

| SECTION         | NET AREA<br>SQ FT | $U$<br>BTU/(HR)<br>(SQ FT) (F DEG) | $(t_p - t_i)$<br>F DEG | $q$<br>BTU PER HR. |
|-----------------|-------------------|------------------------------------|------------------------|--------------------|
| Party wall..... | 1065 <sup>a</sup> | 0.26                               | 2.8                    | 775                |
| Door.....       | 35                | 0.59                               | 14                     | 290                |
|                 |                   |                                    | Total.....             | 1065               |

<sup>a</sup>Calculated from gross wall area less door area.

### Heat Gain Through Glass Areas.

In computing the load for 3:00 p. m., only the south windows and doors will be exposed to direct sunlight. Table 15 and Equation 12 will give the total heat gain from the glass areas. The window reveals will slightly shade the south windows; the fraction of window area receiving direct radiation is obtained from Equation 13 by substituting values as follows:

$$r_1 = s/1 = 4/60; r_2 = 4/36; \beta = 45.5 \text{ deg, } \tan \beta = 1.02.$$

$$\gamma = 16 \text{ deg, } \tan \gamma = 0.287.$$

$$G_f = 1 - \frac{4}{60} \times 1.02 - \frac{4}{36} \times 0.287 + \frac{4}{60} \times \frac{4}{36} \times 1.02 \times 0.287 = 0.902.$$

The south doors will be considered entirely sunlit. The outdoor air temperature is 94 F at 3:00 p. m. From Table 20 the inside Venetian blind factor is taken as 0.75. Referring to Table 15 the instantaneous heat gain due to solar and sky radiation for 40 deg n. latitude for south exposure at 3:00 p. m. is read as 42 Btu per sq ft. These figures are tabulated below.  $60 \times 0.902 \times .75 \times 42 = 1705$  Btu per hr. The normal transmission  $60 \times 1.04 (94 - 80) = 874$ . The sum of these heat gains is totaled in last column. The remaining doors and windows are calculated in a similar manner.

| LOCATION                | AREA<br>SQ FT | FRACTION<br>SUNLIT | INSIDE<br>VENETIAN<br>BLIND<br>SHADING<br>FACTOR | SOLAR<br>HEAT<br>GAIN<br>BTU/SQ FT | RADIATION<br>HEAT<br>GAIN <sup>a</sup><br>BTU/HR | NORMAL<br>HEAT<br>TRANSFER<br>BTU/HR | TOTAL<br>HEAT<br>GAIN<br>BTU/HR |
|-------------------------|---------------|--------------------|--------------------------------------------------|------------------------------------|--------------------------------------------------|--------------------------------------|---------------------------------|
| South windows.....      | 60            | 0.902              | 0.75                                             | 42.                                | 1705.                                            | 874.                                 | 2579.                           |
| South doors.....        | 35            | 1.00               | .....                                            | 42.                                | 1470.                                            | 510.                                 | 1980.                           |
| East <sup>b</sup> ..... | 18            | .....              | .....                                            | 15.                                | 27.                                              | .....                                | .....                           |
| doors.....              | 35            | .....              | .....                                            | .....                              | 270.                                             | 510.                                 | 780.                            |
| North windows.....      | 30            | .....              | .....                                            | 15.                                | 450.                                             | 437.                                 | 887.                            |
|                         |               |                    |                                                  |                                    | Total.....                                       | 6226.                                |                                 |

<sup>a</sup>See Equation 12 and the note under caption of Table 15.

<sup>b</sup>Doors are  $\frac{1}{2}$  glass. Calculate sky radiation for glass portion and normal transmission for entire door assuming  $U = 1.04$  for wood portion as well as glass.

In some jobs it would be proper to increase (or decrease) the instantaneous radiation heat gain by a load-lag factor. The reason for not doing so in this case is that the solar gain is of a low magnitude and reference to the table indicates that 0.8 of the previous hour would not affect the results materially.

### Heat Gain From Ventilation and Infiltration.

Since the necessary ventilation rate of 1275 cfm is greater than one air change per hour, it will be satisfactory for determining the ventilation component of the heat gain.

Window infiltration will be taken as negligible since the windows do not open and the ventilation rate is almost 2 changes per hour which is sufficient to prevent normal expected infiltration through closed windows with storm sash.

