of Equation 18 may be solved by trial and error by substituting values of h_s' and W_s corresponding to assumed apparatus dew-point temperatures.

5. Compute the *required air quantity* from the relation

$$Q_{ra} = \frac{(\text{Space sensible load})}{1.08\left[\begin{pmatrix}\text{Space}\\ \text{dry-bulb}\end{pmatrix} - \begin{pmatrix}\text{Apparatus}\\ \text{dew-point}\end{pmatrix}\right] \times \begin{pmatrix}\text{Coil}\\ \text{by-pass}\\ \text{factor}\end{pmatrix}} \qquad (19)$$

The magnitude of Q_{ra} is substantially the quantity, cfm, of cooled and dehumidified air for which the distribution system must be designed.

The numerical factor 1.08 is derived from the product 1 cfm × 60 min × 0.244 × 0.075 $\left(1 - \frac{0.00923}{0.62}\right)$ = 1.08, assuming an average supply air dew-point of 55 F. Since standard air density (0.075) includes the weight of the water vapor, it is desirable to reduce it to the basis of dry air by the last factor where 0.00923 = humidity ratio of air at 55 F dew-point, and 0.62 = ratio of density of water vapor to dry air at same temperature and pressure. Refer to Chapter 36 for coil selection.

Note that the product [(space dry-bulb) − (apparatus dew-point)] × (coil by-pass factor) is equal to the dry-bulb range through which the conditioned air is cooled. Hence, in rare instances when the *condition line* of the process may not intersect the saturation line, any other convenient reference temperature on the *condition line* may be used instead, provided that the coil by-pass factor is specified accordingly on the proper basis.

MINIMUM ENTERING AIR TEMPERATURE

Due consideration must be given to the temperature of the air entering the conditioned space in order to prevent objectionable drafts. With ceiling type diffusers or wall grilles with a high aspect ratio (see Chapter 31), many engineers consider 20 deg as the maximum difference for good design under average conditions. This difference can only be exceeded with extremely high ceiling outlets or wall grilles. Thus, if 80 F dry-bulb is to be maintained in a space with average ceiling height, the minimum delivered air temperature would be limited to about 60 F dry-bulb temperature. If the latent heat load is relatively high, it is often necessary to circulate more air with a higher delivered dry-bulb temperature in order to produce a thermodynamic balance. If the dry-bulb temperature of the air supplied to the space is known, the required air quantity can be calcuated from the formula,

$$Q_{ra} = \frac{q_s}{1.08\,(t_i - t_s)} \qquad (20)$$

or the supply temperature t_s can be determined as follows,

$$t_s = t_i - \frac{q_s}{1.08 \times Q_{ra}} \qquad (21)$$

EXAMPLE—COOLING LOAD CALCULATION

An effective means of summarizing the calculation procedure will be the use of an illustrative example. While condensed calculation forms are commonly employed for work of this nature, an outline will be used here in order to facilitate explanatory comments.

Example 13: A one-story office building Fig. 6 is located in an eastern state near 40 deg latitude. The adjoining buildings on the north and west are not conditioned, and the air temperature within them is known to be substantially equal to the outdoor air temperature at any time of the day.

South wall construction: 8 in. concrete block, 4 in. brick veneer, ½ in. plaster on walls. (Table 9, Chapter 9, No. 92B, $U = 0.41$.)

East wall and outside north wall construction: 8 in. concrete block, painted white, ½ in. plaster on walls. (Table 8, Chapter 9, No. 82B, $U = 0.52$.)

West wall and adjoining north party wall construction: 13 in. solid brick, no plaster:

$$\frac{1}{U} = \frac{1}{1.65} + \frac{13}{5} + \frac{1}{1.65} \quad \text{or,} \quad U = 0.263. \quad \text{Use } U = 0.26.$$

Roof construction: 2½ in. flat roof deck of 2 in. gypsum fiber concrete on gypsum board surfaced with built-up roofing. (Table 11, $U = 0.34$ *for summer.*)

Floor construction: 4 in. concrete on ground.

Window: 3 ft x 5 ft, non-opening type, with medium colored Venetian blinds for windows on south wall. Approximately 4 in. reveal on all windows.

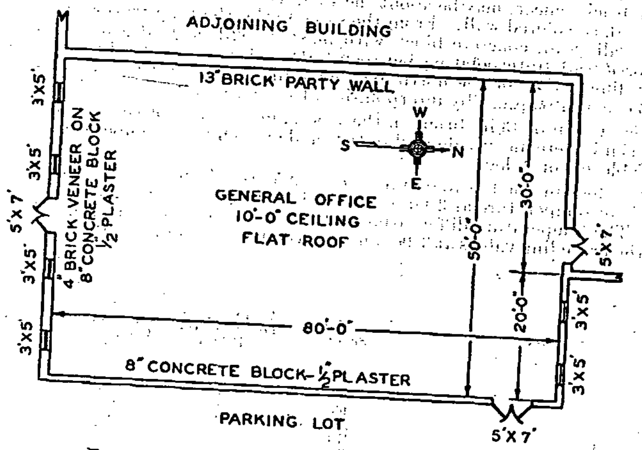

Fig. 6. Plan of One-Story Office Building

Front doors: Two 2 ft-6 in. x 7 ft (glass panels).

Side doors: Two 2 ft-6 in. x 7 ft (½ glass panels).

Rear doors: Two 2 ft-6 in. x 7 ft (wood panels).

Outside design conditions: Maximum dry-bulb 95 F, wet-bulb 78 F; W_o = 0.0169 lbs vapor per lb dry air; h_o = 41.38 Btu per lb dry air.

Indoor design conditions: Dry-bulb 80 F, wet-bulb 65 F; W_i = 0.0098 lb vapor per lb dry air; h_i = 29.95 Btu per lb dry air.

Occupancy: 85 office workers.

Lights: 12,000 watts, fluorescent; 4000 watts tungsten.

Fan motor: 7½ hp.

Assume that cooling coil has a by-pass factor of 0.15, *i.e.*, that 15 percent of the air passes through the coil without contacting the coil surface.

Conditioning equipment to be located in adjoining structure to north.

Find: Total, sensible, and latent maximum cooling loads and required air quantity through conditioning equipment.

Solution: From Table 3, the recommended ventilation rate is 15 cfm per person. Total necessary = 85 × 15 = 1275 cfm or 76,500 cu ft per hr.