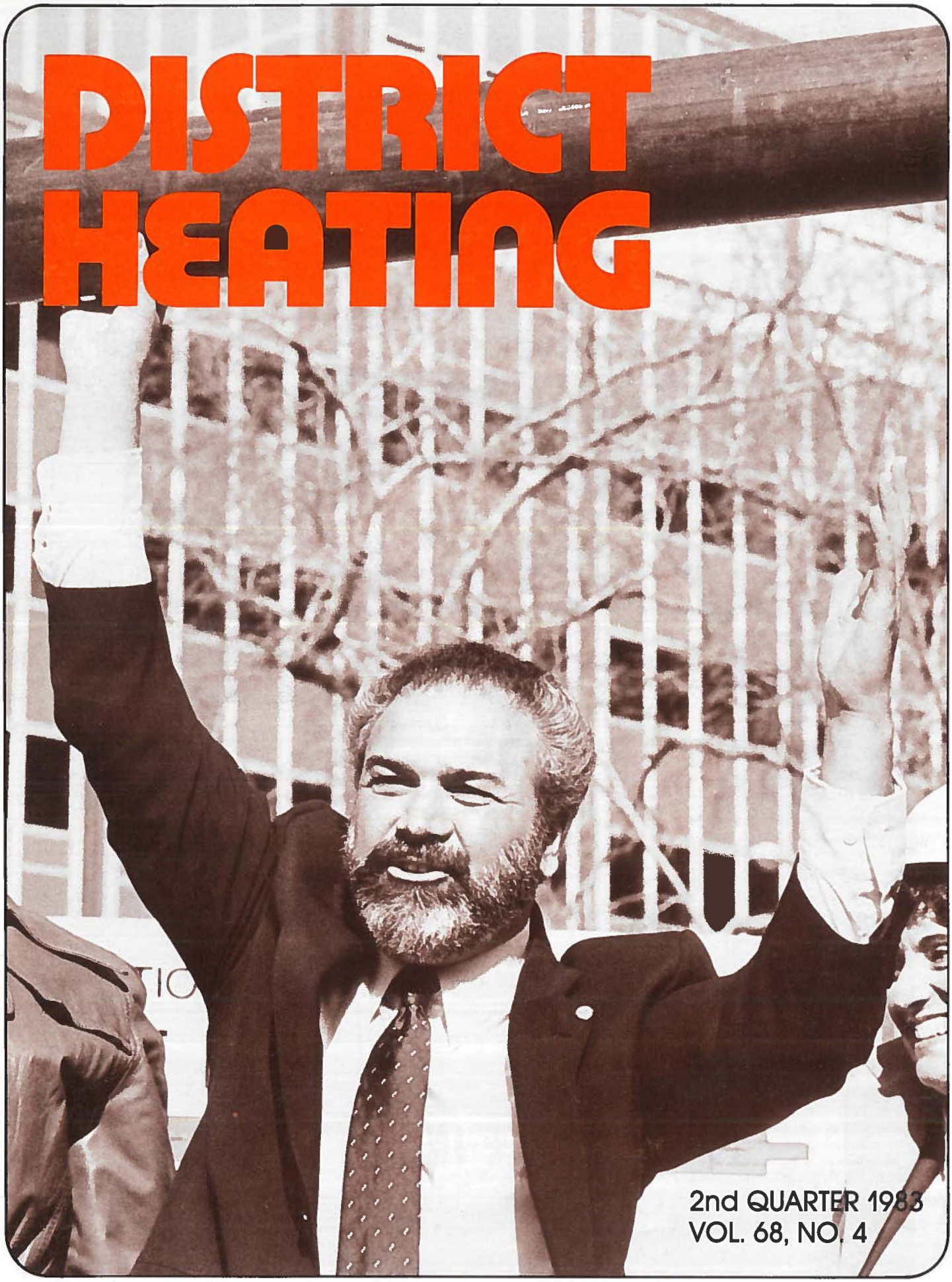
DISTRICT HEATING



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Willmar District Heating Start-up

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The district Heating industry has closely followed the development of the Willmar Minnesota hot water district heating system. The third quarter 1982 issue of District Heating covered the laying of the pipe for the first section, during downtown Willmar's urban redevelopment. The following article by the design engineer, Michael Barnes, brings up to date the development of the system, which has just completed its first winter of operation.

The first section of the Willmar hot water district heating system was completed in late September, 1982, replacing an old steam system in a fourteen block downtown area. A layout of the piping network is shown in Figure 1. The start-up procedures and results were somewhat anticlimatic. The system was filled with 37,000 gallons of treated water from the Municipal Utilities power plant through the expansion tank and pressurizer pumps, which were operated to maintain the system pressure at 50 psig. (The initial fill water was at a temperature of 145 F as it left the treatment plant and no heat was added during filling.) Utilities personnel made the rounds of air vents and drains to purge air from the system. All customer connections were closed to prevent flow through, and possible contamination of, the small heat exchangers in the buildings. Circulation between the return and send out piping was accomplished through available shunt connections.

