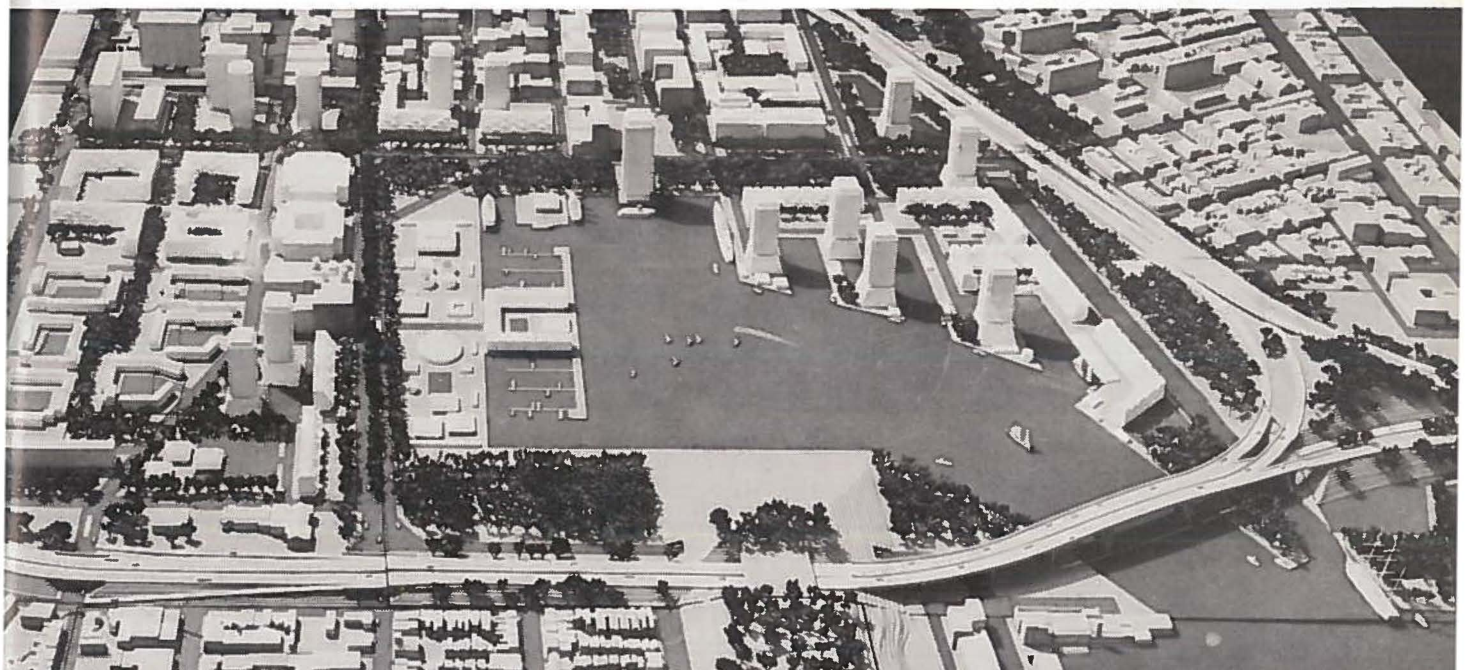
DISTRICT HEATING

INTERNATIONAL DISTRICT HEATING ASSOCIATION

PUBLISHED QUARTERLY SINCE 1915 FALL 1969 — VOL. LV, No. 2



Baltimore's Inner Harbor — "Before" (top) and "After" (bottom) Redevelopment . . . page 12

AN OFFICIAL PUBLICATION OF THE INTERNATIONAL DISTRICT HEATING ASSOCIATION

$14-MILLION CENTRAL PLANT COULD BE MODEL FOR FUTURE INSTALLATIONS

- **High-Temperature Hot Water System For Heat in Winter**
- **Steam-Absorption Air Conditioning For Cooling in Summer**

by . . **Louis Malfitani**
Project Manager

and . . **Bernard S. Breitman**
President, American Hydrotherm Corporation, New York City

The $14 million contract for a central district heating system to serve the downtown area of Sapporo, capital of Hokkaido, Japan's northernmost major island, was recently awarded to the Japanese affiliate of American Hydrotherm Corporation. The project is one of the world's largest of its type, its design based on high-pressure, high-temperature water generation and distribution. Year-round operation of the central plant will provide the domestic hot water requirements during the winter and summer, and steam for absorption air conditioning in the summer. The installation will reduce the city's serious air pollution problem by 50 to 70 per cent, and could well serve as a model for similar projects located in areas of high population density such as newly planned communities, university campuses, large apartment complexes, airports and military bases. Final installed capacity will be 1.2 billion Btu/hr.

