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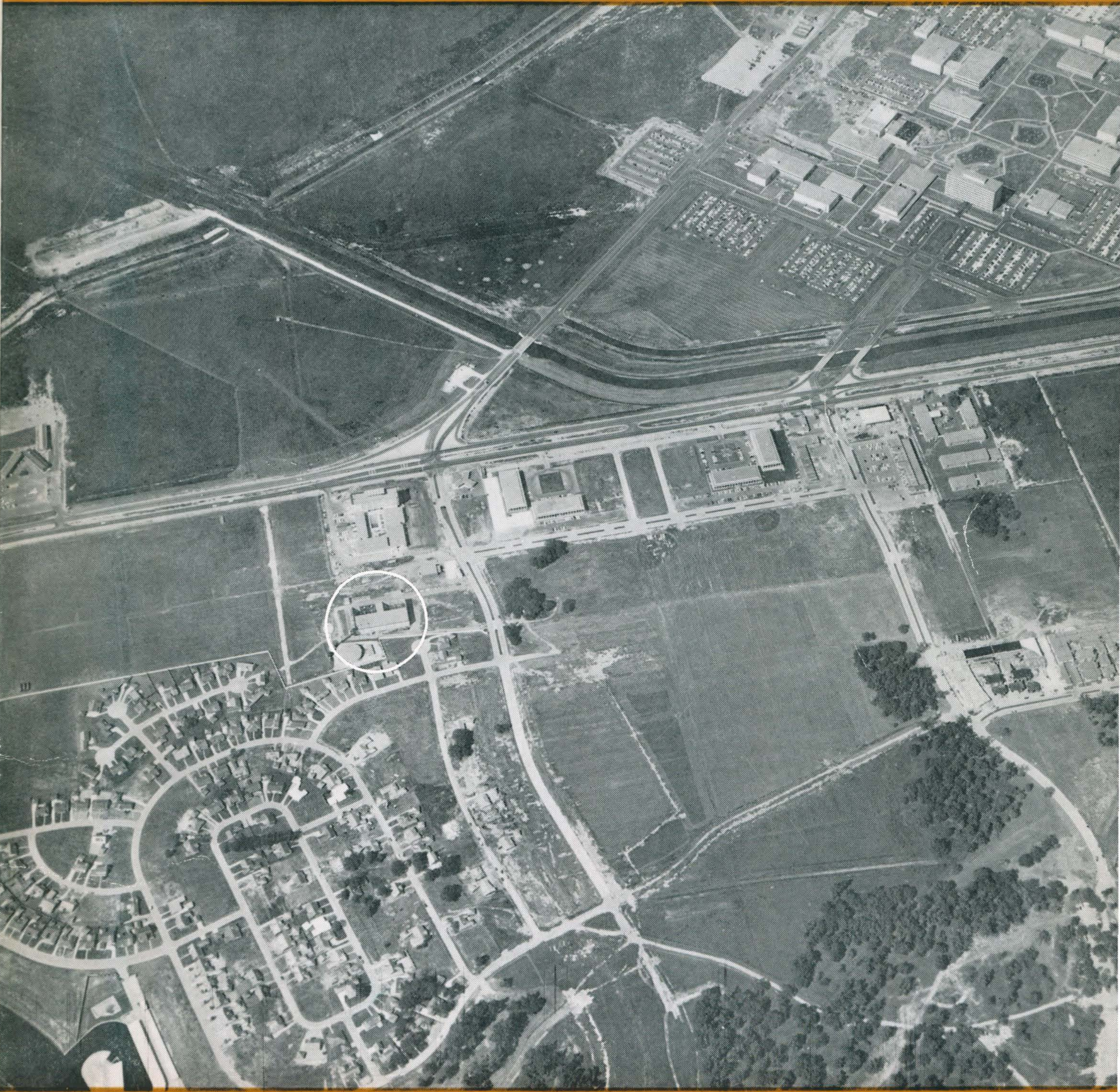

Nassau Bay, Houston, Texas — Page 15

AN OFFICIAL PUBLICATION OF THE NATIONAL DISTRICT HEATING ASSOCIATION

Nassau Bay Central Heating and Cooling Plant in Houston, Texas

Sale of chilled and hot water for air conditioning and heating became the newest enterprise of the Houston Natural Gas Corporation when Thermal Systems, Inc., a Houston Natural wholly-owned subsidiary, opened its Nassau Bay Plant. The central-plant and underground-distribution system on Point Lookout Road off Highway 528 delivers chilled and hot water to buildings in the Nassau Bay commercial area opposite the Manned Spacecraft Center. The Nassau Bay complex will eventually include, in addition to its business district, a hotel, apartment projects, town houses, beautiful residential areas and several large marinas.

