to 5 percent of the air passes through the coil without being cooled. If data of this nature are used, the uncooled portion of the air must be added to the space load before determining the effective air quantity. See later section on Apparatus Dew Point.

To determine the design cooling load caused by the introduction of outdoor air, the maximum rate of outside-air entry is first established. In some applications the use of special exhausters from the conditioned space may add to the outdoor-air requirements in determining the maximum rate. Once this design quantity is established, and with the design indoor and outdoor-air states known, the cooling load may be computed. There are several methods in use; the more accurate of these require rather detailed calculations. Refer to Chapter 3, and also section on Apparatus Dew Point in this chapter. The following equations are considered to be of sufficient precision for use at usual design conditions, as their accuracy is within 1 percent.

$$\textit{Sensible Load}\quad q_s = Q \times 60 \times 0.244 \times 0.075 \left(1 - \frac{0.00923}{0.62}\right)(t_o - t_i)$$

$$= Q \times 1.08\,(t_o - t_i),\ \text{Btu per hour} \qquad (7)$$

$$\textit{Latent Load}\quad q_e = Q \times 60 \times 0.075 \times 1076\,(W_o - W_i)$$

$$= Q \times 4840\,(W_o - W_i),\ \text{Btu per hour} \qquad (8)$$

$$\textit{Total Load}\quad q_t = q_s + q_e \qquad (9)$$

where

Q = rate of entry of outside air, cubic feet per minute.
t_o = outdoor dry-bulb temperature, Fahrenheit.
t_i = indoor dry-bulb temperature, Fahrenheit.
W_o = outdoor humidity ratio, pounds moisture per pound of dry air.
W_i = indoor humidity ratio, pounds moisture per pound of dry air.
0.075 = standard air density, pounds per cubic foot.
0.244 = a constant approximating the specific heat of dry air corrected for moisture Btu per (pound) (Fahrenheit degree).
1076 = a factor approximating the average Btu released in condensing one pound of water vapor from air.

As explained later in the section on Apparatus Dew Point, some methods of load calculations break down the ventilation air into two parts: one portion which does not contact the coil surfaces (*i.e.* bypasses the coil) in passing through the coil and thus becomes a part of the room load; and a second portion, the remainder of the air which contacts the coil surfaces and is cooled down to the apparatus dew point. This detailed method explained in the literature by Ashley,[30] is believed to be very easy and accurate to use. Similar equations, therefore, can be written:

Space Sensible Ventilation Load,

$$q_{si} = Q \times 1.08(t_o - t_i) \times b \qquad (10)$$

Space Latent Ventilation Load,

$$q_{ei} = Q \times 4840(W_o - W_i) \times b \qquad (11)$$

Remaining Sensible Ventilation Load,

$$q_{sx} = Q \times 1.08(t_o - t_i)(1 - b) \qquad (12)$$

Remaining Latent Ventilation Load,

$$q_{ex} = Q \times 4840(W_o - W_i)(1 - b) \qquad (13)$$

$$q_t = q_{si} + q_{sx} + q_{ei} + q_{ex} \qquad (14)$$

where

b = fraction of air passing through coil which does not contact surfaces, coil bypass factor.

Standard air weight (0.075 lb per cu ft) is recommended for use in all calculations, as this is the basis for rating fans and its consistent use keeps all parts of the calculations in conformity.

HOW OUTDOOR AIR LOAD AFFECTS ROOM LOAD

Actually, the outdoor air used for ventilation would pass through the conditioning equipment, and be cooled and dehumidified to a lower temperature and humidity ratio than room conditions before entering the room; but for heat-balance purposes the cooling load chargeable to the outdoor air is that corresponding to the difference between the outdoor and indoor air conditions.

One important purpose of the cooling load estimate is to determine the conditions and quantity of air supplied to the space. All the various sensible and latent heat loads within the space must be included. Infiltration must be included in the space load since this air enters the doors and windows, and its heat and moisture load must be offset by the introduction of cooler, dryer air to the space. However, since outdoor air is taken through the conditioning equipment and cooled, this portion does not become a part of the space load, except a small portion which passes through the coil untreated. To determine the total load on the refrigeration machine, the remaining outdoor air load must be included in the grand total load.

Example 10: For outdoor design conditions of 95 F dry-bulb and 75 F wet-bulb, and indoor design conditions of 80 F dry-bulb and 67 F wet-bulb, and for the supply of outdoor air at the rate of 1000 cfm and the exhaust of room air at the corresponding rate, calculate the total, sensible and latent heat gains.

Solution: Substituting in Equation 7:

$$q_s = 1000 \times 1.08\,(95 - 80) = 16{,}200 \text{ Btu per hr.}$$

From psychrometric data $W_o = 0.01413$, $W_i = 0.01122$.

Substituting in Equations 8 and 9:

$$q_e = 1000 \times 4840\,(0.01413 - 0.01122) = 14{,}100 \text{ Btu per hr.}$$

$$q_t = q_s + q_e = 30{,}300 \text{ Btu per hr.}$$

HEAT SOURCES WITHIN THE CONDITIONED SPACE

People. The rates at which heat and moisture are given off by human beings under different states of activity are given in Table 27. In many applications these sensible and latent heat gains become a large fraction of the total load. Appreciable variations in heat-emission rates must be recognized according to the age and sex of the individual, state of activity, environmental influences, and duration of occupancy (since for short occupancy the extra heat and moisture brought in by people may be a significant factor).

While Chapter 6 should be referred to for detailed information, Table 27 in this chapter summarizes practical data representing conditions commonly encountered.

Lighting. In general, the instantaneous rate of heat gain from electric lighting[31] may be calculated from the following relation: