DOE/R4/10606--T1

GEORGIA INSTITUTE OF TECHNOLOGY CHILLED WATER SYSTEM EVALUATION AND MASTER PLAN

PREPARED FOR
THE GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF FACILITIES
915 ATLANTIC DRIVE
ATLANTA, GEORGIA 30318

RDA ENGINEERING, INC.

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MASTER

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MAY 15, 1996

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PREPARED BY:
RDA ENGINEERING, INC.
134 SOUTH AVENUE
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Acknowledgment

The authors wish to acknowledge funding by the U.S. Department of Energy in support of this project. Special recognition is also due to Mr. Don Alexander, P.E., Manager Facilities Engineering and the staff of the Georgia Institute of Technology, Office of Facilities, Plant Operations Division for their assistance in preparation of this document.

DISCLAIMER

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EXECUTIVE SUMMARY

As the host of the Olympic Village for the 1996 Atlanta Olympics, Georgia Tech has experienced a surge in construction activities over the last three years. Over 1.3 million square feet of new buildings have been constructed on the Georgia Tech campus. This growth has placed a strain on the Georgia Tech community and challenged the facilities support staff charged with planning and organizing utility services. In concert with Olympic construction, utility planners have worked to ensure long term benefits for Georgia Tech facilities while meeting the short term requirements of the Olympic Games. The concentration of building construction in the northwest quadrant of the campus allowed planners to construct a satellite chilled water plant to serve the needs of this area and provide the opportunity to integrate this section of the campus with the main campus chilled water system.

This assessment and master plan, funded in part by the U.S. Department of Energy, has evaluated the chilled water infrastructure at Georgia Tech, identified ongoing problems and made recommendations for long term chilled water infrastructure development and efficiency improvements. The Georgia Tech office of Facilities and RDA Engineering, Inc. have worked together to assemble relevant information and prepare the recommendations contained in this document.

Projected growth for the next fifteen years estimate refrigeration requirements for Georgia Tech buildings will increase by approximately 35%. This growth will primarily take place in the northern area of the campus through construction of office and research facilities. Existing buildings located throughout the campus which currently have individual refrigeration machines will also require replacement or upgrading in this time period due to the age of machinery and CFC refrigerant phase out. The central chilled water piping infrastructure available throughout the campus and associated central plants are available to meet existing refrigeration needs and can be expanded in a logical fashion to provide reliable and efficient air conditioning service to new buildings.

Recommendations included in this master plan include: integration of the satellite chiller facility located at 10th Street with the main campus chilled water system, a plan to address modifications to piping connections which will make the entire system work more efficiently, suggestions to utilize existing refrigeration systems as back-up for the central plant chillers and to segment the chilled water system into central campus vs. east campus residential areas. Additionally, it is recommended that chilled water storage be considered in combination with additional refrigeration machine additions at the satellite chiller plant location. Initial feasibility studies indicate chilled water storage is less expensive than a refrigeration machine addition and will save operating costs due to the new Georgia Power real time pricing rate schedule.

INTRODUCTION

Between July 19 and August 4, 1996, the Georgia Tech Campus will be illuminated by the spotlight of the World. The Centennial Olympic Games, hosted by the Atlanta Committee for the Olympic Games (ACOG) will bring together more than 10,000 athletes representing nearly 200 nations. Over 3,000 hours of television coverage will allow two-thirds of the world's population - 3.5 billion people - to watch the competition and spectacle. Yet, of the thousands of athletes, coaches, organizers, sportscasters, spectators and billions of television viewers, only a handful will be aware of the Georgia Tech district heating and cooling systems laboring behind the scenes to provide indoor comfort and hot water for the Olympic Village.

The lack of recognition for District Energy isn't intentional, it's a fact of life the industry has learned to accept. In our modern society, we don't notice much of the technology that provides the reliable services we've grown accustomed to. In fact, building engineers know the best heating and cooling systems are the ones we don't notice. They're the ones that operate efficiently, don't break down and keep temperatures "just right" so occupants don't complain.

Georgia Tech's DHC systems have performed year after year in their behind-the-scene roles. The Georgia Tech systems which serve the Olympic Village have been expanded to provide reliable service to Olympic facilities and will continue heating and cooling existing buildings throughout the campus. Georgia Tech is also the site of the Olympic natatorium for swimming and diving events and the Alexander Memorial Coliseum which is the venue for boxing. The 330-acre Tech campus normally accommodates a student enrollment of 12,000.

Major construction programs undertaken for the Olympics include more than $150 million in new campus housing facilities, an $11 million renovation of the Coliseum, the $28 million Aquatic Center, over $1.7 million in grounds upgrades and numerous temporary facilities to accommodate the resident athletes. Figure No. 1 is an aerial photograph of the campus taken in January of 1996.

From the time of initial bid preparation Georgia Tech has been the center of Atlanta's Olympic plan. The main reason is the substantial housing and athletic facilities located in a campus setting near Atlanta's urban center. Duplicating these facilities from scratch would have cost several hundred million dollars. Once the go-ahead was received, Tech planners moved to accelerate nearly ten years of projected dormitory construction into a four and one-half year time span. This was in addition to an ongoing campus growth rate of 3-4% per year needed to meet academic and research expansion.

The Georgia Tech campus has been served by a central steam system since 1923. Currently, steam is distributed throughout the south, central and east portions of the facility to 80 buildings. A central campus chilled water plant was constructed in the late 1960's and has been expanded to serve approximately 3,000,000 SF of buildings from a single location. The steam system operates year round to serve classrooms, administration, dormitories and research facilities, while the chilled water system is operated during summer months.

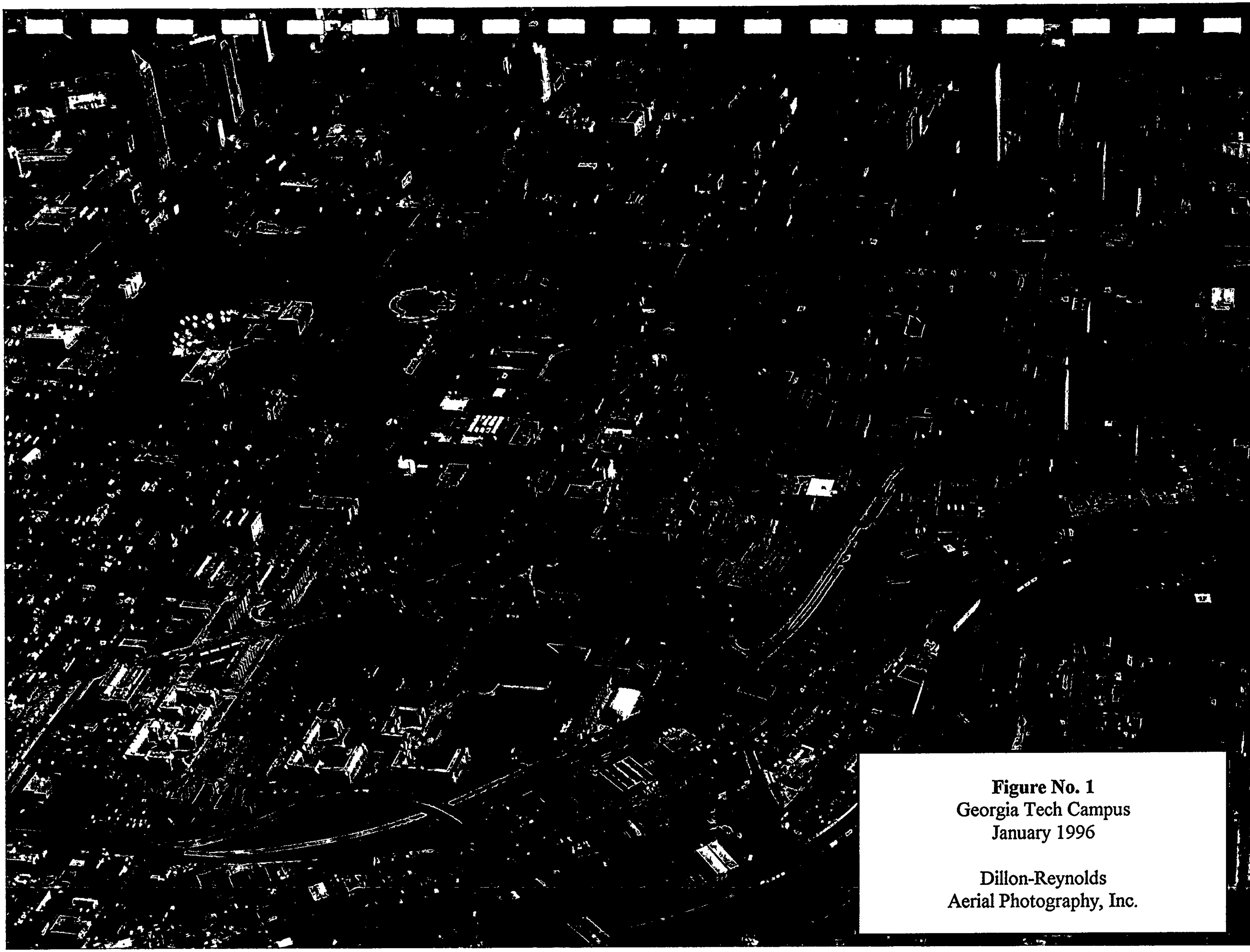

Figure No. 1
Georgia Tech Campus
January 1996

Dillon-Reynolds
Aerial Photography, Inc.

Georgia Tech's central steam and chilled water systems have operational and growth problems which are common to many universities. First, growth of the campus has been away from the central plant. This means that chilled water and steam lines sized 30-40 years ago are too small for new buildings located across campus. The situation is aggravated by numerous building additions which have used different pumping connection schemes to assist chilled water pressure or "draw" water out of the existing chilled water mains. Second, buildings are usually funded one at a time, located some distance from existing district system lines and budgeted without provisions for utility infrastructure development. Additionally, low electricity prices and the high cost of district line extensions have resulted in recent building designs based on individual heating and cooling systems in order to get the "most" building from limited construction budgets.

The Georgia Tech Central chilled water system has been expanded over the years to meet building additions to the campus in the 1970's and the 1980's. Campus growth has caused development of chilled water mains in a radial fashion extending outward from the original chiller plant located at a central site in the southeast quadrant of the campus.

A substantial number of buildings on the Georgia Tech campus do not currently utilize the central chilled water system due to proximity to existing chilled water lines and lack of available capacity in the existing central chiller plant. Summer only operation of the central system is also a drawback for some building requirements. Like many state supported facilities, new buildings are often funded without consideration for utility infrastructure development or provision for future growth.

For Georgia Tech, Olympic related construction allowed consideration of a satellite chilled water plant in the northwestern part of the campus. A 3,000 ton plant was designed and constructed to serve new Olympic dorms and nearby research facilities. The new plant can be expanded to 8,000 tons with future chiller additions. Underground pipe lines are routed through the plant's service area to a connection point with the main campus chilled water system. Without the Olympic push, these dorms would probably have been built one at a time with individual HVAC systems.

A second 1,800 ton satellite chilled water system and natural gas fired hot water heating plant was constructed south of the campus to supply the six building University Apartments complex which will ultimately house students for Georgia State University. Linking this system with the main Georgia Tech campus may be considered in the future.

DOE has provided funding for this master plan to assist Georgia Tech's Plant Operations in planning and analyzing the central chilled water system expansion and future operation after the Games. RDA Engineering, Inc. has worked with Georgia Tech engineers to evaluate the existing chilled water system, plan additional piping interconnections and evaluate chilled water storage as a means to provide for future load growth.

BENEFITS OF DISTRICT SYSTEM DEVELOPMENT

Development of a campus-wide District Cooling System provides benefits to the Georgia Institute of Technology through organization of refrigeration services, reduction of maintenance and operating costs, enhancing ability to optimize refrigeration sources and providing opportunities to apply thermal storage technology. In the future, cogeneration and electrical demand limiting may also be considered.

This opportunity exists at Georgia Tech due to the diversity of the numerous buildings which can benefit from a central cooling system. The campus district cooling system optimizes the use of available refrigeration sources and reduces overall electrical requirements from the local electric utility.

Other benefits which can be derived through central district cooling include: a comprehensive approach to multiple refrigeration unit dispatch, a long-term CFC refrigerant phase-out plan and the potential to reduce capital costs through utilization of central chiller systems rather than individual building systems.

Ongoing construction throughout the campus will require modification of the existing chilled water distribution system and additional central refrigeration units or construction of individual building refrigeration systems. This master plan addresses continued development of a campus-wide district cooling system incorporating state-of-the-art refrigeration systems, current underground piping technology, thermal storage options and integrated resource optimization through state-of-the-art control technology.

Options which can be considered include:

- Multiple central energy plants
- Satellite plants
- Storage
- Electric vs. heat driven refrigeration
- Computerized control and system optimization

CAMPUS DESCRIPTION

Georgia Tech is located on a 350 acre campus within the City of Atlanta close to the city's central business district. The design of the early campus exhibited the traditional urban pattern of a campus quadrangle surrounded by academic buildings. This development fronted North Avenue with other campus buildings surrounding the quadrangle. Over the years, the campus has grown to its present size primarily in a northwesterly direction.

Today, the campus is bounded by North Avenue on the south and by 14th Street at the northern edge of the campus. The eastern boundary of the campus is formed by Interstate 75-85 and the majority of the western boundary of the campus is bordered by Hemphill Avenue. Each of the current physical boundaries presents formidable obstacles to further development beyond the existing 350 acre site. This is especially true in the case of the eastern interstate highway boundary. The Coca-Cola Company and Techwood Homes housing project on the southern boundary prevents significant expansion in that direction. Any further campus expansion will most likely take place on the northern boundary of the campus; however, this requires encroachment into a residential neighborhood which may result in community opposition.

In preparing this master plan for central systems infrastructure, RDA relied on the campus master plan by Sasaki Associates, Inc. which was completed in 1991. Minor changes to that plan which have occurred during the study period have also been incorporated.

For purposes of analysis, RDA divided the campus into four quadrants as shown in Figure No. 2. The southeast quadrant contains the original campus with administration buildings, student housing, etc. The central chiller plant and boiler plant are located near the center of this quadrant.

The southwest quadrant contains academic buildings and student activity facilities constructed primarily in the 1960's -1970's.

The northwest quadrant contains the majority of the construction associated with hosting the 1996 Olympics as well as numerous housing facilities and contract research facilities. This quadrant will likely be the site for building development for the next 10-15 years. A satellite chilled water plant was recently constructed in the northern area of this quadrant in support of dormitory facilities recently constructed.

The northeast quadrant contains contract research facilities, the coliseum and some student housing buildings. This area contains a number of athletic fields which will probably remain for athletic activities. Additional building activity to support contract research activities will likely occur in the northern region of this quadrant.


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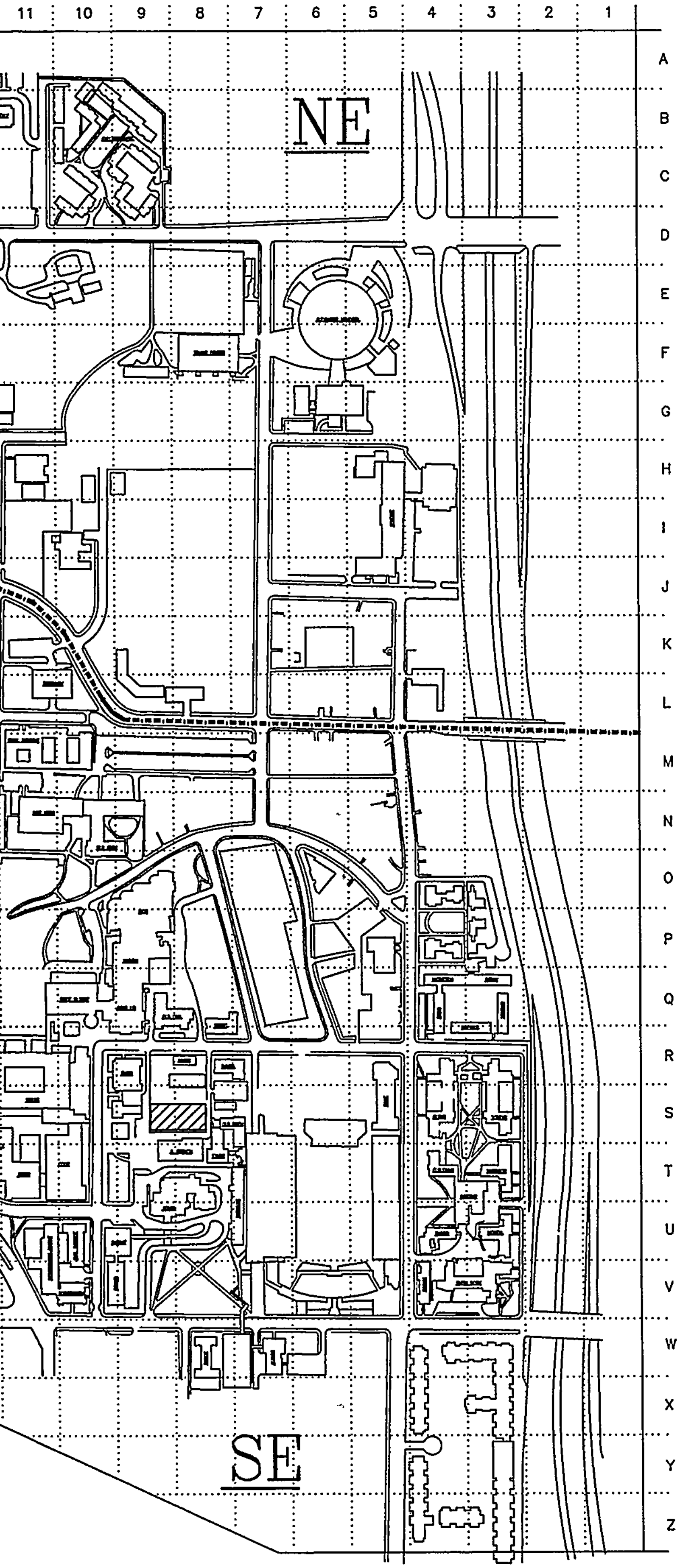

FIGURE NUMBER 2

CHILLED WATER SYSTEM
MASTER PLAN

Georgia Tech
PLANT OPERATIONS

RDA ENGINEERING, INC.
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MAY 15, 1996

CENTRAL SYSTEM DESCRIPTIONS

Boiler Plant

The central boiler plant consists of four boilers with a combined capacity of 160,000 pounds per hour. The boilers were originally designed to fire coal, but were converted to fire heavy oil and natural gas. Steam is generated at a pressure of 150 pounds per square inch and throttled through pressure reducing valves to approximately 40 pounds per square inch for distribution to the Georgia Tech campus. Almost all condensate from the campus is returned and used as makeup water to the boiler system. The boilers are equipped with air pre-heaters and economizers. Low pressure steam drives are used for condensate and boiler feed pumps and I.D. fans.

The boiler plant sees a load varying from a peak of 120,000 pounds per hour during the coldest winter conditions to 20,000 pounds per hour minimum load in summer. The steam loads consist of energy required for building heating and cooling, humidification and service water heating requirements. No significant process load other than minor steam used for cooking facilities is encountered. Figure No. 3 illustrates the current extent of steam piping.

Central Cooling System

In 1965, a chilled water plant was established for the purpose of providing cooling for the Georgia Tech campus. The plant, as configured today, consists of six centrifugal water chillers driven by electric drives with a total installed capacity of 8,000 tons. The water chillers are piped in a parallel arrangement to produce a leaving chilled water temperature of 45° Fahrenheit. Return chilled water temperatures of 55-60° Fahrenheit are typical.

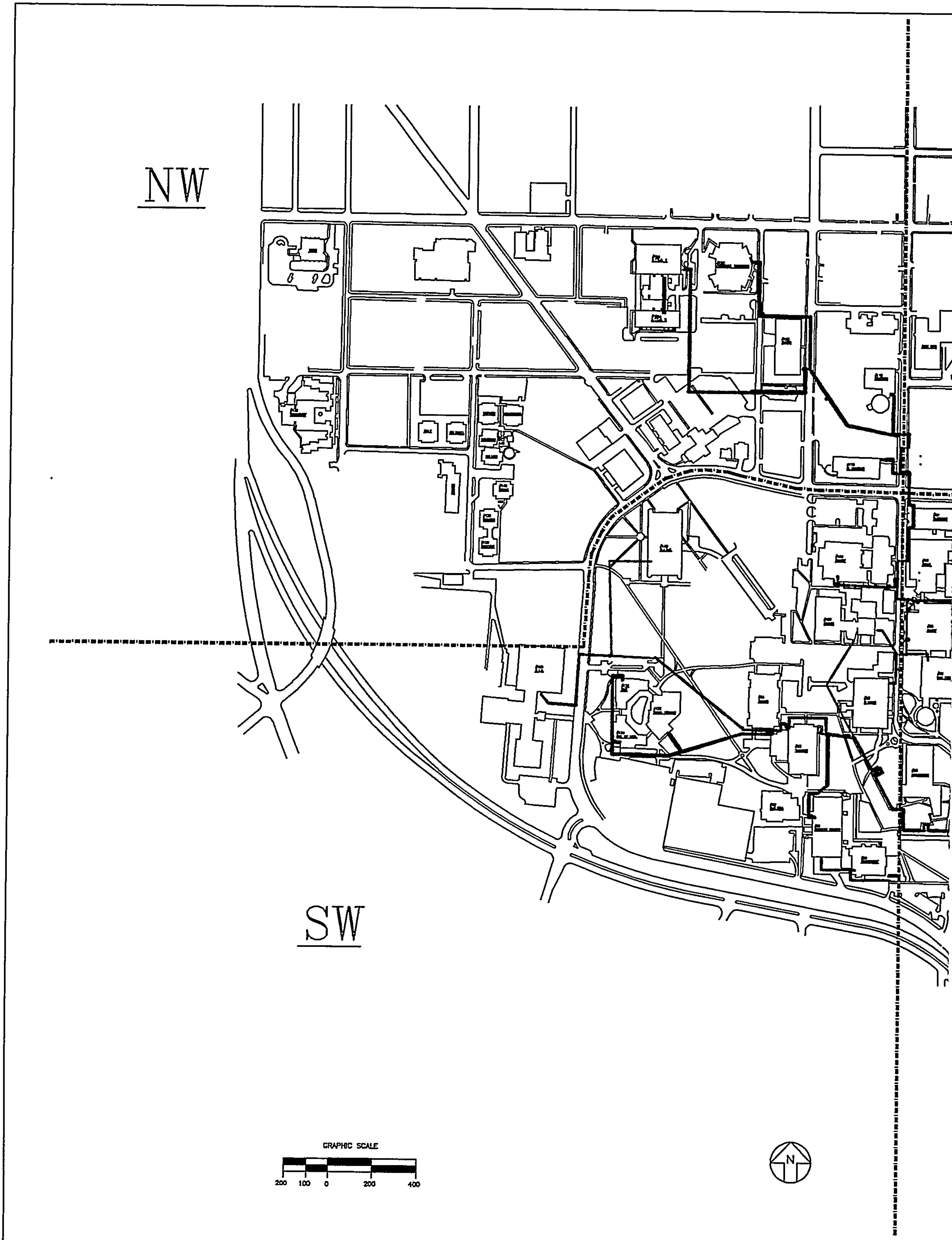
The chilled water load experienced by the central plant consists entirely of space temperature conditioning and dehumidification requirements. The plant is not operated during the coldest winter months.

Central Plant Control and Monitoring System

The central plant is controlled and monitored by a central, computer control system. This system represents the state-of-the-art control technology with computerized control functions and remote sensing capability. The system is capable of monitoring temperatures, pressures, flows and energy consumption at selected points throughout the central energy plant. Computer software allows for trend logging, data collection and integration of selected sensor points. Start, stop and capacity modulation functions are also controlled from the central control system.

Chilled Water System Operation

The present central campus chiller plant has 8,000 tons of installed refrigeration capacity, however, it is operated at 6,000 tons or less on a design day due to evaporative cooling tower limitations. At peak outside design conditions, the plant supplies 47° outgoing water and the return from the campus is 56°. The existing system is being augmented by three chillers located in campus buildings. The Physics Building has a 450 ton chiller which provides booster chilling for the northern leg of the distribution system. The Pettit Building has a 200 ton chiller which can be used locally instead of using the central chilled water and the College of Computing also has a 250 ton chiller which can be used in a similar fashion. These three systems provide supplemental capacity of approximately 900 tons which is operated only on peak days.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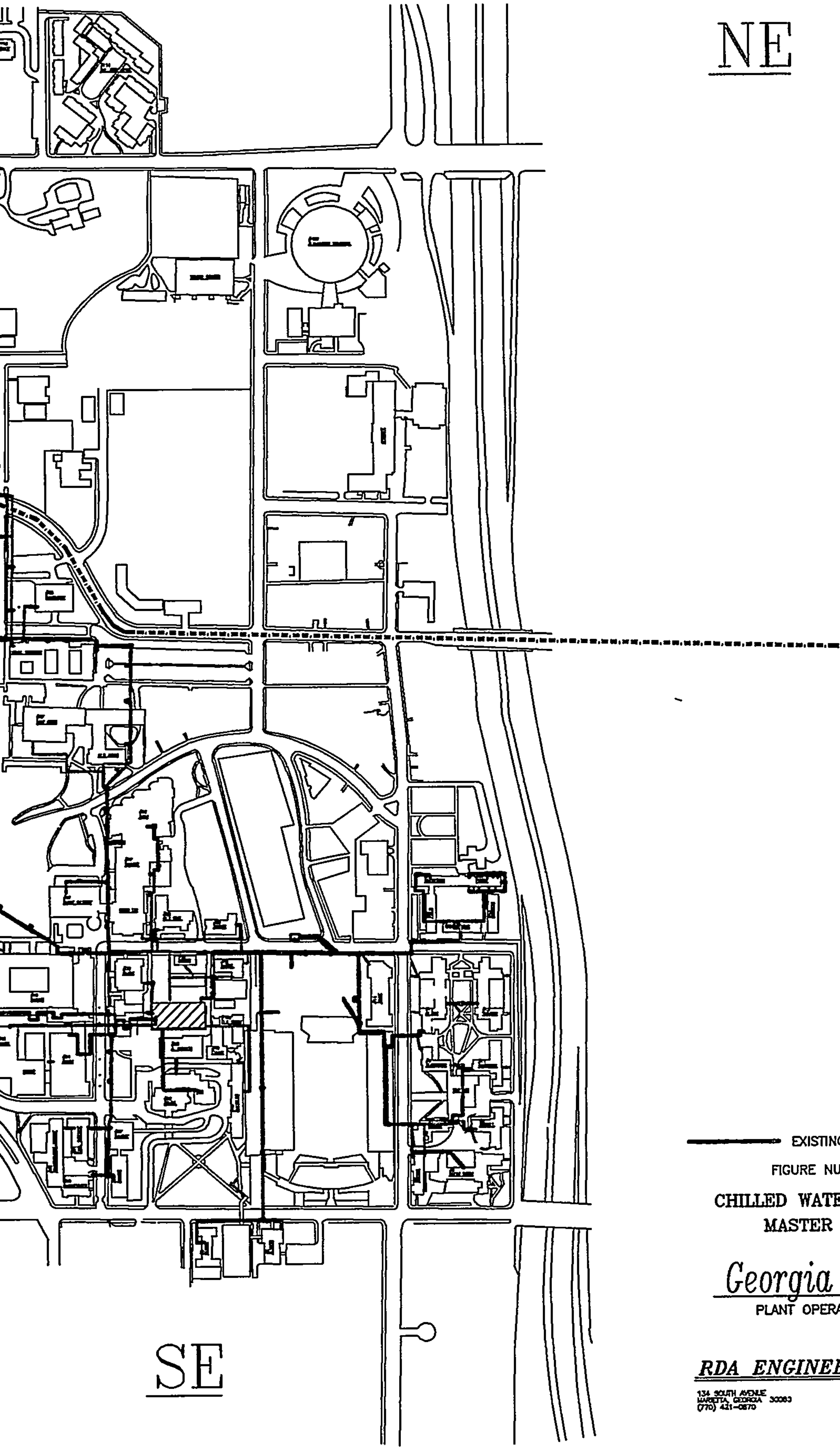

EXISTING STEAM PIPING

FIGURE NUMBER 3

CHILLED WATER SYSTEM MASTER PLAN

Georgia Tech

PLANT OPERATIONS

RDA ENGINEERING, INC.

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(770) 421-0870

MAY 15, 1996

The majority of the campus buildings served by the chilled water distribution piping are connected to the system in a primary/secondary loop. The buildings utilize a building pump and three-way valve which varies from 100 percent chilled water from the distribution system to none depending upon the building load requirements.

Problems

The Georgia Tech staff identified three fundamental problems with the central chiller plant, distribution system and buildings:

Capacity

The existing chiller plant is operated near its maximum capacity. The plant is comprised of two 2,000 ton chillers in parallel and two sets of 1,000 ton chillers piped in series which appears to the system as 2,000 ton parallel chillers. Due to condenser water limitations, the plant can only operate at 6,000 tons on a design day. Should any one of these chillers or their support equipment fail, the plant can only function at a 75 percent or less capacity. Local building chillers in three locations can be brought on-line to help, but can only provide cooling in four or five buildings, the rest would operate at reduced capacity.

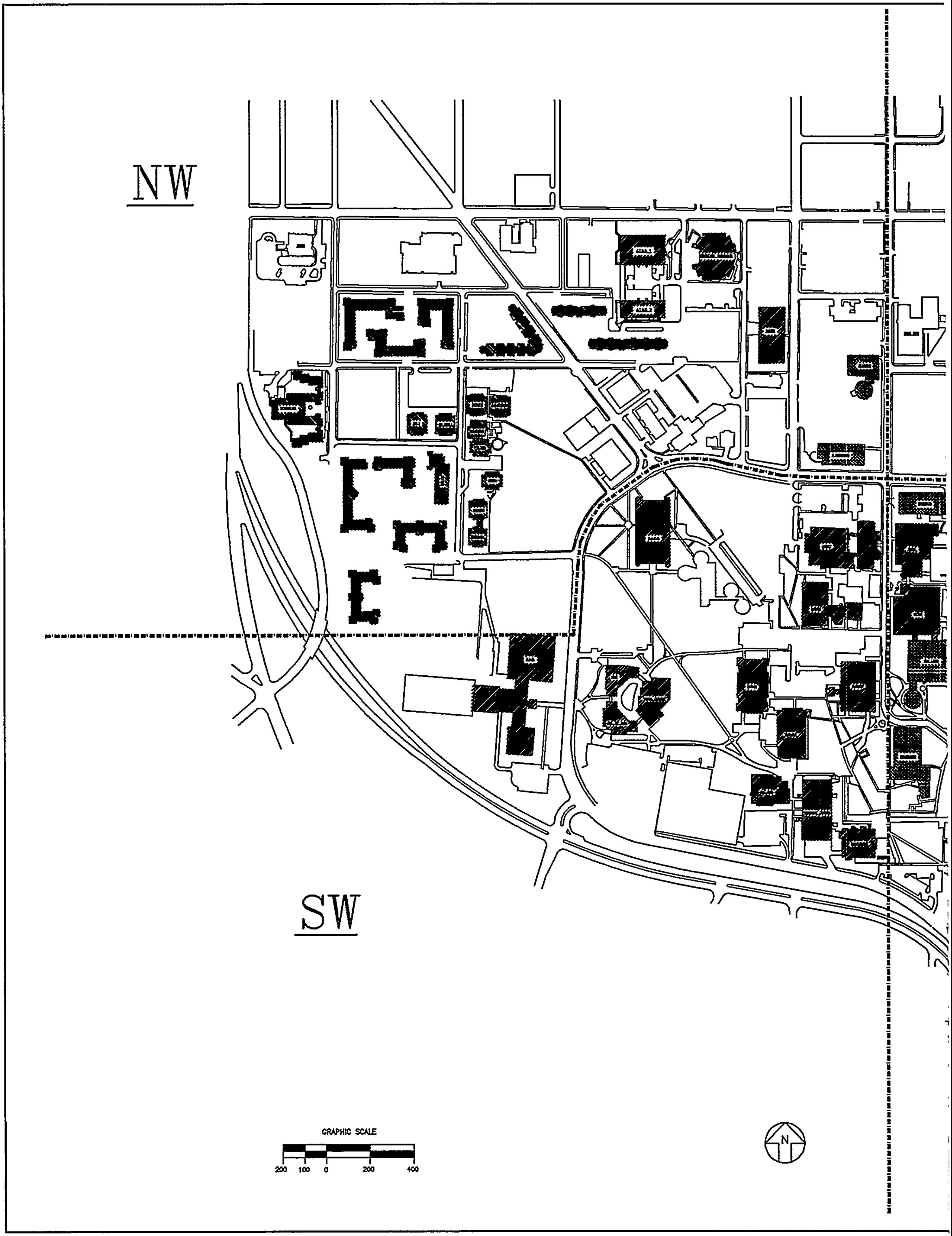
Another capacity problem results from the lack of sufficient temperature differential from the distribution system. This is commonly called "running out of water". At peak loads, the pumps are operated at full capacity. If a chiller is designed to produce its rated load at a 12° Fahrenheit differential and only a 10° differential is available between the return temperature and supply setpoint., the chiller can only produce 83% of its rating.

The unaccessible 1,200 to 1,300 tons of the existing plant chillers is due to the buildings not returning 58° to 60° Fahrenheit return water.

Building Connections

A continuing problem is that the buildings do not use chilled water efficiently. This is due to their original design and connection to the chilled water system. The problem is that the three-way valve connections produce a mixed or blended temperature to the building chilled water coils and do not provide the coolest water to the equipment, but rather a blended temperature. The intent of the building three-way valve control is to supply chilled water at or about 45° Fahrenheit. If the return water is not hot enough then the valve by-passes cold water and it mixes with the building return system. The building chilled water loop control valve controls the amount of chilled water drawn from the distribution system by monitoring the building return water and allowing it to return to the distribution system when it's hot. The problem with this method of control is on mild days the buildings have a light cooling load, because the water is recirculated, it is warmer than desired and dehumidification does not occur.

The recommended solution is to repair and fine tune the building controls to provide an overall 15° rise between chilled water system supply and return temperature. A second, more involved recommendation is to convert the building's three-way control valves to two-way control valves. This will ensure that the optimum cooling is obtained from the water and that only warm return water will be returned to the campus chilled water distribution system.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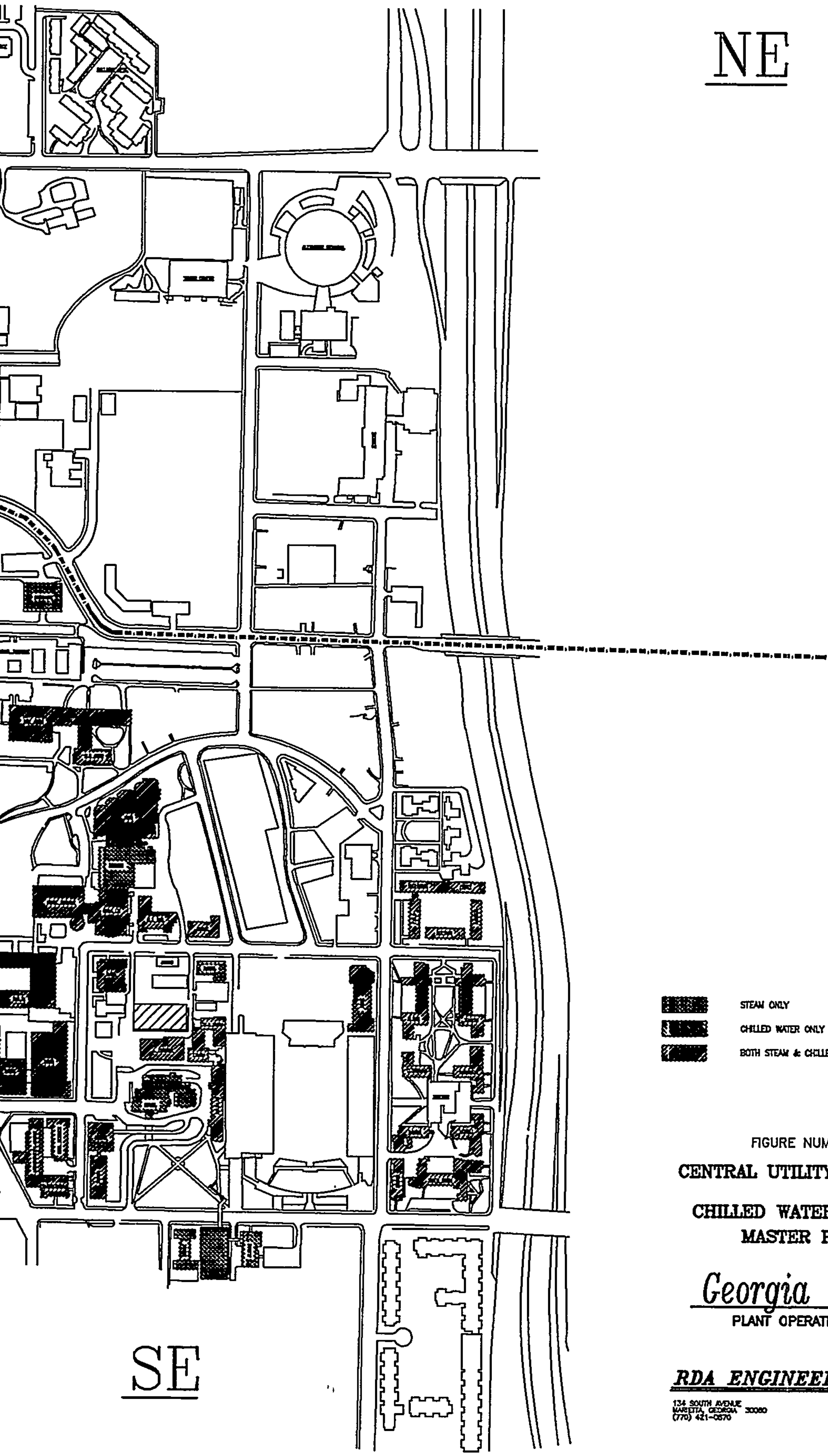

STEAM ONLY

CHILLED WATER ONLY

BOTH STEAM & CHILLED WATER

FIGURE NUMBER 4

CENTRAL UTILITY SERVICES

CHILLED WATER SYSTEM
MASTER PLAN

Georgia Tech
PLANT OPERATIONS

RDA ENGINEERING, INC.

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MAY 15, 1996

Chilled Water Piping
The chilled water system has been expanded over the last 20 years in a non-standardized fashion. Problems include low pressure in some areas, high pressure in others and reverse flow. It is thought that some underground lines may be cross-connected. Uncertainty over load growth and timing of building connections has contributed to the uncoordinated growth.

Recent Chilled Water System Expansion
In the late 1980's and early 1990's most new buildings were being designed with self contained air conditioning plants because of the limited capacity of the central plant and problems previously described. This was not the most efficient design since the life cycle cost of individual building chiller plants are higher than central plant utilities. In 1992, it was determined that there was a need to add chiller capacity to the central plant and that an overall study of system hydraulics should be undertaken. Additionally, funding is being sought for building connection renovations.

Figure No. 4 illustrates building connections to various campus utilities.

OLYMPIC CONSTRUCTION

With the announcement that Atlanta had captured the bid for the 1996 Summer Olympic Games in early September 1990, the Georgia Tech campus became the focal point of construction activities associated with the Olympic Village.

Primary construction efforts were directed at six housing complexes totaling nearly 1.3 million square feet. One half of this square footage was constructed in the south corner of the southeast quadrant of the campus in the six building University complex. The majority of the remaining residential buildings were located in the northwest quadrant of the campus where the majority of new residential construction has occurred in the last fifteen years. Figure No. 5 illustrates construction activities over the 1994-1996 time period.

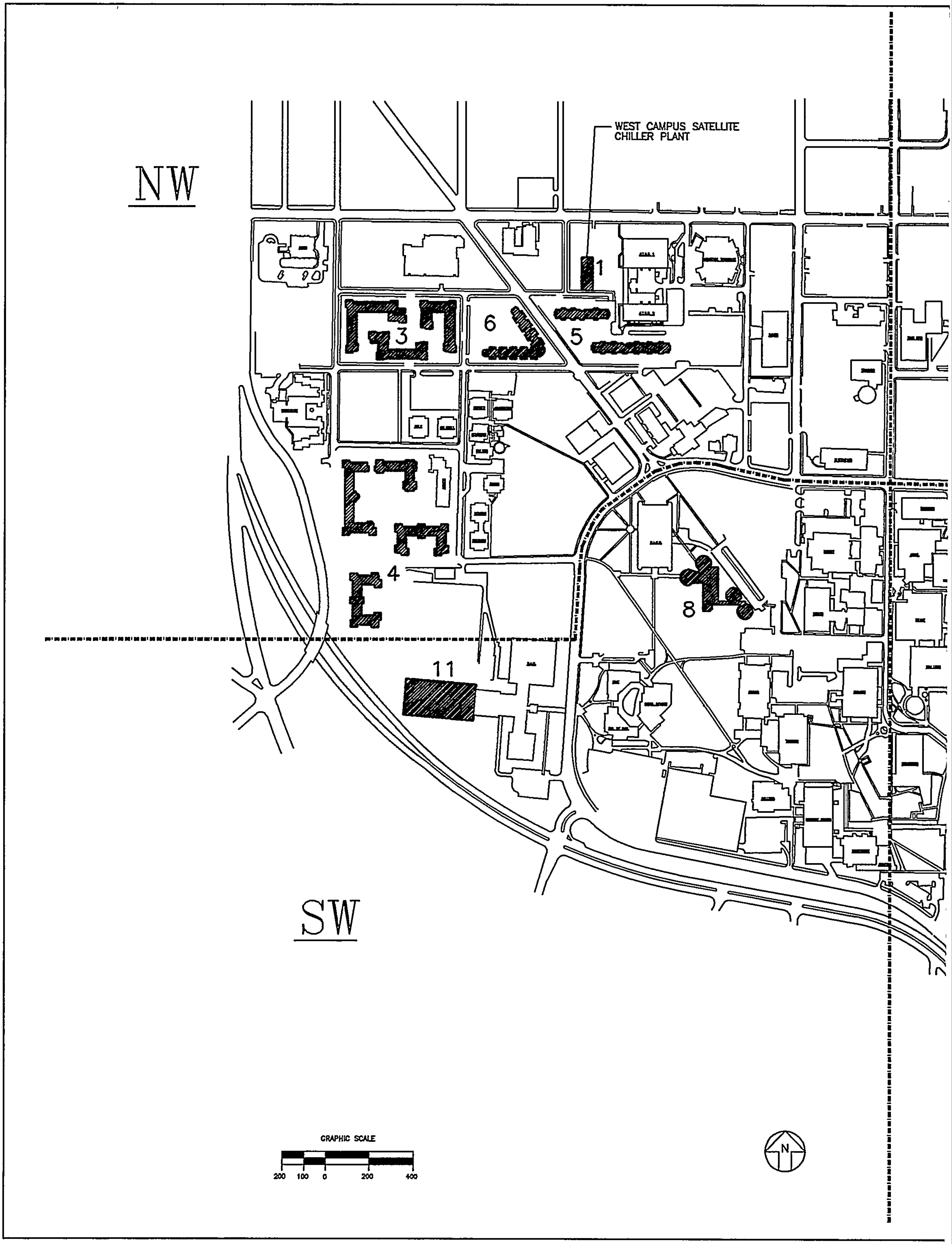
Additional construction activities were directed at renovation of the Alexander Memorial Coliseum and construction of the natatorium/diving venue. General campus landscaping improvements were also undertaken.