Although the central plant has been in operation since June, 1964, the formal opening of the new facility was held on December 3, 1964. The system was the third of its kind in the nation to be utility owned and operated, the first in the Southwest, and the first to serve residential customers. In Hartford, Conn., The Hartford Gas Company has been operating a similar plant in downtown Hartford since 1962, and three more now are in operation or under construction.

The problem really began when man, in his insatiable search for "a better way," began to toy with the idea of improving on nature's climate. Step by step — using wood, coal, steam, oil, and gas, he evolved gradually-improved heating systems for his winter comfort. The first breakthrough in year-round comfort control came with the development of compressor cooling.

The window unit, cumbersome as it was, the individual air-conditioning unit represented an important stride forward, but it had many limitations. It cooled only a small area, was noisy, difficult to regulate exactly, in need of frequent maintenance; and the economics of cooling a room-at-a-time made it impractical for long-range use in large buildings.

Then, with the development of the central unit, capable of heating and cooling an entire building, engineers took their first serious step toward centralized climate control. But to the imaginative, this was simply the introduction to a still bolder concept. If an entire building, why not an entire community?

The Thermal Systems concept of total climate control is new — so new, in fact, that it still needs explanation. Simply stated, the idea is to provide year-round heating and cooling to an entire complex of buildings from a central plant; by circulating hot water or steam for heating, and chilled water for cooling, through a distribution system of underground pipes. This central installation eliminates entirely the need for compressors, boilers, cooling towers and other equipment normally required by individual buildings to provide their own refrigeration and heat. In addition to reducing the capital outlay for construction, this new service provides heating and cooling at considerable savings over the cost of operating on-site installations.

One of the earliest concepts of a "thermal-utility" system originated in early 1950 when H. E. Bovay, Jr., President of Bovay Engineers, Inc. proposed such an idea to the firm's staff for review and discussion. In the years since, the original idea, modified only slightly through advances in technology, has been subjected to thorough analysis and study.

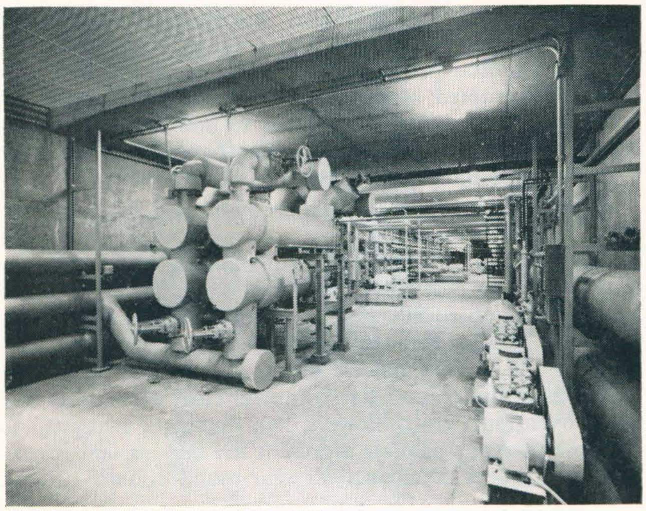

Fig. 1. Plant basement where chilled-water pumps, hot-water pumps, air compressors, and ventilation system are located. (Ed Stewart & Assoc. photo, Houston)

In 1961, Thermal Systems commissioned Bovay Engineers, Inc. of Houston to conduct extensive feasibility and engineering studies in connection with the Nassau Bay installation. With a favorable report from the engineers, and a contract in hand to serve the Nassau Bay Development Group, Thermal Systems, Inc. retained Bovay to design and supervise construction of the central plant.

Nine combinations of refrigeration systems were studied before the final choice was made — natural-gas powered, steam-turbine-driven centrifugal compressors.

