

FINAL SUBMITTAL

VOLUME III

APPENDICES

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS FT. SILL, OKLAHOMA

Prepared for

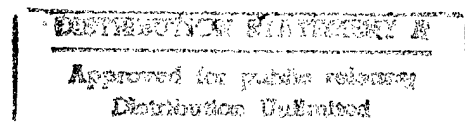
**TULSA DISTRICT
CORPS OF ENGINEERS
TULSA, OKLAHOMA**

Under

CONTRACT NO. DACA 56-90-C-0087



E M C ENGINEERS, INC.
Denver, Colorado
Colorado Springs, Colorado
Atlanta, Georgia





DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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APPENDICES

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Under

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April 1992

EMC No. 3002.000

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This submittal has been prepared at the request of the client, and the observations, conclusions, and recommendations contained herein constitute the opinions of E M C Engineers, Inc. In preparing this submittal, EMC has relied on some information supplied by the client, the client's employees, and others. Because no warranties were given with this source of information, E M C Engineers, Inc. makes no certification and gives no assurances except as explicitly defined in this report.

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LIST OF ABBREVIATIONS

ac	-	alternating current
ACCU	-	air cooled condensing unit
AEL	-	acceptable exposure limit
AHU	-	air handling unit(s)
amp	-	ampere (amp, amps)
ANSI	-	American National Standards Institute
ASCII	-	American Standard Code for Information Interchange
ASHRAE	-	American Society of Heating, Refrigeration, and Air Conditioning Engineers
AWG	-	American wire gauge
bar	-	bar: 14.5 psi
BAU	-	business as usual
B/C	-	benefit-to-cost ratio
Bhp	-	brake horsepower
Bks	-	barracks
BLAST	-	Building Loads Analysis and System Thermodynamics Program, CERL
Bldg	-	building
BOQ	-	Bachelor Officer's Quarters
Btu	-	British thermal units
Btuh	-	British thermal units per hour
B/W	-	black and white
°C	-	Celsius (Centigrade)(degrees)
cc	-	cubic centimeter

LIST OF ABBREVIATIONS (Continued)

ccf	-	one hundred (100) cubic feet
CEP	-	central energy plant
CFC	-	chlorofluorocarbons
cfh	-	cubic feet per hour
cfm	-	cubic feet per minute
ckVAR	-	capacitive kilovolt-ampere reactive
CNW	-	condensed water
CNWP	-	condensed water pump
CNWR	-	condensed water return
CNWS	-	condensed water supply
CO	-	carbon monoxide
COND.	-	condenser
const	-	construction
COP	-	coefficient of performance: ratio of the tons of refrigeration produced to the energy required to operate the equipment
CO ₂	-	carbon dioxide
CPU	-	central processing unit
CY	-	current transducer
CTD	-	Carnahan-Thompson-Delano
CTM	-	cooling tower motor
cu ft	-	cubic foot, cubic feet
CW	-	chilled water

LIST OF ABBREVIATIONS (Continued)

CWE	-	current working estimate
CWP	-	chilled water pump
CWR	-	chilled water return
CWS	-	chilled water supply
CV	-	converter
d	-	day(s)
DB	-	dry bulb
DD	-	Degree Day: the difference between the median temperature for any hour and a selected base temperature (generally 65°F)
deg	-	degrees
DEH	-	Director of Engineering and Housing
DHW	-	domestic hot water
Di	-	inside diameter
DOM.	-	domestic
DP	-	differential pressure transducer
DX	-	direct expansion
E_b	-	boiler efficiency
E/C	-	energy-to-cost ratio
ECIP	-	Energy Conservation Investment Program
ECO	-	energy conservation opportunity(s)
EEAP	-	Energy Engineering Analysis Program
eff	-	efficiency

LIST OF ABBREVIATIONS (Continued)

EIC	-	Engineer In Charge
elec	-	electrical
E _m	-	motor efficiency
EMC	-	E M C Engineers, Inc.
EMCS	-	Energy Monitoring and Control System
EPA	-	Environmental Protection Agency
eqpt	-	equipment
F	-	flow meter
°F	-	Fahrenheit (degrees)
FLA	-	full load amps
ft	-	foot, feet
ft ²	-	square feet
ft ³	-	cubic feet
FO	-	fuel oil
gal	-	gallon(s)
g/dscm	-	grams per dry standard cubic meter
gpm	-	gallons per minute
HCFC	-	hydrochlorofluorocarbon
HCP	-	hot/chilled water pump
HCR	-	hot/chilled water return
HCS	-	hot/chilled water supply
HCW	-	hot/chilled water

LIST OF ABBREVIATIONS (Continued)

HG	-	mercury
hp	-	horsepower
hr	-	hour(s)
HTHW	-	high temperature hot water
H&V	-	heating and ventilating
HVAC	-	heating, ventilating, and air conditioning
HW	-	hot water
HWR	-	hot water return
HWS	-	hot water supply
Hz	-	hertz, frequency
in	-	inch(es)
I/O	-	input/output
°K	-	kelvin (degrees)
kip	-	one thousand pounds
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hour, one thousand watthours
kV	-	kilovolt, one thousand volts
kVAh	-	kilovolt-ampere hour, one thousand volt-ampere hour(s)
kVAR	-	kilovolt-ampere reactive
kVARh	-	kilovolt-ampere reactive hour, one thousand volt-ampere reactive hour(s)
L	-	length

LIST OF ABBREVIATIONS (Continued)

lb	-	pound(s)
LCC	-	life cycle cost
LCCID	-	life cycle cost in design
LTHW	-	low temperature hot water
m	-	meter
m ³	-	cubic meters
maint	-	maintenance
Mbh	-	Btu per hour (thousand)
mcf	-	one thousand cubic feet
MCP	-	Military Construction Program
Mh	-	man-hour(s)
mm	-	millimeter
MMBtu	-	British thermal units (million)
MMBtuh	-	Btus per hour (million)
mo.	-	month(s)
MUX	-	multiplexer
mW	-	megawatt, one million watts
mWh	-	megawatt-hour, one million watt-hours
MZU	-	multizone unit
N/A	-	not available or not applicable
nat	-	natural (gas)
NBS	-	National Bureau of Standards

LIST OF ABBREVIATIONS (Continued)

NOAA	-	National Oceanic and Atmospheric Administration
no.	-	number
O ₂	-	oxygen
OA	-	outside air
O & M	-	operation and maintenance
PD	-	pressure drop or difference
PLT	-	plant
PF	-	power factor: relationship between kW and kVA. When the power factor is unity, kVA equals kW.
PM	-	Project Manager
ppm	-	parts per million
psi(a)(g)	-	pounds per square inch (absolute)(gauge)
Q	-	flow rate
R	-	return
RDF	-	refuse derived fuel
RET.	-	return
RVAC	-	refrigeration, ventilation, air conditioning
R-value	-	the resistance to heat flow expressed in units of (ft ²) x (hours) x (°F)/Btu; R-value = 1/U-value
S	-	supply
scf	-	standard cubic feet
scfm	-	standard cubic feet per minute

LIST OF ABBREVIATIONS (Continued)

SIR	-	Savings-to-Investment Ratio: total life cycle benefits divided by 90% of the differential investment cost
SIOH or SIA	-	supervision, inspection, and overhead
SOW	-	scope of work
sq ft	-	square foot (feet)
st/sp	-	start/stop
SWPA	-	Southwestern Power Administration
SZU	-	single zone unit
stby	-	standby
t	-	ton, a means of expressing cooling capacity: 1 ton - 12,000 Btu/hr cooling
T	-	temperature
temp	-	temperature
TD	-	temperature difference
T_f	-	fluid temperature (°C)
T_g	-	ground temperature (°C)
TPF	-	third party financing
TRY	-	Test Reference Year
UA	-	overall heat transfer coefficient (Btu/hr-°F)
UPW	-	uniform present worth factor: a factor which, when applied to annual savings, will account for the time value of money and inflation over the life of the project
U.S.	-	United States

LIST OF ABBREVIATIONS (Continued)

U-value	-	a coefficient expressing the thermal conductance of a composite structure in Btu per (sq ft)(hour)(°F temperature difference); $\text{Btu/ft}^2 \times \text{hr} \times ^\circ\text{F}$; $\text{U-value} = 1/\text{R-value}$
V	-	volt(s)
VAT	-	value added tax
VAV	-	variable air volume
VSD	-	variable speed drive
W	-	watt(s)
WB	-	wet-bulb
wk	-	week(s)
yr	-	year(s)

APPENDIX A

SCOPE OF WORK

SCOPE OF WORK SUMMARY
ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS, Fort SILL, OKLAHOMA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	REPORT SECTION
1	1	1.1	Survey the boilers to determine their efficiency.	2.0
2	1	1.3	Identify and list all ECOs considered.	4.0
3	1	1.3	Identify low cost or no cost ECOs.	6.0
4	1	1.6	Prepare report.	-
5	1	2.1	Include in the study the results of previous studies concerning boiler and chiller plants.	5.0
6	2	2.5	Determine if ECOs are technically and economically feasible.	4.0
7	2	2.5	Combine ECOs into larger packages for ECIP or MCP funding.	8.0
8	2	2.6	List and prioritize, by SIR, projects which qualify for ECIP funding.	Table 7-2
9	2	2.7	Prioritize, by SIR, feasible non-ECIP projects.	8.0
10	4	5.1	Develop life cycle cost analysis summary sheets for ECIP projects.	Appendix D
11	4	5.1	Provide original backup calculations from previous studies.	Appendix G and H
12	5	5.2	Develop life cycle cost analysis summary sheets for non-ECIP projects.	Appendix D
13	6	5.3	Document nonfeasible ECOs in the report.	4.0
14	6	7.1.1	Conduct boiler efficiency tests.	Appendix F, Survey Notes
15	6	7.1.2	Conduct chiller efficiency tests.	Appendix E, Survey Notes
16	7	7.2.2	Investigate existing local controls and incorporate into EMCS.	4.0
17	7	7.2.3	Review, document, and evaluate operation and maintenance practices.	2.0 and 6.0

SCOPE OF WORK SUMMARY, ECOs EVALUATED
ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS, Fort SILL, OKLAHOMA

ECO DESCRIPTION IN SOW	SOW LOCATION	ECO NO.	ECO DESCRIPTION IN REPORT
Controls to assure proper combustion air-fuel ratio.	Annex A	10	Installation of combustion controls.
Installation of new burner equipment.	Annex A	11	Installation of new high efficiency burner.
Economizer or air preheater.	Annex A	12	Installation of stack economizer or air preheater.
Loading characteristics and scheduling versus equipment capacity (equipment optimization).	Annex A	2 & 8	2 - Chiller optimization. 8 - Boiler optimization.
Control systems to operate chillers at the most energy efficient operating condition.	Annex A	2	Chiller optimization.
Variable or two-speed cooling tower fan.	Annex A	5(A) & 5(B)	5(A) Two-speed motors. 5(B) Variable speed control.
Storage of chilled water or other thermal storage systems.	Annex A & Conf. Notice 1	4	Ice storage cooling system.
High efficiency motors.	Annex A	6	High efficiency motors.
Instruments and controls to facilitate efficient operations.	Annex A	1 & 7	1 - Chiller instruments. 7 - Boiler instruments.
Use smaller boilers where load has been reduced.	Annex A	8	Boiler optimization.
Replace inefficient boilers with more efficient boilers (or repair).	Annex A (para 7.2.1)	9	Renovate or replace boilers.
Replace inefficient chillers with more efficient chillers (or repair).	Annex A (para 7.2.1)	3	Renovate or replace chillers.

Appendix A

GENERAL SCOPE OF WORK
FOR AN
ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FOR
FORT SILL, OKLAHOMA

Performed as part of the
ENERGY ENGINEERING ANALYSIS PROGRAM

Exhibit 1

1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1.1 Determine the efficiency of the boiler/chiller plants by appropriate tests.

1.2 Survey the boiler/chiller plants to determine if efficiency can be improved by the repair, addition, or modification of equipment, control systems and operation and maintenance practices and recommend improvements.

1.3 Identify all energy conservation opportunities (ECOs) including low cost/no cost items and perform complete evaluations of each.

1.4 (Deleted)

1.5 (Deleted)

1.6 Prepare a comprehensive report to document the work performed, the results and recommendations.

2. GENERAL

2.1 Other studies performed under the Energy Engineering Analysis Program (EEAP) have been performed at the installation and may have included the boiler/chiller plants. Results of the previous studies concerning the boiler/chiller plants shall be included in this study. Boiler/chiller plant projects recommended in the previous studies shall be updated and included in this report if they have not been implemented or programmed. Any reports or studies that may have been accomplished on the boiler/chiller plants shall be reviewed by the AE and information included in this report as applicable.

2.2 The information and analysis outlined herein are considered to be minimum essentials for adequate performance of this study.

2.3 This study shall include the boiler plant, chiller plant, all appurtenances, and supporting systems (e.g., fuel storage facilities, pollution abatement, water treatment, etc.). It does not include steam or chilled water distribution systems. However, if during the survey readily identifiable energy conservation opportunities pertaining to the distribution systems are noted, they shall be listed in the report.

2.4 The "Energy Conservation Investment Program (ECIP) Guidance," described in letter from CEHSC-FU, dated 25 April 1988, and revised in letter from CEHSC-FU-P, dated 15 June 1989, establishes criteria for ECIP projects and shall be used for performing the economic analysis of all projects or improvements considered.

2.5 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP or MCA funding, and determining, in coordination with installation personnel, the appropriate packaging and implementation approach for all feasible ECOs. Energy conservation opportunities which do not fit into projects, such as operation procedure changes, shall be developed into detailed and specific instructions and procedures for operating personnel.

2.6 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.7 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.8 Energy Conservation and Management (ECAM) projects for procurement-funded installations will be identified and analyzed using the same criteria as for ECIP. ECAM and ECIP will be considered synonymous in this Scope of Work.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for all work required under this contract. Upon the award of the contract, this individual shall be immediately designated in writing. The AE's designated project manager must be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for complete coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. A coordinator designated by the Commanding Officer at each installation will serve as the point of contact for obtaining available information and assist-

ing in establishing contacts with the proper individuals and organizations as necessary to accomplish the work required under this contract.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed under this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE and/or the designated representative(s) shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE, consultants, if applicable, and/or designated representative(s) thereof shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number, if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, supplies, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of work under this contract. The record shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Engineering and Housing before starting work at the facility and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1. Entry. The entry interview shall thoroughly brief and describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

- a. Schedules.
- b. Names of energy analysts who will be conducting the survey.
- c. Proposed working hours.
- d. Support requirements from the Director of Engineering and Housing.

3.7.2 Exit. The exit interview shall include a thorough briefing describing the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Engineering and Housing.

4. SERVICES AND MATERIALS. All services, supplies, materials (except those specifically enumerated to be furnished by the Government), plant, labor, testing equipment, superintendence and travel necessary to perform the work and render the data required under this contract shall be included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented as such in the report:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than \$200,000, a Savings to Investment Ratio greater than one and a simple payback period of less than eight years. For ECAM projects the \$200,000 limitation may not apply. The AE shall check with the installation for guidance. The overall project and each discrete part of the project shall have a SIR greater than one.

A Life Cycle Cost Analysis Summary Sheet shall be developed for each ECO and for the overall project when more than one ECO is combined. For projects and ECOs updated or developed from the previous studies, the backup data shall consist of copies of the original calculations and analysis, with new pages revising the original calculations and analysis. In addition, the backup data shall include as much of the following as is available: the increment of work the project or ECO was

developed under in the previous study, title(s) of the project(s), the energy to cost (E/C) ratio, the benefit to cost (B/C) ratio, the current working estimate (CWE), and the payback period. This information shall be included as part of the backup data. The purpose of this information is to provide a means to prevent duplication of projects in any future reports.

5.2 Non-ECIP Projects. Projects which normally do not meet ECIP criteria, but which have an overall SIR greater than one shall be individually packaged and fully documented. The Life Cycle Cost Analysis Summary Sheet shall be completed through and including line 6 for all projects or ECOs. Each shall be analyzed to determine if they are feasible even if they do not meet ECIP criteria. These ECOs or projects may not meet the nonenergy qualification test. For projects or ECOs which meet this criteria, the Life Cycle Cost Analysis Summary Sheet, completely filled out, with all the necessary backup data to verify the numbers presented, a complete description of the project and the simple payback period shall be included in the report.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with the reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK: The general Scope of Work is intended to apply to contract efforts for all Army boiler and chiller plants except as modified by the detailed Scope of Work for each specific installation. The detailed Scope of Work is contained in Annex B.

7. WORK TO BE ACCOMPLISHED

7.1 Determine Efficiency

7.1.1 Boilers. The efficiency of the existing boiler installation shall be determined by field testing. The AE shall provide equipment and perform tests in the field to establish the efficiency of the boilers. The tests are intended to determine the efficiency of the boilers as they are actually being operated. The AE shall document any changes made to controls or equipment during boiler efficiency tests.

The AE shall submit the proposed test procedure and testing laboratory to the Contracting Officer for approval. Based upon the results of the tests, any indicated areas of improvement or equipment modification shall be fully analyzed. The study shall establish equipment operating data baselines, system efficiency modeling, and evaluate plant and unit loading profiles versus equipment capacities. The Government will furnish fuel, utilities, other consumables, and provide personnel to operate the plant during testing. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.1.2 Chillers. The efficiency of the existing chiller plant shall be analyzed and evaluated to determine if system efficiency can be improved or energy saving improvements implemented. The efficiency of the existing chillers shall be calculated using standard methods. Meters shall be used to obtain the necessary data to calculate efficiency. The AE is responsible for any metering necessary. If meters are existing, they may be used if their validated accuracy is within the limits specified below. If no meters are present, the AE is responsible for installing temporary meters. Permanent taps or connectors shall be installed so as to cause minimal disruptions to the system. Ultrasonic metering may be used. All meters used must have an accuracy of ± 2 percent and a statement to that effect, signed by an independent testing laboratory must be included in the report. Efficiency tests shall be made at normal operating parameters.

7.2 Survey Existing Plants

7.2.1 The condition of the existing plant shall be studied, documented, and evaluated. possibilities of repairing or replacing equipment or revising systems which will result in improved efficiency or reduced cost of operation shall be investigated.

7.2.2 The existing control system will be investigated, evaluated and documented to determine if equipment can be improved through upgrading, adjustment, repair or replacement, and if an alternate control system would increase efficiency. If an alternate system is recommended, interim improvements to existing controls shall also be recommended, if applicable. Engineering and economic analysis shall be developed. New controls proposed shall be Energy Monitoring and Control Systems (EMCS) compatible. Corps of Engineers Guide Specification (CEGS) 13946, Building Preparation for EMCS, shall be used as a standard for an interface to the existing plant. If an EMCS exists, interaction between this system and proposed modifications shall be clearly defined. The AE shall notify the DEH at least ten days prior to any pending outages of equipment and obtain concurrence prior to proceeding with any work.

7.2.3 The present boiler and chiller operation and maintenance practices shall be reviewed, documented, and evaluated with the intent to increase efficiency. The alternatives and recommendations shall be developed, evaluated, and documented in the report. Recommendations shall be in sufficient detail so that they can be quickly implemented. Detailed engineering and economic analysis of these actions are not required, however, a description and evaluation of these recommendations will be included in the report.

7.3 Identify ECOs. All methods of energy conservation which are reasonable and practical shall be considered, including operational methods and procedures and maintenance practices as well as physical facilities. A list of energy conservation opportunities is included as Annex A to this scope. This list is not intended to be restrictive but only to assure that at least these opportunities are considered, discussed and documented in the report. Each of the items shall considered and discussed in the report. Those items on the list which are not practical, have been previously accomplished, are inappropriate or can be eliminated from detailed analysis based on preliminary analysis shall be listed in the report along with the reason for elimination from further analysis. All potential ECOs which are not eliminated by preliminary considerations shall be thoroughly documented and evaluated as to the technical and economic feasibility. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an or-

derly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers analog cuts, pertinent drawings and sketches shall also be included. A Life Cycle Cost Analysis Summary Sheet shall be prepared for each ECO and included as part of the supporting data.

7.4 (Deleted)

7.5 (Deleted)

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7.6 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. The AE shall give a formal presentation of all but the final submittal to installation, command, and other Government personnel. The AE shall prepare slides or view graphs showing the results of the study to date for his presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. The AE shall provide the comments from all reviewers and written

notification of the action taken on each comment to all reviewing agencies within three weeks after the review meeting. It is anticipated that each presentation and review conference will require approximately one working day. The presentation and review conferences will be at the installation on the date(s) agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.6.1 Interim Submittal. An interim report shall be submitted for review after completion of the field survey and an analysis has been performed on all of the ECOS. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings and SIRs of all the ECOS shall be included. The simple payback period of all ECOS shall be calculated and shown in the report. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. During the review period, the Government's representative shall coordinate with the Director of Engineering and Housing and provide the AE with direction for packaging or combining ECOS for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared.

The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.6.2 Prefinal Submittal. The AE shall prepare and submit the prefinal report when all work under this contract is complete. The AE shall submit the Scope of Work for the installation studied and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The report shall include an order of priority by SIR in which the recommended ECOS should be accomplished. The synergistic effects of all of the ECOS on one another shall have been determined and the results of the original calculations adjusted accordingly.

The prefinal report, separately bound Executive Summary and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The prefinal submittal shall be arranged to include (a) a separately bound Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex D for minimum requirements), (b) the narrative report containing a copy of the Executive Summary at the beginning of the volume and describing in detail what was accomplished and the results of this study, (c) appendices to include the detailed calculations and all backup material.

A list of all projects and ECOs developed during this study shall be included in the Executive Summary and shall include the following data from the Life Cycle Cost Analysis Summary Sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

7.6.3 Final Submittal. Any revisions or corrections resulting from comments made during the review of the prefinal report or during the presentation and review conference shall be incorporated into the final report. These revisions or corrections may be in the form of replacement pages, which may be inserted in the prefinal report, or complete new volumes. Pen and ink changes or errata sheets will not be acceptable. If replacement pages are to be issued, it shall be clearly stated with the prefinal submittal that the submitted documents will be changed only to comply with the comments made during the prefinal conference and that the volumes issued at the time of the prefinal submittal should be retained. Failure to do so will require resubmission of complete volumes. If new volumes are submitted, they shall be in standard three-ring binders and shall contain all the information presented in the prefinal report with any necessary changes made. Detailed instructions of what to do with the replacement pages should be securely attached to the replacement pages.

8. OPERATION AND MAINTENANCE. The contractor will identify operational items noted during the study, which will effect energy conservation, and will explain the savings possible.

ANNEX A

GENERAL ENERGY CONSERVATION OPPORTUNITIES AND OTHER CONSIDERATIONS

General Energy Conservation Opportunities:

- o Controls to assure proper combustion air-fuel ratio.
- o Installation of new burner equipment.
- o Economizers/air preheaters.
- o Loading characteristics and scheduling versus equipment capacity (equipment optimization).
- o Control systems to operate chillers at their most energy efficient operating condition.
- o Variable or two-speed cooling tower fan.
- o Storage of chilled water.
- o High efficiency motors.
- o Instruments and controls to facilitate efficient operations.
- o Use smaller boilers where load has been reduced.
- o Replace inefficient boilers with more efficient boilers.
- o Replace inefficient chillers with more efficient chillers.

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- o Generate electricity on-site with natural gas turbine engines and reclaim heat from those engines to produce steam for steam turbine chillers or domestic hot water/steam.
- o Use natural gas engine driven chillers and reclaim heat from engines and condensers to produce domestic hot water.

Other Considerations (General Overview Only):

- o Provide the general impact on efficiency and capacity of changing the refrigerant to an environmentally safe refrigerant.
- o Generally, determine the extent of equipment modifications ('O' rings, gaskets, motor stators, controls, etc.) required for a new refrigerant.
- o Generally, determine special life safety features required when new refrigerants are used (sensors, alarms, ventilation, etc.).

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ANNEX B

DETAILED SCOPE OF WORK

1. General. This Detailed Scope of Work supplements the General Scope of Work and provides information and requirements specific to the Energy Survey of Army Boiler and Chiller Plants at Fort Sill. Any conflicts in requirements between the General and Detailed Scopes of Work will be resolved by the Corps of Engineers Project Manager.

