TABLE 2. HIGHEST SAFE SURFACE TEMPERATURES FOR HEATING PANEL

TYPE OF PANEL	SURFACE TEMPERATURE DEG F
Plastered Ceiling (Pipes Embedded)	115
Plastered Walls (Pipes Embedded)	120
Floor, Any Method	85
Floor, Border and Aisles	120
Iron, Hot Water Medium[a]	160
Iron, Steam Vapor[a]	180
Electrically Heated Panels[a]	200

[a]Low surface temperature radiation is recommended regardless of the heating medium employed.

The difference between the desired and the actual total radiant emission represents the additional heating effect which must be supplied by the hot surfaces to be installed. The temperature of the proposed hot surface must then be selected from Table 2, and its emission per square foot at that temperature determined from Table 1. The difference between this emission and that of the unheated surface replaced by the panel is divided into the total amount of additional heat needed, and the quotient will be the area of the required heating surfaces.

These calculations depend on the accuracy of estimating the ultimate surface temperatures of the walls, windows, ceiling and floor surfaces under comfort conditions. Some unheated surfaces will absorb a large number of heat rays from the heated panels and thereby become warmer, giving off rays of longer wave length, while other surfaces will reflect a large percentage of rays and become simple reflectors of heat. Windows will be affected largely by curtains, shades or venetian blinds and floors will be affected by rugs and carpets.

Example 1. The surface areas and over-all heat transmission coefficient for a residence room having a volume of 5760 cu ft are given in Table 3. Determine the amount of radiating surface to maintain a room air temperature of 65 F and an MRT of 71 F, with an outside temperature of zero, utilizing ceiling panels with circulating hot water at 130 F which will maintain a surface temperature of approximately 115 F as given in Table 2.

Solution. From Fig. 7 determine the estimated inside surface temperature for the various surfaces. In the case of the outside wall having a $U = 0.25$, it is found from the

TABLE 3. ROOM DATA FOR SOLVING EXAMPLE

SURFACE	AREA SQ FT	U	ESTIMATED INSIDE SURFACE TEMP DEG F	EMISSIVITY e	HEAT EMISSION BTU PER SQ FT PER HOUR	TOTAL HEAT EMISSION FROM AREA BTU PER HOUR
Outside Wall	297	0.25	55.0	0.95	115.1	34,200
Glass	279	1.13	33.6	0.92	94.3	26,300
Inside Wall	480	......	60.0[a]	0.95	119.5	57,300
Ceiling	480	0.20	60.4	0.95	119.8	57,500
Floor	480	0.10	60.0	0.93	117.0	56,200
Total	2,016			Avg. 0.93		231,500

[a]No heat loss through inside wall; assume wall surface temperature 60 F.

chart, that the intersection of this line with the zero outside temperature, that the surface temperature is 55 F.

Since the glass temperature will depend on whether or not shades or curtains are provided, it may be assumed in offices and similar rooms that the whole glass surface will be exposed, whereas in residences, curtains may cover all or part of the window thus increasing the room MRT and reducing the human body heat loss. For this example it is assumed that the windows are partly covered with side curtains to the extent of about one-third. From Fig. 7 the surface temperature of the exposed glass corresponding to a $U = 1.13$, is 19 F. Assuming about a 2 F differential between the room air temperature

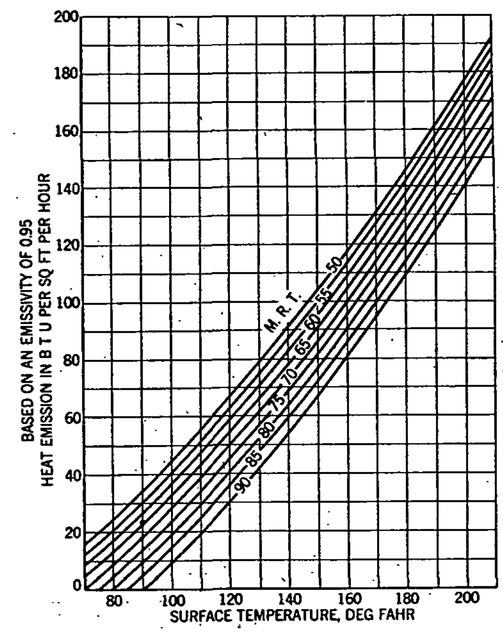

FIG. 8. HEAT EMISSION BY RADIATION FROM PANELS WHEN SURROUNDED BY SURFACES OF VARIOUS TEMPERATURES GIVING AN AVERAGE MRT ACCORDING TO CURVES

and curtain surface temperature or 63 F, then one-third the difference between this value and the glass temperature results in a calculated average of 33.6 F.

With a ceiling $U = 0.20$, the surface temperature for an unheated ceiling from Fig. 7 is 57 F; multiplied by a factor $1.06 \times 57 = 60.4$ F. The surface temperature of the floor with a $U = 0.10$ is from Fig. 7 a value of 62 F; multiplied by a factor $0.968 \times 62 = 60$ F.

The emissivities are selected from Table 6, Chapter 3. The glass emissivity of 0.92 in Table 3 was determined by taking one-third of 0.95 (curtain) and two-thirds of 0.90 (glass). The heat emission in Btu per square foot per hour is taken from Table 1.

The approximate natural mean radiant emission of the room from data in Table 3 is $231{,}500 \div 2016 = 114.8$ Btu per square foot per hour which from Table 1 corresponds to an MRT of 57 F for an average emissivity of 0.93. With a ceiling surface temperature of 115 F and an emissivity of 0.95 from Table 1 the emission is 179.0 Btu per square foot per hour. The difference between 179 and 119.8 used in Table 3 is the additional heat emitted per square foot of warmed ceiling.

For an MRT of 71 F having a heat emission of 127 Btu corresponding to an average emissivity of 0.93, the total emission for all the room surfaces is $2016 \times 127 = 256{,}000$