temperatures under the floors being generally 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 the 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[7] for various localities are not as yet available but in estimating heat losses through vertical walls below grade, it is advisable not to assume average ground temperatures above 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 wall coefficient for basement walls in contact with the soil is only 0.10, any small variation in the assumed ground temperature will not materially affect the calculated heat loss.

Temperatures Under Basement Floors

The temperature under basement floors[8] is influenced by the heat from the basement or protected from the influence of atmospheric conditions by the basement. In computing losses through basement floors the ground temperatures may be assumed the same as the approximate water temperature at depths of 30 to 60 ft given in Fig. 1, Chapter 27. It should be remembered however that the distance of the basement floor below grade may have some effect upon the temperature of the ground under basement floors, the nearer the surface the higher the temperature.

BASEMENT TEMPERATURES AND HEAT LOSSES

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

Unheated Basements

If a basement is completely below grade and is *not heated*, the temperature in the basement will normally range between that in the rooms above and the ground temperature. Basement windows will of course lower the basement temperature when it is colder outside and any heat

[7]The temperatures listed were obtained on February 11, 1941, in Pittsburgh, Pa., at the depths indicated at a location 21 ft from the walls of a heated basement.

Depth below surface, In.	Temperature, Deg Fahr
0	23.2
3	23.5
21	30.0
42	39.4
72	44.0
Average	32.0

[8]A.S.H.V.E. Research Paper—Heat Loss Through Basement Walls and Floors, by F. C. Houghten, S. I. Taimuty, Carl Gutberlet and C. J. Brown (A.S.H.V.E. Transactions, Vol. 48, 1942, p. 369).

given off by the heating plant will increase the basement temperature. In any case, the exact basement temperature is likely to be a somewhat indeterminate quantity, if the basement is not heated. Since the basement temperature will generally be lower than that of the rooms above, an allowance should theoretically be made for the loss from the rooms above through the floor over the basement.

Heated Basements

If the basement is *heated* and a specified temperature is to be maintained, the heat loss should be estimated in the usual manner, based on the proper wall and floor coefficients (see Chapter 4) and the outside air and the ground temperatures. Heat losses through windows and walls above grade should be based on outside temperatures and the proper air-to-air coefficients. Heat losses 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.

HEAT LOSSES THROUGH CEILINGS AND ROOFS

The transmission heat loss through top floor ceilings, attics and roofs may be estimated by either of two methods:

1. By substituting in Equation 1 the ceiling area (A), the inside-outside temperature difference ($t - t_o$) and the proper value of (U):

   a. *Flat roofs.* Select the coefficient of transmission of the ceiling and roof from Table 14, Chapter 4.

   b. *Pitched roofs.* Select the combined roof and ceiling coefficient from Table 16, Chapter 4 or calculate the combined roof and ceiling coefficient by means of Equation 4, Chapter 4, where this formula is applicable as explained in Chapter 4.

2. By estimating the attic temperature (based on the inside and outside design temperature) by means of Equation 4, and substituting for t_o in Equation 1, the value of t_a thus obtained, together with the ceiling area (A) and the ceiling coefficient (U). This applies to *pitched roofs*. In the case of *flat roofs* it is not necessary to calculate the attic temperatures as the ceiling-roof heat loss can be determined as per paragraph 1a.

SELECTION OF WIND VELOCITIES

The effect of wind on the heating requirements of any building should be given consideration under two heads:

1. Wind movement increases the heat transmission of walls, glass, and roof, affecting poor walls to a much greater extent than good walls.

2. Wind movement materially increases the infiltration (inleakage) of cold air through the cracks around doors and windows, and even through the building materials themselves, if such materials are at all porous.

Theoretically as a basis for design, the most unfavorable combination of temperature and wind velocity should be chosen. It is entirely possible that a building might require more heat on a windy day with a moderately low outside temperature than on a quiet day with a much lower outside temperature. However, the combination of wind and temperature which is the worst would differ with different buildings, because wind velocity has a greater effect on buildings which have relatively high infiltration losses. It would be possible to work out the heating load for a building