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, crevices, 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.

Heat Emission of Appliances

Heat generating appliances which give off either sensible heat or both sensible and latent heat in an air conditioned enclosure may be divided

into three general classes of equipment or devices:

1. Electrical appliances.
2. Gas appliances.
3. Steam heating appliances.

In the first group may be found such devices as lights, motors, toasters, waffle irons, etc. The capacities of most electrical devices may be determined from the watt capacity indicated on their name plates. The Btu equivalent of heat generated per hour is determined by multiplying the watt capacity by 3.4 (one watthour is equivalent to 3.413 Btu).

The capacities of electric motors are usually expressed in terms of horsepower instead of watts. If the motor efficiency is known, the watts input may be calculated from the formula:

$$P = \frac{746\ (hp)}{n} \qquad (7)$$

where

P = motor input, watts.
hp = motor load, horsepower.
n = motor efficiency (expressed as a decimal).

When the motor efficiency is not known the heat equivalent of electrical input can be approximately determined by applying data given in Table 9.

TABLE 9. HEAT GENERATED BY MOTORS

Nameplate Rating Horsepower	Heat Gain in Btu per Hour per Horsepower	
	Connected Load in Same Room	Connected Load Outside of Room
⅛ to ½	4250	1700
½ to 3	3700	1150
3 to 20	2950	400

In the second group belong such appliances as coffee urns, gas ranges, steam tables, broilers, hot plates, etc. For heat generating capacities of such appliances refer to Table 10.

Considerable judgment must be exercised in the use of data given in Table 10. Consideration must be given to time of day when appliances are used and the heat they contribute to the space at time of peak load. Only those appliances in use at the time of the peak load need be considered. Consideration must also be given to the way appliances are installed, whether products of combustion are vented to a flue, whether products of combustion escape into the space to be conditioned or whether appliances are hooded allowing part of the heat to escape through a stack connected with the hood. There are no generally accepted data available on the effects of venting and shielding heating appliances but it is believed that when the appliances are properly hooded with a positive fan exhaust system through the hood that 50 per cent of the heat will be conveyed up into the hood and the balance of 50 per cent will be dissipated in the space to be conditioned. Where latent as well as sensible heat is given off, it is usually safe to assume that all latent heat will be removed by a properly designed and operated vent or hood.