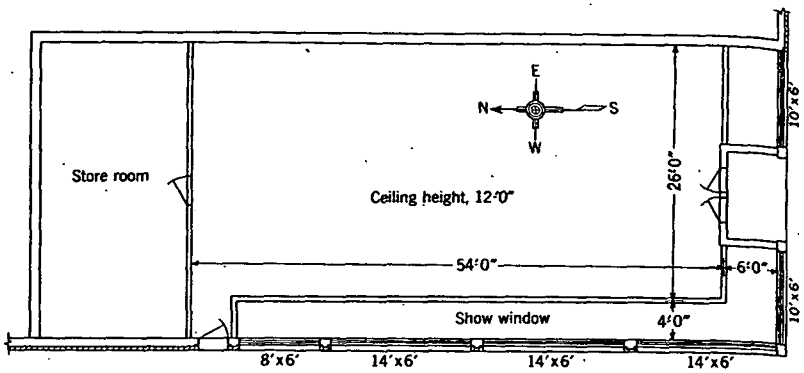

FIG. 3. PLAN DIAGRAM OF CLOTHING STORE

Solution: The normal heat transmission through various surfaces shown in load calculations are determined by application of Formula 1.

It is quite obvious from the shape and exposure of this store that the maximum sun load will exist on the west wall. Since the west wall has a large glass area with a negligible time lag, the peak load may be expected at 4:00 p.m. at which time, from Table 4, $I = 211$. I for the south side at 4:00 p.m. is 8. Because of the small amount of solar radiation transmitted through the south glass, it can be neglected and the total heat gain taken as that due to normal transmission. Assuming time lag in roof and walls to be 2 hours, the corresponding values for I for south and west walls and roof will be those shown in Table 4 for 2:00 p.m. They are respectively 77, 143 and 258. A time lag of 1 hour was assumed for the west door amounting to $I = 192$. By substituting these values in equations 2 and 3 the solar heat load is determined.

To determine the heat gain from the outside air it is necessary first to determine the volume of the outside air to be introduced. Since the show windows are sealed so as not to permit infiltration and since there are only three doors in this store through which infiltration can take place, it is obvious that infiltration of air will be a negligible quantity. The volume of the store is 21,600 cu ft. Good practice indicates that in a store of this character there should be a minimum of from 1 to 1½ outside air changes per hour. On a basis of 1½ air changes the volume of outside air to be introduced would be 32,400 cfh. By reference to Chapter 3 it will be noted that the minimum ventilation requirements are 10 cfm per person. On this basis the ventilation requirements would be 30,000 cfh. Since this will produce approximately 1½ outside air changes per hour, 30,000 cfh will be considered in this application.

To determine load imposed by occupants it will be found from Table 4, Chapter 3 that the average person standing at rest will dissipate 225 Btu sensible heat and 206 Btu latent heat per hour.

NORMAL TRANSMISSION LOAD:

SURFACE	DIMENSIONS	AREA SQ FT	U	TEMP. DIFF. DEG F	BTU PER HOUR
S Glass	2(2 ft 6 in. x 7 ft)+ 2(10 ft x 6 ft)	155	1.13	15	2,627
S Wall	(30 ft x 12 ft) − 155	205	0.33	15	1,015
W Wall	(60 ft x 12 ft) − 321	399	0.33	15	1,975
W Door	3 ft x 7 ft	21	0.51	15	161
Roof	60 ft x 30 ft	1800	0.26	15	7,020
Floor	26 ft x 54 ft	1404	0.34	5	2,387
N Partition	30 ft x 12 ft	360	0.34	8	979
Total					16,164

SUN LOAD:

SURFACE	DIMENSIONS	AREA SQ FT	F	a	I	SHADE FACTOR	BTU PER HOUR
S Wall		205	0.078	0.7	77		862
W Glass	3(14 ft x 6 ft)+ (8 ft x 6 ft)	300			211	0.28	17,724
W Door		21	0.118	0.7	192		333
W Wall		399	0.078	0.7	143		3,113
Roof		1800	0.062	0.9	258		25,914
Total							47,946

OUTSIDE AIR HEAT GAIN:

Sensible heat, $H_s = 0.24 \times 60\, d_o\, Q\, (t_o - t)$ (Formula 4).

$Q = 50 \times 10 = 500$ cfm.

Density of air at 95 F dry-bulb and 75 F wet-bulb for a barometric pressure of 29.92 in. is 0.07105 lb per cubic foot (Table 4, Chapter 1).

Dew-point of outdoor air is 66 F (psychrometric chart).

Partial pressure of vapor is 0.64378 in. Hg. (Pressure of saturated vapor at 66 F, (Table 6, Chapter 1).

$W = 0.622 \left(\frac{e}{B - e}\right) = 0.622 \left(\frac{0.64378}{29.92 - 0.64378}\right) = 0.0137$ lb water vapor per pound dry air (Formula 5 a, Chapter 1).

$\frac{1}{1 \text{ plus } 0.0137} = 0.986$ lb dry air per pound outside air.

$d_o = 0.07105 \times 0.986 = 0.0699$ lb dry air per cubic foot outside air.

$H_s = 60 \times 500 \times 0.0699 \times 0.24\ (95-80) = 7549$ Btu per hour.

Total heat, $H = 60\, d_o\, Q\, (h_o - h)$ (Formula 5).

$h_o = 38.46$ Btu per pound dry air at 75 F wet-bulb (Table 6, Chapter 1).

$h = 31.51$ Btu per pound dry air at 67 F wet-bulb (Table 6, Chapter 1).

$H = 60 \times 0.0699 \times 500\ (38.46 - 31.51) = 14{,}574$ Btu per hour.

Latent heat gain from outside air $= 14{,}574 - 7549 = 7025$ Btu per hour.

PEOPLE HEAT GAIN:

$50 \times 225 = 11{,}250$ Btu per hour, sensible heat.

$50 \times 206 = 10{,}300$ Btu per hour, latent heat.

LIGHT HEAT GAIN:

$4200 \times 3.413 = 14{,}335$ Btu per hour.

SUMMARY:

COMPONENT OF LOAD	BTU PER HOUR	
	Sensible	Latent
Normal Transmission Load	16,164	
Sun Load	47,946	
Outside Air Heat Gain	7,549	7,025
People Heat Gain	11,250	10,300
Light Heat Gain	14,335	
Total	97,244	17,325

TOTAL LOAD:

$97{,}244 + 17{,}325 = 114{,}569$ Btu per hour.