Hydrotherm Japan Ltd. was awarded this contract by the Hokkaido Heating Supply Corporation, a new company formed by the participating firms solely to sell heat on a metered basis to a large number of customers, similar to the sale of other everyday utilities such as gas, electricity and water.

The turnkey contract comprises the engineering, design and construction of a central heating plant and its distribution system which will provide heat to office buildings and apartments houses in an area of about 50 city blocks in central Sapporo. The first stage of the heating plant and distribution piping will be completed in 1971. Three additional expansions will be put into operation in subsequent two to three-year periods. The contract cost estimate is 5,000,000,000 yen or $13,910,000: $5 million for the boiler plant; $5.3 million for the distribution system; $1.94 million for converter rooms for each user and various other expenditures.

Sapporo, with a population of approximately one million, has a cold climate with days of smog and pollution similar to conditions in many northern U. S. cities. It is the site of the 1972 Olympic Winter Games.

ONE STACK IN PLACE OF MANY

The new district heating system will consist of a single central heating plant with one modern smoke stack 230 ft in height, and the most advanced pollution control equipment. This single installation will replace all chimneys, stacks and exhaust units now in existence, including approximately 415 separate boilers. Of course, this is the basis for the air pollution reduction. The single or double-stack method is the main reason for the projected pollution reduction — this could be done in many commercial and older residential areas in dozens of cities in this country.

Heat in Sapporo will be sold to any building owner who wants it, the same way electricity, gas or water is sold here. In the U. S., electric utilities sell steam their generators produce as a by-product. Developers of large apartment house complexes have occasionally installed their own central heating plants in this country, too. Now, American Hydrotherm looks forward to serving cities that will see central heating plants as a means of replacing outmoded individual boilers and chimneys to achieve significant decreases in air pollution.

District heating is practical for almost any group of townhouses or offices buildings, or for any institution — however, it is not practical for private homes separated from one another, where small quantities of heat would have to be piped substantial distances to areas of low population density.

District heating plants, in addition to being cleaner and less expensive, are safer than single-fired units. They afford the convenience of requiring no individual fuel storage, or fuel deliveries to the separate heat users, who therefore need to devote less space to heat equipment and are not dependent on timely deliveries during inclement weather conditions.

American Hydrotherm has proven the value of district heating systems in the more than 100 high-temperature water or steam-cascade plants it has engineered and installed during the last 21 years at military bases, universities, hospi-

FIG. 1 — Aerial view of Sapporo showing distribution piping layout.

tals, and other institutions. For example, 20 individual boiler plants were replaced at New York University, Washington Square Campus, where the company recently designed and supervised construction of a central heating plant. It designed and supervised similar plants for expanded facilities or brand new buildings at Rutgers University, Brigham Young University, Goldsboro Training School, and in many other educational institutions; as well as Northeast Florida Hospital, a medium security prison in Moberly, Missouri, and more than 15 military installations.

TYPE OF SYSTEM

The Sapporo system will use high-temperature hot water instead of steam as its primary heat carrier. Installation and operating costs of a hot-water system are 15 to 20 per cent lower than those for a steam system. To demonstrate this cost saving as well as the district heating idea, Hydrotherm Japan built a small plant of this type in Sapporo. The model plant has been so successful that it has prompted inquiries from several other Japanese cities, as well as the contract from Sapporo.

Hydrotherm Japan also will build another district heating plant, under separate contract and using high-temperature water, for the Olympic village now under construction in Sapporo.

TECHNICAL DETAILS

The major sections of the district heating project are the distribution system, the converter rooms, and the boiler plant. The converter rooms contain heat exchangers to reduce the primary high-temperature water to low-temperature water or low-pressure steam for heating each individual building. All mechanical equipment for producing the high-temperature water and transporting it is concentrated in the central station.

Planning Schedule

Phase	Completion Date	Boiler Plant Capacity
1	1971	200 million Btu/hr
2	1973	360 million Btu/hr
3	1975	520 million Btu/hr
4	1977	680 million Btu/hr
Future After Phase 4		1160 million Btu/hr

Phase	Completion Date	Boiler Sizes
1	1971	2 @ 100 million Btu/hr
2	1973	2 @ 100 million Btu/hr plus 1 @ 160 million
3	1975	2 @ 100 million Btu/hr plus 2 @ 160 million
4	1977	2 @ 100 million Btu/hr plus 3 @ 160 million
Future After Phase 4		2 @ 100 million Btu/hr plus 6 @ 160 million

Cost Estimate

Phase 1 to 4 — $13,910,000 (5,000,000,000 YEN)
Breakdown:

Boiler Plant	$ 5,000,000
Distribution System	5,300,000
Converter Rooms	1,940,000
Other	1,670,000
TOTAL	$13,910,000

DISTRIBUTION SYSTEM

Total length of distribution piping in city streets: main piping, 38,000 ft; branch piping, 76,000 ft. Pipe sizes vary from 16 in. to two in. in diameter.

