

South wall construction: 8 in. concrete block, 4 in. brick veneer, $\frac{1}{2}$ in. plaster on walls. (Table 8, Chapter 9, No. 92B, $U = 0.41$.)

East wall and outside north wall construction: 8 in. concrete block, painted white, $\frac{1}{2}$ in. plaster on walls. (Table 7, 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: 2 $\frac{1}{2}$ in. flat roof deck of 2 in. gypsum fiber concrete on gypsum board surfaced with built-up roofing. (Table 16, $U = 0.34$ 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 ($\frac{1}{2}$ glass panels).

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

Outside design conditions: Maximum dry-bulb 95 F, wet-bulb 78 F; $W_o = 0.0169$ lbs vapor per lb dry air; $h_o = 41.33$ 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: 7 $\frac{1}{2}$ 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 = $85 \times 15 = 1275$ 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 14 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 18 (40 deg N Latitude) shows that solar heat gain through glass on the south wall is 19 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 15 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 15) of 2 deg.

For the door in North Wall estimate $U = 0.59$ from Chapter 9, Table 9, 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 p.m. is given in the following table:

Cooling Load

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*	6	0.41	995
East Wall	765*	11	0.52	4,380
North Exposed Wall	170*	3	0.52	265
West & North Party Wall	1065*	2	0.26	550
Door in North Wall	35	15	0.59	310
Total.....				78,500

* 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. Table 18 and Equation 10 will give the total heat gain from the glass areas. The window reveals will shade the south windows; the fraction of window area receiving direct radiation is obtained from Equation 11 by substituting values as follows:

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

$$\gamma = 16 \text{ deg, } \cot \gamma = 3.487, \cos \gamma = 0.276.$$

$$G_t = 1 - \frac{4}{60} \left(\frac{1.02}{0.276} \right) - \frac{4}{36} (3.487) + \left(\frac{4}{60} \right) \left(\frac{4}{36} \right) \frac{(1.02)(3.487)}{0.276} = 0.462.$$

The south doors will be considered entirely sunlit. The outdoor air temperature is 95 F at 3:00 p.m. From Table 23 the inside Venetian blind factor is taken as 0.74. Referring to Table 18, 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. The radiation gain for south windows is $60 \times 0.462 \times 0.74 \times 42 = 860$ Btu per hr. The normal heat transmission $60 \times 1.04 (95 - 80) = 940$. The sum of these heat gains 1800 Btu per hr is totaled in last column. The remaining doors and windows are calculated in a similar manner.

LOCATION	AREA Sq Ft	FRACTION SUNLIT	INSIDE VENETIAN BLIND SHADING FACTOR	SOLAR HEAT GAIN Btu/sq ft	RADI- ATION HEAT GAIN* Btu/hr	NORMAL HEAT TRANS. Btu/hr	TOTAL HEAT GAIN Btu/hr
South Windows	60	0.462	0.74	42	860	940	1800
South Doors	35	1.00	—	42	1470	550	2020
East ^b (Glass) doors	18	—	—	15	270	—	820
	35	—	—	—	—	550	
North Windows	30	—	—	15	450	470	920
Total.....							5560.

* See Equation 10 and the note under caption of Table 18.

^b 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 desirable 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 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 can be taken as negligible since the windows do not open.

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 Chapter