TABLE 11. HEAT TRANSMISSION FOR WALLS OF VARIOUS CONSTRUCTIONS

| THICKNESS OF BOARD IN IN. | TWO BOARDS WITH PAPER BETWEEN | BOARD AND CORRUGATED IRON | BOARD AND SHEET IRON |
|---|---|---|---|
| | B.t.u. Deg. Fahr. Difference 15 mi. per hr. wind | B.t.u. Deg. Fahr. Difference 15 mi. per hr. wind | B.t.u. Deg. Fahr. Difference 15 mi. per hr. wind |
| ½" | 0.32 | 0.45 | 0.50 |
| 1" | 0.24 | 0.36 | 0.40 |
| 1½" | 0.19 | 0.30 | 0.33 |
| 2" | 0.16 | 0.26 | 0.28 |
| 2½" | 0.14 | 0.23 | 0.25 |

TABLE 12. HEAT TRANSMISSION FOR WALLS OF CLAPBOARD

| CONSTRUCTION | B.t.u. per Deg. Fahr. Difference 15 mi. per hr. wind |
|---|---|
| Clapboard on Studs | 0.62 |
| Clapboard on Studs, Lath and Plaster | 0.48 |
| Clapboard, Paper, Studs, Lath and Plaster | 0.34 |
| Clapboard, Studs, 1" Sheathing | 0.57 |
| Clapboard, Sheathing, Studs, Lath and Plaster | 0.37 |
| Clapboard, Paper, Sheathing, Studs, Lath and Plaster | 0.30 |
| Clapboard, Studs, Brick Fill | 0.40 |
| Clapboard, Studs, Brick Fill, Papered | 0.36 |
| Clapboard, Studs, Brick Fill, Lath and Plaster | 0.31 |
| Clapboard, Sheathing, Studs, Lath and Plaster with Sawdust Fill | 0.21 |
| Clapboard, Paper, Sheathing, Studs, Lath and Plaster with Sawdust Fill | 0.15 |

## AREAS WHERE HEAT LOSSES OCCUR

Heat is lost from a building by transmission through all of those surfaces which separate heated spaces from the outside air or from unheated colder spaces within the building. In general, five kinds of surfaces are involved: (1) outside walls, (2) outside glass, (3) inside walls or partitions next to unheated spaces, (4) ceilings of upper floors, either below a cold attic space or as the underside of a roof slab, and (5) floors of heated rooms above an unheated space. In most cases, only items (1) and (2), outside wall and glass surface, are considered. Failure to take account of the other heat losing surfaces, items (3), (4) and (5), when they exist in a building, has generally resulted in more or less dissatisfaction with the operation of the heating plant, as a result of failure to heat the rooms having such surfaces as indicated by items (3), (4) and (5).

The net outside wall surface is usually determined by reference to the scale plans and elevations of the building concerned. In some cases of course, the actual building may have to be measured. The total area of all outside openings which are occupied by windows and doors is accurately measured and listed as *glass*. The *glass* area is then deducted from the total outside wall area for each room and the difference is the net wall area. The outside wall areas for any floor should be based on the vertical floor to floor heights and the horizontal distance from center to center of partitions separating different rooms. If there are no partitions, measure from inside face of one wall to inside face of next wall. The areas of walls, ceilings and floors next to cold or unheated spaces are found, of





course, by taking the inside dimensions of such areas, measured on the heated side.

## CALCULATIONS FOR HEAT TRANSMISSION LOSSES

The calculations for heat transmission losses are made by multiplying the area $S$ in square feet of wall, glass, roof or floor through which the loss takes place, by the proper coefficient $U$ for such construction (Tables 6 to 12, or by computation as described under Transmission Coefficients by Computation) and by the temperature difference between the inside air temperature $t$ at the proper level (in many cases not the "breathing line") and the outside air temperature $t_o$. Therefore,

$$H_t = SU\,(t - t_o) \qquad (9)$$

where

$H_t$ = B.t.u. per hr. transmitted through the material of the wall, glass, roof or floor.

$S$ = area in sq. ft. of wall, glass, roof or floor, taken from building plans or actually measured. (Use the net inside or heated surface dimensions in all cases.)

$U$ = coefficient of heat transmission or B.t.u. per hr. per sq. ft. per 1 deg. fahr. difference between the inside and outside air temperature for air conditions such as exist in the given locality in coldest weather.

$(t - t_o)$ = temperature difference between inside and outside air, in which $t$ must always be taken at the proper level. Note that $t$ may not be the "breathing line" temperature in many cases.

For examples showing application of equation (9) to practical examples see *Applications* at the end of this chapter, in which the heat requirements are computed for typical cases.

### Wind Movement

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.

It is entirely possible that a building may require more heat on a windy day with a moderately low outside temperature, than on a quiet day with a much lower outside temperature. It will therefore be evident that the wind movement in any locality must be given careful consideration in computing the probable heating requirements of a building, and for the purposes of calculation, not less than the average wind movement in any locality during December, January and February should always be provided for in computing (1) the heat transmission of a building, and (2) the heat required to take care of the infiltration of outside air.

The first condition is readily taken care of as already explained, by using a surface coefficient $K_2$ for the outside wall surface which is based on the proper wind velocity (Table 5). In case specific data are lacking for any locality, use an average wind velocity of approximately 15 miles per hour. In a similar manner, the heat allowance (Table 15) for infiltration (B.t.u. per hour per foot of crack required to raise the temperature