Basic system design temperature will be 425 F, and basic system design pressure 500 psig.

The underground distribution system will be of the prefabricated metal-cased type, consisting of high-temperature water service pipe covered with calcium silicate pipe insulation installed within a spiral welded steel conduit. The outside surface of the casing will be coated to resist corrosion and moisture. After installation and testing, the conduit will be enclosed in a sand cushion and the remainder of the trench backfilled to the street level. This conduit system is believed to be the best commercially available with respect to (a) thermal efficiency (b) resistance to corrosion (c) resistance to moisture penetration and (d) strength and resistance to earthquake shocks.

For added safety, pipe welds will undergo magnetic particle testing and radiographic testing. Also, the entire system will receive a hydrostatic pressure test at 1-1/2 times the design pressure. Finally, the outside casing will be tested for leaks with compressed air at 15 psig pressure. Testing will be done section by section following the installation of conduit in each city block.

Thermal expansion of the piping system will be provided for mainly by off-sets and L-shaped expansion bends, routing the main lines through alternate streets and around corners, thus taking advantage of inherent piping flexibility. Since this method will not be feasible throughout the entire project, U-shaped expansion loops will be used in some streets. Utility manholes will be located at strategic points where main sectioning valves will be installed.

The depth of conduit below street surface was designed to be approximately four ft because (a) this depth is adequate to support the surface traffic (b) surface temperature of the conduit, approximately 140 to 150 F, is usually dissipated within a distance of four ft from the outside of the conduit under dry soil conditions, and therefore there will be no appreciable rise in street surface temperature above the conduit and (c) excavation costs can be held within reasonable limits.

Expansion loops and bends will be cold sprung approximately 50 per cent of the total linear expansion between anchor blocks. Each loop and expansion bend will be provided with moment guides. The benefits derived from cold spring and moment guides are better control of pipe movement and reduction in the amount of over-size required in the outside casing to accommodate pipe expansion.

Piping material will be schedule 40 black steel Grade B, seamless or electric resistance welded. The pipe wall thickness in each size was checked by the ASME Code Formula for design conditions (500 psig at 425 F) and found satisfactory, with ample safety margin.

In the basement of each building a small space will be taken in the existing boiler room for installation of new heat exchangers which will replace the existing boilers. In most cases, the existing buildings use low-pressure steam for space heating, in which case a steam generator will be installed using high-temperature water as primary heat source to produce steam at seven to ten psig. In a few buildings where low-temperature water is used for heating, a converter will be installed to produce the water temperature required (between 200 and 240 F). A Btu meter will be installed in each converter room to meter the consumption of heat.

FIG. 2 — View of initial laying of conduit.

Steam pressure or secondary water temperature, as the case may be, will be maintained at a fixed point by means of a pneumatically operated industrial type control valve. For proper control the temperature controller or pressure sensing element will be located in the shell of the heat exchanger, not in the pipe line. It is essential that all control valves in the converter rooms be of the two-way, single-seating, tight shut-off type. Three-way valves will not be used, since the continual by-passing of HTW (high-temperature water) would greatly impair the economy of the entire system. Therefore, the heating plant and the entire distribution system will be designed for the use of modulating single-seated control valves.

These control valves will be designed to close on power failure. With electric motor operators this cannot be done, therefore it is required that the control valves be pneumatically operated. Control valves will be sized for a pressure drop which is determined in accordance with its relative location from the boiler plant. Thus, at full-rated flow, control valves close to the boiler plant will be sized for a pressure drop of 20 psi, control valves most distant from the boiler plant for a pressure drop of five psi, and those at intermediate locations for a pressure drop between 20 and five psi.

Converter room layouts will be standardized and equipment arranged to facilitate operation and ease of maintenance. In general, a floor area approximately 18 by 24 ft will satisfy most requirements. The converter room enclosure will be of masonry partitions and the floor sloped to the sides of the room with an adequate gutter provided on three sides, and the gutter sloped to a sump pit with drain or sump pump. A single door will be provided with security lock. The room is to be well lighted and provided with one or more electric convenience outlets. A hose bibb is to be provided on the city water piping for cleaning and flushing the floor. Positive ventilation is to be provided by exhaust fan, and louvered openings placed in the walls or door to suit requirements.