Table I

Olympic Related Construction 1994-1996

1.	G-88	University Apartments		689,840 SF
2.	G-89	Eighth Street Apartments		201,555 SF
3.	G-90	Sixth Street Apartments		146,460 SF
4.	G-91	Center Street Apartments		104,160 SF
5.	G-92	Hemphill Avenue Apartments		111,000 SF
6.	G-93	Fourth Street Apartments		36,675 SF
			Total	1,289,690 SF

The Georgia Tech campus offers a substantial number of facilities and infrastructure in support of accommodations for Olympic athletes and trainers. Construction of the six additional housing projects was facilitated by the State accelerating development of these projects into a four year time period. Normally, these projects would have been built over a 10-12 year time span. Needless to say, acceleration of this building program coupled with the on-going building program in support of academic and research needs placed a great strain on normal campus operations.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CHILLER PLANT
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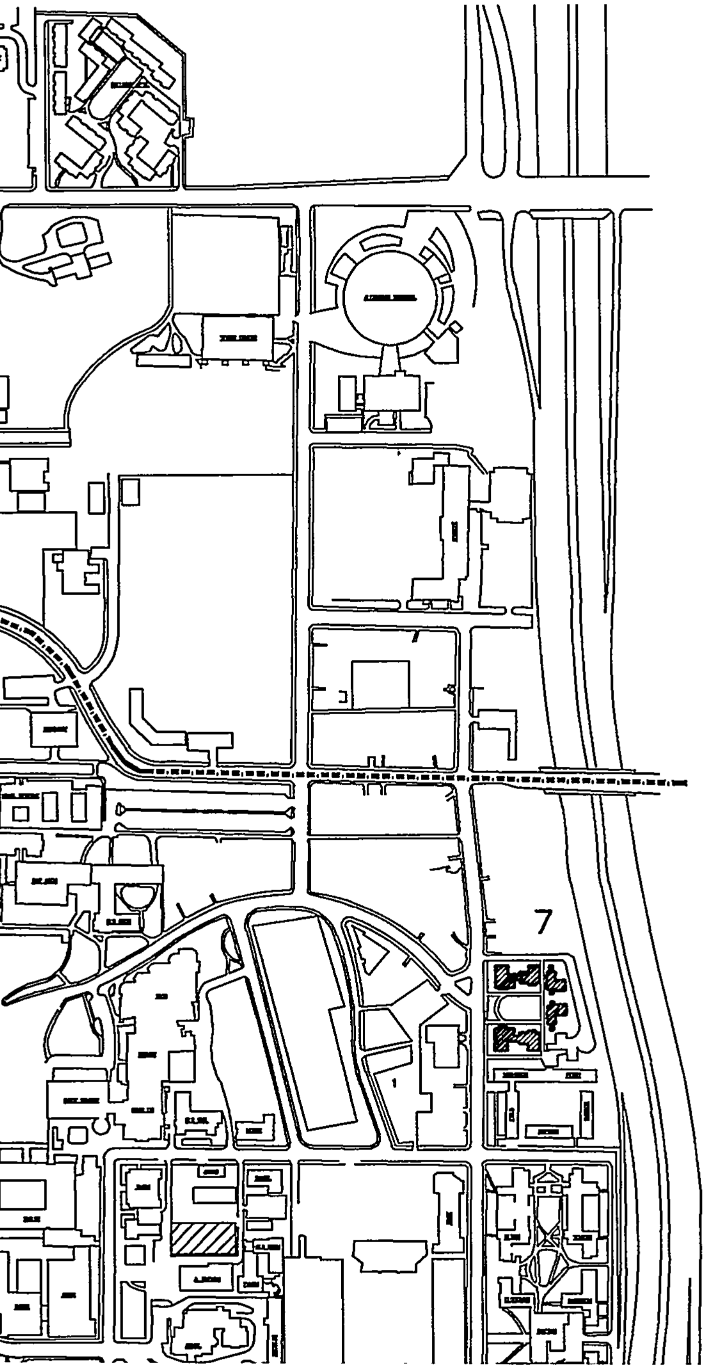


NE

1994–1996 CONSTRUCTION

LEGEND	
1	SATELLITE CHILLER PLANT
2	G88 – UNIVERSITY APTS.
3	G89 – EIGHTH STREET APTS.
4	G90 – SIXTH STREET APTS.
5	G91 – CENTER STREET APTS.
6	G92 – HEMPHILL AVENUE APTS.
7	G93 – FOURTH STREET APTS.
8	MRDC (PHASE 1)
11	NATATORIUM

1994–1996 CONSTRUCTION

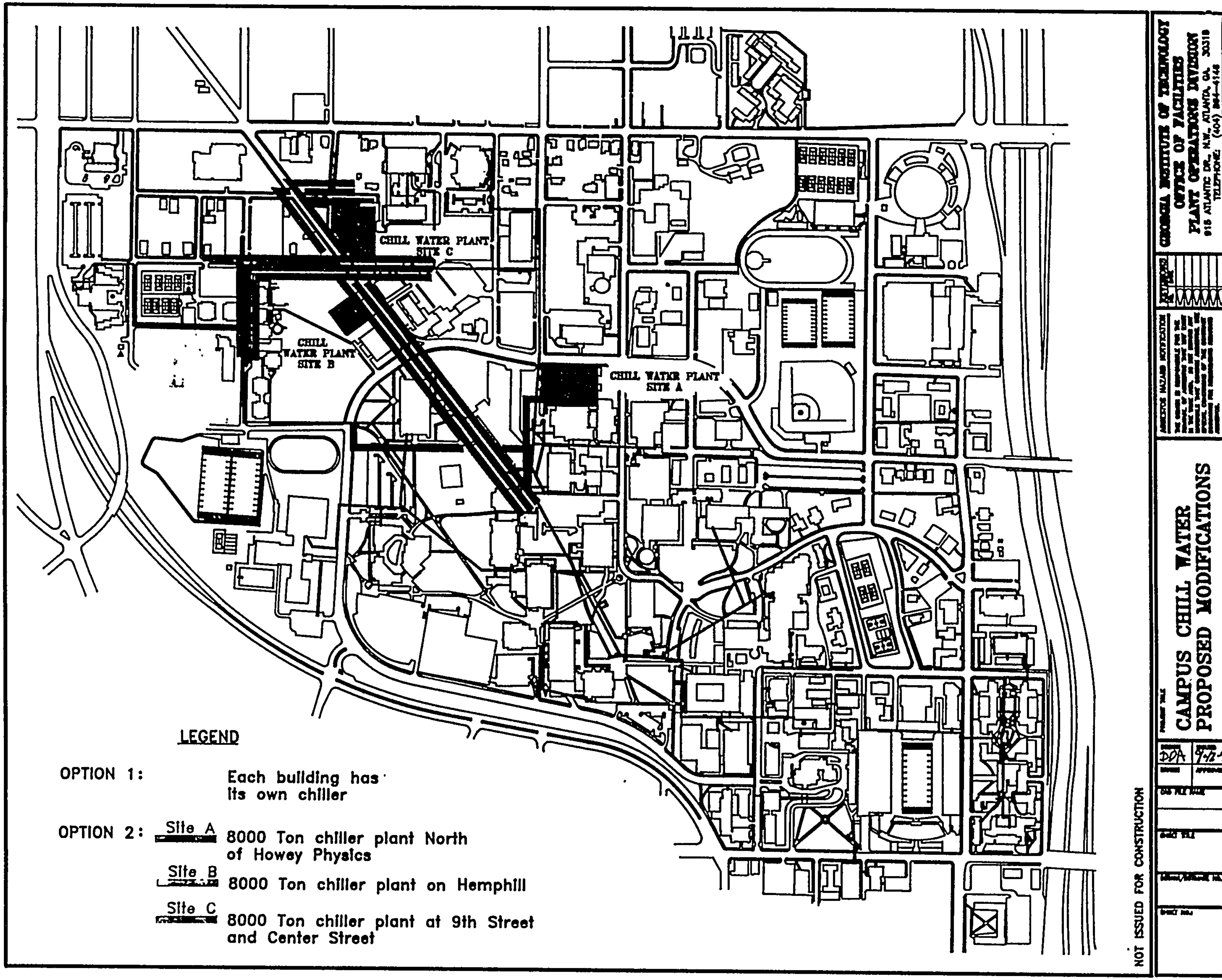

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF FACILITIES
PLANT OPERATIONS DIVISION
915 ATLANTIC DR., N.W., ATLANTA, GA. 30318
TELEPHONE: (404) 894-4146
CAMPUS CHILL WATER
PROPOSED MODIFICATIONS
NOT ISSUED FOR CONSTRUCTION
CHILL WATER PLANT SITE A
CHILL WATER PLANT SITE B
CHILL WATER PLANT SITE C
LEGEND
OPTION 1:
Each building has its own chiller
OPTION 2:
Site A
8000 Ton chiller plant North of Howey Physics
Site B
8000 Ton chiller plant on Hemphill
Site C
8000 Ton chiller plant at 9th Street and Center Street

Figure No. 6

LONG TERM LOAD GROWTH

RDA Engineering, Inc. used the campus master plan prepared by Sasaki Associates, Inc. to predict long term campus growth. Using the near term projects identified in the master plan approximately 730,000 square feet of building additions were identified for near term campus growth. The master plan space needs analysis also identified approximately 1.4 million square feet facilities required over the next 10-15 years. These facilities are generally in support of research activities and will be located on the northern part of the campus. The master plan layout was used to position long term facilities in Figure No. 7 within the campus boundaries.

Table II presents both the near term and long term projected building program which was used as the basis for this study.

In order to predict loads on the central chilled water system, RDA apportioned the projected growth into annual square foot additions. Table III presents the projected square footage additions for the period 1996-2010. Based on 500 SF per ton of air conditioning, RDA predicted air conditioning system load growth over this study period. This projection indicates that required campus refrigeration loads will increase approximately 5,500 tons by the year 2010. As in the past, cooling loads can be met by individual building chillers, or additions to the central chilling plants and piping infrastructure. This report primarily addresses requirements for meeting these loads through the expansion of chilled water infrastructure and associated facilities. A complete table of existing building cooling requirements used in this study is included in the Appendix.

In addition to new construction, there are numerous buildings throughout the Georgia Tech campus which have not been connected to the central chilled water system. These buildings represent additional load which can be added over time as installed refrigeration systems are phased out or need to be replaced. Table III includes an estimate of existing building loads which can be added to the central chilled water system over time. These buildings represent 1,750 tons of additional load which can be supplied from the central system as existing building chillers need replacement.

Table II

Projected Campus Growth (1)

Near Term Potential

Project	**SF**
Library Addition	158,000
Environmental Science and Engineering Building	160,000
Continuing Education	71,500
Indoor Athletic Facility	150,000
GTRI Expansion	191,000
	730,500

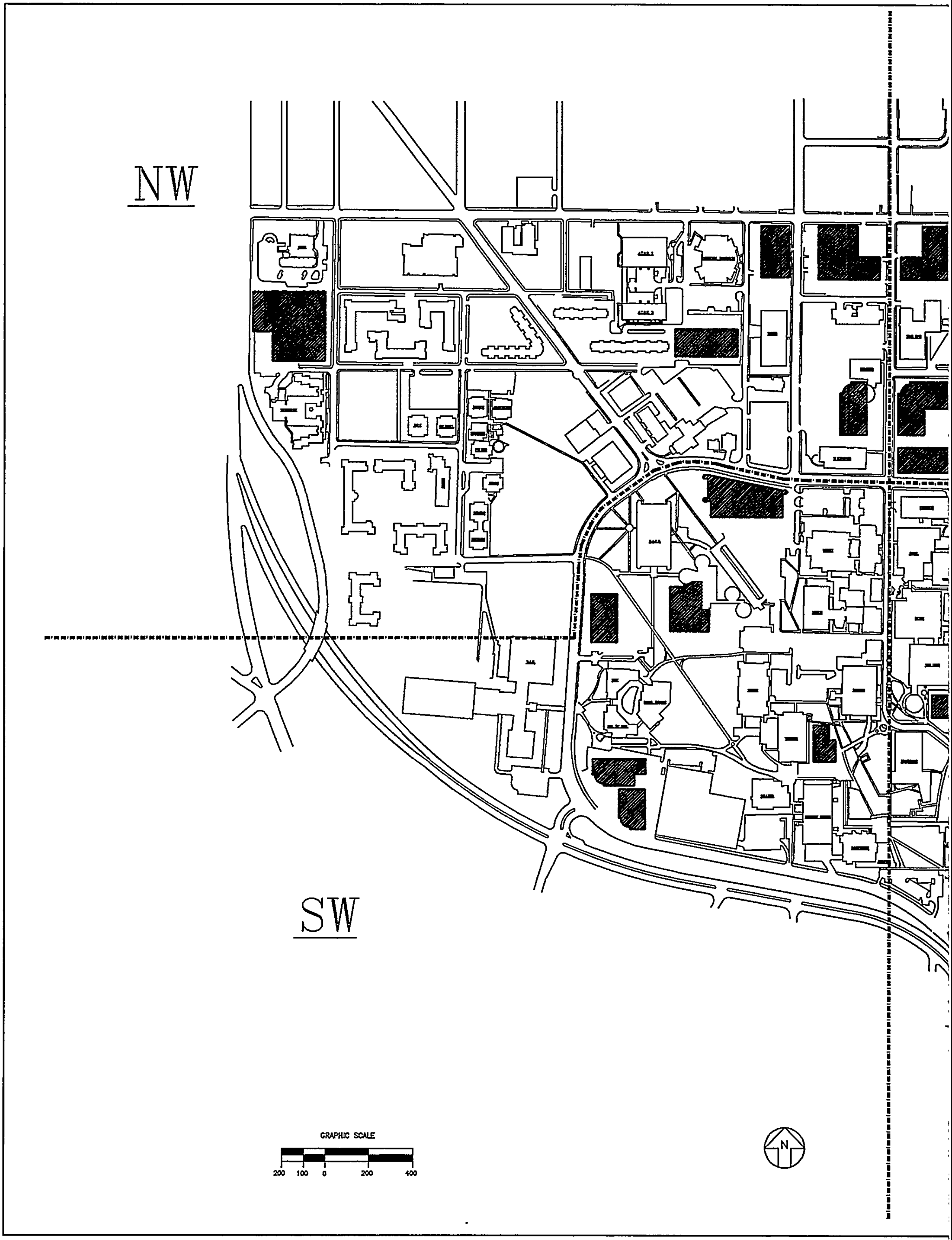
Additional Future Program Derived from Space Needs Analysis

Space Type	**Additional Need (SF)**
Teaching Laboratories	22,000
Research and Academic Offices	1,158,000
Administration Offices	64,000
Library	55,000
Other Space	54,000
Shop and Storage	94,000
Future Total	1,447,000

(1) Information from 1991 Master Plan developed by Sasaki Associates, Inc.

Table III
Georgia Tech - Lond Term Chilled water System Growth

		1996	1997	1998	1999	2000	2001	2002	2004	2004	2005	2006	2007	2008	2009	2010
Projected SF Additions																
Specific Projects																
Library			158000						55000							
ESE Building				160000												
Continuing Education					71500											
Indoor Athletic Facility		150000														
GTRI Expansion						191000										
Additional Space Needs																
Teaching Labs				22000												
Admin. Offices			20000			20000			24000							
Research / Academic								200000		200000		200000		200000		200000
Projected New Const.		150000	178000	182000	71500	211000	0	200000	79000	200000	0	200000	0	200000	0	200000
Tons Req @ 500SF/T		300	356	364	143	422	0	400	158	400	0	400	0	400	0	400
Cum. New Construction		300	656	1020	1163	1585	1585	1985	2143	2543	2543	2943	2943	3343	3343	3743
Existing Major Buildings Not on Central CW																
Burge Apts (03)	63000					63000										
Administration (22)	43000				43000											
Guggenheim (29)	23000						23000									
ESM Building(31)	38000			38000												
Hightower Textiles(59)	82000						82000									
Emerson GTRI (87)	71600			71600												
ERB (119)	63400				63400											
Infirmary (88)	24600							24600								
Van Leer EE (66)	159820						159820									
O'Keefe (98)	108350										108350					
Naval Reserves (84)	48929							48929								
Inst of Paper Tech. (153	140000									140000						
Ajax Placement (125)	10000								10000							
Existing Buildings	875699	0	0	109600	106400	63000	264820	73529	10000	140000	108350					
Tons Req @ 500SF/T		0	0	219	213	126	530	147	20	280	217	0	0	0	0	0
Cum Exist. Buildings		0	0	219	432	558	1088	1235	1255	1535	1751	1751	1751	1751	1751	1751
Total Campus Tons		300	356	583	356	548	530	547	178	680	217	400	0	400	0	400
Cum. Campus Tons		300	656	1239	1595	2143	2673	3220	3398	4078	4294	4694	4694	5094	5094	5494



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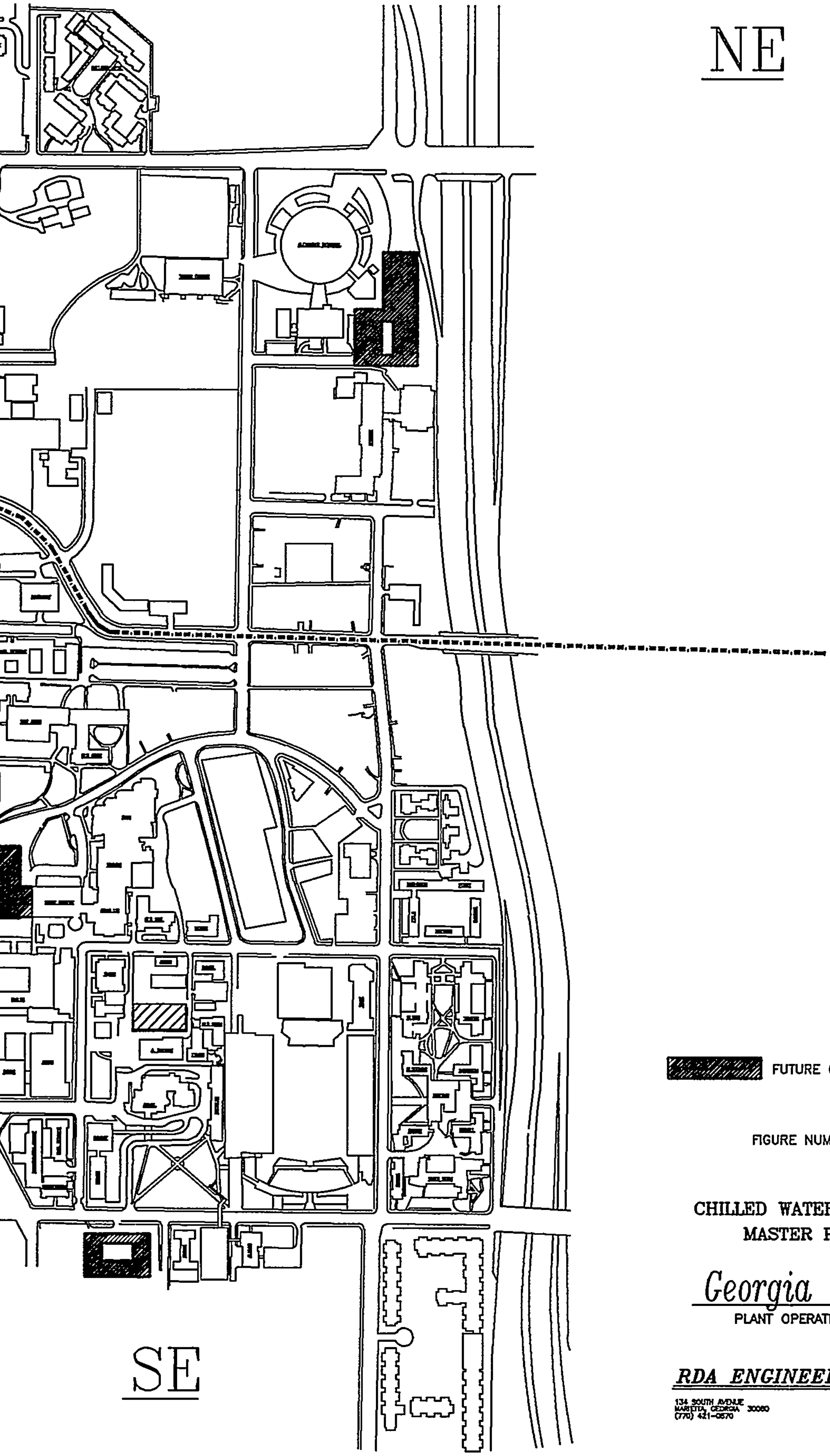

FUTURE CONSTRUCTION

FIGURE NUMBER 7

CHILLED WATER SYSTEM
MASTER PLAN

Georgia Tech
PLANT OPERATIONS

RDA ENGINEERING, INC.

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MAY 15, 1996

CENTRAL SYSTEM OPERATION

Within the Georgia Tech campus, there is a diversity of building uses which range from residential buildings to office areas and academic classrooms. There are also 24 hour per day computer system operations and critical laboratory requirements. The majority of operations, however, can be categorized as residential, office/academic and general research activities.

Traditional campus operation has required twenty-four hour per day operation of the steam distribution system to provide space heating and cooling requirements, humidification and domestic hot water heating. Minor process uses for cooking and some laboratory experiments are also served. Steam is provided continuously from the central plant location in the southeast quadrant of the campus.

The main chiller plant is operated during summer months to service academic and residential facilities. During winter months, building air-side economizer cycles provide necessary space conditioning. Where twenty-four hour per day refrigeration is required, independent or back-up systems have been installed to operate without connection to the central chilled water system.

At the central chiller plant, chilled water supply temperature is varied according to outside air temperature with the chillers and pumps started and stopped in response to chilled water demand. Since the main chiller plant serves academic and residential facilities the system has been operated in an energy conscious fashion which sometimes results in higher than desired space temperatures. Operation in this way has resulted in lower utility costs for the University.

The growing demands of contract research operations, however, require reliable chilled water service throughout the year. In some cases, these facilities require twenty-four hour per day operation. All contribute financial support from their research contracts. Development of the satellite chiller plant in the northwest quadrant of the campus specifically envisioned this facility providing baseload chilled water to existing and new research buildings constructed at the northern edge of the campus.

Long term development of the central chilled water system coupled with revisions to building chilled water system connections and building submetering of the chilled water usage may allow the entire campus to enjoy chilled water services year round. This will depend on appropriate billing mechanisms and the ability to substantially reduce energy use at low refrigeration loads.

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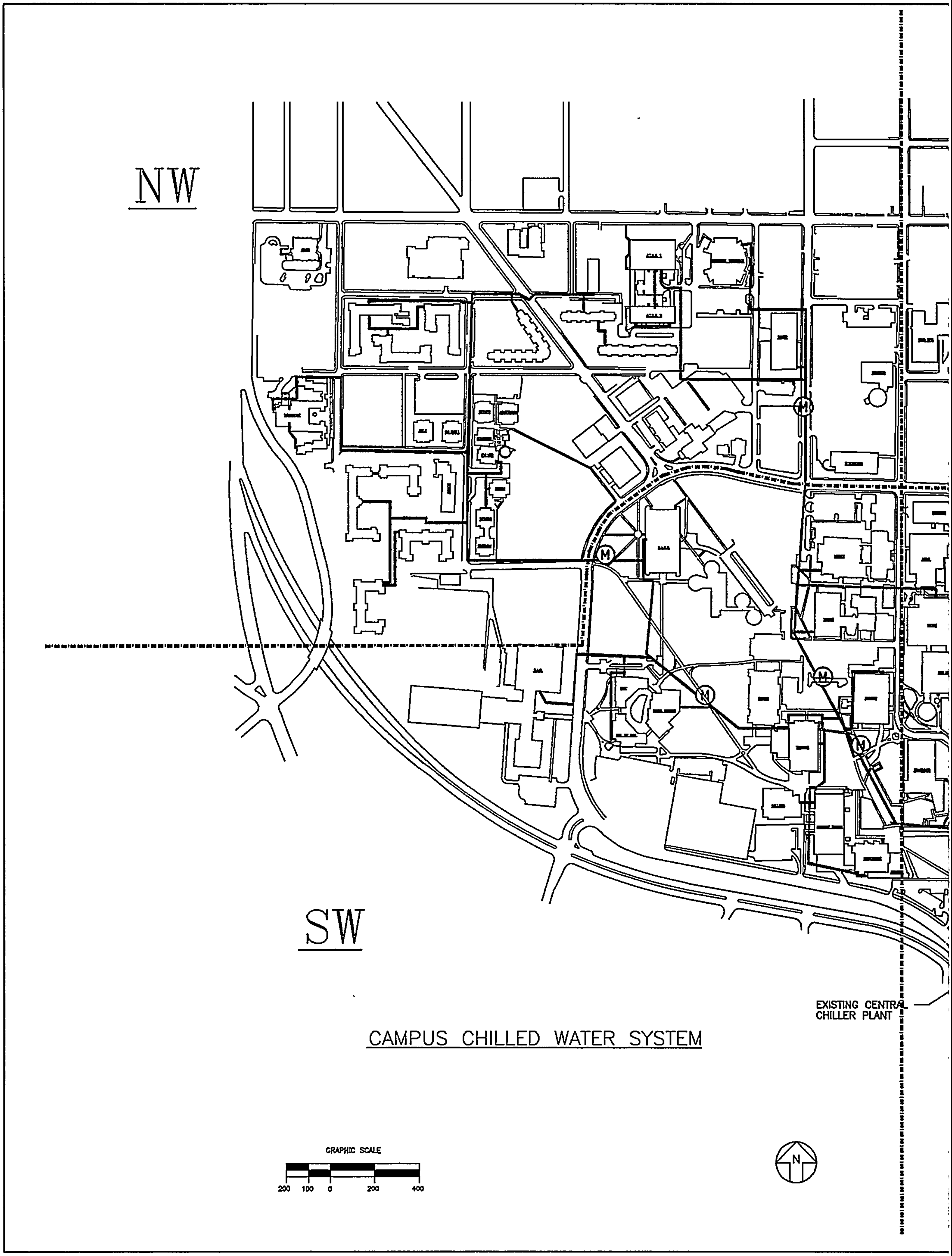
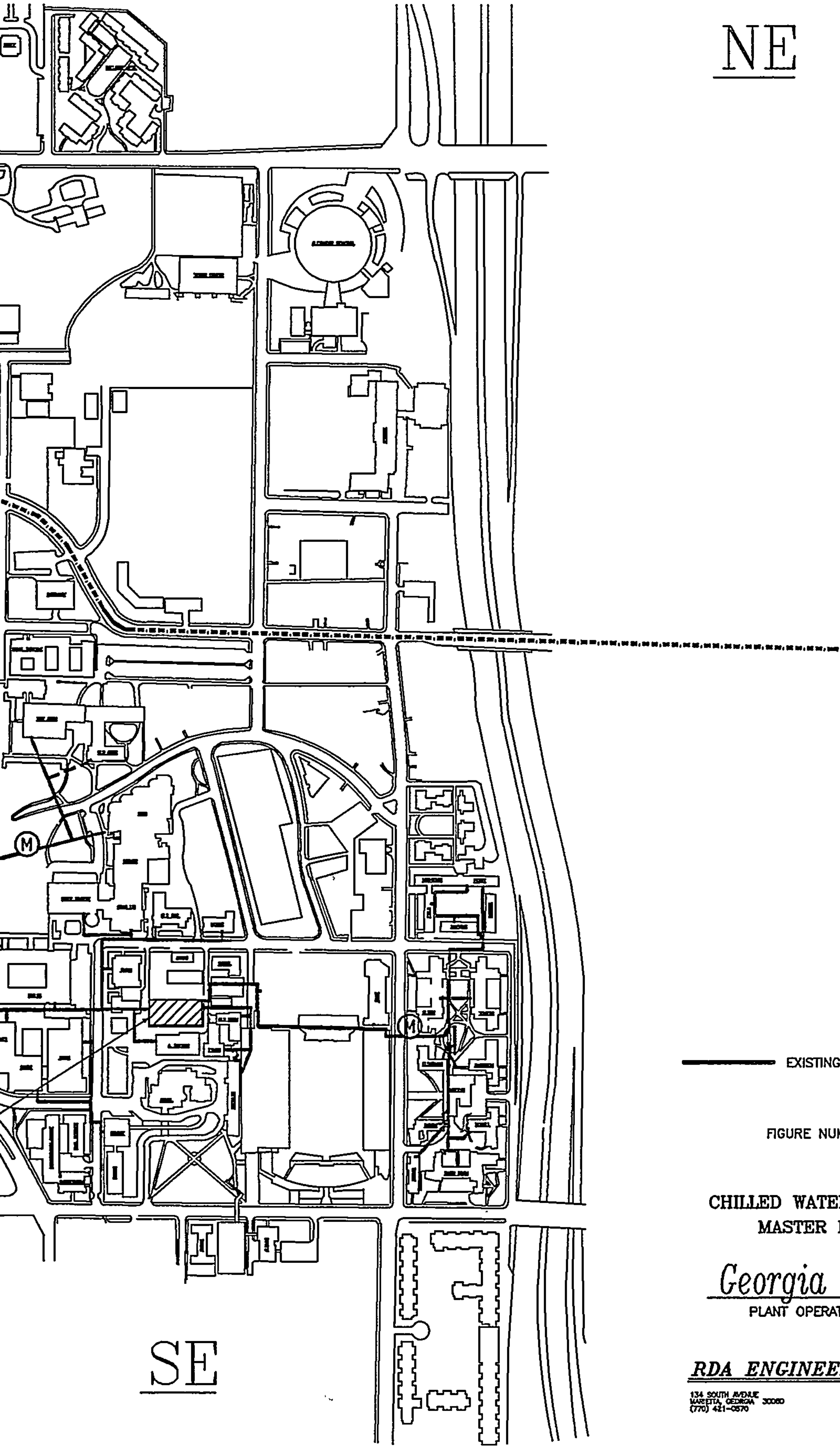


CAMPUS CHILLED WATER SYSTEM



EXISTING C.W. PIPING

FIGURE NUMBER 8

CHILLED WATER SYSTEM MASTER PLAN

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amount of cooling load and using available pump horse power rapidly at peak load conditions.

In addition to general pressure and flow problems throughout the distribution system, certain campus buildings experience specific problems. This may include reverse flow or unusually low supply water temperatures. Causes of these problems may include incorrect supply and return connections from the distribution system, cross connections between supply and return piping or pressure transients caused by building distribution pumps. Since the campus is in dynamic operation at all times these problems are sometimes difficult to isolate and define.

Flow Monitoring

In 1992, the Georgia Tech facilities department initiated a flow monitoring program to install nine flow monitoring stations for the purpose of measuring water flow, direction of flow and temperature of chilled water in the distribution piping. This system was based on ultrasonic flow meters with temperature sensors connected to the campus computer control system. The system was installed in 1993 and operated during portions of 1993, 1994 and 1995 (Figure No. 9). Unfortunately, problems with the system integration and data recording have hampered the effort to obtain meaningful distribution flow information. Preliminary flow data from one of the monitoring stations is included in the appendix for review. This project will probably be revised and reinitiated for data collection at a fewer number of stations.

Corll Model

In addition to the monitoring study, a computer simulation of the chilled water distribution system was undertaken using the "CHYLSYM" computer program provided by Numerical Engineering, Inc. and conducted by Dr. James A. Corll. A description of this computer program and output from the primary computer simulation is included in the appendix for review.

The model used by Dr. Corll is complex and has the ability to simulate pumps, chiller controls and control of building air handling unit coils. Input of the model is tedious and requires significant detailed information for each building, pump, control valve and pipe.

The Georgia Tech campus distribution system required 715 pipe sections, 579 nodes and included 61 constant speed pumps. Both the input and interpretation of the output results are not user friendly. The original purpose of the Georgia Tech computer model was to provide a basis for building additions and changes to the distribution system, pumps and building connections.

At this point, it is unclear whether the results of the simulation provide conclusive data on which to base system changes. As with all computer models of water distribution systems, it is extremely difficult to match actual pressures, flows and temperatures of the operating system with the computer model. It should be noted, however, that the computer model developed during this work effort can be used to evaluate flows and parts of the distribution system including the complex interaction of series pumps and control valves.

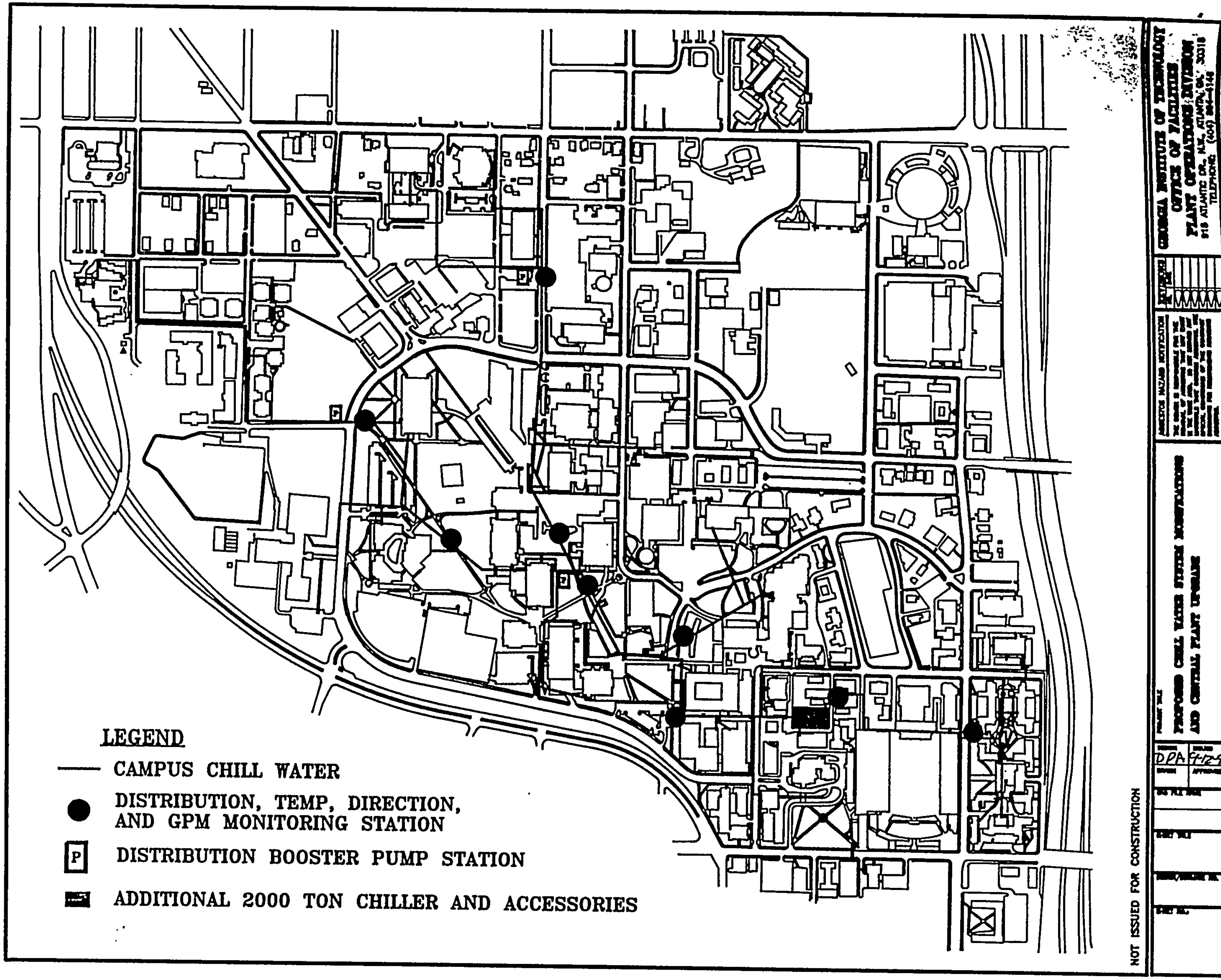
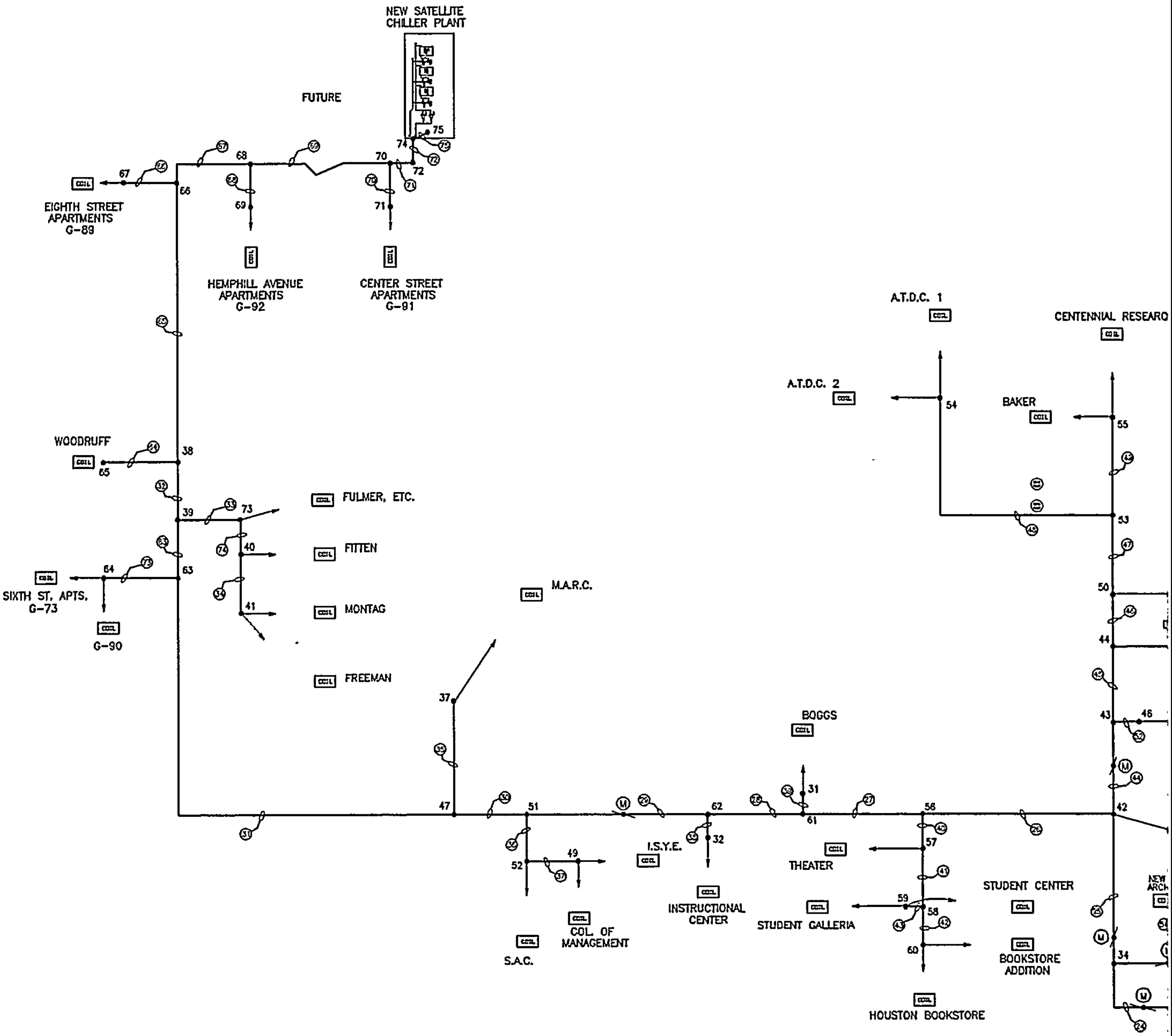

LEGEND
CAMPUS CHILL WATER
DISTRIBUTION, TEMP, DIRECTION, AND GPM MONITORING STATION
P
DISTRIBUTION BOOSTER PUMP STATION
ADDITIONAL 2000 TON CHILLER AND ACCESSORIES
NOT ISSUED FOR CONSTRUCTION
GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF FACILITIES
PLANT OPERATIONS DIVISION
PROPOSED CHILL WATER SYSTEM MODIFICATIONS AND CENTRAL PLANT UPGRADE
DPA

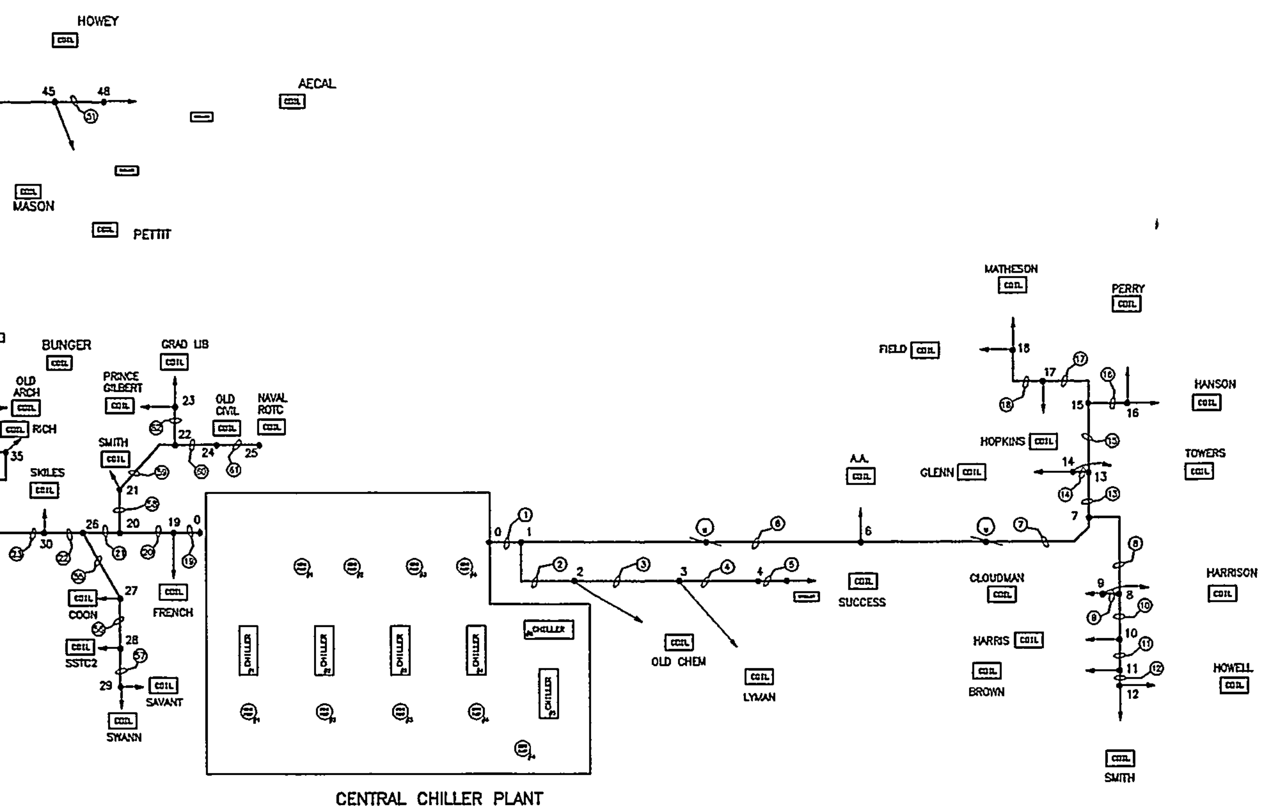
Figure No. 9

RDA Engineering Model

To provide an alternate evaluation of the distribution system, RDA Engineering used a proprietary piping analysis model developed for distribution system evaluation and design. This model is described in detail in the appendix along with computer printouts of several different computer runs. A primary difference between the RDA model and CHYLSYM model is that RDA's model specifies flow rates into buildings without an attempt to model the coil and control interaction within the building. In other words, RDA's model, evaluates only the flow and pressure losses of the distribution system given a required pressure difference at the "worst" case building. The RDA model is not as detailed as the Corll model and is somewhat easier to input, however, it has not been made user friendly at this point in its development. Output from the RDA Engineering model was transferred to a LOTUS spread sheet format so that it could be graphed or evaluated further. One advantage of the RDA model is that it can be used to simulate major distribution changes quickly and can be used to evaluate the operation of the satellite chiller plant connected to the main campus distribution system. It can also be used to simulate the location of a storage system quickly and easily. Figure No. 10 is a node diagram of the system input for the RDA model.



RDA COMPUTER FLOV



ODEL

FIGURE NO. 10

CHILLED WATER SYSTEM
MASTER PLAN
RDA COMPUTER FLOW MODEL

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NORTHWEST CAMPUS INTEGRATION

The satellite chiller plant constructed in the northwest quadrant was strategically located between the residential complexes built during the 1994-1996 time period and the research building area located along the northern part of the campus. Existing research buildings in this area which are served by the central chilled water system are located at the extreme reaches of the central campus chilled water distribution piping. It is doubtful that further extensions of the main campus chilled water system can be implemented in a cost effective fashion in this area unless the satellite system is integrated with the main campus system.

A logical development of the chilled water distribution system is to extend piping from the satellite chiller plant site east through the area of existing research activities and in the direction of planned research buildings. The chilled water system can be connected in a loop arrangement to the main campus system providing chilled water from either direction. A goal should be to operate the satellite plant and the main chiller plant together to feed the distribution system loop. Figure No. 11 illustrates the area in proximity to the satellite chiller plant with existing lines and service connections. Table IV is a summary of possible chilled water loads which can be served from the satellite chiller plant.

The Georgia Tech Plant Operations office has evaluated piping extensions and a chiller addition to the satellite plant. Cost estimates for a single chiller addition range from $1.07 million for 1,500 tons to $2.43 million for 3,000 tons. Initial piping distribution cost is estimated at $824,000. Copies of cost estimates are included in the Appendix.

RDA recommends that a 24" chilled water supply and return piping extension be made from the satellite chiller plant to a connection point with the 8" chilled water lines at the Centennial Research Building. This extension will provide an immediate tie-in with the central campus chilled water system through the 8" chilled water lines to Centennial Building and 4" chilled water lines to the ATDC. Additionally, this will provide adequate pipe capacity in the eastern direction for future campus expansion. Additional piping expansion can take place as projects are identified.