2. Boiler/Chiller Plants to be Surveyed. Attachment 1 (Boiler/Chiller Plant List) to this Annex B lists the boiler/chiller plants (in priority order) to be surveyed under this contract. The Architect-Engineer (AE) will verify the pertinent data in Attachment 1 and develop a testing plan for each boiler/chiller. Those plans will outline the details of any modifications/attachments to plant equipment required in the tests and the plans will be provided to Fort Sill DEH for review and approval. The AE will comply with Occupational Safety and Health Administration (OSHA) Asbestos Standards 1910.1001 and 1926.58 and 40 CFR 61(m) in conducting any work involving asbestos. The AE will also address the Special Considerations outlined in Attachment 1 and present the findings in the report.

3. Previous Boiler/Chiller Plant Studies. As outlined in the General Scope of Work, the AE shall update boiler/chiller projects recommended in previous studies if they have not been implemented or programmed. The statuses of those previously recommended projects are as follows:

a. Central Energy Plant Nos. 445, 462, 730, 913, 1603, and 1653 to be replaced by single 800 Area central energy plant -- neither implemented nor programmed.

b. Chilled Water Plant No. 2471 (serving barracks Nos. 2470 and 2471) to be replaced with extension of chilled water piping from Plant No. 3442 -- designed, but not funded.

c. Central Energy Plant Nos. 5900 and 6003 to be expanded to serve future facilities -- Plant No. 5900 expansion has been completed; however, further expansion using waste oil/sludge fired boilers has been considered -- Plant No. 6003 expansion has neither been implemented nor programmed.

4. Government Furnished Information. The following information will be furnished as required and upon request of the AE:

a. Previously completed studies performed under the Energy Engineering Analysis Program (EEAP) and other programs. The AE may review study availability at Fort Sill DEH Energy Office.

- b. Fort Sill Energy Resources Management Plan.
- c. ETL 1110-3-282, Energy Conservation.
- d. ETL 1110-3-301, Entrance Doors to Heater/Boiler Rooms.
- e. ETL 1110-3-318, Procedures for Programming Energy Monitoring and Control Systems (EMCS) Funded Through the MCA Program.
- f. ETL 1110-3-332, Economic Studies.
- g. ETL 1110-3-354, Direct Digital Control of Heating, Ventilation and Air Conditioning (HVAC) Systems.
- h. Office, Chief of Engineers Architectural and Engineering Instructions, July 1989.
- i. Energy Conservation Investment Program (ECIP) Guidance, dated 25 April 1988 and revision dated 15 June 1989.
- j. Information on Existing EMCS Studies, Designs, Construction Contracts, or Operating Systems.
- k. TM 5-785, Engineering Weather Data.
- l. TM 5-800-2, General Criteria Preparation of Cost Estimates.
- m. TM 5-800-3, Project Development Brochure.
- n. TM 5-815-2, Energy Monitoring and Control Systems (EMCS).
- o. AR 415-15, Military Construction Army (MCA) Program Development.
- p. AR 415-17, Cost Estimating for Military Programming.
- q. AR 415-20, Construction, Project Development and Design Approval.
- r. AR 415-28, Department of the Army Facility Classes and Construction Categories.
- s. AR 415-35, Construction, Minor Construction.
- t. AR 420-10, General Provisions, Organization, Functions, and Personnel.
- u. AR 11-27, Army Energy Program.
- v. AR 5-4, Change No. 1, Depart of the Army Productivity Improvement Program.
- w. HNDSPP-84-076-ED-ME, Preliminary Survey and Feasibility Study for Energy Monitoring and Control Systems.
- x. NCEL CR 82.030, Standardized EMCS Energy Savings Calculations.
- y. HNDSPP88-207-ED-ME, HNDSPP88-208-ED-ME, HNDSPP88-209-ED-ME, and HNDSPP88-210-ED-ME, EMCS Cost Estimating Guides.
- z. Latest applicable Engineering Improvement Recommendation System (EIRS) Bulletin.
- aa. Example of a correctly completed implementation document for a project.
- bb. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee to AE. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977.

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5. Submittals. The AE will make Interim, Prefinal, and Final submittals of the work under this contract as outlined in the General Scope of Work. Attachment 2 (Submittal List) to this Annex B lists the receiving offices, addresses, and number of copies for each submittal. The AE will make submittals directly to the offices listed with a copy of the transmittal letter to the Tulsa District Project Manager.

6. Delivery Schedule. The schedule for completing work under this contract is somewhat dependent on when the peak cooling and peak heating periods occur at Fort Sill. The following target milestones are based on boiler tests being completed by 1 March 1991. Chiller tests will be conducted during the summer of 1990.

<u>Item</u>	<u>Date</u>
Award AE Contract	24 Aug 1990
Interim Submittal	1 May 1991
Interim Submittal Comments	31 May 1991
Prefinal Submittal	1 Aug 1991
Prefinal Submittal Comments	30 Aug 1991
Final Submittal	30 Sep 1991

7. Project Managers/Coordinators. The following persons will serve as points of contact and liaison for all work required under this contract:

AE: (As designated at time of contract award)

Tulsa District: Merle London
US Army Engineer District, Tulsa
ATTN: CESWT-EC-PF
PO Box 61
Tulsa, OK 74121-0061
Tele. No. (918) 581-7991
FAX (918) 581-7365

Fort Sill: Gary Basham
US Army Field Artillery Center and Fort Sill
ATTN: ATZR-EE
Fort Sill, OK 73503-7200
Tele. No. (405) 351-3517
FAX (405) 351-6923

ANNEX B - ATTACHMENT 1

BOILER/CHILLER PLANT LIST

Item	: Plant	:	No. Chillers*	:	Tons	:	No. Boilers*	:	MBTU
Base	: 5900	:	5 (F)	:	2000	:	6 (F)	:	65.20
Base	: 6003	:	3 (F)	:	1300	:	3 (F)	:	16.20
Base	: 730	:	3 (F)	:	1440	:	4 (F)	:	15.99
	:	:	:	:	:	:	:	:	:
Opt 1	: 2812	:	1 (F)	:	372	:	3 (F)	:	6.03
Opt 2	: 4701	:	2 (F)	:	610+	:	3 (F)	:	-
Opt 3	: 5676	:	1 (P)	:	375	:	2 (P)	:	2.98
Opt 4	: 5678	:	1 (P)	:	190	:	2 (P)	:	3.95
Opt 5	: 3442	:	2 (P)	:	1200	:	No Boilers	:	-
Opt 6	: 914	:	1 (P)	:	400	:	4 (P)	:	-
	:	:	:	:	:	:	:	:	:
Opt 7	: 1603	:	1 (P)	:	345	:	4 (M)	:	-
	:	:	:	:	:	:	:	:	:
Opt 8	: 3040	:	1 (P)	:	350	:	2 (P)	:	-
	:	:	:	:	:	:	:	:	:
Opt 9	: 500	:	1 (P)	:	110	:	1 (P)	:	-
	:	:	:	:	:	:	:	:	:
Opt 10	: 1490	:	1 (P)	:	150	:	2 (P)	:	-
	:	:	:	:	:	:	:	:	:

NOTE: Above data were extracted from existing records and contain errors/omissions. A-E and Government will jointly verify the data prior to contract negotiations.

- * (F) = Full Test, as detailed in Pre-Negotiation minutes.
 (P) = Partial Test, as detailed in Pre-Negotiation minutes.
 (M) = Minimum Test, as detailed in Pre-Negotiation minutes.

Annex B - Attachment 1

ANNEX B - ATTACHMENT 1 (Cont.)

Special Considerations.

Plant No. 730: Determine if capacity of plant is sufficient to serve additional buildings.

Plants Nos. 5676 and 5678: Determine the feasibility of interconnecting these two plants.

Plant No. 3442: Explore opportunity for central heating plant. This proposition was investigated in previous studies.

Plant No. 914: Determine feasibility of using one boiler to serve four buildings (similar to single chiller in plant).

Plant No. 4701: Plant was designed for hospital use, but is to be now used for other purposes. Consider downgrading system to low pressure steam and use excess capacity elsewhere.

Annex B - Attachment 1

ANNEX B - ATTACHMENT 2

SUBMITTAL LIST
FORT SILL BOILER/CHILLER SURVEY

Organization

Submittals

USAED, Tulsa
ATTN: CESWT-EC-PF/London
PO Box 61
Tulsa, OK 74121-0061

5 cys - all submittals

USAED, Southwestern
ATTN: CESWD-ED-MM/Hasley
1114 Commerce Street
Dallas, TX 75242-0216

1 cys - all submittals

Commander, USAFACAFS
ATTN: ATZR-EE/Basham
Bldg 1945
Fort Sill, OK 73503-7200

3 cys - all submittals

Commander, TRADOC
ATTN: ATEN-FE/Capra
Fort Monroe, VA 23651-5000

1 cys - all submittals

Commander, HQUSACE
ATTN: CEMP-ET/Beranek
20 Massachusetts Ave NW
Washington, DC 20314-1000

Executive Summaries only

HQDA
ATTN: DALO-TSE/Maj Davies
Pentagon
Washington, DC 20310-0561

Executive Summaries only

USAED, Mobile
ATTN: CESAM-EN-CC/Battaglia
PO Box 2288
Mobile, AL 36628-0001

Final Submittal only

Annex B - Attachment 2

ANNEX C
REQUIRED DD FORM 1391 DATA

(Deleted)

C-1

FORM 1391 AT GOVERNMENT EXPENSE

ANNEX D

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.
2. Boiler Data. (Number, sizes, efficiency, etc.)
3. Present Energy Consumption.
 - o Total Annual Energy Used.
 - o Source Energy Consumption.
 - Electricity - KWH, Dollars, BTU
 - Fuel Oil - GALS, Dollars, BTU
 - Natural Gas - THERMS, Dollars, BTU
 - Propane - GALS, Dollars, BTU
 - Other - QTY, Dollars, BTU
 - o Energy Consumption by Systems.
4. Historical Energy Consumption.
5. Energy Conservation Analysis.
 - o ECOs Investigated.
 - o ECOs Recommended.
 - o ECOs Rejected. (Provide economics or reasons)
 - o ECIP Projects Developed. (Provide list)*
 - o Non-ECIP Projects Developed. (Provide list)*
 - o Operational or Policy Change Recommendations.

* Include the following data from the Life Cycle Cost Analysis Summary Sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost.
6. Energy and Cost Savings.
 - o Total Potential Energy and Cost Savings.
 - o Percentage of Energy Conserved.

- o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

7. Energy Plan.

- o Project Breakouts with Total Cost and SIR.
- o Schedule of Energy Conservation Project Implementation.

D-2

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E M C ENGINEERS, INC.
2750 S. Wadsworth Blvd., Suite C-200
Denver, Colorado 80227
303/988-2951

CONFIRMATION NOTICE

CONFIRMATION NOTICE NO. 1

DATE: 5 July 1990

PROJECT: Central Energy Plant Study
Ft. Sill, Oklahoma

NOTES

PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 4 June 1990

PLACE OF
CONFERENCE: DEH Office, Ft. Sill, Oklahoma

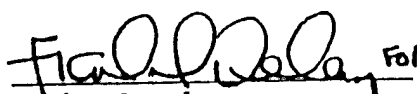
PURPOSE OF
CONFERENCE: Conference to discuss questions related to the Central Plant Study.

ATTENDEES: Carl E. Lundstrom, E M C Engineers, Inc.
Merle London, Tulsa District, COE
Jerry Schmidt, Ft. Sill DEH

CONFERENCE NOTES:

The following is a summary of the items discussed, the comments made, and the decisions made during the Conference.

1. The "Scope Reduction" pages were discussed. Mr. Schmidt agreed the scope reductions seemed reasonable in order to get the project within the project budget.
2. Mr. Lundstrom and Mr. London went through the original scope of services and made corrections, deletions, and changes related to the "Scope Reduction" pages.
3. Mr. London said he would revise the scope and mail a new request for proposal.
4. Mr. Lundstrom said he would start preparing a revised proposal.


Carl E. Lundstrom

cc: Merle London
Jerry Schmidt

Gary Basham
Carl Lundstrom

SCOPE REDUCTION

The following proposed scope changes to the "Energy Survey of Army Boiler and Chiller Plant For Ft. Sill, Oklahoma" are listed for Tulsa District's information.

TESTING:

CHILLER:

- o Eliminate cooling tower testing.
- o Reduce chiller testing metering to the minimum required to calculate efficiency performance at full load: chiller kW input, chilled water flow, chilled water supply and return temperature, condenser water flow, and condenser water supply and return temperature. Flow readings would be taken with ultrasonic flow meters.
- o The chiller testing would only involve measurements at one chilled water and one condenser water setpoint; plus taking the single point pressure, temperature, and kW measurements as originally indicated.
- o Interview operators and report condition.
- o Run chiller through operating range to observe conditions.
- o Observe cooling tower temperature control system.

BOILERS:

- o The boiler testing would involve
 - Taking orsat test (flue gas analysis measurements) while boilers is operating at low fire and high fire.
 - Record gas flow to boiler through existing meters if available.
 - Record temperature, pressure, and flow data through existing meters if available.
 - Correlate part load and full load capacity with manufacturers data and orsat test.
 - Interview operators and report condition of equipment.
 - Obtain operator log data that is available.

MEETINGS:

- o Eliminate the O&M training, and related materials.

ANALYSIS:

- o Eliminate 6 of 11 boiler energy conservation opportunities (ECO's) identified. ECO's left include:
 - Replacement of boilers.
 - Control systems.
 - Installation of new burners.

- Economizer/Air Preheater.
- High efficiency motors.
- o Eliminate 5 of 10 chiller ECO's identified. ECO's left include:
 - Replacement of chillers.
 - Control systems.
 - Variable and two speed motors
 - Storage of chilled water or other thermal storage systems.
 - High efficiency motors.
- o Eliminate all cooling tower ECO's.
- o Eliminate cooling tower computer modeling
- o Eliminate analysis of impact on existing chillers due to changing the refrigerant to an environmentally safe refrigerant and related requirements.

REPORT DEVELOPMENT:

- o Eliminate programming document preparation.
- o Eliminate implementation document preparation.
- o Eliminate O&M training manual development.

[c:\jobs\p10f.12\scope.wp]

CONFIRMATION NOTICE

CONFIRMATION NOTICE NO. 2

DATE: 26 September 1990

PROJECT: Energy Survey of Army Boiler and Chiller Plants
Ft. Sill, Oklahoma
Contract No. DACA 56-90-C-0087

NOTICE

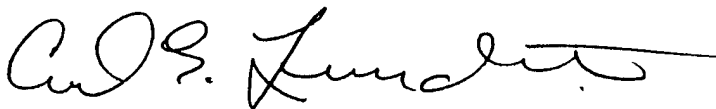
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

This is to confirm a conversation on 11 September 1990 between Merle London, Project Manager, Tulsa District Corps of Engineers, and Carl E. Lundstrom regarding documents related to the contract.

Mr. Lundstrom discussed with Mr. London that four sets of information were prepared and circulated during the negotiations of the referenced contract, which more clearly defined and refined the scope of services. Mr. Lundstrom wanted to reconfirm that these four documents are made part of the contract by this confirmation notice. The three documents are:

- Confirmation Notice No. 1, dated 5 July 1990, regarding "Scope Reductions."
- Conference Notes, dated 1 May 1990.
- Basis of Fee, submitted with fee proposal.
- Test Procedures, dated 14 June 1990.

Mr. London agreed the documents are part of the contract.



Carl E. Lundstrom, P.E.

CONFIRMATION NOTICE

Confirmation No. 3

EMC #3002.000

DATE: February 27, 1991

PROJECT: Energy Survey of Army Boiler and Chiller Plants
CONTRACT NO: DACA 56-90-C-0087

NOTICE
PREPARED BY: Pawn Chulavatr
E M C Engineers, Inc.

DATE OF
CONFERENCE: February 13, 1991

PLACE OF
CONFERENCE: Ft. Sill, Oklahoma

SUBJECT: Exit Interview Meeting Notes

ATTENDEES:	Merle London	Tulsa District COE	(918) 581-7991
	Serge Saltiel	DEH-Ft. Sill	(405) 351-5708
	Jerry Schmidt	DEH - Engineer Design	(405) 351-4250
	Carl Swenson	EMC Engineers, Inc.	(303) 988-2951
	Pawn Chulavatr	EMC Engineers, Inc.	(404) 952-3697

The following is a summary of items discussed, the comments made, and the decision made during the meeting.

EMC reported the preliminary results of the boiler survey. EMC stated that the combustion efficiency test of boilers went well and only one boiler is out of commission (building 4701). There were a few other minor problems encountered. Overall the test results were satisfactory. The preliminary result of the boiler testing is averaging around 77% efficiency.

Mr. Swenson suggests Ft. Sill train specialized groups of personnel in testing/calibrating boilers in all central plants. He expresses the lack of permanent instrumentation such as stack temperature gauge, pump pressure gauge, and opening for flue gas testing on boilers in the central plant. Mr. London asked that these suggestions be put in the report. EMC agreed to incorporate findings and suggestions into the report.

EMC described present operating procedures of boilers in the central plants according to the boiler operators. EMC reported that the only boiler log data was obtained from Central Plant 5900. The other central plants do not have log data.

CONFIRMATION NOTICE

February 27, 1991

Page 2

Mr. Schmidt expressed interest in creating a central heating plant as an addition to chiller central plant in buildings 3442 and 730, utilizing existing underground piping.

Special Notes:

1. For the purpose of determining the base load on central plants, EMC is using the assumption that the proposed buildings listed for the EMCS in the DD1391 Validation Study will be connected to the EMCS. These buildings will incorporate day/night setback and other energy savings associated with EMCS.
2. EMC found the heating and cooling log data was either known to be false (stated by the operators) or upon checking, has been determined to be invalid. Because of the lack of this information, EMC will estimate the loads on the central plants based on BTU per square feet data obtained from previous studies. EMC will also use sound engineering judgment in applying the historical load data to the building and plants involved in this study.

If this method is unsatisfactory, EMC must be notified as soon as possible.



Pawn Chulavatr

CONFERENCE NOTES

DATE: 26 September 1990

PROJECT: Energy Survey of Army Boiler and Chiller Plants
Ft. Sill, Oklahoma
Contract No. DACA 56-90-C-0087

NOTICE

PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 11 September 1990

PLACE OF CONFERENCE: DEH Conference Room, Ft. Sill, Oklahoma

PURPOSE OF CONFERENCE: Entry Interview

ATTENDEES: Merle London, Tulsa District, Corps of Engineers, (918) 581-7991
Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697
Carl Swenson, E M C Engineers, Inc., (303) 988-2951
Kenneth Rodgers, DEH HVAC, Ft. Sill
Jerry Schmidt, DEH, Ft. Sill, (405) 351-4250
Doug Cook, DEH Energy, Ft. Sill, (405) 351-3225

1. Mr. Lundstrom provided an overview of the scope of services, including testing, energy conservation opportunities (ECOs), and documentation of the plants to be evaluated.
2. Mr. Lundstrom described the test procedures to be conducted on the chillers and boilers. He described that the test on the chillers would be conducted immediately and the boiler testing would be conducted during winter months (December-February).
3. Mr. Lundstrom presented his list of personnel conducting the survey, his proposed schedule, and proposed working hours. Mr. Rodgers saw no problem providing HVAC shop personnel for the proposed survey schedule.
4. Mr. London discussed that EMC should be very careful when removing insulation, so as to not have asbestos problems. Mr. Lundstrom agreed with the situation. Mr. Schmidt agreed to contact Mr. Goode at Ft. Sill environmental regarding the testing of insulation for asbestos.
5. Mr. Lundstrom asked if it would be a problem to shut off chillers, or take load off of chillers temporarily so as to increase the load for testing purposes. Mr. Rodgers did not see a problem with this.

Conference Notes
26 September 1990
Page 2

6. Mr. Swenson asked about the general condition of chillers and annual maintenance procedures. Mr. Rodgers explained the chillers are generally in good condition and the condensers are all cleaned before each cooling season.

7. Mr. Schmidt emphasized he is interested in adding more buildings to central plants, especially in those facilities where there is extra cooling capacity.

8. Mr. Cook discussed the Energy Department is interested in developing energy conservation projects for future funding.

9. Mr. Lundstrom agreed to prepare conference notes, and the meeting was adjourned.



Carl E. Lundstrom, P.E.

Enclosure: Meeting Agenda

**ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL
CONTRACT DACA56-90-C-0087**

ENTRY INTERVIEW

AGENDA

1. GENERAL OVERVIEW OF PROJECT

- Testing of boiler and chillers for efficiency of plant.
- Determine current operating procedures of plants.
- Identify energy conservation opportunities (ECO).
- Perform analysis to determine energy consumption of plants, and evaluate ECO's.
- Prepare comprehensive report documenting the findings of the survey and analysis.
- Central Plants,
 - 5900
 - 6003
 - 730
 - 2812
 - 5676
 - 5678
 - 3442
 - 914
 - 4701

2. INTENDED PROCEDURES

- Chiller Testing, September 1990
- Boiler Testing, January 1991
(see attached test procedures)

3. SCHEDULE - CHILLER TESTING

Tuesday, 9/11, Building 2812
Wednesday, 9/12, Building 6003
Thursday, 9/13, Building 730
Friday, 9/14, Building 730 & 914
Saturday, 9/15, Building 5900
Monday, 9/17, Building 5900
Tuesday, 9/18, Building 3442
Wednesday, 9/19, Building 5676
Thursday, 9/20, Building 5678
Friday, 9/21, Building 4701
Saturday, 9/22, optional
Monday, 9/24, optional

4. PERSONNEL CONDUCTING SURVEY

Carl E. Lundstrom
Carl A. Swenson
Jim Watters

5. PROPOSED WORKING HOURS

07:30 to 18:00 hours, dates as shown

6. DEH SUPPORT

One RVAC shop chiller personnel, to bring chillers on and off line for testing. Also EMC will interview RVAC personnel to determine how plants are currently operated.

7. DISCUSSION

Any chillers plants not operational that can not be tested?
Other

TEST PROCEDURES
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Fl. Sill, Oklahoma
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Date: 14 June 1990
EMC Project No.: P10E.012

10/10/90 10:00 AM
P. 10/10/90 10:00 AM
P. 10/10/90 10:00 AM

Boiler Testing:

The boiler test procedure is designed to determine the efficiency of the boiler plants. The procedure is based on the American Society of Mechanical Engineers (ASME) Power Test Code 4.1 and will utilize instrumentation provided by EMC Engineers, Inc. It is noted that this procedure does not strictly adhere to ASME PTC 4.1; it is designed to provide the necessary data while controlling costs. The data obtained during the testing will be used to analyze boiler-related Energy Conservation Opportunities (ECO's). A single reading of the following will be measured:

- Flue gas temperature
- Ambient (combustion) air temperature
- Flue gas CO₂ content
- Flue gas O₂ content
- Outside air temperature
- Outside air relative humidity
- Fuel flow (using existing meters)
- KW input to primary hot water circulation pumps
- Differential pressure on representative primary hot water circulation pumps

Boiler readings will be taken while the boiler is under steady state firing conditions to the extent practical. The test procedure is as follows:

- 1) Install Flue gas thermometer and sampling tube in the stack through existing penetrations if possible. If not, a new penetration will be made using a handheld drill.
- 2) For non modulating burners, set burner control to hi-fire setting (if applicable). Adjust controls of other boilers so that the boiler being tested fires continuously.
- 3) For modulating burners, set burner control to manual, constant setting. Adjust controls of other boilers so that the conditions of the boiler being tested remain relatively steady.
- 4) Observe the following operating conditions relative to manufacturer's recommendations:
 - steam/hot water pressure/temperature setpoints
 - boiler water level

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Ft. Sill, Oklahoma
Page 2 of 3

- flame configuration
 - combustion control
 - make-up water control
 - leaking safety and other valves
 - signs of leaking boiler tubes
 - general condition of boiler insulation
- 5) Record data.
- 6) Remove instrumentation, return control settings to original positions.

Chiller Testing:

This chiller test procedure is made with the intent of determining the efficiency of the chiller plants. The procedure is based on the Air-Conditioning and Refrigeration Institute (ARI) Standard for Centrifugal or Rotary Screw Water-Chilling Packages (ARI 550-88). The procedure will utilize instrumentation provided by EMC Engineers, Inc. It is noted that this procedure does not strictly adhere to ARI 550-88; it is designed to provide the necessary data while controlling costs. The data obtained during the testing will be used to analyze chiller-related ECO's. A single set of readings of the following points will be metered:

- Condenser water inlet temperature
- Condenser water outlet temperature
- Chilled water return temperature
- Chilled water supply temperature
- Chilled water flow
- Chiller Compressor KW input
- Outside air temperature
- Outside air relative humidity
- KW input to chilled and condenser water pumps
- Differential pressure on representative chilled and condenser water pumps
- Condenser inlet/outlet pressure differential
- Evaporator inlet/outlet pressure differential

Readings will be taken at normal chilled water and condenser water supply temperature setpoints. "Normal setpoints" is meant to mean the setpoints used under normal operating conditions by the Ft. Sill maintenance staff. The test procedure is as follows:

- 1) Install all chiller test equipment.
- 2) Adjust setpoints to normal positions. Allow time for chiller to reach steady-state

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Ft. Sill, Oklahoma
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conditions. Steady-state is considered to be established after three sets of data have been taken, at five minute intervals, where the readings remain within the tolerances set forth in ARI 550-88, Para. A7.2.

Practical steps will be taken to obtain steady-state conditions. If these conditions are not reached within 1 hour, the EMC test engineer will use his discretion as to how to proceed with the testing.

- 3) Have DEH personnel remove all non-condensables from the system.
- 4) During the testing, observe the following operating conditions relative to manufacturer's recommendations:
 - refrigerant charge
 - temperatures and pressures
 - speed control
- 5) After the chiller conditions have stabilized, take a single set of readings.
- 6) Remove instrumentation.

At the time of the tests, DEH personnel will be interviewed as to the time of last cleaning and the general cleanliness of all heat exchangers. This information will be used to estimate fouling factors.

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Energy Survey of Army Boiler and Chiller Plants
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The proposal for the above project is based on the following items:

1. EMC will use existing natural gas meters in the boiler plants at Ft. Sill. EMC will not install any additional gas meters.
2. One complete set of metering equipment will be used. This equipment will all be direct readout type equipment; an electronic data acquisition system with sensors, PC, etc. will not be used. Equipment purchased for the project and to be given to the Government at the end of the project are as follows:
 - (2) Stack Thermometers
 - (1) Ultrasonic Flow Meter
 - (6) Thermometers
 - (1) Handheld Flue Gas Analyzer
 - (6) Pressure Gages
3. Asbestos Containing Materials (ACM) removal will amount to no more than (8) horizontal type 44" wide by 60" long glove bags.
4. Any material that is suspected by EMC to be ACM will be treated as ACM unless that material is sampled, tested, and positively identified by the Government as not being ACM. Sampling and testing must be performed according to all applicable EPA, OSHA, and other Federal, State, Regional, and Local regulations.
5. All ACM removal will be classified by EPA regulations as "O & M removal".
6. All ACM removed will be disposed of at the approved ACM disposal site at Ft. Sill.
7. All necessary pipe penetrations are existing. No additional pipe penetrations will be required for the testing.
8. Equipment outages of short duration will be required to connect meters. It is not expected that these outages will significantly effect plant operation. A general schedule of outages will be provided at the survey entrance interview. Given the nature of the survey work, providing a detailed schedule of outages is not possible.
9. In Appendix A, General Scope of Work, Para. 2.1, the phrase "updated and included" is taken to mean as follows: No technical analysis will be done under this contract. An

CONFERENCE NOTES

DATE: 1 May 1990

PROJECT: Ft. Sill
Energy Survey of Army Boiler and Chiller Plants

NOTES

PREPARED BY: Carl E. Lundstrom, P.E.
E M C Engineers, Inc.

DATE OF
CONFERENCE: 17 April 1990

PLACE OF
CONFERENCE: DEH Office, Ft. Sill, Oklahoma

PURPOSE OF
CONFERENCE: Pre-negotiation conference to discuss questions related to the Ft. Sill energy survey of Army boiler and chiller plants

ATTENDEES: F. Mike Denham, E M C Engineers, Inc., (303)988-2951
Carl E. Lundstrom, E M C Engineers, Inc., (404)952-3697
Merle London, Tulsa District, COE, (918)581-7991
Gary W. Basham, Ft. Sill DEH, (405) 351-3517
Jerry E. Schmidt, Ft. Sill DEH, (405) 351-4250
Steve McManus, Ft. Sill Energy Conservation Office, (405) 351-3225
Ron Barnett, Environmental Division, (405) 351-2715
Don Goode, Environmental Division, (405) 351-2715

CONFERENCE NOTES:

The following is a summary of the items discussed, the comments made, and the decisions made during the Conference. The A/E statement of work and conference agenda were distributed to each person.

1. M. London opened the conference with general introductions and explanation of the scope of the project. EMC is to survey boilers and chillers at Ft. Sill, determine their operating efficiency, evaluate energy conservation opportunities, and prepare three submittals of the testing and analysis. In addition EMC is to provide a one-day training seminar.

2. Asbestos removal concerns were discussed with R. Barnett. EMC will be installing instrumentation on the boilers and chillers to test their efficiency. Piping and flue insulation will have to be removed. Unless the insulation has been sampled, tested and positively

identified as not having asbestos containing material (ACM), it will be treated as asbestos. Paragraph 2. in Annex B, in the statement of work, identifies the OSHA standard which must be followed by workers that will be in areas with ACM's. R. Barnett explained if ACM will be removed and disposed of, EMC must follow EPA regulation Title 40CFR 61 (m). It was felt the work would be classified as O&M removal. EMC should investigate inspection notification, ACM removal, and ACM disposal requirements. EMC will have to contract with a licensed ACM removal contractor for this work. The government has an approved ACM disposal site at Ft. Sill for the material.

The following questions relate to Appendix A, General Scope of Work for an Energy Survey of Army Boiler and Chiller Plants for Ft. Sill Oklahoma:

3. Paragraph 2.1: Only the previous studies identified in Annex 'B' paragraph 3.a.b.& c. and related projects in Annex 'B' attachment 1 (cont.) must be updated and included in this study.

4. Paragraph 2.3: The statement that the study shall include supporting systems such as fuel oil storage, pollution abatement, etc. is meant to only note those items related to the existing boiler and chiller plant, which seem not normal, in need of repair, etc. Detailed evaluation of these items is not required.

5. Paragraph 2.3: The study is not intended to include a detailed evaluation of the distribution systems related to the central plants. If EMC notes problems while on-site (such as steam leaks in piping pits) these items should be described briefly in the report.

6. Paragraph 2.5: The term "technically and economically feasible," is meant to be those items which have been done and proven to provide savings, i.e. nothing experimental. All ECO's should be coordinated with DEH on what's feasible for Ft. Sill.

7. Paragraph 2.8: ECAM evaluation does not apply to Ft. Sill. Delete this requirement from the statement of work.

8. Paragraph 3.4: EMC will not be required to attend any non-scheduled meetings. EMC will have a kickoff meeting at the beginning of the field survey, and an exit interview, plus the scheduled submittal review meetings.

9. Paragraph 3.7.1.c: There will be no major restrictions on the working hours for EMC. EMC shall coordinate it's working schedule with DEH.

10. Paragraph 7.1.1: The statement of work regarding "submit...testing laboratory to the Contracting Officer for approval, is meant to include submitting documentation showing testing equipment has been properly calibrated.

11. Paragraph 7.1.1: The efficiency testing requirements for boilers were divided into full testing, partial testing, and minimum testing requirements, based on the size and age of the plants (see Annex B - attachment 1).

Full efficiency testing is to include: Installation of instrumentation for input/output measurement required to meter energy in versus energy out. See attached diagrams for instrumentation of low temperature hot water boilers (LTHW), high temperature hot water boilers (HTHW), and steam boilers.

Partial efficiency testing is to include: Stack temperature and CO measurements to determine the boiler combustion efficiency, plus overall inspection of the general boiler condition and operation. See attached diagrams for instrumentation of low temperature hot water boilers (LTHW), high temperature hot water boilers (HTHW), and steam boilers.

Minimum testing is to include: Overall inspection of the general condition and operation. No instrumentation will be used for this testing.

It is assumed one set of instrumentation equipment will be used for the measurements. This set of instrumentation will be moved from boiler to boiler to make the required measurements. In those locations where an insertion flow meter will be used, a new pipe tap and full bore valve will be installed and left in place after the metering is complete.

EMC will be required to remove asbestos insulation on pipes and stacks as required to make measurements (see item 2.).

12. Paragraph 7.1.2: The efficiency testing requirements for chillers were divided into full testing, partial testing, and minimum testing requirements, based on the size and age of the plants (see Annex B - attachment 1).

Full efficiency testing is to include: Installation of instrumentation for input/output measurement required to meter energy in versus energy out. See attached diagrams for instrumentation of chillers.

Partial efficiency testing is to include: The same as full efficiency testing minus the flow metering installation. See attached diagrams for instrumentation of chillers.

Minimum testing is to include: Overall inspection of the general condition and operation. No instrumentation will be used for this testing.

It is assumed one set of instrumentation equipment will be used for the measurements. This set of instrumentation will be moved from

chiller to chiller to make the required measurements. In those locations where an insertion flow meter will be used, a new pipe tap and full bore valve will be installed and left in place after the metering is complete.

For the full and partial testing EMC will measure the efficiency of the plants at varying loads at the following setpoints:

- Chilled water supply setpoints: 44°, 46°, and 48°, at the normal condenser water setpoint temperature.
- Condenser water supply setpoints: 87, 85, and 82, at the normal chilled water supply setpoint temperature.

EMC will be required to remove asbestos insulation on pipes as required to make measurements (see item 2.).

13. Paragraph 7.2.3: This paragraph is not intended to write an O&M manual for boiler and chiller operation. Include O&M items which would be covered in the one-day training class related to this project.

14. Paragraph 7.5: It was decided \$25,000 or less was the limit for a low cost/no cost ECO.

15. Paragraph 7.6.1: The sample completed DA Form 5108-R should be submitted with the interim submittal. EMC should coordinate with DEH which project should be submitted prior to the interim submittal.

16. Paragraph 8.: EMC will be required to give the one-day training class on three consecutive days, to three different classes of maintenance personnel at Ft. Sill. EMC should estimate on having 15 persons per class.

General comments and questions:

17. Mr. Lundstrom asked about evaluating manpower operation requirements. Mr. Basham explained this was a touchy subject, but is an important area to review. EMC should coordinate all information very closely with DEH, prior to submittals.

18. Mr. Lundstrom explained that to perform detailed ECO calculations, detailed boiler log data would provide the best method of estimating hourly loads. Because there are little or no log data kept, EMC will have to estimate loads, from gross capacities, or what little monthly metering data that's available.

19. After the study is complete, EMC will leave the metering equipment for government to use. There is little or no measurement or metering instrumentation on the central plants. This equipment can be used in the future for metering and adjusting central plant equipment operations. Some of the metering equipment will be site specific for the metering installations.

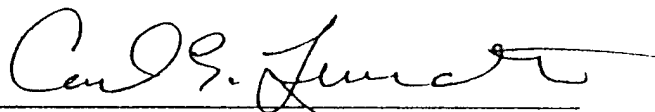
20. EMC will have to review the scheduling impact of: 1) submitting metering plan for approval, and 2) having contractors install metering taps and asbestos abatement.

21. Annex A, regarding impact of new refrigerants, EMC will address: 1) the general question of the affect refrigerant changes will have on Ft. Sill, and the central plants in question, 2) generally what efficiency, equipment changes, capacity, and life expectancy changes will occur, 3) manufacturers input to equipment changes required, 4) a general discussion on cost to convert chillers versus replacement of chillers, 5) life safety requirements for new refrigerants, and 6) general design guidelines and directives for future chiller plant designs. Specific chiller by chiller evaluation for technical modifications will not be provided in this study.

Ft. Sill DEH is to provide EMC with copies of the as-built mechanical plans for the chiller and boiler plants that will require instrumentation installations for measurement, for EMC to prepare a construction estimate for their fee proposal. Ft. Sill is to provide EMC a list of names of mechanical and asbestos abatement contractors who have worked at Ft. Sill.

Tulsa District needs to provide the following documents for EMC to prepare their fee proposal:

1. AR415-17, Tri-Service MCP Index, and EIRS bulletin.
2. Latest ECIP guidance.
3. AR5-4, change no. 1.
4. ETL 1110-3-332.
5. AR415-15, MCP Data, DD Form 1391
6. AR415-20.
7. TM5-800-3 for PDB.
8. Copy of a completed PDB.
9. DA Form 5108-R, copy of a blank form, instructions for completing the form, and a completed form as an example.
10. Copy of a completed DA Form 5108-R.
11. Example completed implementation document



Carl E. Lundstrom, P.E.
Project Manager

[C:\JOBS\SILL\CONFNOTE.WP]

BASIS OF FEE
Energy Survey of Army Boiler and Chiller Plants
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economic analysis will be done using the previous technical analysis results and current economic data. Construction cost estimates from the previous studies will be adjusted for inflation. All necessary technical analysis results from the previous studies will be provided by the Government. Only previous studies that effect the boiler/chiller plants in this study and that are identified in Annex B, Attachment 1, Detailed Scope of Work will be included in this study.

10. The manufacturer's published technical data will be sufficient certification of accuracy for meters and other test equipment that are new (not previously used).
11. EMC will have the full-time assistance of a boiler/chiller operator from Ft. Sill to perform equipment changeover. This will require approximately 1-1/2 weeks during the chiller testing in July or August 1990 and approximately 1 week during the boiler testing in January 1991.
12. Annex A to the General Scope of Work "General Energy Conservation Opportunities and Other Considerations" is revised to eliminate redundant ECO's and to combine certain ECO's to allow for practical implementation and valid technical analysis. Annex A will read as follows:

General Energy Conservation Opportunities:
 - 1) Replacement of Boilers
 - 2) Installation of New Burners and Control Systems (to assure proper combustion air-fuel ratio and most economical operation, including equipment optimization)
 - 3) Economizers/Air Preheaters
 - 4) High Efficiency Motors on Primary Hot Water Circulation Pumps and Chilled and Condenser Water Pumps.
 - 5) Variable or Two Speed Motors on Primary Hot Water Circulation Pumps and Chilled and Condenser Water Pumps.
 - 6) Replacement of Chillers
 - 7) Control Systems (to operate chillers at most economical conditions, including equipment optimization)
 - 8) Storage of Chilled Water
13. No additional ECO's will be analyzed in detail. No ECAM projects will be included. A general discussion of possible low cost / no cost ECO's observed during the surveys will be included in the report.
14. No heating or electrical load calculations are included. These loads will be provided by the Government, as required.

BASIS OF FEE
Energy Survey of Army Boiler and Chiller Plants
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Page 3 of 3

15. EMC project team members will make four trips to Ft. Sill. They are as follows:
 - 1) Chiller testing (approximately 1-1/2 weeks)
 - 2) Boiler testing (approximately 1 week)
 - 3) Interim Report Submittal Presentation
 - 4) Prefinal Report Submittal Presentation
16. No more than two EMC personnel will take part in each site visit to Ft. Sill. This includes the surveys and the submittal presentations.
17. Boiler/Chiller plants 5900, 6003, and 730 are included.
18. Travel costs were established based on 14 day prior notice.

Any additional effort to that indicated above will be accomplished through a modification to the contract.

8.15.91

FORT SILL REVIEW COMMENTS			DATE	ACTION A CONCUR D DO NOT CONCUR E EXCEPTION X DELETE (EXPLAIN D, E, & X) ACTION BY COMPLY _____
DIRECTORATE OF ENGINEERING & HOUSING			DISCIPLINE	
PROJECT BOILER/CHILLER SURVEY			☐ CIVIL ☐ ARCHITECTURAL ☐ MECHANICAL ☐ ELECTRICAL ☐ FIRE PROTECTION ☒ M P	
LOCATION FORT SILL		PROJECT NUMBER		
CMT. NO.	DWG. NO. OR REF.	REVIEWER	PHONE NUMBER	
		SERGE SALTIEL	(405) 351-4250 5708	
EXECUTIVE SUMMARY				
1.	ES 2	THIS ANALYSIS SHOULD BE INDEPENDENT OF THE EMCS. CAN NOT ASSUME THAT THE EMCS WILL BE INSTALLED		✓
2	ES 3	THIS STUDY SHOULD VALIDATE IF A CENTRAL PLANT ADDITION TO 3442 IS A GOOD PROJECT		✓
3	ES 3/4	OPERATIONAL NOTES TO SAVE ENERGY WITH LOW OR NO COST ARE TOO GENERAL.		✓
4	ES 5	STATEMENT ABOUT THE 3442 PLANT ADD. (SAME AS COMM. 2) MUST BE VALIDATED TO SEE IF WE SHOULD INCLUDE IN THE BRKS PROJECT.		✓
5	ES 8	ECO LIST SHOWS 17 ITEMS DESCRIPTIONS ARE NOT CLEAR EXAMPLE: #1 & 7. HOW IS ESTABLISHING CHILLER & BOILER LOAD GOING TO SAVE ENERGY?		✓

PAGE 1 OF

L 836 Army—Fort Sill, Okla.

FORT SILL REVIEW COMMENTS			DATE 17 JUL 91	ACTION	
DIRECTORATE OF ENGINEERING & HOUSING			DISCIPLINE ☐ CIVIL ☐ ARCHITECTURAL ☐ MECHANICAL ☐ ELECTRICAL ☐ FIRE PROTECTION ☒ MP	A CONCUR D DO NOT CONCUR E EXCEPTION X DELETE (EXPLAIN D, E, & X)	
PROJECT BOILER/CHILLER SURVEY				ACTION BY COMPLY _____	
LOCATION FORT SILL	PROJECT NUMBER				
CMT. NO.	DWG. NO. OR REF.	REVIEWER SERGE SALTIEL	PHONE NUMBER (405) 351-4250		
6	ES10	ECO NO 8 FOR BLDG 730 SHOWS AN SIR OF 2.2 & A PAYBACK OF 8 YEARS, HOWEVER ON TABLE ES-7 (PAGE ES21) THE SAME ECO IS SHOWN AS NOT FEASIBLE		WILL CORRECT TABLE ES-4 PAGE ES-10 ✓	
7	ES18/19	NEGATIVE PAYBACK YEARS IS MEANINGLESS. <i>NA</i>		✓	
8		GENERAL COMMENT. THE EXECUTIVE SUMMARY MUST RELATE THE OVERALL FINDINGS OF THE SURVEY, HOWEVER IT MUST CONTAIN SPECIFIC DESCRIPTION OF EACH RECOMMENDATION FOR THE "EXECUTIVE" TO MAKE DECISIONS WITHOUT GOING THROUGH THE BACK-UP REPORTS. RECOMMENDATIONS ARE VERY GENERAL & PROPOSED SCOPE OF PROJECTS TOO HARD TO FOLLOW.		✓	

PAGE 2 OF _____

L 836 Army—Fort Sill, Okla.

FORT SILL REVIEW COMMENTS		DATE	ACTION
		8 July, 1991	
DIRECTORATE OF ENGINEERING & HOUSING		DISCIPLINE	A CONCUR
		CIVIL	D DO NOT CONCUR
ENERGY SURVEY OF ARMY BOILER & CHILLER PLANTS		ARCHITECTURAL	E EXCEPTION
		XX MECHANICAL	X DELETE
		ELECTRICAL	(EXPLAIN D, E & X)
		FIRE PROTECTION	
LOCATION	PROJECT NUMBER		ACTION BY
FORT SILL, OKLAHOMA	DACA 56-90-C-0087		COMPLY
CMT. DWG. REVIEWER	PHONE NUMBER		
NO. NO. JERRY SCHMIDT	(405) 351-4250		

VOLUME 1

1. 2-19 Paragraph 2.2.4
The chillers in central plant building 3442 serves a total of 21 buildings. ✓

2. 2-34 Paragraph 2.2.8 and Paragraph 2.2.8.2
The central plant building 5900 serves a total of 5 barracks (bldgs. no. 5955, 5960, 5970, 6007 & 6050). ✓

3. 2-45 Central plant chiller should be 370 tons Table 2-2 shows chiller to be 170 tons. ✓

4. 2-46 Central plant (No. 5676) chiller should be 375 tons Table 2-2 shows chiller to be 170 tons. ✓

5. 3-2 The distribution loss for the area served by the central plant in building have been more than negligible. The heat loss from the super heated hot water distribution system have caused sufficient ground heating to damaged some of the chilled water piping. If the ground heat was sufficient to cause damage to plastic piping systems then it stands to reason that the losses are more than negligible. Ground temp 155F w/ boilers on. ✓

6. Tab 4 Annual savings for Ice Storage Systems was based on 12 months per year and the existing chiller efficiency. The use of Air Conditioning is only authorized 4 to 5 months per year and the existing chillers, modified to produce ice, will lose efficiency. The savings should be based on the actual period of use and the efficiency achieved while producing ice. ✓

7. 4-47 The estimated construction cost to replace the existing gas chiller appears to be excessive. ✓

8. 6-5 The chiller located at central plant 914 is a 400 ton chiller. ✓

9. 6-13 The central plant 6003 has three chillers one 400 ton and two 450 ton chillers. The operational strategies only addressed using the two 450 ton chillers. ✓

VERIFY FOR HTHW
DISREGARD FOR CHW

NA

NA

FORT SILL REVIEW COMMENTS		DATE	ACTION
		8 July, 1991	
DIRECTORATE OF ENGINEERING & HOUSING		DISCIPLINE	A CONCUR
		CIVIL	D DO NOT CONCUR
ENERGY SURVEY OF ARMY BOILER & CHILLER PLANTS		ARCHITECTURAL	E EXCEPTION
		XX MECHANICAL	X DELETE
		ELECTRICAL	(EXPLAIN D, E & X)
		FIRE PROTECTION	
LOCATION	PROJECT NUMBER		ACTION BY
FORT SILL, OKLAHOMA	DACA 56-90-C-0087		COMPLY
CMT. DWG. REVIEWER		PHONE NUMBER	
NO. NO.	JERRY SCHMIDT	(405) 351-4250	

10. 7-2 Brief description on ECO would be beneficial at this point. ✓

VOLUME II
11. C-3 Building 5900 chiller 4 should be listed as a 450 ton chiller. ✓

EXECUTIVE SUMMARY
12. The executive summary should have included recommendation concerning the CFC issue. The base has a large number of chillers that would be affected by CFC legislation. ✓

CONFIRMATION NOTICE

Confirmation No. 4

EMC #3002.000

DATE: 19 August 1991

PROJECT: Energy Survey of Central Plants, Ft. Sill, Oklahoma
CONTRACT NO.: DACA56-90-C-0087

NOTES
PREPARED BY: Carl Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 15 August 1991

PLACE OF
CONFERENCE: Tulsa District Resident Engineer's Office

SUBJECT: Interim Review Conference Presentation and Comments Review

ATTENDEES: W. Wayne Kiser, DEH (405) 351-5708
Merle London, Tulsa District COE (918) 581-7991
Carl E. Lundstrom, EMC Engineers, Inc. (404) 952-3697
Gene Paulsgrove, DEH Master Planning (405) 351-5708
Kenneth Rogers, DEH (405) 351-5910
Serge Saltiel, DEH (405) 351-5708
Jerry Schmidt, DEH Engr. Design (405) 351-4250
Carl Swenson, EMC Engineers (303) 988-2951

The following is a summary of the items discussed, the comments made, and the decisions made during the Conference:

1. Mr. London made introductions and passed roster to attendees.
2. Mr. Lundstrom made a presentation of the Interim Submittal:
 - Survey Findings.
 - ECO Analysis.
 - Conclusions and Recommendations.

Based on the discussion of the presentation, the following items were concluded and project direction was determined:

CONFIRMATION NO. 4

19 August 1991

Page 2

- Review electrical rates to verify electric demand rate charges.
- ECO 3, Central Plant 914, repair chiller to increase efficiency: This ECO has been done under warranty service.
- ECO 4, Central Plant 914, ice storage: This ECO was rejected; savings are marginal.
- ECO 3, Central Plant 2812, replace chiller: This ECO was not economically justified as a replacement project. To repair the existing chiller is not an acceptable alternative.
- ECO 17, Central Plants 730 and 2812, electric water heaters: This ECO was rejected, because Ft. Sill does not want to do any projects which may increase the Fort's overall summer electrical demand.
- ECO 3, Central Plant 4701, replace chiller: This ECO was not economically justified as a replacement project. To repair the existing chillers is not an acceptable alternative.
- ECO 4, Central Plant 4701, ice storage: This ECO was rejected because of marginal savings.
- RDF boiler, Central Plant 5900: This special project to update a previous study was rejected because of current refuse quantities and operation of the plant.
- ECO 9, Central Plant 5900, replace boilers: This ECO will be investigated in place of the proposed repair project.
- ECO 12, Central Plant 5900, stack economizers: This ECO was rejected because of the potential increase in manpower to support operations.
- Central Plant 3442, service extension to provide cooling to Buildings 2470 and 2471: This special project is not required because these two buildings have new chiller equipment.
- ECO 6, high efficiency motors, all plants: In place of further analysis, it should be noted that high efficiency motors should be installed if replacements are justified.
- ECO 10, boiler combustion controls, all plants: No further analysis or consideration is required, because of the concern regarding the marginal savings and high maintenance requirements.