Welton Becket and Associates of Houston were the architects for the two-story plant and office building of more than 26,500 sq ft. The high architectural standards of Nassau Bay dictated the character of the plant building which is located on a 3.3 acre site, and the architects were careful to observe all restrictions. The result is an attractive building that makes no attempt to disguise its industrial function, yet is aesthetically at home in the commercial/residential area it serves.

H. A. Lott, Inc. was the general contractor, and Straus-Frank Company the mechanical contractor — both are Houston firms.

The thermal-utility concept is based on a sound engineering principle. The equipment load, usually expressed in tons, for the conditioning of air (for either heating or cooling) in a specific building is dependent on the size of the structure, the outside air temperatures, range of inside temperature tolerances, the number of occupants, and exposure to sunlight. Air-conditioning equipment for a particular building must be selected for the total load expected. For several buildings, with individual air-conditioning equipment at each location, the equipment-design capacity must equal the total maximum load of all buildings.

However, with a central plant serving the same several buildings, the load at any one time will be less than total maximum load of all buildings because not all buildings will experience their maximum load at any one time. A theater, motel or hotel will have a greater load at night than in the day; an office building will have a greater load in the day than at night. This diversity of use, called a "diversity factor," enables the design of a central plant to be based on a much smaller total load. Substantial savings in construction and operating costs result.

The engineers also pointed out other advantages of a central plant. Equipment breakdown in one building, with loss of air conditioning, means lost time, decreased personnel efficiency, and dissatisfied tenants. Stand-by equipment in a central plant can pick up the load and thus provide uninterrupted service. Space in individual buildings which would otherwise be devoted to non-revenue-producing mechanical equipment rooms can be rented or used by the owner for more productive use.

In effect, the central installation at Nassau Bay takes the place of compressors, boilers, cooling towers, and other equipment normally required in a building to provide refrigeration and heat. Instead, chilled water at 40 deg, and hot water at up to 300 deg, is circulated continuously between the central plant and individual heat exchangers located at the various offices, shops, motels, and apartment buildings in the Nassau Bay complex. Heat exchangers and the conventional coils, blowers, and ductwork necessary to circulate cool or warm air represent the only capital investment by owners or tenants for year-round climate control.

Central-plant service is billed to customers monthly under individual contracts, and is available 24 hours a day at either a metered or flat-rate charge. Service is currently to commercial customers, but is being extended to a group of residences (town houses) in the area, as they are completed. In addition to the reduction in capital outlay for equipment, the Nassau Bay system provides heating and air-conditioning at an annual cost substantially less than the yearly-operating expense of on-site installations. Greater design latitude and savings in construction costs also are cited as central-plant benefits. Mechanical room space requirements can be reduced appreciably, and no cooling towers or boiler stacks are required on customers' premises.

The central plant utilizes gas-fired boilers to provide hot water for the distribution system, and steam for up to six turbine-driven water-chiller units. The projected refrigeration capacity of the plant is 6,000 tons with 3,000 tons expected to be in operation during 1965. It is planned to increase capacity in 1,000-ton increments as development of the new area to be served progresses. For convenience in connecting pumps and underground piping, all pumps are located in the sub-basement of the plant (Fig. 1). Two 1,050-ton units now are in operation, and additional capacity will be added at intervals as the commercial area served by the system expands. Ultimate cost of the project will exceed $2 million.

The 211 x 126 ft plant building which is located in the center of the commercial complex, is windowless except for a two-story expanse of glass at the entrance. The steel and masonry structure includes an administration and operating core through the midsection of the building, with an entrance lobby and a maintenance shop on the ground floor, and a control room and offices on the mezzanine above. The remaining floorspace is given over entirely to equipment. Special sound control has been provided to assure quiet operation and the building walls completely enclose all of the plant's facilities, including the massive 30-ft cooling towers. This bank handles condensing water for 2100 tons of refrigeration equipment.

All operations are monitored from the control panel located on the mezzanine in the mid-section of the plant building (Fig. 2). Glass walls permit an unobstructed view of the entire plant which is in operation 24 hours a day.

Because the concept of total climate control is so new, there was little experience from which to draw. Thus, the design of the piping system was the subject of long and careful consideration.