Table IV

Satellite Chiller Plant Northwest Campus

Current Buildings Served by Plant	**AC Tons**
G-73: Undergraduate Living Center	400
G-89: Eighth Street Apartments	607
G-90: Sixth Street Apartments	450
G-91: Center Street Apartments	327
G-92: Hemphill Avenue Apartments	304
Woodruff	354
Area II Dorms	542
	2984

Existing Buildings (Possible Service)	
ATDC	125
CRB	400
Baker	415
ERB	225
	1165

Possible Future Buildings	
Future GTRI	500
Future GTRI	500
Nuclear Reactor	180
	1180

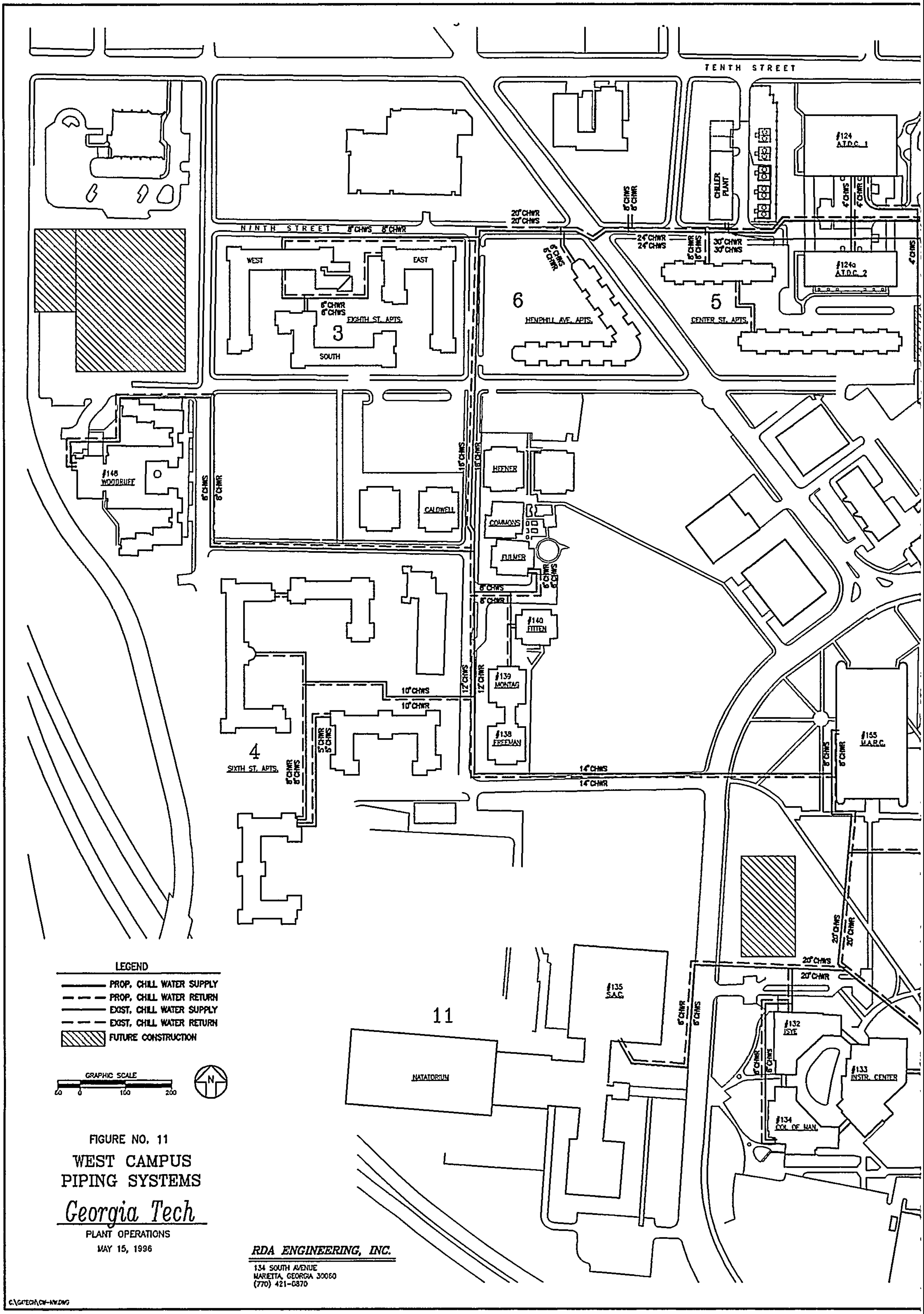

FIGURE NO. 11

WEST CAMPUS PIPING SYSTEMS

Georgia Tech

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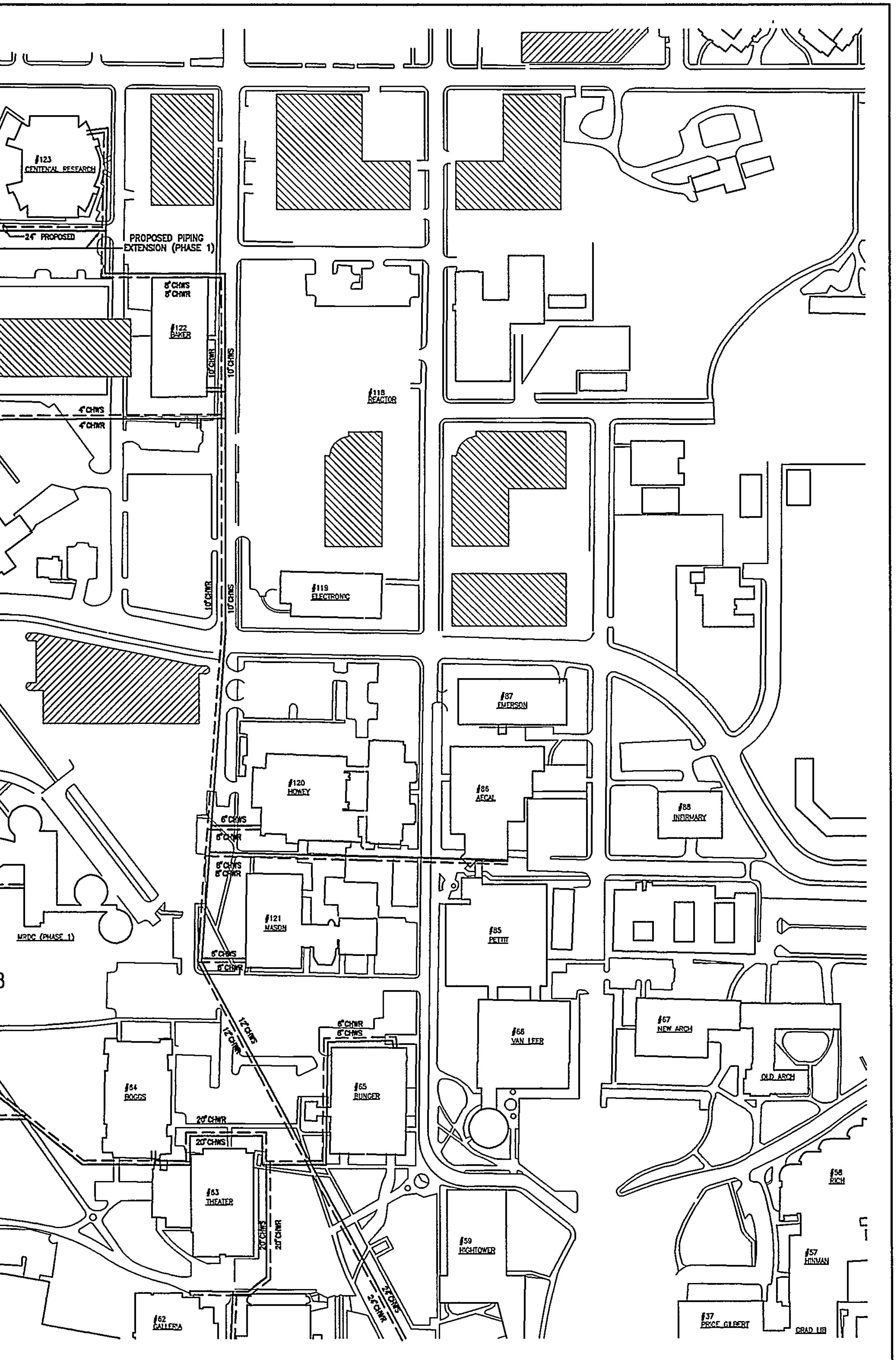


#123 CENTENNIAL RESEARCH
24" PROPOSED
PROPOSED PIPING EXTENSION (PHASE 1)
8" CHWS
8" CHWR
#122 BAKER
10" CHWR
10" CHWS
4" CHWS
4" CHWR
#118 REACTOR
#119 ELECTRONIC
10" CHWR
10" CHWS
#87 EMERSON
#120 HOWEY
#86 AECAL
#88 INFIRMARY
6" CHWS
6" CHWR
6" CHWS
6" CHWR
#121 MASON
MRDC (PHASE 1)
6" CHWS
6" CHWR
#85 PETTIT
#67 NEW ARCH
#66 VAN LEER
OLD ARCH
12" CHWS
12" CHWR
8" CHWR
8" CHWS
#54 BOGGS
#65 BUNGER
20" CHWR
20" CHWS
#63 THEATER
20" CHWS
20" CHWR
#59 HIGHTOWER
#58 RICH
#57 HINMAN
24" CHWS
24" CHWR
#62
#37 PRICE GILBERT
GRAD LIB

CHILLER ADDITIONS/CHILLED WATER STORAGE

Load projections indicate the need for 5,000-6,000 tons of refrigeration for planned expansion over the next 15 years. The majority of this requirement will be located at the northern part of the campus to support research and office facilities. Current plans call for serving northern research buildings from the satellite chiller plant constructed in 1995. The satellite plant is designed for an ultimate output capacity of approximately 8,000 tons and has two machines totaling 3,000 tons installed at this time. A spare bay in the satellite plant building can accommodate one additional machine with capacity up to 3,000 tons. Future machines will require building additions.

Campus refrigeration requirements can be met through the addition of new refrigeration machines, use of existing machines in combination with thermal energy storage, rehabilitation of existing machines which are currently not used and energy conservation activities.

Addition of new refrigeration machines is relatively straightforward in the case of the satellite chiller plant. Additional refrigeration machines located at the central campus chilled water plant would be difficult due to space limitations. As part of RDA's evaluation of the eastern portion of the campus, we have suggested that the eastern dormitories be interconnected with University Apartments to form a residential chilled water service area. This action would free approximately 900 tons in the main campus chiller plant for service to the existing and future loads in the central campus area. Approximately 900 tons of additional refrigeration could be added to the University Apartment central plant to facilitate this arrangement.

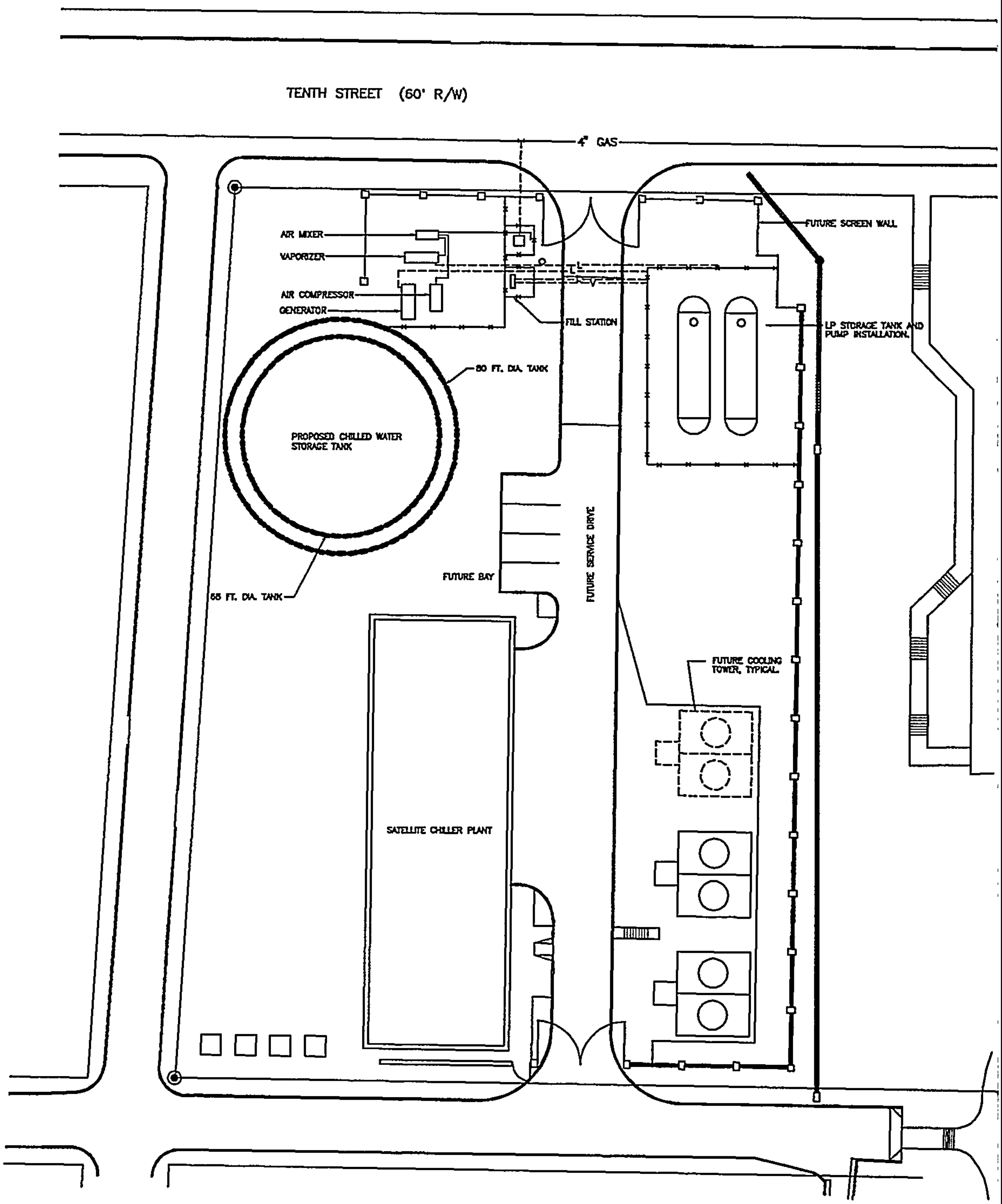
Additionally, RDA Engineering has recommended that standby building chillers located in the Pettit, Bunger and Howey building totally approximately 900 tons be refurbished and interconnected so that they can be used in a peak load or emergency situation.

Chilled Water Storage Evaluation

Another method of meeting the peak refrigeration requirements is to combine new refrigeration machine capacity with chilled water storage. RDA has explored this concept applied to the satellite chiller plant site and believe the application offers an excellent opportunity to reduce costs and conserve energy.

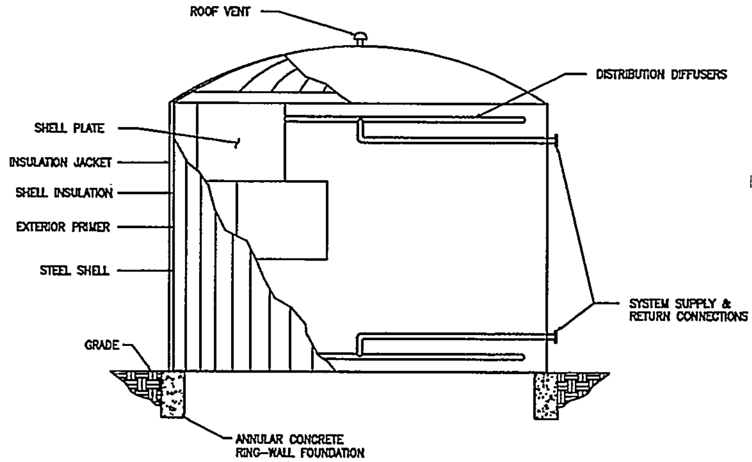
The concept of thermal storage for air conditioning systems has been used since the earliest days of air conditioning. Early systems made ice which could be melted during peak cooling load periods to produce chilled water. Today, ice storage is used in both campus systems and individual building air conditioning systems where economics are favorable. In the past ten years, storage of chilled water has been applied in numerous campus situations by using a large insulated water storage tank designed with water distribution headers to promote stratification of cold water.

Operation of a stratified chilled water storage tank is simple and requires no special low temperature refrigeration, formation of ice or problems associated with melting stored ice. The principle disadvantage of chilled water storage is the large tank area required to store the volume of water required.



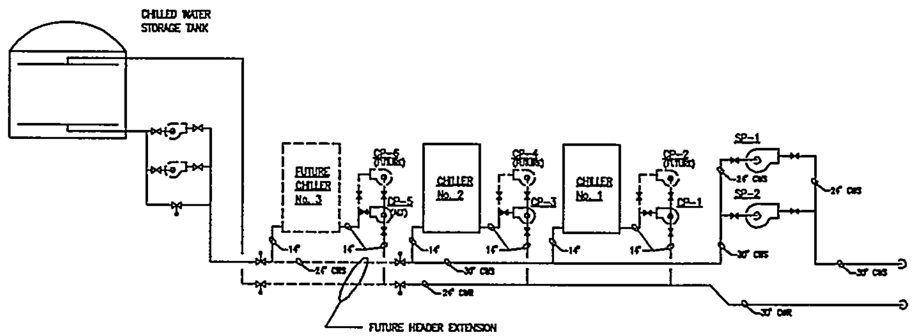
1/M-1 SITE PLAN – SATELLITE CHILLER PLANT & THERMAL STORAGE TANK

SCALE: 1"=20'



TANK DIMENSIONS			
DIAMETER	HEIGHT	GALLONS	TON HRS @ 20° F
68'	64'	1,725,200	20,000
80'	48'	1,785,200	20,000

TYPICAL STRATIFIED CHILLED WATER
THERMAL ENERGY STORAGE INSTALLATION



GEORGIA TECH SATELLITE CHILLER
PLANT W/STORAGE PIPING SCHEMATIC

FIGURE NUMBER 13

CHILLED WATER SYSTEM
MASTER PLAN

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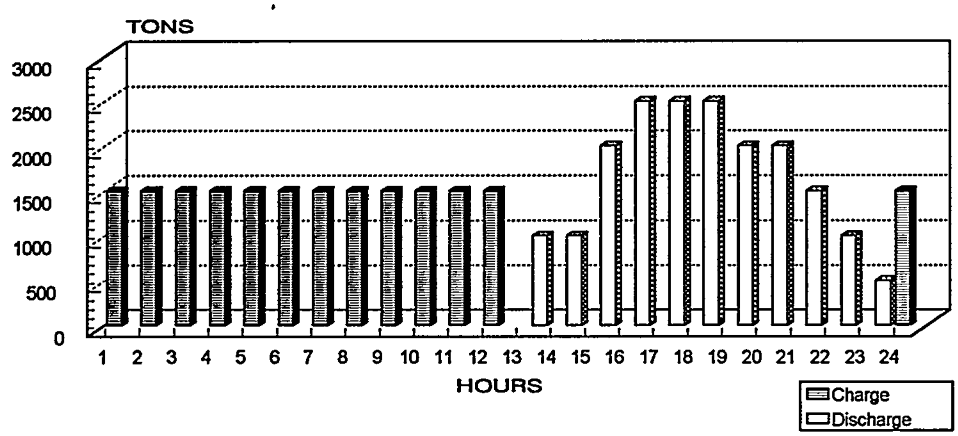
Consideration of chilled water storage for the Georgia Tech campus in the past has been unfavorable due to the electric rate structure for electric energy from the Georgia Power Company. Recently, however, a new rate structure based on real time pricing has been adopted by Georgia Tech. The new electric rate structure allows the University to purchase electric energy at very low rates during off peak hours. Prices may be as low as 2¢/kilowatt hour during off peak times. During summer hours, prices rise to as much as 45¢/kilowatt hour during peak load times. No demand charge is imposed on real time pricing. As a result, it is possible to use electricity during off peak times to produce chilled water and store it with the intent of using the refrigeration effect to displace expensive electricity use during peak load times.

A unique condition of this utility rate is that it is applied to electric load growth beyond a specific base load profile. In Georgia Tech's case, the base load was established prior to Olympic construction and provides an excellent opportunities for future electric load management and chilled water storage in response to on-peak and off-peak pricing.

In order to evaluate a chilled water thermal storage application, RDA assumed that a chilled water storage tank would be constructed adjacent to the satellite chiller plant. Figure No. 12 is an illustration of the storage tank location, a typical storage tank arrangement and the proposed piping schematic for the satellite plant. It is assumed that an additional 2,000 - 2,500 ton chiller will be installed in the spare bay of the satellite plant and will be piped in a way that it can feed the distribution system or can separately charge the thermal storage tank. A tank volume of approximately 1,700,000 gallons was chosen which can provide up to 20,000 ton hours at a 20° temperature differential.

In operation, the chiller would be run continuously during off peak hours (approximately 13 hours per day) to produce 40° Fahrenheit chilled water for storage. During peak load times, the chilled water storage tank would be discharged and operate as a parallel chiller in the satellite plant piping arrangement. Using the profile in Figure No. 13, the chilled water storage tank would produce up to 2,500 tons per hour for delivery to the system. This arrangement would allow a peak output of 8,000 tons from the satellite plant site.

Figure No. 13
CHILLED WATER STORAGE TANK OPERATION



Using an hour by hour simulation and actual real time energy costs provided by the Georgia Power Company, RDA estimated that the operation of the chilled water storage tank would produce savings in the order of $52,000 per year at 1995 prices. Table V presents the results of this analysis using 1995, 1994, 1993 energy prices. Operation of the chilled water storage tank always produces favorable operating costs during summer months.

Table V
Electric Cost Savings - Storage

	Total	May	June	July	August	September	October
1995	$52,369	601	2,589	17,585	27,969	3,087	$538
1994	$11,284	417	4,122	2,404	2,201	2,070	$70
1993	$37,748	320	3,534	22,611	9,377	1,649	$257

Initial costs of chiller additions vs. chilled water storage are equally important. Georgia Tech estimates the cost of a 2,000 ton chiller addition (assuming no addition to the existing building) as follows:

Cooling Tower & Pump	$167,250
Chiller	622,500
Chiller Pump	15,750
Piping	100,000
Controls	20,000
Electrical	95,000
Engineering, Misc.	351,690
Total	$1,372,190

Unit Cost $686/ton

*RDA estimates approximately $80/ton additional expense if a bay is added to the building

RDA contacted two turnkey chilled water storage tank vendors and obtained an estimated price of $780,000 for the tank and site preparation. Allowing $250,000 for installation of piping, pumps, controls and engineering, a total cost of $1,030,000 is anticipated for a 1.7 million gallon chilled water storage tank system. RDA estimates the chilled water storage tank is approximately $885,000 less expensive than the addition of a fourth 2,500 ton chiller at the satellite plant site

and will result in annual energy savings proportionate to the differential in on peak, off peak real time energy prices.

RDA recommends that Georgia Tech pursue a more detailed thermal storage evaluation to look at daily load cycles and evaluate potential electrical energy cost savings during the 1996 summer cooling period. It may be advantageous to consider constructing a thermal energy storage tank prior to installing an additional chiller in the existing satellite chiller plant building.

SATELLITE SYSTEM EVALUATION

RDA used its simplified flow model to evaluate the campus wide distribution piping including the new dormitory area in the northwest quadrant of the campus which is served by the satellite chiller plant. Although the satellite plant is interconnected with the main distribution system, it is currently valved off and operates as a separate chilled water loop. Table VI is a listing of the buildings served by the separate loop and their required tonnage and GPM assuming a 10° Fahrenheit temperature difference.

The system was modeled both as an independent operating chilled water loop and in conjunction with the main campus system. Ultimately, integration of the satellite plant and northwest quadrant of the campus into the central distribution system requires construction of distribution piping in the east direction from the new satellite chiller plant. Additional flow model runs can be used to explore the desirability of chiller additions at the satellite plant site. Pressure distribution for the campus model is shown as Figure No. 14.

Table VI
Satellite Chiller Plant Building Service

Building	Tons	GPM
G-91 Center Street Apartments	305	732
G-92 Hemphill Avenue Apartments	330	792
G-89 Eighth Street Apartments	625	1,500
Woodruff Dormitory	350	840
Fulmer, Hefner, Etc.	330	792
Fitten	60	144
Montag, Freeman	98	235.2
G-73 Sixth Street Apartments	415	996
G-90 Sixth Street Apartments	437	1,048.8
Total	2,950	7,080

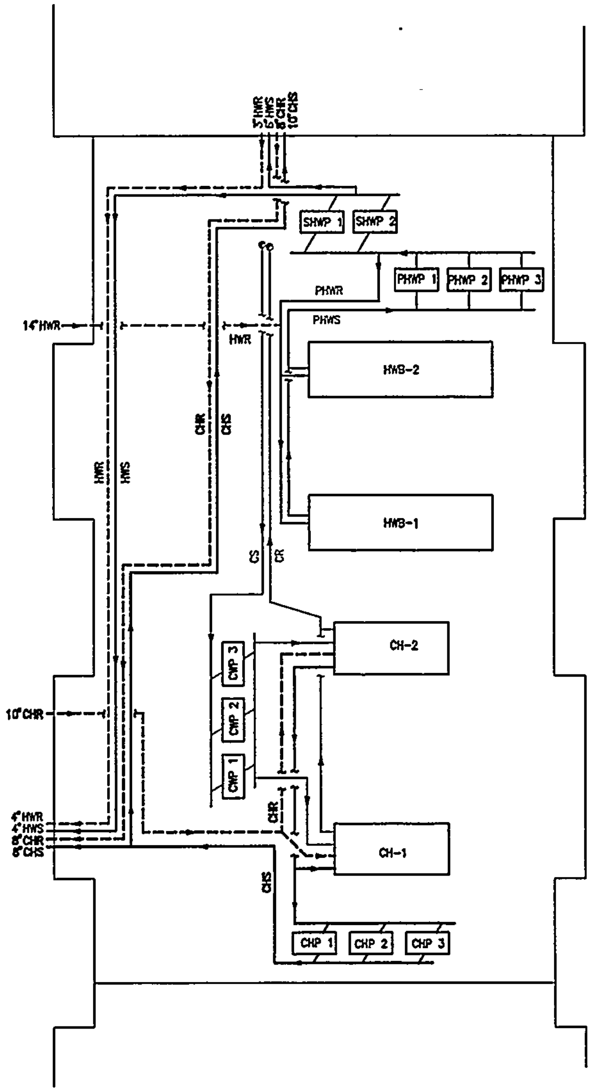
EAST SYSTEM EVALUATION

RDA used its simplified flow model to evaluate the distribution piping systems for piping located east of the central chiller plant. This system primarily serves dormitories located within the southeast quadrant of the campus. Table VI is a listing of the buildings served and their required tonnage and GPM assuming a 10° Fahrenheit temperature difference. Figure No. 15 is a site plan.

Table VI

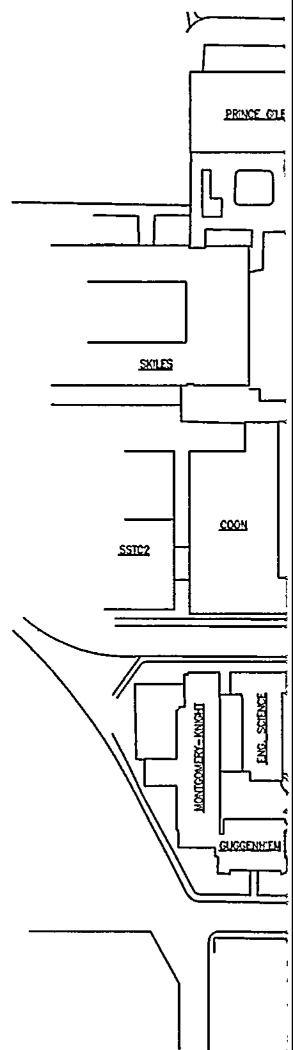
Building	**SF**	**Tons**	**GPM**
6 Smith Dorm	62,000	122	292.8
5 Brown	17,000	33.3	79.92
8 Howell	24,000	47.1	113.04
7 Harris	22,305	44.7	107.28
9 Cloudman	20,000	39	93.6
11 Harrison	29,300	57.7	138.48
13 Towers	48,000	93.4	224.16
12 Glenn	62,000	122	292.8
20 Success	40,000	125	300
41 Field	26,100	50.4	120.96
45 Matheson	30,800	60.9	146.16
44 Perry	22,200	43.1	103.44
43 Hanson	24,300	47.9	114.96
42 Hopkins	25,100	50.2	120.48
19 Lyman/Emerson	45,400	37.4	89.76
Old Chem Building		109.7	263.28
14 Edge Building		130	312
		1,213.8	2,913.12

The system was modeled using 18 pipes and 18 nodes. Figure No. 16 illustrates the calculated pressure along the piping route. A total dynamic pressure difference of approximately 40 psi is required to pump the required flow to all buildings in the area.



UNIVERSITY APARTMENTS CENTRAL PLANT SCHEMATIC

NOT TO SCALE



LEGEND

- HOT WATER RETURN
- HOT WATER SUPPLY
- CHILL WATER RETURN
- CHILL WATER SUPPLY
- POSSIBLE CHILL WATER RETURN
- POSSIBLE CHILL WATER SUPPLY

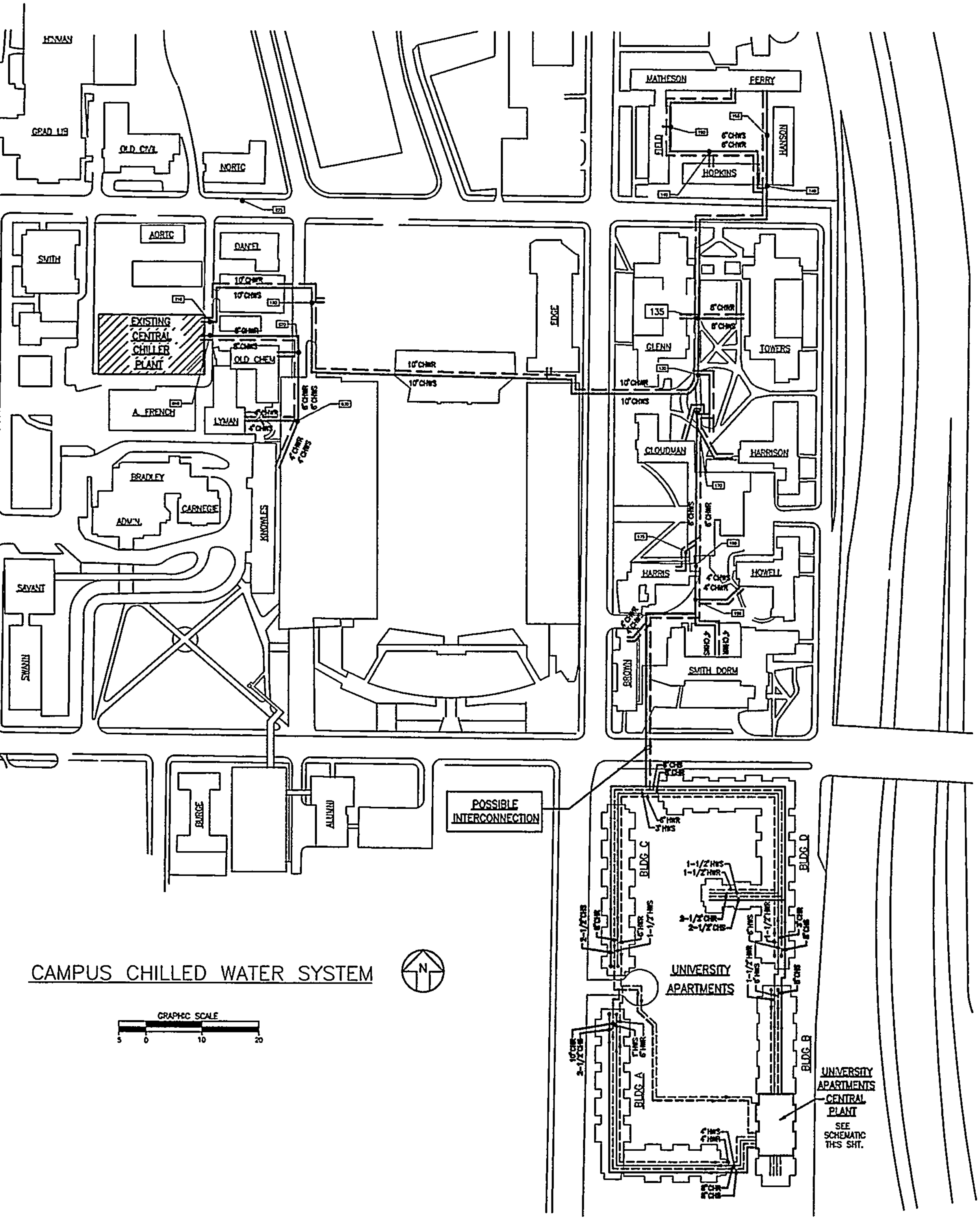


FIGURE NO. 15

POSSIBLE EAST DORMATORY INTERCONNECTION

CENTRAL PIPING SYSTEMS
UNIVERSITY APARTMENTS
VICINITY

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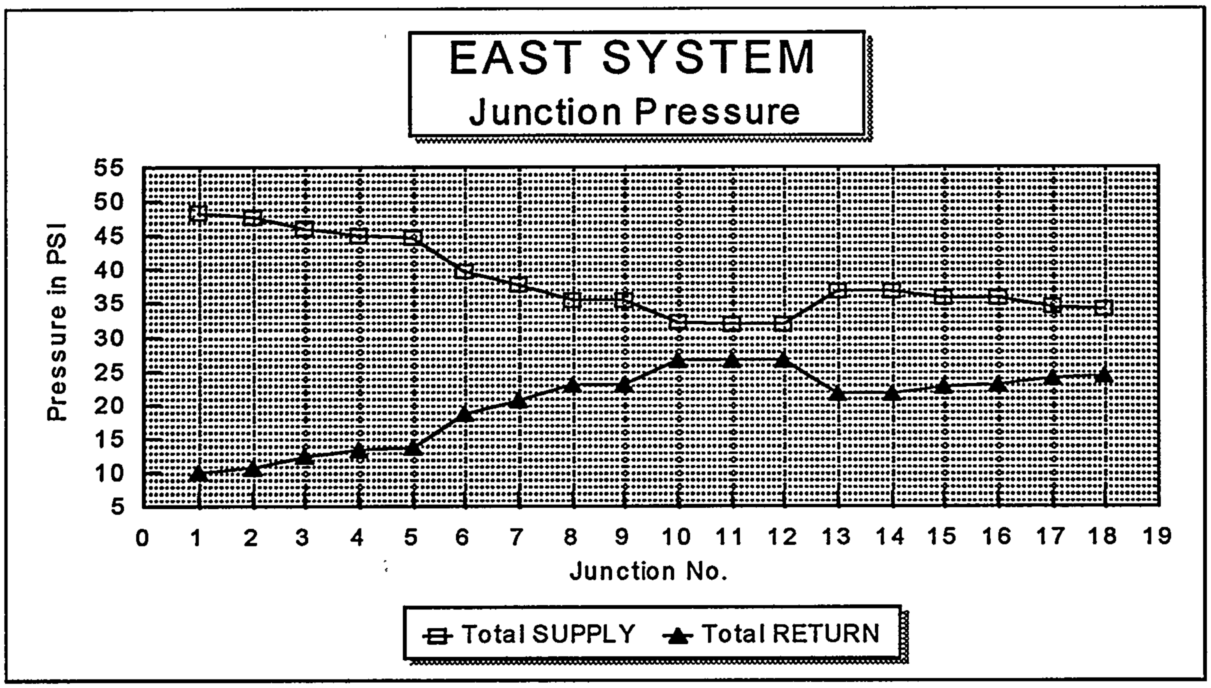
The limiting factor for the east dorm area appears to be flow required for dormitories adjacent to North Avenue. A review of the individual pipe flow rates indicate several pipes with high velocities which result in high pressure losses between the central plant and dormitory buildings. Since pump pressure is available at the chiller plant, this does not appear to be a serious problem at the assumed flow rates. Pressure losses could be improved by increasing the temperature difference at the buildings which would result in lower flow requirements.

The University apartments which have been constructed south of North Avenue represent a unique opportunity to integrate a satellite central chiller plant with the requirements of the existing dormitories in this area of the chilled water system. RDA recommends evaluation of connection of the existing dormitories to the University apartment system. This would allow a totally residential oriented system operation. Approximately 900 tons of refrigeration would be made available in the central chiller plant for service to academic/research buildings on the main campus or new construction.

RDA Engineering, Inc. has put together a model which can be used to evaluate this option once refrigeration load requirements of the apartment complex are determined. The existing University apartments central plant has 1,800 tons, in two 900 ton refrigeration machines. It is believed that additional tonnage can be added within the existing plant space. Piping modifications would be required to connect the two systems.

Figure No. 16



RECOMMENDATIONS

RDA's review of existing campus chilled water systems evaluation of future refrigeration requirements and discussion with the Georgia Tech staff have led to the following recommendations:

1. In order to integrate the satellite chiller plant with the central campus, a 24" supply and return main should be installed from the chiller plant to a point near the Centennial Research Building. This will allow interconnection with the main campus system through the 8" line serving the CRB and the 4" line serving ATDC. This project should be considered Phase I of expansion in the eastern direction. Future expansion will depend on research building growth and building locations. - Budget Estimate $380,000

2. RDA recommends that a building by building chilled water connection evaluation be conducted in order to verify piping connections, sizes, valving arrangements and automatic control functions. This building by building evaluation will develop suggested modifications to the three way valving connections which will foster higher temperature differentials and reduced interaction between the building and main distribution piping. This evaluation can also be used to develop costs and prioritize building piping renovations. - Budget Estimate $20,000

3. In order to provide peak chiller capacity and limited back-up, we recommend that a complete evaluation of existing chillers in buildings such as the Pettit, Howey and Bunger building be conducted in order to suggest refrigerant conservation measures and appropriate renovations for reliable service. This will include developing a maintenance and operating plan which allows these units to be placed in standby status during non-summer months and brought back on line within 4-8 hours when needed. - Budget Estimate $4,000

4. Due to implementation to real time pricing electric rate structure, the use of chilled water storage appears to be cost effective. In order to fully evaluate the use of chilled water storage, we recommend that a more detailed study be conducted to determine daily load profiles and interaction with campus electric load profile. This will require hourly supply and return chilled water temperatures and flow rates from both the central chiller plant and satellite plant during a representative summer service period. Optimization of a chiller addition and thermal storage system can be conducted and the economics fully documented. - Budget Estimate $15,000

5. Cooling tower renovations or replacement at the central chiller plant should be implemented in order to provide condenser water for the 8,000 tons of refrigeration available. - Budget Estimate $950,000

6. We recommend that the plant operations department consider developing a more user friendly distribution system model based on the RDA Engineering simplified

computer model which can be used to easily plan building additions or deletions from the central chilled water piping system. Work efforts include developing a specific Georgia Tech input and output program module and verifying flow rates predicted by the model with the ongoing chilled water flow monitoring project. - Budget Estimate $15,000

7. In order to free up additional tonnage in the central chiller plant and create a primary residential chilled water system, we recommend a more detailed evaluation of the interconnection of the University Apartments chiller plant and with the dormitory system with the chilled water piping serving the dormitories on the eastern portion of the campus. - Budget Estimate $7,500

8. Consider the use of heat regenerated desiccant systems to reduce humidity in selected buildings. Use of this technology can reduce peak air conditioning requirements and the use of reheat. Increasing outside air requirements due to upgraded codes may make this technology useful especially where the existing Georgia Tech steam system can be used as a regeneration source. - Budget Estimate - N.A.

9. Consider long term redevelopment of the existing steam system into a hot water distribution system by creating hot water satellite networks at the perimeter of the existing steam lines. As these satellite networks grow back toward the main central steam plant, they will reduce energy loss and create a viable long term central heating system. - Budget Estimate - N.A.

APPENDIX

LOCATION	NUMBERS	13/OCT/93	CAMPUS GSF	STEAM GSF	CHILLED WATER GSF
W8	3	Burge	63,000	63,000	
R11	35	Skiles	137,200	137,200	137,200
W7	2	ROBERT Alum/	23,300	23,300	
X4	1	McDaniel			
		BRGE PRK DCK			
U4	6	Smith DOEM	62,000	62,000	62,000
V4	5	Brown	17,000	17,000	17,000
		PTR PRK DCK			
K19	155	MANUF RSCH	119,797	119,797	119,797
U3	8	Howell	24,000	24,000	24,000
U4	7	Harris	22,305	22,305	22,305
T4	10	Brittain Din	15,200	15,200	
T4	9	Cloudman	20,000	20,000	20,000
T3	11	Harrison	29,300	29,300	29,300
R3	13	Towers	48,000	48,000	48,000
R4	12	Glenn	62,000	62,000	62,000
	16	DODD STDM/Gr	28,000		
R5	14	EDGE (TP ADJ)	66,400	66,400	80,171
R6	15	HEISMAN GYM	47,626	47,626	
		348 10TH	2,295		
R7	17	190 3RD ST Office	12,300	12,300	
R8	18	Daniel Lab	19,800	19,800	
R8	25	Military	14,000	14,000	
R9	36	D M Smith	35,200	35,200	35,200
S10	26	CHAPIN Dean	7,500	7,500	
S9	24	HOLLAND Powe	34,000		
		ACTF Solar S	2,350		
		Old Ch E	10,500	10,500	
S8	19	LYMAN/EMERSO	45,400	45,400	
S9	23	A French	32,200	32,200	32,200
		POST OFFICE	5,576	5,576	5,576
		CON ED #98	16,844	16,844	
I5	159/98	O'keefe-MAIN	108,350		
E21	150	ORGT	3,600		
T9	22	Administration	43,000	43,000	
T8	21	Carnagie	10,100	10,100	
T8	20	SUCCESS/KNOW	40,000	40,000	40,000
U10	27	Savant	21,479	21,419	21,419
U10	28	Swann (part)	12,602	12,602	26
V10	29	Guggenheim	20,000	20,000	
U10	31	E S M	38,000	38,000	
		CON ED #38	1,681	1,681	1,681
		#39	10,198	10,198	10,198
P13	59	HIGHTOWER TE	82,000	82,000	
	34	J S Coon	66,600	66,600	66,600
H19	126	BERINGAUSE P	9,266		
U10	33	M E Research	9,892	9,892	
		Research II	24,617		
		STDNT CNTR D			
P9	57	Hinman	16,700	16,700	
O9	58	Rich	77,920	77,920	94,620
	19A	C E Lab HIGH	46,400	46,400	
		SAC FEILD HO	600		
O19	133	Inst. Center	40,360	40,360	40,360
N20	132	GROSECLOSE I	53,600	53,600	53,600
O20	134	COLLEDGE O MG	49,000	49,000	4,900
Q9	38	Old C E	32,918	32,918	
Q8	39	NROTC ARM	10,576	10,576	10,576
L11	84	Naval Rsrv.	48,929		
D19	124	ATDC-North	39,200	39,200	39,200
F19	124	ATDC-South	39,100	39,100	39,100

LOCATION	NUMBERS	13/OCT/93	CAMPUS GSF	STEAM GSF	CHILLED WATER GSF
		ATDC STATION	210		
	162	GRAD LV CTR	114,000		
		POD SHOP	6,456		
		PPD STOR	3,200		
J12	87	Emerson	66,325	56,425	
		Emerson GTRI	5,275	5,275	
		GAGE WAREHO	8,700		
		GROUND GREEN	4,800		
		CHANDLER STD	10,000		
		KING POD ADD	4,800		
B10	114	Callaway Apr	144,400		
E10	111	President's	7,700		
		Britton T-ro	1,900	1,900	
E6	102	Alex Mem col	93,000		
		Bradley	83,000	8,300	
M11	67A	Architecture	52,000	52,000	52,000
N10	67B	Architecture	71,500	71,500	
Q10	37	Gilbert (Old)	96,500	96,500	96,500
		Research Are	15,792		
I14	119	ERB	63,400	63,400	
F8	103	Tennis Cente	25,956		
K15	120	Howey Physic	140,600	140,600	140,600
K11	88	Infirmary	24,600	24,600	
F13	110	King PPD	35,579		
S12	32	WEBER SST #	50,800	50,800	50,800
N13	66	Van Leer EE	159,820	159,820	
N14	65	Bunger-Henry	142,200	142,200	
G14	118	Neely Nuclea	38,000	38,000	
		AA lecture	1,536	1,536	
		AA ANEX T-cl	2,600	2,600	
Q4	41	Field	26,100	26,100	26,100
P4	45	Matheson	30,800	30,800	30,800
P3	44	Perry	22,200	22,200	22,200
Q3	43	Hanson	24,300	24,300	24,300
Q3	42	Hopkins	25,100	25,100	25,100
		FIBER OPTIC	2,100		
		Hemphill CNT	22,059		
H19	125	Ajax placmen	10,600		
T11	32	WEBER SST #	18,156	18,156	
F16	122	Baker	103,582	103,582	114,707
		Graduate (New	121,385	11,385	121,385
		Photo lab	16,915	16,915	18,732
U11	30	Knight	55,700	55,700	55,700
		A E Lab	10,600	10,600	10,600
N16	64	Boggs	146,500	146,500	146,500
Q15	61	Wenn Student	74,145	74,145	89,523
Q16	62	Wenn (ARA)	23,205	23,205	28,018
		Wenn (aux)	13,150	13,150	15,877
H23	142	Commons	7,100		
I23	141	Fulmer	15,600		
H23	144	Hefner	22,300		
H22	143	Armstrong	22,300		
H23	146	Caldwell	28,700		
H24	147	Folk	28,700		
L15	121	Mason C E	93,800	93,800	93,800
B11	115	Healy Apts	54,200		
		PROPOERTY CNT	1,200	22,343	
R14	60A	HOUSTON Old	22,343	22,900	22,343
R13	60B	HOUSTON NEW	22,900		22,900
I24	145	COUCH	31,335		
K23	138	freeman	23,462		23,462
J23	139	Montag	25,538		25,538
J22	140	Fitten	29,394		29,394

LOCATION	NUMBERS	13/OCT/93	CAMPUS GSF	STEAM GSF	CHILLED WATER GSF
I17	128	Environ safe	4,038		
		Grounds	8,555		
O22	135	CALLAWAY STU	116,600	116,600	116,600
H27	148	Woodruff-Hou	113,941		113,941
G27	148	Woodruff-Kit	17,251		12,076
I27	148	Woodruff-Lau	1,508		1,508
	4	Wardlaw	82,000		
F5	100	JAMES LUCK	12,250		
F6	101	personell	6,600		
D27	151	SREB	20,000		
D17	123	CRB (TP ADJ)	191,000	191,000	230,613
		WASTE Storag	3,000		
		729 Britt (AD	2,400		
		GROUNDS PRD	1,000		
		171 5TH (ACO	2,800		
		176 5TH (DST	2,500		
		563 8TH (AGD	1,150		
		328 10TH (F/	3,400		
		388 10TH (F/	1,200		
		STOR ROOM AN	6,500		
		949 STATE (F/	1,700		
		363 PTREE (F	600		
		267 ROBIN HO	3,900		
		STEAM SHOP	1,200		
		BLDG 1	20,000		
		BLDG 3	40,000		
		BLDG 4	25,000		
		BLDG 5	40,000		
M13	85	PETIT MRC	95,268	95,268	95,268
K13	86	COC AECAL	118,904	118,904	118,904
		490 10TH ST	16,148		
		PHYS PLNT BO	1,200		
		741 BRITTAIN	2,642		
		STD SERVICES	41,590		
		GALLERIA THE	37,073		
		TOTAL	5,672,817	3,895,823	3,092,818
		% OF TOTAL	100%	73%	58%
			CAMPUS	STEAM	CHILLED WATER

RDA ENGINEERING, INC.
Computer Flow Model

RDA FLOW ANALYSIS MODEL

In order to analyze the system dynamics of the Georgia Tech cooling network, RDA Engineering used their in-house piping network computer program. The program utilizes the Darcy Weisbach friction loss calculation in determining pipe head loss and can therefore model the pressure characteristics of any given pipe configuration This ability becomes extremely valuable when dealing with large scale hydronic systems. The following is a discussion of the input, output and operation of the computer program.

