fuel-burning and dust-collecting equipment to limit the emission of smoke and fly ash is usually necessary.

5. *Plant location.* A boiler plant location is determined by an economic study of fuel handling, water supply, system piping, land costs, and other associated factors. Such a study usually reveals that the economical location of the plant will be near the distribution center, in order to simplify and shorten the distribution piping. Plant location and the local air pollution ordinances will have a direct bearing on the type of firing equipment selected and the dust collection apparatus required.

STEAM DISTRIBUTION

Distribution piping in district heating systems must be designed in accordance with the same basic principles applying to any other steam piping. The piping may be run through buildings, through the air on poles or other structures, or underground in conduits or tunnels. Local conditions and investment will be governing factors in establishing the route of the pipes.

Design Considerations

Important points in laying out distribution piping are:

1. Piping within buildings or basements is normally least expensive to install and to maintain.

TABLE 3. LOAD DURATION FOR TYPICAL DISTRICT-HEATING SYSTEM
(*Cumulative Hours of Plant Send-out per Year at Various Loads Expressed in Percent of Peak Hourly Load*[a])

Plant Output % of Peak	Hours per Year	Plant Output % of Peak	Hours per Year	Plant Output % of Peak	Hours per Year
100	5	70	750	30	4100
95	40	65	1050	20	5150
90	90	60	1400	15	5700
85	150	55	1800	10	6400
80	300	50	2200	6	8760
75	500	40	3100		

[a] Based on curve on page 89, *District Heating Handbook*, Third Edition, 1951.
Note: A plant having a peak send-out of 100,000 lb per hr will send out 80,000 (80 percent of 100,000) lb per hr *or more* for 300 hr per yr.

2. Underground installations involve excavation which represents a substantial portion of the total cost. The depth of such excavations should be kept to a minimum after due consideration has been given to the possible damaging effect of the operating-line heat on lawns and shrubbery and the possible damage to the underground structure due to heavy traffic, etc.

3. Walking tunnels usually are not provided for steam mains in the district heating industry because of their relatively high first cost as compared with smaller conduits unless they are required to accommodate miscellaneous other services or to provide underground passage between buildings.

4. Overhead piping on poles or structures is generally less expensive than underground lines, especially in some institutional and industrial areas and may be a means of eliminating buried conduit in areas where underground installations would be expensive or undesirable. Thin corrugated aluminum sheets or asphalt saturated asbestos felt are available for covering the insulation on lines exposed to the weather. Such lines may introduce freeze-up problems, higher heat losses and, in many locations, would be considered unsightly.

5. High-pressure transmission feeders may be employed where the plant is remote from the distribution area, or where it is desirable to augment the capacity of an existing system. Design of such feeders and of distribution systems for various load conditions is covered fully in *District Heating Handbook*, 3rd Edition.[3]

6. Piping routed in loops with suitable valves to provide alternate feeds for major loads, allows service to be maintained despite trouble in any one feeder.[4]

7. It is desirable to estimate as far as possible the probable growth and change in load centers. Since character of the district served is almost certain to change with time the distribution system must be planned so that it can be adapted to accommodate changes. It is helpful to provide a master distribution plan which can be revised from time to time to suit conditions as the system grows.

Steam Distribution Pressure

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.[3]

The advantages of low-pressure distribution (2 to 50 psig) compared with high pressure are: (1) lower heat loss per square foot of pipe surface; (2) lower losses from leakage, trap discharge and venting; (3) less trouble with traps and valves; (4) less trouble from flash steam at drainage points; (5) simplified problems in pressure reduction at the buildings; (6) suitability of standard fittings; and (7) general reduction in maintenance costs.

Some heating companies find that the overall losses in relation to steam delivery are higher with high-pressure distribution. With distribution pressures not exceeding 50 psig, there is less danger if the full distribution pressure should build up in the radiators or heaters through the faulty operation of pressure-regulating valves. With pressures higher than 50 psig, or safe working pressure of heating or process equipment, a second pressure-reducing valve or some form of emergency relief is required to prevent excessive pressures in the radiators or other equipment.[5]

The advantages of high-pressure distribution are: (1) smaller pipe sizes; (2) availability of the steam for various other operations requiring higher pressures than the building heating system; and (3) wider flexibility in allowance for maximum pressure drop. Where distribution pressures are not as high as desired, higher pressures can be obtained by use of a steam compressor.[6]

It is sometimes desirable to install a separate high-pressure line from the boiler plant for steam supply to laundries or other high-pressure equipment rather than to operate the entire distribution system at higher pressures.

Pipe Sizes

In district heating work it is common practice to design the piping system on the basis of pressure drop. The initial pressure and the minimum permissible terminal pressure are specified, and the pipe sizes are so chosen that the required amount of steam, with suitable allowances for future increases, will be transmitted without exceeding this pressure drop. The steam velocity is therefore almost disregarded and may be very high. Velocities of 35,000 fpm are not considered high for pipes in conduits. Where pipes pass through buildings, however, consideration should be given to the possibility of objectionable noise due to high velocity. By the use of permissible pressure drops with high velocities, after allowance has been made for future increase in load, the pipe sizes may be kept to a minimum with consequent savings in investment. Some lines in a loop system may need to be increased in size in order to handle reverse-direction flow in emergencies.[4]

The steam flowing through any section of the piping can be computed from a study of the hourly steam requirements of the several buildings served. In this connection, allowance should be made for the diversity of the load, that is, the ratio of the coincident maximum demand of all of the group of buildings served by the main, to the sum of the individual maximum demands of each of the buildings served. This ratio is known as the