It was decided to circulate 40 F chilled water for cooling and 300 F hot water for heating, the latter temperature to

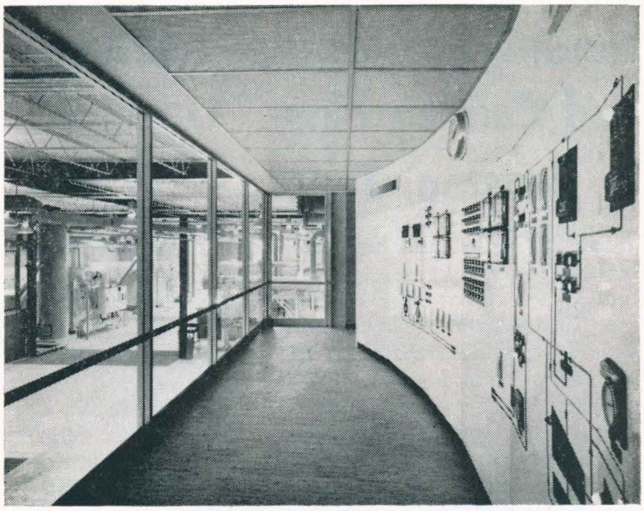

Fig. 2. Control panel. (Ed Stewart & Assoc. photo, Houston)

be lowered to 200 F for summer use. Choice of these extremes of temperature allowed economy in the selection of pipe sizes without the problem of heat or cold dissipation during the distribution process.

The initial phase of the distribution system consists of three miles of piping. Four pipes are laid, two for the supply and return of hot water, and two for the supply and return of chilled water. Pipe diameter varies from 4 to 14 in. for chilled water, and up to 8 in. for hot water. The system will ultimately have more than ten miles of piping.

Insulation is a foam glass material whose fine air bubbles give it excellent insulation properties and provide both moisture- and cathodic-protection. Since moisture seepage is possible at seams and joints of the insulation, three coatings of an asphalt compound were added as further protection.

All pipe was coated with asphalt, then laid on a bed of sand and covered with a 4-in. layer of sand. This furnishes good drainage and adds an insulation factor to prevent temperature losses between plant and customer.

Pertinent facts are:

Cooling Capacity —

Present: 2,100 tons.

Projected: 3,000 tons by the end of 1965; ultimate capacity of plant, 6,000 tons.

Heating Capacity —

Present: 72,000,000 Btu's per hr, supplied by two heat exchangers, each with a capacity of 36,000,000 Btu's per hr.

Distribution System —

Present: Over three miles of underground, cathodically protected pipelines.

Projected: Over 12 miles of underground, cathodically protected pipelines.

Cost of System —

Ultimate cost: $2,000,000.

Equipment —

2 Carrier centrifugal compressor chillers, each rated at a capacity of 1,050 tons with 52 F water entering and 40 F leaving. Full load rated speed of 4,150 rpm. Driven by Terry five-stage steam turbines. Entering steam pressure at throttle is 220 psig, and exhausting pressure is three inches of mercury. Refrigerant is R-11.

2 Keeler natural gas fired steam boilers. Each water tube boiler has the capacity to produce 27,000 lbs per hr of

superheated steam at a temperature of 600 F, and a pressure of 230 psig.

1 Marley cooling tower with two cells. Each cell is capable of handling 3,300 gpm from a temperature of 103.2 F to 86 F. Condensing water is handled by three Worthington turbine type pumps, each rated at 100 hp, with capacity to handle 3,300 gpm of water against an 80 ft head. Pump speed is 1,800 rpm and pump casing is rated at 150 psig.

1 General Electric motor control center and switch gear. Switch gear is rated three-phase, four-wire, 600 v, with a short circuit rating of 100,000 amp. Power is transmitted from a transformer at rear of building through a bus-duct conductor and distributed to various individual control center sections. Each section contains starters, circuit breakers, and switches for complete plant protection.

1 Chicago Heater Company boiler feedwater deaerating heater. Capable of deaerating 110,000 lb per hr of boiler feedwater at a temperature of 212 F. Design pressure is 50 psig, and normal operating temperature is 30 psig.

