In order to determine the amount of radiating surface necessary to maintain the MRT at 72 F, assume the surface temperature of the hot plates to be installed to be 200 F, which is approximately the temperature they would have if heated by steam.

The 2016 sq ft total area of the surfaces of the room multiplied by 130.9, which is the emission in Btu per square foot per hour necessary to maintain a body surface temperature of 83 F, gives a total desired emission of 263,890 Btu per hour. It is necessary to supply enough radiant heating surface to increase the total actual mean radiant heat emission by the room from 228,310, as shown in Table 2, to the 263,890 Btu desired. The additional heat needed is the difference between these figures, or 35,580 Btu. Since, from Table 1, the emission per square foot at 200 F is 309 Btu, the required radiant heating surface needed is $\frac{35,580}{309} = 115$ square feet. The effect of this surface suitably placed would be to raise immediately the mean radiant temperature to the required degree and to maintain it at that value as long as the surfaces remained at the values assumed.

In the solution of this particular example, the radiation loss from the human body was selected as 217 Btu per hour, which is that taking place under optimum comfort conditions, with a body surface temperature of 83 F in a uniform environment at 72 F. The mean radiant temperature necessarily was 72 F. If the optimum BET of 72 deg Fahr is desired, an air temperature of 72 F also must be maintained. If it is desired to maintain a lower air temperature than this, a mean radiant temperature greater than 72 F must be selected and the radiation loss from the individual must be recalculated from Equation 1.

The calculation 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 surface at various temperatures up to a general standard of from 60 F to 70 F. It would then be necessary only to multiply the respective areas by the appropriate factors, and to add the results, to obtain the required total.

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PROBLEMS IN PRACTICE

1 ● Differentiate between radiant and convection heating.

The primary function of radiant heating is to warm the individual by direct heat rays and without heating the surrounding air, while in convection heating it is generally the function of the heating medium to transfer the heat to the air and thence to the occupant of the room.

2 ● What is the mean normal surface temperature of the human body as determined for the United States?

83 F.

3 ● Explain the difference between radiant heating and ordinary methods of heating.

Radiant heating provides conditions to control the heat loss from the human body according to the physiological requirement of the body; whereas, ordinary methods of heating warm the air in a building to a predetermined temperature compatible with a feeling of comfort.

4 ● Describe how to calculate the required amount of radiant heating surface.

a. Obtain the mean heat emission in Btu per square foot per hour for room surfaces X, using values given in Table 1, and surface temperatures as shown in second column of Table 2.

b. Deduct X from 142 (142 being the emission per square foot given off by the human body at 83 F surface temperature) $= Y$ in Btu per square foot per hour.

c. From (142-X) deduct 11.1 (11.1 being the average radiation which the human body should lose per square foot for comfort conditions) $=$ (142-X-11.1) $= Z$.

d. Multiply total interior surface of room by Z and divide by the emission per square foot from radiant heater, giving the surface S of radiant heater in square feet.

5 ● Give a simple formula to calculate radiant heating surface required, and explain.

$$S = \frac{(142 - X - 11.1)\,A}{B}$$

where

S = surface of radiant heater, square feet.
142 = Heat emission, Btu per square foot per hour which the human body would give off at 83 F, with surroundings at absolute zero.
X = mean heat emission, Btu per square foot per hour from surfaces of room.
11.1 = heat emission, Btu per square foot per hour from human body.
A = total surface, square feet of walls, ceilings, windows, etc., in room.
B = heat emission per square foot from radiant heater surface.

6 ● Is the heat generated in the body affected by action? If so, does it vary greatly?

Yes. With hard work or energetic exercise, the total heat generated in the body may be five to six times that generated when it is at rest.

7 ● When and why does the human body feel cold?

The body feels cold not only when it loses heat at a greater rate than it can generate it, but also when heat is abstracted from the body disproportionately. The human body does not require any heat from without because it generates more heat than is sufficient to maintain the correct temperature; therefore, it is only necessary to provide conditions that will maintain the correct ratio of losses.