High-temperature water supply and return pipes are to be sized so that the total head loss in the converter room between the HTW flow and return service entrance valves does not exceed 30 ft of water when operating at design capacity. This head loss is to include losses through control valves, shut-off valves and heat exchanger coils.

Each converter room will contain the following features:

ENTRANCE CONNECTIONS . . . The HTW piping will enter the converter room from underground or basement area and be fitted with HTW flow and return service entrance valves. The service entrance valve group will consist of: gate valve on the flow, globe valve on the return, and a 1/2-in. globe valve by-pass installed between the HTW flow and return pipes ahead of the service entrance valves. The HTW pipes will be anchored at the entrance to the converter room so that the expansion of the distribution system does not affect the converter room piping.

ISOLATING VALVES . . . Each heat exchanger will have isolating valves of the globe type on both high-temperature water connections to the coil. The automatic control valve will be installed in the high-temperature water return pipe from the heat exchanger and fitted with a globe valve by-pass arrangement.

EQUIPMENT SUPPORTS . . . Pumps, air compressors, and all similar equipment will be mounted on four-in. high concrete bases.

DRAINS AND OVERFLOWS . . . Drain, vent and overflow connections at equipment will be connected with piping and terminated over drain gutter or sump pit.

AIR REMOVAL . . . Air separation chambers will be installed at all high points in the high-temperature water piping. A 1/2-in. globe type purge valve and vent pipe will be installed for venting and discharge over sump pit.

THERMOMETERS . . . An indicating thermometer will be installed in the converter room for high-temperature water-flow temperature. Also, an indicating thermometer will be installed on the high-temperature water return from all heat exchangers.

PRESSURE GAGES . . . A pressure gage will be installed on the high-temperature water supply and return piping in each converter room and mounted on a panel board.

EQUIPMENT ARRANGEMENT . . . Heat exchangers and other equipment, together with their connecting piping, are to be arranged to facilitate operating and maintenance functions; sufficient space allowance to be provided for tube bundle removal without necessitating pipe removal. Maintenance areas and passageways are to be free from overhead and underfoot pipes and other obstruction.

ALARMS . . . High and low-water level alarms and pressure temperature alarms will be installed to indicate any abnormal condition that might occur in the converter rooms.

PANEL BOARD . . . A central panel board for each converter room for mounting all local controls, instruments and gages.

Building and equipment for the central heating plant will be arranged for incremental expansion to accommodate large blocks of heating load which will be added in approximately two to three-year stages over a ten-year period. In the first phase, two boilers of 100 million Btu per hr capacity each will be installed to supply heat to a single zone. Later on, new boilers of even larger capacity (160 million Btu per hr) will be added with additional pumping equipment to supply new heating zones as well as additions to the original zone.

The larger high-temperature water boiler is believed to be the largest of its type ever to have been constructed anywhere. The plant will have an emergency diesel generator to provide partial load operation in case of complete electric power failure.

The buildings in the central core of downtown Sapporo will be heated from the 410-420 F high-temperature water piped from the central heating plant to the converter room of each building. In each converter room the primary high-temperature water will pass through heat exchangers to generate low-pressure steam or low-temperature water for the existing space heating system, and also for domestic hot water.

High-temperature water systems for district heating applications are those operating with supply water temperatures in the range of 350 to 450 F. The practical temperature limit of 450 F is a result of the increase in system cost due to the rapid rise in saturation pressures above 450 F.

The major system components in the central heating plant are:

1. High-temperature water generators, direct-fired, for heating the water.
2. Expansion vessels which take up the expansion of the water as it is being heated and which at the same time are used for pressurizing the system.
3. Circulating pumps which transport the heat from the central heating plant to the terminal points in the distribution system.
4. Fuel handling and ash removal systems.
5. Auxiliaries such as water make-up and feed equipment, compressed air systems, and emergency electric generating equipment.

The high-temperature water generators will be of the forced-circulation water tube type, equipped with spreader stokers for coal firing. The use of coal as the fuel is dictated by the fact that there are abundant coal reserves close to Sapporo. The Japanese islands are deficient in crude oil and natural gas which must be imported at greater expense. Circulation of water through the generators will be maintained at all times by separate circulating pumps.

The basic high-temperature water pumping arrangement for the Sapporo plant will be the so-called two-pump type where in one group of pumps circulates high-temperature water through the generator and the second group of pumps circulates high-temperature water through the system. One pump will be used for each generator to draw water from the cooler system return or expansion drum, and pump it through the generator into the expansion drum.