After the majority of the air had been removed, the two-speed circulating pump was started at low speed and the system was brought to the operating send-out pressure of 100 psig. The leak detection system was monitored with no alarms observed.

Because of the limited capacity of the power plant water treatment system, steam was not admitted to the small (summer) heat exchanger until 5 days after filling began. A malfunctioning trap on the main steam line was discovered when it was observed that part of the 20 inch steam supply line had filled with condensate. The trap was replaced, and heating was thereafter uneventful. Somewhat surprisingly, the fill water had lost very little temperature during the five days before heat was added.

The system send-out temperature is automatically controlled from the outside temperature, with a maximum of 235 F and a minimum of 175 F. The control computer actuates a three-way valve to mix return water and heated water from the main heat exchangers to the desired temperature. This valve required considerable attention initially until mechanical deadband and non-linearity problems were rectified.

The system has demonstrated outstanding reliability throughout the first heating season with no forced outages of any kind. The most notable events so far have been a defective thermocouple on the temperature control system which required a two hour outage to replace a loose bearing bore on the two-speed pump motor which was repaired while service was maintained with the second pump.

The first alarm on the leak detection system was tracked down by the locator and found to be a pipe ending within a building where the insulation had become wet from a domestic water leak. Six other such alarms have been noted in the first five months of operations. All alarms represented damp insulation in basements caused by moisture from domestic water pipes or condensation. It must be emphasized that there have been *no* leaks in the district heating piping system and *no* false alarms have been observed. After the initial fill, no water has been added.

The Willmar Municipal Utilities and its contractors installed all primary side water equipment in the

buildings. This approach was selected after considerable analysis and debate. It has significant advantages over the practice of requiring building owners to purchase heat exchangers individually. In particular, it allowed the city to control the quality and performance of the units, provided uniformity and informed selection of what are not yet standard products, and utilized the city's bidding and purchasing mechanism to minimize costs. Five standard heat exchange and control valve sizes were chosen and building installations were as standardized as feasible.

The building owners were responsible for the conversion of the secondary side of the heating system. Local mechanical contractors were briefed on the requirements and characteristics of the heat exchangers but, because of the wide diversity of extant building systems, no attempt was made to give detailed guidance on an individual basis. In most instances this approach worked well, but there were some difficulties.

Improper controllers had been installed in a few buildings and a number of others were mis-wired. Considerable effort was required to obtain the manufacturers assistance in correcting the problem. The system delta T was very low due to these controllers and 4 large customers (one a construction site) that had uncontrolled flows. The delta T has been increased by individual attention to building control systems. Interestingly, despite dire predictions, converted cast iron steam radiation systems are functioning well and are compatible with modern hot water district heating operating parameters. The actual costs for building conversion were, in many instances, much less than estimates published in previous studies.

Until hot water district heating and the conversion of buildings to utilize it becomes commonplace, it is clear that the system operator must take an active part in the building conversion process. While the basic mechanical techniques are well known and simple, many of the details involved are neither. One of the most important long term marketing techniques is the provision of trained technicians for the assistance of building operators and mechanical contractors. The legal line of responsibility must be somewhat blurred until the pool of hot water experience is expanded.

There were also a few light moments. A call from one of the single family residences—no heat—brought a utility representative who found the owner had—for the first time—a thermostat and was not aware of what it was for. Easily solved.

The energy meters used consist of a mechanical flow meter, pulse transmitter, resistance thermometers, and an electronic integrator. The flow meters were not installed until the system had been operating for one month to prevent mechanical damage to the meters from uncontrolled flows or foreign matter. A few meters installed in buildings with uncontrolled water flow read erratically, as expected, and bills were estimated.

Meters are now in place in all buildings and are used for billing. Metering has historically been a problem in district heating and even with modern solid state electronics, there is still need for improvements, especially in low cost flow metering. The Willmar piping system has wiring included within the insulation for central metering and the Utilities are following the available technology for future application. There appears to be an opportunity in this area as the foreign technology for remote metering is not especially advanced.