3. The Ft. Sill DEH engineers conferred as to proposed ECOs to develop into projects for the final submittal.

Based on their discussion, the following projects were developed:

Project A:

Boiler and chiller controls project (ECOs 1, 2, 7, and 8) for Central Plants 730, 914, 2812, 3442, 5676, 5678, 5900, and 6003. The control project is to be a stand-alone project, and the savings or costs should not assume an EMCS exists.

Project B:

Central heating plant replacement project at Central Plant 5900, boilers 1 and 2, and Central Plant 2812, boilers 1 and 2.

Project C:

One new central plant to provide heating and cooling to both Buildings 5676 and 5678.

In preparing the final analysis, Ft. Sill DEH engineers requested the energy analysis be based on the assumption the EMCS was not installed. Mr. Lundstrom agreed to use non-EMCS loads to prepare the final analysis. The Ft. Sill DEH engineers asked that the computer input for the final project energy analysis be included with the final report. Mr. Lundstrom agreed to provide this information.

4. Additional analysis comparison:

- Compare central heating plant at 3442, to individual boilers at each building. Consider plant to also serve Buildings 2470 and 2471. Do not consider using chilled water lines for distribution from heating plant.



Carl E. Lundstrom
/rt

If any portion of this Confirmation Notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 10 days, it will be assumed that the decisions and conclusions, and status outlined in this Confirmation Notice is correct.

CONFERENCE NOTICE

Conformation No. 5

EMC #3002.000

DATE: 10 September 1991

PROJECT: Energy Survey of Army Boiler and Chiller Plants Ft. Sill, Oklahoma
CONTRACT No. DACA 56-90-C-0087

NOTICE
PREPARED BY: Kamchornvuthi Chulavatr
E M C Engineers, Inc.

DATE OF
CONFERENCE: 6 September 1991

PLACE
OF CONFERENCE: Public Work Center, Mr. Howard Hovis office, Ft. Sill, Oklahoma

SUBJECT: To discuss central plant's control strategy and projects to be evaluated in the study

ATTENDEES: W. Wayne Keiser, DEH, Ft. Sill (405) 351-5708
Serge Saltiel, DEH, Ft. Sill (405) 351-5708
Jerry Schmidt, DEH, Ft. Sill, (405) 351-4250
Howard Hovis, PWC, Ft. Sill, (405) 351-3608/5341
Kamchornvuthi Chulavatr, E M C Engineers, Inc., (404) 952-3697

The following is a summary of the items discussed, the comments made, and the decisions made during the conference.

The control and monitoring points for central plants will include the following:

<u>Boiler</u>	- Natural gas line pressure before and after the regulator - Flow and accumulative of the make-up water - Boiler stack temperature and O₂ - Boilers alarm - Pumps start/stop and status - Supply and return water temperatures - Flow of the supply steam and hot water - Supply pressure for steam and nitrogen in the expansion tank for high temperature hot water - LEDs display

CONFERENCE NOTICE

10 September 1991

Page 2

- Chiller
- Pumps start/stop and status
 - Supply and return chilled water and condenser water temperatures
 - Flow of the chilled water
 - Chiller start/stop and status
 - Cooling towers start/stop and status
 - Chiller kW consumption
 - LEDs display

Projects to be evaluated are:

- Project 1. - Control project for central plant 730, 5900, and 6003.
- Project 2. - Central plant project and control project for building 5676 and 5678.
- Project 3. - Replace boiler number 1 and 2 in central plant 2812 and 5900.
- Project 4. - Replace a chiller in central plant 2812 with the small higher efficiency chiller.
- Project 5. - Compare local hot water boiler in each barracks versus central heating plant project for 3442.

The following are result of general item discussed:

- The control project will include the fiber optics DTM cost from the central plant to RVAC shop, building 1950.
- There will not be any new control projects for central plant 914, 2812, and cooling plant 3442.
- The central computer for the control project will be an existing PC located in the RVAC shop, and, if possible, use existing software.



Kamchornvuthi Chulavatr

If any portion of this conformation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this notice are correct.

CONFIRMATION NOTICE

Confirmation No. 6

EMC# 3002.000

DATE: 9 March 1992

PROJECT: Energy Survey of Army Boiler and Chiller Plants
Ft. Sill, Oklahoma

CONTRACT NO: DACA56-90-C-0087

NOTES
PREPARED BY: Carl E. Lundstrom
EMC Engineers, Inc.

DATE OF
CONFERENCE: 5 March 1992

PLACE OF
CONFERENCE: Mr. Kiser's Office, Dept. of Public Works
Ft. Sill, OK

SUBJECT: To discuss results of the Prefinal report.

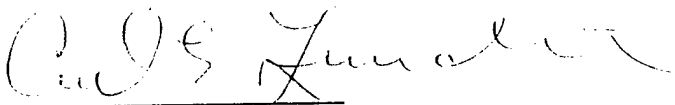
ATTENDEES: Carl Lundstrom, EMC Engineers, Inc. (404) 952-3697
Merle London, Tulsa District COE (918)-581-7991
Jerry Schmidt, Ft. Sill DPW, Engineering Design (405)-351-4250
Howard Hovis, Ft. Sill DPW, Chief FMD, (405) 351-3608
Gene Paulsgrove, Ft. Sill DPW, Planning, (405) 351-5708
W. Wayne Kiser, Ft. Sill DPW, Chief Engineering Division, (405) 351-5708

The following is a summary of the items discussed, the comments made, and the decisions made during the conference:

1. Mr. Lundstrom explained EMC finished and submitted the Prefinal report in October 1991.
2. Mr. Lundstrom reviewed the results of the evaluation of the five projects developed from the Interim Submittal.
3. Mr. Lundstrom went over the review comments made by Jerry Schmidt. Mr. Lundstrom confirmed he would make the following revisions to the final submittal:
 - o Distribution losses for chilled water lines will be included in the project energy calculations for Central Plants 6003 and 5900.

Confirmation No. 6
9 March 1992
Page 2

- o Project 2: (Central Plants 5676 and 5678) will be reviewed as a heating plant replacement project only, with the idea of chiller plant replacement in the future.
- o Comments regarding Project 4 are not applicable, since the chiller is being replaced under a current construction project.



Carl E. Lundstrom, P.E.

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

SILL REVIEW COMMENTS		DATE	ACTION
		6 November, 1991	
=====			A CONCUR
DIRECTORATE OF PUBLIC WORKS		DISCIPLINE	D DO NOT CONCUR
=====		CIVIL	E EXCEPTION
ENERGY SURVEY OF ARMY BOILER & CHILLER PLANTS		ARCHITECTURAL	X DELETE
=====		XX MECHANICAL	
LOCATION	PROJECT NUMBER	ELECTRICAL	(EXPLAIN D, E & X)
FORT SILL, OKLAHOMA	DACA 56-90-C-0087	FIRE PROTECTION	
=====			ACTION BY
CMT. DWG. REVIEWER		PHONE NUMBER	
NO. NO.	JERRY SCHMIDT	(405)351-4250	-----
=====			

VOLUME I

1. 3-2 The distribution loss for the area served by the central plant in building 5900 and 6003 have been more than negligible. The heat loss from the super heated hot water and steam distribution systems have caused sufficient ground heating to damaged some of the chilled water piping; by causing ovaling, blistering and collapse of the plastic chilled water piping. If the ground heat was sufficient to cause damage to plastic piping systems then it stands to reason that the losses are more than negligible.

2. Section 6, paragraph 6.2.1
The Central Plant at building 730 has three CHILLERS, two 300 tons and one 800 tons. Chiller Optimization should utilize all three chillers. For low load conditions of 0 to 300 tons, one 300 tons chiller. Medium load of 300 to 600 tons, two 300 tons chillers. High load of 600 to 800 tons, one 800 tons chiller. Peak load of 800 tons and above, one 800 tons and one 300 tons chillers. This strategy will have the chillers operating at 70 to 80 percent of there peak capacity (the most economical portion of there efficiency curve) the majority of there operating time.

3. Section 8, paragraph 8.1.2
The difference in cost of a central plant and replacing the existing equipment is what should be compared.

VOLUME II

4. C-3 (Reference Review Comment number 11 dated 8 July 1991.)

Building 5900 chiller 4 should be listed as a 450 ton chiller.

VOLUME III

5. J.1.8 The drawing indicates that there may be adequate space in the existing mechanical room for the heating and cooling equipment, if one chiller is used, thus eliminated the need for the addition to the building.

L 836 Army-Fort Sill, Okla.

SILL REVIEW COMMENTS		DATE	ACTION
=====		6 November, 1991	
DIRECTORATE OF PUBLIC WORKS		DISCIPLINE	A CONCUR
=====		CIVIL	D DO NOT CONCUR
ENERGY SURVEY OF ARMY BOILER & CHILLER PLANTS		ARCHITECTURAL	E EXCEPTION
=====		XX MECHANICAL	X DELETE
LOCATION	PROJECT NUMBER	ELECTRICAL	(EXPLAIN D, E & X)
FORT SILL, OKLAHOMA	DACA 56-90-C-0087	FIRE PROTECTION	
=====			ACTION BY
CMT. DWG. REVIEWER		PHONE NUMBER	
NO. NO.	JERRY SCHMIDT	(405)351-4250	-----
=====			

6. J.1.4 & J.1.5

If the scope is reduced from two chillers to one chiller and eliminating the addition to the building the project bare cost could be reduces approximately \$200,000.
(Building addition \$120,000 Chiller \$80,000)

A

7. L.1.4 If the chiller sizing is based on the combined load of the connected buildings (Reference Volume II page B-5) 305.7 Tons and a diversity factor of 0.85 used the chiller size should be 260 Tons. This down sizing of the chiller from 342 Tons to 260 Tons should increase the energy savings and lower the cost of the chiller without altering the comfort level in the buildings.

X

APPENDIX I

PROJECT 1 - CONTROL PROJECT FOR CENTRAL PLANTS 730, 5900, AND 6003

APPENDIX I.1 - PROJECT ANALYSIS

APPENDIX I.2 - PC-CUBE BASERUN

APPENDIX I.3 - PC-CUBE ECO RUN

APPENDIX I.1
PROJECT ANALYSIS

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS FT. SILL, OKLAHOMA

CENTRAL PLANT: 730, 5900, AND 6003
ENERGY CONSERVATION OPPORTUNITY: PROJECT 1
SYSTEM MODIFICATION: INSTALL AN AUTOMATED CONTROL SYSTEM
SYSTEMS TO MODIFY: BOILERS, CHILLERS, COOLING TOWERS, AND PUMPS

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for Project 1, install automated control system in central plant 730, 5900, and 6003. The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas (MMBtu)	Total Energy (MMBtu)
	Demand(kW)	Energy(kWh)		
Baseline	3,206	8,188,208	149,090	177,036
ECO	3,042	6,681,000	141,408	164,210
Savings (Baseline-ECO)	164	1,507,208	7,682	12,826

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 5144 MMBtu/Yr X \$4.0141 /MMBtu = \$20,649 per year
 Nat. Gas: 7682 MMBtu/Yr X \$2.92 /MMBtu = \$22,431 per year
 Total Energy Cost Savings: \$20,649 + \$22,431 = \$43,080 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 164 kW/month X \$1.787 /kW X 12 months/year
 = (+) \$3,517 per year
 Maintenance: = (-) \$27,000 per year
 Total: \$3,517 - \$27,000 = (\$23,483)per year

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: PROJECT1

LCCID 1.062

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

INSTALLATION & LOCATION: FT. SILL, OK REGION NOS. 6 CENSUS: 3

PROJECT NO. & TITLE: 3002-000 CENTRAL PLANT CONTROLS

FISCAL YEAR 1992 DISCRETE PORTION NAME: AUTOMATED CONTROL CENTRAL PLANTS

ANALYSIS DATE: 04-07-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	576814.
B. SIOH	\$	31725.
C. DESIGN COST	\$	34609.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	643148.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 4.01	5144.	\$ 20648.	11.11	229399.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 2.92	7682.	\$ 22431.	14.45	324134.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		12826.	\$ 43079.		\$ 553534.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A) 10.59

(2) DISCOUNTED SAVING/COST (3A X 3A1) \$ -248685.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4) \$ -248685.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 182666.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS\ ECONOMIC\ LIFE))$ \$ 19596.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 304849.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .47
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 32.82

COST ESTIMATE ANALYSIS

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER		INVOITATION NO./CONTRACT NO.				EFFECTIVE PRICING		DATE PREPARED			
LOCATION FT. SILL, OKLAHOMA		DACA 59-90 - C-0087				DATE APR. 91		21 - Sep -91			
		CODE A ☐ CODE B ☒ CODE C ☐				DRAWING NO.		SHT OF			
		OTHER				ESTIMATOR		CHECKED BY			
						KC		SHIPPING			
						TOTAL					
						Unit		Wt			
						Cost					
						Price					
						Unit		Total			
						Price		Wt			
BLDG. 730		Quantity		LABOR		EQUIPMENT		MATERIAL		TOTAL	
TASK DESCRIPTION		No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit	Total Wt
INSTRUMENTATION FOR CHILLERS (3)											
CWS/R TEMPERATURE SENSOR	7	LS			176	1232		328.00	2298.00		\$3,528
CNWS/R TEMPERATURE SENSOR	2	LS			176	352		328.00	656.00		\$1,008
INSERT. FLOW METER	2	LS			197	394		764.00	1528.00		\$1,922
CWP ST/SP	5	LS			123	616		226.00	1130.00		\$1,746
CNWP ST/SP	3	LS			123	370		226.00	678.00		\$1,048
DP (LIQUID) PUMP STATUS	8	LS			155	1240		205.00	1640.00		\$2,880
COOLING TOWER ST/SP	2	LS			123	246		226.00	452.00		\$698
COOLING TOWER ST/SP STATUS	2	LS			113	226		137.00	274.00		\$500
CW TEMP CONTROL	3	LS			108	324		558.00	1674.00		\$1,998
CHILLER ST/SP	3	LS			123	370		226.00	678.00		\$1,048
ALARM	3	LS			84	252		37.00	111.00		\$363
CHILLER STATUS	3	LS			113	339		137.00	411.00		\$750
KW TRANSDUCER	3	LS			226	678		374.00	1122.00		\$1,800
CURRENT TRANSDUCER	3	LS			126	378		270.00	810.00		\$1,188
FID PANEL & ACCESSORIES	3	LS			208	624		3681.00	11043.00		\$11,667
FID SOFTWARE COMMISSIONING	3	EA			270	810					\$810
FID TESTING	3	EA			270	810					\$810
SUBTOTAL											
OVERHEAD, BOND						\$9,261			\$24,503		\$33,764
PROFIT	16%					\$1,482			\$3,920		\$5,402
COST SUB - TOTAL	10%					\$926			\$2,450		\$3,376
CONTINGENCY	20%					\$11,868			\$30,874		\$42,542
SUBTOTAL						\$2,334			\$6,175		\$8,508
S&A	5.5%					\$14,002			\$37,049		\$51,051
TOTAL THIS SHEET											
						\$14,772			\$39,086		\$53,858

COST ESTIMATE ANALYSIS

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER LOCATION FT. SILL, OKLAHOMA										INVITATION NO./CONTRACT NO. DACA 59-90-C-0087 CODE A ☐ CODE B ☐ CODE C ☐ OTHER ☐				EFFECTIVE PRICING DATE APR. 91 DRAWING NO.		DATE PREPARED 23-Sep-91 SHT OF	
TASK DESCRIPTION		Quantity		LABOR		EQUIPMENT		MATERIAL		ESTIMATOR		CHECKED BY					
		No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost				
BLDG. 5900																	
INSTRUMENTATION FOR BOILERS (6)																	
HWS/R TEMPERATURE SENSOR		3	LS			176	528			328	984	\$1,512					
STACK TEMPERATURE SENSOR		6	LS			178	1068			398	2,388	\$3,456					
INSERT. FLOW METER		2	LS			197	394			764	1,528	\$1,922					
HWP ST/SP		11	LS			123	1355			226	2,486	\$3,841					
STACK OXYGEN SENSOR		6	LS			338	2028			3,483	20,898	\$22,926					
DP (LIQUID) PUMP STATUS		11	LS			155	1705			205	2,255	\$3,960					
LIQUID (AND GAS) PRESSURE SENSOR		4	LS			187	748			296	1,184	\$1,932					
GAS METER		1	LS			216	216			2,769	2,769	\$2,985					
HIGH LIMIT ALARM		6	LS			84	504			37	222	\$726					
FID PANEL & ACCESSORIES		6	LS			208	1248			3,681	22,086	\$23,334					
FID SOFTWARE COMMISSIONING		6	EA			270	1620					\$1,620					
FID TESTING		6	EA			270	1620					\$1,620					
SUBTOTAL							\$13,034				56,800	\$69,834					
OVERHEAD, BOND		16%					\$2,085				9,088	\$11,173					
PROFIT		10%					\$1,303				5,680	\$6,983					
COST SUB - TOTAL							\$16,423				71,568	\$87,991					
CONTINGENCY		20%					\$3,285				14,314	\$17,598					
SUBTOTAL							\$19,708				85,882	\$105,589					
S&A		5.5%					\$1,084				4,723	\$5,807					
TOTAL THIS SHEET							\$20,792				90,605	\$111,397					

COST ESTIMATE ANALYSIS

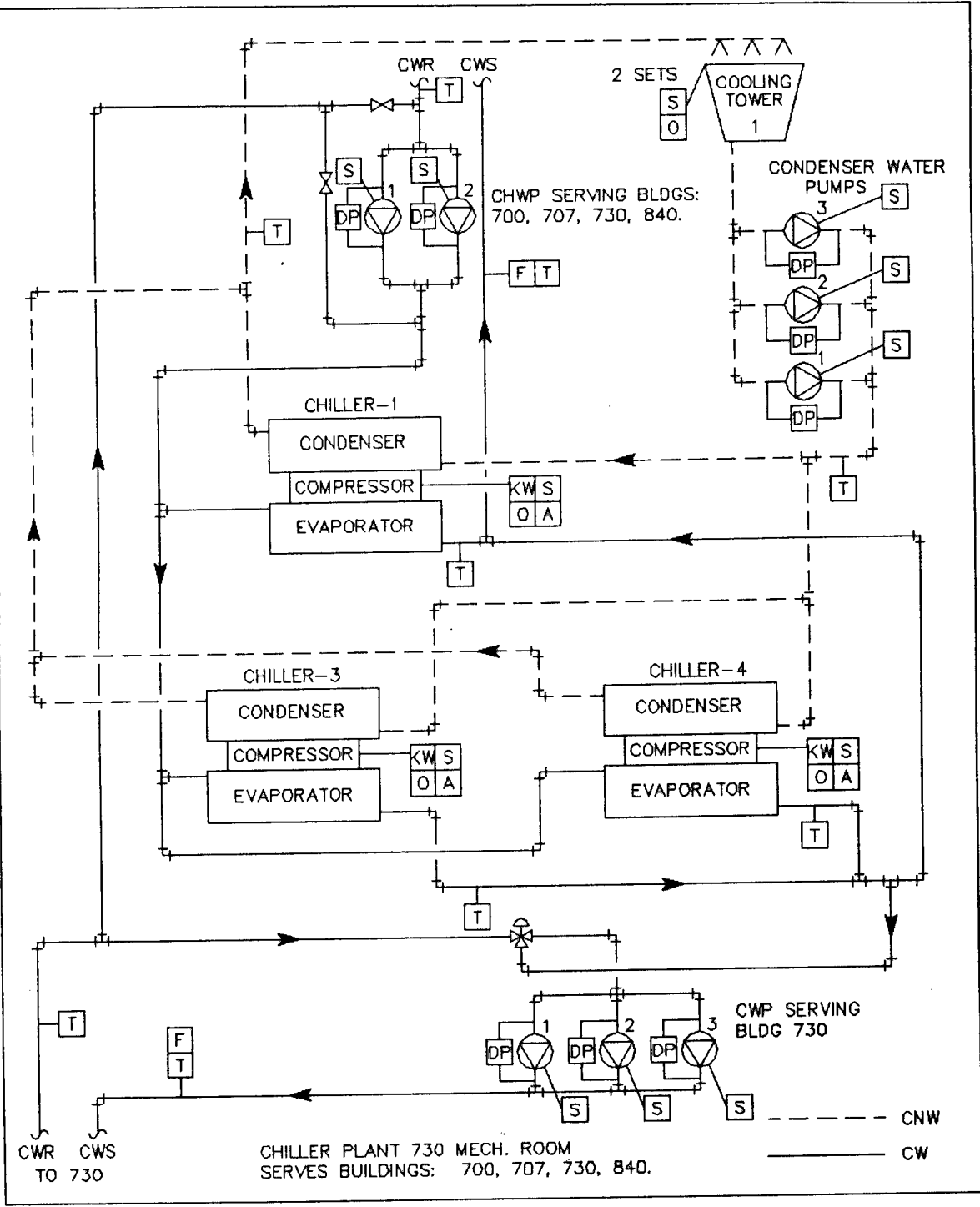
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DACA 59-90-C-0087										DATE APR. 91		21-Sep-91	
CODE A X CODE B CODE C OTHER										DRAWING NO.		SHT OF	
										ESTIMATOR		KC	
										TOTAL		SHIPPING	
										Unit		Wt	
										Wt		Wt	
BLDG. 6003													
TASK DESCRIPTION										MATERIAL		TOTAL	
										Unit		Cost	
										Price			
INSTRUMENTATION FOR CHILLERS (3)													
CWS/R TEMPERATURE SENSOR										328.00		1640.00	
CNWS/R TEMPERATURE SENSOR										328.00		1312.00	
INSERT FLOW METER										764.00		764.00	
CWP ST/SP										226.00		904.00	
CNWP ST/SP										226.00		452.00	
DP (LIQUID) PUMP STATUS										205.00		1230.00	
COOLING TOWER ST/SP										226.00		452.00	
COOLING TOWER ST/SP STATUS										137.00		274.00	
CW TEMP CONTROL										558.00		1674.00	
CHILLER ST/SP										226.00		678.00	
ALARM										37.00		111.00	
CHILLER STATUS										137.00		411.00	
KW TRANSUDUCER										374.00		1122.00	
CURRENT TRANSUDUCER										270.00		810.00	
FID PANEL & ACCESSORIES										3681.00		11043.00	
FID SOFTWARE COMMISSIONING												810	
FID TESTING												810	
SUBTOTAL												\$31,384	
OVERHEAD, BOND												\$3,660	
PROFIT												\$2,288	
COST SUB - TOTAL												\$39,544	
CONTINGENCY												\$5,765	
SUBTOTAL												\$34,590	
S&A												\$1,902	
TOTAL THIS SHEET												\$50,063	

