to lower the indoor temperature about 3 deg as indicated by the Effective Temperature Line on the Comfort Chart. (See Chapter 28, p. 394). 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 32, Chapter 3, and discussion regarding the use of combined coefficients of pitched roofs, unheated attics and top-floor ceilings on p. 38).

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.

Therefore, 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, although it is not probable that this rule applies to heights above 20 ft.

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, air temperature, and direction and velocity of air discharge. In some cases it has been possible to reduce the temperature between the floor and ceiling to a few degrees, whereas, in other cases, the temperature at the ceiling has actually been increased because of improper design, installation or operation of equipment. So much depends upon the factors enumerated, that it is not advisable to allow less than 1 per cent per foot (and usually more) above the breathing line in arriving at the air temperature at any given level for any of these types of heating and ventilating systems, unless the manufacturers are willing to guarantee that the particular type of equipment under consideration will maintain a smaller temperature differential for the specific conditions involved.

Rietschel's Formula: Rietschel states that the average mean temperature t_m never exceeds 1.15 t for the highest ceilings. His formula is:

$$t_m = t\,[\,1. + 0.017\,(h - 10)\,]$$

in which h is the height of the ceiling or outside walls. Substituting $t_m = 1.15\,t$, it is found that $h = 19$ ft, so that for heights over 19 ft a value of $t_m = 1.15\,t$ may be used.

Temperature at Floor Level: In determining mean air temperatures just above floors which are next to ground or unheated spaces, a temperature 5 deg lower than the breathing-line temperature may be used, provided the breathing-line temperature is not less than 55 F.

Summer

Where buildings are being artificially cooled for human comfort during the summer a different scale of inside temperatures is required and this inside temperature must depend to a large extent upon the variation in outside temperatures. It is manifestly undesirable and impracticable to maintain a temperature of 70 F inside when it is 95 F outside, nor can it be said that the inside temperature should be as much as 15 deg below the outside temperature. At 95 F outside, and dry air, a temperature somewhat lower than 80 F might be desirable. On the other hand with 85 F outside a 70 F temperature inside would be entirely too cold. In other words, the spread between the inside and outside temperature must be varied as the outside temperature varies.

Table 2 is based on average moisture conditions outside and upon the assumption of relative humidities inside, between 50 and 60 per cent, which is usual in such installations.

OUTSIDE TEMPERATURES

Winter

The outside temperature used in computing the heat loss from a building is seldom taken as the lowest temperature ever recorded in a given locality. Such temperatures are usually of short duration and are rarely repeated in successive years. It is therefore evident that a temperature somewhat higher than the lowest on record may be properly assumed in making the heat-loss computations.