OBSERVATIONS:

Many articles could be written on what has been learned with the Willmar hot water district heating project. Among the high points:

1. It's hard being first. The project and its participants have dealt with conflicts from all sides—suppliers, consultants, engineers, governmental agencies, and other projects. It appears that the 'institutional barriers' to district heating are much closer to the industry itself than previously suspected.
2. The use of Scandanavian technology in the U.S. was demonstrated to be extremely attractive although somewhat controversial. Any city or utility desiring cost-effective district heating should consider this approach.
3. The majority of studies of building conversion costs and techniques have been wrong (including one of the first such studies initiated by the author). While conversions, by their nature, are an eclectic lot, none of the predicted difficulties have surfaced. Actual costs were reasonable and steam systems were found to be relatively easy to convert. However, the conversion process has been the most troublesome aspect of the project and suport and monitoring ot the contractors involved is most important.
4. Marketing of district heating is much the same as for any other product. If you have a good product at the right price, it's easy. Willmar achieved the right price by utilizing modern technology to reduce the capital cost of the project. Achieving the 'good product' status required honest communication with customers and hard work in meeting their needs. No contracts with customers were required and the only present marketing difficulty is the need to resist pressure from the many building owners who want to receive service.

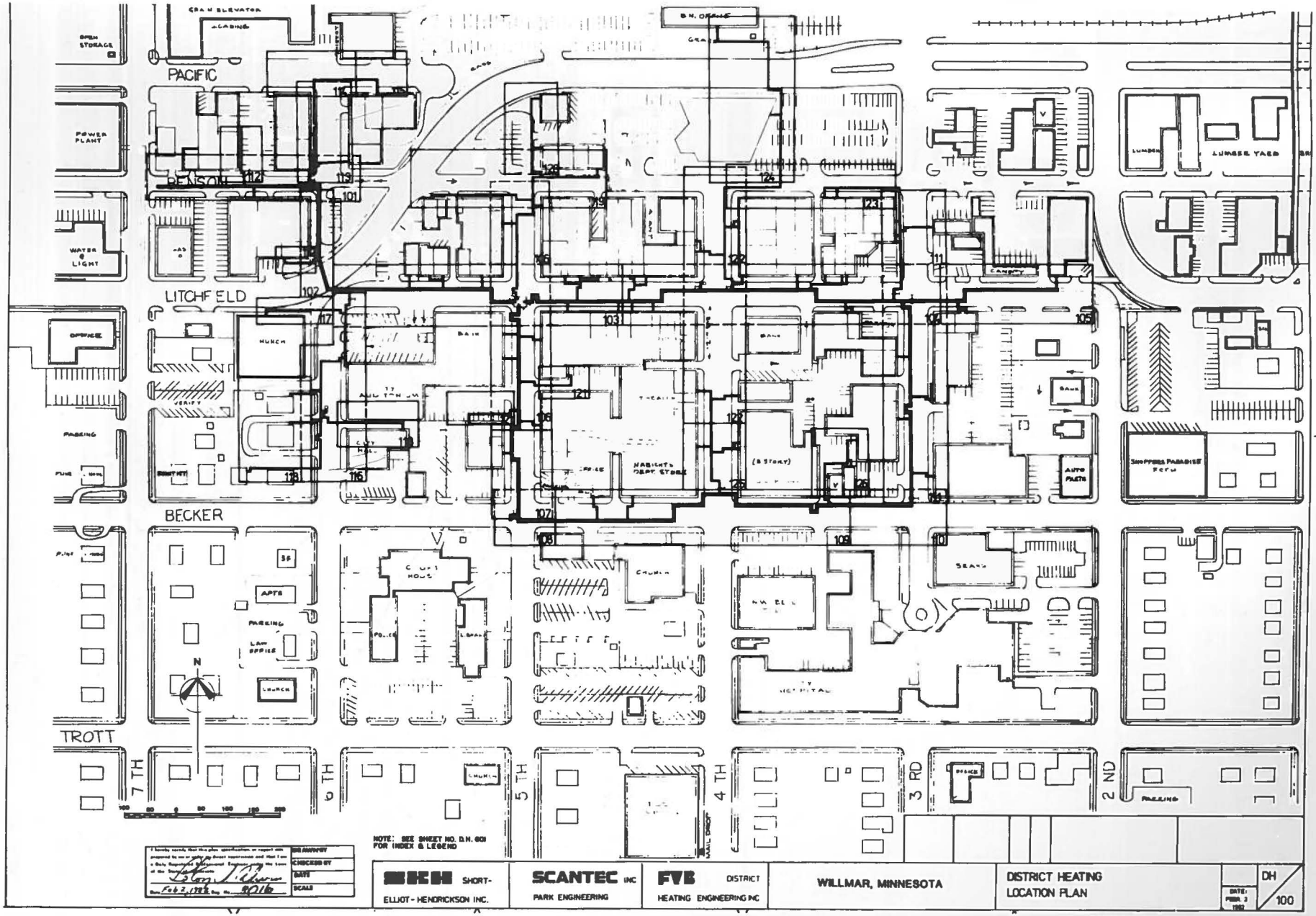

Figure 1
Piping Diagram