

basis are given for various United States and Canadian cities in Table 3. The United States values were computed from daily mean temperatures recorded by the Weather Bureau over a 43-year period⁴ from 1899 to 1941. The number of degree-days for a calendar day of a given year was obtained by taking the difference between 65 F and the mean temperature determined from a reading of the maximum and minimum thermometers for a particular locality. The daily normal was established by taking an average of the 43 daily degree-day figures. These daily values were then added to obtain a monthly normal, and the yearly or seasonal degree-day figure was established by taking a summation of the monthly values. In general, attempts to apply the degree-day method to fuel consumption over a period of less than a month are of questionable value.

Formula for Degree-Day Method

The general equation for calculating the probable fuel consumption by the degree-day method is:

$$F = U \times N \times D \quad (4)$$

where

F = fuel consumption for the estimate period.

U = unit fuel consumption, or quantity of fuel used per degree-day per building load unit.

N = number of building load units (when available use calculated heat loss instead of actual amount of radiation installed).

D = number of degree-days for the estimate period.

Values of N depend on the particular building for which the estimate is being prepared and must be found by surveying plans, by observation, or by measurement of the building. Values of U for use in this equation are the unit fuel consumptions per degree-day and are obtained as a result of the collection of operating information. Certain of this information is presented later but before referring to these data attention is directed to the nature of the unit.

Unit Fuel Consumptions per Degree-Day

The quantity of fuel used per degree-day in a given heating plant can be reduced to a unit basis in terms of quantity of fuel or steam per degree-day per square foot of radiation, per cubic foot of heated building space, or per thousand Btu hourly heat loss at design conditions. A less frequently used basis is quantity of fuel per degree-day per square foot of floor area. In fact any convenient unit can be used to relate the consumption to the degree-day and to the building.

The choice of these units requires explanation and some discrimination and judgment. The use of heated space in preference to the gross building cubage is obviously more accurate for this purpose. The gross cubage includes the outer walls and certain percentages of attic and basement space which are usually unheated. The net heated space is usually about 80 per cent of the gross volume and can be calculated from the latter if it cannot be measured. The cubical content is not considered accurate as a basis of comparison due to differences in types of construction, exposure, and ratio of exposed area to cubical contents.

⁴Received from U. S. Weather Bureau Sept. 1943.

The calculated heat loss or its equivalent square foot of calculated radiator surface may be used as the unit. The use of the unit equivalent direct radiation is of questionable value when referring to heat transfer surfaces as applied to warm air furnace or central air conditioning systems. In view of all these considerations it is believed that the unit based on *thousands of Btu of hourly calculated heat loss for the design hour* is probably the most desirable although the one most widely used seems to be *units of fuel per degree-day per square foot of equivalent direct radiator surface*. The equivalent heating load for the hot water supply is not included in the latter unit, but it generally includes the piping load.

Since this unit is the one most widely used at present the unit fuel consumptions given in succeeding paragraphs of this chapter make use of this unit to a considerable extent, although it should be understood that most of these units of consumption can be transposed as desired.

Estimating Gas Consumption

Values of the Unit Fuel Consumption Constant (U) for gas are given in Table 4 for various gas heating values, and different types and sizes of heating plants. They are based on an inside design temperature of 70 F and an outside design temperature of 0 F and apply only to these conditions. For other design conditions corrections must be made as given in Table 7.

The factors in Table 4, as corrected if necessary, are satisfactory for regions having 3500 to 6500 degree-days per heating season. In regions with less than 3500 degree-days the unit gas consumption is higher than given; where over 6500, the unit is less than given. Ten per cent addition or deduction in these cases is recommended by AGA publications. Estimates for industrial buildings where low inside temperatures are maintained cannot be made from this table.

For gas heating values other than those given in Table 4, simply interpolate or extrapolate. It will also be noted that Table 4 applies only to small installations. In general the larger the installation the smaller the unit gas consumption becomes and the values in the table should be used with care, if at all, in large gas-burning installations.

Example 5. Estimate the gas required to heat a building located in Chicago, Ill., which has 6287 degree-days and a gas heating value of 800 Btu per cubic foot. The calculated heating surface requirements are 1000 sq ft of hot water radiation based on design temperature of -10 F and 70 F.

Solution. From Equation 4 and Table 4, the fuel consumption for a design temperature of 0 F with 800 Btu gas is found to be 0.085 cu ft of gas per degree-day per square foot of hot water radiation. From Table 7, the correction factor is 0.875 for -10 F outside design temperature, hence $0.875 \times 0.085 = 0.07438$.

$$0.07438 \times 1000 \times 6287 = 467,000 \text{ cu ft.}$$

Estimating Oil Consumption

Unit fuel consumption factors for oil, similar to those for gas in Table 4 are given in Table 5. The factors in Table 5 apply only to an inside design temperature of 70 F and an outside design temperature of 0 F. For other outside design temperatures, the constants in Table 5 must be multiplied by the values in Table 7 as explained under Estimating Gas Consumption.