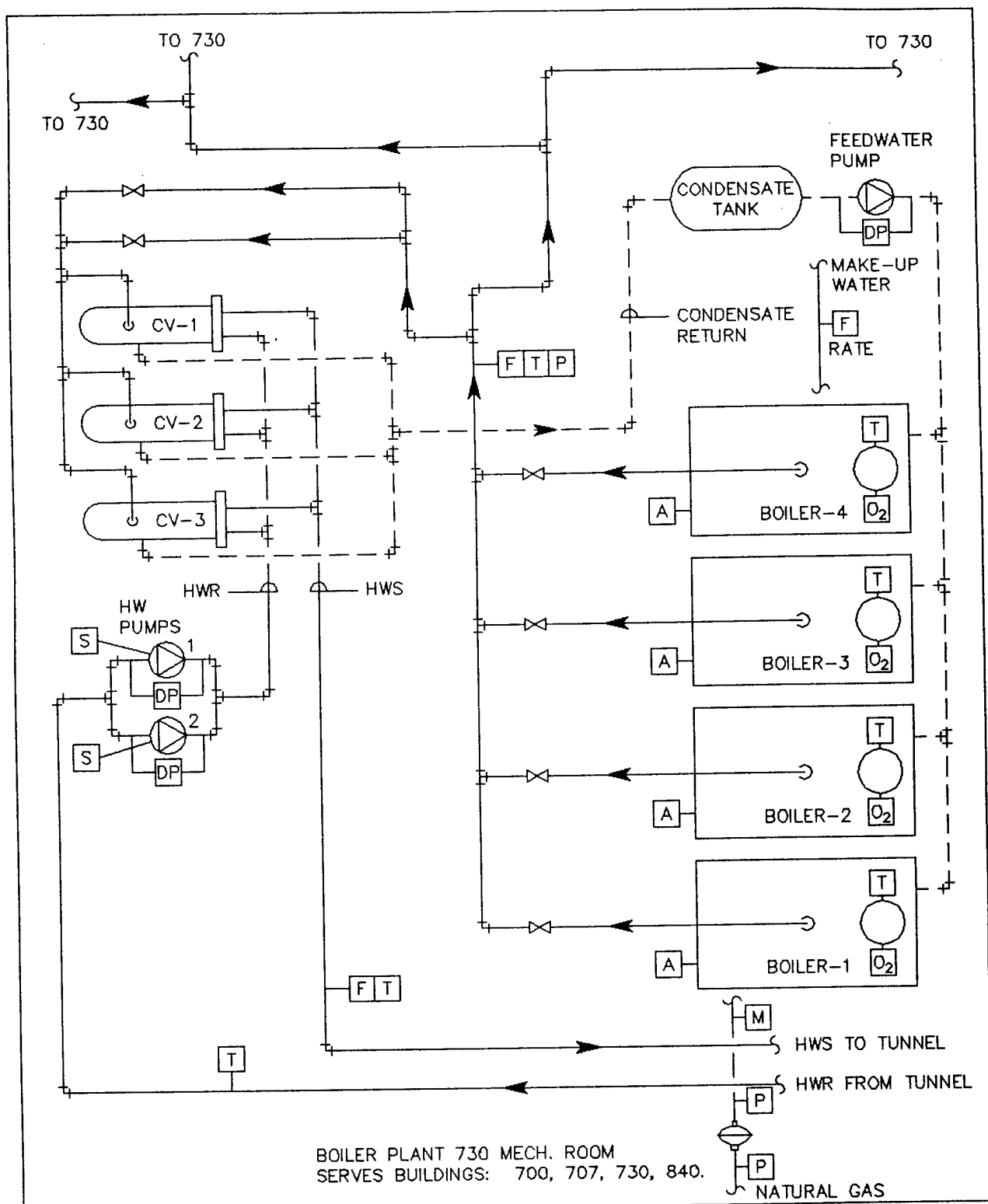
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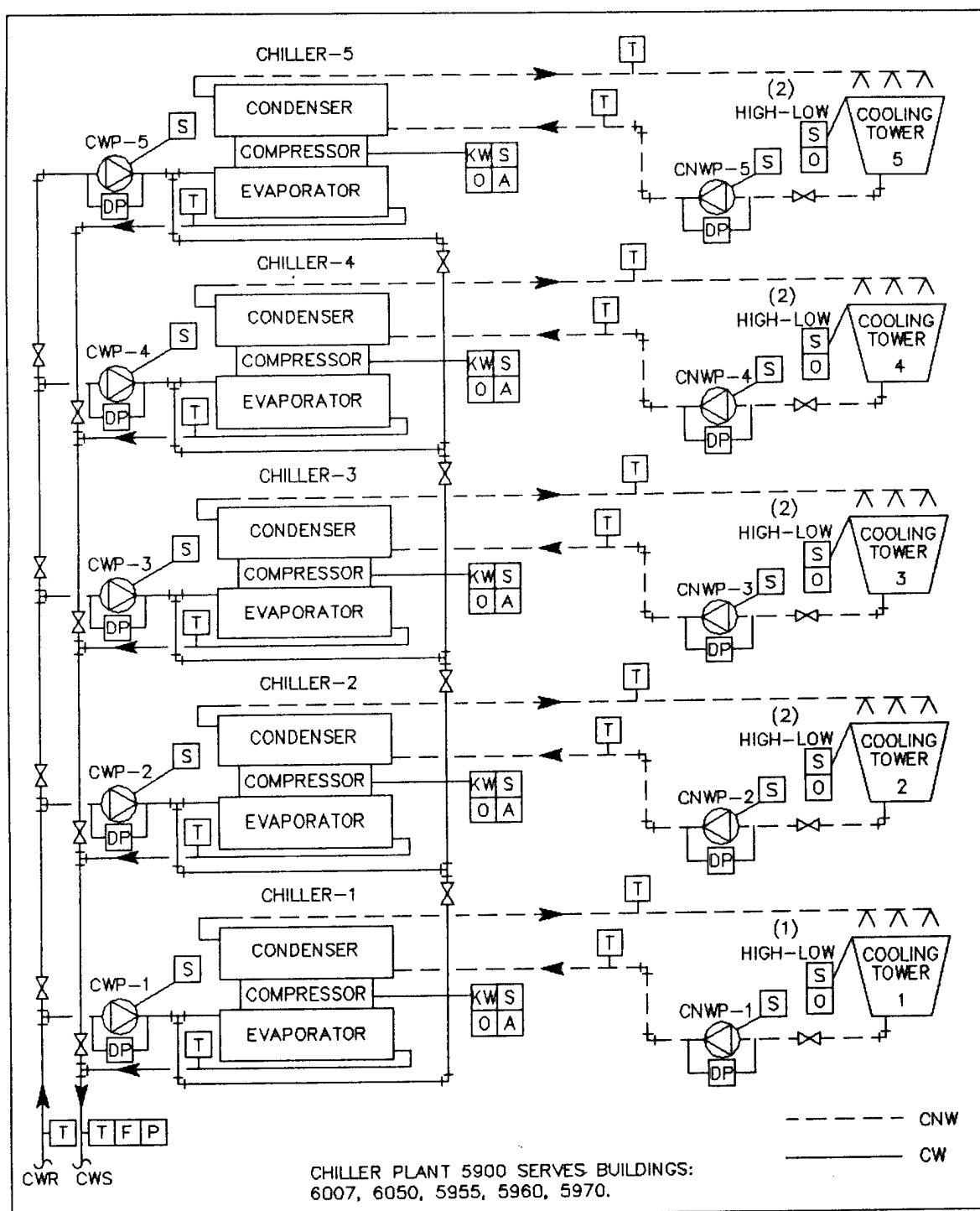
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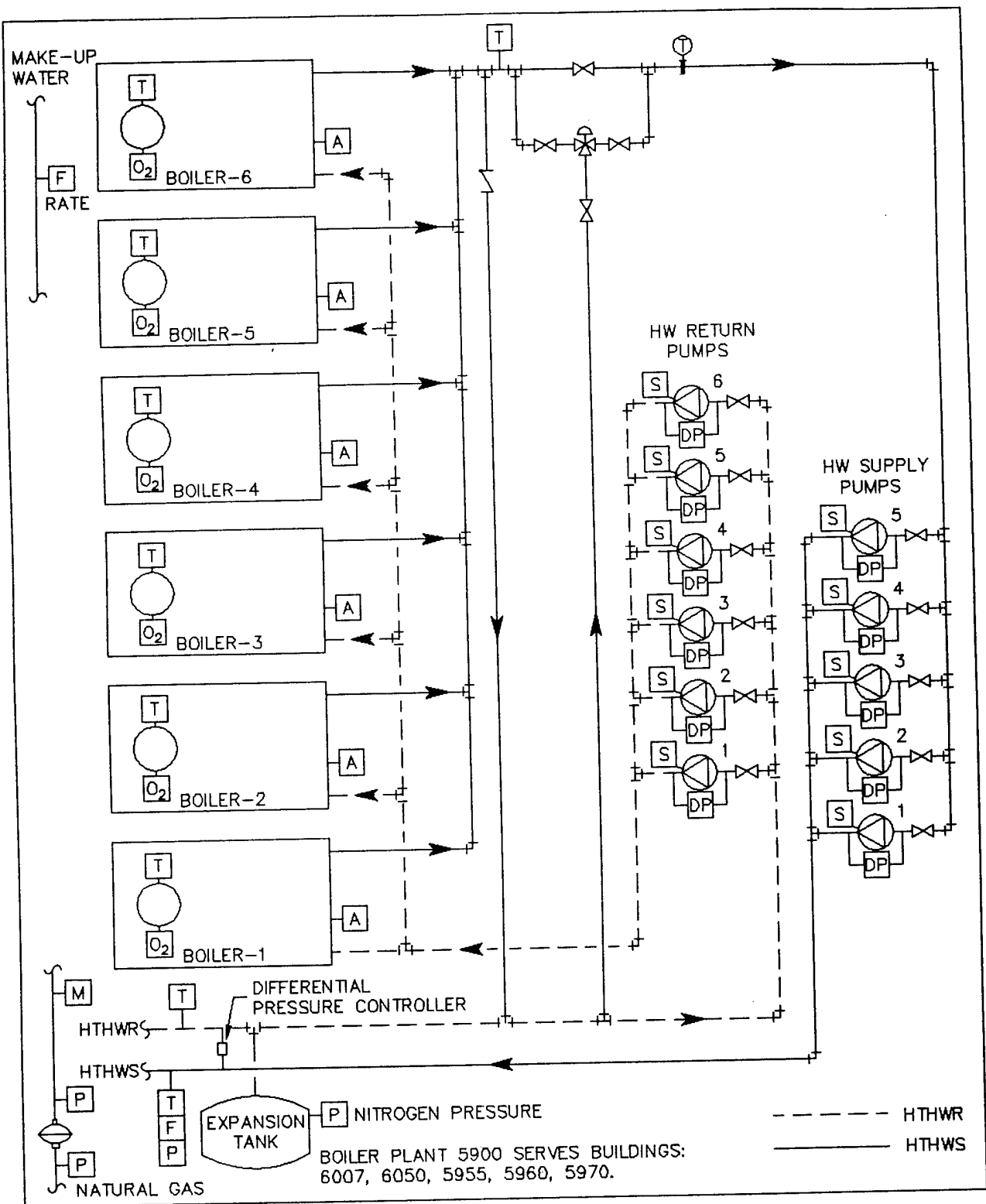
SYMBOLS LEGEND

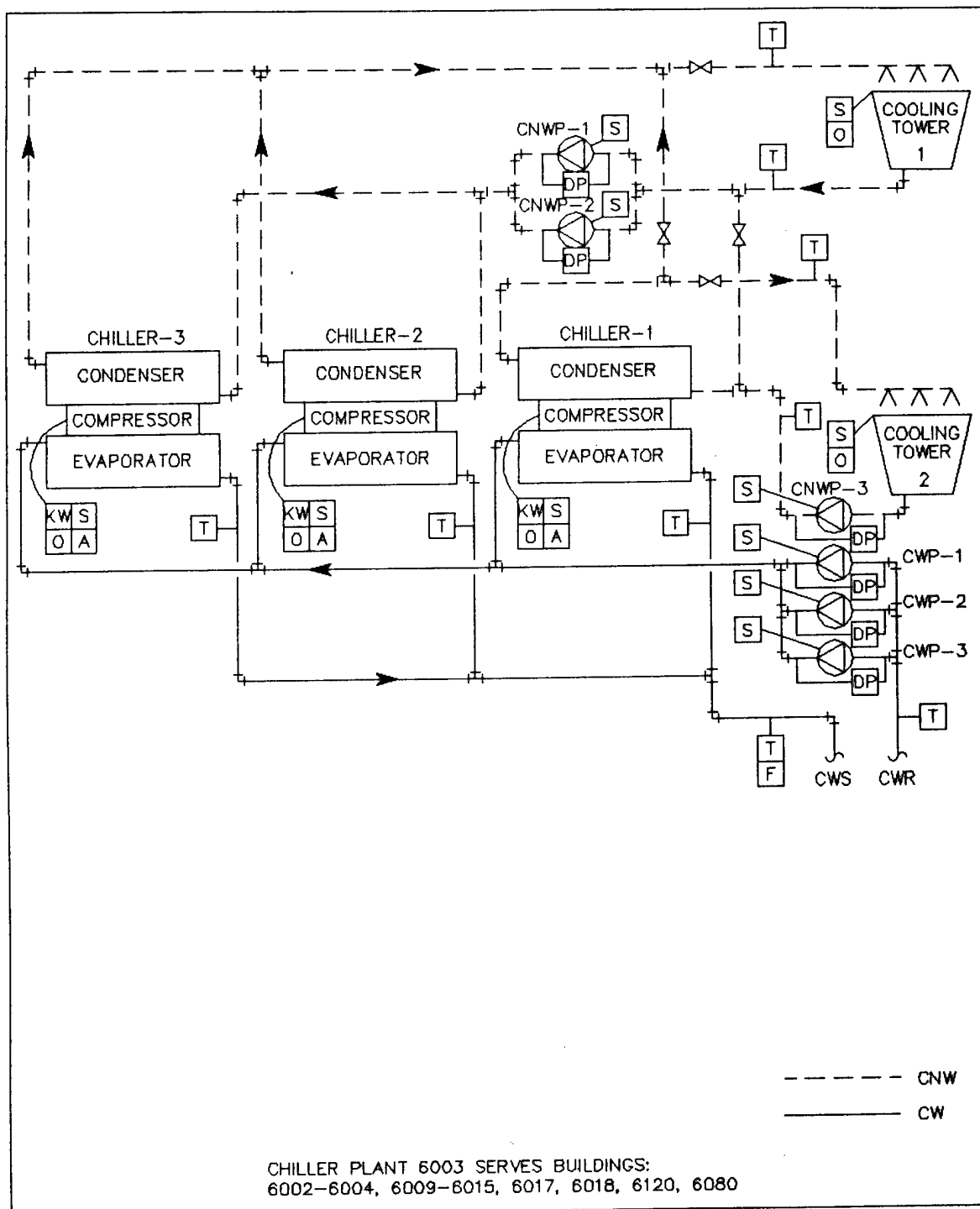
	ALARM CONTACT SIGNAL
	FLOW INDICATION
	PRESSURE INDICATION
	METER
	ON-OFF STATUS SIGNAL
	DIFFERENTIAL PRESSURE SWITCH
	START-UP INTERFACE
	TEMPERATURE INDICATION
	FLUE GAS ANALYSIS, OXYGEN
	KILOWATT METER
	EXISTING-TO-NEW

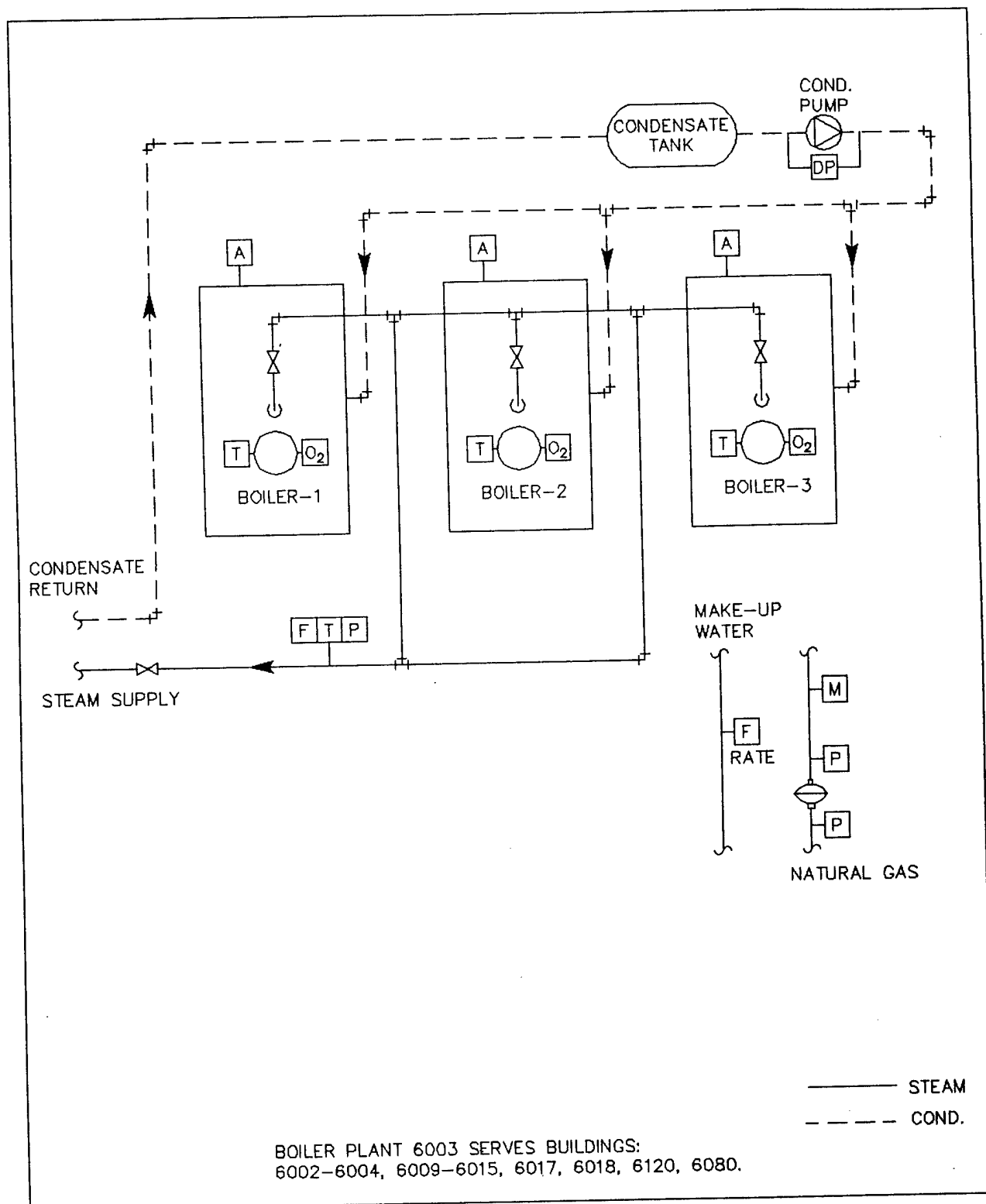












I/O SUMMARY TABLE

18-Sep-91

Building No.	730	HARDWARE										SOFTWARE									
		OUTPUT					INPUT					ALARMS					APPLICATION PROGRAMS				
		DIG	ANA	DIG	ANA	DIG	ANA	DIG	ANA	DIG	ANA	DIG	ANA	DIG	ANA	DIG	ANA	DIG	ANA	DIG	ANA
SYSTEM(S) CENTRAL COOLING PLANT	System No.	C S T R L E N A U T O	P O S I T I O N R E A D O	P R E S S E S S W	P R E S S E S S W	F L O W S S W	F L O W S S W	D A U X C O N T A C T	C U R R E N T S E E L L A Y	S T A T P P S W	E N D P P S W	T E E M P	T E E M P	T K W	P P S I P S	F L O N T	C O N T	R B T U	H I G W	L I M I T	S C H E D S / T S P
OCCUPANCY TIME	GRAPHIC DISPLAY																				
WATER COOLED CHILLER	POINT DESCRIPTION																				
CHILLER (3)	CW PUMP (3)																				
CNW SUPPLY (3)	CNW RETURN (1)																				
COOLING TOWER FAN (2)	CNW SUPPLY (1)																				
CHILLER SAFETY ALARMS (3)	POWER (3)																				
PLANT	CW SUPPLY																				
CW RETURN																					

C - LAST COMMAND
H - HIGH VALUE
L - LOW VALUE
O - ON (OPEN)
F - OFF (CLOSED)
N - LOCAL LOOP

I/O SUMMARY TABLE

Date Prepared
18--Sep--91

[illegible]

C – LAST COMMAND
H – HIGH VALUE
L – LOW VALUE
O – ON (OPEN)
F – OFF (CLOSED)
N – LOCAL LOOP

Date Prepared
18-Sep-91

C – LAST COMMAND
H – HIGH VALUE
L – LOW VALUE
O – ON (OPEN)
F – OFF (CLOSED)
N – LOCAL LOOP

Date Prepared
18-Sep-91

C — LAST COMMAND
H — HIGH VALUE
L — LOW VALUE
O — ON (OPEN)
F — OFF (CLOSED)
N — LOCAL LOOP

APPENDIX I.2
PC-CUBE BASERUN

CENTRAL PLANT 730

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	1
DIFFERENT TYPE BOILERS OR HEATERS	3
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	3	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	7968000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	280.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.08			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	100.	0.	0.	0.
20	141.	0.	0.	0.
30	188.	0.	0.	0.
40	241.	0.	0.	0.
50	295.	0.	0.	0.
60	348.	0.	0.	0.
70	401.	0.	0.	0.
80	459.	0.	0.	0.
90	524.	0.	0.	0.
100	589.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	6160000.
ELECTRIC ACCESSORIES, KW	87.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1879860.
20	1831410.
30	2800410.
40	3798480.
50	4835310.
60	5804310.
70	6705480.
80	7655100.
90	8624100.
100	9690000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	6160000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1831410.
20	1967070.
30	2945760.
40	3934140.
50	4922520.
60	5891520.
70	6734550.
80	7664790.
90	8595030.
100	9690000.

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

BOILER/HEATER IDENT. NO.	3
MAXIMUM OUTPUT, BTU/HR	6180000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1841100.
20	1976760.
30	2955450.
40	3924450.
50	4883760.
60	5852760.
70	6792690.
80	7752000.
90	8701620.
100	9690000.

PC-CUBE

CENTAL PALNT 730 BASELINE-1

MONTH	DAY TYPE		
	1	2	3

JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR							
	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	15158.0	6758.0	.0	.0	.0	.0	.0	.0
FEB	15158.0	4865.0	.0	.0	.0	.0	.0	.0
MAR	15158.0	3506.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	3119.0	400.0	.0	.0	.0	.0
JUN	.0	.0	11526.0	962.0	.0	.0	.0	.0
JUL	.0	.0	11526.0	1193.0	.0	.0	.0	.0
AUG	.0	.0	11526.0	1169.0	.0	.0	.0	.0
SEP	.0	.0	11526.0	721.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	8563.0	2981.0	.0	.0	.0	.0	.0	.0
DEC	15158.0	5644.0	.0	.0	.0	.0	.0	.0
TOTAL		23754.0		4445.0		.0		.0

PC-CUBE

CENTAL PALNT 730 BASELINE-1

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
4	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
5	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
6	.900	.000	.000	.900	.000	.000	.000	.000	.000	.000	.000	.000
7	.900	.000	.000	.900	.000	.000	.000	.000	.000	.000	.000	.000
8	.800	.000	.000	.800	.000	.000	.000	.000	.000	.000	.000	.000
9	.700	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
10	.600	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
11	.500	.000	.000	.500	.000	.000	.000	.000	.000	.000	.000	.000
12	.400	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
13	.300	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
14	.300	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
15	.300	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
16	.300	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
17	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
18	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
19	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
20	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
21	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
22	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
23	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
24	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	6	6	0	0
END HOUR	16	16	0	0
NO DAY TYPES	1	1	0	0
ADJUST LIMIT	.20	.20	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	25888.
PEAK DAY GAS CONSUMP., 1000 CU FT	290.
ELECTRICAL CONSUMPTION, KWH	1030266.
PEAK KW DEMAND (15 MIN BASIS)	732.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	1030266.
ON-PEAK KW DEMAND (15 MIN BASIS)	732.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
BOILER OPERATING HOURS	
BOILER 1	1619
BOILER 2	1177
BOILER 3	946
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 11

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	396
JUN	337
JUL	396
AUG	372
SEP	372
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	NORMAL	HEATING	AND COOLING	SEASONS								
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL	
1	663	148	142	166	213	275	153	113	0	0	1873	
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL	
1	0	403	39	0	0	0	0	0	0	1177	1619	
2	0	0	55	168	8	0	0	0	0	946	1177	
3	0	4	216	111	602	13	0	0	0	0	946	

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

		GAS		***** PURCHASED ELECTRICAL *****		*****		AUX			
		DEMAND	CONSUMP	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	FUEL	FUEL
		MCF	MCF	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	CONSUMP	HRS
				KW	THOU KWH	KW	THOU KWH	KW	THOU KWH		
C1	1	287.	6092.	87.	31.	0.	0.	0.	0.	0.	0.
C1	2	290.	5282.	87.	26.	0.	0.	0.	0.	0.	0.
C1	3	287.	5533.	87.	28.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	432.	153.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	688.	171.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	720.	205.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	732.	196.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	560.	165.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	173.	3152.	87.	25.	0.	0.	0.	0.	0.	0.
C1	12	287.	5828.	87.	30.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	15157.	3835.	87.	31.	0.	0.	0.	0.
C1	2	0.	0.	15157.	3334.	87.	26.	0.	0.	0.	0.
C1	3	0.	0.	15157.	3483.	87.	28.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	172.	33333.	0.	0.	432.	153.	0.	0.	0.	0.
C1	6	480.	80167.	0.	0.	688.	171.	0.	0.	0.	0.
C1	7	515.	99416.	0.	0.	720.	205.	0.	0.	0.	0.
C1	8	528.	97414.	0.	0.	732.	196.	0.	0.	0.	0.
C1	9	328.	60082.	0.	0.	560.	165.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	8562.	1978.	87.	25.	0.	0.	0.	0.
C1	12	0.	0.	15157.	3668.	87.	30.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

SYSTEM C1 OFF SEASON COOLONG, DOMESTIC HW, AND DISTR. LOSS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	1
DIFFERENT TYPE BOILERS OR HEATERS	1
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM	GENERATOR	CHILLER	PERCENTAGE	DIRECT FIRED		AF	PROC	STEAM		
ID	OPERATION	OPERATION	PROCESS HEAT	PROCESS HEAT		KEY	KEY	TURB	KEY	AUX FUEL
DESCRIPTION	SCHEDULE	SCHEDULE	DIRECT FIRED	EFFICIENCY						

C1	0	1	0.	100.		0	0	0		
1.										

