The actual radiation transfer in a room may be somewhat different from that given by Equation 3 because of non-uniform temperatures, irregular room surfaces, variations in emissivity of materials, etc. It is generally agreed, however, that the equation is accurate to within 10 percent when used in conventional heating and cooling calculations. Tests[4] conducted in the ASHAE Environment Laboratory[5] showed that the value of the constant of Equation 3 was 0.152 in the test room. The design information in this Chapter is based on that value of the constant.

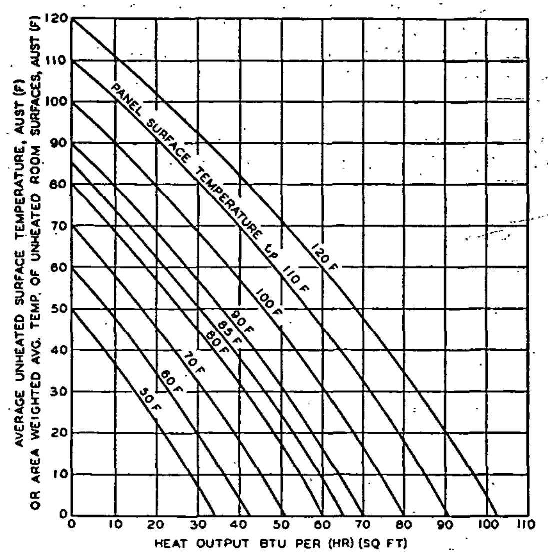


FIG. 9. HEAT OUTPUT BY RADIATION

Radiation exchange calculated from Equation 3 is given in Fig. 9. The values apply to either ceiling, floor, or wall panel radiation output.

## Convection Transfer

Convection values of heat transfer are not easily established. Convection in a panel heated space is usually considered to be of the *natural* type, that is, air motion is generated by the warming (by conduction) of the boundary layer of air which starts moving as soon as its temperature exceeds that of the surrounding air. In practice, however, there are many factors which interfere with or affect *natural* convection. The configuration of the room and the space connected to it and the variation in temperature throughout the two spaces determine the *natural* convection. Infiltration, ventilation, and the movement of persons may serve to introduce some *forced* convection which can disturb the natural process.

The laboratory approach has been to measure the *natural* convection in a bare, box-like room which is sealed against infiltration and in which all surfaces, except the heated panel, are at one uniform temperature. Convection is also measured with varying amounts of infiltration and a correction determined for use in practical problems.[6, 7]

Tests[4] conducted in the ASHAE Environment Laboratory indicated that



the natural convection from floors and ceilings can be calculated from Equations 4 to 9 which follow.

Natural convection from heated ceiling

$$q_c = 0.041 \frac{(t_p - t_a)^{1.25}}{D_e^{0.25}} \tag{4}$$

Natural convection from heated floor

$$q_c = 0.39 \frac{(t_p - t_a)^{1.31}}{D_e^{0.08}} \tag{5}$$

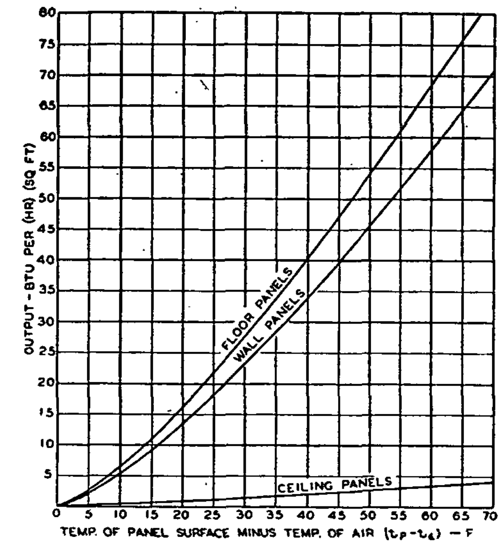


FIG. 10. HEAT OUTPUT BY CONVECTION FROM FLOOR AND CEILING PANELS

Natural convection from heated wall

$$q_c = 0.29 \frac{(t_p - t_a)^{1.32}}{H^{0.05}} \tag{6}$$

*where*

$q_c$ = heat transfer by convection, BTU per (hour) (square foot)
$t_p$ = temperature of panel surface, Fahrenheit.
$t_a$ = temperature of the air, Fahrenheit.
$D_e$ = equivalent diameter of panel (area × 4 ÷ perimeter), feet.
$H$ = height of wall panel, feet

Measurements of panel performance in furnished test rooms which did not have uniform temperature surfaces showed variations that are not large enough to be significant in heating practice.[8] Other tests[9] established that the effect of room size was also usually insignificant. The convection equations can therefore be simplified to:

Natural convection from heated ceiling

$$q_c = 0.021 (t_p - t_a)^{1.25} \tag{7}$$