TABLE 3. AIR CHANGES TAKING PLACE UNDER AVERAGE CONDITIONS EXCLUSIVE OF AIR PROVIDED FOR VENTILATION

KIND OF ROOM OR BUILDING	NUMBER OF AIR CHANGES TAKING PLACE PER HOUR
Rooms, 1 side exposed	1
Rooms, 2 sides exposed	1½
Rooms, 3 sides exposed	2
Rooms, 4 sides exposed	2
Rooms with no windows or outside doors	½ to ¾
Entrance Halls	2 to 3
Reception Halls	2
Living Rooms	1 to 2
Dining Rooms	1 to 2
Bath Rooms	2
Drug Stores	2 to 3
Clothing Stores	1
Churches, Factories, Lofts, etc	½ to 3

Solution. From Table 2, the leakage per foot of crack is 35 cu ft per hour. Length of crack for room = 4 (windows) $\times$ (7 + 7 + 4 + 4 + 4) = 104 ft. The infiltration (Q) is equal to 35 $\times$ 104 or 3,640 cu ft per hour and the additional heat loss (maximum) due to infiltration is equal to 0.018 $\times$ 3,640 $\times$ 70 or 4,590 Btu per hour.

Example. What is the probable inleakage of air for a room with four windows on the first floor, if the wind velocity is 20 mph? The building is 100 ft high and is equipped with heavy casement section projected steel windows, with three ventilators each of a total perimeter of 36.5 ft, $\frac{1}{32}$-in. crack.

Solution. For a temperature difference of 70 F the equivalent wind velocity (M_e) is equal to $\sqrt{20^2 + 1.75 \times 50}$ or 22 mph. Leakage per foot of crack for this type of window (Table 2, interpolating) is equal to 61 cu ft per hour. The total leakage rate (Q) is equal to 4 (windows) $\times$ 36.5 (ft of crack per window) $\times$ 61 or 8,910 cu ft per hour. For a similar room in the top story, on the same side of the building, the equivalent wind velocity (M_e) is equal to $\sqrt{20^2 - 1.75 \times 50}$ or 18 mph for which the leakage per foot of crack is 48 cu ft per hour (Table 2). The total inleakage of air into the room (Q) is equal to 4 $\times$ 36.5 $\times$ 48 or 7,010 cu ft per hour. For a similar room 20 ft above the ground (30 ft below mid-height), $M_e = \sqrt{20^2 + 1.75 \times 30} \doteq 21$ mph for which the unit crack leakage will be 58 cu ft per hour, and the total leakage for the room will be 8,470 cu ft per hour.

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Chapter 5

GRAVITY WARM AIR HEATING SYSTEMS

Description of Gravity System; Design Rules; Heat Loss Calculations; Leader Pipe Sizes; Wall Stacks; Register Area; Recirculating Ducts and Grilles; Size of Furnace; Application of Data; Forced or Booster Circulation.

IN the gravity warm air heating system described in this chapter, the motive head producing flow depends upon the difference in weight between the heated air leaving the casing and the cooler air entering the bottom of the casing. In the fan-circulating type, a fan may supply all or part of the motive head. The fan-circulating type may consist merely of a booster fan operated in conjunction with a gravity-designed system (see p. 94), or it may consist of the fan-furnace type described in Chapter 31. The majority of residence warm air installations are of the gravity type, although the use of fans is increasing.

DESCRIPTION OF GRAVITY SYSTEM

In general, a warm-air furnace heating plant consists of a fuel-burning furnace or heater enclosed in a casing of sheet metal or brick, which is placed in the basement of the building. The heated air, taken from the top or sides near the top of the furnace casing, is distributed to the various rooms of the building through sheet-metal warm-air pipes. The warm-air pipes in the basement are known as leaders, and the vertical warm-air pipes which are run in the inside partitions of the building are called stacks. The heated air is finally discharged into the rooms through registers which are set in register boxes placed either in the floor or in the side wall, usually at or near the baseboard.

The air supply to the furnace may be taken (1) entirely from inside the building through one or more recirculating ducts; (2) entirely from outside the building, in which case no air is recirculated, or (3) through a combination of the inside and the outside air supply systems.

DESIGN RULES

The design of a furnace heating system involves the determination of the following items:

a. Heat loss in Btu from each room in the building.
b. Area and diameter in inches of warm-air pipes in basement (known as leaders).

All figures and much of the engineering data which follow are from Bulletins Nos. 141, 188 and 189, Warm Air Furnaces and Heating Systems, Part II, by Professors A. C. Willard, A. P. Kratz, and V. S. Day, Engineering Experiment Station, University of Illinois.