from one to another, and with a temperature difference of 70 deg., the pressure causing infiltration near the ground, and exfiltration near the roof, may easily exceed 0.20 in. of water, which is the equivalent of a twenty-mile wind.

The factors influencing the pressures causing infiltration are so numerous that it does not seem wise at this time to attempt to include any quantitative values to express the effect of temperature difference, but it is something that should be kept in mind in the design and operation of heating systems in tall buildings.

HEAT SOURCES

Heat Available from Sources other than Heating Plant

The heat supplied by persons, lights, motors and machinery should always be ascertained in the case of theaters, assembly halls, and industrial plants, but allowances for such heat sources must be made only after careful consideration of all local conditions. In many cases, these heat sources should not be allowed to affect the size of the installation at all, although they may have a marked effect on the operation and control of the system later. In general, it is safe to say that where audiences are involved, the heating installation must have sufficient capacity to bring the building up to the stipulated inside temperature before the audience 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 deg. fahr. in the building. The following allowances may be made when required:

TABLE 20. HEAT GIVEN UP BY PERSONS AND LIGHTS

*PERSONS:

Man at rest.......400 B.t.u. per hr.
Man at work.......500 B.t.u. per hr.

LIGHTS:

Electric lamps, B.t.u. per hr. equals watts per lamp × number of lamps × 3.415

Gas lighting:

1 cu. ft. producer gas.......150 B.t.u.
1 cu. ft. illuminating gas.......700 B.t.u.
1 cu. ft. natural gas.......1000 B.t.u.

A Welsbach burner averages 3 cu. ft. of gas per hour and a fish tail burner 5 cu. ft. per hour.

*For more detailed information see Table 21, Heat Emitted by Persons per Hour at Different Room Temperatures.

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 B.t.u. supplied per hour $= \dfrac{\text{Motor horsepower}}{\text{Efficiency of motor}} \times 2546$, and

in the second case B.t.u. per hr. = b.hp. × 2546, in which 2546 is the B.t.u. 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.

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

TABLE 21. HEAT EMITTED BY PERSONS PER HOUR AT DIFFERENT ROOM TEMPERATURES

H = Heat emitted by man at rest per hour.
Hl = Heat emitted by man at light labor per hour.
Ha = Heat emitted by man at average labor per hour.
Hh = Heat emitted by man at hard labor per hour.

HE = Heat Energy $= \left(\dfrac{\text{Foot-Pounds per hour}}{778}\right) = 84$ B.t.u., 168 B.t.u. and 252 B.t.u. respectively for light, average and hard labor.

T = Room Temperature.

$H = 13.2\ (98.6 - T)$ Heat due labor $= \dfrac{T \times HE}{100}$

Hl, Ha, or $Hh = 13.2\ (98.6 - T)$ plus $\dfrac{T \times HE}{100}$

Room Temp. Deg. Fahr.	Heat Emitted by Man* B.t.u. per Hour at Rest	84 B.t.u. Light Labor	168 B.t.u. Average Labor	252 B.t.u. Hard Labor	Condition Required to Balance Excess and Shortage in Heat Emission
30	905	931	954	981	Increasing Humidity
40	773	807	838	874	Heavy Clothing for Reduction or Pre-
50	642	684	723	768	vention of Radiation
60	509	559	606	660	
68	404	461	518	575	Normal Condition
70	378	436	491	554	
75	312	375	438	501	Decreasing Humidity
80	246	313	375	447	Air Currents for Producing Evapora-
85	180	251	322	394	tion of Perspiration
90	114	189	259	342	

*For children use one-half of table values.

Application to Factory Heating[6] (See Fig. 9)

Lowest outside temperature for Philadelphia, Pa. = −6 deg. fahr. (Table 3), hence use (−6 + 10) = + 4 for heat loss computations. Average wind movement (Table 3) for December, January, February = 11.0 miles per hour from the Northwest. Long axis of building is north and south.

Inside breathing-line temperature = 60 deg. fahr.

Walls: 9 in. concrete (stone), ½ in. cement mortar, 2 in. tile, plastered ½ in.

K_1 = 1.34 Average for surface in still air (Table 4).
$K_2 = 3 \times 1.34 = 4.02$ Average for surface exposed to moving air (Tables 4 and 6).
C_1 = 8.3 for stone concrete (Table 5).
C_2 = for tile as shown use 1.14 (not per 1 in.), (Table 5).
C_3 = 8.0 for cement mortar (Table 5).
C_4 = 2.32 for gypsum plaster (Table 5).

[6]In this example a design temperature only 10 deg. fahr. above lowest on record instead of 15 deg. fahr. above was used. Infiltration values were taken from Table 15 for a plain window.