First, the user must specify and input the overall system characteristics, including pipe diameters, roughness, minor losses, and pump curves. Second, the user must specify any required f lows at building nodes and where they occur. Third, a minimum end point pressure required to induce flow through the last building load is input. Fourth, the computer then analyzes the junction and pipes upstream from the end pressure point and calculates the pressure at each junction, the head loss through each pipe, and the resulting flow through each pipe.

From this, the user can then determine the total head loss in pumping a certain amount of water through the piping system while maintaining a desired pressure difference at the endpoint. The user can use this reference analysis to adjust and optimize the flows and line sizes between the pump and system buildings.

DATA REQUIREMENTS

Pipe System Configuration

All pipe systems can be described in terms of junctions, primary loops and terminal energy points in the system. The end points of pipes are called nodes, and the nodes are classified either as a junction or a terminal energy point. Prior to data preparation the junctions, primary loops and terminal energy points must be identified and are defined as follows:

junction:	a node where two or more pipes meet or where flow is put in or removed from the system.
primary loop:	a closed pipe circuit with no closed pipe circuits contained within it.
terminal energy point:	a node in the system where both the pressure and elevation are known.

If the junctions, primary loops, and terminal energy points are identified as described above, the following holds for all pipe systems:

$$p = j + l + t - 1 \qquad (1)$$

where p = number of pipes

j = number of junctions

l = number of loops

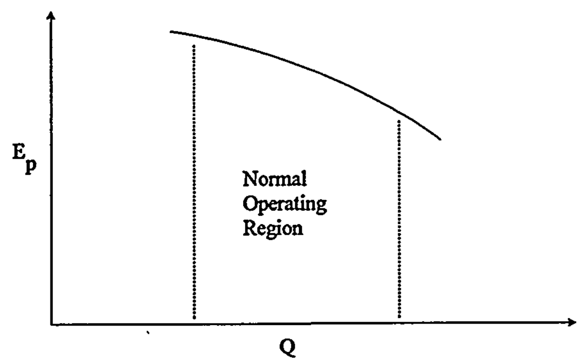
t = number of terminal energy points. (TEP's)

PIPE SYSTEM COMPONENTS

Data regarding the physical characteristics of the components in the pipe system must be obtained prior to making an analysis. This includes the following information:

Pipes -The length, inside diameter and roughness of each pipe must be input as data. The designation of pipe roughness depends on the type of head loss equation used. Because the properties of water vary significantly at -.medium to high temperatures (200° F and up), the Darcy Weisbach equation for head loss is the most applicable.

Pumps -A pump can be included in any line of the pipe system. The characteristics of pumps can be described in two ways. The power the pump puts into the system (in horsepower) can be specified. The power here refers to the useful power which is transformed into an increase in pressure head and kinetic energy of the liquid as it passes through the pump. Alternately, the coefficients of a parabolic characteristic curve may be specified. This curve represents a fit of the pump head--discharge data which is normally furnished by the manufacturer. A typical characteristic curve is shown below.



In the normal range of pump operation this relationship can be described closely by:

$$Ep = A + BQ + CQ^2 \qquad (2)$$

where Ep is the increase in pressure head at the pump and A, B, and C are coefficients of the fitted curve.

If the coefficients A, B, and C are not provided by the pump manufacturer they can be determined by choosing three operating points covering the expected range of operations where the flowrate and corresponding pump head are known and passing a second order curve through these points.

An alternate method of incorporating a pump into the system may be desirable if the analysis is to be made for a situation where the pump discharge pressure is to be specified or is fairly closely known. For this application the pump discharge is taken as a terminal energy point using the specified pump discharge pressure.

Finally, if a pump of unknown size is to be selected to input a specified amount of water into the water distribution system the pump station can terminate at a junction node. The desired inflow can be specified at this node and the analysis will compute the pump discharge pressure which would be required to produce the specified inflow. This is the primary method used in this evaluation.

Minor loss components - A number of components in a pipe system (such as valves, junctions, bends, meters, etc.) produce a head loss which may be substantial and should be included in an analysis of the flow distribution of that system. The need to include such losses depends on the relative importance of these losses compared to the line losses, and this judgment must be made by the user. These losses are included by using the concept of a minor loss coefficient (M) which is a term which multiplies the velocity head to give the concentrated head loss at the components. Hence, the loss is given by:

$$^{h}LM = M \frac{v^2}{2_g} \qquad (3)$$

where hLM is the head loss in feet head, v is the line velocity in fps (m/s) and G = 32.2 fps2(m/s2). The minor loss coefficient may vary somewhat with flow conditions, but it is usually sufficient to consider this to be a constant for a certain component.

PRESSURE AND FLOW REQUIREMENTS

At any junction the external inflow or outflow requirements may be specified. Also the elevations of junctions must be given so the pressure can be calculated. Values for the elevation of junctions are not required to compute the flow distribution and only affect the pressure calculation at the junctions, so junction elevations need only be specified where pressures are desired. At each terminal energy point the total energy (pressure head plus elevation) is known and is computed.

FORMULATION AND SOLUTION OF SYSTEM EQUATIONS

Basic Equations

Equation 1 giving the relationship between the number of pipes, loops, junctions and terminal energy points becomes significant when formulating a proper set of hydraulic equations to describe a general system of pipes.

In terms of the unknown discharge in each pipe, a number of continuity and energy equations can be written equaling the number of pipes in the system. For each junction a continuity equation equating the flow into the junction to the flow out is written as:

$$Q_{in} = Q_{out} \qquad \text{(j equations)} \qquad (4)$$

For each loop the energy equation can be written as follows:

$$h_L = E_p \qquad \text{(1 equations)} \qquad (5)$$

where h_L = head loss in each pipe (including minor loss)

E_P = energy put into the liquid by a pump.

If there are no pumps in the loop then the energy equation states that the sum of the head loss around the loop equals zero.

If there are t terminal energy points, t - 1 energy equations can be written for paths between any two terminal energy points as follows:

$$E = h_L - E_P \qquad \text{(t - i equations)} \qquad (6)$$

where E is the energy difference between the two terminal energy points. These junction, loop and path equations constitute a set of simultaneous nonlinear equations in which each term can be expressed as a function of the line discharge, Q. This is done as follows. The head loss in each pipe is the sum of the line loss plus the minor loss for that pipe. The line loss is given by:

$$h_{LP} = K_P Q^2 \qquad (7)$$

where K_P is a pipe line constant. For the Darcy Weisbach equation this is given by:

$$K_P = \frac{.025\ fl}{D^5} \qquad (8)$$

Here L = line length in ft., D = line diameter in ft. and f is the Darcy friction factor. The discharge 0 in eqn. 7 is in cfs.

Minor losses are given by a loss coefficient, M, which multiplies the velocity head to give the loss at the component. This is

$$h_{LM} = M\ \frac{V^2}{2_g} \qquad (9)$$

where V is the mean line velocity and g is the gravitational constant. In terms of the discharge this is

$$h_{LM} = K_M Q^2 \qquad (10)$$

where

$$K_M = \frac{.02517\ M}{D^4} \qquad (11)$$

The pump head is expressed two ways. In terms of the power input

$$E_P = \frac{Z_P}{Q}$$

where (12)

$$Z_P = \frac{550\ HP}{\gamma}$$

For this expression the horsepower put into the system by the pump is given as HP and γ is the specific weight of the liquid (#/ft^3). Alternately the pump head can be expressed as:

$$Ep = A + BQ + CQ^2 \qquad (13)$$

where A, B and C are coefficients of a parabolic characteristic curve which fits the pump operating data in the vicinity of the normal operating point.

The basic energy equation for a closed loop or path between terminal energy points can now be written as a single expression in terms of the discharge Q:

$$\Delta E = \sum (K_P Q^n + K_M Q^2) - \sum \frac{Z_P}{Q} \qquad (14)$$

or

$$\Delta E = \sum (K_P Q^n + K_M Q^2) - (A + BQ + CQ^2) \qquad (15)$$

depending on how the pumps are described. For a closed loop the term E = 0 and these equations reduce to Equation 5.

The continuity equations (4) for the junctions and the energy equations (14 or 15) for loops and paths between terminal energy points make up the basic set of hydraulic equations which can be solved for the unknown flow rates. The solution procedure is identical to that employed for the Hardy Cross method. After obtaining a set of balanced flowrates (continuity equations all satisfied) flow corrections are computed for each energy equation which tend to satisfy the energy equation without disturbing flow continuity. The flow corrections can be computed from gradient approximation based on an initial value of flowrate, Q_i, as follows:

$$f(Q) = f(Q) + \left| \frac{2f(Q)}{2Q} \right|_{Q=Q_i} \Delta Q \qquad (16)$$

When this is applied to the energy equations (16 and 17) the following expressions are obtained:

$$\Delta Q = \frac{\Delta E - \Sigma \left(K_P Q_i^n + K_M Q_i^2 - \frac{Z_P}{Q_i}\right)}{\Sigma \left(nK_P Q_i^{n-1} = 2K_M Q_i + \frac{Z_P}{Q_i^2}\right)} \qquad (17)$$

or

$$\Delta Q = \frac{\Delta E - \Sigma \left(K_P Q_i^n + K_M Q_i^2 - (A + BQ_i + CQ_i)\right)}{\Sigma \left(nK_P Q_i^{n-1} = Q_I - B - 2CQ_i\right)} \qquad (18)$$

The numerator of these equations represents the unbalanced energy in the path due to the incorrect values of flowrate.

It can be noted that for closed loops (E = 0) and for paths with no pumps or minor loss components this reduces to

$$\Delta Q = \frac{\Sigma K_p Q_i^n}{n\Sigma K_p Q_i^{n-1}} = - \frac{\Sigma h_{L_i}}{n\Sigma \frac{h_{L_i}}{Q_i}} \qquad (21)$$

This is the well known flow correction factor for the Hardy Cross method applicable to closed loop systems with no pumps.

The correction factor is computed along a path of connected pipes which forms either a closed loop or joints two terminal energy points. The energy difference, AE, is the algebraic difference between the hydraulic grade line at the beginning and at the end of the path. The remaining terms in the numerator represent the sum of the changes in hydraulic gradeline for the pipes in the path, and for each pipe this is added if the flow direction for ^{Q}I is in the path direction and is subtracted if the direction of flow is opposite to the path direction. The sign of the denominator is not affected by the flow direction in the pipes.

The technique for analyzing a pipe network using the path adjustment method can be summarized as follows:

1. Collect all the necessary pipe system data including pipe length, diameters, and roughness factors, minor loss coefficients for all components to be included, pump characteristics, water level elevations for storage tanks and pressure and flow specifications.

2. Identify junctions, primary loops and terminal energy points. Verify the expression p - j + 1 + t - 1 and identify specifically the loops and paths to be adjusted.

3. Obtain a balanced flow distribution for the system.

4. Correct each path identified in (2) using equation 19 or 20.

5. Repeat step 4 until the average correction factor is less than the accuracy specified.

OUTPUT

The output of the program consists of:

1. Original input data.
2. Correction factors (to show convergence).
3. Pipe flowrates, head losses, and velocity.
4. Junction elevations, demands, pressure due to friction head loss, and total pressure (head loss + static head).

With flowrates and pressures known for the entire system, the user can proceed to adjust the system configuration until the desired pressure profile is attained.

DA ENGINEERING

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PIPE NETWORK ANALYSIS

JN DATE: 05-12-1996

INPUT PARAMETERS

DATA FILE = EAST
NUMBER OF PIPES = 18
JMBER OF PATHS = 0
HE FLOW CONVERSION FACTOR = 448.86
KINEMATIC VISCOSITY = .0000166 SQFT/S
ENGTH MULTIPLIER = 1
JILDING PRESSURE DIFFERENCE = 5 PSI
PRESSURE SAFETY CUSHION = 10 PSI

INPUT PIPELINE DATA

PIPE	FROM	TO	LENGTH	DIA	ROUGHNESS	MINOR L	PUMP DATA	TEP
1	0	1	1	60	.0018	0	0	100
2	1	2	225	8	.0018	0	0	
3	2	3	335	6	.0018	0	0	
4	3	4	335	6	.0018	0	0	
5	4	5	12	4	.0018	0	0	
6	1	6	825	10	.0018	0	0	
7	6	7	225	10	.0018	0	0	
8	7	8	112	6	.0018	0	0	
9	8	9	12	4	.0018	0	0	
10	8	10	335	6	.0018	0	0	
11	10	11	35	6	.0018	0	0	
12	11	12	12	6	.0018	0	0	
13	7	13	115	8	.0018	0	0	
14	13	14	15	8	.0018	0	0	
15	13	15	445	8	.0018	0	0	
16	15	16	25	6	.0018	0	0	
17	15	17	225	6	.0018	0	0	
18	17	18	115	6	.0018	0	0	

INPUT DATA FOR PATHS

ATH NO.	DELTA E	NUMBER OF PIPES	PIPES IN PATH

RIAL AVERAGE CORRECTION FACTOR

PIPE FLOW RESULTS

PIPE	FLOWRATE	HEAD LOSS (FT)	MINOR LOSS (FT)	VELOCITY (FT/S)
1	-0.10	-0.00	0.00	-0.00
2	653.00	1.61	0.00	4.17
3	389.70	3.80	0.00	4.43
4	300.00	2.34	0.00	3.41
5	300.00	0.63	0.00	7.66
6	2259.90	20.11	0.00	9.24
7	1947.90	4.14	0.00	7.96
8	825.00	5.20	0.00	9.37
9	232.00	0.39	0.00	5.93
10	593.00	8.33	0.00	6.73
11	485.70	0.60	0.00	5.52
12	405.80	0.15	0.00	4.61
13	1122.90	2.27	0.00	7.17
14	516.90	0.07	0.00	3.30
15	606.00	2.77	0.00	3.87
16	218.40	0.10	0.00	2.48
17	387.60	2.52	0.00	4.40
18	267.10	0.65	0.00	3.03

NODE PRESSURE RESULTS

JUNCTION NUMBER	DEMAND	ELEVATION (FT)	DYNAMIC SUPPLY PRESSURE (PSI)	DYNAMIC RETURN PRESSURE (PSI)
1	-2913	0	38.39	0.00
2	263	0	37.70	0.70
3	90	0	36.05	2.34
4	0	0	35.04	3.36
5	300	0	34.77	3.63
6	312	0	29.68	8.72
7	0	0	27.88	10.51
8	0	0	25.63	12.76
9	232	0	25.46	12.93
10	107	0	22.02	16.37
11	80	0	21.76	16.63
12	406	0	21.70	16.70
13	0	0	26.90	11.49
14	517	0	26.87	11.52
15	0	0	25.70	12.69
16	218	0	25.66	12.74
17	121	0	24.61	13.79
18	267	0	24.32	14.07

AXIMUM ELEVATION = 0

JUNCTION NUMBER	RANK	STATIC PRESSURE (PSI)	TOTAL SUPPLY PRESSURE (PSI)	TOTAL RETURN PRESSURE (PSI)
1	1	0.00	48.39	10.00
2	2	0.00	47.70	10.70
3	3	0.00	46.05	12.34
4	4	0.00	45.04	13.36
5	5	0.00	44.77	13.63
6	6	0.00	39.68	18.72
7	7	0.00	37.88	20.51
8	12	0.00	35.63	22.76
9	13	0.00	35.46	22.93
10	16	0.00	32.02	26.37
11	17	0.00	31.76	26.63
12	18	0.00	31.70	26.70
13	8	0.00	36.90	21.49
14	9	0.00	36.87	21.52
15	10	0.00	35.70	22.69
16	11	0.00	35.66	22.74
17	14	0.00	34.61	23.79
18	15	0.00	34.32	24.07

THE FOLLOWING CHANGES ARE MADE

ENGINEERING
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PE NETWORK ANALYSIS
N DATE: 05-13-1996

UT PARAMETERS

TA FILE = SAT1
MBER OF PIPES = 75
MBER OF PATHS = 0
FLOW CONVERSION FACTOR = 448.86
NEMATIC VISCOSITY = .0000166 SQFT/S
NGTH MULTIPLIER = 1
LDING PRESSURE DIFFERENCE = 5 PSI
SSURE SAFETY CUSHION = 10 PSI

UT PIPELINE DATA

E	FROM	TO	LENGTH	DIA	ROUGHNESS	MINOR L	PUMP DATA	TEP
	0	1	1	60	.0018	0	0	100
	1	2	225	8	.0018	0	0	
	2	3	335	6	.0018	0	0	
	3	4	335	6	.0018	0	0	
	4	5	12	4	.0018	0	0	
	1	6	825	10	.0018	0	0	
	6	7	225	10	.0018	0	0	
	7	8	112	6	.0018	0	0	
	8	9	12	4	.0018	0	0	
	8	10	335	6	.0018	0	0	
	10	11	35	6	.0018	0	0	
	11	12	12	6	.0018	0	0	
	7	13	115	8	.0018	0	0	
	13	14	15	8	.0018	0	0	
	13	15	445	8	.0018	0	0	
	15	16	25	6	.0018	0	0	
	15	17	225	6	.0018	0	0	
	17	18	115	6	.0018	0	0	
	0	19	12	24	.0018	0	0	100
	19	20	225	24	.0018	0	0	
	20	26	100	24	.0018	0	0	
	26	30	100	24	.0018	0	0	
	30	33	290	24	.0018	0	0	
	33	34	445	24	.0018	0	0	
	34	42	355	24	.0018	0	0	
	42	56	168	20	.0018	0	0	
	56	61	168	20	.0018	0	0	
	61	62	334	20	.0018	0	0	
	62	51	345	20	.0018	0	0	
	51	66	612	20	.0018	0	0	
	47	63	628	12	.0018	0	0	
	39	38	158	12	.0018	0	0	
	39	73	150	8	.0018	0	0	

[illegible]	40	41	168	8	.0018	0	0
[illegible]	47	37	56	8	.0018	0	0
[illegible]	51	52	112	20	.0018	0	0
[illegible]	52	49	112	6	.0018	0	0
[illegible]	62	32	112	6	.0018	0	0
[illegible]	61	31	12	8	.0018	0	0
[illegible]	56	57	56	16	.0018	0	0
[illegible]	57	58	334	16	.0018	0	0
[illegible]	58	60	445	8	.0018	0	0
[illegible]	58	59	35	6	.0018	0	0
[illegible]	42	43	612	12	.0018	0	0
[illegible]	43	44	224	12	.0018	0	0
[illegible]	44	50	56	12	.0018	0	0
[illegible]	50	53	1035	10	.0018	0	0
[illegible]	53	54	1356	4	.0018	0	0
[illegible]	53	55	56	10	.0018	0	0
[illegible]	44	45	335	8	.0018	0	0
[illegible]	45	48	335	8	.0018	0	0
[illegible]	43	46	67	6	.0018	0	0
[illegible]	34	35	445	10	.0018	0	0
[illegible]	35	36	335	8	.0018	0	0
[illegible]	26	27	112	8	.0018	0	0
[illegible]	27	28	335	8	.0018	0	0
[illegible]	28	29	68	6	.0018	0	0
[illegible]	20	21	145	8	.0018	0	0
[illegible]	21	22	224	8	.0018	0	0
[illegible]	22	24	90	4	.0018	0	0
[illegible]	24	25	224	4	.0018	0	0
[illegible]	22	23	90	6	.0018	0	0
[illegible]	63	39	440	12	.0018	0	0
[illegible]	38	65	1515	10	.0018	0	0
[illegible]	38	66	775	16	.0018	0	0
[illegible]	66	67	305	12	.0018	0	0
[illegible]	66	68	305	20	.0018	0	0
[illegible]	68	69	160	10	.0018	0	0
[illegible]	68	70	225	24	.0018	0	0
[illegible]	70	71	160	10	.0018	0	0
[illegible]	70	72	135	24	.0018	0	0
[illegible]	72	74	260	30	.0018	0	0
[illegible]	63	64	800	12	.0018	0	0
[illegible]	73	40	90	8	.0018	0	0
[illegible]	74	75	1	60	.0018	0	0

UT DATA FOR PATHS

H J.	DELTA E	NUMBER OF PIPES	PIPES IN PATH

AL AVERAGE CORRECTION FACTOR

1.70141[illegible]E+38

PIPE FLOW RESULTS

PIPE	FLOWRATE	HEAD LOSS (FT)	MINOR LOSS (FT)	VELOCITY (FT/S)
1	2913.00	0.00	0.00	0.33
2	653.00	1.61	0.00	4.17
3	390.00	3.80	0.00	4.43
4	300.00	2.34	0.00	3.41
5	300.00	0.63	0.00	7.66
6	2260.00	20.11	0.00	9.24
7	1948.00	4.14	0.00	7.96
8	825.00	5.20	0.00	9.37
9	232.00	0.39	0.00	5.93
10	593.00	8.33	0.00	6.73
11	486.00	0.60	0.00	5.52
12	406.00	0.15	0.00	4.61
13	1123.00	2.27	0.00	7.17
14	517.00	0.07	0.00	3.30
15	606.00	2.77	0.00	3.87
16	218.00	0.10	0.00	2.48
17	388.00	2.53	0.00	4.41
18	267.00	0.65	0.00	3.03
19	11254.40	0.08	0.00	7.99
20	11117.90	1.43	0.00	7.89
21	9773.90	0.50	0.00	6.94
22	9128.70	0.44	0.00	6.48
23	8543.60	1.12	0.00	6.06
24	8299.80	1.62	0.00	5.89
25	7870.70	1.17	0.00	5.59
26	3652.80	0.32	0.00	3.73
27	2690.30	0.18	0.00	2.75
28	1715.80	0.16	0.00	1.75
29	1638.60	0.15	0.00	1.67
30	634.60	0.05	0.00	0.65
31	-561.60	-0.47	0.00	-1.59
32	-3774.60	-4.10	0.00	-10.72
33	1169.00	3.20	0.00	7.47
34	235.00	0.18	0.00	1.50
35	561.60	0.30	0.00	3.59
36	1004.00	0.02	0.00	1.03
37	467.90	1.79	0.00	5.31
38	77.20	0.07	0.00	0.88
39	974.50	0.18	0.00	6.22
40	962.50	0.03	0.00	1.54
41	787.10	0.11	0.00	1.26
42	114.50	0.13	0.00	0.73
43	672.60	1.10	0.00	7.64
44	3632.80	14.78	0.00	10.31
45	3194.10	4.23	0.00	9.07
46	2219.30	0.53	0.00	6.30
47	1634.20	13.65	0.00	6.68
48	370.40	105.34	0.00	9.46
49	1263.80	0.46	0.00	5.17
50	974.80	5.07	0.00	6.23

51	536.10	1.66	0.00	3.42
52	438.70	0.95	0.00	4.98
53	429.10	0.49	0.00	1.75
54	243.80	0.39	0.00	1.56
55	645.20	0.78	0.00	4.12
56	333.20	0.69	0.00	2.13
57	89.40	0.05	0.00	1.02
58	1344.00	4.03	0.00	8.58
59	1178.20	4.85	0.00	7.53
60	107.20	0.69	0.00	2.74
61	48.70	0.41	0.00	1.24
62	1071.00	6.88	0.00	12.16
63	-2605.60	-5.65	0.00	-7.40
64	840.00	5.76	0.00	3.43
65	-4614.60	-7.00	0.00	-7.37
66	1500.00	1.39	0.00	4.26
67	-5480.00	-1.26	0.00	-5.60
68	790.00	0.54	0.00	3.23
69	-6270.00	-0.48	0.00	-4.45
70	730.00	0.47	0.00	2.98
71	-7000.00	-0.36	0.00	-4.97
72	-7000.00	-0.23	0.00	-3.18
73	2044.00	6.50	0.00	5.80
74	379.00	0.24	0.00	2.42
75	-7000.00	-0.00	0.00	-0.79

)E PRESSURE RESULTS

.ICTION UMBER	DEMAND	ELEVATION (FT)	DYNAMIC SUPPLY PRESSURE (PSI)	DYNAMIC RETURN PRESSURE (PSI)
1	0	0	91.67	0.00
2	263	0	90.97	0.70
3	90	0	89.32	2.35
4	0	0	88.31	3.36
5	300	0	88.04	3.63
6	312	0	82.95	8.72
7	0	0	81.16	10.51
8	0	0	78.90	12.76
9	232	0	78.74	12.93
10	107	0	75.29	16.37
11	80	0	75.03	16.63
12	406	0	74.97	16.70
13	0	0	80.17	11.49
14	517	0	80.14	11.52
15	0	0	78.97	12.69
16	218	0	78.93	12.74
17	121	0	77.88	13.79
18	267	0	77.60	14.07
19	137	0	91.63	0.03
20	0	0	91.01	0.65
21	166	0	89.27	2.40

22	0	0	87.17	4.50
23	1071	0	84.19	7.48
24	59	0	86.87	4.80
25	49	0	86.69	4.97
26	0	0	90.80	0.87
27	312	0	90.46	1.21
28	244	0	90.16	1.51
29	89	0	90.14	1.53
30	585	0	90.61	1.06
31	974	0	88.62	3.05
32	77	0	88.60	3.07
33	244	0	90.13	1.54
34	0	0	89.42	2.24
35	185	0	89.21	2.46
36	244	0	89.04	2.63
37	562	0	80.95	10.72
38	0	0	85.51	6.16
39	0	0	83.73	7.94
40	144	0	82.24	9.42
41	235	0	82.16	9.50
42	585	0	88.92	2.75
43	0	0	82.51	9.15
44	0	0	80.68	10.99
45	439	0	78.48	13.18
46	439	0	82.10	9.56
47	0	0	81.08	10.59
48	536	0	77.76	13.90
49	468	0	87.78	3.89
50	585	0	80.45	11.22
51	0	0	88.56	3.10
52	536	0	88.55	3.11
53	0	0	74.53	17.13
54	370	0	28.89	62.78
55	1264	0	74.33	17.33
56	0	0	88.78	2.89
57	175	0	88.76	2.90
58	0	0	88.72	2.95
59	673	0	88.24	3.43
60	115	0	88.66	3.01
61	0	0	88.70	2.97
62	0	0	88.63	3.04
63	0	0	81.28	10.38
64	2044	0	78.47	13.20
65	840	0	83.01	8.65
66	0	0	88.54	3.12
67	1500	0	87.94	3.73
68	0	0	89.09	2.58
69	790	0	88.85	2.82
70	0	0	89.30	2.37
71	730	0	89.09	2.57
72	0	0	89.45	2.22
73	790	0	82.35	9.32
74	0	0	89.55	2.12
75	-7000	0	89.55	2.12

'IMUM ELEVATION = 0

JCTION NUMBER	RANK	STATIC PRESSURE (PSI)	TOTAL SUPPLY PRESSURE (PSI)	TOTAL RETURN PRESSURE (PSI)
1	75	0.00	101.67	10.00
2	4	0.00	100.97	10.70
3	15	0.00	99.32	12.35
4	35	0.00	98.31	13.36
5	37	0.00	98.04	13.63
6	47	0.00	92.95	18.72
7	54	0.00	91.16	20.51
8	63	0.00	88.90	22.76
9	64	0.00	88.74	22.93
10	70	0.00	85.29	26.37
11	71	0.00	85.03	26.63
12	72	0.00	84.97	26.70
13	59	0.00	90.17	21.49
14	60	0.00	90.14	21.52
15	61	0.00	88.97	22.69
16	62	0.00	88.93	22.74
17	67	0.00	87.88	23.79
18	69	0.00	87.60	24.07
19	2	0.00	101.63	10.03
20	3	0.00	101.01	10.65
21	17	0.00	99.27	12.40
22	40	0.00	97.17	14.50
23	44	0.00	94.19	17.48
24	41	0.00	96.87	14.80
25	42	0.00	96.69	14.97
26	5	0.00	100.80	10.87
27	7	0.00	100.46	11.21
28	8	0.00	100.16	11.51
29	9	0.00	100.14	11.53
30	6	0.00	100.61	11.06
31	30	0.00	98.62	13.05
32	31	0.00	98.60	13.07
33	10	0.00	100.13	11.54
34	14	0.00	99.42	12.24
35	18	0.00	99.21	12.46
36	21	0.00	99.04	12.63
37	56	0.00	90.95	20.72
38	43	0.00	95.51	16.16
39	45	0.00	93.73	17.94
40	50	0.00	92.24	19.42
41	51	0.00	92.16	19.50
42	22	0.00	98.92	12.75
43	48	0.00	92.51	19.15
44	57	0.00	90.68	20.99
45	65	0.00	88.48	23.18
46	52	0.00	92.10	19.56
47	55	0.00	91.08	20.59
48	68	0.00	87.76	23.90
49	39	0.00	97.78	13.89
50	58	0.00	90.45	21.22
51	32	0.00	98.56	13.10
52	33	0.00	98.55	13.11

53	73	0.00	84.53	27.13
54	0	0.00	38.89	72.78
55	74	0.00	84.33	27.33
56	24	0.00	98.78	12.89
57	25	0.00	98.76	12.90
58	26	0.00	98.72	12.95
59	36	0.00	98.24	13.43
60	28	0.00	98.66	13.01
61	27	0.00	98.70	12.97
62	29	0.00	98.63	13.04
63	53	0.00	91.28	20.38
64	66	0.00	88.47	23.20
65	46	0.00	93.01	18.65
66	34	0.00	98.54	13.12
67	38	0.00	97.94	13.73
68	20	0.00	99.09	12.58
69	23	0.00	98.85	12.82
70	16	0.00	99.30	12.37
71	19	0.00	99.09	12.57
72	13	0.00	99.45	12.22
73	49	0.00	92.35	19.32
74	12	0.00	99.55	12.12
75	11	0.00	99.55	12.12

E FOLLOWING CHANGES ARE MADE

NUMERICAL ENGINEERING
Computer Flow Model

CHAPTER 8

METHODOLOGY

SIMULATION OVERVIEW

A hydraulic simulation is performed using equations linearized by the Newton-Raphson technique. This simulation provides pressure and flow information. Steady state energy balance equations are then invoked for the units, and at each node in the system to obtain the water temperatures in every section of the system. The temperatures of the water entering and leaving the units are then used to re-calculate the temperature of the load fluids conditioned by the units. This temperature is compared with the set point for the unit, and the unit control valve resistance is adjusted. (For the case of radiators, the unit heating load is used rather than the temperature.) The temperature of the water circulating through the control sections for the water temperature control valves is then compared with the set temperatures for these sections and the resistance of these water temperature control valves is adjusted. A new hydraulic simulation is then performed, starting a new iteration.

Adjustment of the unit control valves continues until the absolute temperature change between iterations (for the load fluid conditioned by the unit) is less than twice the convergence criteria entered by the user. The hydraulic simulations continue until the temperature change between iterations for every section is less than the convergence criteria.

MATHEMATICAL METHODS

A least-squares fit is made to the input data sets for the constant speed pumps to obtain coefficients which are then used to describe the flow/pressure curves of the pumps. To avoid the possibility of later manipulations becoming trapped in a minimum, these fits are of only second order. The "design" data set is given triple weight in the fitting process on the assumption that the final operational point will be near these values.

Many of the equations encountered in a flow network simulation are nonlinear. Such equations are handled with the Newton-Raphson technique, which uses a first order Taylor series expansion of the residual form of the equation to approximate the solution. The first order Taylor expansion is linear and may be solved directly.

Gaussian elimination is used extensively for solving the linearized equations arranged in matrix form. Most of the matrices in WTRSYM are sparse matrices; that is, the vast majority of the elements in the matrix are zeros. A proprietary sparse matrix technique is used to minimize the memory requirements as well as the computer processing time for the Gaussian solution. If the matrices were not sparse, the simulation time required for even a 100 node system would be unreasonable.

CONTINUITY OF MASS

The balance of flow at a given node is rather straight forward – what goes in must equal what comes out. These equations are obviously linear. However, to represent the entire set of hydraulic equations as an equivalent set for matrix solution, these equations must also be transformed using the Newton-Raphson method so that change in flow rates can be made linear.

HYDRAULIC SIMULATION

The set of hydraulic equations is stored and solved as a matrix problem. The residual terms and the partial derivatives of the equations are evaluated using data from the previous iteration. A modification of Gaussian elimination routine is used to solve for the changes in the flow rates and pressures. The pressures and flow rates are then updated by adjusting the values of these variables from the previous iteration.

FRICTION EFFECTS

Friction effects are taken into account by calculating the pressure drop through a pipe section of component based on the velocity of the flow thought that pipe or component. The sum of such pressure drops in any given circuit must equal the pumping head available for that circuit. During the hydraulic simulation, such a balance is made, and the flows adjusted so the available head and the pressure drops match.

The pressure drops are calculated using the Reynolds number, the Darcy-Weisbach equation, and the Colebrook equation and are shown below. The flow is taken as turbulent if the Reynolds number is greater than 2000. These equations are nonlinear and the Newton-Raphson method is employed.

Equation 8.1 - Velocity

$$Velocity = \frac{Flow \times 0.4085}{Diameter^2}$$

Where:		
	Velocity	= Fluid velocity, ft/s
	Flow	= Flow rate of fluid, gpm
	Diameter	= Diameter of pipe, in.

Equation 8.2 - Reynolds Number

$$\mathrm{Re} = \frac{Velocity \times Diameter \times Density \times 300}{Viscosity}$$

Where:		
	Re	= Reynolds Number
	Diameter	= Diameter of pipe, in.
	Density	= Density of fluid, lbs/ft^3
	Viscosity	= Viscosity of fluid, lbs/hr·ft

Reference: *1989 ASHRAE Handbook – Fundamentals, I-P Edition*, pg. 33.1

Equation 8.3 - Colebrook Equation (Friction Factor)

$$f = \frac{1}{\left(1.74 - 2 \times \log\left(\frac{24 \times Roughness}{Diameter} + \frac{18.7}{\mathrm{Re} \times \sqrt{f}}\right)\right)^2}$$

Where:		
	f	= Friction factor
	Roughness	= Roughness factor for pipe, ft.
	Diameter	= Diameter of pipe, in.
	Re	= Reynolds number

Equation 8.4 - Darcy-Weisbach (Pressure Drop)

$$\Delta Pressure = \frac{f \times 18.63354037 \times Velocity^2}{Diameter}$$

Where: ΔPressure = Pressure drop through pipe, ft of H_2O / 100 ft
f = Friction factor
Diameter = Diameter of pipe, in.
Velocity = Velocity of fluid, ft/s

Reference: *1989 ASHRAE Handbook – Fundamentals, I-P Edition*, pg. 33.1

Equation 8.5 - Pressure Loss Conversion

$$\Delta p = \frac{\Delta Pressure}{100} \times Length$$

Where: Δp = Absolute pressure loss through pipe, ft of H_2O
ΔPressure = Pressure drop through pipe, ft of H_2O / 100 ft
Length = Length of pipe section (including fittings), ft

SIMULATING EQUIPMENT

Control Valves

A two-way unit (common or loop) control valve simulation is handled by adding a term to the section flow equation that describes the pressure drop across the valve as a function of the valve Cv setting. The Newton-Raphson method is used to linearize the relationship.

A three-way unit control valve is only slightly more complicated. The section that contains the unit is handled as if the three-way valve were a two-way valve in that section. The bypass or complementary section is handled as if a second two-way valve were in that section also. The Cv setting for the unit section is adjusted to obtain the desired flow through the unit, and the CV section for the unit bypass section is adjusted in a complementary fashion so that the sum of these Cv values equals the "wide open Cv" value entered by the user for the three-way valve. Again, the Newton-Raphson method is used to linearize these equations for entry into the matrix.

Water temperature control valves are adjusted in a similar manner. If it is a three-way water temperature control valve, the complementary branch resistance is adjusted similar to the bypass sections above.

The Cv adjustment for a better valve resistance value can be solved directly by assuming that the pressure drop across the valve section may be used for the next iteration. The new Cv value is then used for calculations of the next iterations. This approximation becomes quite good as the simulation approaches convergence.

Check Valves

The pressures at the nodes on either side of the check valve are compared to determine if the check valve should be open or closed. If the check valve should be open, that section is handled like a simple pipe section. If the check valve should be closed, the normal flow resistance for that section is increased by six orders of magnitude. This reduces the flow to a negligible amount. This change is not permanent. This resistance is reset at the start of each hydraulic iteration. Note: The flow is not reversed in the section containing the check valve although the pressures indicate it should be reversed. This can cause problems if there are other sections in the system that flow only into or out of the section containing the check valve. The program will cease and the calculation log will indicate the previously reversed adjacent section has no input. To avoid this possibility, add dummy bypass sections around the check valve. These dummy sections should have high flow resistance so they cannot contribute significantly to the overall flow.

Fixed Flow Control Valves

The simulation of a fixed-flow control valve is made by adjusting the flow resistance in this section until the flow is equal or less than the flow setting entered by the user. The equations are similar to those for a two-way valve control, only the adjustment is based of flow rather than on temperature. Such adjustments can be quite radical and may create major changes in the system. Therefore, to allow the overall system simulation to "settle down" before these adjustments are made, a fixed-flow valve is considered to be wide open until after the third iteration.

Relief Valves

Pressure relief valves are handled like a check valve, only the pressure difference comparison is made to the relief valve setting entered by the user rather than to zero.

Constant Speed Pumps

The flow through a constant speed pump is taken to be the flow through the first section upstream from the pump. The coefficients previously calculated from the input pump data are then used to calculate the pressure rise across the pump. This pressure rise is then used during the following hydraulic iteration to obtain a modified flow through the pump.

Variable Speed Pumps

Although sometimes a control problem in real systems, variable speed pumps are quite easy to model in a computer simulation. The pressure drop between the two control nodes specified by the user is set to the constant value input by the user. The hydraulic simulation routine will determine the pressure rise across the pump required to maintain this control value.

HEAT TRANSFER CHARACTERISTICS

Boilers and Chillers

The mechanism for heat transfer by a boiler or chiller is not modeled. The assumption is made that the boiler or chiller can provide or remove the amount of energy required to maintain the temperature setting. This set temperature is input by the user, and is independent of the temperature of the water entering the boiler or chiller. After the entire simulation has been completed, a load for the boiler or chiller is calculated from the flow and the temperature change. This calculated load is listed (in MBtu/h for boilers, and tons for chillers) for comparison with the capacity input by the user.

Coils

The modeling of coil units is significantly more complex. Coil units are modeled as counter-flow heat exchangers. The fact that a coil has a cross-flow arrangement rather than a counter flow arrangement has been taken into account by the inclusion of a correction factor based on the number of rows in the coil and the temperature differences.

The modeling of coils is further complicated by the fact that two fluids with different heat capacities and flows are involved. The temperature of the water leaving the coil cannot be directly determined, and requires some iterative techniques. Because of this, there are some potential problems you should be aware of.

The first case is when the temperature differences of the air side and the water side are equal. This situation would yield an indeterminate value in the Log Mean Temperature Difference (LMTD) equation. When this situation does occur, the coil is more properly simulated by equations that are based on the Arithmetic Mean Temperature Difference (AMTD). The WTRSYM calculation module will switch from one set of equations to the other as the situation dictates. Switching will occur when the air temperature difference and the water temperature difference are equal within 0.01% (0.0001). Such switching is a rare occurrence. However, if it does occur during the final iterations, it could cause an oscillation that could prevent convergence. If this does occur, which is extremely unlikely, the user should make some minor, insignificant changes in the input data for the coil in question and rerun the simulation. For example, change the operation air flow by ½%.

The second potential problem area is that of very large or very small numbers. Under certain situations, values could be encountered in the solution routines that exceed the capacity of the computer. The WTRSYM calculation module checks for situations where the exponent is likely to exceed 30 (positive or negative). When this occurs, WTRSYM will issue a warning (in the calculation log), and either reset this value or switch calculation procedures to avoid crashing the program. In the equations used by WTRSYM, very little accuracy is lost by approximating the very small values with zero and the very large values with infinity.

The warning statements will refer to the pertinent coil and temperature differences. Experience has shown that when such situations occur, usually there is an error in the input values or arrangements. Such warnings may also occur during the first few iterations even with good input data, another reason to require at least four iterations before convergence is allowed.

The temperature of the air leaving the coils is an important goal of HSYM. By equating the airside and waterside heat transfer rates, the outlet air temperature may be calculated from the waterside flow and temperature change calculations of the previous iteration. The temperature of the airflow leaving the coil may or may not be the desired set temperature input by the user. If a control valve is included, it is then adjusted by HSYM to correct the water flow. If no control valve is present (wild coil) the leaving air temperature is a function of the system flows.

Exchangers

The modeling of heat exchangers is similar to that for coil units. However, considerable simplification is made be the assumptions that both fluids are water, that the heat exchanger is truly a counter-flow arrangement, and that the UA remains constant.

Radiators

The modeling of radiators involves a completely different set of circumstances and equations. The controlling feature is the heating load transferred from the unit to the surroundings rather than to the fluid heated by the unit. Following the characterization equation presented in the *ASHRAE 1992 Equipment Handbook* on page 38.4, the modeling of radiators uses the following equation.

Equation 8.6 - Radiator Output

$$Heat = C \times (T_s - T_a)^n$$

Where: *Heat* = Heat output, Btu/hr
C = Constant calculated from design conditions
T_s = Average temperature of heating medium, °F
T_a = Room air temperature, °F
n = Correction for different types of radiators

Reference: *1992 ASHRAE Handbook – HVAC Systems and Equipment, I-P Edition*, pg. 33.4

The exponent N is used to differentiate among the three types of radiators: cast-iron radiators, base-board radiators, and fin-tube radiators. The constant C is calculated from the design conditions, and the control valves are adjusted to attempt to match the heat transferred to the operational load value.

ENERGY SIMULATION

The flow is assumed to be steady state with negligible kinetic energies, and the specific heat of the fluid is considered to be constant. Thus, the energy (temperature) required to balance equations at nodes merely conserve the average temperature of the flows entering and leaving the node. The energy solutions for the units, combined with the temperature balances at the nodes, yield the temperatures throughout the system.

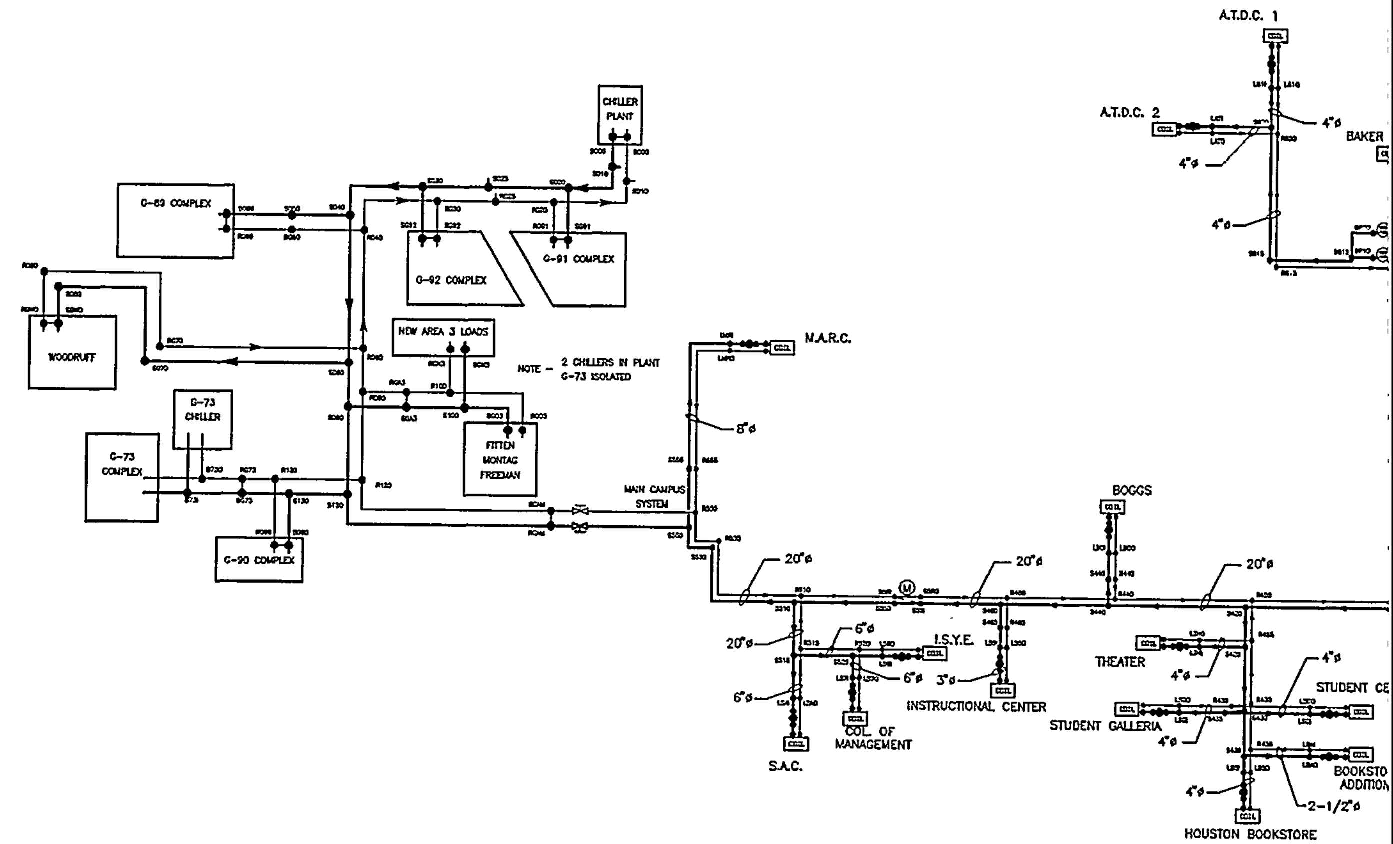
Hot Water Systems

First the heat loss of each section through the insulation is calculated to determine the temperature drop along the section. Then at the nodes, the energy balance equations merely conserve the average temperature of the flow. To determine the total loss through the insulation, the sum of the heating unit loads is subtracted from the sum of the boiler loads. Note that the heat loss through the insulation is sections containing active components such as boilers, pumps, and heating units is not determined by HSYM. This loss is usually only a relatively minor portion of the total energy of the system, and may be ignored for most practical purposes. If the user considers such losses to be important for the simulation, these losses may be approximated by artificially lowering the insulation effectiveness and/or ambient temperature for sections adjacent to such units.

