

use. The heat loss downward into the ground and outward through the edges of the floor slab is called the reverse loss.

The results¹³ 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 Table 5 for unheated floors are given in Table 6 for concrete floors with a warm-air perimeter duct.

The desirability of edge insulation is apparent. One inch of water-resistant material is the minimum thickness of edge insulation that should be used, but a 2-in. thickness is recommended.^{12, 14} The values of edge loss in Table 6 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

TABLE 5. HEAT LOSS OF CONCRETE FLOORS AT OR NEAR GRADE LEVEL PER FOOT OF EXPOSED EDGE

OUTDOOR DESIGN TEMPERATURE, F	HEAT LOSS PER FOOT OF EXPOSED EDGE, BTU/HR			
	RECOMMENDED 2-IN. EDGE INSULATION	1-IN. EDGE INSULATION	1-IN. EDGE INSULATION	NO EDGE INSULATION*
				
-20 to -30	50	55	60	75
-10 to -20	45	50	55	65
0 to -10	40	45	50	60

* This construction not recommended; shown for comparison only.

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:

$$H_t = AU(t - t_o) \quad (4)$$

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.

Heating Load

U = coefficient of transmission, air to air, Btu per (hour) (square foot) (Fahrenheit degree temperature difference) (Chapter 9).

t = inside temperature near surface involved (this may not necessarily be the so-called breathing line temperature), Fahrenheit degrees.

t_o = outside temperature, or temperature of adjacent unheated space or of the ground, Fahrenheit degrees.

Example 4: Calculate the transmission loss through an 8 in. brick wall having an area of 150 sq ft, if the inside temperature t is 70 F and the outside temperature t_o is -10 F.

Solution: The coefficient of transmission (U) of a plain 8 in. brick wall is 0.50 (Chapter 9, Table 8). The area (A) is 150 sq ft. Substituting in Equation 4:

$$H_t = 150 \times 0.50 \times [70 - (-10)] = 6000 \text{ Btu per hour.}$$

TABLE 6. FLOOR HEAT LOSS TO BE USED WHEN WARM-AIR PERIMETER HEATING DUCTS ARE EMBEDDED IN SLAB*
Btu per (hour) (linear foot of heated edge)

OUTDOOR DESIGN TEMPERATURE, F	EDGE INSULATION		
	1-IN. VERTICAL EXTENDING DOWN 18 IN. BELOW FLOOR SURFACE	1-IN. L-TYPE EXTENDING AT LEAST 12 IN. DEEP AND 12 IN. UNDER	2-IN. L-TYPE EXTENDING AT LEAST 12 IN. DEEP AND 12 IN. UNDER
-20	105	100	85
-10	95	90	75
0	85	80	65
10	75	70	55
20	62	57	45

* Factors include loss downward through inner area of slab.

Transmission Loss 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 4 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 Tables 15 or 16, Chapter 9, or use appropriate coefficients in Equation 1 if side walls extend appreciably above the ceiling of the floor below.

b. **Pitched roofs.** Select the combined roof and ceiling coefficient from Table 18, Chapter 9 or calculate the combined roof and ceiling coefficient by means of Equations 4 and 5, Chapter 9, where these formulas are applicable as explained in Chapter 9.

2. By estimating the attic temperature (based on the inside and outside design temperatures) by means of Equation 1, and substituting for t_o in Equation 4, the value of t_o 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 suggested in paragraph 1a.

INFILTRATION HEAT LOSS

The infiltration heat loss includes (1) the *sensible heat loss* or the heat required to warm the outside air entering by infiltration, and (2) the *latent heat loss* or the heat equivalent of any moisture which must be added.