

for several different combinations of temperature and wind velocity which records show to have occurred and to select the worst combination; but designers generally do not feel that such a degree of refinement is justified.

It has been the practice for many years in estimating air leakage by the crack method to use the *average* wind velocity during the months of December, January and February. Although this practice is still followed by some engineers, data are not as yet available to substantiate this assumption. This *average* wind velocity may not necessarily correspond with that occurring during periods when the outside design temperature prevails, the latter being not an *average* but rather a near extreme, that is, a specified number of degrees above the lowest temperature recorded in the locality involved. Therefore instead of using the aforementioned *average* wind velocity, it is the practice of some designers to use in all cases a wind velocity of 15 mph together with the proper design temperature. Although a 15 mph wind velocity is higher than the general average wind velocity during December, January and February in various United States cities, this and higher wind velocities frequently occur during periods of outside temperature corresponding to the design temperature. Because of the unpredictable and intangible nature of this variable there appears to be ample justification for this assumption. It should be added that this wind velocity also corresponds with that on which the heat loss coefficients in Chapter 4 are based, although the effect of variations in wind velocity on the infiltration losses is generally much greater than the effect of wind velocity on the heat loss by transmission through walls, except in the case of single pane windows or other materials and constructions having a high rate of heat transfer. Therefore, pending further investigation of this subject, either the average during December, January and February or a 15 mph wind velocity may be used at the discretion of the designer, the actual wind velocity used however to be specified in each case. Where the air change method is used for estimating infiltration losses, the wind velocity is not considered.

Exposure Factors: Many designers use empirical exposure factors to increase the calculated heat loss of rooms or spaces on the side or sides of the building exposed to the prevailing winds. However, according to a survey made in 1943, many GUIDE users have found that the use of exposure factors is not necessary as the GUIDE method of calculating heat losses provides an ample heat loss allowance. Therefore exposure factors may be regarded as "factors of safety" for the rooms or spaces exposed to the prevailing winds, to allow for additional capacity for these rooms or spaces, or to "balance the radiation," particularly in the case of multi-story buildings. Although the exposure allowance is frequently assumed to be 15 per cent, the actual allowance to be made, if any, must to a large extent be a matter of experience and judgment of the designer, since there are at present no authentic test data available from which rules could be developed for the many conditions encountered in practice.

As stated previously, the value of U in the tables of Chapter 4 are based on a wind velocity of 15 mph and the surface resistance for this wind velocity (0.17) is sufficiently low that higher wind velocities will decrease the surface resistance to a negligible degree and therefore have only a slight effect on the average overall coefficient. On the other hand, infiltration losses vary almost directly as the wind velocity as will be

apparent from the factors in Table 2 of Chapter 5. The more exact method therefore would be to differentiate among the various exposures more accurately by calculating the infiltration and transmission losses separately for the different sides of the building, using different assumed wind velocities for the infiltration losses on the various sides of the building.

AUXILIARY HEAT SOURCES

The heat supplied by persons, lights, motors and machinery should always be ascertained in the case of theaters, assembly halls, and industrial plants, but allowances for such heat sources must be made only after careful consideration of all local conditions. In many cases, these heat sources should not be allowed to affect the size of the installation at all, although they may have a marked effect on the operation and control of the system. In general, it is safe to say that where audiences are involved, the heating installation must have sufficient capacity to bring the building up to the stipulated inside temperature before the audience arrives. In industrial plants, quite a different condition exists, and heat sources, if they are always available during the period of human occupancy, may be substituted for a portion of the heating installation. In no case should the actual heating installation (exclusive of heat sources) be reduced below that required to maintain at least 40 F in the building.

Electric Motors and Machinery

Motors and the machinery which they drive, if both are located in the room, convert all of the electrical energy supplied into heat, which is retained in the room if the product being manufactured is not removed until its temperature is the same as the room temperature.

If power is transmitted to the machinery from the outside, then only the heat equivalent of the brake horsepower supplied is used. In the first case the Btu supplied per hour = $\frac{\text{Motor horsepower}}{\text{Efficiency of motor}} \times 2546$, and in the second case Btu per hour = bhp $\times$ 2546, in which 2546 is the Btu equivalent of 1 hp-hr. In some mills this is the chief source of heating and it is frequently sufficient to overheat the building even in zero weather, thus requiring cooling by ventilation the year round.

The heat (in Btu per hour) from electric lamps is obtained by multiplying the watts per lamp by the number of lamps and by 3.413. One cubic foot of producer gas gives off about 150 Btu per hour; one cubic foot of manufactured gas about 535 Btu per hour; and one cubic foot of natural gas about 1000 Btu per hour. A Welsbach burner averages 3 cu ft of gas per hour and a fish-tail burner, 5 cu ft per hour. For information concerning the heat supplied by persons, refer to data given in Chapter 2.

GENERAL PROCEDURE

The eight steps required for calculating heat losses of a structure are:

1. Determine on an outside air temperature for design purposes, based on the minimum temperatures recorded in the locality in question, which will provide for all but the most severe weather conditions. Such conditions as may exist for only a few consecu-