Chilled Water Systems

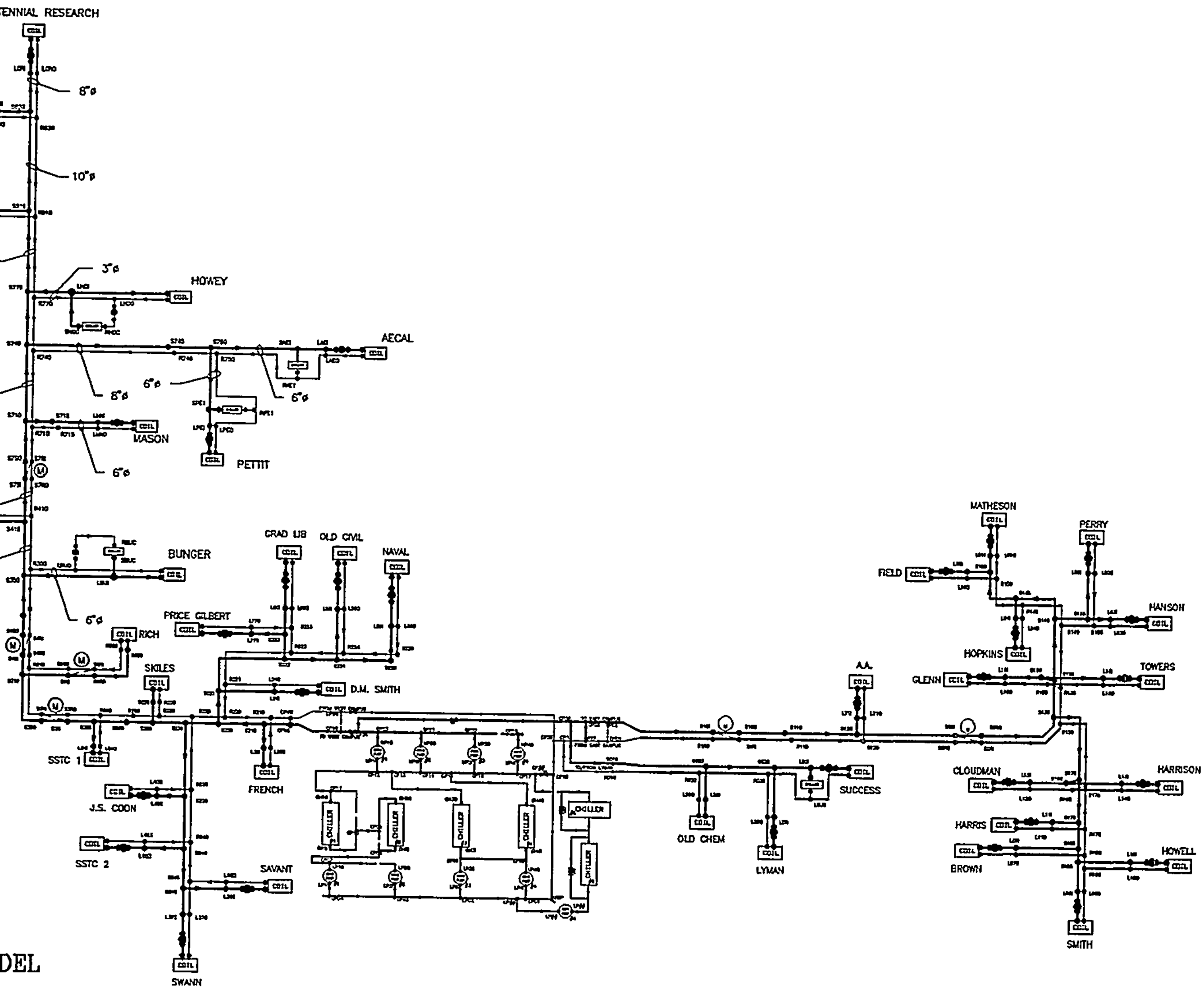
HSYM assumes that no heat transfer occurs in the pipes and fittings. This assumption is fairly accurate because these components are normally insulated and the temperature differences are usually less than twenty degrees. Hence, the heat transfers are relatively small. For chilled water systems, heat transfer is assumed to occur only at the chillers and cooling units.

(End of Chapter)



COMPUTER FLOW

C:\GATECH\D-NODAL.DWG



DEL

CHILLED WATER SYSTEM
MASTER PLAN
COMPUTER FLOW MODEL

Georgia Tech

PLANT OPERATIONS

MAY 15, 1996

RDA ENGINEERING, INC.

134 SOUTH AVENUE
MARIETTA, GEORGIA 30060
(770) 421-0870

9-22-92
DON TEST

TRIAL-46 1NPUT FOR GEOGR1A TECH SYSTEM

Will now make some more minor adjustments to try and make the system run in a reasonable fashion

GENERAL RUN PARAMETERS

NUMBER OF NODES	579
NUMBER OF SECTIONS	715
NUMBER OF CHILLERS	11
NUMBER OF COILS/EXCHANGERS	56
NUMBER OF CONSTANT SPEED PUMPS	61
NUMBER OF VARIABLE SPEED PUMPS	0
NUMBER OF 2-way UNIT CONTROL VALVES	2
NUMBER OF 3-way UNIT CONTROL VALVES	3
NUMBER OF CHECK VALVES	0
NUMBER OF PRESSURE RELIEF VALVES	0
NUMBER OF FIXED-FLOW CONTROL VALVES	0
NUMBER OF 2-way WATER TEMP VALVES	0
NUMBER OF 3-way WATER TEMP VALVES	47
NUMBER OF 2-way LOOP CONTROL VALVES	0
NUMBER OF 3-way LOOP CONTROL VALVES	3
NUMBER OF NON-HORIZONTAL SECTIONS	0

ELEVATION OF PROJECT(feet above sea level) .	500
AIR DENSITY AT ELEVATION(#/cuft)	.075
MAKEUP WATER PRESSURE(1st node--ft w.g.) ...	50.00

CONVERGENCE CRITERIA	.56
MAX NUMBER OF ITERATIONS	40
FREQUENCY OF SECTION STATUS PRINT	25

NEW PIPE ROUGHNESS FACTOR(inches)	.0020
OLD PIPE ROUGHNESS FACTOR(inches)	.0040

---- Type "A" pipe is schedule 40 steel pipe
---- Type "B" pipe is regular wt copper pipe

```
                        **********     Pipe Sectional Data     **********

                                         9 9 9  4 4  T T T T  G B A G C 6 Y   O   E
                        T                0 0 0  5 5           L U N A H O     T   Q
                        Y A                                B N 2 5  O T G T E   S   H   1
                        P G              S L M  S M  R O 5 0  B F L E C Y T   E   P
SEC  BEG   END   D1A   E E   LEN   GPM   E E E  E E           E Y E   K   R   R
=== ==== ==== ==.== = = ===.= ===.  = = =  = =  = = = =  = = = = = = =  ===. ==
  1 MUWP CP01 15.00 A N  49.1   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
  2 CP01 CP02 15.00 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
  3 CP02 CP03 15.00 A N 141.3   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
  4 CP03 CP04 15.00 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
  5 CP04 LP1I 10.02 A N  85.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
    LP1I LP1O                                                              CP
 **** INNER LOOP PUMP #1**    Design      2 nd      3 rd      4 th   **
                        FLOW(GPM)  2800.0      3250.0    2250.0    1000.0
                        TDH(FT WG)   45.0        37.0      53.0      67.0
          (TDH = ( .7298E+02) + (-.3771E-02)*GPM + (-.2234E-05)*GPM*GPM)
  7 LP1O CP07 10.02 A N 136.1   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 1 0 0   0.
  8 CP07 CP08 10.02 A N  86.1   0.  3 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
  9 CP08 CP09   .10 B N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 10 CP09 CP10 10.02 A N  86.1   0.  3 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 11 CP10 CH1I 10.02 A N  61.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 12 CH1I CH1O  7.98 A N  71.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  60. CH
 **** CHILLER #1    Control  CH1O CP11   ** Temp = 45.0   ** 1000.0 Tons **
 13 CH1O CP11 10.02 A N  60.1   0.  1 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
 14 CP11 CP12 10.02 A N  86.1   0.  3 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 15 CP12 CP13 15.00 A N  11.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 16 CP13 CP14 15.00 A N  87.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 17 CP14 CP15 15.00 A N  33.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 18 CP15 CP16 15.00 A N 125.1   0.  3 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 19 CP16 CP17 15.00 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 20 CP17 CP18   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 21 CP18 MUWP 15.00 A N 196.4   0.  4 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 22 CP03 LP2I 10.02 A N  60.1   0.  1 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
 23 LP2I LP2O   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
 24 LP2O CP07 10.02 A N 161.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 1 0 0   0.
 25 CP08 CH2I 10.02 A N  85.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
 26 CH2I CH2O  7.98 A N  71.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  60. CH
 **** CHILLER #2    Control  CH2O CP09   ** Temp = 50.5   ** 1000.0 Tons **
 27 CH2O CP09 10.02 A N  85.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
 28 CP10 CP11   .10 B O 499.3   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
 29 CP02 LP3I 10.02 A N 132.3   0.  3 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
    LP3I LP3O                                                              CP
 **** INNER LOOP PUMP #3 *    Design      2 nd      3 rd      4 th   **
                        FLOW(GPM)  2800.0      3250.0    2250.0    1000.0
                        TDH(FT WG)   45.0        37.0      53.0      67.0
          (TDH = ( .7298E+02) + (-.3771E-02)*GPM + (-.2234E-05)*GPM*GPM)
 31 LP3O CP06 10.02 A N 160.1   0.  1 0 0  0 0  0 0 0 0  0 1 0 0 1 0 0   0.
 32 CP06 CH3I 10.02 A N 110.1   0.  3 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
 33 CH3I CH3O  7.98 A N  91.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  80. CH
 **** CHILLER #3    Control  CH3O CP13   ** Temp = 45.0   ** 2000.0 Tons **
```

```
34 CH3O CP13 10.02 A N 168.4   0.  4 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
35 CP01 LP4I 10.02 A N 132.3   0.  3 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
   LP4I LP4O                                                               CP
 **** INNER LOOP PUMP #4 *    Design      2 nd      3 rd      4 th   **
                 FLOW(GPM)  2800.0      3250.0    2250.0    1000.0
                 TDH(FT WG)   45.0        37.0      53.0      67.0
       (TDH = ( .7298E+02) + (-.3771E-02)*GPM + (-.2234E-05)*GPM*GPM)
37 LP4O CP05 10.02 A N 160.1   0.  1 0 0  0 0  0 0 0 0  0 1 0 0 1 0 0    0.
38 CP05 CH4I 10.02 A N  60.1   0.  1 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
39 CH4I CH4O  7.98 A N  91.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   80. CH
 **** CHILLER #4    Control  CH4O CP15  ** Temp = 45.0  ** 2000.0 Tons **
40 CH4O CP15 10.02 A N 168.4   0.  4 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
41 CP05 CP06 10.02 A N 107.3   5.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
42 CP12 MP1I 10.02 A N 246.2   0.  4 0 0  0 0  0 0 0 0  0 1 0 0 1 0 0    0.
   MP1I MP1O                                                               CP
 **** MAIN PUMP #1       **   Design      2 nd      3 rd      4 th   **
                 FLOW(GPM)  2800.0      3400.0    2400.0    1200.0
                 TDH(FT WG)  125.0        83.0     142.0     175.0
       (TDH = ( .1590E+03) + ( .3232E-01)*GPM + (-.1601E-04)*GPM*GPM)
44 MP1O CP23 10.02 A N 122.2   0.  4 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
45 CP23 CP24 15.00 A N  98.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
46 CP24 CPWS 22.63 A N 175.5   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
47 CPWR CP26 22.63 A N 208.8   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
48 CP26 CP18 15.00 A N 136.2   0.  3 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
49 CP14 MP2I 10.02 A N 246.2   0.  4 0 0  0 0  0 0 0 0  0 1 0 0 1 0 0    0.
   MP2I MP2O                                                               CP
 **** MAIN PUMP #2       **   Design      2 nd      3 rd      4 th   **
                 FLOW(GPM)  2800.0      3400.0    2400.0    1200.0
                 TDH(FT WG)  125.0        83.0     142.0     175.0
       (TDH = ( .1590E+03) + ( .3232E-01)*GPM + (-.1601E-04)*GPM*GPM)
51 MP2O CP21 10.02 A N 122.2   0.  4 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
52 CP21 CP23 15.00 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
53 CP16 MP3I 10.02 A N 246.2   0.  4 0 0  0 0  0 0 0 0  0 1 0 0 1 0 0    0.
   MP3I MP3O                                                               CP
 **** MAIN PUMP #3       **   Design      2 nd      3 rd      4 th   **
                 FLOW(GPM)  2540.0      3400.0    2200.0    1200.0
                 TDH(FT WG)  125.0        72.0     138.0     165.0
       (TDH = ( .1584E+03) + ( .2204E-01)*GPM + (-.1393E-04)*GPM*GPM)
55 MP3O CP20 10.02 A N 246.2   0.  4 0 0  0 0  0 0 0 0  0 1 0 0 1 0 0    0.
56 CP20 CP21 15.00 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
57 CP17 MP4I 10.02 A N 146.2   0.  4 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
58 MP4I MP4O   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
59 MP4O CP19 10.02 A N 246.2   0.  4 0 0  0 0  0 0 0 0  0 1 0 0 1 0 0    0.
60 CP19 CP20 10.02 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
61 CP24 CP32 10.02 A N 262.8   0.  6 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
62 CP32 CP28 10.02 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
63 CP28 CP27   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
64 CP28 CPES 10.02 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
65 CPER CP27 10.02 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
66 CP27 CP33 10.02 A N  44.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
67 CP33 CP26 10.02 A N 107.3   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
68 CPES S1SI 10.02 A N 185.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
```

```
 69 S1SO S110 10.02 A N 518.4   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 70 S110 S120 10.02 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 71 S120 S2SI 10.02 A N 185.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 72 S2SO S130 10.02 A N 135.1   0.  0 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 73 S130 S135  7.98 A N 131.1   0.  0 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 74 S135 S140  7.98 A N 484.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 75 S140 S145  6.07 A N 272.2   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 76 S145 S150  6.07 A N 127.1   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 77 S150 L91I  4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 78 L91I P91I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P91I P91O                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                      FLOW(GPM)   200.0      300.0     100.0     30.0
                      TDH(FT WG)   40.0       14.0      55.0     58.0
          (TDH = ( .5785E+02) + ( .2619E-01)*GPM + (-.5754E-03)*GPM*GPM)
 80 P91O D911  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 81 D911 D912  3.07 A N 155.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  144. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                 XEWT  XLWT   XGPM    EWT   LWT   GPM
              DESIGN             80.0  60.5    75.0  45.0  55.0  150.0
              OPERATION          80.0  60.5    75.0  ----  ----  -----
       (Oper Load =   60.9 tons    **     eff = .98     **    UA =  37740.)
 82 D912 L91O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 83 L91O L91I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 84 L91O R150  4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
         Control Section  D912 L91O    Complement Section  L91O L91I
 85 R150 R145  6.07 A N 127.1   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 86 R145 R140  6.07 A N 272.2   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 87 R140 R135  7.98 A N 484.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 88 R135 R130  7.98 A N 131.1   0.  0 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 89 R130 S2RI 10.02 A N 135.1   0.  0 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 90 S2RO R120 10.02 A N 185.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 91 R120 R110 10.02 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 92 R110 S1RI 10.02 A N 518.4   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 93 S1RO CPER 10.02 A N 185.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
 94 S150 L90I  4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 95 L90I P90I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P90I P90O                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                      FLOW(GPM)   200.0      300.0     100.0     30.0
                      TDH(FT WG)   40.0       14.0      55.0     58.0
          (TDH = ( .5785E+02) + ( .2619E-01)*GPM + (-.5754E-03)*GPM*GPM)
 97 P90O D901  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
 98 D901 D902  3.07 A N 166.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  155. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                 XEWT  XLWT   XGPM    EWT   LWT   GPM
              DESIGN             80.0  60.5    62.0  45.0  55.0  124.0
              OPERATION          80.0  60.5    62.0  ----  ----  -----
       (Oper Load =   50.4 tons    **     eff = .98     **    UA =  31198.)
 99 D902 L90O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
100 L90O L90I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
```

```
101 L900 R150  4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
           Control Section  D902 L900   Complement Section  L900 L90I
102 S145 L94I  4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
103 L94I P94I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P94I P94O                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                    FLOW(GPM)   200.0      300.0     100.0     30.0
                    TDH(FT WG)   40.0       14.0      55.0     58.0
          (TDH = ( .5785E+02) + ( .2619E-01)*GPM + (-.5754E-03)*GPM*GPM)
105 P94O D941  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
106 D941 D942  3.07 A N 188.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  177. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
            DESIGN              80.0  60.5   60.0   45.0  55.0  120.0
            OPERATION           80.0  60.5   60.0   ----  ----  -----
       (Oper Load =  48.8 tons    **     eff = .98     **    UA =   30192.)
107 D942 L94O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
108 L94O L94I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
109 L94O R145  4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
           Control Section  D942 L94O   Complement Section  L94O L94I
110 S140 S155  6.07 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
111 S155 L93I  4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
112 L93I P93I  4.03 A N  42.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P93I P93O                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                    FLOW(GPM)   160.0      240.0     100.0     30.0
                    TDH(FT WG)   40.0       13.0      52.0     58.0
          (TDH = ( .5758E+02) + ( .4034E-01)*GPM + (-.9411E-03)*GPM*GPM)
114 P93O D931  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
115 D931 D932  3.07 A N 199.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  188. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
            DESIGN              80.0  60.5   59.0   45.0  55.0  118.0
            OPERATION           80.0  60.5   59.0   ----  ----  -----
       (Oper Load =  47.9 tons    **     eff = .98     **    UA =   29689.)
116 D932 L93O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
117 L93O L93I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
118 L93O R155  4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
           Control Section  D932 L93O   Complement Section  L93O L93I
119 R155 R140  6.07 A N  11.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
120 S155 L92I  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
121 L92I P92I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P92I P92O                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                    FLOW(GPM)   160.0      250.0     100.0     30.0
                    TDH(FT WG)   40.0       13.0      52.0     58.0
          (TDH = ( .5871E+02) + ( .3067E-02)*GPM + (-.7452E-03)*GPM*GPM)
123 P92O D921  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
124 D921 D922  3.07 A N 233.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
            DESIGN              80.0  60.5   53.0   45.0  55.0  106.0
            OPERATION           80.0  60.5   53.0   ----  ----  -----
       (Oper Load =  43.1 tons    **     eff = .98     **    UA =   26669.)
```

