standard conduit sizes, are primary controlling factors in the amount and thickness of insulation for use.

When sectional insulation is applied to pipes in tunnels or conduits, usual practice is to apply the most efficient materials ½ in. less in thickness than that determined by the use of Fig. 6. The data in Fig. 6 are based on conditions of insulation exposed to the air, whereas normal ground temperature is substituted for air temperature in determining the temperature difference for use with the chart when applying it for underground pipe system estimates.

REFERENCES

[1] Heat Loss from Copper Piping, by R. H. Heilman (*Heating, Piping and Air Conditioning*, September 1933, p. 458).

[2] Rapid Method of Determining the Economical Thickness of Pipe Insulation, by Utley W. Smith (A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, October 1947, p. 118).

[3] *District Heating Handbook* of the *National District Heating Association*, Third Edition, 1951.

[4] Theory of Heat Losses from Pipes Buried in the Ground, by J. R. Allen (A.S.H.V.E. TRANSACTIONS, Vol. 26, 1920, p. 335).

BIBLIOGRAPHY

Heat Emission from Iron and Copper Pipe, by F. C. Houghten and Carl Gutberlet (A.S.H.V.E. TRANSACTIONS, Vol. 39, 1938, p. 97).

Heat Transmission from Surfaces (Philip Carey Mfg. Co., Bulletin 102-A).

Surface Heat Transmission, by R. H. Heilman (*Mechanical Engineering*, Sec. 1, May 1929, p. 355).

Piping Handbook, by S. Crocker (McGraw-Hill Book Co., Fourth Edition, 1945).

Insulation Handbook, by P. Swain (*Power*, Vol. 94, Nos. 2, 3, 5, 7, and 9, 1950).

How to Insulate Equipment, by U. W. Smith (*Plant Engineering*, Vol. 1, No. 2, Dec. 1947, p. 32).

Heat Transfer Through Thick Insulation on Cylindrical Enclosures, by T. S. Nickerson and G. M. Dusinberre (*ASME Transactions*, Vol. 70, No. 8, November 1948, p. 903).

Applied Heat Transmission, by Herman J. Stoever (McGraw-Hill Book Co., 1941).

CHAPTER 29

DISTRICT HEATING

Steam Requirements, Distribution Pressures, Boiler Plants, Distribution Piping, Pipe Sizes, Conduits for Piping, Accessory Equipment, Insulation, Return of Condensate, Pipe Tunnels, Building Piping and Equipment, Zoning and Operation, Metering

THE term *district heating* refers to the supplying of heat from a central plant to a group of buildings in a city, institution, housing development, or factory area. The heat may be used for space heating, air conditioning, processing, or other purposes. It is usually preferable that groups of industrial or institutional buildings be supplied from a central plant rather than by individual plants in order to permit use of less expensive fuel, improve efficiency of combustion, reduce the labor required, assure use of competent operators, and often decrease the investment for heating purpose.

Those phases of district heating which frequently fall within the province of the heating engineer are outlined here, and information is given for solving incidental problems in connection with institutions, housing developments, and factories. Some data are included with reference to special requirements for district heating steam piping. Design of a complete district heating installation to provide utility service in a city should not be attempted unless a thorough study of the entire problem has been made by competent men having experience in district heating.

STEAM REQUIREMENTS

The first step in the design of a district heating system is to determine the maximum hourly and the annual steam requirements of each of the buildings to be supplied. Methods of determining the maximum *hourly* requirements, or heat load, will be found for space heating in Chapter 12, for building service-water heating in Chapter 49, and for various process applications in Table 1. Measured demands of several types of buildings are given in Table 10, Chapter 18.

Methods of estimating *annual* steam requirements for heating various types of buildings are also given in Chapter 18. Table 7 in Chapter 18 lists average annual steam consumption per degree day for buildings located in all sections of the United States. Annual steam requirements for building service-water heating are given in Table 2. Table 1 may be used to estimate annual consumptions for process applications if the hourly requirements are multiplied by the hours per year the equipment will be in use.

Additional data on steam requirements of various types of buildings in a number of cities may be found in the *District Heating Handbook*, Third Edition.

STEAM DISTRIBUTION PRESSURES

The pressure at which the steam is to be distributed will depend upon that available at the plant and pressure requirements of apparatus to be served.

The advantages of low-pressure distribution (2 to 50 psig) compared