CHILLER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

GENERATOR SYSTEM TYPE												
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3725000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	54.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.16			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	41.	0.	0.	0.
20	59.	0.	0.	0.
30	78.	0.	0.	0.
40	100.	0.	0.	0.
50	122.	0.	0.	0.
60	144.	0.	0.	0.
70	166.	0.	0.	0.
80	190.	0.	0.	0.
90	217.	0.	0.	0.
100	244.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	2110000.
ELECTRIC ACCESSORIES, KW	43.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	627480.
20	680600.
30	1019240.
40	1354560.
50	1686560.
60	2018560.
70	2347240.
80	2672600.
90	2997960.
100	3320000.

PC-CUBE

CENTRAL PLANT 730 BASELINE-2

NUMBER OF EACH DAY TYPE PER MONTH

MONTH	DAY TYPE		
	1	2	3
JAN	0	0	31
FEB	0	0	28
MAR	0	0	31
APR	22	8	0
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	23	8	0
NOV	0	0	30
DEC	0	0	31

INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR

MONTH	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK	LOAD	PEAK	LOAD	DEMAND	LOAD	PEAK	LOAD
	THOUSAND BTU/HR	MILLION BTU	THOUSAND BTU/HR	MILLION BTU	KILOWATT	THOUSAND KWH	THOUSAND BTU/HR	MILLION BTU
JAN	.0	.0	.0	.0	.0	.0	.0	.0
FEB	.0	.0	.0	.0	.0	.0	.0	.0
MAR	.0	.0	.0	.0	.0	.0	.0	.0
APR	566.0	151.0	992.0	18.0	.0	.0	.0	.0
MAY	566.0	156.0	.0	.0	.0	.0	.0	.0
JUN	566.0	151.0	.0	.0	.0	.0	.0	.0
JUL	566.0	156.0	.0	.0	.0	.0	.0	.0
AUG	566.0	156.0	.0	.0	.0	.0	.0	.0
SEP	566.0	151.0	.0	.0	.0	.0	.0	.0
OCT	566.0	156.0	2244.0	22.0	.0	.0	.0	.0
NOV	.0	.0	.0	.0	.0	.0	.0	.0
DEC	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL		1077.0		40.0		.0		.0

INPUT LOAD PROFILES

PROFILE ADJUSTMENT		START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION	
HEATING		COOLING	ELECTRIC PROCESS
START HOUR	6	6	0
END HOUR	16	16	0
NO DAY TYPES	1	1	0
ADJUST LIMIT	.30	.20	.00

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

** TOTAL **

SYSTEM C1 OFF SEASON COOLONG, DOMESTIC HW, AND DISTR. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	1581.
PEAK DAY GAS CONSUMP., 1000 CU FT	12.
ELECTRICAL CONSUMPTION, KWH	145159.
PEAK KW DEMAND (15 MIN BASIS)	130.
PURCHASED ELECTRIC POWER	145159.
ON-PEAK CONSUMPTION KWH	130.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	768
BOILER OPERATING HOURS	
BOILER 1	1810
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 9

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	372
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	396
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	OFF SEASON COOLONG,	DOMESTIC HW,	AND DISTR. LOSS							
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	768	0	0	0	0	0	0	0	0	0
768										
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	105	1635	70	0	0	0	0	0	0
1810										

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

		GAS		PURCHASED ELECTRICAL		OFF-PK		OFF-PK		AUX	
		DEMAND	CONSUMP	ON-PK	ON-PK	MID-PK	MID-PK	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	CONSUMP	HRS
				KW	THOU KWH	KW	THOU KWH	KW	THOU KWH		
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	12.	224.	130.	43.	0.	0.	0.	0.	0.	0.
C1	5	12.	235.	43.	12.	0.	0.	0.	0.	0.	0.
C1	6	12.	205.	43.	10.	0.	0.	0.	0.	0.	0.
C1	7	12.	235.	43.	12.	0.	0.	0.	0.	0.	0.
C1	8	12.	224.	43.	11.	0.	0.	0.	0.	0.	0.
C1	9	12.	224.	43.	11.	0.	0.	0.	0.	0.	0.
C1	10	12.	235.	130.	46.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVEL HEAT USED MMBTU	RECOVEL HEAT UNUSED MMBTU
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	10.	1500.	566.	137.	130.	43.	0.	0.	0.	0.
C1	5	0.	0.	566.	143.	43.	12.	0.	0.	0.	0.
C1	6	0.	0.	566.	125.	43.	10.	0.	0.	0.	0.
C1	7	0.	0.	566.	143.	43.	12.	0.	0.	0.	0.
C1	8	0.	0.	566.	137.	43.	11.	0.	0.	0.	0.
C1	9	0.	0.	566.	137.	43.	11.	0.	0.	0.	0.
C1	10	11.	1833.	566.	143.	130.	46.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

CENTRAL PLANT 5900

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	5
DIFFERENT TYPE BOILERS OR HEATERS	5
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL
DESCRIPTION								

C1	0	1	0.	100.	0	0	0	
1.								

CHILLER IDENTIFICATION NUMBERS

C1	1	2	3	4	5	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	3	3	4	5	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.25			
MAXIMUM OUTPUT, BTU/HR	4440000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	76.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.25			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	54.	0.	0.	0.
20	75.	0.	0.	0.
30	95.	0.	0.	0.
40	119.	0.	0.	0.
50	142.	0.	0.	0.
60	170.	0.	0.	0.
70	203.	0.	0.	0.
80	278.	0.	0.	0.
90	288.	0.	0.	0.
100	339.	0.	0.	0.

CHILLER IDENTIFICATION NO.	2			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4032000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	76.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.19			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	51.	0.	0.	0.
20	70.	0.	0.	0.
30	88.	0.	0.	0.
40	111.	0.	0.	0.
50	133.	0.	0.	0.
60	158.	0.	0.	0.
70	190.	0.	0.	0.
80	259.	0.	0.	0.
90	269.	0.	0.	0.
100	316.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

CHILLER IDENTIFICATION NO.	3			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3552000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	80.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.18			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	40.	0.	0.	0.
20	55.	0.	0.	0.
30	70.	0.	0.	0.
40	88.	0.	0.	0.
50	105.	0.	0.	0.
60	126.	0.	0.	0.
70	151.	0.	0.	0.
80	206.	0.	0.	0.
90	213.	0.	0.	0.
100	251.	0.	0.	0.

CHILLER IDENTIFICATION NO.	4			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4752000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	101.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.20			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	59.	0.	0.	0.
20	82.	0.	0.	0.
30	104.	0.	0.	0.
40	130.	0.	0.	0.
50	156.	0.	0.	0.
60	186.	0.	0.	0.
70	223.	0.	0.	0.
80	304.	0.	0.	0.
90	315.	0.	0.	0.
100	371.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

CHILLER IDENTIFICATION NO.	5			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3504000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	83.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.21			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	40.	0.	0.	0.
20	55.	0.	0.	0.
30	70.	0.	0.	0.
40	87.	0.	0.	0.
50	105.	0.	0.	0.
60	125.	0.	0.	0.
70	149.	0.	0.	0.
80	204.	0.	0.	0.
90	212.	0.	0.	0.
100	249.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

BOILER/HEATER IDENT. NO. 1
MAXIMUM OUTPUT, BTU/HR 6940000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2062500.
20	2512500.
30	3700000.
40	4875000.
50	6000000.
60	7262500.
70	8462500.
80	9750000.
90	11050000.
100	12500000.

BOILER/HEATER IDENT. NO. 2
MAXIMUM OUTPUT, BTU/HR 7170000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2137500.
20	2550000.
30	3737500.
40	4875000.
50	5962500.
60	7225000.
70	8512500.
80	9812500.
90	11150000.
100	12500000.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

BOILER/HEATER IDENT. NO.	3
MAXIMUM OUTPUT, BTU/HR	7610000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2268310.
20	2583690.
30	3796690.
40	4961170.
50	6077130.
60	7290130.
70	8430350.
80	9631220.
90	10819960.
100	12130000.

BOILER/HEATER IDENT. NO.	4
MAXIMUM OUTPUT, BTU/HR	6220000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1900000.
20	2180000.
30	3220000.
40	4240000.
50	5230000.
60	6220000.
70	7240000.
80	8200000.
90	8140000.
100	10000000.

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CENTRAL PLANT 5900 BASELINE

BOILER/HEATER IDENT. NO.	5
MAXIMUM OUTPUT, BTU/HR	8880000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2646000.
20	3052000.
30	4508000.
40	5936000.
50	7140000.
60	8526000.
70	9870000.
80	11242000.
90	12600000.
100	14000000.

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CENTRAL PLANT 5900 BASELINE

NUMBER OF EACH DAY TYPE PER MONTH

MONTH	DAY TYPE		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR

MONTH	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK	LOAD	PEAK	LOAD	DEMAND	LOAD	PEAK	LOAD
	THOUSAND BTU/HR	MILLION BTU	THOUSAND BTU/HR	MILLION BTU	KILOWATT	THOUSAND KWH	THOUSAND BTU/HR	MILLION BTU
JAN	57938.0	11818.0	.0	.0	.0	.0	.0	.0
FEB	57938.0	9046.0	.0	.0	.0	.0	.0	.0
MAR	57938.0	7725.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	5212.0	7368.0	.0	.0	.0	.0
JUN	.0	.0	18384.0	30305.0	.0	.0	.0	.0
JUL	.0	.0	18384.0	8487.0	.0	.0	.0	.0
AUG	.0	.0	18384.0	8494.0	.0	.0	.0	.0
SEP	.0	.0	18384.0	7888.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	21864.0	6339.0	.0	.0	.0	.0	.0	.0
DEC	57938.0	9820.0	.0	.0	.0	.0	.0	.0
TOTAL		44748.0		62542.0		.0		.0

PC-CUBE

CENTRAL PLANT 5900 BASELINE

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
2	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
3	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
4	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
5	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
6	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
7	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
8	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
9	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
10	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
11	.600	.700	.000	.300	.300	.000	.700	.700	.700	.700	.300	.300
12	.600	.700	.000	.300	.300	.000	.700	.700	.700	.700	.300	.300
13	.400	.500	.000	.500	.500	.000	.700	.700	.700	.700	.300	.300
14	.400	.500	.000	.600	.500	.000	.700	.700	.700	.700	.300	.300
15	.400	.500	.000	.700	.500	.000	.700	.700	.700	.700	.300	.300
16	.400	.500	.000	.600	.500	.000	.700	.700	.700	.700	.300	.300
17	.400	.500	.000	.600	.500	.000	.700	.700	.700	.700	.300	.300
18	.400	.700	.000	.500	.500	.000	.700	.700	.700	.500	.300	.300
19	.600	.700	.000	.500	.500	.000	.700	.700	.700	.500	.300	.300
20	.600	.700	.000	.500	.500	.000	.500	.500	.500	.500	.300	.300
21	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
22	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
23	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
24	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	24	24	24
NO DAY TYPES	2	2	3	1
ADJUST LIMIT	.30	.20	.30	.30

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

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CENTRAL PLANT 5900 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	79220.
PEAK DAY GAS CONSUMP., 1000 CU FT	833.
ELECTRICAL CONSUMPTION, KWH	4113574.
PEAK KW DEMAND (15 MIN BASIS)	1781.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	4113574.
ON-PEAK KW DEMAND (15 MIN BASIS)	1781.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
CHILLER 3	2512
CHILLER 4	1456
CHILLER 5	934
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3458
BOILER 3	1191
BOILER 4	0
BOILER 5	0
BOILER 6	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total additional annual energy use due to operating chiller 3, 4, and 5 more than necessary: 519,104 kWh/yr

Total electrical consumption: 4,632,678 kWh/yr

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

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SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

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SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

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CENTRAL PLANT 5900 BASELINE

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1 NORMAL HEATING AND COOLING LOADS										
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	0	0	0	0	0	0	0	0	3672
3672										
2	42	702	0	0	0	0	0	0	112	2816
3672										
3	240	208	192	240	144	32	0	0	0	1456
2512										
4	0	0	36	64	84	112	156	25	12	967
1456										
5	48	47	32	84	723	0	0	0	0	0
934										
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	0	0	0	0	0	0	30	60	3534
3624										
2	69	211	218	292	291	254	258	243	198	1424
3458										
3	327	174	207	112	202	74	38	0	38	19
1191										
4	0	0	0	0	0	0	0	0	0	0
0										
5	0	0	0	0	0	0	0	0	0	0
0										
6	0	0	0	0	0	0	0	0	0	0
0										

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CENTRAL PLANT 5900 BASELINE

		GAS		***** PURCHASED ELECTRICAL *****		*****		AUX		AUX	
		DEMAND	CONSUMP	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	FUEL	FUEL
		MCF	MCF	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	CONSUMP	HRS
				KW	THOU KWH	KW	THOU KWH	KW	THOU KWH		
C1	1	833.	20696.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	712.	16067.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	544.	13678.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	547.	406.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	1781.	1280.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	1781.	827.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	1781.	827.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	1781.	774.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	466.	11322.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	693.	17456.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	21302.	11818.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	17970.	9046.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	13558.	7725.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	434.	320682.	0.	0.	547.	406.	0.	0.	0.	0.
C1	6	1532.	1099390.	0.	0.	1781.	1280.	0.	0.	0.	0.
C1	7	1532.	702426.	0.	0.	1781.	827.	0.	0.	0.	0.
C1	8	1532.	703110.	0.	0.	1781.	827.	0.	0.	0.	0.
C1	9	1532.	654209.	0.	0.	1781.	774.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	11589.	6339.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	17455.	9820.	0.	0.	0.	0.	0.	0.

CENTRAL PLANT 6003

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	3
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM	GENERATOR	CHILLER	PERCENTAGE	DIRECT FIRED	AF	PROC	STEAM		
ID	OPERATION	OPERATION	PROCESS HEAT	PROCESS HEAT	KEY	KEY	TURB	KEY	AUX FUEL
DESCRIPTION	SCHEDULE	SCHEDULE	DIRECT FIRED	EFFICIENCY					

C1	0	3	0.	100.	0	0	0		
1.									

CHILLER IDENTIFICATION NUMBERS

C1	2	3	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

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CENTRAL PLANT 6003 BASELINE-1

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

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CENTRAL PLANT 6003 BASELINE-1

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	1000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	0.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.00			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	0.	0.	0.	0.
20	0.	0.	0.	0.
30	0.	0.	0.	0.
40	0.	0.	0.	0.
50	1.	0.	0.	0.
60	1.	0.	0.	0.
70	1.	0.	0.	0.
80	1.	0.	0.	0.
90	1.	0.	0.	0.
100	1.	0.	0.	0.

CHILLER IDENTIFICATION NO.	2			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	64.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	142.	0.	0.	0.
60	168.	0.	0.	0.
70	193.	0.	0.	0.
80	222.	0.	0.	0.
90	253.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

CHILLER IDENTIFICATION NO.	3			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	65.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	142.	0.	0.	0.
60	168.	0.	0.	0.
70	193.	0.	0.	0.
80	222.	0.	0.	0.
90	253.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	9410000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2798150.
20	3384150.
30	4849150.
40	6196950.
50	7442200.
60	8907200.
70	10357550.
80	11793250.
90	13228950.
100	14650000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	9120000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2710250.
20	3032550.
30	4497550.
40	5947900.
50	7383600.
60	8848600.
70	10284300.
80	11734650.
90	13185000.
100	14650000.

PC-CUBE

CENTRAL PLANT 6003 BASELINE-1

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR						PROCESS	
	HEATING		COOLING		ELECTRIC		PEAK THOUSAND BTU/HR	LOAD MILLION BTU
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH		
JAN	23809.0	4711.0	.0	.0	.0	.0	.0	.0
FEB	23809.0	3064.0	.0	.0	.0	.0	.0	.0
MAR	23809.0	3064.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	3233.0	6182.0	.0	.0	.0	.0
JUN	.0	.0	8525.0	6504.0	.0	.0	.0	.0
JUL	.0	.0	8525.0	6625.0	.0	.0	.0	.0
AUG	.0	.0	8525.0	6626.0	.0	.0	.0	.0
SEP	.0	.0	8525.0	6387.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	9454.0	2527.0	.0	.0	.0	.0	.0	.0
DEC	23809.0	3064.0	.0	.0	.0	.0	.0	.0
TOTAL		16430.0		32324.0		.0		.0

PC-CUBE

CENTRAL PLANT 6003 BASELINE-1

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
2	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
3	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
4	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
5	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
6	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
7	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
8	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
9	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
10	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
11	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
12	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
13	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
14	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
15	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
16	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
17	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
18	.500	.700	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
19	.700	.700	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
20	.700	.700	.000	.400	.400	.000	.500	.500	.500	.000	.000	.000
21	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
22	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
23	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
24	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	24	24	0
NO DAY TYPES	2	2	3	0
ADJUST LIMIT	.30	.00	.30	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	26405.
PEAK DAY GAS CONSUMP., 1000 CU FT	270.
ELECTRICAL CONSUMPTION, KWH	1862266.
PEAK KW DEMAND (15 MIN BASIS)	563.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	1862266.
ON-PEAK KW DEMAND (15 MIN BASIS)	563.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 11

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1		NORMAL HEATING AND COOLING LOADS									
CHR		0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL											
1		0	0	0	744	0	0	0	2928	0	0
3672											
2		0	0	0	744	0	0	0	2928	0	0
3672											
BLR		0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL											
1		0	0	155	771	1403	718	230	310	37	0
3624											
2		0	0	0	0	0	0	0	0	0	0
0											

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

		***** PURCHASED ELECTRICAL *****									
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	270.	7413.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	201.	4899.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	181.	4952.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	287.	213.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	563.	405.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	563.	419.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	563.	419.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	563.	405.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	157.	4189.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	180.	4952.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	7632.	4711.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	5637.	3064.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	5049.	3064.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	269.	200426.	0.	0.	287.	213.	0.	0.	0.	0.
C1	6	710.	511449.	0.	0.	563.	405.	0.	0.	0.	0.
C1	7	710.	528498.	0.	0.	563.	419.	0.	0.	0.	0.
C1	8	710.	528498.	0.	0.	563.	419.	0.	0.	0.	0.
C1	9	710.	511449.	0.	0.	563.	405.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	4288.	2527.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	5009.	3064.	0.	0.	0.	0.	0.	0.

I.2.63

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.25			
MAXIMUM OUTPUT, BTU/HR	1000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	0.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.00			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	0.	0.	0.	0.
20	0.	0.	0.	0.
30	0.	0.	0.	0.
40	0.	0.	0.	0.
50	1.	0.	0.	0.
60	1.	0.	0.	0.
70	1.	0.	0.	0.
80	1.	0.	0.	0.
90	1.	0.	0.	0.
100	1.	0.	0.	0.

CHILLER IDENTIFICATION NO.	2			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	64.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	142.	0.	0.	0.
60	168.	0.	0.	0.
70	193.	0.	0.	0.
80	222.	0.	0.	0.
90	253.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

CHILLER IDENTIFICATION NO.	3			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	65.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	142.	0.	0.	0.
60	168.	0.	0.	0.
70	193.	0.	0.	0.
80	222.	0.	0.	0.
90	253.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	9370000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2783500.
20	3208350.
30	4688000.
40	6079750.
50	7383600.
60	8848600.
70	10313600.
80	11763950.
90	13199650.
100	14650000.

PC-CUBE

CENTRAL PLANT 6003 BASELINE-2

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	1	2	3
JAN	0	0	31
FEB	0	0	28
MAR	0	0	31
APR	22	8	0
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	23	8	0
NOV	0	0	30
DEC	0	0	31

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR							
	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	.0	.0	.0	.0	.0	.0	.0	.0
FEB	.0	.0	.0	.0	.0	.0	.0	.0
MAR	.0	.0	.0	.0	.0	.0	.0	.0
APR	6617.4	1219.0	.0	.0	.0	.0	.0	.0
MAY	6617.4	1180.0	.0	.0	.0	.0	.0	.0
JUN	6617.4	1219.0	.0	.0	.0	.0	.0	.0
JUL	6617.4	1219.0	.0	.0	.0	.0	.0	.0
AUG	6617.4	1180.0	.0	.0	.0	.0	.0	.0
SEP	6617.4	1180.0	.0	.0	.0	.0	.0	.0
OCT	6617.4	1219.0	.0	.0	.0	.0	.0	.0
NOV	.0	.0	.0	.0	.0	.0	.0	.0
DEC	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL		8416.0		.0		.0		.0

PC-CUBE

CENTRAL PLANT 6003 BASELINE-2

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
6	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
15	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
16	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
17	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
20	.700	.700	.000	.700	.700	.000	.500	.500	.500	.000	.000	.000
21	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS

START HOUR	0	0	0	0
END HOUR	24	24	24	0
NO DAY TYPES	2	2	3	0
ADJUST LIMIT	.30	.30	.30	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0	0	0	0	0	0	0	0	0	0	0	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

** TOTAL **

SYSTEM C1 SUMMER HW LOAD ONLY

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	15997.
PEAK DAY GAS CONSUMP., 1000 CU FT	82.
ELECTRICAL CONSUMPTION, KWH	0.
PEAK KW DEMAND (15 MIN BASIS)	0.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	0.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	0
BOILER OPERATING HOURS	
BOILER 1	5136
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	SUMMER HW LOAD ONLY										
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	0	0	0	0	0	0	0	0	0	0
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	4092	1044	0	0	0	0	0	0	0	5136

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

		GAS		***** PURCHASED ELECTRICAL *****		***** PURCHASED ELECTRICAL *****				AUX	
		DEMAND	CONSUMP	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	FUEL	FUEL
		MCF	MCF	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	CONSUMP	HRS
				KW	THOU KWH	KW	THOU KWH	KW	THOU KWH		
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	81.	2273.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	77.	2291.	0.	0.	0.	0.	0.	0.	0.	0.
C1	6	82.	2271.	0.	0.	0.	0.	0.	0.	0.	0.
C1	7	79.	2315.	0.	0.	0.	0.	0.	0.	0.	0.
C1	8	77.	2291.	0.	0.	0.	0.	0.	0.	0.	0.
C1	9	79.	2241.	0.	0.	0.	0.	0.	0.	0.	0.
C1	10	79.	2315.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

		COOLING	COOLING	HEAT	HEAT	ELECT	ELECT	GEN	SOLD	RECOVBL	RECOVBL
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	ELECT	ELECT	HEAT	HEAT
		TONS	TON-HRS	MBH	MMBTU	KW	THOU KWH	THOU KWH	THOU KWH	MMBTU	MMBTU
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	2057.	1219.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	1912.	1180.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	2089.	1219.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	1975.	1219.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	1927.	1180.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	1992.	1180.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	1975.	1219.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

APPENDIX I.3
PC-CUBE ECO RUN

CENTRAL PLANT 730

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	2
DIFFERENT TYPE BOILERS OR HEATERS	3
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	4	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	2	1	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	3	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

CHILLER IDENTIFICATION NO. 1
 CHILLER TYPE 4 ** ELECTRIC MOTOR **
 PERCENT OF MAX OUTPUT TO START .00
 MAXIMUM OUTPUT, BTU/HR 7968000.
 PILOT FUEL IN, BTU/HR 0.
 ELECTRIC ACCESSORIES, KW 151.
 STEAM ACCESSORIES BTU/HR 0.
 PERCENT ACCESSORY LOAD TO VARY .15

LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	100.	0.	0.	0.
20	141.	0.	0.	0.
30	188.	0.	0.	0.
40	241.	0.	0.	0.
50	295.	0.	0.	0.
60	348.	0.	0.	0.
70	401.	0.	0.	0.
80	459.	0.	0.	0.
90	524.	0.	0.	0.
100	589.	0.	0.	0.