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125 D922 L920  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
126 L920 L92I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
127 L920 R155  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
       Control Section  D922 L920    Complement Section  L920 L92I
128 S135 S160  7.98 A N  91.1   0.  0 0 0  0 0  2 0 0 0  0 0 0 0 0 0 0    0.
129 S160 L16I  7.98 A N 106.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
130 L16I P16I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P16I P160                                                                 CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                 FLOW(GPM)    285.0       400.0     200.0      57.0
                 TDH(FT WG)    50.0        25.0      62.0      72.0
       (TDH = ( .7181E+02) + ( .2181E-01)*GPM + (-.3465E-03)*GPM*GPM)
132 P160 D161  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
133 D161 D162  4.03 A N 166.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  155. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
         DESIGN                 80.0  60.5   150.0  45.0  55.0  300.0
         OPERATION              80.0  60.5   150.0  ----  ----  -----
      (Oper Load = 121.9 tons    **     eff = .98     **    UA =   75479.)
134 D162 L160  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
135 L160 L16I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
136 L160 R160  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
       Control Section  D162 L160    Complement Section  L160 L16I
137 R160 R135  7.98 A N  91.1   0.  0 0 0  0 0  2 0 0 0  0 0 0 0 0 0 0    0.
138 S160 L15I  7.98 A N 151.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
139 L15I P15I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P15I P150                                                                 CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                 FLOW(GPM)    235.0       305.0     141.0      47.0
                 TDH(FT WG)    50.0        32.0      66.0      72.0
       (TDH = ( .7147E+02) + ( .3776E-01)*GPM + (-.5487E-03)*GPM*GPM)
141 P150 D151  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
142 D151 D152  4.03 A N 199.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  188. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
         DESIGN                 80.0  60.5   115.0  45.0  55.0  230.0
         OPERATION              80.0  60.5   115.0  ----  ----  -----
      (Oper Load =  93.4 tons    **     eff = .98     **    UA =   57867.)
143 D152 L150  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
144 L150 L15I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
145 L150 R160  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
       Control Section  D152 L150    Complement Section  L150 L15I
146 S130 S170  6.07 A N 161.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
147 S170 S175  6.07 A N 349.3   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
148 S175 S180  6.07 A N  51.3   0.  0 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
149 S180 S185  6.07 A N  29.1   0.  0 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
150 S185 L06I  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
151 L06I P06I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P06I P060                                                                 CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                 FLOW(GPM)    400.0       560.0     240.0      80.0
                 TDH(FT WG)    80.0        40.0     105.0     115.0
       (TDH = ( .1144E+03) + ( .3125E-01)*GPM + (-.2930E-03)*GPM*GPM)
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153 P06O D061  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
154 D061 D062  3.07 A N  44.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   33. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM   EWT   LWT   GPM
           DESIGN               80.0  60.5   150.0  45.0  55.0  300.0
           OPERATION            80.0  60.5   150.0  ----  ----  -----
      (Oper Load = 121.9 tons    **    eff = .98    **    UA =  75479.)
155 D062 L06O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
156 L06O L06I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
157 L06O R185  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
         Control Section  D062 L06O    Complement Section  L06O L06I
158 R185 R180  6.07 A N  11.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
159 R180 R175  6.07 A N  83.3   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
160 R175 R170  6.07 A N 349.3   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
161 R170 R130  6.07 A N 161.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
162 S185 L10I  4.03 A N 242.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111.
163 L10I P10I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P10I P10O                                                              CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                   FLOW(GPM)    125.0      175.0     100.0      50.0
                   TDH(FT WG)    40.0       20.0      45.0      55.0
        (TDH = ( .5572E+02) + ( .5283E-01)*GPM + (-.1459E-02)*GPM*GPM)
165 P10O D101  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
166 D101 D102  3.07 A N 177.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  166. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM   EWT   LWT   GPM
           DESIGN               80.0  60.5    58.0  45.0  55.0  116.0
           OPERATION            80.0  60.5    58.0  ----  ----  -----
      (Oper Load =  47.1 tons    **    eff = .98    **    UA =  29185.)
167 D102 L10O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
168 L10O L10I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
169 L10O R185  4.03 A N 242.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
         Control Section  D102 L10O    Complement Section  L10O L10I
170 S180 L07I  4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
171 L07I P07I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P07I P07O                                                              CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                   FLOW(GPM)    150.0      210.0     105.0      30.0
                   TDH(FT WG)    50.0       25.0      62.0      72.0
        (TDH = ( .7172E+02) + ( .4445E-01)*GPM + (-.1268E-02)*GPM*GPM)
173 P07O D071  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
174 D071 D072  3.07 A N 233.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM   EWT   LWT   GPM
           DESIGN               80.0  60.5    41.0  45.0  55.0   82.0
           OPERATION            80.0  60.5    41.0  ----  ----  -----
      (Oper Load =  33.3 tons    **    eff = .98    **    UA =  20631.)
175 D072 L07O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
176 L07O L07I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
177 L07O R180  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
         Control Section  D072 L07O    Complement Section  L07O L07I
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178 S175 L11I  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
179 L11I P11I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P11I P11O                                                                  CP
  **** CONSTANT SPD PUMP **   Design      2 nd      3 rd      4 th   **
                  FLOW(GPM)   125.0       175.0     100.0      25.0
                  TDH(FT WG)   35.0        27.5      41.0      51.0
         (TDH = ( .5485E+02) + (-.1452E+00)*GPM + (-.7501E-04)*GPM*GPM)
181 P11O D111  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
182 D111 D112  3.07 A N 233.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222. EX
  **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN                80.0  60.5   55.0   45.0  55.0  110.0
        OPERATION             80.0  60.5   55.0   ----  ----  -----
     (Oper Load =  44.7 tons    **     eff = .98     **     UA =  27676.)
183 D112 L11O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
184 L11O L11I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
185 L11O R175  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
         Control Section  D112 L11O    Complement Section  L11O L11I
186 S170 S190  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
187 S190 L13I  4.03 A N 242.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111.
188 L13I P13I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P13I P13O                                                                  CP
  **** CONSTANT SPD PUMP **   Design      2 nd      3 rd      4 th   **
                  FLOW(GPM)   230.0       300.0     115.0      46.0
                  TDH(FT WG)   30.0        19.0      41.0      43.0
         (TDH = ( .4265E+02) + ( .2439E-01)*GPM + (-.3446E-03)*GPM*GPM)
190 P13O D131  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
191 D131 D132  3.07 A N 233.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222. EX
  **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN                80.0  60.5   48.0   45.0  55.0   96.0
        OPERATION             80.0  60.5   48.0   ----  ----  -----
     (Oper Load =  39.0 tons    **     eff = .98     **     UA =  24153.)
192 D132 L13O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
193 L13O L13I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
194 L13O R190  4.03 A N 242.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
         Control Section  D132 L13O    Complement Section  L13O L13I
195 R190 R170  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
196 S190 L14I  4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
197 L14I P14I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P14I P14O                                                                  CP
  **** CONSTANT SPD PUMP **   Design      2 nd      3 rd      4 th   **
                  FLOW(GPM)   210.0       273.0     105.0      42.0
                  TDH(FT WG)   50.0        32.0      68.0      72.0
         (TDH = ( .7159E+02) + ( .3662E-01)*GPM + (-.6647E-03)*GPM*GPM)
199 P14O D141  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
200 D141 D142  4.03 A N 233.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222. EX
  **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN                80.0  60.5   71.0   45.0  55.0  142.0
        OPERATION             80.0  60.5   71.0   ----  ----  -----
     (Oper Load =  57.7 tons    **     eff = .98     **     UA =  35727.)
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201 D142 L14O  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
202 L14O L14I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
203 L14O R190  4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
 **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
          Control Section  D142 L14O    Complement Section  L14O L14I
204 S120 L21I  6.07 A N 365.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222.
205 L21I P21I  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P21I P21O                                                                CP
 **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                   FLOW(GPM)   440.0       616.0     308.0     88.0
                   TDH(FT WG)   50.0        25.0      62.0     72.0
          (TDH = ( .7172E+02) + ( .1515E-01)*GPM + (-.1474E-03)*GPM*GPM)
207 P21O D211  6.07 A N  76.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
208 D211 D212  4.03 A N 144.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  133. EX
 **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
         DESIGN               80.0  60.5   160.0  45.0  55.0  320.0
         OPERATION            80.0  60.5   160.0  ----  ----  -----
      (Oper Load = 130.0 tons    **     eff = .98      **    UA =  80511.)
209 D212 L21O  6.07 A N  76.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
210 L21O L21I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
211 L21O R120  6.07 A N 365.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222. W3
 **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
          Control Section  D212 L21O    Complement Section  L21O L21I
212 CP32 S010  7.98 A N 171.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
213 S010 S020  7.98 A N 131.1   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
214 S020 S030  6.07 A N 349.3   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
215 S030 LSUI   .10 B O 453.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
216 LSUI PSUI  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PSUI PSUO                                                                CP
 **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                   FLOW(GPM)   310.0       434.0     217.0     93.0
                   TDH(FT WG)  115.0        58.0     143.0    164.0
          (TDH = ( .1653E+03) + ( .4667E-01)*GPM + (-.6765E-03)*GPM*GPM)
218 PSUO DSU1  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
219 DSU1 DSU2  3.07 A N 122.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. C2
 **** COOLING COIL **    2-way Control    **   CV = 100.0    **
                          N    EAT   LAT     CFM     EWT   LWT   GPM
         DESIGN           4   90.0  60.0   40000.  45.0  55.0  300.0
         OPERATION        -   90.0  60.0   40000.  ----  ----  -----
    (Sens Load = 103.5 tons ** TSR = 1.193 ** Factor = .991 ** UA =   64098.)
220 DSU2 LSUO  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
221 LSUO R030  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
222 LSUO R031  4.03 A N  21.1   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
223 R031 R032  3.07 A N 240.6   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222. CH
 **** SUCESS CHILL Control  R032 LSUI   ** Temp = 45.0   **  130.0 Tons **
224 R032 LSUI  4.03 A N  51.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
225 R030 R020  6.07 A N 349.3   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
226 R020 R010  6.07 A N 127.1   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
227 R010 CP33  7.98 A N 171.1   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
228 S030 L29I  4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
229 L29I P29I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
```

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  P29I P29O                                                                  CP
 **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                  FLOW(GPM)   280.0       392.0     196.0     112.0
                  TDH(FT WG)   65.0        32.0      81.0      91.0
        (TDH = ( .9270E+02) + ( .3900E-01)*GPM + (-.4940E-03)*GPM*GPM)
231 P29O D291   4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
232 D291 D292   3.07 A N 233.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222. EX
 **** HEAT EXCHANGER **  Wild Exch **
                             XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN               80.0  60.5    46.0   45.0  55.0   92.0
        OPERATION            80.0  60.5    46.0   ----  ----  -----
     (Oper Load =  37.4 tons   **     eff = .98     **    UA =   23147.)
233 D292 L29O   4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
234 L29O L29I   3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
235 L29O R03O   4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
 **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
       Control Section  D292 L29O    Complement Section  L29O L29I
236 S02O L28I   6.07 A N 254.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
237 L28I L28O   4.03 A N 273.1   0.  0 0 0  0 0  0 0 0 0  0 2 0 0 0 0 0  222. EX
 **** HEAT EXCHANGER **  Wild Exch **
                             XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN               80.0  60.5   135.0   45.0  55.0  270.0
        OPERATION            80.0  60.5   135.0   ----  ----  -----
     (Oper Load = 109.7 tons   **     eff = .98     **    UA =   67931.)
238 L28O R02O   6.07 A N 254.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
239 CPWS S21O  22.63 A N  11.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
240 S21O S22O  22.63 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
241 S22O S23O  22.63 A N  44.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
242 S23O S25O  22.63 A N 155.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
243 S25O S26O  22.63 A N  66.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
244 S26O S28O  22.63 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
245 S28O S3SI  22.63 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
246 S3SO S31O  22.63 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
247 S31O S4SI  22.63 A N 363.3   0.  0 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0    0.
248 S4SO S35O  22.63 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
249 S35O S41O  22.63 A N  11.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
250 S41O S42O  18.81 A N 266.6   0.  0 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
251 S42O S44O  18.81 A N 166.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
252 S44O S46O  18.81 A N 359.3   0.  0 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0    0.
253 S46O S5SI  18.81 A N 111.1   0.  0 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
254 S5SO S51O  18.81 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
255 S51O S53O  18.81 A N 470.4   0.  0 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0    0.
256 S53O S55O  18.81 A N 316.6   0.  1 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
257 S55O S6SI  13.13 A N  66.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
258 S6SO S61O  11.94 A N1045.9   0.  1 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0    0.
259 S61O S615   7.98 A N 837.7   0.  1 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
260 S615 LWOI   7.98 A N 726.6   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
261 LWOI PWOI   7.98 A N 151.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PWOI PWOO                                                                CP
 **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                  FLOW(GPM)   700.0       980.0     490.0     210.0
                  TDH(FT WG)   80.0        40.0     100.0     115.0
        (TDH = ( .1164E+03) + ( .1212E-01)*GPM + (-.9185E-04)*GPM*GPM)
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263 PWOO DWO1  7.98 A N  84.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
264 DWO1 DWO2  6.07 A N 344.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  333. C2
  **** COOLING COIL **   2-way Control   **   CV = *****   **
                             N    EAT    LAT     CFM     EWT    LWT    GPM
            DESIGN           4   95.0   60.0   80000.   45.0   55.0   636.0
            OPERATION        -   95.0   60.0   80000.   ----   ----   -----
    (Sens Load = 239.4 tons ** TSR = 1.094 ** Factor = .992 ** UA = 125807.)
265 DWO2 LWOO  7.98 A N  11.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
266 LWOO R615  7.98 A N 726.6   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
267 R615 R610  7.98 A N 837.7   0.  1 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
268 R610 S6RI 11.94 A N1045.9   0.  1 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0    0.
269 S6RO R550 13.13 A N  66.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
270 R550 R530 18.81 A N 316.6   0.  1 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
271 R530 R510 18.81 A N 470.4   0.  0 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0    0.
272 R510 S5RI 18.81 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
273 S5RO R460 18.81 A N 161.1   0.  1 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
274 R460 R440 18.81 A N 359.3   0.  0 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0    0.
275 R440 R420 18.81 A N 192.6   0.  0 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0    0.
276 R420 R410 18.81 A N 266.6   0.  0 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
277 R410 R350 22.63 A N  11.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
278 R350 S4RI 22.63 A N 137.2   0.  0 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
279 S4RO R310 22.63 A N 363.3   0.  0 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0    0.
280 R310 S3RI 22.63 A N 282.2   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
281 S3RO R280 22.63 A N 397.2   0.  1 0 0  0 0  1 0 0 0  0 0 0 0 0 0 0    0.
282 R280 R260 22.63 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
283 R260 R250 22.63 A N  66.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
284 R250 R230 22.63 A N 155.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
285 R230 R220 22.63 A N  44.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
286 R220 R210 22.63 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
287 R210 CPWR 22.63 A N  11.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
288 S610 S620  7.98 A N 151.1   0.  1 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
289 S620 S625  7.98 A N 206.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
290 S625 LFRI  2.47 A N 123.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
291 LFRI PFRI  2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PFRI PFRO                                                                CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                     FLOW(GPM)   90.0       126.0      63.0      27.0
                     TDH(FT WG)  50.0        25.0      62.0      71.0
         (TDH = ( .7121E+02) + ( .8534E-01)*GPM + (-.3581E-02)*GPM*GPM)
293 PFRO DFR1  2.47 A N  56.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
294 DFR1 DFR2  2.07 A N  55.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   44. EX
  **** HEAT EXCHANGER **  Wild Exch **
                              XEWT   XLWT    XGPM    EWT    LWT    GPM
            DESIGN            80.0   60.5    56.0   45.0   55.0   112.0
            OPERATION         80.0   60.5    56.0   ----   ----   -----
      (Oper Load =  45.5 tons    **     eff = .98     **    UA =  28179.)
295 DFR2 LFRO  2.47 A N  56.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
296 LFRO LFRI  2.07 A N  21.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
297 LFRO R625  2.47 A N 123.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
          Control Section  DFR2 LFRO    Complement Section  LFRO LFRI
298 R625 R620  7.98 A N 206.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
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299 R620 R610   7.98 A N 131.1   0.  1 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
300 S625 LMOI   2.47 A N  56.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
301 LMOI PMOI   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PMOI PMOO                                                              CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                   FLOW(GPM)    90.0       126.0      63.0      27.0
                   TDH(FT WG)   50.0        25.0      62.0      71.0
         (TDH = ( .7121E+02) + ( .8534E-01)*GPM + (-.3581E-02)*GPM*GPM)
303 PMOO DMO1   2.47 A N  56.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
304 DMO1 DMO2   2.47 A N 122.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. EX
  **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN                80.0  60.5   61.0   45.0  55.0  122.0
        OPERATION             80.0  60.5   61.0   ----  ----  -----
    (Oper Load =  49.6 tons    **    eff = .98     **    UA =  30695.)
305 DMO2 LMOO   2.47 A N  56.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
306 LMOO LMOI   2.07 A N  21.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
307 LMOO R625   2.47 A N  56.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
         Control Section  DMO2 LMOO    Complement Section  LMOO LMOI
308 S620 LFII   2.47 A N  56.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
309 LFII PFII   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PFII PFIO                                                              CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                   FLOW(GPM)   150.0       210.0     105.0      30.0
                   TDH(FT WG)   50.0        25.0      62.0      72.0
         (TDH = ( .7172E+02) + ( .4445E-01)*GPM + (-.1268E-02)*GPM*GPM)
311 PFIO DFI1   2.47 A N  56.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
312 DFI1 DFI2   2.47 A N  77.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   66. EX
  **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN                80.0  60.5   71.0   45.0  55.0  142.0
        OPERATION             80.0  60.5   71.0   ----  ----  -----
    (Oper Load =  57.7 tons    **    eff = .98     **    UA =  35727.)
313 DFI2 LFIO   2.47 A N  56.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
314 LFIO LFII   2.07 A N  21.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
315 LFIO R620   2.47 A N  56.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
         Control Section  DFI2 LFIO    Complement Section  LFIO LFII
316 S550 S555   7.98 A N 115.5   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0    0.
317 S555 LMRI   7.98 A N 151.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
318 LMRI PMRI   7.98 A N 151.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PMRI PMRO                                                              CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                   FLOW(GPM)  1000.0      1300.0     600.0     200.0
                   TDH(FT WG)   80.0        51.0     105.0     115.0
         (TDH = ( .1142E+03) + ( .1361E-01)*GPM + (-.4781E-04)*GPM*GPM)
320 PMRO DMR1   7.98 A N  84.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
321 DMR1 DMR2   6.07 A N 344.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  333. EX
  **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN                80.0  60.5  288.0   45.0  55.0  576.0
        OPERATION             80.0  60.5  288.0   ----  ----  -----
    (Oper Load = 234.0 tons    **    eff = .98     **    UA = 144920.)
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322 DMR2 LMRO  7.98 A N  84.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
323 LMRO LMRI  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
324 LMRO R555  7.98 A N 151.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
       Control Section  DMR2 LMRO    Complement Section  LMRO LMRI
325 R555 R550  7.98 A N 115.5   0.  2 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0   0.
326 S510 S515 18.81 A N 111.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
327 S515 LSAI  6.07 A N 698.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
328 LSAI PSAI  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
    PSAI PSAO                                                               CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                   FLOW(GPM)   475.0       618.0     285.0      95.0
                   TDH(FT WG)   60.0        39.0      79.0      87.0
       (TDH = ( .8717E+02) + ( .1261E-01)*GPM + (-.1467E-03)*GPM*GPM)
330 PSAO DSA1  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
331 DSA1 DSA2  4.03 A N  77.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  66. EX
  **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN                80.0  60.5   275.0  45.0  55.0  550.0
        OPERATION             80.0  60.5   275.0  ----  ----  -----
    (Oper Load = 223.4 tons    **    eff = .98    **    UA = 138379.)
332 DSA2 LSAO  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
333 LSAO LSAI  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
334 LSAO R515  6.07 A N 698.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
       Control Section  DSA2 LSAO    Complement Section  LSAO LSAI
335 R515 R510 18.81 A N 111.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
336 S515 S520  6.07 A N 111.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
337 S520 L56I  6.07 A N 520.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0 444.
338 L56I P56I  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
    P56I P56O                                                               CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                   FLOW(GPM)   150.0       195.0     105.0      45.0
                   TDH(FT WG)   50.0        33.0      63.0      72.0
       (TDH = ( .7365E+02) + ( .1746E-01)*GPM + (-.1162E-02)*GPM*GPM)
340 P56O D561  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
341 D561 D562  4.03 A N 344.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0 333. EX
  **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN                80.0  60.5   125.0  45.0  55.0  250.0
        OPERATION             80.0  60.5   125.0  ----  ----  -----
    (Oper Load = 101.6 tons    **    eff = .98    **    UA =  62899.)
342 D562 L56O  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
343 L56O L56I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
344 L56O R520  6.07 A N 520.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0 444. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 250.0 ** T-Set = 56.00 **
       Control Section  D562 L56O    Complement Section  L56O L56I
345 R520 R515  6.07 A N 111.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
346 S520 L57I  6.07 A N 409.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0 333.
347 L57I P57I  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   0.
    P57I P57O                                                               CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                   FLOW(GPM)   150.0       210.0     105.0      45.0
                   TDH(FT WG)   30.0        15.0      37.5      43.0
       (TDH = ( .4343E+02) + ( .2411E-01)*GPM + (-.7588E-03)*GPM*GPM)
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349 P570 D571  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
350 D571 D572  4.03 A N 344.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  333. EX
  **** HEAT EXCHANGER **  Wild Exch **
                            XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN              80.0  60.5   115.0   45.0  55.0  230.0
        OPERATION           80.0  60.5   115.0   ----  ----  -----
    (Oper Load =  93.4 tons    **    eff = .98     **    UA =  57867.)
351 D572 L570  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
352 L570 L57I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
353 L570 R520  6.07 A N 409.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  333. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 250.0 ** T-Set = 56.00 **
       Control Section  D572 L570    Complement Section  L570 L57I
354 S460 S465  6.07 A N 111.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
355 S465 L55I  3.07 A N  81.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
356 L55I P55I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P55I P550                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd     3 rd     4 th    **
                 FLOW(GPM)      163.0      212.0    114.0     49.0
                 TDH(FT WG)      25.0       12.0     32.0     36.0
       (TDH = ( .3284E+02) + ( .1088E+00)*GPM + (-.9713E-03)*GPM*GPM)
358 P550 D551  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
359 D551 D552  3.07 A N 122.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. EX
  **** HEAT EXCHANGER **  Wild Exch **
                            XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN              80.0  60.5    95.0   45.0  55.0  190.0
        OPERATION           80.0  60.5    95.0   ----  ----  -----
    (Oper Load =  77.2 tons    **    eff = .98     **    UA =  47804.)
360 D552 L550  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
361 L550 L55I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
362 L550 R465  3.07 A N  81.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  75.0 ** T-Set = 56.00 **
       Control Section  D552 L550    Complement Section  L550 L55I
363 R465 R460  6.07 A N 171.1   0.  0 0 0  0 0  2 0 0 0  0 0 0 0 0 0 0    0.
364 S440 S445  7.98 A N  91.1   0.  0 0 0  0 0  2 0 0 0  0 0 0 0 0 0 0    0.
365 S445 LBOI  7.98 A N 306.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222.
366 LBOI PBOI  7.98 A N  51.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PBOI PBOO                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd     3 rd     4 th    **
                 FLOW(GPM)     1800.0     2520.0   1080.0    360.0
                 TDH(FT WG)      85.0       42.0    111.0    122.0
       (TDH = ( .1210E+03) + ( .7937E-02)*GPM + (-.1557E-04)*GPM*GPM)
368 PBOO DBO1  7.98 A N 284.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222.
369 DBO1 DBO2  6.07 A N  77.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   66. EX
  **** HEAT EXCHANGER **  Wild Exch **
                            XEWT  XLWT   XGPM    EWT   LWT   GPM
        DESIGN              80.0  60.5   500.0   45.0  55.0 1000.0
        OPERATION           80.0  60.5   500.0   ----  ----  -----
    (Oper Load = 406.3 tons    **    eff = .98     **    UA = 251598.)
370 DBO2 LBOO  7.98 A N 284.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222.
371 LBOO LBOI  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
372 LBOO R445  7.98 A N 306.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = ***** ** T-Set = 56.00 **
       Control Section  DBO2 LBOO    Complement Section  LBOO LBOI
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373 R445 R440  7.98 A N  91.1   0.  0 0 0  0 0  2 0 0 0  0 0 0 0 0 0 0     0.
374 S420 S425 15.00 A N  55.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
375 S425 S430 15.00 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
376 S430 S438  7.98 A N 484.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
377 S438 LBSI  4.03 A N 242.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111.
378 LBSI PBSI  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
    PBSI PBSO                                                                  CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                     FLOW(GPM)   140.0       196.0      84.0      28.0
                     TDH(FT WG)   55.0        28.0      72.0      80.0
         (TDH = ( .8020E+02) + ( .3316E-01)*GPM + (-.1526E-02)*GPM*GPM)
380 PBSO DBS1  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
381 DBS1 DBS2  3.07 A N 233.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   222. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                 XEWT  XLWT   XGPM    EWT   LWT   GPM
            DESIGN               80.0  60.5    55.0  45.0  55.0  110.0
            OPERATION            80.0  60.5    55.0  ----  ----  -----
       (Oper Load =  44.7 tons    **     eff = .98     **     UA =  27676.)
382 DBS2 LBSO  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
383 LBSO LBSI  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
384 LBSO R438  4.03 A N 242.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  75.0 ** T-Set = 56.00 **
         Control Section  DBS2 LBSO    Complement Section  LBSO LBSI
385 R438 R430  7.98 A N 484.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
386 R430 R425 15.00 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
387 R425 R420 15.00 A N  87.5   0.  0 0 0  0 0  0 0 0 0  0 1 0 0 0 0 0     0.
388 S438 LBAI  2.47 A N 123.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
389 LBAI PBAI  2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
    PBAI PBAO                                                                  CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                     FLOW(GPM)    88.0       114.0      53.0      26.0
                     TDH(FT WG)   40.0        26.0      53.0      56.0
         (TDH = ( .5524E+02) + ( .1256E+00)*GPM + (-.3370E-02)*GPM*GPM)
391 PBAO DBA1  2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
392 DBA1 DBA2  2.07 A N 122.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                 XEWT  XLWT   XGPM    EWT   LWT   GPM
            DESIGN               80.0  60.5    55.0  45.0  55.0  110.0
            OPERATION            80.0  60.5    55.0  ----  ----  -----
       (Oper Load =  44.7 tons    **     eff = .98     **     UA =  27676.)
393 DBA2 LBAO  2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
394 LBAO LBAI  2.07 A N  21.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
395 LBAO R438  2.47 A N 123.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
         Control Section  DBA2 LBAO    Complement Section  LBAO LBAI
396 S430 S435  6.07 A N 144.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111.
397 S435 LSGI  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
398 LSGI PSGI  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
    PSGI PSGO                                                                  CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                     FLOW(GPM)   120.0       168.0      72.0      36.0
                     TDH(FT WG)   40.0        20.0      52.5      57.0
         (TDH = ( .5727E+02) + ( .5073E-01)*GPM + (-.1622E-02)*GPM*GPM)
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400 PSGO DSG1  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
401 DSG1 DSG2  3.07 A N 155.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  144. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
             DESIGN             80.0  60.5    95.0  45.0  55.0  190.0
             OPERATION          80.0  60.5    95.0  ----  ----  -----
       (Oper Load =  77.2 tons    **     eff = .98    **    UA =  47804.)
402 DSG2 LSGO  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
403 LSGO LSGI  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
404 LSGO R435  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
          Control Section  DSG2 LSGO    Complement Section  LSGO LSGI
405 R435 R430  6.07 A N 144.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111.
406 S435 LSCI  4.03 A N  75.5   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
407 LSCI PSCI  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PSCI PSCO                                                                CP
  **** CONSTANT SPD PUMP **     Design      2 nd      3 rd      4 th   **
                      FLOW(GPM)   690.0      897.0     483.0     138.0
                      TDH(FT WG)   65.0       42.0      81.0      93.0
          (TDH = ( .9247E+02) + ( .1460E-01)*GPM + (-.7894E-04)*GPM*GPM)
409 PSCO DSC1  4.03 A N  42.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
410 DSC1 DSC2  3.07 A N  33.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   22. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
             DESIGN             80.0  60.5   250.0  45.0  55.0  500.0
             OPERATION          80.0  60.5   250.0  ----  ----  -----
       (Oper Load = 203.1 tons    **     eff = .98    **    UA = 125799.)
411 DSC2 LSCO  4.03 A N  42.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
412 LSCO LSCI  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
413 LSCO R435  4.03 A N 108.8   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
          Control Section  DSC2 LSCO    Complement Section  LSCO LSCI
414 S425 LTHI  3.07 A N  70.5   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
415 LTHI PTHI  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PTHI PTHO                                                                CP
  **** CONSTANT SPD PUMP **     Design      2 nd      3 rd      4 th   **
                      FLOW(GPM)   150.0      195.0      90.0      30.0
                      TDH(FT WG)   40.0       26.0      53.0      58.0
          (TDH = ( .5804E+02) + ( .3183E-01)*GPM + (-.1009E-02)*GPM*GPM)
417 PTHO DTH1  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
418 DTH1 DTH2  3.07 A N 122.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
             DESIGN             80.0  60.5    90.0  45.0  55.0  180.0
             OPERATION          80.0  60.5    90.0  ----  ----  -----
       (Oper Load =  73.1 tons    **     eff = .98    **    UA =  45288.)
419 DTH2 LTHO  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
420 LTHO LTHI  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
421 LTHO R425  4.03 A N  75.5   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
          Control Section  DTH2 LTHO    Complement Section  LTHO LTHI
422 S410 S7SI 11.94 A N  55.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
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423 S7SO S710 11.94 A N 555.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
424 S710 S740 11.94 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
425 S740 S770 11.94 A N  55.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
426 S770 S8SI 10.02 A N 777.7   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
427 S8SO S810 10.02 A N 255.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
428 S810 S811 10.02 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
429 S811 BP1I  4.03 A N  44.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
430 BP1I BP1O   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
431 BP1O S812  4.03 A N  44.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
432 S811 BP2I  4.03 A N  44.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    BP2I BP2O                                                                CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                     FLOW(GPM)  288.0       375.0     202.0     58.0
                     TDH(FT WG)  40.0        26.0      53.0     60.0
         (TDH = ( .6052E+02) + ( .1285E-01)*GPM + (-.2845E-03)*GPM*GPM)
434 BP2O S812  4.03 A N  44.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
435 S812 S815  4.03 A N 444.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
436 S815 S820  4.03 A N 777.7   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
437 S820 L61I  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
438 L61I P61I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P61I P61O                                                                CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                     FLOW(GPM)  100.0       130.0      60.0     20.0
                     TDH(FT WG)  30.0        19.0      39.0     43.0
         (TDH = ( .4260E+02) + ( .5141E-01)*GPM + (-.1784E-02)*GPM*GPM)
440 P61O D611  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
441 D611 D612  3.07 A N 199.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  188. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
           DESIGN               80.0  60.5    95.0  45.0  55.0  190.0
           OPERATION            80.0  60.5    95.0  ----  ----  -----
       (Oper Load =  77.2 tons   **     eff = .98     **    UA =  47804.)
442 D612 L61O  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
443 L61O L61I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
444 L61O R820  4.03 A N  64.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
         Control Section  D612 L61O    Complement Section  L61O L61I
445 R820 R815  4.03 A N 777.7   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
446 R815 R810  4.03 A N 666.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
447 R810 S8RI 10.02 A N 255.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
448 S8RO R770 10.02 A N 777.7   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
449 R770 R740 11.94 A N  55.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
450 R740 R710 11.94 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
451 R710 S7RI 11.94 A N 555.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
452 S7RO R410 11.94 A N  55.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
453 S820 LATI  4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
454 LATI PATI  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PATI PATO                                                                CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                     FLOW(GPM)  100.0       130.0      60.0     20.0
                     TDH(FT WG)  30.0        19.0      39.0     43.0
         (TDH = ( .4260E+02) + ( .5141E-01)*GPM + (-.1784E-02)*GPM*GPM)
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456 PATO DAT1   4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
457 DAT1 DAT2   3.07 A N 199.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  188. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM   EWT   LWT   GPM
           DESIGN               80.0  60.5   95.0  45.0  55.0  190.0
           OPERATION            80.0  60.5   95.0  ----  ----  -----
     (Oper Load =  77.2 tons    **    eff = .98    **    UA =  47804.)
458 DAT2 LATO   4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
459 LATO LATI   3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
460 LATO R820   4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
         Control Section  DAT2 LATO    Complement Section  LATO LATI
461 S810 S830 10.02 A N  55.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
462 S830 LCRI   7.98 A N  84.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
463 LCRI PCRI   7.98 A N  51.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PCRI PCRO                                                                 CP
  **** CONSTANT SPD PUMP **     Design       2 nd     3 rd     4 th   **
                      FLOW(GPM)   970.0      1262.0    590.0    195.0
                      TDH(FT WG)   30.0        19.0     39.0     43.0
         (TDH = ( .4261E+02) + ( .5430E-02)*GPM + (-.1908E-04)*GPM*GPM)
465 PCRO DCR1   7.98 A N  51.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
466 DCR1 DCR2   7.98 A N 177.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  166. C3
  **** COOLING COIL **   3-way Control   **   CV = *****   **
                             N    EAT   LAT    CFM    EWT   LWT   GPM
           DESIGN            4   90.0  60.0 125000.  45.0  55.0  900.0
