DISTRICT HEATING

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DISTRICT HEATING-COOLING AT CENTURY CITY IN LOS ANGELES

by **DONALD F. BUCKNER**
Holladay, Eggett & Helin
Los Angeles, California

One problem encountered in underground piping systems for district heating and cooling systems is limited right of way for piping runs. One solution to this problem can be seen in the piping system designed for Century City, Los Angeles, which ultimately will be a 60-building complex.

Selection of very narrow right of ways, which were 12-ft maximum width, was dictated in part by the extremely high land values in the Century City area. Buildings were located to permit optimum utilization of real estate with minimal setbacks for buildings fronting the right of way.

The problem was complicated by the uncertainty of future service point locations and the fact that some of the already narrow easements were to be shared with existing oil company lines. In addition, the system had to be designed to handle external loading stresses and internal pressures with a minimum of anchors, guides and pipe supports.

These were the primary reasons for the selection of ball-joint offsets in the piping. Equipment was specified to handle all possible expansion, settling and other pipe movement for the life of the system.

The Century City system must supply uninterrupted high-temperature water, chilled water and steam service to the buildings.

High-temperature water requirement is 300 psi and 375 F. For this system, pipe sizes selected were 12 in. at the initial distribution point, reducing to 4 in. at the remotest legs. The 150-psi saturated steam line to be supplied only to the Century Plaza Hotel in the complex, used 10-in. pipe throughout. Expansion of these lines could be as much as 3 in./100 ft, even before considering all other movement factors.

Internal stress factors affected the design and equipment specification. Combined stresses caused by external loading and internal pressures were the prime considerations. These stresses can produce extremely high anchor loads, torsional forces at directional changes in the piping, internal thrusts, and vibration.

In such systems, the engineer cannot overlook such external factors as manhole settlement and the weight of earth on the buried lines.

Not the least important factor is economy. The amount of pipe used in the system, cost of joints (if used), and the number and size of anchors, guides and other supports greatly affect costs.

Study Preceded Selection

An extensive study was made by the engineering firm concerning the interaction of restraints and movement in the piping system and their effects on a system. In addition to movement caused by the factors previously mentioned, movement also can be caused by thermal expansion of freely supported lines.

Restraint occurs at fixed connections to stationary equipment, at anchors and directional guides. Friction at supports and earth loads on buried lines also cause movement.

The deformation of the system that would occur as the result of these factors must be calculated. From this calculation can be determined the amount of expansion compensation necessary to place the entire system in a relaxed state during operation.

Drawing From The Past

Solutions to many pipe movement problems have been made by drawing on past experience to estimate the number of loops, bends, anchors and guides. A feel for good piping design helps too. Systems designed by this method usually operate successfully, without extensive leakage or vessel distortion. The method is supported by the Code for Pressure Piping, Paragraph 21, which states that, if a configuration has proven itself under one condition, it may be used again.

However, the increasing requirements for higher pressures and temperatures, and resulting higher stresses, dictate a more scientific method of predicting system behavior.

Possible Solutions

Trial-and-error methods of the past and the more sophisticated analysis using square-cornered idealized models are evolving into today's scientific methods of achieving a predictable piping system. Mathematical models are used to take into account elbow ovalization, joint stiffness, torsion, and controlled yield. Pipe loops, linear expansion joints, and ball-joint offsets were all considered during early planning of the Century City distribution system.

Natural pipe loops, consisting of a loop for every 100 ft of pipe, would require much wider right of way and additional excavation cost to bury the loops. This alone made the selection of loops prohibitive for most of the system.

Linear expansion joints would solve space problems but would not resolve the interaction of restraint and movement within this system.

Slip-type joints and bellows aim at localizing movement but do so with some drawbacks. A large number of joints would be required, along with more and heavier anchors. A comparison of anchor loads is given in Table I.

TABLE 1. COMPARISON OF ANCHOR LOADS IN LB FOR EXPANSION JOINTS AND LOOPS*

Pipe Size In.	Line Size Ball Joint	Line Size Slip Joint	Line Size Bellows Joint	Typical System Pipe Loop
8	2,460	13,042	22,442	8,000
10	4,370	19,933	31,513	10,000
12	6,460	27,836	41,196	12,000

**Figures are approximate and are based on 200 psia, but show the relative forces involved.*

Guiding and over-traverse difficulties would result from the effects of settlement or installation errors or the more-common omission of guides. Leakage also can result from improper installation.

The elimination of human error, then, was one reason for the ultimate selection of the ball-joint offset method of handling pipe movement.

The choice of device for providing flexibility would therefore have to be made between methods that handle the expansion by configuration. The space problem encountered by loops led to consideration of the arrangement of two ball joints to give a leg normal to the thrust of movement.

The basic difference between the two methods, loops and ball-joint offsets, is that the loop always requires anchors to maintain the thrust due to thermal expansion. Ball joints, once initial friction is overcome, resolve expansion by angular movement of the joint and, thus require anchors only to overcome friction.

The selection of ball-joint offsets, which would be located in the service vaults at Century City, was made after calculation and testing proved this method to be most economical and efficient. Offsets could be installed well within the 12-ft right of way. Excavation and installation costs were reduced by the need for fewer access points, which also reduced future maintenance costs and simplified operation.

One ball-joint offset can handle as much as 12 in. of expansion in two right-angle planes as well as minor side movements, because of its ability to flex in any direction. In addition, ball joints were found to produce less pressure drop than natural loops and could easily accommodate the combined external and internal stresses that, according to calculation, could be produced in the system.

