spaces. This temperature generally will range between the inside and outside temperatures, depending on the relative areas of the surfaces adjacent to the heated room and those exposed to the outside. If the respective surface areas adjacent to the heated room and exposed to the outside are approximately the same, and if the coefficients of transmission are approximately equal, the temperature in the unheated space may be assumed to be the mean of the inside and outside design temperatures. If, however, the surface areas and coefficients are unequal, the temperature in the unheated space should be estimated by means of Equation 2.

$$t_u = \frac{t(A_1U_1 + A_2U_2 + A_3U_3 + \text{etc.}) + t_o(A_aU_a + A_bU_b + A_cU_c + \text{etc.})}{A_1U_1 + A_2U_2 + A_3U_3 + \text{etc.} + A_aU_a + A_bU_b + A_cU_c + \text{etc.}} \quad (2)$$

where

t_u = temperature in unheated space, Fahrenheit degrees.

t = inside design temperature of heated room, Fahrenheit degrees.

t_o = outside design temperature, Fahrenheit degrees.

A_1, A_2, A_3, etc. = areas of surface of unheated space adjacent to heated space, square feet.

A_a, A_b, A_c, etc. = areas of surface of unheated space exposed to outside, square feet.

U_1, U_2, U_3, etc. = coefficients of transmission of surfaces of A_1, A_2, A_3, etc.

U_a, U_b, U_c, etc. = coefficients of transmission of surfaces A_a, A_b, A_c, etc.

Example 2. Calculate the temperature in an unheated space adjacent to a heated room having surface areas (A_1, A_2, and A_3) in contact therewith of 100, 120, and 140 sq ft and coefficients (U_1, U_2, and U_3) of 0.15, 0.20, and 0.25, respectively. The surface areas of the unheated space exposed to the outside (A_a and A_b) are respectively 100 and 140 sq ft, and the corresponding coefficients are 0.10 and 0.30. The sixth surface is on the ground and is neglected in this example. Assume $t = 70$ and $t_o = -10$.

Solution. Substituting in Equation 2:

$$t_u = \frac{70[(100 \times 0.15) + (120 \times 0.20) + (140 \times 0.25)] + -10[(100 \times 0.10) + (140 \times 0.30)]}{(100 \times 0.15) + (120 \times 0.20) + (140 \times 0.25) + (100 \times 0.10) + (140 \times 0.30)}$$

$$t_u = \frac{4660}{126} = 37 \text{ F.}$$

The temperatures in unheated spaces having large glass areas and having two or more surfaces exposed to the outside (such as sleeping porches and sun parlors), generally are assumed to be the same as outside.

GROUND TEMPERATURES

Ground temperatures to be assumed for estimating basement heat losses usually will differ in the case of basement walls and floors, the temperatures under the floors generally being higher than those adjacent to walls.

Temperatures Adjacent to Basement Walls

Ground temperatures near the surface and under open spaces vary with the climate, the season of the year and the depth below the surface. The nearer the surface (during the cold weather) the lower will be the ground temperature. Frost will penetrate to a depth of over 4 ft in some localities if not protected by snow. A thick blanket of snow will result in a higher ground temperature near the surface. Consequently, ground

temperatures near the surface may be higher in cold climates where the snow remains on the ground for a greater length of time, than in more moderate climates where the snow melts away periodically during the winter.

Complete data are not available, but in estimating heat losses through walls below grade, it is advisable to assume average ground temperatures not higher than 32 F in northern climates when estimating heat losses from heated basements. This is for the mean height of the basement wall. Since the recommended transmission coefficient for basement walls in contact with the soil is only 0.10, any reasonable, assumed ground temperature will not materially affect the calculated heat loss.

Temperatures Under Basement Floors

The temperature of the ground under basement floors[6] is affected by heat sources within the basement and is not influenced by atmospheric conditions. In computing losses through basement floors, the ground temperatures may be assumed to be the same as water temperatures at depths of 30 to 60 ft given in Fig. 3, Chapter 34. Test observations indicate that heat losses through basement floors frequently are over-estimated.[7]

BASEMENT TEMPERATURES AND HEAT LOSS

The allowance to be made for basement heat loss depends on whether the basement is to be heated or not.

If the basement is *heated* to a specified temperature, the heat loss should be calculated in the usual manner, based on the proper wall and floor coefficients (see Chapter 9) and the outside air and ground temperatures. Heat loss through windows and walls above grade should be based on outside temperatures and the proper air-to-air coefficients. Heat loss through basement walls below grade should be based on the floor and wall coefficients for surfaces in contact with the soil, and on the proper ground temperature.

If a basement is completely below grade and is *not heated*, the temperature in the basement normally will range between that in the rooms above and the ground temperature. Basement windows will, of course, lower the basement temperature when it is cold outside and heat given off by the heating plant will increase the basement temperature. In any case, the exact basement temperature is indeterminate if the basement is not heated. Since the basement temperature generally will be lower than that of the rooms above, an allowance theoretically should be made for the loss from the rooms above through the floor over the basement.

The temperature in crawl spaces below floors will vary widely depending on the number and size of wall vents, the amount of warm piping present and type of piping insulation. It is necessary, therefore, to evaluate the conditions and to select an appropriate temperature by judgment.

FLOOR HEAT LOSS IN BASEMENTLESS HOUSES

Two types of concrete floors are in common use in basementless houses: (a) the floor not heated but relying for warmth on radiation received from walls, ceiling, etc., and (b) the floor containing heating pipes or ducts and constituting a *radiant* slab for heating or partially heating the house.

For type (a) the floor heat loss, economically considered, is of minor importance since it comprises generally about 10 per cent of the total heat loss of the house. From the comfort standpoint, however, it may be most