           OPERATION         -   90.0  60.0 125000.  ----  ----  -----
    (Sens Load = 323.5 tons ** TSR = 1.146 ** Factor = .991 ** UA = 192295.)
467 DCR1 DCR2   6.07 A N 177.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  166.
468 DCR2 LCRO   7.98 A N  62.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
469 LCRO R830   7.98 A N  84.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
470 R830 R810 10.02 A N  55.5   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
471 S830 L99I   6.07 A N 453.8   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  333.
472 L99I P99I   6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P99I P99O                                                                 CP
  **** CONSTANT SPD PUMP **     Design       2 nd     3 rd     4 th   **
                      FLOW(GPM)   830.0      1029.0    498.0    166.0
                      TDH(FT WG)   80.0        51.0    105.0    115.0
         (TDH = ( .1102E+03) + ( .4057E-01)*GPM + (-.9409E-04)*GPM*GPM)
474 P99O D991   6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
475 D991 D992   4.03 A N  77.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   66. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM   EWT   LWT   GPM
           DESIGN               80.0  60.5  250.0  45.0  55.0  500.0
           OPERATION            80.0  60.5  250.0  ----  ----  -----
     (Oper Load = 203.1 tons    **    eff = .98    **    UA = 125799.)
476 D992 L99O   6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
477 L99O L99I   4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
478 L99O R830   6.07 A N 453.8   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  333. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
         Control Section  D992 L99O    Complement Section  L99O L99I
479 LHOI S770   3.07 A N 237.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
480 LHOI DHO1   6.07 A N  65.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
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481 DHO1 DHO2  4.03 A N  77.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   66. EB
  **** HEAT EXCHANGER 3-way Loop Control**  CV = 100.0 **
         Valve Location   LHOI DHO1       Bypass Section  LHOI S770
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
           DESIGN               80.0  60.5   325.0  45.0  55.0  650.0
           OPERATION            80.0  60.5   300.0  ----  ----  -----
       (Oper Load = 243.8 tons   **     eff = .98     **    UA = 163539.)
482 DHO2 LHOO  6.07 A N  65.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
483 R770 LHOO  3.07 A N 237.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
484 LHOO PHOI  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PHOI PHOO                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                 FLOW(GPM)  1100.0      1430.0     660.0     330.0
                 TDH(FT WG)  120.0        76.0     158.0     171.0
         (TDH = ( .1707E+03) + ( .2100E-01)*GPM + (-.6100E-04)*GPM*GPM)
486 PHOO RHOC  6.07 A N  76.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
487 RHOC SHOC  4.03 A N 133.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. CH
  **** HOWEY CHILL  Control  SHOC LHOI  ** Temp = 45.0  **  450.0 Tons **
488 SHOC LHOI  6.07 A N 255.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222.
489 S740 S745  7.98 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
490 S745 S750  7.98 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
491 S750 SAE1  6.07 A N 254.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
492 SAE1 LAEI  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
493 LAEI PAEI  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PAEI PAEO                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                 FLOW(GPM)   600.0       780.0     360.0     120.0
                 TDH(FT WG)   50.0        32.0      66.0      72.0
         (TDH = ( .7155E+02) + ( .1411E-01)*GPM + (-.8323E-04)*GPM*GPM)
495 PAEO DAE1  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
496 DAE1 DAE2  4.03 A N  66.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   55. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
           DESIGN               80.0  60.5   275.0  45.0  55.0  550.0
           OPERATION            80.0  60.5   275.0  ----  ----  -----
       (Oper Load = 223.4 tons   **     eff = .98     **    UA = 138379.)
497 DAE2 LAEO  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
498 LAEO LAEI  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
499 LAEO RAE1  6.07 A N  65.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
         Control Section  DAE2 LAEO    Complement Section  LAEO LAEI
500 RAE1 R750  6.07 A N 444.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222.
501 RAE1 RAE2  6.13 B O  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
502 RAE2 SAE2  6.07 A N 133.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. CH
  **** AECAL CHILL  Control  SAE2 SAE1  ** Temp = 45.0  **  200.0 Tons **
503 SAE2 SAE1  6.07 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
504 R750 R745  7.98 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
505 R745 R740  7.98 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
506 S750 SPE1  6.07 A N 143.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
507 SPE1 LPEI  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
508 LPEI PPEI  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PPEI PPEO                                                                CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                 FLOW(GPM)   740.0       962.0     444.0     148.0
                 TDH(FT WG)   50.0        32.0      66.0      72.0
         (TDH = ( .7155E+02) + ( .1144E-01)*GPM + (-.5471E-04)*GPM*GPM)
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510 PPEO DPE1   6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
511 DPE1 DPE2   4.03 A N  66.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   55. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
           DESIGN               80.0  60.5   225.0  45.0  55.0  450.0
           OPERATION            80.0  60.5   225.0  ----  ----  -----
      (Oper Load = 182.8 tons    **     eff = .98    **    UA = 113219.)
512 DPE2 LPEO   6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
513 LPEO LPEI   4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
514 LPEO RPE1   6.07 A N  65.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
        Control Section  DPE2 LPEO   Complement Section  LPEO LPEI
515 RPE1 R750   6.07 A N 555.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222.
516 RPE1 RPE2   4.03 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
517 RPE2 SPE2   6.07 A N 133.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. CH
  **** PETIT CHILL  Control  SPE2 SPE1  ** Temp = 45.0  **  200.0 Tons **
518 SPE2 SPE1   6.07 A N  22.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
519 S710 S715   6.07 A N  66.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
520 S715 LMAI   6.07 A N  87.5   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
521 LMAI PMAI   6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PMAI PMAO                                                                 CP
  **** CONSTANT SPD PUMP **    Design      2 nd     3 rd     4 th   **
                     FLOW(GPM)  500.0      650.0    300.0    100.0
                     TDH(FT WG)  70.0       45.0     92.0    101.0
         (TDH = ( .1006E+03) + ( .1983E-01)*GPM + (-.1622E-03)*GPM*GPM)
523 PMAO DMA1   6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
524 DMA1 DMA2   4.03 A N  99.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   88. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
           DESIGN               80.0  60.5   225.0  45.0  55.0  450.0
           OPERATION            80.0  60.5   225.0  ----  ----  -----
      (Oper Load = 182.8 tons    **     eff = .98    **    UA = 113219.)
525 DMA2 LMAO   6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
526 LMAO LMAI   4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
527 LMAO R715   6.07 A N  98.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
        Control Section  DMA2 LMAO   Complement Section  LMAO LMAI
528 R715 R710   6.07 A N  66.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
529 LBUI S350   4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
530 LBUI DBU1   6.07 A N  65.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
531 DBU1 DBU2   4.03 A N  77.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   66. EB
  **** HEAT EXCHANGER 3-way Loop Control**  CV = 100.0 **
        Valve Location   LBUI DBU1      Bypass Section  LBUI S350
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
           DESIGN               80.0  60.5   325.0  45.0  55.0  650.0
           OPERATION            80.0  60.5   300.0  ----  ----  -----
      (Oper Load = 243.8 tons    **     eff = .98    **    UA = 163539.)
532 DBU2 LBUO   6.07 A N  65.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
533 R350 LBUO   4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
534 LBUO PBUI   6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    PBUI PBUO                                                                 CP
  **** CONSTANT SPD PUMP **    Design      2 nd     3 rd     4 th   **
                     FLOW(GPM)  750.0      975.0    450.0    150.0
                     TDH(FT WG)  80.0       51.0    105.0    115.0
         (TDH = ( .1142E+03) + ( .1814E-01)*GPM + (-.8499E-04)*GPM*GPM)
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536 PBUO RBUC   6.07 A N  76.4    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
537 RBUC SBUC   6.07 A N 133.2    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111. CH
  **** BUNGR CHILL  Control  SBUC LBUI  ** Temp = 45.0  **  300.0 Tons **
538 SBUC LBUI   6.07 A N 255.3    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   222.
539 S310 S9SI  10.02 A N 124.1    0.  0 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0     0.
540 S9SO S320  10.02 A N 333.3    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
541 S320 S330   7.98 A N 333.3    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
542 S330 L75I   6.07 A N 231.8    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111.
543 L75I P75I   6.07 A N  43.1    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
    P75I P75O                                                                   CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                      FLOW(GPM)   320.0      416.0     192.0     64.0
                      TDH(FT WG)   55.0       35.0      72.0     80.0
         (TDH = ( .7990E+02) + ( .1926E-01)*GPM + (-.3047E-03)*GPM*GPM)
545 P75O D751   6.07 A N  54.2    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
546 D751 D752   4.03 A N 122.1    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                  XEWT  XLWT   XGPM    EWT   LWT   GPM
             DESIGN               80.0  60.5   125.0  45.0  55.0  250.0
             OPERATION            80.0  60.5   125.0  ----  ----  -----
        (Oper Load = 101.6 tons    **    eff = .98     **    UA =   62899.)
547 D752 L75O   6.07 A N  54.2    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
548 L75O L75I   4.03 A N  31.1    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
549 L75O R330   6.07 A N 231.8    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
           Control Section  D752 L75O    Complement Section  L75O L75I
550 R330 R320   7.98 A N 343.3    0.  0 0 0  1 0  0 0 0 0  0 0 0 0 0 0 0     0.
551 R320 S9RI  10.02 A N 333.3    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
552 S9RO R310  10.02 A N 111.1    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
553 L76I S330   4.03 A N 353.3    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
554 L76I D761   6.07 A N  65.3    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
555 D761 D762   4.03 A N 122.1    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111. C3
  **** COOLING COIL **   3-way Control   **  CV = 350.0   **
                              N   EAT   LAT    CFM    EWT   LWT   GPM
             DESIGN           4   90.0  60.5  50000.  45.0  55.0  350.0
             OPERATION        -   90.0  60.5  45000.  ----  ----  -----
    (Sens Load = 114.5 tons ** TSR = 1.133 ** Factor = .992 ** UA =   73709.)
556 D761 D762   4.03 A N 122.1    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111.
557 D762 L76O   6.07 A N  65.3    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
558 R330 L76O   4.03 A N 353.3    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
559 L76O P76I   6.07 A N  54.2    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
    P76I P76O                                                                   CP
  **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                      FLOW(GPM)   750.0      975.0     450.0    150.0
                      TDH(FT WG)   80.0       51.0     105.0    115.0
         (TDH = ( .1142E+03) + ( .1814E-01)*GPM + (-.8499E-04)*GPM*GPM)
561 P76O R76C   6.07 A N  76.4    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
562 R76C S76C   4.03 A N  88.2    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    66. CH
  **** OARCH CHILL  Control  S76C L76I  ** Temp = 45.0  **  300.0 Tons **
563 S76C L76I   6.07 A N 255.3    0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   222.
564 S320 L51I   6.07 A N 198.6    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
565 L51I P51I   6.07 A N  43.1    0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
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  P51I P51O                                                                          CP
 **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                  FLOW(GPM)   335.0       435.0     201.0      67.0
                  TDH(FT WG)  100.0        64.0     131.0     143.0
         (TDH = ( .1416E+03) + ( .5620E-01)*GPM + (-.5390E-03)*GPM*GPM)
567 P51O D511  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
568 D511 D512  4.03 A N 177.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  166. EX
 **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
            DESIGN            80.0  60.5    95.0  45.0  55.0  190.0
            OPERATION         80.0  60.5    95.0  ----  ----  -----
       (Oper Load =  77.2 tons    **     eff = .98    **    UA =  47804.)
569 D512 L51O  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
570 L51O L51I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
571 L51O R320  6.07 A N 198.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
 **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
         Control Section  D512 L51O    Complement Section  L51O L51I
572 S280 L84I  4.03 A N  75.5   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
573 L84I P84I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
  P84I P84O                                                                          CP
 **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                  FLOW(GPM)   150.0       195.0      90.0      30.0
                  TDH(FT WG)   60.0        39.0      79.0      87.0
         (TDH = ( .8713E+02) + ( .4148E-01)*GPM + (-.1480E-02)*GPM*GPM)
575 P84O D841  4.03 A N  42.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
576 D841 D842  3.07 A N 122.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. EX
 **** HEAT EXCHANGER **  Wild Exch **
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
            DESIGN            80.0  60.5   125.0  45.0  55.0  250.0
            OPERATION         80.0  60.5   125.0  ----  ----  -----
       (Oper Load = 101.6 tons    **     eff = .98    **    UA =  62899.)
577 D842 L84O  4.03 A N  42.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
578 L84O L84I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
579 L84O R280  4.03 A N  75.5   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
 **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
         Control Section  D842 L84O    Complement Section  L84O L84I
580 L02I S250  3.07 A N 348.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
581 L02I D021  6.07 A N  65.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
582 D021 D022  4.03 A N  99.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   88. EB
 **** HEAT EXCHANGER 3-way Loop Control**  CV = 350.0 **
         Valve Location   L02I D021        Bypass Section  L02I S250
                              XEWT  XLWT   XGPM    EWT   LWT   GPM
            DESIGN            80.0  60.5   325.0  45.0  55.0  650.0
            OPERATION         80.0  60.5   300.0  ----  ----  -----
       (Oper Load = 243.8 tons    **     eff = .98    **    UA = 163539.)
583 D022 L02O  6.07 A N  65.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
584 R250 L02O  3.07 A N 348.3   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
585 L02O P02I  6.07 A N  54.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
  P02I P02O                                                                          CP
 **** CONSTANT SPD PUMP **    Design       2 nd      3 rd      4 th   **
                  FLOW(GPM)   980.0      1274.0     588.0     196.0
                  TDH(FT WG)   80.0        51.0     105.0     115.0
         (TDH = ( .1142E+03) + ( .1389E-01)*GPM + (-.4978E-04)*GPM*GPM)
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587 P02O R02C  6.07 A N  76.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
588 R02C S02C  4.03 A N  88.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   66. CH
 **** SKILE CHILL  Control  S02C L02I  ** Temp = 45.0  **  350.0 Tons **
589 S02C L02I  4.03 A N 255.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  222.
590 S230 S235  7.98 A N 111.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
591 S235 S240  7.98 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
592 S240 S245  6.07 A N  66.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
593 S245 L37I  4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
594 L37I P37I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P37I P37O                                                                CP
 **** CONSTANT SPD PUMP **   Design      2 nd     3 rd     4 th   **
                      FLOW(GPM)   185.0       259.0    111.0     37.0
                      TDH(FT WG)   13.0         6.5     17.0     19.0
        (TDH = ( .1904E+02) + ( .5792E-02)*GPM + (-.2087E-03)*GPM*GPM)
596 P37O D371  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
597 D371 D372  3.07 A N 177.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  166. EX
 **** HEAT EXCHANGER **  Wild Exch **
                                  XEWT  XLWT   XGPM   EWT   LWT   GPM
           DESIGN                 80.0  60.5   55.0  45.0  55.0  110.0
           OPERATION              80.0  60.5   55.0  ----  ----  -----
       (Oper Load =  44.7 tons    **    eff = .98    **    UA =  27676.)
598 D372 L37O  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
599 L37O L37I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
600 L37O R245  4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
 **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
          Control Section  D372 L37O   Complement Section  L37O L37I
601 R245 R240  6.07 A N  66.6   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
602 R240 R235  7.98 A N 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
603 R235 R230  7.98 A N 111.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
604 S245 L38I  3.07 A N  59.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
605 L38I P38I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P38I P38O                                                                CP
 **** CONSTANT SPD PUMP **   Design      2 nd     3 rd     4 th   **
                      FLOW(GPM)    90.0       117.0     72.0     36.0
                      TDH(FT WG)   28.0        18.5     33.0     40.0
        (TDH = ( .4284E+02) + (-.2171E-01)*GPM + (-.1592E-02)*GPM*GPM)
607 P38O D381  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
608 D381 D382  3.07 A N 122.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. EX
 **** HEAT EXCHANGER **  Wild Exch **
                                  XEWT  XLWT   XGPM   EWT   LWT   GPM
           DESIGN                 80.0  60.5   55.0  45.0  55.0  110.0
           OPERATION              80.0  60.5   55.0  ----  ----  -----
       (Oper Load =  44.7 tons    **    eff = .98    **    UA =  27676.)
609 D382 L38O  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
610 L38O L38I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
611 L38O R245  3.07 A N  59.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
 **** REVERSE WATER TEMP VALVE - 3-way **  CV =  75.0 ** T-Set = 56.00 **
          Control Section  D382 L38O   Complement Section  L38O L38I
612 S240 L01I  6.07 A N 254.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
613 L01I P01I  6.07 A N  43.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P01I P01O                                                                CP
 **** CONSTANT SPD PUMP **   Design      2 nd     3 rd     4 th   **
                      FLOW(GPM)   300.0       390.0    180.0     60.0
                      TDH(FT WG)   70.0        45.0     91.0    101.0
        (TDH = ( .1008E+03) + ( .2679E-01)*GPM + (-.4337E-03)*GPM*GPM)
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615 P010 D011   6.07 A N  76.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
616 D011 D012   4.03 A N 177.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  166. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM   EWT   LWT   GPM
             DESIGN             80.0  60.5  125.0  45.0  55.0  250.0
             OPERATION          80.0  60.5  125.0  ----  ----  -----
        (Oper Load = 101.6 tons   **    eff = .98    **   UA =  62899.)
617 D012 L010   6.07 A N  76.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
618 L010 L01I   4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
619 L010 R240   6.07 A N 254.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 350.0 ** T-Set = 56.00 **
           Control Section  D012 L010   Complement Section  L010 L01I
620 S235 L45I   4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
621 L45I P45I   4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P45I P450                                                                CP
  **** CONSTANT SPD PUMP **   Design      2 nd     3 rd     4 th   **
                      FLOW(GPM)  540.0      702.0    378.0    108.0
                      TDH(FT WG)  40.0       26.0     50.0     58.0
            (TDH = ( .5812E+02) + ( .6978E-02)*GPM + (-.7509E-04)*GPM*GPM)
623 P450 D451   4.03 A N  42.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
624 D451 D452   3.07 A N  44.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   33. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM   EWT   LWT   GPM
             DESIGN             80.0  60.5  160.0  45.0  55.0  320.0
             OPERATION          80.0  60.5  160.0  ----  ----  -----
        (Oper Load = 130.0 tons   **    eff = .98    **   UA =  80511.)
625 D452 L450   4.03 A N  42.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
626 L450 L45I   3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
627 L450 R235   4.03 A N  86.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV = 100.0 ** T-Set = 56.00 **
           Control Section  D452 L450   Complement Section  L450 L45I
628 S220 S221   7.98 A N 144.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
629 S221 S222   4.03 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
630 S222 S224   4.03 A N  88.8   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
631 S224 S225   4.03 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
632 S225 L59I   2.47 A N  78.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
633 L59I P59I   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P59I P590                                                                CP
  **** CONSTANT SPD PUMP **   Design      2 nd     3 rd     4 th   **
                      FLOW(GPM)   60.0       78.0     36.0     12.0
                      TDH(FT WG)  40.0       26.0     52.5     57.5
            (TDH = ( .5735E+02) + ( .9068E-01)*GPM + (-.6321E-02)*GPM*GPM)
635 P590 D591   2.47 A N  34.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
636 D591 D592   2.07 A N 133.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  122. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM   EWT   LWT   GPM
             DESIGN             80.0  60.5   25.0  45.0  55.0   50.0
             OPERATION          80.0  60.5   25.0  ----  ----  -----
        (Oper Load =  20.3 tons   **    eff = .98    **   UA =  12580.)
637 D592 L590   2.47 A N  34.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
638 L590 L59I   2.07 A N  21.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
639 L590 R225   2.47 A N  78.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
           Control Section  D592 L590   Complement Section  L590 L59I
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640 R225 R224   4.03 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
641 R224 R222   4.03 A N  88.8   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
642 R222 R221   4.03 A N 222.2   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
643 R221 R220   7.98 A N 144.4   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
644 S224 L58I   2.47 A N  78.6   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
645 L58I P58I   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
    P58I P58O                                                                   CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                     FLOW(GPM)   265.0      371.0     159.0     53.0
                     TDH(FT WG)   50.0       25.0      66.0     72.0
         (TDH = ( .7168E+02) + ( .2965E-01)*GPM + (-.4196E-03)*GPM*GPM)
647 P58O D581   2.47 A N 100.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    44.
648 D581 D582   2.07 A N  77.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    66. EX
  **** HEAT EXCHANGER **  Wild Exch **
                               XEWT  XLWT   XGPM    EWT   LWT   GPM
           DESIGN              80.0  60.5    30.0  45.0  55.0   60.0
           OPERATION           80.0  60.5    30.0  ----  ----  -----
       (Oper Load =  24.4 tons    **     eff = .98      **    UA =  15096.)
649 D582 L58O   2.47 A N 100.4   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    44.
650 L58O L58I   2.07 A N  21.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
651 L58O R224   2.47 A N 123.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
         Control Section  D582 L58O    Complement Section  L58O L58I
652 S222 S223   2.47 A N  88.8   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
653 S223 L00I   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
654 L00I P00I   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
    P00I P00O                                                                   CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                     FLOW(GPM)   310.0      403.0     186.0     62.0
                     TDH(FT WG)   75.0       48.0      99.0    110.0
         (TDH = ( .1104E+03) + ( .2025E-01)*GPM + (-.4339E-03)*GPM*GPM)
656 P00O D001   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
657 D001 D002   2.47 A N  44.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    33. EX
  **** HEAT EXCHANGER **  Wild Exch **
                               XEWT  XLWT   XGPM    EWT   LWT   GPM
           DESIGN              80.0  60.5   325.0  45.0  55.0  650.0
           OPERATION           80.0  60.5   325.0  ----  ----  -----
       (Oper Load = 264.1 tons    **     eff = .98      **    UA = 163539.)
658 D002 L00O   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
659 L00O L00I   2.07 A N  21.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
660 L00O R223   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
         Control Section  D002 L00O    Complement Section  L00O L00I
661 R223 R222   2.47 A N  88.8   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
662 S223 L77I   2.47 A N 234.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   111.
663 L77I P77I   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
    P77I P77O                                                                   CP
  **** CONSTANT SPD PUMP **    Design      2 nd      3 rd      4 th   **
                     FLOW(GPM)   320.0      416.0     224.0     64.0
                     TDH(FT WG)  150.0       96.0     189.0    218.0
         (TDH = ( .2176E+03) + ( .6183E-01)*GPM + (-.8521E-03)*GPM*GPM)
665 P77O D771   2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0     0.
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666 D771 D772  2.47 A N  33.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   22. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
          DESIGN                80.0  60.5   225.0  45.0  55.0  450.0
          OPERATION             80.0  60.5   225.0  ----  ----  -----
      (Oper Load = 182.8 tons    **     eff = .98     **    UA = 113219.)
667 D772 L770  2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
668 L770 L77I  2.47 A N  23.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
669 L770 R223  2.47 A N 234.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0  111. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
        Control Section  D772 L770   Complement Section  L770 L77I
670 S221 L24I  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
671 L24I P24I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
    P24I P240                                                              CP
  **** CONSTANT SPD PUMP **    Design      2 nd     3 rd     4 th   **
                 FLOW(GPM)     280.0       364.0    168.0    84.0
                 TDH(FT WG)     40.0        26.0     53.0    58.0
         (TDH = ( .5940E+02) + ( .6721E-02)*GPM + (-.2709E-03)*GPM*GPM)
673 P240 D241  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
674 D241 D242  3.07 A N  77.1   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0   66. EX
  **** HEAT EXCHANGER **  Wild Exch **
                                XEWT  XLWT   XGPM    EWT   LWT   GPM
          DESIGN                80.0  60.5    85.0  45.0  55.0  170.0
          OPERATION             80.0  60.5    85.0  ----  ----  -----
      (Oper Load =  69.1 tons    **     eff = .98     **    UA =  42772.)
675 D242 L240  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
676 L240 L24I  3.07 A N  26.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
677 L240 R221  4.03 A N 131.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0. W3
  **** REVERSE WATER TEMP VALVE - 3-way **  CV =  50.0 ** T-Set = 56.00 **
        Control Section  D242 L240   Complement Section  L240 L24I
678 S210 L30I  4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
679 L30I P30I  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
680 P30I P300  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
681 P300 D301  4.03 A N  31.1   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
682 D301 D302  4.03 A N 139.1   0.  0 0 0  0 0  0 0 0 0  0 2 0 0 0 0 0   88. C3
  **** COOLING COIL **    3-way Control   **   CV = 100.0   **
                             N   EAT   LAT    CFM    EWT   LWT   GPM
          DESIGN             4   90.0  60.0  22000.  45.0  55.0  150.0
          OPERATION          -   90.0  60.0  22000.  ----  ----  -----
    (Sens Load =   56.9 tons ** TSR = 1.085 ** Factor = .991 ** UA =  32049.)
683 D301 D302  3.07 A N 127.1   0.  0 0 0  0 0  0 0 0 0  0 2 0 0 0 0 0   88.
684 D302 L300  4.03 A N  42.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
685 L30I L300   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
686 L300 R210  4.03 A N 242.2   0.  2 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
687 CPES CPER   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
688 CPWS CPWR   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
689 S1SI S1SO 10.02 A N   1.0   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
690 S1SI S1RI   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
691 S1RI S1RO 10.02 A N   1.0   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
692 S2SI S2SO 10.02 A N   1.0   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
693 S2SI S2RI   .10 B O 333.3   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
694 S2RI S2RO 10.02 A N   1.0   0.  0 0 0  0 0  0 0 0 0  0 0 0 0 0 0 0    0.
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695	S3SI	S3SO	22.63	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
696	S3SI	S3RI	.10	B	O	333.3	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
697	S3RI	S3RO	22.63	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
698	S4SI	S4SO	22.63	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
699	S4SI	S4RI	.10	B	O	333.3	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
700	S4RI	S4RO	22.63	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
701	S5SI	S5SO	22.63	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
702	S5SI	S5RI	.10	B	O	333.3	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
703	S5RI	S5RO	22.63	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
704	S6SI	S6SO	11.94	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
705	S6SI	S6RI	.10	B	O	333.3	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
706	S6RI	S6RO	11.94	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
707	S7SI	S7SO	11.94	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
708	S7SI	S7RI	.10	B	O	333.3	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
709	S7RI	S7RO	11.94	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
710	S8SI	S8SO	10.02	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
711	S8SI	S8RI	.10	B	O	333.3	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
712	S8RI	S8RO	10.02	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
713	S9SI	S9SO	10.02	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
714	S9SI	S9RI	.10	B	O	333.3	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.
715	S9RI	S9RO	10.02	A	N	1.0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.

COIL/EXCHANGER SUMMARY FOR ITERATION # 24

UNIT #	SEC #	BEG NODE	END NODE	FLOW lbs/hr	TEMP--degF SET	OUT	IN	LOAD tons	WATER gpm	VALVE TYPE	CV	FULLY OPEN?
1X	81	D911	D912	37500.	60.5	61.6	80.0	58.8	153.6			
2X	98	D901	D902	31000.	60.5	62.6	80.0	46.1	157.9			
3X	106	D941	D942	30000.	60.5	62.3	80.0	45.3	156.4			
4X	115	D931	D932	29500.	60.5	62.1	80.0	45.2	146.8			
5X	124	D921	D922	26500.	60.5	62.7	80.0	39.2	144.2			
6X	133	D161	D162	75000.	60.5	60.9	80.0	122.3	254.3			
7X	142	D151	D152	57500.	60.5	61.8	80.0	89.2	241.2			
8X	154	D061	D062	75000.	60.5	61.8	80.0	116.8	338.2			
9X	166	D101	D102	29000.	60.5	61.2	80.0	46.5	89.8			
10X	174	D071	D072	20500.	60.5	63.3	80.0	29.3	137.0			
11X	182	D111	D112	27500.	60.5	61.7	80.0	43.0	72.5			
12X	191	D131	D132	24000.	60.5	61.0	80.0	39.0	86.8			
13X	200	D141	D142	35500.	60.5	65.7	80.0	43.5	229.6			
14X	208	D211	D212	80000.	60.5	62.8	80.0	117.4	513.1			
15C	219	DSU1	DSU2	172525.	60.0	60.1	90.0	123.3	276.2	2	56.5	NO
16X	232	D291	D292	23000.	60.5	63.9	80.0	31.7	279.4			
17X	237	L28I	L28O	67500.	60.5	60.2	80.0	114.1	306.9			
18C	264	DWO1	DWO2	341939.	60.0	60.1	95.0	261.5	580.4	2	103.1	NO
19X	294	DFR1	DFR2	28000.	60.5	60.9	80.0	45.6	103.5			
20X	304	DMO1	DMO2	30500.	60.5	60.8	80.0	50.1	110.4			
21X	312	DFI1	DFI2	35500.	60.5	61.3	80.0	56.9	141.0			
22X	321	DMR1	DMR2	144000.	60.5	63.4	80.0	204.4	1191.7			
23X	331	DSA1	DSA2	137500.	60.5	62.0	80.0	211.9	641.8			
24X	341	D561	D562	62500.	60.5	61.1	80.0	101.2	238.1			
25X	350	D571	D572	57500.	60.5	61.3	80.0	91.9	224.1			
26X	359	D551	D552	47500.	60.5	61.0	80.0	77.0	177.7			
27X	369	DBO1	DBO2	250000.	60.5	63.3	80.0	355.8	2063.6			
28X	381	DBS1	DBS2	27500.	60.5	63.0	80.0	39.9	188.5			
29X	392	DBA1	DBA2	27500.	60.5	60.8	80.0	45.0	96.1			
30X	401	DSG1	DSG2	47500.	60.5	60.9	80.0	77.5	174.4			
31X	410	DSC1	DSC2	125000.	60.5	60.8	80.0	205.1	442.9			
32X	418	DTH1	DTH2	45000.	60.5	62.0	80.0	69.1	210.8			
33X	441	D611	D612	47500.	60.5	62.8	80.0	70.0	95.4			
34X	457	DAT1	DAT2	47500.	60.5	63.0	80.0	69.1	91.0			
35C	466	DCR1	DCR2	539140.	60.0	60.1	90.0	369.8	827.6	3	896.9	NO
36X	475	D991	D992	125000.	60.5	63.0	80.0	181.8	863.0			
37L	481	DHO1	DHO2	150000.	60.5	60.6	80.0	248.8	432.6	3	62.6	NO
38X	496	DAE1	DAE2	137500.	60.5	62.3	80.0	207.5	738.7			
39X	511	DPE1	DPE2	112500.	60.5	63.1	80.0	162.5	814.8			
40X	524	DMA1	DMA2	112500.	60.5	62.8	80.0	165.1	687.1			
41L	531	DBU1	DBU2	150000.	60.5	60.6	80.0	248.9	433.5	3	75.3	NO
42X	546	D751	D752	62500.	60.5	63.2	80.0	89.8	474.0			
43C	555	D761	D762	194090.	60.5	60.6	90.0	129.4	201.3	3	69.8	NO
44X	568	D511	D512	47500.	60.5	63.7	80.0	66.0	506.3			
45X	576	D841	D842	62500.	60.5	60.9	80.0	101.9	229.8			
46L	582	D021	D022	150000.	60.5	60.6	80.0	249.3	437.7	3	111.5	NO
47X	597	D371	D372	27500.	60.5	62.7	80.0	40.7	159.6			
48X	608	D381	D382	27500.	60.5	61.9	80.0	42.6	139.0			
49X	616	D011	D012	62500.	60.5	63.1	80.0	90.3	450.2			
50X	624	D451	D452	80000.	60.5	62.2	80.0	122.0	388.5			

51X	636	D591	D592	12500.	60.5	63.7	80.0	17.4	76.0			
52X	648	D581	D582	15000.	60.5	63.6	80.0	21.0	128.5			
53X	657	D001	D002	162500.	60.5	70.0	80.0	139.2	104.0			
54X	666	D771	D772	112500.	60.5	64.6	80.0	148.2	157.1			
55X	674	D241	D242	42500.	60.5	62.3	80.0	64.3	225.0			
56C	682	D301	D302	94889.	60.0	60.1	90.0	61.5	136.4	3	65.8	NO

* UNIT # 1 IS OVERLOADED

* UNIT # 2 IS OVERLOADED

* UNIT # 3 IS OVERLOADED

* UNIT # 4 IS OVERLOADED

* UNIT # 5 IS OVERLOADED

* UNIT # 7 IS OVERLOADED

* UNIT # 8 IS OVERLOADED

* UNIT # 10 IS OVERLOADED

* UNIT # 11 IS OVERLOADED

* UNIT # 13 IS OVERLOADED

* UNIT # 14 IS OVERLOADED

* UNIT # 16 IS OVERLOADED

* UNIT # 22 IS OVERLOADED

* UNIT # 23 IS OVERLOADED

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* UNIT # 28 IS OVERLOADED

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* UNIT # 38 IS OVERLOADED

* UNIT # 39 IS OVERLOADED

* UNIT # 40 IS OVERLOADED

* UNIT # 42 IS OVERLOADED

* UNIT # 44 IS OVERLOADED

* UNIT # 47 IS OVERLOADED

* UNIT # 48 IS OVERLOADED

* UNIT # 49 IS OVERLOADED

* UNIT # 50 IS OVERLOADED

* UNIT # 51 IS OVERLOADED

* UNIT # 52 IS OVERLOADED

* UNIT # 53 IS OVERLOADED

* UNIT # 54 IS OVERLOADED

* UNIT # 55 IS OVERLOADED

WATER TEMP CONTROL VALVE SUMMARY

CONTROL SECTION					VALVE				
SEC #	BEG NODE	END NODE	TEMP--degF SET	OUT	#	type	FLOW gpm	CV	FULLY OPEN?
82	D912	L910	56.0	56.3	1	3	124.6	93.0	NO
99	D902	L900	56.0	56.6	2	3	95.6	85.0	NO
107	D942	L940	56.0	56.1	3	3	97.7	86.0	NO
116	D932	L930	56.0	55.9	4	3	99.2	86.9	NO
125	D922	L920	56.0	56.5	5	3	82.0	82.9	NO
134	D162	L160	56.0	56.6	6	3	253.9	100.0	YES
143	D152	L150	56.0	56.5	7	3	186.8	87.1	NO
155	D062	L060	56.0	56.0	8	3	254.2	85.0	NO
167	D102	L100	56.0	57.5	9	3	89.0	100.0	YES
175	D072	L070	56.0	56.5	10	3	60.8	82.1	NO
183	D112	L110	56.0	59.3	11	3	72.4	100.0	YES
192	D132	L130	56.0	56.2	12	3	83.7	49.8	YES
201	D142	L140	56.0	60.0	13	3	69.7	56.9	NO
209	D212	L210	56.0	56.0	14	3	255.9	252.3	NO
233	D292	L290	56.0	56.0	15	3	69.1	18.0	NO
295	DFR2	LFRO	56.0	56.0	16	3	99.5	48.6	NO
305	DMO2	LMOO	56.0	55.9	17	3	110.1	49.9	YES
313	DFI2	LFIO	56.0	56.0	18	3	124.0	44.6	NO
322	DMR2	LMRO	56.0	56.1	19	3	443.4	114.1	NO
332	DSA2	LSAO	56.0	56.1	20	3	457.8	273.5	NO
342	D562	L560	56.0	56.0	21	3	221.0	136.0	NO
351	D572	L570	56.0	56.2	22	3	197.4	109.4	NO
360	D552	L550	56.0	56.1	23	3	167.2	70.2	NO
370	DBO2	LBOO	56.0	56.0	24	3	775.8	276.2	NO
382	DBS2	LBSO	56.0	56.1	25	3	86.6	27.5	NO
393	DBA2	LBAO	56.0	56.3	26	3	96.0	50.0	YES
402	DSG2	LSGO	56.0	56.0	27	3	168.9	95.8	NO
411	DSC2	LSCO	56.0	56.1	28	3	442.5	100.0	YES
419	DTH2	LTHO	56.0	56.2	29	3	148.6	57.4	NO
442	D612	L610	56.0	62.6	30	3	95.3	100.0	YES
458	DAT2	LATO	56.0	63.2	31	3	91.0	100.0	YES
476	D992	L990	56.0	56.0	32	3	396.5	229.6	NO
497	DAE2	LAEO	56.0	56.0	33	3	452.5	218.5	NO
512	DPE2	LPEO	56.0	56.0	34	3	354.0	146.0	NO
525	DMA2	LMAO	56.0	56.2	35	3	354.6	153.5	NO
547	D752	L750	56.0	56.0	36	3	195.5	64.9	NO
569	D512	L510	56.0	56.0	37	3	143.8	44.9	NO
577	D842	L840	56.0	56.0	38	3	221.5	78.4	NO
598	D372	L370	56.0	56.2	39	3	87.4	28.6	NO
609	D382	L380	56.0	55.6	40	3	96.6	31.8	NO
617	D012	L010	56.0	56.0	41	3	196.8	62.3	NO
625	D452	L450	56.0	56.2	42	3	262.1	61.3	NO
637	D592	L590	56.0	57.4	43	3	33.7	28.7	NO
649	D582	L580	56.0	56.3	44	3	44.8	19.5	NO
658	D002	L000	56.0	77.1	45	3	104.0	50.0	YES
667	D772	L770	56.0	67.6	46	3	157.1	50.0	YES
675	D242	L240	56.0	56.0	47	3	140.3	28.3	NO

=== CONVERGENCE ACHIEVED ===

*** CHILLER LOADS ***

CHILLER # 1	(CH1I-CH1O)	691.13 tons
NOMINAL CAPACITY		1000.00 tons
CHILLER # 2	(CH2I-CH2O)	737.05 tons
NOMINAL CAPACITY		1000.00 tons
CHILLER # 3	(CH3I-CH3O)	1582.07 tons
NOMINAL CAPACITY		2000.00 tons
CHILLER # 4	(CH4I-CH4O)	1671.84 tons
NOMINAL CAPACITY		2000.00 tons
CHILLER # 5	(R031-R032)	123.27 tons
NOMINAL CAPACITY		130.00 tons
CHILLER # 6	(RHOC-SHOC)	341.50 tons
NOMINAL CAPACITY		450.00 tons
CHILLER # 7	(RAE2-SAE2)	122.85 tons
NOMINAL CAPACITY		200.00 tons
CHILLER # 8	(RPE2-SPE2)	81.27 tons
NOMINAL CAPACITY		200.00 tons
CHILLER # 9	(RBUC-SBUC)	308.69 tons
NOMINAL CAPACITY		300.00 tons
CHILLER #10	(R76C-S76C)	188.47 tons
NOMINAL CAPACITY		300.00 tons
CHILLER #11	(R02C-S02C)	302.69 tons
NOMINAL CAPACITY		350.00 tons

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	----- INLET NODE	TEMP degF	PRESS ftwg -----	DELTA ftwg	- OUTLET - PRESS ftwg	NODE	---------- FLOW VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
1	MUWP	56.4	50.0	-2.64	47.4	CP01	17.9	1758310	9887.0	-.03
2	CP01	56.4	47.4	-.52	46.8	CP02	11.7	1145655	6442.0	-.03
3	CP02	56.4	46.8	-.77	46.1	CP03	5.5	536339	3015.8	-.03
4	CP03	56.4	46.1	-.12	45.9	CP04	5.5	536342	3015.8	-.03
5	CP04	56.4	45.9	-3.55	42.4	LP1I	12.2	802907	3015.8	-.03
6	LP1I	56.4	42.4	41.29	83.7	LP1O	-- CONS	PUMP --	3015.8	-.03
7	LP1O	56.4	83.7	-5.67	78.0	CP07	12.2	802907	3015.8	-.03
8	CP07	56.4	78.0	-3.59	74.4	CP08	12.2	802903	3015.8	-.03
9	CP08	56.4	74.4	-16.55	57.9	CP09	.4	266	.0	-.07
10	CP09	50.5	57.9	-3.61	54.3	CP10	12.2	732386	3015.8	-.03
11	CP10	50.5	54.3	-2.56	51.7	CH1I	12.2	732386	3015.8	-.03
12	CH1I	50.5	51.7	-9.48	42.2	CH1O	-- CHILLER	----	3015.8	-.03
13	CH1O	45.0	42.2	-2.54	39.7	CP11	12.2	668382	3015.8	-.03
14	CP11	45.0	39.7	-3.63	36.1	CP12	12.2	668383	3015.8	-.03
15	CP13	45.0	36.1	.00	36.1	CP12	.7	53940	364.3	-.02
16	CP13	45.0	36.1	-.47	35.6	CP14	5.4	440648	2976.5	-.03
17	CP15	45.0	35.6	.00	35.6	CP14	.7	58050	392.0	.00
18	CP15	45.0	35.6	-.75	34.8	CP16	5.7	464602	3138.3	-.03
19	CP17	48.5	34.8	.00	34.8	CP16	.0	5	.0	.02
20	CP18	56.4	60.6	-25.71	34.8	CP17	.4	274	.0	-.24
21	CP18	56.4	60.6	-10.55	50.0	MUWP	17.9	1758310	9887.0	-.03
22	LP2I	56.4	46.1	.00	46.1	CP03	.0	3	.0	.07
23	LP2O	56.4	78.0	-31.95	46.1	LP2I	.5	343	.0	.07
24	CP07	56.4	78.0	.00	78.0	LP2O	.0	3	.0	.07
25	CP08	56.4	74.4	-3.55	70.9	CH2I	12.2	802901	3015.8	-.03
26	CH2I	56.4	70.9	-9.44	61.4	CH2O	-- CHILLER	----	3015.8	-.03
27	CH2O	50.5	61.4	-3.57	57.9	CP09	12.2	732384	3015.8	-.03
28	CP10	50.5	54.3	-14.58	39.7	CP11	.1	87	.0	-.06
29	CP02	56.4	46.8	-7.06	39.8	LP3I	13.9	912149	3426.2	-.03
30	LP3I	56.4	39.8	33.83	73.6	LP3O	-- CONS	PUMP --	3426.2	-.03
31	LP3O	56.4	73.6	-8.54	65.1	CP06	13.9	912149	3426.2	-.03
32	CP06	56.4	65.1	-5.59	59.5	CH3I	13.6	889415	3340.8	-.03
33	CH3I	56.4	59.5	-14.77	44.7	CH3O	-- CHILLER	----	3340.8	-.03
34	CH3O	45.0	44.7	-8.66	36.1	CP13	13.6	740400	3340.8	-.03
35	CP01	56.4	47.4	-7.13	40.2	LP4I	14.0	917149	3445.0	-.03
36	LP4I	56.4	40.2	33.47	73.7	LP4O	-- CONS	PUMP --	3445.0	-.03
37	LP4O	56.4	73.7	-8.63	65.1	CP05	14.0	917149	3445.0	-.03
38	CP05	56.4	65.1	-3.40	61.7	CH4I	14.3	939883	3530.4	-.03
39	CH4I	56.4	61.7	-16.45	45.2	CH4O	-- CHILLER	----	3530.4	-.03
40	CH4O	45.0	45.2	-9.63	35.6	CP15	14.3	782413	3530.4	-.03
41	CP06	56.4	65.1	-.01	65.1	CP05	.3	22734	85.4	-.03
42	CP12	45.0	36.1	-12.94	23.1	MP1I	13.7	749131	3380.1	-.03
43	MP1I	45.0	23.1	85.38	108.5	MP1O	-- CONS	PUMP --	3380.1	-.03
44	MP1O	45.0	108.5	-6.42	102.1	CP23	13.7	749131	3380.1	-.03
45	CP23	45.0	102.1	-5.33	96.7	CP24	17.9	1463721	9887.0	-.03
46	CP24	45.0	96.7	-.74	96.0	CPWS	6.1	755315	7685.5	.11
47	CPWR	56.4	68.7	-.87	67.9	CP26	6.1	907884	7685.5	.11
48	CP26	56.4	67.9	-7.32	60.6	CP18	17.9	1758312	9887.0	-.03
49	CP14	45.0	35.6	-12.86	22.7	MP2I	13.7	746553	3368.5	-.03
50	MP2I	45.0	22.7	86.26	109.0	MP2O	-- CONS	PUMP --	3368.5	-.03

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	----- INLET ----- NODE	TEMP degF	PRESS ftwg	DELTA ftwg	- OUTLET - PRESS ftwg	NODE	---------- FLOW ---------- VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
51	MP2O	45.0	109.0	-6.38	102.6	CP21	13.7	746553	3368.5	-.03
52	CP21	45.0	102.6	-.54	102.1	CP23	11.8	963301	6506.9	-.03
53	CP16	45.0	34.8	-11.22	23.6	MP3I	12.7	695520	3138.4	-.03
54	MP3I	45.0	23.6	90.33	114.0	MP3O	-- CONS	PUMP --	3138.4	-.03
55	MP3O	45.0	114.0	-11.22	102.7	CP20	12.7	695520	3138.4	-.03
56	CP20	45.0	102.7	-.13	102.6	CP21	5.7	464604	3138.3	-.03
57	MP4I	45.0	34.8	.00	34.8	CP17	.0	5	.0	.13
58	MP4O	45.0	102.7	-67.90	34.8	MP4I	.9	506	.0	.13
59	CP19	45.0	102.7	.00	102.7	MP4O	.0	5	.0	.13
60	CP20	45.0	102.7	.00	102.7	CP19	.0	5	.0	.13
61	CP24	45.0	96.7	-6.07	90.7	CP32	8.9	485633	2201.5	-.49
62	CP32	45.0	90.7	-.36	90.3	CP28	7.4	401928	1825.5	-.68
63	CP28	45.0	90.3	-19.30	71.0	CP27	.3	147	.0	1.37
64	CP28	45.0	90.3	-.36	90.0	CPES	7.4	401926	1825.5	-.68
65	CPER	56.6	71.4	-.35	71.0	CP27	7.4	484742	1825.5	-.68
66	CP27	56.6	71.0	-.70	70.3	CP33	7.4	484743	1825.5	-.68
67	CP33	56.2	70.3	-2.44	67.9	CP26	8.9	582126	2201.5	-.49
68	CPES	45.0	90.0	-2.99	87.0	S1SI	7.4	401925	1825.5	-.68
69	S1SO	45.0	87.0	-8.38	78.6	S110	7.4	401924	1825.5	-.68
70	S110	45.0	78.6	-3.59	75.0	S120	7.4	401924	1825.5	-.68
71	S120	45.0	75.0	-2.24	72.7	S2SI	6.4	348161	1569.6	.06
72	S2SO	45.0	72.7	-1.64	71.1	S130	6.4	348162	1569.6	.06
73	S130	45.0	71.1	-1.88	69.2	S135	6.0	261261	939.9	-.13
74	S135	45.0	69.2	-2.12	67.1	S140	3.2	138318	499.2	-.44