Door infiltration requires some judgment. Assume that for each person passing through the double doors, the infiltration will be 100 cu ft of outdoor air, see Table 21. Assume that the outside doors will be used at the rate of 10 persons per hour, and the inside doors at the rate of 30 persons per hour. Total infiltration will then be  $40 \times 100 = 4000$  cfh or 67 cfm.

The design rate of entry of outside air is then

$$Q = 1275 + 67 = 1342 \text{ cfm.}$$

### Cooling Load

The sensible, latent and total loads are determined from Equations 15, 16 and 17, respectively at 3:00 p. m. (Table 10)  $t_o = 94$ ,  $t_i = 80$ ,  $W_o = 0.0169$ ,  $W_i = 0.0098$ .

$$q_s = 1342 \times 1.08 (94 - 80) = 21,700 \text{ Btuh.}$$

$$q_e = 1342 \times 4840 (0.0169 - 0.0098) = 46,100 \text{ Btuh.}$$

$$q_t = q_s + q_e = 21,700 + 46,100 = 67,800 \text{ Btuh.}$$

### Heat Gain from Sources Within the Conditioned Space.

For the occupants, use the data of Table 22 for moderately active office work.

$$\text{Sensible heat} = 85 \times 200 = 17,000 \text{ Btu per hr.}$$

$$\text{Latent heat} = 85 \times 250 = 21,250 \text{ Btu per hr.}$$

$$\text{Total} = 38,250 \text{ Btu per hr.}$$

For the lighting, use Equation 18 with a use factor of unity, and a special allowance factor of 1.20 for the fluorescents and of unity for the tungsten globes:

$$q_{el} = (12,000 \times 1.20 + 4000) \times 3.41 = 62,700 \text{ Btu per hr.}$$

For the fan motor, use Equation 19 with a load factor of unity and do not introduce the motor efficiency because of the motor being external to the space.

$$q_{em} = 7.5 \times 2544 = 19,100 \text{ Btu per hr.}$$

### Moisture Permeation, Miscellaneous Allowance, and the Load-Lag Estimate.

Moisture permeation will be negligible, since this is a comfort job with a good building construction.

There would be some heat gain in the ductwork, but this would not be great because of the short run involved. Practical judgment on this job would suggest that no adjustment for load lag need be made to the load as computed. While it is true that inside radiation forms an important part of the total heat gain, it is advisable to be conservative in recognizing the effect of the large, flat, hot roof on the *comfort sensations of the occupants*. Radiation from the relatively low ceiling, augmented by heat absorption from the lighting fixtures, would produce a sensation of warmth in excess of the nominal effective temperature (see Chapter 12) established by the wet-bulb and dry-bulb temperatures. Hence, it is not desirable to take advantage of every small decrease possible in the peak design load, especially since the peak occurs in mid-afternoon when everything would be rather well warmed.

### Total Loads and Required Air Quantity Through Conditioning Equipment.

The total loads are summarized below.

| LOAD COMPONENT                    | SENSIBLE, BTU<br>PER HOUR | LATENT, BTU<br>PER HOUR |
|-----------------------------------|---------------------------|-------------------------|
| Outer walls and roof.....         | 116,720                   | .....                   |
| Party wall and inside door.....   | 1,065                     | .....                   |
| Glass areas.....                  | 6,226                     | .....                   |
| Ventilation and infiltration..... | 21,700                    | 46,100                  |
| Occupants.....                    | 17,000                    | 21,250                  |
| Lighting.....                     | 62,700                    | .....                   |
| Motor.....                        | 19,100                    | .....                   |
| Totals.....                       | 244,511                   | 67,350                  |
| Grand Total.....                  |                           | 311,861                 |

Compute the *specific enthalpy of the water removed* from Equation 22.

$$q_w = \frac{244,500}{67,350} \times 1076 = 3900 \text{ Btu per lb.}$$

From the Mollier diagram, determine that the *apparatus dewpoint* is 47.9 F. (Refer to Chapters 3 and 43.)

In computing the effective air quantity, assume a coil efficiency of 85 per cent. Then,

$$Q_{ra} = \frac{244,500}{1.08 (80 - 47.9) \times 0.85} = 8300 \text{ cfm.}$$

(Refer to Chapter 25 for coil selection and efficiency.)