a building having floors of high heat capacity such as concrete floors on which the solar radiation falls, approximately one-half of the heat entering a bare window is absorbed by the floor and does not immediately become a part of the cooling load, but is delivered back to the air in the building at a slow rate over a period of 24 hr or longer.

The maximum solar intensity on any surface is of limited duration as shown in Fig. 1. In the case of windows the total energy impinging on the glass before and after the time of maximum intensity is further reduced by increased shading of the glass from the frame, or wall. The cooling load due to solar radiation therefore does not have to be calculated as a steady load. Another point which should be noted is that the maximum solar radiation load on the east wall occurs early in the morning when the outside temperature is low.

Tests have been made which indicated that solar radiation through window glass is the most important factor to contend with in the cooling of an office building. At times it was shown to account for as much as

TABLE 8. SOLAR RADIATION TRANSMITTED THROUGH SHADED WINDOWS

TYPE OF APPURTENANCE	FINISH FACING SUN	PER CENT DELIVERED TO ROOM
Canvas awning	Plain	28
Canvas awning	Aluminum	22
Inside shade, fully drawn	Aluminum	45
Inside shade, one-half drawn	Buff	68
Inside Venetian blind, fully covering window, slats at 45 deg	Aluminum	58
Outside Venetian blind, fully covering window, slats at 45 deg	Aluminum	22

75 per cent of the total cooling necessary. Because of the importance of the sun load, cooling systems should be zoned so that the side of the building on which the sun is shining can be controlled separately from the other sides of the building. If buildings are provided with awnings so that the window glass is shielded from sunshine, the amount of cooling required will be reduced and there will also be less difference in the cooling requirements of different sides of the building. The total cooling load for a building exposed to the sun on more than one side is of course less than the sum of the maximum cooling loads in the individual rooms since the maximum solar radiation load on the different sides occurs at different times. In determining the total cooling load for a building if the time when the maximum load occurs is not obvious, the load should be calculated for various times of day to determine the times at which the sum of the loads on the different sides of the building is a maximum.

Heat Emission of Occupants

The heat and moisture given off by human beings under different states of activity are shown in various tables and figures of Chapter 3 which covers the physical and physiological principles of air conditioning. It will be observed from these data that the rate of sensible and latent heat emission by human beings varies greatly depending upon state of activity. In many applications this component becomes a large per-

centage of total load. Metabolic rates are markedly variable for some extreme environmental conditions and this is another important factor which must be considered in cooling load computations.

Heat Introduced by Outside Air

An allowance must be made for the heat and moisture in the outside air introduced for ventilation purposes or entering the building through cracks, doors, and other places where infiltration might occur.

The volume of air entering due to infiltration may be estimated from data given in Chapter 6. Information on the amount of outside air required for ventilation will be found in Chapter 3.

In the event the volume of air entering an enclosure due to infiltration exceeds that required for ventilation, the former should be used as a basis for determining the portion of the load contributed by outside air. Where volume of air required for ventilation exceeds that due to infiltration it is assumed that a slight positive pressure will exist within the enclosure with a resulting exfiltration instead of infiltration. In this case the air required for ventilation is used in determining outside air load.

The sensible heat gain resulting from the outside air introduced may be determined by the following formula:

$$H_s = 0.24 \times 60\, d_o\, Q\, (t_o - t) \qquad (4)$$

where

H_s = sensible heat to be removed from outside air entering the building, Btu per hour.
Q = volume of outside air entering building, cubic feet per minute.
d_o = density of air, pounds of dry air per cubic foot at temperature t_o.
t_o = temperature of outside air, degrees Fahrenheit.
t = temperature of inside air, degrees Fahrenheit.

The total heat gain resulting from outside air introduced may be determined by the following formula:

$$H = 60\, d_o\, Q\, (h_o - h) \qquad (5)$$

where

H = total heat to be removed from outside air entering the enclosure, Btu per hour.
Q = volume of outside air entering enclosure, cubic feet per minute.
d_o = density of air, pounds of dry air per cubic foot of air (at temperature t_o).
h_o = heat content of mixture of outside dry air and water vapor, Btu per pound of dry air (at temperature t_o).
h = heat content of mixture of inside dry air and water vapor, Btu per pound of dry air (at temperature t).

The latent heat gain resulting from outside air introduced may be determined by the following formula:

$$H_l = H - H_s \qquad (6)$$

where

H_l = latent heat to be removed, Btu per hour.
H = total heat to be removed, Btu per hour.
H_s = sensible heat to be removed, Btu per hour.