75	S140	45.0	67.1	-2.00	65.1	S145	3.5	116653	317.9	.18
76	S145	45.0	65.1	-.47	64.6	S150	2.5	81091	220.3	.53
77	S150	45.0	64.6	-.85	63.8	L91I	3.2	69438	124.6	1.00
78	L91I	47.1	63.8	-.45	63.3	P91I	3.9	88862	153.6	1.15
79	P91I	47.1	63.3	48.30	111.6	P91O	-- CONS	PUMP --	153.6	1.15
80	P91O	47.1	111.6	-.92	110.7	D911	3.9	88862	153.6	1.15
81	D911	47.1	110.7	-8.61	102.1	D912	-- WILD	EXCH --	153.6	1.15
82	D912	56.3	102.1	-.90	101.2	L91O	3.9	102778	153.6	1.15
83	L91O	56.3	101.2	-37.43	63.8	L91I	.7	19525	29.0	1.83
84	L91O	56.3	101.2	-4.99	96.2	R150	3.2	83253	124.6	1.00
85	R150	56.4	96.2	-.46	95.8	R145	2.5	97427	220.3	.53
86	R145	56.3	95.8	-1.95	93.8	R140	3.5	140009	317.9	.18
87	R140	56.3	93.8	-2.07	91.7	R135	3.2	165984	499.2	-.44
88	R135	56.4	91.7	-1.84	89.9	R130	6.0	313941	939.9	-.13
89	R130	56.7	89.9	-1.61	88.3	S2RI	6.4	420112	1569.6	.06
90	S2RO	56.7	88.3	-2.20	86.1	R120	6.4	420110	1569.6	.06
91	R120	56.6	86.1	-3.53	82.5	R110	7.4	484739	1825.5	-.68
92	R110	56.6	82.5	-8.23	74.3	S1RI	7.4	484739	1825.5	-.68
93	S1RO	56.6	74.3	-2.94	71.4	CPER	7.4	484740	1825.5	-.68
94	S150	45.0	64.6	-.52	64.1	L90I	2.4	52722	95.6	-.09
95	L90I	49.6	64.1	-.47	63.6	P90I	4.0	95310	157.9	1.25
96	P90I	49.6	63.6	47.65	111.3	P90O	-- CONS	PUMP --	157.9	1.25
97	P90O	49.6	111.3	-.96	110.3	D901	4.0	95310	157.9	1.25
98	D901	49.6	110.3	-9.67	100.7	D902	-- WILD	EXCH --	157.9	1.25
99	D902	56.6	100.7	-.95	99.7	L90O	4.0	106253	157.9	1.25
100	L90O	56.6	99.7	-35.60	64.1	L90I	1.6	42736	62.2	3.31

SECTION RESULTS AFTER 24 ITERATIONS

	----- INLET	-----			- OUTLET -		---------- FLOW	-------------		
SEC #	NODE	TEMP degF	PRESS ftwg	DELTA ftwg	PRESS ftwg	NODE	VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
101	L900	56.6	99.7	-3.49	96.2	R150	2.4	63516	95.6	-.09
102	S145	45.0	65.1	-.54	64.6	L94I	2.4	53572	97.7	-.61
103	L94I	49.2	64.6	-.46	64.1	P94I	4.0	93928	156.4	1.30
104	P94I	49.2	64.1	47.88	112.0	P94O	-- CONS	PUMP --	156.4	1.30
105	P94O	49.2	112.0	-.95	111.0	D941	4.0	93928	156.4	1.30
106	D941	49.2	111.0	-10.75	100.3	D942	-- WILD	EXCH --	156.4	1.30
107	D942	56.1	100.3	-.93	99.3	L94O	4.0	104644	156.4	1.30
108	L94O	56.1	99.3	-34.79	64.6	L94I	1.5	40496	58.7	4.47
109	L94O	56.1	99.3	-3.58	95.8	R145	2.4	64148	97.7	-.61
110	S140	45.0	67.1	-.06	67.0	S155	2.0	65361	181.2	-1.53
111	S155	45.0	67.0	-.56	66.5	L93I	2.4	52366	99.2	-4.32
112	L93I	48.5	66.5	-.55	65.9	P93I	3.7	88013	146.8	1.49
113	P93I	48.5	65.9	43.22	109.1	P93O	-- CONS	PUMP --	146.8	1.49
114	P93O	48.5	109.1	-.84	108.3	D931	3.7	88013	146.8	1.49
115	D931	48.5	108.3	-10.10	98.2	D932	-- WILD	EXCH --	146.8	1.49
116	D932	55.9	98.2	-.83	97.4	L93O	3.7	98582	146.8	1.49
117	L93O	55.9	97.4	-30.89	66.5	L93I	2.3	46952	47.6	13.60
118	L93O	55.9	97.4	-3.53	93.8	R155	2.4	62802	99.2	-4.32
119	R155	56.2	93.8	-.03	93.8	R140	2.0	78412	181.2	-1.53
120	S155	45.0	67.0	-.59	66.4	L92I	2.1	46097	82.0	1.84
121	L92I	49.9	66.4	-.39	66.0	P92I	3.7	87000	144.2	.94
122	P92I	49.9	66.0	43.67	109.7	P92O	-- CONS	PUMP --	144.2	.94
123	P92O	49.9	109.7	-.81	108.9	D921	3.7	87000	144.2	.94
124	D921	49.9	108.9	-11.42	97.5	D922	-- WILD	EXCH --	144.2	.94
125	D922	56.5	97.5	-.80	96.7	L92O	3.7	96357	144.2	.94
126	L92O	56.5	96.7	-30.24	66.4	L92I	2.7	53849	62.1	-.25
127	L92O	56.5	96.7	-2.84	93.8	R155	2.1	55322	82.0	1.84
128	S135	45.0	69.2	-.32	68.9	S160	2.8	122943	440.7	.23
129	S160	45.0	68.9	-.13	68.8	L16I	1.6	71049	253.9	.53
130	L16I	45.0	68.8	-1.15	67.6	P16I	6.4	141274	254.3	.65
131	P16I	45.0	67.6	54.96	122.6	P16O	-- CONS	PUMP --	254.3	.65
132	P16O	45.0	122.6	-2.38	120.2	D161	6.4	141274	254.3	.65
133	D161	45.0	120.2	-6.15	114.0	D162	-- WILD	EXCH --	254.3	.65
134	D162	56.6	114.0	-2.34	111.7	L16O	6.4	169965	254.3	.65
135	L16O	56.6	111.7	-42.93	68.8	L16I	.0	567	.3	89.95
136	L16O	56.6	111.7	-19.65	92.0	R160	6.4	169533	253.9	.53
137	R160	56.5	92.0	-.31	91.7	R135	2.8	147957	440.7	.23
138	S160	45.0	68.9	-.11	68.8	L15I	1.2	51894	186.8	-.18
139	L15I	47.6	68.8	-1.04	67.8	P15I	6.1	140085	241.2	.66
140	P15I	47.6	67.8	48.66	116.4	P15O	-- CONS	PUMP --	241.2	.66
141	P15O	47.6	116.4	-2.15	114.3	D151	6.1	140085	241.2	.66
142	D151	47.6	114.3	-6.64	107.6	D152	-- WILD	EXCH --	241.2	.66
143	D152	56.5	107.6	-2.12	105.5	L15O	6.1	161165	241.2	.66
144	L15O	56.5	105.5	-36.72	68.8	L15I	2.4	49071	54.4	3.55
145	L15O	56.5	105.5	-13.47	92.0	R160	4.7	123771	186.8	-.18
146	S130	45.0	71.1	-4.26	66.8	S170	7.0	231403	629.7	.34
147	S170	45.0	66.8	-5.46	61.4	S175	5.3	174650	476.3	.11
148	S175	45.0	61.4	-.59	60.8	S180	4.5	147532	403.9	-.28
149	S180	45.0	60.8	-.25	60.5	S185	3.8	124828	343.2	-.68
150	S185	45.0	60.5	-4.86	55.7	L06I	6.3	138545	254.2	-1.20

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	----- INLET NODE	INLET TEMP degF	----- PRESS ftwg	DELTA ftwg	- OUTLET - PRESS ftwg	OUTLET NODE	---------- FLOW VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
151	L06I	47.7	55.7	-1.97	53.7	P06I	8.6	197401	338.2	.74
152	P06I	47.7	53.7	91.44	145.1	P06O	-- CONS	PUMP --	338.2	.74
153	P06O	47.7	145.1	-4.08	141.1	D061	8.6	197401	338.2	.74
154	D061	47.7	141.1	-11.07	130.0	D062	-- WILD	EXCH --	338.2	.74
155	D062	56.0	130.0	-4.03	126.0	L06O	8.6	224903	338.2	.74
156	L06O	56.0	126.0	-70.30	55.7	L06I	3.9	77580	84.0	6.62
157	L06O	56.0	126.0	-25.53	100.4	R185	6.3	165783	254.2	-1.20
158	R185	56.4	100.4	-.09	100.4	R180	3.8	150154	343.2	-.68
159	R180	56.4	100.4	-.93	99.4	R175	4.5	177439	403.9	-.28
160	R175	56.9	99.4	-5.34	94.1	R170	5.3	211300	476.3	.11
161	R170	57.1	94.1	-4.18	89.9	R130	7.0	280949	629.7	.34
162	S185	45.0	60.5	-1.27	59.3	L10I	2.3	49502	89.0	.83
163	L10I	45.1	59.3	-.17	59.1	P10I	2.3	50641	89.8	1.76
164	P10I	45.1	59.1	48.70	107.8	P10O	-- CONS	PUMP --	89.8	1.76
165	P10O	45.1	107.8	-.34	107.4	D101	2.3	50641	89.8	1.76
166	D101	45.1	107.4	-3.61	103.8	D102	-- WILD	EXCH --	89.8	1.76
167	D102	57.5	103.8	-.33	103.5	L10O	2.3	61564	89.8	1.76
168	L10O	57.5	103.5	-44.25	59.3	L10I	.1	1506	.9	98.56
169	L10O	57.5	103.5	-3.06	100.4	R185	2.3	60417	89.0	.83
170	S180	45.0	60.8	-.64	60.1	L07I	1.6	34204	60.8	1.97
171	L07I	51.4	60.1	-.36	59.8	P07I	3.5	84487	137.0	.70
172	P07I	51.4	59.8	53.99	113.8	P07O	-- CONS	PUMP --	137.0	.70
173	P07O	51.4	113.8	-.74	113.0	D071	3.5	84487	137.0	.70
174	D071	51.4	113.0	-10.36	102.7	D072	-- WILD	EXCH --	137.0	.70
175	D072	56.5	102.7	-.73	102.0	L07O	3.5	91504	137.0	.70
176	L07O	56.5	102.0	-41.81	60.1	L07I	3.3	66139	76.3	-.31
177	L07O	56.5	102.0	-1.60	100.4	R180	1.6	41103	60.8	1.97
178	S175	45.0	61.4	-.47	60.9	L11I	1.9	40852	72.4	2.30
179	L11I	45.0	60.9	-.11	60.8	P11I	1.9	40969	72.5	2.41
180	P11I	45.0	60.8	43.94	104.7	P11O	-- CONS	PUMP --	72.5	2.41
181	P11O	45.0	104.7	-.23	104.5	D111	1.9	40969	72.5	2.41
182	D111	45.0	104.5	-3.19	101.3	D112	-- WILD	EXCH --	72.5	2.41
183	D112	59.3	101.3	-.22	101.1	L11O	1.9	51123	72.5	2.41
184	L11O	59.3	101.1	-40.18	60.9	L11I	.0	154	.1	90.83
185	L11O	59.3	101.1	-1.66	99.4	R175	1.9	51006	72.4	2.30
186	S170	45.0	66.8	-.45	66.4	S190	3.9	85496	153.4	1.03
187	S190	45.0	66.4	-1.14	65.2	L13I	2.1	46293	83.7	.22
188	L13I	45.4	65.2	-.16	65.1	P13I	2.3	49980	86.8	3.18
189	P13I	45.4	65.1	42.18	107.3	P13O	-- CONS	PUMP --	86.8	3.18
190	P13O	45.4	107.3	-.32	106.9	D131	2.3	49980	86.8	3.18
191	D131	45.4	106.9	-4.43	102.5	D132	-- WILD	EXCH --	86.8	3.18
192	D132	56.2	102.5	-.31	102.2	L13O	2.3	59112	86.8	3.18
193	L13O	56.2	102.2	-36.96	65.2	L13I	.2	4869	3.0	84.74
194	L13O	56.2	102.2	-7.69	94.5	R190	2.1	55401	83.7	.22
195	R190	57.9	94.5	-.43	94.1	R170	3.9	104921	153.4	1.03
196	S190	45.0	66.4	-.81	65.6	L14I	1.8	39202	69.7	2.01
197	L14I	55.4	65.6	-.93	64.6	P14I	5.8	150153	229.6	.39
198	P14I	55.4	64.6	44.96	109.6	P14O	-- CONS	PUMP --	229.6	.39
199	P14O	55.4	109.6	-1.93	107.7	D141	5.8	150153	229.6	.39
200	D141	55.4	107.7	-6.99	100.7	D142	-- WILD	EXCH --	229.6	.39

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	----- INLET ----- NODE	TEMP degF	PRESS ftwg	DELTA ftwg	- OUTLET - PRESS ftwg	NODE	---------- FLOW ---------- VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
201	D142	60.0	100.7	-1.92	98.8	L14O	5.8	160591	229.6	.39
202	L14O	60.0	98.8	-33.19	65.6	L14I	6.9	145766	159.9	-.32
203	L14O	60.0	98.8	-4.25	94.5	R190	1.8	49510	69.7	2.01
204	S120	45.0	75.0	-1.80	73.2	L21I	2.7	88822	255.9	-5.22
205	L21I	50.5	73.2	-.77	72.4	P21I	5.7	209715	513.1	.92
206	P21I	50.5	72.4	40.70	113.1	P21O	-- CONS	PUMP --	513.1	.92
207	P21O	50.5	113.1	-1.36	111.8	D211	5.7	209715	513.1	.92
208	D211	50.5	111.8	-20.21	91.5	D212	-- WILD	EXCH --	513.1	.92
209	D212	56.0	91.5	-1.34	90.2	L21O	5.7	227966	513.1	.92
210	L21O	56.0	90.2	-17.02	73.2	L21I	6.9	182572	257.2	7.03
211	L21O	56.0	90.2	-4.13	86.1	R120	2.7	106773	255.9	-5.22
212	CP32	45.0	90.7	-.44	90.2	S010	2.4	105091	376.0	.42
213	S010	45.0	90.2	-.34	89.9	S020	2.4	105091	376.0	.42
214	S020	45.0	89.9	-.16	89.7	S030	.8	25247	69.1	-.30
215	S030	45.0	89.7	-61.24	28.5	LSUI	.6	337	.0	.36
216	LSUI	45.0	28.5	-1.35	27.1	PSUI	6.9	152405	276.2	-.01
217	PSUI	45.0	27.1	126.61	153.7	PSUO	-- CONS	PUMP --	276.2	-.01
218	PSUO	45.0	153.7	-2.79	151.0	DSU1	6.9	152405	276.2	-.01
219	DSU1	45.0	151.0	-76.07	74.9	DSU2	-- 2-way	COIL -	276.2	-.01
220	DSU2	55.7	74.9	-2.74	72.1	LSUO	6.9	181274	276.2	-.01
221	LSUO	55.7	72.1	.00	72.1	R030	.0	10	.0	.36
222	LSUO	55.7	72.1	-.90	71.2	R031	6.9	181264	276.2	-.01
223	R031	55.7	71.2	-40.55	30.7	R032	-- CHILLER	----	276.2	-.01
224	R032	45.0	30.7	-2.21	28.5	LSUI	6.9	152397	276.2	-.01
225	R030	56.0	72.1	-.15	72.0	R020	.8	30168	69.1	-.30
226	R020	54.3	72.0	-1.25	70.7	R010	4.2	160886	376.0	.42
227	R010	54.3	70.7	-.43	70.3	CP33	2.4	122262	376.0	.42
228	S030	45.0	89.7	-.81	88.9	L29I	1.7	38025	69.1	-.30
229	L29I	53.3	88.9	-1.36	87.6	P29I	7.0	176640	279.4	.00
230	P29I	53.3	87.6	65.04	152.6	P29O	-- CONS	PUMP --	279.4	.00
231	P29O	53.3	152.6	-2.81	149.8	D291	7.0	176640	279.4	.00
232	D291	53.3	149.8	-40.26	109.5	D292	-- WILD	EXCH --	279.4	.00
233	D292	56.0	109.5	-2.80	106.7	L29O	7.0	184202	279.4	.00
234	L29O	56.0	106.7	-17.81	88.9	L29I	9.1	182095	210.3	.10
235	L29O	56.0	106.7	-34.59	72.1	R030	1.7	45437	69.1	-.30
236	S020	45.0	89.9	-1.75	88.1	L28I	3.4	113043	306.9	.58
237	L28I	45.0	88.1	-14.44	73.7	L28O	-- WILD	EXCH --	306.9	.58
238	L28O	53.9	73.7	-1.71	72.0	R020	3.4	130719	306.9	.58
239	CPWS	45.0	96.0	-.05	96.0	S210	6.1	755315	7685.5	.11
240	S210	45.0	96.0	-.89	95.1	S220	6.0	734879	7477.8	.10
241	S220	45.0	95.1	-.16	94.9	S230	5.6	687737	6998.0	.10
242	S230	45.0	94.9	-.46	94.4	S250	5.1	624568	6355.1	.11
243	S250	45.0	94.4	-.20	94.2	S260	5.2	636008	6471.8	.10
244	S260	45.0	94.2	-.68	93.6	S280	5.2	636008	6471.8	.10
245	S280	45.0	93.6	-.64	92.9	S3SI	5.0	614246	6250.3	.10
246	S3SO	45.0	92.9	-.64	92.3	S310	5.0	614245	6250.3	.10
247	S310	45.0	92.3	-.97	91.3	S4SI	4.8	593540	6039.7	.10
248	S4SO	45.0	91.3	-.06	91.3	S350	4.8	593540	6039.7	.10
249	S350	45.0	91.3	-.03	91.2	S410	4.9	606427	6170.5	.11
250	S410	45.0	91.2	-.87	90.4	S420	4.7	486696	4119.3	.07

SECTION RESULTS AFTER 24 ITERATIONS

	----- INLET	-----			- OUTLET -		---------- FLOW	----------		
SEC #	NODE	TEMP degF	PRESS ftwg	DELTA ftwg	PRESS ftwg	NODE	VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
251	S420	45.0	90.4	-.33	90.0	S440	3.7	375332	3176.6	.07
252	S440	45.0	90.0	-.43	89.6	S460	2.8	283840	2400.8	.14
253	S460	45.0	89.6	-.12	89.5	S5SI	2.6	264088	2233.6	.14
254	S5SO	45.0	89.5	-.35	89.1	S510	2.6	264088	2233.6	.14
255	S510	45.0	89.1	-.20	88.9	S530	1.6	160301	1357.4	.02
256	S530	45.0	88.9	-.13	88.8	S550	1.6	160301	1357.4	.02
257	S550	45.0	88.8	-.08	88.7	S6SI	2.2	154682	914.1	-.01
258	S6SO	45.0	88.7	-1.94	86.8	S610	2.6	170062	914.1	-.01
259	S610	45.0	86.8	-4.86	81.9	S615	3.7	161519	580.4	-.02
260	S615	45.0	81.9	-4.21	77.7	LWOI	3.7	161519	580.4	-.02
261	LWOI	45.0	77.7	-.88	76.8	PWOI	3.7	161519	580.4	-.02
262	PWOI	45.0	76.8	92.51	169.4	PWOO	-- CONS	PUMP --	580.4	-.02
263	PWOO	45.0	169.4	-.49	168.9	DWO1	3.7	161519	580.4	-.02
264	DWO1	45.0	168.9	-81.14	87.7	DWO2	-- 2-way	COIL -	580.4	-.02
265	DWO2	55.8	87.7	-.06	87.7	LWOO	3.7	192418	580.4	-.02
266	LWOO	55.8	87.7	-4.12	83.6	R615	3.7	192418	580.4	-.02
267	R615	55.8	83.6	-4.74	78.8	R610	3.7	192418	580.4	-.02
268	R610	55.9	78.8	-1.89	76.9	S6RI	2.6	202782	914.1	-.01
269	S6RO	55.9	76.9	-.08	76.8	R550	2.2	184443	914.1	-.01
270	R550	55.9	76.8	-.13	76.7	R530	1.6	191317	1357.4	.02
271	R530	55.9	76.7	-.19	76.5	R510	1.6	191317	1357.4	.02
272	R510	56.0	76.5	-.34	76.2	S5RI	2.6	315434	2233.6	.14
273	S5RO	56.0	76.2	-.16	76.0	R460	2.6	315435	2233.6	.14
274	R460	56.0	76.0	-.42	75.6	R440	2.8	339050	2400.8	.14
275	R440	56.0	75.6	-.38	75.2	R420	3.7	448379	3176.6	.07
276	R420	56.0	75.2	-.85	74.4	R410	4.7	581646	4119.3	.07
277	R410	56.0	74.4	-.03	74.4	R350	4.9	724142	6170.5	.11
278	R350	56.0	74.4	-.36	74.0	S4RI	4.8	708754	6039.7	.10
279	S4RO	56.0	74.0	-.95	73.0	R310	4.8	708754	6039.7	.10
280	R310	56.0	73.0	-.79	72.2	S3RI	5.0	733500	6250.3	.10
281	S3RO	56.0	72.2	-1.11	71.1	R280	5.0	733500	6250.3	.10
282	R280	56.0	71.1	-.67	70.5	R260	5.2	759513	6471.8	.10
283	R260	56.0	70.5	-.20	70.3	R250	5.2	759513	6471.8	.10
284	R250	56.0	70.3	-.45	69.8	R230	5.1	745851	6355.1	.11
285	R230	56.0	69.8	-.15	69.7	R220	5.6	821352	6998.0	.10
286	R220	56.5	69.7	-.87	68.8	R210	6.0	884911	7477.8	.10
287	R210	56.4	68.8	-.05	68.7	CPWR	6.1	907883	7685.5	.11
288	S610	45.0	86.8	-.31	86.5	S620	2.1	92860	333.6	.00
289	S620	45.0	86.5	-.18	86.3	S625	1.3	58371	209.6	.07
290	S625	45.0	86.3	-8.99	77.3	LFRI	6.7	89555	99.5	.06
291	LFRI	45.4	77.3	-1.82	75.5	PFRI	6.9	93878	103.5	.06
292	PFRI	45.4	75.5	41.66	117.1	PFRO	-- CONS	PUMP --	103.5	.06
293	PFRO	45.4	117.1	-4.44	112.7	DFR1	6.9	93878	103.5	.06
294	DFR1	45.4	112.7	-10.62	102.1	DFR2	-- WILD	EXCH --	103.5	.06
295	DFR2	56.0	102.1	-4.36	97.7	LFRO	6.9	111346	103.5	.06
296	LFRO	56.0	97.7	-20.42	77.3	LFRI	.4	5197	4.0	.01
297	LFRO	56.0	97.7	-18.48	79.3	R625	6.7	106996	99.5	.06
298	R625	56.0	79.3	-.18	79.1	R620	1.3	69693	209.6	.07
299	R620	56.0	79.1	-.27	78.8	R610	2.1	110903	333.6	.00
300	S625	45.0	86.3	-4.96	81.3	LMOI	7.4	99127	110.1	.07

SECTION RESULTS AFTER 24 ITERATIONS

	----- INLET -----				- OUTLET -		---------- FLOW ----------			
SEC #	NODE	TEMP degF	PRESS ftwg	DELTA ftwg	PRESS ftwg	NODE	VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
301	LMOI	45.0	81.3	-2.06	79.3	PMOI	7.4	99483	110.4	.06
302	PMOI	45.0	79.3	36.94	116.2	PMOO	-- CONS PUMP --		110.4	.06
303	PMOO	45.0	116.2	-5.02	111.2	DMO1	7.4	99483	110.4	.06
304	DMO1	45.0	111.2	-10.86	100.3	DMO2	-- WILD EXCH --		110.4	.06
305	DMO2	55.9	100.3	-4.93	95.4	LMOO	7.4	118645	110.4	.06
306	LMOO	55.9	95.4	-14.08	81.3	LMOI	.0	428	.3	-.95
307	LMOO	55.9	95.4	-16.16	79.3	R625	7.4	118286	110.1	.07
308	S620	45.0	86.5	-6.22	80.3	LFII	8.3	111486	124.0	-.10
309	LFII	46.3	80.3	-3.26	77.0	PFII	9.4	129831	141.0	.09
310	PFII	46.3	77.0	52.79	129.8	PFIO	-- CONS PUMP --		141.0	.09
311	PFIO	46.3	129.8	-7.96	121.8	DFI1	9.4	129831	141.0	.09
312	DFI1	46.3	121.8	-10.88	110.9	DFI2	-- WILD EXCH --		141.0	.09
313	DFI2	56.0	110.9	-7.86	103.1	LFIO	9.4	151660	141.0	.09
314	LFIO	56.0	103.1	-22.83	80.3	LFII	1.6	22036	16.9	1.51
315	LFIO	56.0	103.1	-24.01	79.1	R620	8.3	133211	124.0	-.10
316	S550	45.0	88.8	-.41	88.4	S555	2.8	123505	443.4	.09
317	S555	45.0	88.4	-.53	87.9	LMRI	2.8	123505	443.4	.09
318	LMRI	51.9	87.9	-3.35	84.5	PMRI	7.6	372025	1191.7	.01
319	PMRI	51.9	84.5	62.48	147.0	PMRO	-- CONS PUMP --		1191.7	.01
320	PMRO	51.9	147.0	-1.87	145.1	DMR1	7.6	372025	1191.7	.01
321	DMR1	51.9	145.1	-30.60	114.5	DMR2	-- WILD EXCH --		1191.7	.01
322	DMR2	56.1	114.5	-1.86	112.7	LMRO	7.6	396645	1191.7	.01
323	LMRO	56.1	112.7	-24.78	87.9	LMRI	8.3	327620	748.4	-.03
324	LMRO	56.1	112.7	-35.42	77.2	R555	2.8	147677	443.4	.09
325	R555	56.1	77.2	-.40	76.8	R550	2.8	147677	443.4	.09
326	S510	45.0	89.1	-.02	89.1	S515	1.0	103787	876.2	.33
327	S515	45.0	89.1	-10.13	79.0	LSAI	5.1	167819	457.8	.09
328	LSAI	48.2	79.0	-1.18	77.8	PSAI	7.1	248043	641.8	.03
329	PSAI	48.2	77.8	34.82	112.6	PSAO	-- CONS PUMP --		641.8	.03
330	PSAO	48.2	112.6	-1.48	111.1	DSA1	7.1	248043	641.8	.03
331	DSA1	48.2	111.1	-16.74	94.4	DSA2	-- WILD EXCH --		641.8	.03
332	DSA2	56.1	94.4	-1.46	92.9	LSAO	7.1	281362	641.8	.03
333	LSAO	56.1	92.9	-13.96	79.0	LSAI	4.6	121372	184.1	-.11
334	LSAO	56.1	92.9	-16.39	76.5	R515	5.1	200794	457.8	.09
335	R515	56.1	76.5	-.02	76.5	R510	1.0	124118	876.2	.33
336	S515	45.0	89.1	-1.36	87.8	S520	4.7	154134	418.4	.59
337	S520	45.0	87.8	-1.95	85.8	L56I	2.5	81589	221.0	.81
338	L56I	45.8	85.8	-.18	85.6	P56I	2.6	88239	238.1	.01
339	P56I	45.8	85.6	11.95	97.6	P56O	-- CONS PUMP --		238.1	.01
340	P56O	45.8	97.6	-.23	97.3	D561	2.6	88239	238.1	.01
341	D561	45.8	97.3	-11.25	86.1	D562	-- WILD EXCH --		238.1	.01
342	D562	56.0	86.1	-.23	85.9	L56O	2.6	104059	238.1	.01
343	L56O	56.0	85.9	-.06	85.8	L56I	.4	10080	17.1	*****
344	L56O	56.0	85.9	-7.99	77.9	R520	2.5	97368	221.0	.81
345	R520	56.1	77.9	-1.33	76.5	R515	4.7	184227	418.4	.59
346	S520	45.0	87.8	-1.25	86.5	L57I	2.2	72546	197.4	.34
347	L57I	46.3	86.5	-.17	86.3	P57I	2.5	83916	224.1	.00
348	P57I	46.3	86.3	10.71	97.0	P57O	-- CONS PUMP --		224.1	.00
349	P57O	46.3	97.0	-.21	96.8	D571	2.5	83916	224.1	.00
350	D571	46.3	96.8	-10.03	86.8	D572	-- WILD EXCH --		224.1	.00

SECTION RESULTS AFTER 24 ITERATIONS

SEC	----- INLET -----				- OUTLET -		---------- FLOW ----------			
#	NODE	TEMP degF	PRESS ftwg	DELTA ftwg	PRESS ftwg	NODE	VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
351	D572	56.2	86.8	-.20	86.6	L570	2.5	98294	224.1	.00
352	L570	56.2	86.6	-.10	86.5	L57I	.7	17227	26.7	-2.49
353	L570	56.2	86.6	-8.73	77.9	R520	2.2	86859	197.4	.34
354	S460	45.0	89.6	-.25	89.3	S465	1.9	61271	167.2	.05
355	S465	45.0	89.3	-5.35	84.0	L55I	7.2	121124	167.2	.05
356	L55I	45.7	84.0	-.59	83.4	P55I	4.5	99257	177.7	.10
357	P55I	45.7	83.4	21.49	104.9	P550	-- CONS PUMP --		177.7	.10
358	P550	45.7	104.9	-.59	104.3	D551	4.5	99257	177.7	.10
359	D551	45.7	104.3	-8.97	95.4	D552	-- WILD EXCH --		177.7	.10
360	D552	56.1	95.4	-.57	94.8	L550	4.5	117355	177.7	.10
361	L550	56.1	94.8	-10.77	84.0	L55I	.5	9184	10.5	.82
362	L550	56.1	94.8	-18.38	76.4	R465	7.2	144816	167.2	.05
363	R465	56.1	76.4	-.37	76.0	R460	1.9	73255	167.2	.05
364	S440	45.0	90.0	-.91	89.1	S445	5.0	215678	775.8	-.11
365	S445	45.0	89.1	-3.06	86.1	LBOI	5.0	215678	775.8	-.11
366	LBOI	51.9	86.1	-3.26	82.8	PBOI	13.2	643499	2063.6	.00
367	PBOI	51.9	82.8	71.09	153.9	PBOO	-- CONS PUMP --		2063.6	.00
368	PBOO	51.9	153.9	-18.12	135.8	DBO1	13.2	643499	2063.6	.00
369	DBO1	51.9	135.8	-19.95	115.8	DBO2	-- WILD EXCH --		2063.6	.00
370	DBO2	56.0	115.8	-18.04	97.8	LBOO	13.2	686324	2063.6	.00
371	LBOO	56.0	97.8	-11.73	86.1	LBOI	14.3	563997	1287.8	.07
372	LBOO	56.0	97.8	-21.29	76.5	R445	5.0	257726	775.8	-.11
373	R445	56.0	76.5	-.89	75.6	R440	5.0	257726	775.8	-.11
374	S420	45.0	90.4	-.04	90.3	S425	1.7	139681	942.6	.06
375	S425	45.0	90.3	-.16	90.2	S430	1.4	117640	794.1	.04
376	S430	45.0	90.2	-.34	89.8	S438	1.2	50875	182.6	.09
377	S438	45.0	89.8	-1.21	88.6	LBSI	2.2	47879	86.6	.15
378	LBSI	51.0	88.6	-.65	88.0	PBSI	4.7	114855	188.5	.02
379	PBSI	51.0	88.0	32.21	120.2	PBSO	-- CONS PUMP --		188.5	.02
380	PBSO	51.0	120.2	-.65	119.5	DBS1	4.7	114855	188.5	.02
381	DBS1	51.0	119.5	-18.99	100.5	DBS2	-- WILD EXCH --		188.5	.02
382	DBS2	56.1	100.5	-.64	99.9	LBSO	4.7	124375	188.5	.02
383	LBSO	56.1	99.9	-11.27	88.6	LBSI	4.4	88098	101.9	-.10
384	LBSO	56.1	99.9	-24.12	75.8	R438	2.2	57240	86.6	.15
385	R438	56.2	75.8	-.33	75.4	R430	1.2	60922	182.6	.09
386	R430	56.1	75.4	-.15	75.3	R425	1.4	140760	794.1	.04
387	R425	56.1	75.3	-.05	75.2	R420	1.7	167152	942.6	.06
388	S438	45.0	89.8	-8.40	81.4	LBAI	6.4	86381	96.0	.03
389	LBAI	45.0	81.4	-1.58	79.8	PBAI	6.4	86517	96.1	.09
390	PBAI	45.0	79.8	36.21	116.1	PBAO	-- CONS PUMP --		96.1	.09
391	PBAO	45.0	116.1	-1.58	114.5	DBA1	6.4	86517	96.1	.09
392	DBA1	45.0	114.5	-20.42	94.1	DBA2	-- WILD EXCH --		96.1	.09
393	DBA2	56.3	94.1	-1.55	92.5	LBAO	6.4	103729	96.1	.09
394	LBAO	56.3	92.5	-11.09	81.4	LBAI	.0	164	.1	93.58
395	LBAO	56.3	92.5	-16.75	75.8	R438	6.4	103592	96.0	.03
396	S430	45.0	90.2	-3.61	86.6	S435	6.8	224002	611.4	.03
397	S435	45.0	86.6	-2.25	84.3	LSGI	4.2	93280	168.9	.10
398	LSGI	45.3	84.3	-.57	83.7	PSGI	4.4	96876	174.4	.07
399	PSGI	45.3	83.7	16.75	100.5	PSGO	-- CONS PUMP --		174.4	.07
400	PSGO	45.3	100.5	-.57	99.9	DSG1	4.4	96876	174.4	.07

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	----- INLET -----			DELTA	- OUTLET -		---------- FLOW ----------			
	NODE	TEMP degF	PRESS ftwg	ftwg	PRESS ftwg	NODE	VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
401	DSG1	45.3	99.9	-11.00	88.9	DSG2	-- WILD	EXCH --	174.4	.07
402	DSG2	56.0	88.9	-.55	88.4	LSGO	4.4	115072	174.4	.07
403	LSGO	56.0	88.4	-4.06	84.3	LSGI	.2	4750	5.5	-.82
404	LSGO	56.0	88.4	-9.38	79.0	R435	4.2	111452	168.9	.10
405	R435	56.1	79.0	-3.55	75.4	R430	6.8	267962	611.4	.03
406	S435	45.0	86.6	-8.03	78.5	LSCI	11.1	244169	442.5	.01
407	LSCI	45.0	78.5	-3.31	75.2	PSCI	11.1	244662	442.9	.09
408	PSCI	45.0	75.2	83.45	158.7	PSCO	-- CONS	PUMP --	442.9	.09
409	PSCO	45.0	158.7	-4.50	154.2	DSC1	11.1	244662	442.9	.09
410	DSC1	45.0	154.2	-14.07	140.1	DSC2	-- WILD	EXCH --	442.9	.09
411	DSC2	56.1	140.1	-4.44	135.6	LSCO	11.1	292718	442.9	.09
412	LSCO	56.1	135.6	-57.13	78.5	LSCI	.0	650	.4	90.79
413	LSCO	56.1	135.6	-56.66	79.0	R435	11.1	292222	442.5	.01
414	S425	45.0	90.3	-3.69	86.6	LTHI	6.4	107759	148.6	.17
415	LTHI	48.3	86.6	-.80	85.8	PTHI	5.3	122892	210.8	.03
416	PTHI	48.3	85.8	19.92	105.7	PTHO	-- CONS	PUMP --	210.8	.03
417	PTHO	48.3	105.7	-.80	104.9	DTH1	5.3	122892	210.8	.03
418	DTH1	48.3	104.9	-12.36	92.6	DTH2	-- WILD	EXCH --	210.8	.03
419	DTH2	56.2	92.6	-.79	91.8	LTHO	5.3	139278	210.8	.03
420	LTHO	56.2	91.8	-5.16	86.6	LTHI	2.7	53733	62.2	-.30
421	LTHO	56.2	91.8	-16.50	75.3	R425	3.7	98331	148.6	.17
422	S410	45.0	91.2	-.47	90.8	S7SI	5.9	382334	2051.2	.17
423	S7SO	45.0	90.8	-4.66	86.1	S710	5.9	382333	2051.2	.17
424	S710	45.0	86.1	-1.30	84.8	S740	4.9	316245	1696.6	.18
425	S740	45.0	84.8	-.21	84.6	S770	3.8	248526	1335.1	.04
426	S770	45.0	84.6	-9.12	75.5	S8SI	6.3	342068	1542.2	.06
427	S8SO	45.0	75.4	-3.00	72.5	S810	6.3	342069	1542.2	.06
428	S810	45.0	72.5	-.05	72.4	S811	.8	41308	186.3	.01
429	BP1I	45.0	72.4	.00	72.4	S811	.0	9	.0	.01
430	BP1O	45.0	123.6	-51.20	72.4	BP1I	.7	381	.0	.01
431	S812	45.0	123.6	.00	123.6	BP1O	.0	9	.0	.01
432	S811	45.0	72.4	-.92	71.5	BP2I	4.7	102818	186.3	.01
433	BP2I	45.0	71.5	53.03	124.5	BP2O	-- CONS	PUMP --	186.3	.01
434	BP2O	45.0	124.5	-.92	123.6	S812	4.7	102818	186.3	.01
435	S812	45.0	123.6	-9.18	114.4	S815	4.7	102809	186.3	.01
436	S815	45.0	114.4	-16.06	98.4	S820	4.7	102809	186.3	.01
437	S820	45.0	98.4	-.38	98.0	L61I	2.4	52603	95.3	.00
438	L61I	45.0	98.0	-.19	97.8	P61I	2.4	52704	95.4	.07
439	P61I	45.0	97.8	31.26	129.0	P61O	-- CONS	PUMP --	95.4	.07
440	P61O	45.0	129.0	-.19	128.9	D611	2.4	52704	95.4	.07
441	D611	45.0	128.9	-4.55	124.3	D612	-- WILD	EXCH --	95.4	.07
442	D612	62.6	124.3	-.18	124.1	L61O	2.4	69142	95.4	.07
443	L61O	62.6	124.1	-26.16	98.0	L61I	.0	134	.1	91.09
444	L61O	62.6	124.1	-2.47	121.7	R820	2.4	69040	95.3	.00
445	R820	62.9	121.7	-15.53	106.1	R815	4.7	135473	186.3	.01
446	R815	62.9	106.1	-13.32	92.8	R810	4.7	135473	186.3	.01
447	R810	55.7	92.8	-2.94	89.9	S8RI	6.3	407053	1542.2	.06
448	S8RO	55.7	89.9	-8.96	80.9	R770	6.3	407051	1542.2	.06
449	R770	55.7	80.9	-.20	80.7	R740	3.8	295739	1335.1	.04
450	R740	55.8	80.7	-1.28	79.4	R710	4.9	376651	1696.6	.18

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	----- NODE	INLET TEMP degF	----- PRESS ftwg	DELTA ftwg	- OUTLET - PRESS ftwg	NODE	---------- FLOW VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
451	R710	55.9	79.4	-4.58	74.8	S7RI	5.9	455800	2051.2	.17
452	S7RO	55.9	74.8	-.46	74.4	R410	5.9	455801	2051.2	.17
453	S820	45.0	98.4	-1.33	97.0	LATI	2.3	50206	91.0	.02
454	LATI	45.0	97.0	-.17	96.9	PATI	2.3	50284	91.0	.08
455	PATI	45.0	96.9	32.49	129.3	PATO	-- CONS PUMP --		91.0	.08
456	PATO	45.0	129.3	-.17	129.2	DAT1	2.3	50284	91.0	.08
457	DAT1	45.0	129.2	-4.17	125.0	DAT2	-- WILD EXCH --		91.0	.08
458	DAT2	63.2	125.0	-.16	124.8	LATO	2.3	66511	91.0	.08
459	LATO	63.2	124.8	-27.82	97.0	LATI	.0	103	.191.53	
460	LATO	63.2	124.8	-3.18	121.7	R820	2.3	66432	91.0	.02
461	S810	45.0	72.5	-.51	71.9	S830	5.5	300761	1355.9	.06
462	S830	45.0	71.9	-1.26	70.7	LCRI	6.1	267279	959.4	.10
463	LCRI	45.0	70.7	-.76	69.9	PCRI	6.1	267279	959.4	.10
464	PCRI	45.0	69.9	30.27	100.2	PCRO	-- CONS PUMP --		959.4	.10
465	PCRO	45.0	100.2	-.76	99.4	DCR1	6.1	267279	959.4	.10
466	DCR1	45.0	99.4	-3.96	95.5	DCR2	-- 3-way COIL -		827.6	-.04
467	DCR1	45.0	99.4	-3.96	95.5	DCR2	--- BYPASS ----		131.8	.95
468	DCR2	54.3	95.5	-.91	94.6	LCRO	6.1	310810	959.4	.10
469	LCRO	54.3	94.6	-1.24	93.3	R830	6.1	310810	959.4	.10
470	R830	54.8	93.3	-.50	92.8	R810	5.5	352543	1355.9	.06
471	S830	45.0	71.9	-5.03	66.9	L99I	4.4	145173	396.5	-.03
472	L99I	50.9	66.9	-2.06	64.8	P99I	9.6	348950	863.0	.02
473	P99I	50.9	64.8	75.16	140.0	P99O	-- CONS PUMP --		863.0	.02
474	P99O	50.9	140.0	-2.59	137.4	D991	9.6	348950	863.0	.02
475	D991	50.9	137.4	-29.71	107.7	D992	-- WILD EXCH --		863.0	.02
476	D992	56.0	107.7	-2.58	105.1	L99O	9.6	377698	863.0	.02
477	L99O	56.0	105.1	-38.22	66.9	L99I	11.7	307705	466.5	.06
478	L99O	56.0	105.1	-11.81	93.3	R830	4.4	173441	396.5	-.03
479	LHOI	45.0	178.2	-93.62	84.6	S770	- LOOP BYPASS -		207.1	.15
480	LHOI	45.0	178.2	-111.57	66.6	DHO1	-- LOOP VALVE -		432.6	-.13
481	DHO1	45.0	66.6	-7.86	58.8	DHO2	-- LOOP UNIT --		432.6	-.13
482	DHO2	58.8	58.8	-.83	57.9	LHOO	4.8	197065	432.6	-.13
483	R770	55.7	80.9	-22.96	57.9	LHOO	9.0	178657	207.1	.15
484	LHOO	57.8	57.9	-1.45	56.5	PHOI	7.1	287452	639.7	-.04
485	PHOI	57.8	56.5	159.19	215.7	PHOO	-- CONS PUMP --		639.7	-.04
486	PHOO	57.8	215.7	-2.04	213.6	RHOC	7.1	287452	639.7	-.04
487	RHOC	57.8	213.6	-28.48	185.2	SHOC	-- CHILLER ----		639.7	-.04
488	SHOC	45.0	185.2	-6.96	178.2	LHOI	7.1	234184	639.7	-.04
489	S740	45.0	84.8	-.80	84.0	S745	2.3	101294	361.5	.67
490	S745	45.0	84.0	-.80	83.2	S750	2.3	101294	361.5	.67
491	S750	45.0	83.2	-.68	82.5	SAE1	2.1	68053	184.6	.67
492	SAE1	45.0	82.5	-.61	81.9	LAEI	5.0	165752	452.5	.01
493	LAEI	49.3	81.9	-1.53	80.3	PAEI	8.2	290519	738.7	.00
494	PAEI	49.3	80.3	36.57	116.9	PAEO	-- CONS PUMP --		738.7	.00
495	PAEO	49.3	116.9	-1.93	115.0	DAE1	8.2	290519	738.7	.00
496	DAE1	49.3	115.0	-18.84	96.1	DAE2	-- WILD EXCH --		738.7	.00
497	DAE2	56.0	96.1	-1.91	94.2	LAEO	8.2	323222	738.7	.00
498	LAEO	56.0	94.2	-12.35	81.9	LAEI	7.2	188605	286.1	-.01
499	LAEO	56.0	94.2	-10.81	83.4	RAE1	5.0	198024	452.5	.01
500	RAE1	56.0	83.4	-1.16	82.3	R750	2.1	81303	184.6	.67

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	----- INLET ----- NODE	TEMP degF	PRESS ftwg	DELTA ftwg	- OUTLET - PRESS ftwg	NODE	---------- FLOW ---------- VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
501	RAE1	56.0	83.4	-.12	83.3	RAE2	2.9	115578	267.9	-.44
502	RAE2	56.0	83.3	-.69	82.6	SAE2	-- CHILLER ----		267.9	-.44
503	SAE2	45.0	82.6	-.12	82.5	SAE1	3.0	97699	267.9	-.44
504	R750	56.0	82.3	-.78	81.5	R745	2.3	121028	361.5	.67
505	R745	56.0	81.5	-.78	80.7	R740	2.3	121028	361.5	.67
506	S750	45.0	83.2	-.36	82.8	SPE1	2.0	65241	176.9	.67
507	SPE1	45.0	82.8	-.39	82.4	LPEI	3.9	129661	354.0	.01
508	LPEI	51.2	82.4	-1.85	80.6	PPEI	9.0	330885	814.8	.00
509	PPEI	51.2	80.6	44.55	125.1	PPEO	-- CONS PUMP --		814.8	.00
510	PPEO	51.2	125.1	-2.32	122.8	DPE1	9.0	330885	814.8	.00
511	DPE1	51.2	122.8	-22.76	100.1	DPE2	-- WILD EXCH --		814.8	.00
512	DPE2	56.0	100.1	-2.31	97.7	LPEO	9.0	356602	814.8	.00
513	LPEO	56.0	97.7	-15.31	82.4	LPEI	11.6	303799	460.8	.00
514	LPEO	56.0	97.7	-14.14	83.6	RPE1	3.9	154937	354.0	.01
515	RPE1	56.0	83.6	-1.34	82.3	R750	2.0	77959	176.9	.67
516	RPE1	56.0	83.6	-.41	83.2	RPE2	4.4	115965	177.0	-.65
517	RPE2	56.0	83.2	-.32	82.9	SPE2	-- CHILLER ----		177.0	-.65
518	SPE2	45.0	82.9	-.06	82.8	SPE1	1.9	64421	177.0	-.65
519	S710	45.0	86.1	-.60	85.5	S715	3.9	130084	354.6	.17
520	S715	45.0	85.5	-.79	84.7	LMAI	3.9	130084	354.6	.17
521	LMAI	50.4	84.7	-1.33	83.4	PMAI	7.6	275312	687.1	.01
522	PMAI	50.4	83.4	37.68	121.1	PMAO	-- CONS PUMP --		687.1	.01
523	PMAO	50.4	121.1	-1.68	119.4	DMA1	7.6	275312	687.1	.01
524	DMA1	50.4	119.4	-24.51	94.9	DMA2	-- WILD EXCH --		687.1	.01
525	DMA2	56.2	94.9	-1.66	93.2	LMAO	7.6	301425	687.1	.01
526	LMAO	56.2	93.2	-8.50	84.7	LMAI	8.3	219390	332.5	-.15
527	LMAO	56.2	93.2	-13.19	80.0	R715	3.9	155792	354.6	.17
528	R715	56.2	80.0	-.58	79.4	R710	3.9	155792	354.6	.17
529	LBUI	45.0	158.1	-66.86	91.3	S350	- LOOP BYPASS -		130.8	.34
530	LBUI	45.0	158.1	-77.57	80.5	DBU1	-- LOOP VALVE -		433.5	-.12
531	DBU1	45.0	80.5	-7.89	72.7	DBU2	-- LOOP UNIT --		433.5	-.12
532	DBU2	58.8	72.7	-.83	71.8	LBUO	4.8	197403	433.5	-.12
533	R350	56.0	74.4	-2.52	71.8	LBUO	3.3	86482	130.8	.34
534	LBUO	58.1	71.8	-1.14	70.7	PBUI	6.2	254819	564.3	-.02
535	PBUI	58.1	70.7	97.33	168.0	PBUO	-- CONS PUMP --		564.3	-.02
536	PBUO	58.1	168.0	-1.61	166.4	RBUC	6.2	254819	564.3	-.02
537	RBUC	58.1	166.4	-2.80	163.6	SBUC	-- CHILLER ----		564.3	-.02
538	SBUC	45.0	163.6	-5.49	158.1	LBUI	6.2	206637	564.3	-.02
539	S310	45.0	92.3	-.04	92.3	S9SI	.9	46753	210.6	.13
540	S9SO	45.0	92.3	-.10	92.2	S320	.9	46751	210.6	.13
541	S320	45.0	92.2	-.04	92.1	S330	.4	18768	66.8	.97
542	S330	45.0	92.1	-.69	91.4	L75I	2.2	71580	195.5	-.01
543	L75I	51.5	91.4	-.66	90.8	P75I	5.3	193258	474.0	.00
544	P75I	51.5	90.8	20.56	111.3	P75O	-- CONS PUMP --		474.0	.00
545	P75O	51.5	111.3	-.83	110.5	D751	5.3	193258	474.0	.00
546	D751	51.5	110.5	-14.70	95.8	D752	-- WILD EXCH --		474.0	.00
547	D752	56.0	95.8	-.82	95.0	L75O	5.3	207469	474.0	.00
548	L75O	56.0	95.0	-3.55	91.4	L75I	7.0	183679	278.6	.01
549	L75O	56.0	95.0	-21.77	73.2	R330	2.2	85541	195.5	-.01
550	R330	56.0	73.2	-.04	73.2	R320	.4	22429	66.8	.97

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	----- INLET ----- NODE	TEMP degF	PRESS ftwg	DELTA ftwg	- OUTLET - PRESS ftwg	NODE	---------- FLOW ---------- VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
551	R320	56.0	73.2	-.10	73.1	S9RI	.9	55876	210.6	.13
552	S9RO	56.0	73.1	-.03	73.0	R310	.9	55877	210.6	.13
553	L76I	45.0	95.8	-3.67	92.1	S330	3.2	70626	128.7	-.51
554	L76I	45.0	95.8	-2.02	93.8	D761	7.6	250407	683.3	.07
555	D761	45.0	93.8	-22.14	71.6	D762	-- 3-way COIL -		201.3	-.02
556	D761	45.0	93.8	-22.14	71.6	D762	--- BYPASS ----		482.0	.10
557	D762	49.5	71.6	-2.00	69.6	L760	7.6	270130	683.3	.07
558	R330	56.0	73.2	-3.57	69.6	L760	3.2	84402	128.7	-.51
559	L760	50.6	69.6	-2.31	67.3	P76I	9.0	326094	811.9	-.02
560	P76I	50.6	67.3	72.86	140.2	P760	-- CONS PUMP --		811.9	-.02
561	P760	50.6	140.2	-3.25	136.9	R76C	9.0	326094	811.9	-.02
562	R76C	50.6	136.9	-30.18	106.7	S76C	-- CHILLER ----		811.9	-.02
563	S76C	45.0	106.7	-10.96	95.8	L76I	9.0	297290	811.9	-.02
564	S320	45.0	92.2	-.34	91.8	L51I	1.6	52541	143.8	-.26
565	L51I	52.9	91.8	-.74	91.1	P51I	5.6	211170	506.3	.00
566	P51I	52.9	91.1	31.89	123.0	P510	-- CONS PUMP --		506.3	.00
567	P510	52.9	123.0	-.74	122.2	D511	5.6	211170	506.3	.00
568	D511	52.9	122.2	-24.18	98.0	D512	-- WILD EXCH --		506.3	.00
569	D512	56.0	98.0	-.74	97.3	L510	5.6	221631	506.3	.00
570	L510	56.0	97.3	-5.48	91.8	L51I	9.1	239274	362.5	.10
571	L510	56.0	97.3	-24.13	73.2	R320	1.6	62798	143.8	-.26
572	S280	45.0	93.6	-2.16	91.4	L84I	5.6	122306	221.5	.09
573	L84I	45.4	91.4	-.95	90.5	P84I	5.8	127652	229.8	.01
574	P84I	45.4	90.5	18.50	109.0	P840	-- CONS PUMP --		229.8	.01
575	P840	45.4	109.0	-1.29	107.7	D841	5.8	127652	229.8	.01
576	D841	45.4	107.7	-14.64	93.0	D842	-- WILD EXCH --		229.8	.01
577	D842	56.0	93.0	-1.27	91.8	L840	5.8	151569	229.8	.01
578	L840	56.0	91.8	-.34	91.4	L84I	.4	7060	8.3	-2.05
579	L840	56.0	91.8	-20.63	71.1	R280	5.6	146189	221.5	.09
580	L02I	45.0	106.6	-12.16	94.4	S250	- LOOP BYPASS -		116.7	-.18
581	L02I	45.0	106.6	-36.52	70.1	D021	-- LOOP VALVE -		437.7	.01
582	D021	45.0	70.1	-10.33	59.8	D022	-- LOOP UNIT --		437.7	.01
583	D022	58.7	59.8	-.85	58.9	L020	4.8	199235	437.7	.01
584	R250	56.0	70.3	-11.35	58.9	L020	5.0	100753	116.7	-.18
585	L020	58.1	58.9	-1.10	57.8	P02I	6.1	250208	554.5	-.03
586	P02I	58.1	57.8	106.55	164.4	P020	-- CONS PUMP --		554.5	-.03
587	P020	58.1	164.4	-1.56	162.8	R02C	6.1	250208	554.5	-.03
588	R02C	58.1	162.8	-14.28	148.5	S02C	-- CHILLER ----		554.5	-.03
589	S02C	45.0	148.5	-41.92	106.6	L02I	13.9	305811	554.5	-.03
590	S230	45.0	94.9	-.78	94.1	S235	4.1	179082	642.9	.08
591	S235	45.0	94.1	-.88	93.2	S240	2.4	106096	380.8	.11
592	S240	45.0	93.2	-.18	93.1	S245	2.0	67567	184.0	.29
593	S245	45.0	93.1	-1.23	91.8	L37I	2.2	48205	87.4	-.03
594	L37I	50.1	91.8	-.48	91.4	P37I	4.0	95791	159.6	.01
595	P37I	50.1	91.4	14.65	106.0	P370	-- CONS PUMP --		159.6	.01
596	P370	50.1	106.0	-.48	105.5	D371	4.0	95791	159.6	.01
597	D371	50.1	105.5	-10.53	95.0	D372	-- WILD EXCH --		159.6	.01
598	D372	56.2	95.0	-.47	94.5	L370	4.0	105471	159.6	.01
599	L370	56.2	94.5	-2.70	91.8	L37I	3.1	62633	72.2	.05
600	L370	56.2	94.5	-22.92	71.6	R245	2.2	57742	87.4	-.03

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	NODE	----- INLET ----- TEMP degF	PRESS ftwg	DELTA ftwg	- OUTLET - PRESS ftwg	NODE	---------- FLOW VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
601	R245	55.9	71.6	-.17	71.4	R240	2.0	80536	184.0	.29
602	R240	55.9	71.4	-.86	70.6	R235	2.4	126628	380.8	.11
603	R235	56.0	70.6	-.76	69.8	R230	4.1	214044	642.9	.08
604	S245	45.0	93.1	-1.39	91.7	L38I	4.2	70313	96.6	.57
605	L38I	48.2	91.7	-.37	91.3	P38I	3.5	80921	139.0	.05
606	P38I	48.2	91.3	9.08	100.4	P38O	-- CONS	PUMP --	139.0	.05
607	P38O	48.2	100.4	-.37	100.0	D381	3.5	80921	139.0	.05
608	D381	48.2	100.0	-5.61	94.4	D382	-- WILD	EXCH --	139.0	.05
609	D382	55.6	94.4	-.36	94.0	L38O	3.5	91029	139.0	.05
610	L38O	55.6	94.0	-2.37	91.7	L38I	1.8	36018	42.4	-1.14
611	L38O	55.6	94.0	-22.44	71.6	R245	4.2	83436	96.6	.57
612	S240	45.0	93.2	-.77	92.5	L01I	2.2	72045	196.8	-.05
613	L01I	51.2	92.5	-.60	91.9	P01I	5.0	182747	450.2	.00
614	P01I	51.2	91.9	24.94	116.8	P01O	-- CONS	PUMP --	450.2	.00
615	P01O	51.2	116.8	-1.06	115.8	D011	5.0	182747	450.2	.00
616	D011	51.2	115.8	-19.32	96.4	D012	-- WILD	EXCH --	450.2	.00
617	D012	56.0	96.4	-1.05	95.4	L01O	5.0	197041	450.2	.00
618	L01O	56.0	95.4	-2.91	92.5	L01I	6.4	167136	253.4	.04
619	L01O	56.0	95.4	-23.95	71.4	R240	2.2	86095	196.8	-.05
620	S235	45.0	94.1	-3.40	90.7	L45I	6.6	144686	262.1	.04
621	L45I	48.6	90.7	-2.57	88.2	P45I	9.8	227912	388.5	.04
622	P45I	48.6	88.2	49.49	137.7	P45O	-- CONS	PUMP --	388.5	.04
623	P45O	48.6	137.7	-3.48	134.2	D451	9.8	227912	388.5	.04
624	D451	48.6	134.2	-14.49	119.7	D452	-- WILD	EXCH --	388.5	.04
625	D452	56.2	119.7	-3.45	116.2	L45O	9.8	256850	388.5	.04
626	L45O	56.2	116.2	-25.51	90.7	L45I	5.5	109650	126.4	.04
627	L45O	56.2	116.2	-45.67	70.6	R235	6.6	173292	262.1	.04
628	S220	45.0	95.1	-.59	94.5	S221	3.1	133647	479.9	.07
629	S221	45.0	94.5	-14.25	80.2	S222	8.5	187480	339.6	.06
630	S222	45.0	80.2	-.37	79.8	S224	2.0	43383	78.5	.13
631	S224	45.0	79.8	-.20	79.6	S225	.8	18615	33.7	.03
632	S225	45.0	79.6	-.77	78.9	L59I	2.3	30354	33.7	.03
633	L59I	51.9	78.9	-1.00	77.9	P59I	5.1	76644	76.0	.07
634	P59I	51.9	77.9	27.75	105.6	P59O	-- CONS	PUMP --	76.0	.07
635	P59O	51.9	105.6	-1.48	104.1	D591	5.1	76644	76.0	.07
636	D591	51.9	104.1	-14.09	90.1	D592	-- WILD	EXCH --	76.0	.07
637	D592	57.4	90.1	-1.47	88.6	L59O	5.1	83427	76.0	.07
638	L59O	57.4	88.6	-9.71	78.9	L59I	4.0	55425	42.2	.10
639	L59O	57.4	88.6	-3.96	84.6	R225	2.3	37027	33.7	.03
640	R225	57.4	84.6	-.19	84.4	R224	.8	22707	33.7	.03
641	R224	56.8	84.4	-.36	84.1	R222	2.0	52410	78.5	.13
642	R222	68.0	84.1	-13.84	70.2	R221	8.5	262870	339.6	.06
643	R221	64.5	70.2	-.56	69.7	R220	3.1	179734	479.9	.07
644	S224	45.0	79.8	-1.30	78.6	L58I	3.0	40387	44.8	.21
645	L58I	52.3	78.6	-2.71	75.8	P58I	8.6	130505	128.5	.03
646	P58I	52.3	75.8	68.56	144.4	P58O	-- CONS	PUMP --	128.5	.03
647	P58O	52.3	144.4	-11.78	132.6	D581	8.6	130505	128.5	.03
648	D581	52.3	132.6	-22.30	110.3	D582	-- WILD	EXCH --	128.5	.03
649	D582	56.3	110.3	-11.71	98.6	L58O	8.6	138703	128.5	.03
650	L58O	56.3	98.6	-20.05	78.6	L58I	8.0	107826	83.7	-.07

SECTION RESULTS AFTER 24 ITERATIONS

SEC #	----- INLET ----- NODE	TEMP degF	PRESS ftwg	DELTA ftwg	- OUTLET - PRESS ftwg	NODE	---------- FLOW ---------- VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
651	L58O	56.3	98.6	-14.18	84.4	R224	3.0	48433	44.8	.21
652	S222	45.0	80.2	-41.13	39.1	S223	17.5	234967	261.1	.04
653	S223	45.0	39.1	-1.83	37.3	L00I	7.0	93602	104.0	.07
654	L00I	45.0	37.3	-1.83	35.4	P00I	7.0	93624	104.0	.08
655	P00I	45.0	35.4	107.79	143.2	P00O	-- CONS PUMP --		104.0	.08
656	P00O	45.0	143.2	-1.83	141.4	D001	7.0	93624	104.0	.08
657	D001	45.0	141.4	-3.50	137.9	D002	-- WILD EXCH --		104.0	.08
658	D002	77.1	137.9	-1.76	136.1	L00O	7.0	142492	104.0	.08
659	L00O	77.1	136.1	-98.86	37.3	L00I	.0	26	.09	6.28
660	L00O	77.1	136.1	-11.74	124.4	R223	7.0	142470	104.0	.07
661	R223	71.4	124.4	-40.31	84.1	R222	17.5	341294	261.1	.04
662	S223	45.0	39.1	-40.75	-1.7	L77I	10.5	141365	157.1	.01

***** WARNING *****
NEGATIVE PRESSURE ?

663	L77I	45.0	-1.7	-4.02	-5.7	P77I	10.5	141434	157.1	.03

***** WARNING *****
NEGATIVE PRESSURE ?

664	P77I	45.0	-5.7	206.27	200.6	P77O	-- CONS PUMP --		157.1	.03

***** WARNING *****
NEGATIVE PRESSURE ?

665	P77O	45.0	200.6	-4.02	196.6	D771	10.5	141434	157.1	.03
666	D771	45.0	196.6	-5.76	190.8	D772	-- WILD EXCH --		157.1	.03
667	D772	67.6	190.8	-3.92	186.9	L77O	10.5	197417	157.1	.03
668	L77O	67.6	186.9	-188.54	-1.7	L77I	.0	70	.09	4.37

***** WARNING *****
NEGATIVE PRESSURE ?

669	L77O	67.6	186.9	-62.51	124.4	R223	10.5	197347	157.1	.01
670	S221	45.0	94.5	-1.60	92.9	L24I	3.5	77458	140.3	.09
671	L24I	49.1	92.9	-.91	92.0	P24I	5.7	133091	225.0	.04
672	P24I	49.1	92.0	47.19	139.2	P24O	-- CONS PUMP --		225.0	.04
673	P24O	49.1	139.2	-.91	138.3	D241	5.7	133091	225.0	.04
674	D241	49.1	138.3	-8.83	129.4	D242	-- WILD EXCH --		225.0	.04
675	D242	56.0	129.4	-.90	128.5	L24O	5.7	148356	225.0	.04
676	L24O	56.0	128.5	-35.65	92.9	L24I	3.7	73263	84.7	-.03
677	L24O	56.0	128.5	-58.31	70.2	R221	3.5	92526	140.3	.09
678	S210	45.0	96.0	-6.13	89.8	L30I	5.2	114846	207.6	.25
679	L30I	45.0	89.8	-.79	89.0	P30I	5.2	114844	207.6	.25
680	P30I	45.0	89.0	-.79	88.3	P30O	5.2	114844	207.6	.25
681	P30O	45.0	88.3	-.79	87.5	D301	5.2	114844	207.6	.25
682	D301	45.0	87.5	-11.59	75.9	D302	-- 3-way COIL -		136.4	-.13
683	D301	45.0	87.5	-11.59	75.9	D302	--- BYPASS ----		71.3	.98
684	D302	52.1	75.9	-1.05	74.8	L30O	5.2	129113	207.6	.25
685	L30I	45.0	89.8	-15.00	74.8	L30O	.2	113	.0	.58

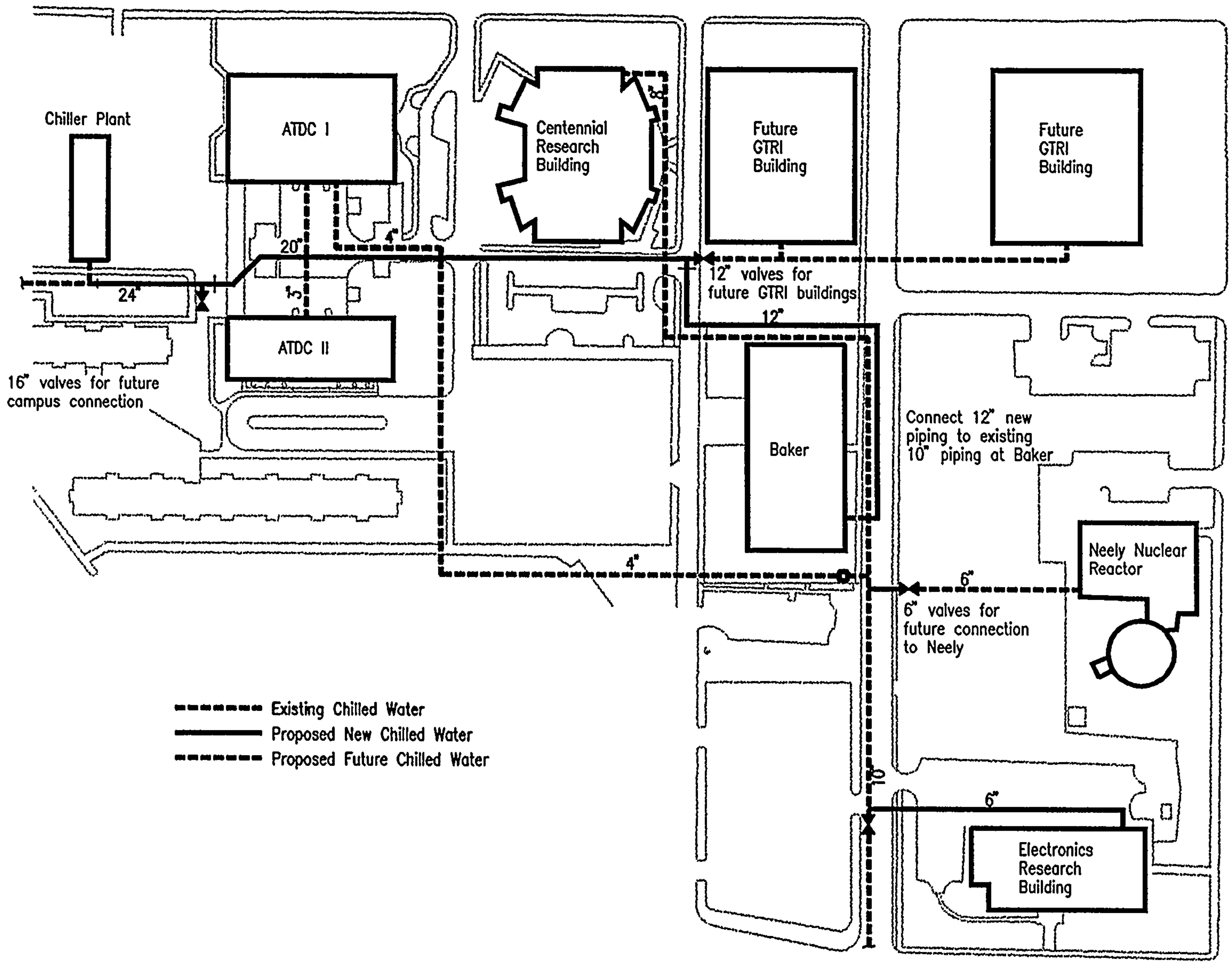
686	L300	52.1	74.8	-6.04	68.8	R210	5.2	129116	207.6	.25
687	CPES	45.0	90.0	-18.59	71.4	CPER	.3	142	.0	1.48
688	CPWS	45.0	96.0	-27.26	68.7	CPWR	.4	205	.0	.57
689	S1SI	45.0	87.0	-.02	87.0	S1SO	7.4	401924	1825.5	-.68
690	S1SI	45.0	87.0	-12.65	74.3	S1RI	.2	99	.0	2.83
691	S1RI	56.6	74.3	-.02	74.3	S1RO	7.4	484740	1825.5	-.68
692	S2SI	45.0	72.7	-.01	72.7	S2SO	6.4	348162	1569.6	.06
693	S2RI	56.7	88.3	-15.55	72.7	S2SI	.2	153	.0	-4.89
694	S2RI	56.7	88.3	-.01	88.3	S2RO	6.4	420110	1569.6	.06
695	S3SI	45.0	92.9	.00	92.9	S3SO	5.0	614245	6250.3	.10
696	S3SI	45.0	92.9	-20.69	72.2	S3RI	.3	156	.0	.68
697	S3RI	56.0	72.2	.00	72.2	S3RO	5.0	733500	6250.3	.10
698	S4SI	45.0	91.3	.00	91.3	S4SO	4.8	593540	6039.7	.10
699	S4SI	45.0	91.3	-17.33	74.0	S4RI	.2	131	.0	.77
700	S4RI	56.0	74.0	.00	74.0	S4RO	4.8	708754	6039.7	.10

SECTION RESULTS AFTER 24 ITERATIONS

	----- INLET	-----		- OUTLET -		---------- FLOW	--------------		
SEC #	NODE	TEMP degF	PRESS ftwg	DELTA ftwg	PRESS ftwg	NODE	VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
701	S5SI	45.0	89.5	.00	89.5	S5SO	1.8	219595	2233.6	.14
702	S5SI	45.0	89.5	-13.29	76.2	S5RI	.2	101	.0	.94
703	S5RI	56.0	76.2	.00	76.2	S5RO	1.8	262291	2233.6	.14
704	S6SI	45.0	88.7	.00	88.7	S6SO	2.6	170062	914.1	-.01
705	S6SI	45.0	88.7	-11.81	76.9	S6RI	.2	90	.0	1.04
706	S6RI	55.9	76.9	.00	76.9	S6RO	2.6	202783	914.1	-.01
707	S7SI	45.0	90.8	-.01	90.8	S7SO	5.9	382333	2051.2	.17
708	S7SI	45.0	90.8	-15.91	74.8	S7RI	.2	120	.0	.81
709	S7RI	55.9	74.8	-.01	74.8	S7RO	5.9	455801	2051.2	.17
710	S8SI	45.0	75.5	-.01	75.4	S8SO	6.3	342069	1542.2	.06
711	S8RI	55.7	89.9	-14.42	75.5	S8SI	.2	150	.0	-.44
712	S8RI	55.7	89.9	-.01	89.9	S8RO	6.3	407051	1542.2	.06
713	S9SI	45.0	92.3	.00	92.3	S9SO	.9	46751	210.6	.13
714	S9SI	45.0	92.3	-19.19	73.1	S9RI	.3	145	.0	.71
715	S9RI	56.0	73.1	.00	73.1	S9RO	.9	55877	210.6	.13

10 th Street Chiller Plant Expansion

Georgia Institute of Technology
Office of Facilities



GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF FACILITIES
PLANT OPERATIONS DIVISION
915 ATLANTIC DR., N.W., ATLANTA, GA. 30318
TELEPHONE: (404) 894-4146

EXPANSION OF 10th ST CHILLER PLANT

Chilled Water Distribution

12/20/95

File:95352dp.dwg

Preliminary Cost Estimate

Expansion of 10th Street Chiller Plant
Dec 1995

Central Plant

	1500 tons	2000 tons	3000 tons
Cooling Tower ($*1.5 for installation)	$117,000.00	$141,000.00	$211,500.00
Tower Pump ($*1.5 for installation)	$14,250.00	$26,250.00	$28,500.00
Tower basin			
Chiller	$510,000.00	$622,500.00	$1,800,000.00
Chiller Pump	$14,250.00	$15,750.00	$28,500.00
Piping and pipe specialties	$100,000.00	$100,000.00	$100,000.00
Controls	$20,000.00	$20,000.00	$20,000.00
Electrical	$95,000.00	$95,000.00	$95,000.00
Central Plant Sub Total	**$775,500.00**	**$925,500.00**	**$2,188,500.00**
Markups, Engineering, Contingency	$294,690.00	$351,690.00	$831,630.00
Central Plant Total	**$1,070,190.00**	**$1,156,250.00**	**$2,432,000.00**

Distribution

Plant to CRB						
24" Straight pipe	200 ft	750 $/ft	$150,000.00			
20" Straight pipe	600 ft	640 $/ft	$384,000.00			
24" to 20" transition	2	1500 ea	$3,000.00			
20" 90 Elbows	2	5500 ea	$11,000.00			
20" 45 Elbows	4	4100 ea	$16,400.00			
16" Valves	2	5900 ea	$11,800.00			
8" Valves	2	1500 ea	$3,000.00			
Valve Boxes			$1,000.00			
Resurfacing			$17,500.00			
Section Subtotal			**$597,700.00**	**Total w/markups**		**$824,826.00**
Connections for Future GTRI Buildings						
12" Valves	2	3300 ea	$6,600.00			
Valve Boxes			$1,000.00			
Resurfacing			$500.00			
Section Subtotal			**$8,100.00**			**$836,004.00**
From Future GTRI Buildins to Baker						
12" Straight pipe	550 ft	365 $/ft	$200,750.00			
12" 90 Elbows	6	2000 ea	$12,000.00			
20" to 12" transition	2	1500 ea	$3,000.00			
8" Valves	2	1500 ea	$3,000.00			
Valve Boxes			$1,000.00			
Resurfacing			$6,100.00			
Section Subtotal			**$225,850.00**			**$1,147,677.00**
ERB Connection to Chilled Water						
6" Straight pipe	350 ft	190 $/ft	$66,500.00			
6" 90 Elbows	6	1150 ea	$6,900.00			
6" Valves	2	975 ea	$1,950.00			

Valve Boxes			$1,000.00		
Resurfacing			$3,800.00		
Section Subtotal			**$80,150.00**		**$1,258,284.00**
Shut off between systems					
10" Valves	2	2425 ea	$4,850.00		
Valve Boxes			$1,000.00		
Resurfacing			$500.00		
Section Subtotal			**$6,350.00**		**$1,267,047.00**
Neely Connection to Chilled Water					
6" Straight pipe	350 ft	190 $/ft	$66,500.00		
6" 90 Elbows	6	1150 ea	$6,900.00		
6" Valves	2	975 ea	$1,950.00		
Valve Boxes			$1,000.00		
Resurfacing			$800.00		
Section Subtotal			**$77,150.00**		**$1,373,514.00**
Reconnecting ATDC near Chiller Plant					
4" Valves	2	600 ea	$1,200.00		
Valve Boxes			$1,000.00		
Resurfacing			$500.00		
Section Subtotal			**$2,700.00**		**$1,377,240.00**

	1500 tons	**2000 tons**	**3000 tons**
Project Total	**$2,447,430.00**	**$2,533,490.00**	**$3,809,240.00**

Chiller Plant Expansion for GTRI

Dec 1995

Pros

ERB's Chiller is 30 years old and uses a refrigerant which is not being produced any more.

Chillers at Central Plant run intermittently depending on the weather and Chillers at 10th Street run on demand.

Central Plant will have extra capacity without having to support these buildings

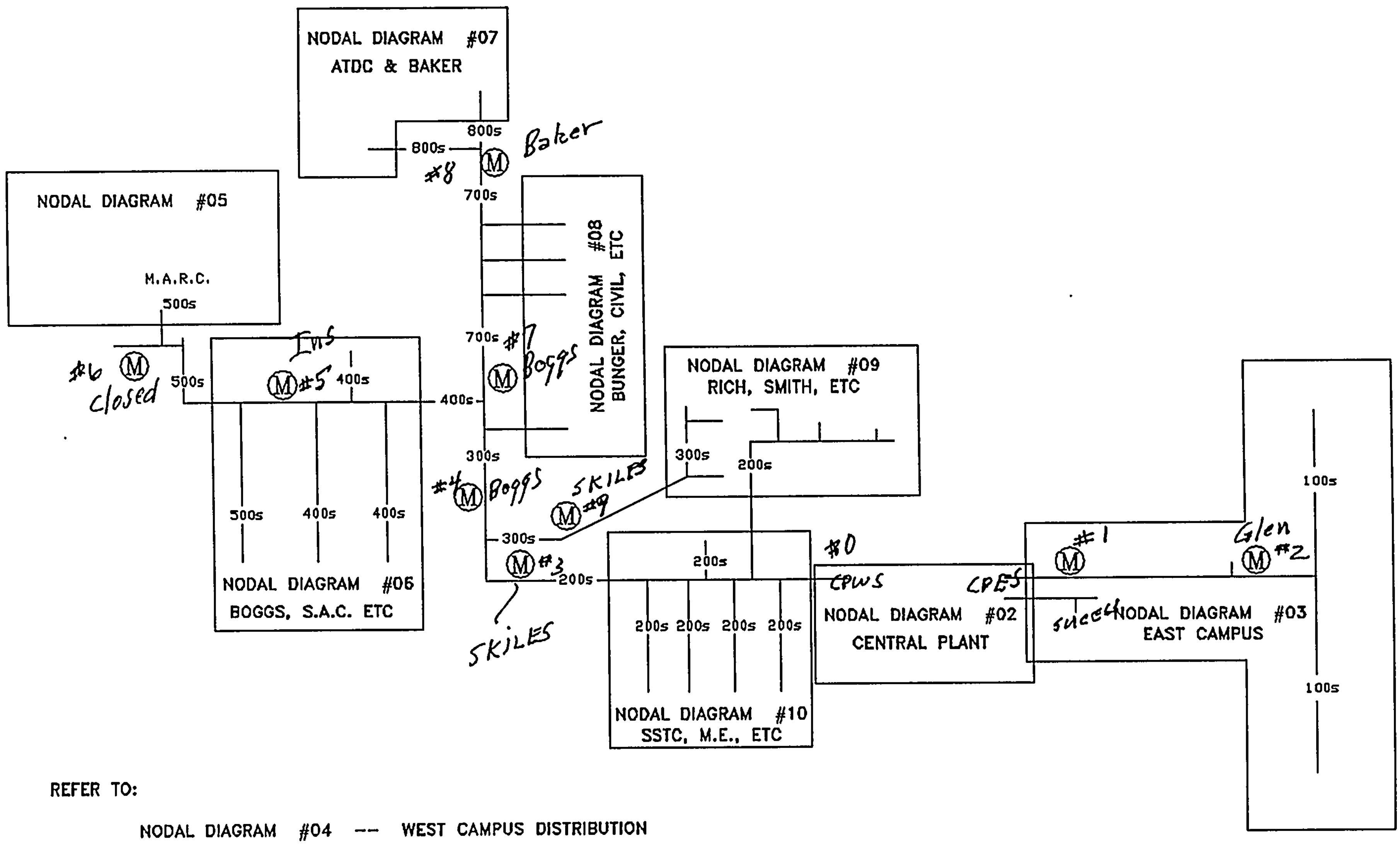
Cons

Cost.

Adding more than one chiller will require the chiller plant to be expanded.

FLOW MEASUREMENT PROJECT

Sample Data



REFER TO:

NODAL DIAGRAM #04 -- WEST CAMPUS DISTRIBUTION

FOR INTERCONNECTING PIPING NOTATION

LATEST MODS 24 DEC 93

CAMPUS CHILLED WATER SYSTEM

NODAL DIAGRAM #01

NODAL DIAGRAM ARRANGEMENT

GEORGIA INSTITUTE OF TECHNOLOGY

Data for around 5pm on 01 Aug 93

Plant						
04:57:10pm Aug 01,93	91.699		58.647	83.246		71.357
04:57:10pm Aug 01,93	69.933		57.670	56.474		58.695
04:53:10pm Aug 01,93	8912.916		8719.874	1171.493		948.454
GLEN						
05:02:04pm Aug 01,93	76.779		223.884			
05:02:04pm Aug 01,93	49.865	#2	54.980			
05:02:04pm Aug 01,93	859.434		696.530			
SKILES						
05:05:04pm Aug 01,93	78.762		77.656	72.301		75.624
05:05:04pm Aug 01,93	51.282	#9	55.573	50.293	#3	56.999
05:05:04pm Aug 01,93	552.054		399.627	5692.034		5739.202
BOGGS						
04:54:08pm Aug 01,93	70.961		0.000			
04:54:08pm Aug 01,93	55.910	#4	58.263		#7	
04:57:08pm Aug 01,93	5995.992		5459.272	2701.844		2630.742
BAKER						
04:59:02pm Aug 01,93	104.393		83.418			
04:59:02pm Aug 01,93	51.804	#8	59.351			
05:07:02pm Aug 01,93	1037.911		967.607			
Ins-Center						
04:59:04pm Aug 01,93	60.335	#5	60.244			
04:59:04pm Aug 01,93	51.447		60.451			

SECTION RESULTS AFTER 9 ITERATIONS

SEC #	----- INLET ----- NODE	TEMP degF	PRESS ftwg	DELTA ftwg	- OUTLET - PRESS ftwg	NODE	---------- FLOW ---------- VELOCITY ft/sec	REYNOLDS NUMBER	gpm	% del
650	CPES	45.0	94.8	-24.32	70.4	CPER	.4	192	.0	2.98
651	CPWS	45.0	99.7	-31.24	68.5	CPWR	.4	242	.0	2.02
652	S0SI	45.0	99.7	.00	99.7	S0SO *CP-west*	6.2	764855	7776.4	.18
653	S0SI	45.0	99.7	-31.14	68.5	S0RI	.4	241	.0	2.02
654	S0RI	55.3	68.5	.00	68.5	S0RO	6.2	903332	7776.4	.18
655	S1SI	45.0	92.6	-.01	92.6	S1SO *CP-east*	6.2	341415	1550.5	-.67
656	S1SI	45.0	92.6	-19.96	72.6	S1RI	.3	161	.0	3.93
657	S1RI	57.4	72.6	-.01	72.6	S1RO	6.2	416971	1550.5	-.67
658	S2SI	45.0	82.2	-.01	82.2	S2SO	5.2	285835	1300.0	-.82
659	S2SI	45.0	82.2	.55	82.8	S2RI *Glen*	.0	13	.0	*****
660	S2RI	57.7	82.8	-.01	82.7	S2RO	5.2	350480	1300.0	-.82
661	S3SI	45.0	96.6	.00	96.6	S3SO	4.9	603391	6133.1	.21
662	S3SI	45.0	96.6	-24.67	72.0	S3RI *Skiles*	.4	193	.0	2.54
663	S3RI	55.0	72.0	.00	72.0	S3RO	4.9	709518	6133.2	.21
664	S4SI	45.0	95.2	.00	95.2	S4SO	4.4	541137	5517.4	-.10
665	S4SI	45.0	95.2	-21.66	73.5	S4RI *Boggs*	.3	171	.0	2.92
666	S4RI	55.4	73.5	.00	73.5	S4RO	4.4	641027	5517.4	-.10
667	S5SI	45.0	94.0	.00	94.0	S5SO	1.2	144686	1472.4	.09
668	S5SI	45.0	94.0	-18.99	75.0	S5RI *Ins.*	.3	151	.0	3.38
669	S5RI	55.2	75.0	.00	75.0	S5RO	1.2	170647	1472.4	.09
670	S6SI *closed*	45.0	93.8	-18.54	75.2	S6RO	.3	148	.0	3.47
671	S7SI	45.0	94.6	-.01	94.6	S7SO	6.2	405471	2185.3	-.28
672	S7SI	45.0	94.6	-20.20	74.4	S7RI *Boggs*	.3	160	.0	3.18
673	S7RI	55.6	74.4	-.01	74.4	S7RO	6.2	481313	2185.3	-.28
674	S8SI	45.0	78.6	-.01	78.6	S8SO	6.2	339659	1534.7	-.16
675	S8RI	55.4	90.1	-11.51	78.6	S8SI *Baker*	.1	94	.0	*****
676	S8RI	55.4	90.1	-.01	90.1	S8RO	6.2	401699	1534.7	-.16
677	S9SI	45.0	95.8	.00	95.8	S9SO	2.6	140573	615.8	2.98
678	S9SI	45.0	95.8	-22.80	73.0	S9RI *Skiles*	.3	179	.0	2.68
679	S9RI	50.9	73.0	.00	73.0	S9RO	2.6	154713	615.8	2.98