7. The sum of the heat losses by transmission (par. 5) through the outside wall and glass, as well as through any cold floors, ceilings or roof, and the heat equivalent (par. 6) of the cold air entering by infiltration represents the total heat loss equivalent for any building.

Item 7 represents the heat losses after the building is heated and under stable operating conditions in coldest weather. Additional heat is required for raising the temperature of the air, the building materials and the material contents of the building to standard inside temperature.

The rate at which this additional heat is required depends upon the heat capacity of the structure and its material contents and upon the time in which these are to be heated.

This additional heat may be figured and allowed for as conditions require, but inasmuch as the heating system proportioned for taking care of the heat losses will usually have a capacity about 100 per cent greater than that required for average winter weather, and inasmuch as most buildings may either be continuously heated or more time be allowed for heating-up, during the few minimum temperature days, no allowance is made except in the size of boilers or furnaces.

General Statement on Specifications

In order that no misunderstanding may occur, the specifications for all heating systems or plants shall include a clause covering the following points:

1. The lowest recorded outside temperature in the locality, as reported by the U. S. Weather Bureau for the preceding 10 years.

2. The outside air and inside breathing-line temperatures which were assumed and actually used in making the heat-loss computations.

3. The heating load should be calculated on a temperature not more than 15 deg. above the minimum outside temperature recorded for the locality for the preceding 10 years and at a wind velocity which is the highest recorded in the locality for such temperature (*i.e.*, for a temperature 15 deg. above the minimum) for the locality in which the heating plant is located. Both wind velocity and direction are to be taken from the U. S. Weather Bureau records of 10 years.

INSIDE TEMPERATURES

Winter

The inside air temperature which must be maintained within a building and which should always be stated in the heating specifications, is understood to be the temperature at the breathing line, 5 ft. above the floor and not less than 3 ft. from the outside walls. Inside air temperatures, usually specified, vary in accordance with the use to which the building is to be put and Table 1 presents values which are in conformity with good practice.

Effect of Humidification: In connection with inside temperatures for winter where humidifying means are provided, approximately 1 deg. variation for each 10 per cent variation in relative humidity should be provided. For example: If the relative humidity is raised from a condition of 15 per cent to one of 45 per cent by artificial humidification it is desirable to lower the indoor temperature about 3 deg. as indicated by the Effective Temperature Line on the Comfort Chart. (See Chapter 3, p. 91.) The temperatures given in the table are for normal dry air with dew-points

approximately equivalent to outdoor air. A reduction in the temperatures will be required corresponding to the raise of the moisture content by artificial humidification.

Temperature at Proper Level: In making the actual heat-loss computations, however, for the various rooms in a building it is often necessary to modify the temperatures given in Table 1 so that the air temperature at the proper level will be used. By ***air temperature at the proper level*** is meant, in the case of walls, the air temperature at the mean height between floor and ceiling; in the case of glass, the air temperature at the mean height of the glass; in the case of roof or ceiling, the air temperature at the mean height of the roof or ceiling above the floor of the heated room, and in the case of floors, the air temperature at the floor level. In the case of heated spaces adjacent to unheated spaces, it will usually be sufficient to assume the temperature in such spaces as the mean between the temperature of the inside heated spaces and the outside air temperature, excepting where the combined heat transmission coefficient of the roof and ceiling can be used, in which case the usual inside and outside temperatures should be applied. (See Table 35, pp. 58 and 59 and discussion regarding the use of combined coefficients of pitched roofs, unheated attics and top-floor ceilings on p. 27.)

The air temperature at the mean height between floor and ceiling is the ***breathing-line*** temperature, Table 1, for rooms not over 10 ft. in height. For rooms above this height, the temperature should be increased according to the difference between the mean height of the vertical wall, glass, roof or ceiling surface, and the height of the breathing line. The amount of the increase per foot of height will depend on the inside breathing-line temperature; the outside temperature; the wall and roof construction, and the type and location of heaters and other factors.

High Ceilings: Research data concerning stratification of air in buildings are lacking, but in general it may be said that where the increase in temperature is due to the natural tendency of the warmer or less dense air to rise, as where a direct radiation system is installed, the temperature of the air at the ceiling increases with the ceiling height. The relation, however, is not a straight-line function, as the amount of increase per foot of height apparently decreases as the height of the ceiling increases, according to present available information.

Furthermore, the temperature of the air at any level in a building such as at the mean height of walls, is not necessarily proportional to the distance from the floor or breathing line, although in general the temperature increases as the height increases. It is the common practice of engineers to allow 2 per cent per foot of height above the breathing line in determining the probable air temperature at any given level for a direct radiation system, and this value is, no doubt, sufficiently accurate in most cases.

With certain types of heating and ventilating systems, which tend to oppose the natural tendency of warm air to rise, the temperature differential between floor and ceiling can be greatly reduced. These include unit heaters, fan-furnace heaters, and the various types of mechanical ventilating systems. The amount of reduction is problematical in certain instances, as it depends upon many factors such as location of heaters,