

arrives. In industrial plants, quite a different condition exists, and heat sources, if they are always available during the period of human occupancy, may be substituted for a portion of the heating installation. In no case should the actual heating installation (exclusive of heat sources) be reduced below that required to maintain at least 40 F in the building.

Motors and Machinery

Motors and the machinery which they drive, if both are located in the room, convert all of the electrical energy supplied into heat, which is retained in the room if the product being manufactured is not removed until its temperature is the same as the room temperature.

If power is transmitted to the machinery from the outside, then only the heat equivalent of the brake horsepower supplied is used. In the first case the Btu supplied per hour = $\frac{\text{Motor horsepower}}{\text{Efficiency of motor}} \times 2,546$, and in the second case Btu per hour = bhp $\times 2,546$, in which 2,546 is the Btu equivalent of 1 hp-hour. In high-powered mills this is the chief source of heating and is frequently sufficient to overheat the building even in zero weather, thus requiring cooling by ventilation the year round.

The heat (in Btu per hour) from electric lamps is obtained by multiplying the watts per lamp by the number of lamps and by 3.415. One cubic foot of producer gas gives off about 150 Btu per hour; one cubic foot of illuminating gas gives off about 535 Btu per hour, and one cubic foot of natural gas gives off about 1000 Btu per hour. A Welsbach burner averages 3 cu ft of gas per hour and a fish tail burner, 5 cu ft per hour. For information concerning the heat supplied by persons, see Chapter 2.

For intermittent heating allow 10 per cent additional for rooms heated in the day time only, and for unheated intervals of several days or more, add 25 per cent in determining minimum heating requirements and size of plant.

EXAMPLE OF HEAT LOSS COMPUTATIONS (See Fig. 1.)

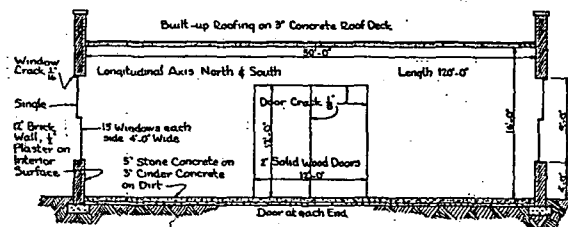


FIG. 1. ELEVATION OF FACTORY BUILDING

1. LOCATION.....Philadelphia, Pa.
2. LOWEST OUTSIDE TEMPERATURE. (Table 2).....- 6 F

3. BASE TEMPERATURE: In this example a design temperature 10 deg F above lowest on record instead of 15 F is used. Hence the base temperature =
 $(- 6 + 10) = + 4 \text{ F.}$
4. DIRECTION OF PREVAILING WIND (during Dec., Jan., Feb.).....Northwest
5. BREATHING-LINE TEMPERATURE (5 ft from floor).....60 F
6. INSIDE AIR TEMPERATURE AT ROOF:
 The air temperature just below roof is higher than at the breathing line. Height of roof is 16 ft, or it is $16 - 5 = 11$ ft above breathing line. Allowing 2 per cent per foot above 5 ft, or $2 \times 11 = 22$ per cent, makes the temperature of the air under the roof = $1.22 \times 60 = 73.2 \text{ F.}$
7. INSIDE TEMPERATURE AT WALLS:
 The air temperature at the mean height of the walls is greater than at the breathing line. The mean height of the walls is 8 ft and allowing 2 per cent per foot above 5 ft, the average mean temperature of the walls is $1.06 \times 60 = 63.6 \text{ F.}$ By similar assumptions and calculations, the mean temperature of the glass will be found to be 64.2 F and that of the doors 61.2 F.
8. AVERAGE WIND VELOCITY (Table 2).....11.0 mph
9. OVER-ALL DIMENSIONS (See Fig. 1).....120 x 50 x 16 ft
10. CONSTRUCTION:
 Walls—12-in. brick, with $\frac{1}{2}$ -in. plaster applied directly to inside surface.
 Roof—3-in. stone concrete and built-up roofing.
 Floor—5-in. stone concrete on 3-in. cinder concrete on dirt.
 Doors—One 12 ft x 12 ft wood door (2 in. thick) at each end.
 Windows—Fifteen, 9 ft x 4 ft single glass double-hung windows on each side.
11. TRANSMISSION COEFFICIENTS:
 Walls—(Table 8, Chapter 5, Wall 2B)..... $U = 0.34$
 Roof—(Table 16, Chapter 5, Roofs 2A and 3A)..... $U = 0.77$
 Floor—(Table 15, Chapter 5, Floors 5A and 6A)..... $U = 0.63$
 Doors—(Table 18B, Chapter 5)..... $U = 0.46$
 Windows—(Table 18A, Chapter 5)..... $U = 1.13$

12. INFILTRATION COEFFICIENTS:

Windows—Average windows, non-weatherstripped, $\frac{1}{8}$ -in. crack and $\frac{3}{4}$ -in. clearance. The leakage per foot of crack for an 11 mile wind velocity is 25.0 cfh. (Determined by interpolation of Table 2, Chapter 6). The heat equivalent per hour per degree per foot of crack, is from Chapter 6.

$$25.0 \times 0.018 = 0.45 \text{ Btu per deg Fahr per foot of crack.}$$

Doors—Assume infiltration loss through door crack twice that of windows or $2 \times 0.45 = 0.90 \text{ Btu per deg Fahr per foot of crack.}$

Walls—As shown by Table 1, Chapter 6, a plastered wall allows so little infiltration that in this problem it may be neglected.

13. CALCULATIONS: See calculation sheet, Table 3.