

## HEATING LOAD

*General Procedure, Design Outdoor Weather Conditions, Inside Temperatures, Attic Temperatures, Temperatures in Unheated Spaces, Ground Temperatures, Basement Temperatures and Heat Loss, Transmission Heat Loss, Infiltration Loss, Selection of Wind Velocities, Auxiliary Heat Sources, Intermittently Heated Buildings, Residence Heat Loss Problems*

IN the design of a heating system, an estimate must be made of the maximum probable heat loss of each room or space to be heated, based on maintaining a specified inside air temperature during periods of design outdoor weather conditions. The heat losses may be divided into two groups, namely (1) the transmission losses or heat losses through the confining walls, floor, ceiling, glass or other surfaces and (2) the infiltration losses or heat losses due to air leakage through cracks and crevices, around doors and windows, opening of doors and windows or heat required by outside air used for ventilation.

## GENERAL PROCEDURE

The general procedure for calculating heat losses of a structure is:

1. Select the design outdoor weather conditions: temperature, wind direction and wind velocity. The data on climatic conditions given in Table 1 and the isotherms of average design temperature in Fig. 1 will be useful but should be applied with judgment as suggested in the section Design Outdoor Weather Conditions.
2. Select the inside air temperature, at the 60-in. breathing line or the 30-in. line which is to be maintained in the building during the coldest weather. (See Table 2).
3. Estimate temperatures in adjacent unheated spaces and the attic. The attic temperature need not be estimated if the combined roof and ceiling coefficient is used.
4. Select or compute the heat transmission coefficients for outside walls and glass; also for inside walls, floors, or top-floor ceilings, if these are next to unheated space; include roof if next to heated space. (See Chapter 6).
5. Measure amount of net outside wall, glass and roof next to heated spaces, as well as any cold walls, floors or ceilings next to unheated space. Such measurements are made from building plans, or from the actual building, using inside dimensions.
6. Compute the heat transmission losses for each kind of wall, glass, floor, ceiling and roof in the building by multiplying the heat transmission coefficient in each case by the area of the surface in square feet and the temperature difference between the inside and outside air. (See Items 1, 2, and 3).
7. Select unit values and compute the heat equivalent of the infiltration of cold air taking place around outside doors and windows. These unit values depend on the kind or width of crack, wind velocity, and the temperature difference between the inside and outside air; the result expresses the heat required to warm up the cold air leaking into the building per hour. (See Chapter 8).
8. When mechanical exhaust fans are used and the replacement air is drawn from outside the heat required to raise this air to room temperature is added to the infiltration loss. If the mechanically exhausted air quantity is equal to, or greater than, the natural infiltration rate, the infiltration loss should be disregarded.
9. The sum of the heat losses by transmission (Item 6) through the outside wall and glass, as well as through any cold floors, ceilings or roof, plus the heat equivalent (Item 7) of the cold air entering by infiltration, or required to replace mechanical exhaust, represents the total heat loss equivalent for any building.

## DESIGN OUTDOOR WEATHER CONDITIONS

*There are no hard and fast rules for selecting the design outdoor weather conditions to be used for a given locality or type of building or heating system,*

and the problem is to some extent a matter of judgment and experience. The outside design temperature is seldom taken as the lowest temperature, or even the lowest daily mean temperature ever recorded in a given locality. Such temperatures are rarely repeated in successive years. Likewise the wind direction and velocity prevailing at the time of design outside conditions frequently are entirely different from those prevailing during the winter season.

The A.S.H.V.E. Technical Advisory Committee on Weather Design Conditions has recommended the adoption for heating load calculations of an *outside design temperature which is equalled or exceeded during 97½ percent of the hours in December, January, February and March.*

Complete data of this nature is not available but Column 7, Table 1, lists this recommended design temperature based on airport station readings for the period indicated, generally a five year period 1935-1939 inclusive. It is pointed out that in most cases these stations are outside of the city and that these data would apply primarily to rural areas. A comparison of the lowest recorded temperatures, with due regard to the period of record, makes it possible to determine an equivalent design temperature for city stations. In general the use of the airport data for buildings within an adjacent city will not make any appreciable difference in design load.

The calculation of these design temperatures is being carried on but due to the extensive amount of work involved will not be completed for some time. It should also be noted that the period of record for the stations listed occurred in what is known as a warm cycle and when longer periods are used it is expected that many of these design temperatures will be somewhat lower.

Because of the limited data available, design temperatures in common use are listed in Column 9. Many of these values were furnished by A.S.H.V.E. members—the balance were taken from an ACRMA Bulletin<sup>1</sup>, manufacturers' publications and other sources<sup>2</sup>, and a few were estimated. The map, Fig. 1, shows isotherms approximated for these design temperatures. They may be used as a guide for localities not listed in the table. Interpolation between these lines is suggested and due consideration must be given to elevations and other local conditions.

Column 8 of the table gives the maximum wind velocity which occurred with temperatures the same as, and lower than, those shown in Column 7. Winter average velocities for all temperatures are given in Column 10.

Column 6 lists the average annual minimum temperature which is the average of readings of the one lowest temperature occurring for each year the station has been in existence. It is of interest as a guide to the lowest temperature to be encountered except for an occasional extreme of short duration.

Finally, large differences in climate occur within relatively small distances of Weather Bureau stations in hilly and mountainous regions. The designer must use experience and judgment to deal properly with this factor.

## INSIDE TEMPERATURES

The inside air temperature which must be maintained within a building is understood to be the dry-bulb temperature at the breathing line, 5 ft above the floor, or the 30-in. line, and not less than 3 ft from the outside walls. Inside air temperatures, usually specified, vary in accordance