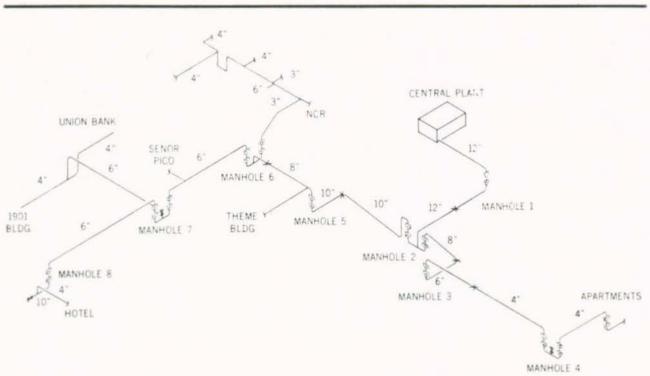

FIG. 1 — Isometric drawing of the high-temperature water system.

Fig. 1 is an isometric drawing of the high-temperature water supply system. The HTW return lines and the 10-in. steam and 4-in. condensate return lines run parallel to this line in most cases. Since easement requirements dictated that some manholes be deeper that others, and because there was a need to slip the HTW lines between or under existing lines, several offsets also had to handle movement due to changes in elevation.

For example, one of the street crossings is 22 ft underground so the pipe could be installed under a sewer line. A plan view of the system is shown in Fig. 2.

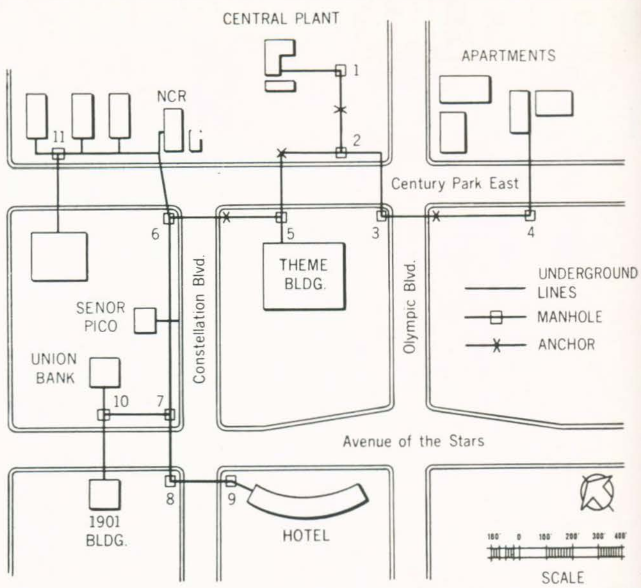

FIG. 2 — Plan view of Century City piping system.

Fig. 3 shows the ball-joint installation in Manhole 7. The joints are installed in coldset position to allow maximum room for expansion. Each manhole provides a takeoff to permit the addition of future distribution lines to new buildings.

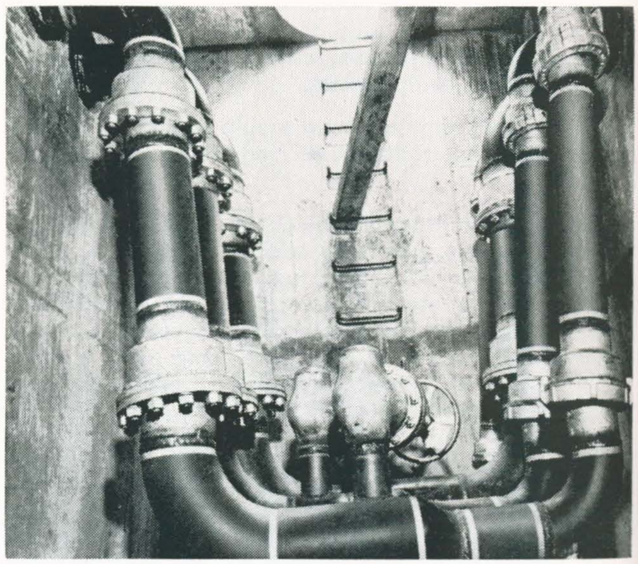

FIG. 3 — Ball joint installation in the high-temperature water system manholes.

After installation, the HTW system was tested with water at 450 psig. A four-hour test was called for, but in a 12-hour test of a system with 30 large ball joints, the pressure drop was less than allowable.

The 3,000-ft. 10-in. steam line, containing 14 ball joints, was given an air test because of the difficulty of draining water from the system after the test. The contractor protested that the test was beyond specified limits, and the system could not pass it.

A preliminary test was run at 225 psig. After compensation for temperature change, the leakage with air in 12 hours was well within the allowed limits of the original water test specified. *(Continued on page 25.)*

QUESTIONS and ANSWERS

QUESTION

"The IDHA Statistics Committee Report for 1969 indicates, with few exceptions, that of the largest thirty of the companies reporting, the seven which have the words "steam" or "heating" in the company name, report noticeably higher average revenues per M lb of steam sold. What are the reasons for this?"

ROGER A. PARSONS
Board of Water and Light
Lansing, Michigan

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Please see that they reach us by March 15. Mail them to:

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(Continued from page 24.)

It should be emphasized that the steam line had been brought to 150 psig several times prior to the air test and the joints were well seated, contributing to the remarkable tightness of the system.

A prime advantage of the Century City system is that the HTW and steam lines are at nearly constant temperature. After the system had reached operating temperature and the joints had moved, no residual expansion stress had to be resolved by the system.•

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Reprint on "Heat Exchanger Maintenance" Available

Loss of production while a heat exchanger is down is expensive and the speed with which it can be returned to service is a vital consideration regardless of whether the exchanger is in a power plant, a process industry or a marine application. A reprint titled "Heat Exchanger Maintenance", prepared by Thomas C. Wilson, Inc. of Long Island City, is designed to aid maintenance engineers and other personnel in selection of the proper techniques and equipment in order to reduce down-time to a minimum and to get an ailing heat exchanger back on-line in the least possible time.

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