3 Worthington chilled water circulating pumps. Each pump is rated at 200 hp and has capacity to handle 2,100 gpm of chilled water against a 240 ft head. Pump speed is 1,800 rpm, and pump casing is rated at 150 psig.

2 Worthington hot-water circulating pumps. Each is rated at 60 hp, with a capacity to handle 600 gpm of water against a 225 ft head. Pump speed is 1,800 rpm, and pump casing is rated at 250 psig.

2 Worthington pumps which supply boiler feedwater. Each pump is rated at 40 hp and has capacity to handle 60,000 lb of water per hr against a 700 ft head.

Heat exchangers, or hot water converters, which heat water by heat transfer from super-heated steam. Each converter consists of two sections, a heating unit and a condensate cooler. Both sections are conventional tubular heat exchangers with removable tube bundles. Water to be heated enters the condensate cooler at the bottom, flows through the condensate cooler tube bundle and leaves through a nozzle at the top. It then passes through the heater tube and leaves at the top connection. Steam enters the heater's shell at the top, and flows on through the condensate cooler shell and leaves it at the bottom. Heating capacity: 600 gpm of water at outlet temperature of 300 F and steam capacity of 31,300 lb per hr.

6 Carrier Ventilating Units. 4 Units are powered by 10 hp motors, and each is capable of circulating 22,000 cu ft of air per minute. 2 Units are powered by 7½ hp motors, and each is capable of circulating 17,500 cu ft of air per minute to properly ventilate the basement area.

2 DeVilbiss Air Compressors. Supply compressed air necessary for the operation of the plant's Pneumatic instrumentation and control system. Provides compressed air at 100 psig.

Physical Makeup of Plant —

26,500 sq ft building constructed of tile and brick with an exposed steel frame. Includes basement, an administration and operating core through the midsection of the building, an entrance lobby, a maintenance shop, a control room and offices, and plant equipment area. Windowless, except for two-story expanse of glass at entrance. Plant dimensions: 211- by 126-feet.

Natural Gas Usage —

Present: 260 MCF's per average day.
Projected by 1965: 600 MCF's per average day.

Officers and Personnel —

Carrington Mason, Vice President and General Manager
W. E. Long, Vice President
Willard Amann, Operations Manager
Raymond R. Smith, Sales Manager and Nassau Bay Plant Manager

Comparative Heating and Cooling Costs for Typical Applications — Thermal Systems Central Plant System vs. Individual Building Systems

Motel Project — 220 guest units, 104,000 sq ft, assumed 260-ton refrigeration — 4,700,000 Btu/hr heating

	TSI Plant	Owner Plant Bldg.
Annual heating/cooling cost	$27,785	$39,914
Annual savings	$12,129	
Annual cost per sq ft	$ 0.27	$ 0.38
Annual cost per guest unit	$126.00	$181.00

Apartment Project — 124 units, 92,226 sq ft, 150-ton refrigeration — 4,000,000 Btu/hr heating

Annual heating/cooling cost	$18,614	$22,355
Annual savings	$ 3,741	
Annual cost per sq ft	$ 0.202	$ 0.242
Annual cost per apartment unit	$150.00	$180.00

Supermarket Project — 15,000 sq ft, equipment producing 100,000 ton hours per year

Annual heating/cooling cost	$ 4,750	$ 5,030
Annual savings	$280.00	
Annual cost per sq ft	$ 0.316	$ 0.335

Advantages of Thermal Systems' Total Climate Control to Building Owners and Tenants

1. *Operating Economy* — Central-plant heating and cooling can be furnished at less cost than from individual installations in each building.

2. *Low Capital Investment* — Building owners save the cost of installing compressors, boilers, cooling towers and other plant equipment. Construction costs are also reduced, because installation of equipment in penthouses often requires heavier structural support; in basements, it means additional excavation and headroom.

3. *Tax Advantage* — There is a tax advantage in paying for service rather than amortization of equipment.

4. *Space Savings* — Space requirements are reduced by 70%. This gives owners or tenants more usable or rentable space and allows greater design flexibility.

5. *Maintenance Costs Cut* — Because refrigeration machinery is eliminated, no equipment operators or full-time maintenance men are required.

6. *Constant Availability* — Central plant furnishes around-the-clock service, with heating and cooling available in all seasons. Spare equipment is maintained for peak loads and stand-by service.

