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 area in square feet of each type or different surface temperature, horizontal or vertical, is multiplied by the emission value corresponding to its actual surface temperature. These products are added together to give the total radiant heat effect inside the room from all surfaces.

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.

It is evident that this method of calculation depends for its accuracy on a correct estimate of the ultimate surface temperatures naturally attained by the actual wall, window, ceiling and floor surfaces.

Example 1. The surface areas, assumed temperatures, and emissions for a room having a volume of 5760 cu ft are given in Table 3. The figures for temperatures are based on a room air temperature of 65 F and an outside temperature of zero. The heat emissions in Btu per square foot per hour are taken from Table 1.

The values for glass will depend on whether or not shades and curtains are provided. In offices and other similar rooms the whole glass surface will invariably be fully exposed to the occupants; whereas in a residence, curtains may cover part or the whole window, thus increasing the natural MRT and reducing the heat loss from the human body.

The mean radiant emission of the room in Example 1 is 223,912 ÷ 2016 = 111.0 Btu per square foot per hour which from Table 1 corresponds to an MRT of 54 F for an average emissivity of 0.92.

Table 3. Surface Area, Temperatures and Emissions for a Room of 5760 Cu Ft

	Area Sq Ft	Assumed Surface Temperature Deg F	Emissivity	Heat Emission Btu per Sq Ft per Hour	Total Heat Emission from Area Btu per Hour
External Wall	297	50	0.95	110.6	32,850
Glass	279	40	0.80	86.1	24,022
Inner Wall	480	60	0.95	119.5	57,360
Ceiling	480	60	0.95	119.5	57,360
Floor	480	55	0.90	109.0	52,320
Total	2016				223,912

In order to determine the amount of radiating surface necessary to maintain the MRT at 71 F, assume ceiling panels have a surface temperature of 115 F, which is approximately the mean temperature for pipes embedded in the plaster with circulating water at 130 F as given in Table 2. With a ceiling surface temperature of 115 F and an emissivity of 0.95, from Table 1 the emission is 179 Btu per square foot per hour.

The difference between 179 and 119.5 used in Table 3 is the extra Btu emitted by warmed ceiling, per square foot, and therefore 480 sq ft multiplied by (179 − 119.5) = 28,560 Btu per hour.

Therefore the total radiant heat emission with ceiling heated will be 223,912 + 28,560 = 252,472 Btu per hour or an average emission of 252,472 ÷ 2016 = 125.21 Btu per square foot per hour. With an average emissivity of 0.92 it is found from Table 1 that

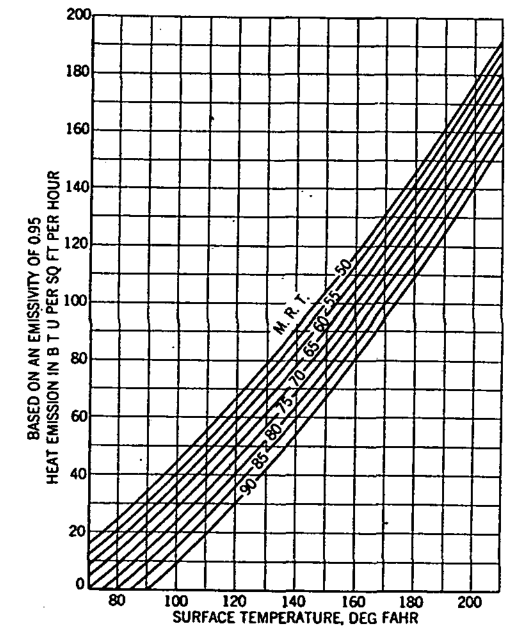

Fig. 7. Heat Emission by Radiation from Panels when Surrounded by Surfaces of Various Temperatures Giving an Average MRT According to Curves

this emission corresponds to an MRT of 70.5 F which is close to the 71 F necessary for optimum comfort conditions.

If the MRT derived by this calculation had been much below 71 F, it would have been desirable to add either some floor heating or panels in side walls. On the other hand, metal panels might have been installed in the ceiling and operated at a higher temperature.

Similar calculations may be used for any kind and surface temperature of panel selected by using the difference between the actual emission from the heated surface as obtained from Table 1 and the emission for the unheated surface as used in Table 3.

Such calculations may be simplified, by preparing tables showing at the usual temperatures the area of hot surface required to bring each square foot of actual wall or other surface up to one or more desired standard MRT's.