plant warms the air near the basement ceiling sufficiently to make it unnecessary to make an allowance for floor heat loss from rooms located 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.

HEAT LOSSES FROM FLOOR SLABS

Two types of concrete floors used in basementless houses are (a) the unheated floor, relying for warmth on heat delivered above floor level by the heating system, and (b) the heated floor containing heated pipes or ducts that constitute a radiant slab or portion thereof for complete or partial heating of the house.

For type (a) the floor heat loss, economically considered, is of minor importance since is comprises generally about 10 percent of the total heat loss of the house. From the comfort standpoint, however, it may be most important, since houses with cold floors are not successfully heated. In this connection, it should be remembered that a well insulated floor does not assure comfort if down-drafts from windows or exposed walls create pools of chilly air over considerable areas of the floor. For this reason a floor of type (a) should not be used in a severe climate except with a heating system that delivers enough heat near the floor to counteract the down-drafts of the exterior walls and the heat transmission through the floor.

The results of some experiments[10, 11] with type (a) unheated floor slabs indicate that the heat loss from a concrete slab floor on grade is more nearly proportional to the perimeter than to the area of the floor, and that the heat loss can be estimated by means of the equation:

$$H_F = FP\,(t - t_o) \qquad (3)$$

where

H_F = heat loss of the floor, Btu per hour.
P = perimeter or exposed edge of the floor, linear feet.
F = heat loss coefficient, Btu per (hour) (linear foot of exposed edge) (degree difference in temperature between the inside air and the outside air). (F ranges between 0.81 for a floor with no edge insulation to 0.55 for a floor with edge insulation).
t = inside air temperature, Fahrenheit.
t_o = outside air temperature, Fahrenheit.

In most instances the values given in Fig. 2 for edge loss are of sufficient precision for use.[12] The insulation shown extending under the floor horizontally for 2 ft can also be located along the foundation wall with equal effectiveness if the insulation extends 24 in. below the floor level. A common application not shown in Fig. 2 is that of 1 in. of vertical edge insulation extending down 18 in. below the floor level, the values for Zones A, B, and C being 55, 50 and 45 Btu per (hour) (linear foot of exposed edge), respectively.

Example 3: Calculate the heat loss from the floor of a 12 ft x 15 ft room with two exposures. The floor is an unheated concrete slab which is insulated at the edge with 2 in. of insulation extending horizontally for a distance of 2 ft from the edge, and the house is located in Zone B, (outside temperature = −10 F).

Solution: From Fig. 2 the heat loss per foot of exposed edge is 45 Btu per hr. The length of exposed edge is 12 ft + 15 ft = 27 ft, and the total edge loss 27 x 45 = 1215 Btu per hr.

Floors of type (b) containing heating pipes or ducts, are now in common use. The heat loss downward into the ground and outward through the edges of the floor slab is called the reverse loss.

The results[13] of an investigation in which a warm-air perimeter duct was embedded in four types of concrete floor slab and foundation constructions has verified the indication that Equation 3 can be used to calculate the reverse loss when warm-air perimeter heating ducts are used. To make the results of this application more usable, values corresponding to those shown in Fig. 2 are given in Table 5.

The desirability of edge insulation is apparent. One inch of water-resistant material is the minimum thickness of edge insulation that should

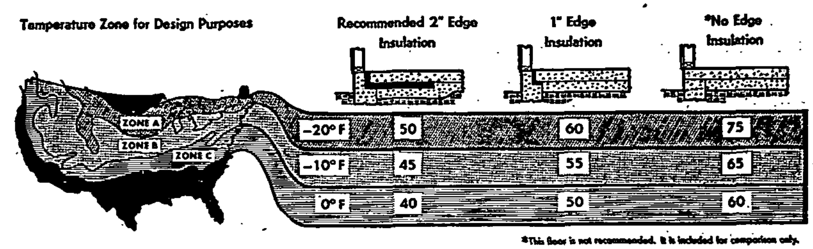

Fig. 2. Heat Loss per Foot of Exposed Edge for Concrete Floors at or Near Grade Level.[12]

be used, but a 2-in. thickness is recommended.[12, 14] The values of edge loss in Table 5 indicate that the reverse heat loss of heated slabs is likely to be about 20 percent of the total heat loss of many types of present day houses, and may exceed 20 per cent if only one inch of insulation is used at the edge of the floor.

The concrete floor slab is usually placed on a gravel fill 4 in. thick or more, both to insulate the floor from the earth and to retard the rise of ground water by capillarity. A waterproof membrane should be installed over the gravel fill. Obviously, it is important that such floors be laid several inches above grade, and that effective subsoil drainage be provided to avoid slabs soaked by rain or melting snow, and consequent excessive heat loss.

TRANSMISSION HEAT LOSS

The basic formula for the loss of heat by transmission through any surface is given in Equation 4:

$$H_t = AU\,(t - t_o) \qquad (4)$$

where

H_t = heat loss transmitted through the wall, roof, ceiling, floor, or glass, Btu per hour.
A = area of wall, glass, roof, ceiling, floor, or other exposed surface, square feet.