7. *No Nuisance Problems* — There is no noise or vibration, no cooling tower misting, no periodic cleaning or acidizing needed. Owners and managers are freed from responsibility and less bookkeeping is required.

According to W. E. Long, Vice-President of Thermal Systems, Inc. the central-plant concept with its many customer advantages, should have wide application in future years, not only in new developments, but also in urban redevelopment projects and in shopping-center and office complexes. The concept already is widely used in privately-owned plants serving large areas. The unusual aspect of the

(Cont'd. on pg. 33)

LADIES' ATTENDANCE

Harriet Althouse
Gladys Angelery
Harriet Archibald

Virginia Bahr
Lillian Behnken
Lee Belletini
Veronica Boquel
Coradell Bosl
Kathleen Bossone
Ruth Boyle
Vivian Brandt
Ethel Brennan
Helen Brown
Evelyn Bruce
Mary Bruce (Miss)
Barbara Buffone

Nan Carey
Anne Carlson
Lucille Chumbley
Posie Clymer
Stephanie Coffey
Beatrice Collins
Christine Cousley
Alva Curley

Erna Deutsch
Barbara Dull

Ruth Ewing

Eleanor Fehlinger
Harriet Flansbaum (Miss)
Adele Foy

Mary Gillespie
Pauline Gillim
Mildred Gilmore
Toni Goetz
Winona Goffe
Catherine Gordon

Jacqueline Hannah
Anne Harrington
Jane Harris
Roberta Hauser
Virginia Hausrath
Pat Heaton
Rosemary Heffernan
Beatrice Heinrich
Lorry Henderson
Helen Hickey
Elaine Holtermann

Emily Johnson
Mary Johnson
Maryellen Judson

Rosalyn Kaiser
Fay Kight
Sylvia Kiss
Louise Kneen
Marie Krieger

Pat Leggoe
Blanche Lemon
Jan Lengefeld
Dorothy Leo
Lucile Liedel
Helen Loucks
Iris Lubel

Elsie MacGregor
Ruth Mauger
Violet McCarrick
Margaret Megley
Isabelle Metzger
Meredith Metzger (Miss)
Eulah Meyer
Marion Miller
Amelia Milusich
Mrs. T. R. Moore
Marge Morris

Helen Norris

Sue Ohab

Donna Pearce
Madeleine Peck
Mildred Prestwich

Mary Renker
Marion Ritter
Marjorie Ruschell

Esther Segeler
Gloria Sheppard
Bernona Signor
Irene Sloan
Dorothy Smith
Justine Spetz
Dorothy Swoyer

Ruth Thomas
Gertrude Thompson

Ann Webster
Ruth Whirl

Pat Zahornasky (Miss)
Jane Zelenka
Morine Zoitos

(Cont'd from pg. 17)

Thermal Systems' plant, Mr. Long continued, is that it serves a variety of customers on a metered basis. Airports, including La Guardia and Idlewild; universities, such as the University of Houston and Rice University; the Manned Spacecraft Center opposite the Thermal Systems' central plant; shopping centers and other projects use central plants similar to the Nassau Bay Plant to supply heating and cooling needs.

The central plant at the Manned Spacecraft Center, across the highway from the Nassau Bay Plant, is of special interest since world attention has been focused on it because of U. S. spaceflights. Beginning with the second manned Gemini space flight in which Air Force Majors McDevitt and White orbited the earth 62 times in a four-day mission, control of all manned spaceflights has been switched from Cape Kennedy to the Mission Control Center-Houston at MSC.

Houston Pipe Line serves the research, training, and mission control center, providing the fuel for the central plant distribution of chilled and hot water for air conditioning and heating — 12,000 tons of cooling, with a projected increase to 16,000 tons. The Control Center, a three-story, windowless building, is one of the complex of buildings air conditioned by the central plant. The bottom floor is the computer complex and message center, while the other two floors are duplicate control centers which screen information from the world-wide tracking network and from the spacecraft itself. Temperature control is vital to computer operations, as it is to the many research projects carried out at the center.

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MSC's news center, where information is relayed to reporters, is located in Nassau Bay's office complex. From this location, television commentators broadcast flight reports to world-wide audiences. Newsmen by the hundreds come to Houston during a spaceflight.

