or the supply temperature t_s can be determined as follows,

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

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 18: 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.

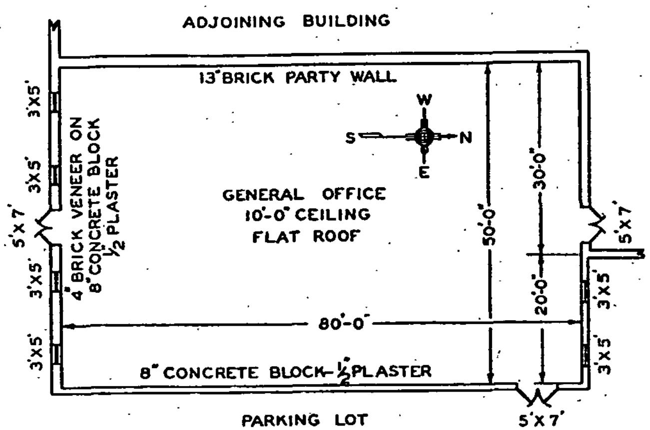

FIG. 6. PLAN OF ONE-STORY OFFICE BUILDING

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 14, $U = 0.34$ *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.

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.

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 4, the recommended ventilation rate is 15 cfm per person. Total necessary = 85 × 15 = 1275 cfm or 76,500 cu ft per hr.

As the room volume is 40,000 cu ft, the air changes per hour will be 76,500/40,000 = 1.91 which is more than one air change.

Estimated Time of Maximum Cooling Load:

For this job, judgment indicates that the roof will make the greatest single contribution to the cooling load. Hence, the time of maximum cooling load probably will be the time of maximum heat gain through the roof. From Table 12 the maximum temperature differential for a 2 in. gypsum roof of medium weight construction is 54 deg at 4:00 p.m., and 53 deg at 3:00 p.m. Examination of Table 16 (40 deg N Latitude) shows that solar heat gain through glass on the south wall is 18 Btu per (hr) (sq ft) at 4:00 p.m., and 42 Btu at 3:00 p.m. This indicates that the maximum cooling load occurs at approximately 3:00 p.m. Therefore make load calculations at 3:00 p.m. sun time. (This may be slightly different from 3:00 p.m. local time.) In some cases, there would be no clear-cut evidence of this nature, and consequently, it would be necessary to estimate the load for several successive times, and then to select the maximum.

Heat Gain Through Outer Wall and Roof Areas:

From Table 13 the temperature differential for the south wall (8 in. concrete block with 4 in. brick veneer) may be about the same as a 12 in. brick which is 6 deg at 3:00 p.m. for a dark colored wall. From the same table, the temperature differential for the east wall (8 in. concrete block with plaster) will be 11 deg at 3:00 p.m. for a *light colored* wall (interpolating between 2:00 and 4:00 p.m.). Likewise, the temperature differential for the north exposed wall (8 in. concrete block plus plaster) will be 3 deg at 3:00 p.m. (by interpolation) for a light wall.

The party wall of 13 in. brick on the west side and part of the north side may be treated as if it were an outside wall in the shade which has a temperature differential (from Table 13) of 2 deg.

For the door in north wall estimate $U = 0.59$ from Chapter 9, Table 10, No. 5A. The outdoor temperature at 3:00 p.m. is 95 F. Neglect time lag and any decrement factor. The temperature differential is $(t_o - t_i) = 95 - 80 = 15$ deg. The tabulation of the preceding values at 3:00 p.m. is given in the following table:

Section	Net Area Sq Ft	Temperature Differential F Deg	Heat Transmission Coefficient (U)	Heat Flow Rate per Hour Btu
Roof	4000	53	0.34	72,000
South Wall	405[a]	6	0.41	995
East Wall	765[a]	11	0.52	4,380
North Exposed Wall	170[a]	3	0.52	265
West & North Party Wall	1065[a]	2	0.26	550
Door in North Wall	35	15	0.59	310
Total				78,500

[a] Calculated from gross wall area, less windows and doors.

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. Tables 16 and 17 will give the total heat gain from the glass areas. The window reveals will shade the south windows; the fraction of the window area receiving direct radiation is obtained from Equation 10 by substituting values as follows:

$r_1 = s/l = 4/60$; $r_2 = 4/36$; $\beta = 45.5$ deg, $\tan \beta = 1.02$

$\gamma = 74$ deg, $\tan \gamma = 3.487$, $\cos \gamma = 0.276$