CHILLER IDENTIFICATION NO. 2
 CHILLER TYPE 4 ** ELECTRIC MOTOR **
 PERCENT OF MAX OUTPUT TO START .00
 MAXIMUM OUTPUT, BTU/HR 3725000.
 PILOT FUEL IN, BTU/HR 0.
 ELECTRIC ACCESSORIES, KW 141.
 STEAM ACCESSORIES BTU/HR 0.
 PERCENT ACCESSORY LOAD TO VARY .16

LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	41.	0.	0.	0.
20	59.	0.	0.	0.
30	78.	0.	0.	0.
40	100.	0.	0.	0.
50	122.	0.	0.	0.
60	144.	0.	0.	0.
70	166.	0.	0.	0.
80	190.	0.	0.	0.
90	217.	0.	0.	0.
100	244.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

BOILER/HEATER IDENT. NO. 1
MAXIMUM OUTPUT, BTU/HR 6160000.
ELECTRIC ACCESSORIES, KW 87.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1879860.
20	1831410.
30	2800410.
40	3798480.
50	4835310.
60	5804310.
70	6705480.
80	7655100.
90	8624100.
100	9690000.

BOILER/HEATER IDENT. NO. 2
MAXIMUM OUTPUT, BTU/HR 6160000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1831410.
20	1967070.
30	2945760.
40	3934140.
50	4922520.
60	5891520.
70	6734550.
80	7664790.
90	8595030.
100	9690000.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

BOILER/HEATER IDENT. NO.	3
MAXIMUM OUTPUT, BTU/HR	6180000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1841100.
20	1976760.
30	2955450.
40	3924450.
50	4883760.
60	5852760.
70	6792690.
80	7752000.
90	8701620.
100	9690000.

PC-CUBE

CENTRAL PLANT 730 CHILLER CONTROL ECO

NUMBER OF EACH DAY TYPE PER MONTH

MONTH	DAY TYPE		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR

MONTH	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK	LOAD	PEAK	LOAD	DEMAND	LOAD	PEAK	LOAD
	THOUSAND BTU/HR	MILLION BTU	THOUSAND BTU/HR	MILLION BTU	KILOWATT	THOUSAND KWH	THOUSAND BTU/HR	MILLION BTU
JAN	15158.0	6758.0	.0	.0	.0	.0	.0	.0
FEB	15158.0	4865.0	.0	.0	.0	.0	.0	.0
MAR	15158.0	3506.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	3119.0	400.0	.0	.0	.0	.0
JUN	.0	.0	11526.0	962.0	.0	.0	.0	.0
JUL	.0	.0	11526.0	1193.0	.0	.0	.0	.0
AUG	.0	.0	11526.0	1169.0	.0	.0	.0	.0
SEP	.0	.0	11526.0	721.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	8563.0	2981.0	.0	.0	.0	.0	.0	.0
DEC	15158.0	5644.0	.0	.0	.0	.0	.0	.0
TOTAL		23754.0		4445.0		.0		.0

PC-CUBE

CENTRAL PLANT 730 CHILLER CONTROL ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
4	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
5	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
6	.900	.000	.000	.900	.000	.000	.000	.000	.000	.000	.000	.000
7	.900	.000	.000	.900	.000	.000	.000	.000	.000	.000	.000	.000
8	.800	.000	.000	.800	.000	.000	.000	.000	.000	.000	.000	.000
9	.700	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
10	.600	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
11	.500	.000	.000	.500	.000	.000	.000	.000	.000	.000	.000	.000
12	.400	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
13	.300	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
14	.300	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
15	.300	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
16	.300	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
17	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
18	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
19	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
20	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
21	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
22	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
23	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
24	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION			
	HEATING	COOLING	ELECTRIC
START HOUR	6	6	0
END HOUR	16	16	0
NO DAY TYPES	1	1	0
ADJUST LIMIT	.20	.20	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH	0	0	0	0	0	0	0	0	0	0	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	25888.
PEAK DAY GAS CONSUMP., 1000 CU FT	290.
ELECTRICAL CONSUMPTION, KWH	721433.
PEAK KW DEMAND (15 MIN BASIS)	603.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	721433.
ON-PEAK KW DEMAND (15 MIN BASIS)	603.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1227
CHILLER 2	646
BOILER OPERATING HOURS	
BOILER 1	1619
BOILER 2	1177
BOILER 3	946
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	396
JUN	337
JUL	396
AUG	372
SEP	372
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	NORMAL HEATING AND COOLING SEASONS										
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	663	0	11	101	97	65	46	74	82	88	1227
2	0	0	0	0	105	275	153	113	0	0	646
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	403	39	0	0	0	0	0	0	1177	1619
2	0	0	55	168	8	0	0	0	0	946	1177
3	0	4	216	111	602	13	0	0	0	0	946

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

		***** PURCHASED ELECTRICAL *****									
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	287.	6092.	87.	31.	0.	0.	0.	0.	0.	0.
C1	2	290.	5282.	87.	26.	0.	0.	0.	0.	0.	0.
C1	3	287.	5533.	87.	28.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	265.	82.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	559.	118.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	591.	143.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	603.	138.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	431.	101.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	173.	3152.	87.	25.	0.	0.	0.	0.	0.	0.
C1	12	287.	5828.	87.	30.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER CONTROL ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	15157.	3835.	87.	31.	0.	0.	0.	0.
C1	2	0.	0.	15157.	3334.	87.	26.	0.	0.	0.	0.
C1	3	0.	0.	15157.	3483.	87.	28.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	172.	33333.	0.	0.	265.	82.	0.	0.	0.	0.
C1	6	480.	80167.	0.	0.	559.	118.	0.	0.	0.	0.
C1	7	515.	99416.	0.	0.	591.	143.	0.	0.	0.	0.
C1	8	528.	97414.	0.	0.	603.	138.	0.	0.	0.	0.
C1	9	328.	60082.	0.	0.	431.	101.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	8562.	1978.	87.	25.	0.	0.	0.	0.
C1	12	0.	0.	15157.	3668.	87.	30.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	1
DIFFERENT TYPE BOILERS OR HEATERS	3
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	3	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	7968000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	280.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.08			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	100.	0.	0.	0.
20	141.	0.	0.	0.
30	188.	0.	0.	0.
40	241.	0.	0.	0.
50	295.	0.	0.	0.
60	348.	0.	0.	0.
70	401.	0.	0.	0.
80	459.	0.	0.	0.
90	524.	0.	0.	0.
100	589.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

BOILER/HEATER IDENT. NO. 1
MAXIMUM OUTPUT, BTU/HR 6170000.
ELECTRIC ACCESSORIES, KW 87.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1879860.
20	1831410.
30	2800410.
40	3798480.
50	4835310.
60	5804310.
70	6705480.
80	7655100.
90	8624100.
100	9690000.

BOILER/HEATER IDENT. NO. 2
MAXIMUM OUTPUT, BTU/HR 6170000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1831410.
20	1967070.
30	2945760.
40	3934140.
50	4922520.
60	5891520.
70	6734550.
80	7664790.
90	8595030.
100	9690000.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

BOILER/HEATER IDENT. NO.	3
MAXIMUM OUTPUT, BTU/HR	6190000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1841100.
20	1976760.
30	2955450.
40	3924450.
50	4883760.
60	5852760.
70	6792690.
80	7752000.
90	8701620.
100	9690000.

PC-CUBE

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR						PROCESS	
	HEATING		COOLING		ELECTRIC		PEAK THOUSAND BTU/HR	LOAD MILLION BTU
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH		
JAN	15158.0	6758.0	.0	.0	.0	.0	.0	.0
FEB	15158.0	4865.0	.0	.0	.0	.0	.0	.0
MAR	15158.0	3506.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	3119.0	400.0	.0	.0	.0	.0
JUN	.0	.0	11526.0	692.0	.0	.0	.0	.0
JUL	.0	.0	11526.0	1193.0	.0	.0	.0	.0
AUG	.0	.0	11526.0	1169.0	.0	.0	.0	.0
SEP	.0	.0	11526.0	721.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	8563.0	2981.0	.0	.0	.0	.0	.0	.0
DEC	15158.0	5644.0	.0	.0	.0	.0	.0	.0
TOTAL		23754.0		4175.0		.0		.0

PC-CUBE

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
4	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
5	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
6	.900	.000	.000	.900	.000	.000	.000	.000	.000	.000	.000	.000
7	.900	.000	.000	.900	.000	.000	.000	.000	.000	.000	.000	.000
8	.800	.000	.000	.800	.000	.000	.000	.000	.000	.000	.000	.000
9	.700	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
10	.600	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
11	.500	.000	.000	.500	.000	.000	.000	.000	.000	.000	.000	.000
12	.400	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
13	.300	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
14	.300	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
15	.300	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
16	.300	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
17	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
18	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
19	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
20	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
21	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
22	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
23	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
24	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	6	6	0	0
END HOUR	16	16	0	0
NO DAY TYPES	1	1	0	0
ADJUST LIMIT	.20	.20	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	25847.
PEAK DAY GAS CONSUMP., 1000 CU FT	290.
ELECTRICAL CONSUMPTION, KWH	1011890.
PEAK KW DEMAND (15 MIN BASIS)	732.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	1011890.
ON-PEAK KW DEMAND (15 MIN BASIS)	732.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
BOILER OPERATING HOURS	
BOILER 1	1619
BOILER 2	1177
BOILER 3	946
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 11

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	396
JUN	337
JUL	396
AUG	372
SEP	372
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	NORMAL HEATING AND COOLING SEASONS											
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL	
1	663	148	161	262	212	216	120	91	0	0	1873	
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL	
1	0	403	39	0	0	0	0	0	0	1177	1619	
2	0	0	55	168	8	0	0	0	0	946	1177	
3	0	4	216	129	584	13	0	0	0	0	946	

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

		***** PURCHASED ELECTRICAL *****									
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	287.	6083.	87.	31.	0.	0.	0.	0.	0.	0.
C1	2	290.	5274.	87.	26.	0.	0.	0.	0.	0.	0.
C1	3	287.	5525.	87.	28.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	432.	153.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	576.	152.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	720.	205.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	732.	196.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	560.	165.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	173.	3147.	87.	25.	0.	0.	0.	0.	0.	0.
C1	12	287.	5819.	87.	30.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-1 ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	15157.	3835.	87.	31.	0.	0.	0.	0.
C1	2	0.	0.	15157.	3334.	87.	26.	0.	0.	0.	0.
C1	3	0.	0.	15157.	3483.	87.	28.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	172.	33333.	0.	0.	432.	153.	0.	0.	0.	0.
C1	6	347.	57667.	0.	0.	576.	152.	0.	0.	0.	0.
C1	7	515.	99416.	0.	0.	720.	205.	0.	0.	0.	0.
C1	8	528.	97414.	0.	0.	732.	196.	0.	0.	0.	0.
C1	9	328.	60082.	0.	0.	560.	165.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	8562.	1978.	87.	25.	0.	0.	0.	0.
C1	12	0.	0.	15157.	3668.	87.	30.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

SYSTEM C1 OFF SEASON COOLONG, DOMESTIC HW, AND DISTR. LOSS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	1
DIFFERENT TYPE BOILERS OR HEATERS	1
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM	GENERATOR	CHILLER	PERCENTAGE	DIRECT FIRED		AF	PROC	STEAM		
ID	OPERATION	OPERATION	PROCESS HEAT	PROCESS HEAT		KEY	KEY	TURB	KEY	AUX FUEL
DESCRIPTION	SCHEDULE	SCHEDULE	DIRECT FIRED	EFFICIENCY						

C1	0	1	0.	100.		0	0	0		
1.										

CHILLER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3725000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	54.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.16			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	41.	0.	0.	0.
20	59.	0.	0.	0.
30	78.	0.	0.	0.
40	100.	0.	0.	0.
50	122.	0.	0.	0.
60	144.	0.	0.	0.
70	166.	0.	0.	0.
80	190.	0.	0.	0.
90	217.	0.	0.	0.
100	244.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	2120000.
ELECTRIC ACCESSORIES, KW	43.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	627480.
20	680600.
30	1019240.
40	1354560.
50	1686560.
60	2018560.
70	2347240.
80	2672600.
90	2997960.
100	3320000.

PC-CUBE

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

MONTH	DAY TYPE			NUMBER OF EACH DAY TYPE PER MONTH
	1	2	3	
JAN	0	0	31	
FEB	0	0	28	
MAR	0	0	31	
APR	22	8	0	
MAY	23	8	0	
JUN	20	10	0	
JUL	23	8	0	
AUG	22	9	0	
SEP	22	8	0	
OCT	23	8	0	
NOV	0	0	30	
DEC	0	0	31	

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR							
	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	.0	.0	.0	.0	.0	.0	.0	.0
FEB	.0	.0	.0	.0	.0	.0	.0	.0
MAR	.0	.0	.0	.0	.0	.0	.0	.0
APR	566.0	151.0	992.0	18.0	.0	.0	.0	.0
MAY	566.0	156.0	.0	.0	.0	.0	.0	.0
JUN	566.0	151.0	.0	.0	.0	.0	.0	.0
JUL	566.0	156.0	.0	.0	.0	.0	.0	.0
AUG	566.0	156.0	.0	.0	.0	.0	.0	.0
SEP	566.0	151.0	.0	.0	.0	.0	.0	.0
OCT	566.0	156.0	2244.0	22.0	.0	.0	.0	.0
NOV	.0	.0	.0	.0	.0	.0	.0	.0
DEC	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL		1077.0		40.0		.0		.0

PC-CUBE

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
4	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
5	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
6	.100	.000	.000	.800	.000	.000	.000	.000	.000	.000	.000	.000
7	.100	.000	.000	.800	.000	.000	.000	.000	.000	.000	.000	.000
8	.500	.000	.000	.700	.000	.000	.000	.000	.000	.000	.000	.000
9	.500	.000	.000	.600	.000	.000	.000	.000	.000	.000	.000	.000
10	.500	.000	.000	.500	.000	.000	.000	.000	.000	.000	.000	.000
11	.600	.000	.000	.400	.000	.000	.000	.000	.000	.000	.000	.000
12	.800	.000	.000	.300	.000	.000	.000	.000	.000	.000	.000	.000
13	.800	.000	.000	.400	.000	.000	.000	.000	.000	.000	.000	.000
14	.600	.000	.000	.400	.000	.000	.000	.000	.000	.000	.000	.000
15	.700	.000	.000	.400	.000	.000	.000	.000	.000	.000	.000	.000
16	.400	.000	.000	.400	.000	.000	.000	.000	.000	.000	.000	.000
17	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
18	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
19	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
20	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
21	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
22	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
23	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
24	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION			
	HEATING	COOLING	ELECTRIC
START HOUR	6	6	0
END HOUR	16	16	0
NO DAY TYPES	1	1	0
ADJUST LIMIT	.30	.20	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

** TOTAL **

SYSTEM C1 OFF SEASON COOLONG, DOMESTIC HW, AND DISTR. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	1573.
PEAK DAY GAS CONSUMP., 1000 CU FT	12.
ELECTRICAL CONSUMPTION, KWH	145029.
PEAK KW DEMAND (15 MIN BASIS)	130.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	145029.
ON-PEAK KW DEMAND (15 MIN BASIS)	130.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	768
BOILER OPERATING HOURS	
BOILER 1	1807
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 9

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	372
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	396
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	OFF SEASON COOLONG, DOMESTIC HW, AND DISTR. LOSS									
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	768	0	0	0	0	0	0	0	0	0
768										
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	102	1632	73	0	0	0	0	0	0
1807										

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

		***** PURCHASED ELECTRICAL *****									
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	12.	223.	130.	43.	0.	0.	0.	0.	0.	0.
C1	5	12.	234.	43.	12.	0.	0.	0.	0.	0.	0.
C1	6	12.	204.	43.	10.	0.	0.	0.	0.	0.	0.
C1	7	12.	234.	43.	12.	0.	0.	0.	0.	0.	0.
C1	8	12.	223.	43.	11.	0.	0.	0.	0.	0.	0.
C1	9	12.	223.	43.	11.	0.	0.	0.	0.	0.	0.
C1	10	12.	234.	130.	46.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER CONTROL-2 ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	10.	1500.	566.	137.	130.	43.	0.	0.	0.	0.
C1	5	0.	0.	566.	143.	43.	12.	0.	0.	0.	0.
C1	6	0.	0.	566.	125.	43.	10.	0.	0.	0.	0.
C1	7	0.	0.	566.	143.	43.	12.	0.	0.	0.	0.
C1	8	0.	0.	566.	137.	43.	11.	0.	0.	0.	0.
C1	9	0.	0.	566.	137.	43.	11.	0.	0.	0.	0.
C1	10	11.	1833.	566.	143.	130.	46.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

CENTRAL PLANT 5900

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	5
DIFFERENT TYPE BOILERS OR HEATERS	5
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	1	2	3	4	5	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	5	4	2	3	3	1	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.25			
MAXIMUM OUTPUT, BTU/HR	4440000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	76.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.25			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	54.	0.	0.	0.
20	75.	0.	0.	0.
30	95.	0.	0.	0.
40	119.	0.	0.	0.
50	142.	0.	0.	0.
60	170.	0.	0.	0.
70	203.	0.	0.	0.
80	278.	0.	0.	0.
90	288.	0.	0.	0.
100	339.	0.	0.	0.

CHILLER IDENTIFICATION NO.	2			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4032000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	76.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.19			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	51.	0.	0.	0.
20	70.	0.	0.	0.
30	88.	0.	0.	0.
40	111.	0.	0.	0.
50	133.	0.	0.	0.
60	158.	0.	0.	0.
70	190.	0.	0.	0.
80	259.	0.	0.	0.
90	269.	0.	0.	0.
100	316.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

CHILLER IDENTIFICATION NO.	3			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3552000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	80.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.18			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	40.	0.	0.	0.
20	55.	0.	0.	0.
30	70.	0.	0.	0.
40	88.	0.	0.	0.
50	105.	0.	0.	0.
60	126.	0.	0.	0.
70	151.	0.	0.	0.
80	206.	0.	0.	0.
90	213.	0.	0.	0.
100	251.	0.	0.	0.

CHILLER IDENTIFICATION NO.	4			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4752000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	101.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.20			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	59.	0.	0.	0.
20	82.	0.	0.	0.
30	104.	0.	0.	0.
40	130.	0.	0.	0.
50	156.	0.	0.	0.
60	186.	0.	0.	0.
70	223.	0.	0.	0.
80	304.	0.	0.	0.
90	315.	0.	0.	0.
100	371.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

CHILLER IDENTIFICATION NO.	5			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3504000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	83.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.21			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	40.	0.	0.	0.
20	55.	0.	0.	0.
30	70.	0.	0.	0.
40	87.	0.	0.	0.
50	105.	0.	0.	0.
60	125.	0.	0.	0.
70	149.	0.	0.	0.
80	204.	0.	0.	0.
90	212.	0.	0.	0.
100	249.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	6940000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2062500.
20	2512500.
30	3700000.
40	4875000.
50	6000000.
60	7262500.
70	8462500.
80	9750000.
90	11050000.
100	12500000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	7170000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2137500.
20	2550000.
30	3737500.
40	4875000.
50	5962500.
60	7225000.
70	8512500.
80	9812500.
90	11150000.
100	12500000.

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

BOILER/HEATER IDENT. NO.	3
MAXIMUM OUTPUT, BTU/HR	7610000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2268310.
20	2583690.
30	3796690.
40	4961170.
50	6077130.
60	7290130.
70	8430350.
80	9631220.
90	10819960.
100	12130000.

BOILER/HEATER IDENT. NO.	4
MAXIMUM OUTPUT, BTU/HR	6220000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1900000.
20	2180000.
30	3220000.
40	4240000.
50	5230000.
60	6220000.
70	7240000.
80	8200000.
90	8140000.
100	10000000.

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

BOILER/HEATER IDENT. NO.	5
MAXIMUM OUTPUT, BTU/HR	8880000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2646000.
20	3052000.
30	4508000.
40	5936000.
50	7140000.
60	8526000.
70	9870000.
80	11242000.
90	12600000.
100	14000000.

PC-CUBE

CENTRAL PALNT 5900 BOILER CONTROL ECO

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR				PROCESS			
	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	57938.0	11818.0	.0	.0	.0	.0	.0	.0
FEB	57938.0	9046.0	.0	.0	.0	.0	.0	.0
MAR	57938.0	7725.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	5212.0	7368.0	.0	.0	.0	.0
JUN	.0	.0	18384.0	30305.0	.0	.0	.0	.0
JUL	.0	.0	18384.0	8487.0	.0	.0	.0	.0
AUG	.0	.0	18384.0	8494.0	.0	.0	.0	.0
SEP	.0	.0	18384.0	7888.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	21864.0	6339.0	.0	.0	.0	.0	.0	.0
DEC	57938.0	9820.0	.0	.0	.0	.0	.0	.0
TOTAL		44748.0		62542.0		.0		.0

PC-CUBE

CENTRAL PALNT 5900 BOILER CONTROL ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
2	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
3	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
4	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
5	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
6	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
7	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
8	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
9	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
10	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
11	.600	.700	.000	.300	.300	.000	.700	.700	.700	.700	.300	.300
12	.600	.700	.000	.300	.300	.000	.700	.700	.700	.700	.300	.300
13	.400	.500	.000	.700	.700	.000	.700	.700	.700	.700	.300	.300
14	.400	.500	.000	1.000	.700	.000	.700	.700	.700	.700	.300	.300
15	.400	.500	.000	.800	.700	.000	.700	.700	.700	.700	.300	.300
16	.400	.500	.000	.700	.700	.000	.700	.700	.700	.700	.300	.300
17	.400	.500	.000	.700	.700	.000	.700	.700	.700	.700	.300	.300
18	.400	.700	.000	.700	.700	.000	.700	.700	.700	.500	.300	.300
19	.600	.700	.000	.700	.700	.000	.700	.700	.700	.500	.300	.300
20	.600	.700	.000	.700	.700	.000	.500	.500	.500	.500	.300	.300
21	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
22	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
23	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
24	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	24	24	24
NO DAY TYPES	2	2	3	1
ADJUST LIMIT	.30	.30	.30	.30

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

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CENTRAL PAINT 5900 BOILER CONTROL ECO

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	71669.
PEAK DAY GAS CONSUMP., 1000 CU FT	790.
ELECTRICAL CONSUMPTION, KWH	4102470.
PEAK KW DEMAND (15 MIN BASIS)	1781.
PURCHASED ELECTRIC POWER	4102470.
ON-PEAK CONSUMPTION KWH	1781.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
CHILLER 3	2048
CHILLER 4	1456
CHILLER 5	1249
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3050
BOILER 3	791
BOILER 4	0
BOILER 5	0
BOILER 6	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 13

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 14

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1 NORMAL HEATING AND COOLING LOADS											
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	0	0	0	0	0	0	0	0	3672	3672
2	46	698	0	0	0	144	256	256	160	2112	3672
3	128	176	160	96	16	16	0	0	0	1456	2048
4	0	0	0	0	0	0	6	50	103	1297	1456
5	26	49	176	43	955	0	0	0	0	0	1249
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	0	0	0	0	18	60	129	134	3283	3624
2	251	268	250	200	234	225	192	184	201	1045	3050
3	138	170	130	184	74	38	0	38	19	0	791
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0

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CENTRAL PALNT 5900 BOILER CONTROL ECO

		***** PURCHASED ELECTRICAL *****				*****					
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HR
C1	1	790.	18997.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	657.	14440.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	494.	12412.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	547.	405.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	1781.	1275.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	1781.	825.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	1781.	827.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	1781.	770.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	423.	10189.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	638.	15632.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PALNT 5900 BOILER CONTROL ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	21302.	11818.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	17970.	9046.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	13558.	7725.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	434.	319241.	0.	0.	547.	405.	0.	0.	0.	0.
C1	6	1532.	1096550.	0.	0.	1781.	1275.	0.	0.	0.	0.
C1	7	1532.	705420.	0.	0.	1781.	825.	0.	0.	0.	0.
C1	8	1532.	705825.	0.	0.	1781.	827.	0.	0.	0.	0.
C1	9	1532.	655873.	0.	0.	1781.	770.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	11589.	6339.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	17455.	9820.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 CHILLER CONTROL ECO

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	5
DIFFERENT TYPE BOILERS OR HEATERS	5
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM	GENERATOR	CHILLER	PERCENTAGE	DIRECT FIRED		AF	PROC	STEAM		
ID	OPERATION	OPERATION	PROCESS HEAT	PROCESS HEAT		KEY	KEY	TURB	KEY	AUX FUEL
DESCRIPTION	SCHEDULE	SCHEDULE	DIRECT FIRED	EFFICIENCY						

C1	0	1	0.	100.		0	0	0		
1.										

