ment in the heating of residences that the gas consumption varied directly as the difference between 65 F and the outside temperature. In other words, on a day when the temperature was 20 deg below 65 F, twice as much gas was consumed as on a day when the temperature was 10 deg below 65 F. The degree-day is defined in Chapter 47.

Some years ago the *National District Heating Association* studied the metered steam consumption of 163 buildings[3] in 22 different cities and published data substantiating the fact that the 65 F base originally chosen by the gas industry is approximately correct. (See Table 2.)

If the degree-days occurring each day are totaled for a reasonably long period, the fuel consumption during that period as compared with another period will be in direct proportion to the number of degree-days in the two periods. Consequently, for a given installation, the fuel consumption can be calculated in terms of fuel used per degree-day for any sufficiently long period and compared with similar ratios for other periods to determine the relative operating efficiencies with the outside temperature variable eliminated.

Predictions of fuel consumption are generally based on the average number of degree-days which have occurred over a long period of years, and such averages, by months, on a 65 F base, are given for various United States and Canadian cities in Table 3. In general, attempts to apply the degree-day method to fuel consumptions over a period of less than a month are of questionable value.

Formula for Degree-Day Method

The general formula for predicting fuel consumption by the Degree-Day Method is:

$$F = U \times N \times D \qquad (3)$$

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.

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

Values of D for use in Equation 3 are given in Table 3. 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

[3]These buildings are all served with steam from a district heating company.

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 used by architects is obviously more accurate for this purpose. The architects' 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 cubage and can be calculated from the latter if it cannot be measured. The cubical content is somewhat inaccurate as a basis of comparison due to differences in types of construction, exposure, and ratio of exposed area to cubical contents. Use of equivalent radiator surface figures is fundamentally the same as

TABLE 2. BASE TEMPERATURE FOR THE DEGREE-DAY[a]

TYPE OF BUILDING	NO. OF BUILDINGS ANALYZED	TEMPERATURE F CORRESPONDS TO ZERO STEAM CONSUMPTION
Office	60	66.2
Office and Bank	4	65.8
Bank	3	66.2
Office and Telephone Exchange	2	65.5
Office and Stores	6	67.4
Stores	11	64.0
Department Stores	12	64.3
Hotels	7	66.5
Apartments	14	68.8
Residences	8	66.9
Clubs	4	65.5
Lodges	5	64.9
Theaters	3	67.6
Churches	2	65.8
Garages	2	64.8
Auto Sales and Service	4	61.2
Newspaper and Printing	3	67.7
Warehouse and Loft	3	67.7
Office and Loft	2	65.2
Manufacturing	8	65.4
Average for 163 Buildings		66.0 F

[a]Report of Commercial Relations Committee, *Proceedings, National District Heating Association*, 1932.

using a calculated heat loss and therefore units in terms of fuel per degree-day per equivalent square foot of calculated radiator surface, per 1000 Btu of calculated heat loss, or per Btu of heat loss at design conditions are all of equal accuracy and desirability. It is doubtful if installed radiator surface as determined by count should be used at all. Radiator units are also of questionable value where there is fan coil surface or warm air 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 (or heat) per degree-day per square foot of equivalent direct radiator surface.*

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.