The system circulating pumps will draw the hottest water from th expansion drum and circulate it through the distribution system only. This system provides full flexibility. The supply temperature to the distribution system can be varied by mixing water from the return into the supply on the pump suction side.

The plant will be designed for two separate distribution system zones with provisions made for the addition of future zones as the need arises. A separate group of pumps will be available for each zone, thus making it possible to vary the temperature and flow rate in each zone without affecting the generator circulation.

The system circulation pumps will be equipped with variable speed drives to vary the capacity and head of the pumps so that substantial power savings can be realized during mild weather or other off-peak periods.

Steam pressurization is to be achieved through the use of two expansion drums which are separate from the high-temperature water generators and elevated above the generators.

All generators will discharge into the expansion drums where a small portion of the water flashes into steam to maintain a steam pressure cushion in the space above the liquid level in the drums. The operating level in the expansion drums has been established at a level above the highest point in the distribution system to prevent the flashing of water into steam in the supply system.

Each expansion drum is sized for slightly more than 50 per cent of the total system capacity. Two drums will provide greater flexibility and reliability in operation than a single drum. This system need never be shut down for routine inspection, maintenance or repairs on the expansion drums.

To further carry through the principle of flexibility in system operation, the piping in the central heating plant is divided into two major groupings of boilers and circulating pumps with cross connections, so that fully 50 per cent of the plant can be shut down without affecting the remaining half. The expansion drums, being a critical part of the system, will be equipped with safety devices for high and low-water lèvels, excess pressure and interlocks with boiler combustion safety and water flow controls. ●

NEW ENGLAND SECTION OF IDHA

The Executive Board of the New England Section met on October 3rd, in Boston, Mass.

The next general meeting (a dinner meeting) for Section members and guests is scheduled for November 5th, in Dorchester, Mass. at Blinstrub's Old Colony House.

Mr. Robert Graham, Boston Edison Company, will be assisted by Messers. H. K. Archibald and W. G. Cleaves, Hayes Pump and Machinery Company, in presenting a program on: design and erection problems for constructing equipment to pump No. 6 fuel oil through six miles of underground pipe serving two electric power generating plants and two steam generating stations.

"... HAVE YOU HEARD!

LONDON, ENGLAND

The first international convention devoted entirely to district heating will take place at the Cafe Royal in London, from April 20 to 24, 1970. It will be opened by the Minister of Power.

Mr. Derek Ezra, deputy chairman of the National Coal Board, is president of the convention which is being organized jointly by the District Heating Association, the Institution of Heating and Ventilating Engineers, and the Heating, Ventilating and Air Conditioning Association. It has the support of national bodies including the Gas Council, the National Coal Board, and the Electricity Council, which are sponsoring it; as well as Shell-Mex and B. P., Esso petroleum, and G. N. Haden and Sons.

As the development of district heating will obviously have far reaching influence on a great many parts of industry, the convention is being desigend to encourage a free enchange of information, ideas, and experience on an international scale. The program will include discussions between heads of industry and official groups, as well as speakers who will present reviews of the progress already made in other countries, and its success in England.

Running concurrently with the convention, there will be an international exhibition at Olympia in London, from April 20 to 25. Its theme will be district heating associated with the general context of heating, ventilating and air conditioning.

Details concerning the convention and the exhibition may be obtained from the Secretary, International District Heating Convention 1970, Derbyshire House, St. Chad's Street, London, W.C.1, England.

JAPAN

Long before the development of central heating and air conditioning, the Japanese had a method of combating uncomfortable temperatures.

Theirs was the psychological approach. In summer, they hung a picture of a winter scene — perhaps snow-capped Mount Fuji — in a place of honor in their homes. In winter, the picture was replaced by one of sunshine and greenery.

SAN FRANCISCO, CALIFORNIA

The Semi-Annual Meeting of the American Society of of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) will be held at The San Francisco-Hilton Hotel from January 19-22, 1970.

STATISTICAL STEW

Ever Wonder what the most expensive trip in the world is? Probably the route travelled by a business letter from your secretary's dictation pad to the company mailroom. The Dartnell Corporation reports the present cost of a dictated business letter is $2.74 — double what it was in 1960.

• • •

Nobody Really Knows how many magazines are published in the U. S., but an educated estimate is, about 16,000. Of these,10,000 are in some way related to the business world, and about 8,000 of these are company house publications.

• • •

It Costs the average car owner about $1,053 a year to keep his car, even if he never takes it out of the garage. This includes depreciation for the first three years, insurance and registration fees for a medium-priced four-door sedan. If he drives it 10,000 miles per year, gas, oil and other operating costs raise the total to $1,448.