flows through the wall at the rate of 17 Btuh per square foot. If the indoor film coefficient is 1.65, the temperature difference, indoor air to inside wall surface, is 17/1.65 or 10 deg and the wall surface temperature is 68 − 10, or 58 F. This value may be taken directly from Fig. 8. However, the film coefficient 1.65 was deter-

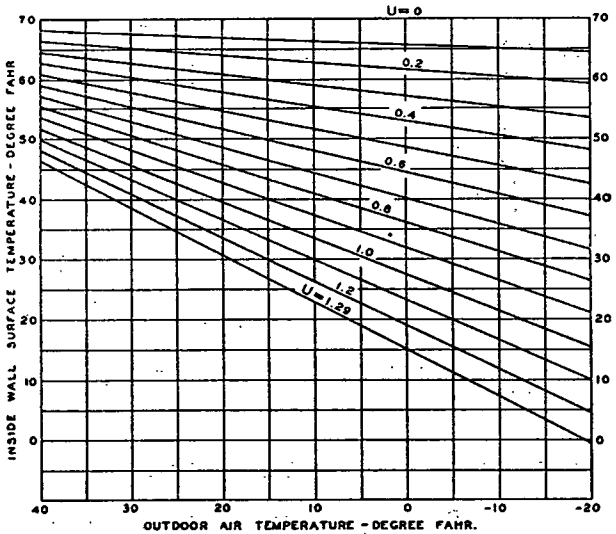

FIG. 8. CHART FOR ESTIMATING INSIDE SURFACE TEMPERATURES OF OUTSIDE WALLS[a]

[a]NOTE: The value of U, the over-all coefficient of heat transmission, cannot exceed 1.29 if the inside and outside film coefficients are 1.65 and 6.0 respectively (*e.g.* $\frac{1}{U} = \frac{1}{1.65} + \frac{1}{6} = \frac{1}{0.773}$. Therefore $U = 1.29$ maximum).

mined to represent the sum of the heat flow into the wall, by conduction from the air in contact with the wall, and by radiation from the warmer surfaces *seen* by the wall surface. In a panel-heated room, the rate of heat flow into the outside wall by radiation is greater than it is in a radiator-heated room; consequently, the film coefficient is higher, and the temperature difference, air to wall surface, is smaller, and therefore, the wall surface temperature is higher than the calculated 58 F. It is impossible to determine accurately how much higher than 58 F the temperature of the wall surface will be until the corresponding indoor air film coefficient has been determined accurately.

In the following example, *60 F will be selected as the probable mean inside surface temperature of the outside walls.*

The probable mean inside surface temperatures of the floor and the glass may be determined by calculations and by reasoning similar to that employed to determine the inside surface temperature of the outside walls.

In the following example, *80 F and 70 F will be selected as the probable inside surface temperatures of the glass and floor*, respectively.

TABLE 1. CALCULATED HEAT LOSS OF ROOM

SURFACE	AREA SQ FT	U	CALCULATION	HEAT LOSS BTUH
Outside Walls	360	0.25	360 x 0.25 x 68	6,120
Glass	216	1.13	216 x 1.13 x 68	16,597
Inside Walls	480	-----	No heat loss	-----
Ceiling	480	-----	Heating Panel	-----
Floor	480	0.10	480 x 0.10 x 38	1,824
Infiltration	-----	-----	5,760 cu ft x 1.50 x 68 x 0.018	10,576
			Total	35,117

4. *Determine the heat loss of the room.*

In the following example, the heat loss calculation will be based on an outdoor air temperature of 0 F. Since the functioning of a panel-heating system differs very little from that of a radiator-type heating system, the heat loss shown in Table 1 may be calculated according to Chapter 14.

The heat loss through the outside walls and through the glass is probably a little greater than calculated because the calculation is based on an indoor air film coefficient of 1.65 Btuh, whereas, for a panel-heated room, this coefficient is a little higher, but the difference is probably not sufficiently large to be considered in design calculations for a heating system.

5. *Estimate the Mean Radiant Temperature.*

The Mean Radiant Temperature of the surfaces enclosing the room but not including the heating panels may be estimated as follows:

SURFACE	AREA	FAHR DEG	PRODUCT
Interior Walls	480	70	33,600
Exterior Walls	360	60	21,600
Glass	216	30	6,480
Floor	480	70	33,600
	1,536		95,280

The sum of these products divided by the sum of the surface areas is: 95,280/1,536 or 62.03 F, the required mean surface temperature.

In the following example, *62 F will be selected as the MRT of walls, glass and floors.*

6. *Determine the temperature of the ceiling panel.*

Determine the temperature of the ceiling so that the ceiling panel will deliver heat to the room at a rate equal to the rate at which the room is calculated to lose heat, namely, 35,117 Btuh.

When a room is heated by means of a panel, air convection currents are developed in the room similar to those which are developed when the room is heated by means of a free-standing radiator. Consequently, the heating panel delivers heat to the room partly by radiation and partly by convection. The proportion of the total heat flow delivered by convection varies with the location of the heating panel, with the height of the ceiling, and with the size, number, and location of pieces of furniture and other articles which interfere with the free flow of air along the floor and along the walls. It is generally sufficiently accurate to assume that a ceiling panel will deliver 70 per cent of its heat by radiation and 30 per cent by convection; a floor panel 55 per cent by radiation and 45 per cent by convection; and a wall panel 65 per cent by radiation and 35 per cent by convection.

In the following example, *it will be assumed that the ceiling panel must deliver 70 per cent of its heat or 24,582 Btuh by radiation*, since the total calculated heat loss is 35,117.