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portable pressurization chamber. Smoke pencils, thermography, and photographs provided additional documentation. In addition to window leakage, other parameters were studied, including the effect of sash and frame material, the effect of leakage between window frame and wall, differences among the product lines of a single manufacturer and between manufacturers, the effect of installation practices, the effect of cold weather, the effects of aging, and the characteristics of fixed glazing.

Casement windows were far more airtight than sliding and hung windows. The manufacturer had more effect on window performance than the installer; however, the window type had more influence on performance than either the manufacturer or the installer.

Excessive air leakage occurred most frequently at corners, sills, and meeting rails. Often, excessive leakage could be related to irregularities in weatherstripping, sash fit, and hardware.

This abstract is based on a report prepared by the Minnesota Energy Agency for the U.S. Department of Energy and the Lawrence Berkeley Laboratory. Copies of the full report are available for $11.50 from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; (703)487-4600. Ask for "Air Leakage of Newly Installed Residential Windows," Order #LBL-11111.

FEATURE BASEMENT HEAT LOSS CALCULATION— AN EXTENSION OF THE ASHRAE METHOD

Basement heat loss is the most difficult to calculate of all the heat loss components of a house. First of all, soil conductivity varies with soil type and moisture content, neither of which can be easily predicted. Further complications are due to the fact that heat loss from basement walls goes in two directions -- upward toward the ground surface which varies seasonally in temperature, and downward toward the "deep earth" which stays at a constant temperature all year long.

Despite the uncertainties, some estimate of basement wall heat loss is necessary for specifying insulation thickness. The most common method is that prescribed in the ASHRAE Handbook of Fundamentals. The ASHRAE handbook offers a fairly simple method for calculating heat loss from basement walls, but only supplies information for a maximum insulation level of R-12.5. Superinsulated houses often have foundation insulation with R-values greater than 12.5, sometimes as high as R-30. How can those be dealt with?

We recently received a call from David Jacobson of Princeton University who, in studying the ASHRAE method for basement heat loss, discovered a way to extend the method for any level of insulation. The following procedure uses the same approach as that outlined in the ASHRAE 1981 Handbook of Fundamentals, Chapter 25, except we have incorporated Jacobson's information to allow calculations for any R-value.

PROCEDURE

With this method, the R-value of the wall is considered to increase with depth due to the thermal resistance of the soil. An R-value for the soil at incremental depths, called the "no insulation R-value," is added to the R-value of the insulation. The heat loss is then calculated using an estimated design soil temperature.

STEP 1: Divide the total foundation wall area into one-foot-high horizontal segments.

STEP 2: Calculate R-value of each segment by adding the R-value of the foundation insulation to the "no insulation" R-values listed in Table 1.

"No insulation" R-values for below grade wall sections at various depths.

Table 1

Depth Below Grade (feet)	"No Insulation" R-Value
0-1	2.43
1-2	4.50
2-3	6.45
3-4	8.40
4-5	10.40
5-6	12.70
6-7	14.50

The "no insulation" R-values are derived from Table 18, Chapter 25 of the 1981 ASHRAE Handbook of Fundamentals.

STEP 3: Find the "external design temperature."

The external design temperature is the average winter temperature of the soil outside the foundation. This is obviously somewhat of a guess because we are looking for an average soil temperature for depths ranging from the surface to 4 to 6 feet below grade. The top foot of soil undergoes extreme temperature fluctuations, tracking outdoor air temperatures fairly closely. The lower depths, say 3 to 4 feet, vary much less in temperature and lag several months behind outdoor air temperature.

The external design temperature is estimated as the average annual air temperature minus a temperature correction factor. Table 2 lists the temperature correction factors for various regions of the U.S.

Temperature Correction Factors

Table 2

Location	Factor
North Central States	22
Western, South Central, Northeastern	18
Mid-Atlantic States	14

The above factors are taken from Figure 4, Chapter 25 of the ASHRAE Handbook of Fundamentals.

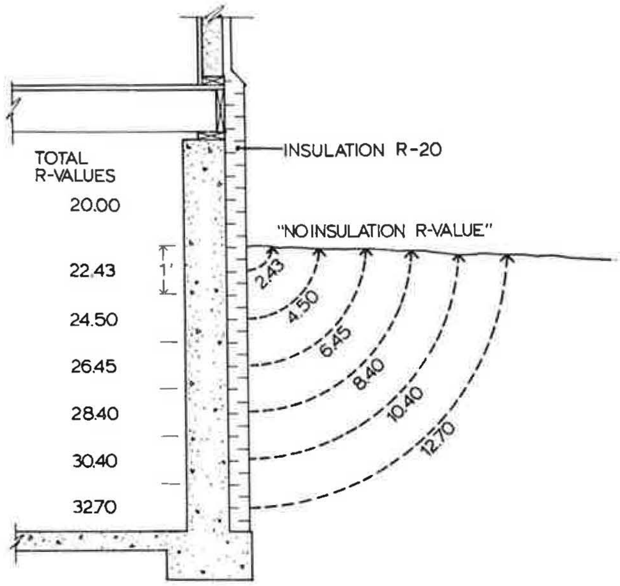
STEP 4: Calculate the heat loss from each segment using the following equation:

$$\text{Heat Loss (Btu/hr)} = (A/R) \times DT \qquad \text{Eq. 1}$$

where A is area of each segment in square feet, R is the R-value derived in Step 2 above, and DT is the difference between basement indoor temperature and external design temperature.

EXAMPLE: Consider a basement 30 feet wide by 40 feet long sunk 6 feet below grade with R-20 insulation applied to the entire wall. Assume an internal air temperature of 70°F, and a mean annual air temperature of 40 degrees. The house is located in Minnesota for which the design temperature correction factor is 22 degrees (from Table 2).

SOLUTION: The below-grade foundation wall is divided up from top to bottom into six 1-foot-high segments, each with an area of 140 square feet (STEP 1). R-values are calculated according to the method in STEP 2. The external design temperature (STEP 3) is (40 - 22) or 18 degrees.



Basement Wall Heat Loss

Area of each Segment = 140 square feet
Delta T = 70-18 degrees F
= 52 degrees F

R-value -- Varies with depth; equal to "no insulation" (from Table 1 plus R-20.)

Segment Depth (ft)	R-value	Heat Loss [(A/R) x DT] (Btu/hr)
1	22.43	324
2	24.50	297
3	26.45	275
4	28.40	256
5	30.40	239
6	32.70	223
Total heat loss		1614 Btu/hr

The calculated heat loss is only for the below-grade section of the foundation walls. To calculate the above-grade heat loss, one uses the same method as for other above-grade walls.

SOME QUALIFICATIONS

The above calculation procedure produces a rough approximation at best. It doesn't take into account increased heat loss at corners, or variability in soil conductivity. For a more sophisticated method of basement heat loss calculation, see the study by G. Mitalas cited in the March, 1984 issue of EDU, page 15.

FEATURE THE IMPACT OF ENERGY EFFICIENCY ON THE AFFORDABILITY OF NEW HOUSING

A recent survey of lending institutions commi ...] Fiberglas
and conducted by Burson-Marsteller Research, New Y ... 60 percent
of those polled plan to offer preferential treatme ... homes in the