calculations, as this is the basis for rating fans and its consistent use keeps all parts of the calculations in conformity.

HOW OUTSIDE 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 ventilation air is taken through the conditioning equipment and cooled, this portion does not become a part of the space load. To determine the total load on the refrigeration machine, the ventilation air load must be included in the grand total load.

Example 17: 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 12:

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

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

Substituting in Equations 13 and 14:

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

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

Many cooling coil manufacturers publish tables giving psychrometric data based on the *average* conditions of the leaving air for various coil temperatures, air velocities, and entering dry-bulb and wet-bulb conditions. When these tables are used, it is necessary to calculate the mixed air condition entering the coil, and determine from the tables what coil and air velocity will produce the desired leaving air conditions as required for the space to be conditioned. When cooling coils are listed as 80 to 95 percent efficient, the manufacturer indicates that 20 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.

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 28. 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 28 in this chapter summarizes practical data representing conditions commonly encountered.

Lighting. In general, the instantaneous rate of heat gain from electric lighting[26] may be calculated from the following relation:

$$q_{el} = \begin{Bmatrix}\text{total light}\\ \text{wattage}\end{Bmatrix} \times \begin{Bmatrix}\text{use}\\ \text{factor}\end{Bmatrix} \times \begin{Bmatrix}\text{special allow-}\\ \text{ance factor}\end{Bmatrix} \times 3.41, \text{ Btu per hr.} \qquad (15)$$

The *total light wattage* is obtained from the ratings of all fixtures installed, both for general illumination and for display use.

TABLE 28. RATES OF HEAT GAIN FROM OCCUPANTS OF CONDITIONED SPACES[a]

Degree of Activity	Typical Application	Total Heat Adults, Male Btu/Hr	Total Heat Adjusted[b] Btu/Hr	Sensible Heat Btu/Hr	Latent Heat Btu/Hr
Seated at Rest	Theater-Matinee	390	330	180	150
	Theater-Evening	390	350	195	155
Seated, Very Light Work	Offices, Hotels, Apartments	450	400	195	205
Moderately Active Office Work	Offices, Hotels, Apartments	475	450	200	250
Standing, Light Work; or Walking Slowly	Department Store, Retail Store Dime Store	550	450	200	250
Walking; Seated Standing; Walking Slowly	Drug Store Bank	550	500	200	300
Sedentary Work	Restaurant[c]	490	550	220	330
Light Bench Work	Factory	800	750	220	530
Moderate Dancing	Dance Hall	900	850	245	605
Walking 3 mph; Moderately Heavy Work Bowling[d]	Factory Bowling Alley	1000	1000	300	700
Heavy Work	Factory	1500	1450	465	985

[a] *Note:* Tabulated values are based on 80 F from dry-bulb temperature. For 78 F room dry-bulb, the total heat remains the same, but the sensible heat values should be increased by approximately 10 percent, and the latent heat values decreased accordingly.

[b] *Adjusted total heat gain is based on normal percentage of men, women, and children for the* application listed, with the postulate that the gain from an adult female is 85 percent of that for an adult male, and that the gain from a child is 75 percent of that for an adult male.

[c] Adjusted total heat value for *sedentary work, restaurant*, includes 60 Btu per hour for food per individual (30 Btu sensible and 30 Btu latent).

[d] For *bowling* figure one person per alley actually bowling, and all others as sitting (400 Btu per hour) or standing (550 Btu per hour).

The *use factor* is the ratio of the wattage in use, for the conditions under which the load estimate is being made, to the total installed wattage. For commercial applications such as stores, the use factor would be unity.

The *special allowance factor* is introduced to care for fluorescent fixtures, and for fixtures which are either ventilated or installed so that only part of their heat goes to the conditioned space. For *fluorescent fixtures*, the special allowance factor is recommended to be taken as 1.20 in order to allow for power consumed in the *ballast*. For *ventilated fixtures, recessed fixtures*, and the like, manufacturers' or other data[27] must be sought to establish the fraction of the total wattage which may be expected to enter the conditioned space.

Power. When equipment of any sort is operated within the conditioned space by electric motors, the heat equivalent of this operation must be considered in the cooling load. The general equation for calculating this load is:

$$q_{em} = \left(\frac{\text{Horsepower Rating}}{\text{Motor Efficiency}}\right) \times \left(\frac{\text{Load}}{\text{Factor}}\right) \times 2544, \text{ Btu per hr.} \qquad (16)$$

It is assumed that both the motor and the driven equipment are within