The existing air conditioning tonnage in the relatively small area is 14,100 tons, approximately the same tonnage as at the New York World's Fair, which claims to have the largest concentration of gas air conditioning in the world on its 646 acres of exhibits. Planned capacity of the NASA area, bare prairie in 1961 and now focal point of the massive U. S. effort to accomplish a manned landing on the moon, totals 22,000 tons.

Dedication of Thermal Systems' Nassau Bay central-heating and cooling plant — third of its kind in the country — marks a major milestone in the control of indoor climate, according to Russell Gray, president of Carrier Air Conditioning Company.

"The trend to utility-supplied air conditioning is now firmly established," Mr. Gray said. "Houston Natural Gas Corporation and other progressive utilities have pioneered a new public service that some day will be commonplace, bringing the benefits of air conditioning to more people."

Chilled water for cooling and hot water or steam for heating can now be purchased from public-utility subsidiaries in Hartford, Conn., and Southern California as well as in Houston; and piped air conditioning will soon be reality in Washington, D. C., and Pittsburgh, Pa.

Mr. Gray added that other public utilities are studying the new business that can logically be called "district cooling" in the same sense that utility-supplied central heating has been called "district steam."

Roots of the district-cooling concept lie in the plant installed at Southern Methodist University in Dallas in 1940, the same year that Dr. Willis H. Carrier predicted that within 25 years public-service companies would build plants to provide cooling and heating in the same manner.

The 90-ton SMU plant fed chilled water to a single building through a 500-ft line. Today, thousands of tons of privately-owned cooling capacity are supplied through thousands of feet of pipe to multi-building complexes. One of the largest of these is the 12,000-ton system at the Manned Spacecraft Center, also in Houston.

Gray said district cooling has become a rapidly-expanding innovation in climate control because in most cases it offers savings in space and cost, increased efficiency of operation and flexibility in planning.

"But it remained for The Hartford Gas Company to realize Dr. Carrier's dream of utility-supplied air conditioning — three years short of the anticipated 25 years," Gray noted. "In 1962, company subsidiaries began piping chilled water and steam under Hartford streets to 10 major new and existing buildings, including all of an urban renewal project known as Constitution Plaza."

The original Hartford plant was equipped with 6,500 tons of cooling capacity. Last year the plant grew to 11,000 tons, and by next summer the company will have 15,000 tons ready to serve 14 major customers, including a 26-story office building and an apartment complex now under construction. William T. Jebb, chairman of the board of Hartford Gas, said that when these buildings are completed his company will have $5.6 million invested in a plant that will account for $1,750,000 in gross revenue each year.

Early in 1963, the Pacific Lighting Corporation of California announced the formation of two subsidiaries to build, operate and maintain district-heating and cooling plants in that company's distribution area. Uni-Plant Corporation was set up to serve single customers, and Central Plants, Inc., was created to serve a number of customers.

The first Uni-Plant customer was the Douglas Aircraft Company's new Space Systems Center at Huntington Beach. The $1.4 million central plant was completed in the Fall of 1963 with 2,500 tons of cooling capacity. As the space center expands, capacity could reach 10,000 tons.

Douglas spokesmen said the resultant savings in capital investment enabled the company to add one more building immediately to the research complex — a building which would have otherwise been deferred.

Cypress Park, a commercial-residential project under construction in Fullerton, Calif., is the second Uni-Plant customer. Capacity of the system is now 500 tons, with an eventual capacity of 1,500 tons.

Central Plants, Inc., has contracts for two major systems — a senior citizens residential condominium at Friendly Valley; and Century City, a large commercial-residential complex near Beverly Hills.

Utilities now constructing central plants are Washington (D.C.) Gas Light Company, and Equitable Gas Company in Pittsburgh. Washington Gas will operate a 3,000-ton plant for a luxury apartment project called Watergate. Equitable Gas is building a 4,000-ton plant for Allegheny Center, a commercial-residential project in Pittsburgh's urban renewal program.

"And in Reston, Va., an entire village will soon be air conditioned from a central plant operated by a privately-owned utility," Gray said. "The exciting Reston project is the world's first 'community air conditioning'."