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 13:

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

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

Substituting in Equations 14 and 15.

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

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

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

TABLE 24. 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;	Drug Store				
Standing; Walking Slowly	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	Factory	1000	1000	300	700
Bowling[d]	Bowling Alley				
Heavy Work	Factory	1500	1450	465	985

[a] *Note:* Tabulated values are based on 80 F room 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 per cent 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 per cent of that for an adult male and that the gain from a child is 75 per cent 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 space to be conditioned. When cooling coils are listed as 80 to 95 per cent efficient, the manufacturer indicates that 20 to 5 per cent 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 24. 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 12 should be referred to for detailed information, Table 24 in this chapter summarizes practical data representing conditions commonly encountered.

Lighting. In general, the instantaneous rate of heat gain from electric lighting[17] may be calculated from the following relation:

$$q_{el} = \begin{Bmatrix}\text{total light}\\ \text{wattage}\end{Bmatrix} \times \begin{Bmatrix}\text{use}\\ \text{factor}\end{Bmatrix} \times \begin{Bmatrix}\text{special allow-}\\ \text{ance factor}\end{Bmatrix} \times 3.41, \text{ Btu per hour} \qquad (16)$$

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

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, manufacturer's or other data[17] 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:

$$q_{em} = \left(\frac{\text{Horsepower Rating}}{\text{Motor Efficiency}}\right) \times \left(\frac{\text{Load}}{\text{Factor}}\right) \times 2544, \text{ Btu per hour.} \qquad (17)$$

It is assumed that both the motor and the driven equipment are within the conditioned space. If the motor is without the space, then *do not divide* by the motor efficiency in Equation 17. The *load factor* is merely the fraction of the rated load which is being delivered under the conditions of the cooling-load estimate. *Motor efficiencies* may be approximated as follows: about 50 to 60 per cent at $\frac{1}{8}$ hp rating, increasing to 80 per cent at 1 hp, and to 88 per cent at 10 hp and above.

Appliances. Care must be taken in a cooling-load estimate to properly account for the heat gain from all appliances, electrical, gas, or steam. Table 25 presents recommended data[18]. Note that the *maintaining rate* in Table 25 is the heat input required to maintain the appliance at the normal operating temperature even though it is not being used; *i.e.*, no coffee is being made, no toast is being made, no food is being cooked in the fry kettle, etc. The maintaining rate is useful in setting up a lower limit to the heat gain to a room from the appliance when in operation.

Experienced judgment must be used in the application of data given in Table 25. Consideration must be given to the heat contributed by appliances which are in use at the time of peak load. The quantity of heat will depend upon whether products of combustion are vented to a flue, whether they escape into the space to be conditioned, or whether appliances are hooded allowing part of the heat to escape through a stack. There are no generally accepted data available on the effects of venting and shielding heating appliances but it is believed that, when they are properly hooded