CHILLER IDENTIFICATION NUMBERS

C1	3	5	1	2	4	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	3	3	4	5	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY
TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD
EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER
FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

	C1								
GENERATOR SYSTEM TYPE	0								
DAYTYPE	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0						
GENERATOR STOP TIME	0	0	0						

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 CHILLER CONTROL ECO

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.25			
MAXIMUM OUTPUT, BTU/HR	4440000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	76.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.25			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	54.	0.	0.	0.
20	75.	0.	0.	0.
30	95.	0.	0.	0.
40	119.	0.	0.	0.
50	142.	0.	0.	0.
60	170.	0.	0.	0.
70	203.	0.	0.	0.
80	278.	0.	0.	0.
90	288.	0.	0.	0.
100	339.	0.	0.	0.

CHILLER IDENTIFICATION NO.	2			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4032000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	76.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.19			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	51.	0.	0.	0.
20	70.	0.	0.	0.
30	88.	0.	0.	0.
40	111.	0.	0.	0.
50	133.	0.	0.	0.
60	158.	0.	0.	0.
70	190.	0.	0.	0.
80	259.	0.	0.	0.
90	269.	0.	0.	0.
100	316.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 CHILLER CONTROL ECO

CHILLER IDENTIFICATION NO.	3			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3552000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	80.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.18			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	40.	0.	0.	0.
20	55.	0.	0.	0.
30	70.	0.	0.	0.
40	88.	0.	0.	0.
50	105.	0.	0.	0.
60	126.	0.	0.	0.
70	151.	0.	0.	0.
80	206.	0.	0.	0.
90	213.	0.	0.	0.
100	251.	0.	0.	0.

CHILLER IDENTIFICATION NO.	4			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4752000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	101.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.20			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	59.	0.	0.	0.
20	82.	0.	0.	0.
30	104.	0.	0.	0.
40	130.	0.	0.	0.
50	156.	0.	0.	0.
60	186.	0.	0.	0.
70	223.	0.	0.	0.
80	304.	0.	0.	0.
90	315.	0.	0.	0.
100	371.	0.	0.	0.

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

CHILLER IDENTIFICATION NO.	5			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3504000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	83.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.21			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	40.	0.	0.	0.
20	55.	0.	0.	0.
30	70.	0.	0.	0.
40	87.	0.	0.	0.
50	105.	0.	0.	0.
60	125.	0.	0.	0.
70	149.	0.	0.	0.
80	204.	0.	0.	0.
90	212.	0.	0.	0.
100	249.	0.	0.	0.

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	6940000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2062500.
20	2512500.
30	3700000.
40	4875000.
50	6000000.
60	7262500.
70	8462500.
80	9750000.
90	11050000.
100	12500000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	7170000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2137500.
20	2550000.
30	3737500.
40	4875000.
50	5962500.
60	7225000.
70	8512500.
80	9812500.
90	11150000.
100	12500000.

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

BOILER/HEATER IDENT. NO. 3
MAXIMUM OUTPUT, BTU/HR 7610000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2268310.
20	2583690.
30	3796690.
40	4961170.
50	6077130.
60	7290130.
70	8430350.
80	9631220.
90	10819960.
100	12130000.

BOILER/HEATER IDENT. NO. 4
MAXIMUM OUTPUT, BTU/HR 6220000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1900000.
20	2180000.
30	3220000.
40	4240000.
50	5230000.
60	6220000.
70	7240000.
80	8200000.
90	8140000.
100	10000000.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 CHILLER CONTROL ECO

BOILER/HEATER IDENT. NO.	5
MAXIMUM OUTPUT, BTU/HR	8880000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2646000.
20	3052000.
30	4508000.
40	5936000.
50	7140000.
60	8526000.
70	9870000.
80	11242000.
90	12600000.
100	14000000.

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

NUMBER OF EACH DAY TYPE PER MONTH

MONTH	DAY TYPE		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR

MONTH	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK	LOAD	PEAK	LOAD	DEMAND	LOAD	PEAK	LOAD
	THOUSAND BTU/HR	MILLION BTU	THOUSAND BTU/HR	MILLION BTU	KILOWATT	THOUSAND KWH	THOUSAND BTU/HR	MILLION BTU
JAN	57938.0	11818.0	.0	.0	.0	.0	.0	.0
FEB	57938.0	9046.0	.0	.0	.0	.0	.0	.0
MAR	57938.0	7725.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	5212.0	7368.0	.0	.0	.0	.0
JUN	.0	.0	18384.0	30305.0	.0	.0	.0	.0
JUL	.0	.0	18384.0	8487.0	.0	.0	.0	.0
AUG	.0	.0	18384.0	8494.0	.0	.0	.0	.0
SEP	.0	.0	18384.0	7888.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	21864.0	6339.0	.0	.0	.0	.0	.0	.0
DEC	57938.0	9820.0	.0	.0	.0	.0	.0	.0
TOTAL		44748.0		62542.0		.0		.0

PC-CUBE

CENTRAL PLANT 5900 CHILLER CONTROL ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
2	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
3	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
4	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
5	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
6	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
7	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
8	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
9	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
10	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
11	.600	.700	.000	.300	.300	.000	.700	.700	.700	.700	.300	.300
12	.600	.700	.000	.300	.300	.000	.700	.700	.700	.700	.300	.300
13	.400	.500	.000	.500	.500	.000	.700	.700	.700	.700	.300	.300
14	.400	.500	.000	.600	.500	.000	.700	.700	.700	.700	.300	.300
15	.400	.500	.000	.700	.500	.000	.700	.700	.700	.700	.300	.300
16	.400	.500	.000	.600	.500	.000	.700	.700	.700	.700	.300	.300
17	.400	.500	.000	.600	.500	.000	.700	.700	.700	.700	.300	.300
18	.400	.700	.000	.500	.500	.000	.700	.700	.700	.500	.300	.300
19	.600	.700	.000	.500	.500	.000	.700	.700	.700	.500	.300	.300
20	.600	.700	.000	.500	.500	.000	.500	.500	.500	.500	.300	.300
21	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
22	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
23	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
24	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	24	24	24
NO DAY TYPES	2	2	3	1
ADJUST LIMIT	.30	.20	.30	.30

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	79220.
PEAK DAY GAS CONSUMP., 1000 CU FT	833.
ELECTRICAL CONSUMPTION, KWH	3988915.
PEAK KW DEMAND (15 MIN BASIS)	1749.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	3988915.
ON-PEAK KW DEMAND (15 MIN BASIS)	1749.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
CHILLER 3	2928
CHILLER 4	1456
CHILLER 5	988
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3458
BOILER 3	1191
BOILER 4	0
BOILER 5	0
BOILER 6	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 13

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	NORMAL HEATING AND COOLING LOADS									
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	0	0	0	0	0	0	0	0	3672
3672										
2	0	0	0	42	702	0	0	0	16	2912
3672										
3	0	0	384	272	224	336	224	32	0	1456
2928										
4	0	0	0	4	32	64	60	88	104	1104
1456										
5	12	21	56	57	40	110	692	0	0	0
988										
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	0	0	0	0	0	0	30	60	3534
3624										
2	69	211	218	292	291	254	258	243	198	1424
3458										
3	327	174	207	112	202	74	38	0	38	19
1191										
4	0	0	0	0	0	0	0	0	0	0
0										
5	0	0	0	0	0	0	0	0	0	0
0										
6	0	0	0	0	0	0	0	0	0	0
0										

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

		GAS		***** PURCHASED ELECTRICAL *****		*****					
		DEMAND	CONSUMP	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		MCF	MCF	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
				KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	833.	20696.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	712.	16067.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	544.	13678.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	505.	374.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	1749.	1256.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	1749.	802.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	1749.	802.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	1749.	754.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	466.	11322.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	693.	17456.	0.	0.	0.	0.	0.	0.	0.	0.

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CENTRAL PLANT 5900 CHILLER CONTROL ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	21302.	11818.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	17970.	9046.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	13558.	7725.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	434.	320682.	0.	0.	505.	374.	0.	0.	0.	0.
C1	6	1532.	1099390.	0.	0.	1749.	1256.	0.	0.	0.	0.
C1	7	1532.	702426.	0.	0.	1749.	802.	0.	0.	0.	0.
C1	8	1532.	703110.	0.	0.	1749.	802.	0.	0.	0.	0.
C1	9	1532.	654209.	0.	0.	1749.	754.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	11589.	6339.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	17455.	9820.	0.	0.	0.	0.	0.	0.

CENTRAL PLANT 6003

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 CHILLER CONTROL ECO

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	3
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL
DESCRIPTION								

C1	0	2	0.	100.	0	0	0	
1.								

CHILLER IDENTIFICATION NUMBERS

C1	2	3	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

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CENTRAL PLANT 6003 CHILLER CONTROL ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY
TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD
EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER
FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

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CENTRAL PLANT 6003 CHILLER CONTROL ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

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CENTRAL PLANT 6003 CHILLER CONTROL ECO

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	1000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	0.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.00			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	0.	0.	0.	0.
20	0.	0.	0.	0.
30	0.	0.	0.	0.
40	0.	0.	0.	0.
50	1.	0.	0.	0.
60	1.	0.	0.	0.
70	1.	0.	0.	0.
80	1.	0.	0.	0.
90	1.	0.	0.	0.
100	1.	0.	0.	0.

CHILLER IDENTIFICATION NO.	2			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	64.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	148.	0.	0.	0.
60	170.	0.	0.	0.
70	193.	0.	0.	0.
80	222.	0.	0.	0.
90	253.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 CHILLER CONTROL ECO

CHILLER IDENTIFICATION NO.	3			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	65.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	148.	0.	0.	0.
60	170.	0.	0.	0.
70	193.	0.	0.	0.
80	224.	0.	0.	0.
90	256.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 CHILLER CONTROL ECO

BOILER/HEATER IDENT. NO. 1
MAXIMUM OUTPUT, BTU/HR 9410000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2798150.
20	3384150.
30	4849150.
40	6196950.
50	7442200.
60	8907200.
70	10357550.
80	11793250.
90	13228950.
100	14650000.

BOILER/HEATER IDENT. NO. 2
MAXIMUM OUTPUT, BTU/HR 9120000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2710250.
20	3032550.
30	4497550.
40	5947900.
50	7383600.
60	8848600.
70	10284300.
80	11734650.
90	13185000.
100	14650000.

PC-CUBE

CENTRAL PLANT 6003 CHILLER CONTROL ECO

NUMBER OF EACH DAY TYPE PER MONTH

MONTH	DAY TYPE		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR

MONTH	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	23809.0	4711.0	.0	.0	.0	.0	.0	.0
FEB	23809.0	3064.0	.0	.0	.0	.0	.0	.0
MAR	23809.0	3064.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	3233.0	6182.0	.0	.0	.0	.0
JUN	.0	.0	8525.0	6504.0	.0	.0	.0	.0
JUL	.0	.0	8525.0	6625.0	.0	.0	.0	.0
AUG	.0	.0	8525.0	6626.0	.0	.0	.0	.0
SEP	.0	.0	8525.0	6387.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	9454.0	2527.0	.0	.0	.0	.0	.0	.0
DEC	23809.0	3064.0	.0	.0	.0	.0	.0	.0
TOTAL		16430.0		32324.0		.0		.0

PC-CUBE

CENTRAL PLANT 6003 CHILLER CONTROL ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
2	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
3	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
4	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
5	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
6	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
7	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
8	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
9	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
10	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
11	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
12	.700	.700	.000	.200	.200	.000	.700	.700	.700	.000	.000	.000
13	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
14	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
15	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
16	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
17	.500	.500	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
18	.500	.700	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
19	.700	.700	.000	.400	.400	.000	.700	.700	.700	.000	.000	.000
20	.700	.700	.000	.400	.400	.000	.500	.500	.500	.000	.000	.000
21	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
22	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
23	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000
24	.700	.700	.000	.200	.200	.000	.500	.500	.500	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS

START HOUR	0	0	0	0
END HOUR	24	24	24	0
NO DAY TYPES	2	2	3	0
ADJUST LIMIT	.30	.00	.30	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0	0	0	0	0	0	0	0	0	0	0	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 CHILLER CONTROL ECO

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	26405.
PEAK DAY GAS CONSUMP., 1000 CU FT	270.
ELECTRICAL CONSUMPTION, KWH	1826896.
PEAK KW DEMAND (15 MIN BASIS)	566.
PURCHASED ELECTRIC POWER	1826896.
ON-PEAK CONSUMPTION KWH	566.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2928
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 11

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 CHILLER CONTROL ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1 NORMAL HEATING AND COOLING LOADS										
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	0	0	0	0	0	744	2928	0	0
3672										
2	0	0	0	0	0	0	0	2928	0	0
2928										
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	0	155	771	1403	718	230	310	37	0
3624										
2	0	0	0	0	0	0	0	0	0	0
0										

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CENTRAL PLANT 6003 CHILLER CONTROL ECO

		***** PURCHASED ELECTRICAL *****									
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	270.	7413.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	201.	4899.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	181.	4952.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	228.	170.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	566.	407.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	566.	421.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	566.	421.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	566.	407.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	157.	4189.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	180.	4952.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 CHILLER CONTROL ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	7632.	4711.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	5637.	3064.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	5049.	3064.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	269.	200426.	0.	0.	228.	170.	0.	0.	0.	0.
C1	6	710.	511449.	0.	0.	566.	407.	0.	0.	0.	0.
C1	7	710.	528498.	0.	0.	566.	421.	0.	0.	0.	0.
C1	8	710.	528498.	0.	0.	566.	421.	0.	0.	0.	0.
C1	9	710.	511449.	0.	0.	566.	407.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	4288.	2527.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	5009.	3064.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	3
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TUBE KEY	AUX FUEL DESCRIPTION
C1	0	3	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	2	3	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	1000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	0.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.00			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	0.	0.	0.	0.
20	0.	0.	0.	0.
30	0.	0.	0.	0.
40	0.	0.	0.	0.
50	1.	0.	0.	0.
60	1.	0.	0.	0.
70	1.	0.	0.	0.
80	1.	0.	0.	0.
90	1.	0.	0.	0.
100	1.	0.	0.	0.

CHILLER IDENTIFICATION NO.	2			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	64.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	142.	0.	0.	0.
60	168.	0.	0.	0.
70	193.	0.	0.	0.
80	222.	0.	0.	0.
90	253.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

CHILLER IDENTIFICATION NO.	3			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	65.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	142.	0.	0.	0.
60	168.	0.	0.	0.
70	193.	0.	0.	0.
80	222.	0.	0.	0.
90	253.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	9430000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2798150.
20	3384150.
30	4849150.
40	6196950.
50	7442200.
60	8907200.
70	10357550.
80	11793250.
90	13228950.
100	14650000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	9140000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2710250.
20	3032550.
30	4497550.
40	5947900.
50	7383600.
60	8848600.
70	10284300.
80	11734650.
90	13185000.
100	14650000.

PC-CUBE

CENTRAL PLANT 6003 BOILER CONTROL ECO

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR						PROCESS	
	HEATING		COOLING		ELECTRIC		PEAK THOUSAND BTU/HR	LOAD MILLION BTU
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH		
JAN	23809.0	4711.0	.0	.0	.0	.0	.0	.0
FEB	23809.0	3064.0	.0	.0	.0	.0	.0	.0
MAR	23809.0	3064.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	3233.0	6182.0	.0	.0	.0	.0
JUN	.0	.0	8525.0	6504.0	.0	.0	.0	.0
JUL	.0	.0	8525.0	6625.0	.0	.0	.0	.0
AUG	.0	.0	8525.0	6626.0	.0	.0	.0	.0
SEP	.0	.0	8525.0	6387.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	9454.0	2527.0	.0	.0	.0	.0	.0	.0
DEC	23809.0	3064.0	.0	.0	.0	.0	.0	.0
TOTAL		16430.0		32324.0		.0		.0

PC-CUBE

CENTRAL PLANT 6003 BOILER CONTROL ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
6	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
15	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
16	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
17	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
20	.700	.700	.000	.700	.700	.000	.500	.500	.500	.000	.000	.000
21	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION												
	HEATING			COOLING			ELECTRIC			PROCESS		
START HOUR	0			0			0			0		
END HOUR	24			24			24			0		
NO DAY TYPES	2			2			3			0		
ADJUST LIMIT	.30			.30			.30			.00		

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	26355.
PEAK DAY GAS CONSUMP., 1000 CU FT	269.
ELECTRICAL CONSUMPTION, KWH	1847736.
PEAK KW DEMAND (15 MIN BASIS)	563.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	1847736.
ON-PEAK KW DEMAND (15 MIN BASIS)	563.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 11

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1 CHR	NORMAL HEATING AND COOLING LOADS										TOTAL
	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	
1	0	0	128	616	0	0	62	2866	0	0	3672
2	0	0	128	616	0	0	62	2866	0	0	3672
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	0	155	771	1421	700	230	329	18	0	3624
2	0	0	0	0	0	0	0	0	0	0	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

		***** PURCHASED ELECTRICAL *****				*****					
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	269.	7398.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	201.	4890.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	181.	4943.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	287.	212.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	563.	403.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	563.	415.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	563.	415.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	563.	402.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	157.	4181.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	179.	4943.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	7632.	4711.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	5637.	3064.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	5049.	3064.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	269.	198025.	0.	0.	287.	212.	0.	0.	0.	0.
C1	6	710.	508491.	0.	0.	563.	403.	0.	0.	0.	0.
C1	7	710.	522166.	0.	0.	563.	415.	0.	0.	0.	0.
C1	8	710.	523162.	0.	0.	563.	415.	0.	0.	0.	0.
C1	9	710.	506564.	0.	0.	563.	402.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	4288.	2527.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	5009.	3064.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

SYSTEM C1 SUMMER HW LOAD ONLY

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	3
DIFFERENT TYPE BOILERS OR HEATERS	1
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	3	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1 0 0 3 0 0 0 0 0 0 0

BOILER/HEATER IDENTIFICATION NUMBERS

C1 1 0 0 0 0 0 0 0 0 0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED
DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.25			
MAXIMUM OUTPUT, BTU/HR	1000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	0.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.00			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	0.	0.	0.	0.
20	0.	0.	0.	0.
30	0.	0.	0.	0.
40	0.	0.	0.	0.
50	1.	0.	0.	0.
60	1.	0.	0.	0.
70	1.	0.	0.	0.
80	1.	0.	0.	0.
90	1.	0.	0.	0.
100	1.	0.	0.	0.

CHILLER IDENTIFICATION NO.	2			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	64.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	142.	0.	0.	0.
60	168.	0.	0.	0.
70	193.	0.	0.	0.
80	222.	0.	0.	0.
90	253.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

CHILLER IDENTIFICATION NO.	3			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	5346000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	65.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.28			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	48.	0.	0.	0.
20	68.	0.	0.	0.
30	91.	0.	0.	0.
40	116.	0.	0.	0.
50	142.	0.	0.	0.
60	168.	0.	0.	0.
70	193.	0.	0.	0.
80	222.	0.	0.	0.
90	253.	0.	0.	0.
100	284.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	9430000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2783500.
20	3208350.
30	4688000.
40	6079750.
50	7383600.
60	8848600.
70	10313600.
80	11763950.
90	13199650.
100	14650000.

PC-CUBE

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	1	2	3
JAN	0	0	31
FEB	0	0	28
MAR	0	0	31
APR	22	8	0
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	23	8	0
NOV	0	0	30
DEC	0	0	31

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR						PROCESS	
	HEATING		COOLING		ELECTRIC		PEAK THOUSAND BTU/HR	LOAD MILLION BTU
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH		
JAN	.0	.0	.0	.0	.0	.0	.0	.0
FEB	.0	.0	.0	.0	.0	.0	.0	.0
MAR	.0	.0	.0	.0	.0	.0	.0	.0
APR	6617.4	1219.0	.0	.0	.0	.0	.0	.0
MAY	6617.4	1180.0	.0	.0	.0	.0	.0	.0
JUN	6617.4	1219.0	.0	.0	.0	.0	.0	.0
JUL	6617.4	1219.0	.0	.0	.0	.0	.0	.0
AUG	6617.4	1180.0	.0	.0	.0	.0	.0	.0
SEP	6617.4	1180.0	.0	.0	.0	.0	.0	.0
OCT	6617.4	1219.0	.0	.0	.0	.0	.0	.0
NOV	.0	.0	.0	.0	.0	.0	.0	.0
DEC	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL		8416.0		.0		.0		.0

PC-CUBE

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
6	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.700	.700	.700	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
15	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
16	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
17	.500	.500	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.700	.700	.700	.000	.000	.000
20	.700	.700	.000	.700	.700	.000	.500	.500	.500	.000	.000	.000
21	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.500	.500	.500	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	24	24	0
NO DAY TYPES	2	2	3	0
ADJUST LIMIT	.30	.30	.30	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

** TOTAL **

SYSTEM C1 SUMMER HW LOAD ONLY

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	15959.
PEAK DAY GAS CONSUMP., 1000 CU FT	82.
ELECTRICAL CONSUMPTION, KWH	0.
PEAK KW DEMAND (15 MIN BASIS)	0.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	0.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	0
BOILER OPERATING HOURS	
BOILER 1	5136
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 11

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	SUMMER HW	LOAD ONLY										
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL	
1	0	0	0	0	0	0	0	0	0	0	0	
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL	
1	0	4222	914	0	0	0	0	0	0	0	5136	

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER CONTROL-2 ECO

		GAS		***** PURCHASED ELECTRICAL *****		*****		*****		*****	
		DEMAND	CONSUMP	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		MCF	MCF	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
				KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	81.	2266.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	77.	2287.	0.	0.	0.	0.	0.	0.	0.	0.
C1	6	82.	2264.	0.	0.	0.	0.	0.	0.	0.	0.
C1	7	78.	2310.	0.	0.	0.	0.	0.	0.	0.	0.
C1	8	77.	2287.	0.	0.	0.	0.	0.	0.	0.	0.
C1	9	79.	2236.	0.	0.	0.	0.	0.	0.	0.	0.
C1	10	78.	2310.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5003 BOILER CONTROL-2 ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	2057.	1219.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	1912.	1180.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	2089.	1219.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	1975.	1219.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	1927.	1180.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	1992.	1180.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	1975.	1219.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

APPENDIX J

PROJECT 2 - CENTRAL PLANT PROJECT FOR BUILDINGS 5676 AND 5678

APPENDIX J.1 - PROJECT ANALYSIS
APPENDIX J.2 - PC-CUBE BASERUN
APPENDIX J.3 - PC-CUBE ECO RUN

APPENDIX J.1
PROJECT ANALYSIS

**ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA**

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: PROJECT 2
SYSTEM MODIFICATION: EXPAND CENTRAL PLANT 5678 TO SERVE BLDG. 5676 AND 5678
SYSTEMS TO MODIFY: BOILERS AND PUMPS

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for Project 2, install a new automated control system, boilers, and pumps. The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas (MMBtu)	Total Energy (MMBtu)
	Demand(kW)	Energy(kWh)		
Baseline	311	390,000	10,419	11,750
ECO	311	390,000	7,463	8,794
Savings (Baseline-ECO)	0	0	2,956	2,956

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	\$4.0141 /MMBtu	=	\$0 per year
Nat. Gas:	2956 MMBtu/Yr	X	\$2.92 /MMBtu	=	\$8,632 per year
Total Energy Cost Savings:		\$0 +	\$8,632	=	\$8,632 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand:	0 kW/month	X	\$1.787 /kW	X	12 months/year
	= (+)		\$0 per year		
Maintenance:	= (-)		\$3,000 per year		
Total:	\$0	-	\$3,000	=	(\$3,000)per year

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: PROJECT2

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062

INSTALLATION & LOCATION: FT. SILL, OKLA REGION NOS. 6 CENSUS: 3

PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS

FISCAL YEAR 1991 DISCRETE PORTION NAME: CENTRAL HEATING PLANT 5678

ANALYSIS DATE: 04-02-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 293101.
B. SIOH	\$ 16121.
C. DESIGN COST	\$ 17586.
D. SALVAGE VALUE COST	-\$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ 326808.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 4.01	0.	\$ 0.	15.61	0.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 2.92	2956.	\$ 8632.	23.77	205171.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		2956.	\$ 8632.		\$ 205171.

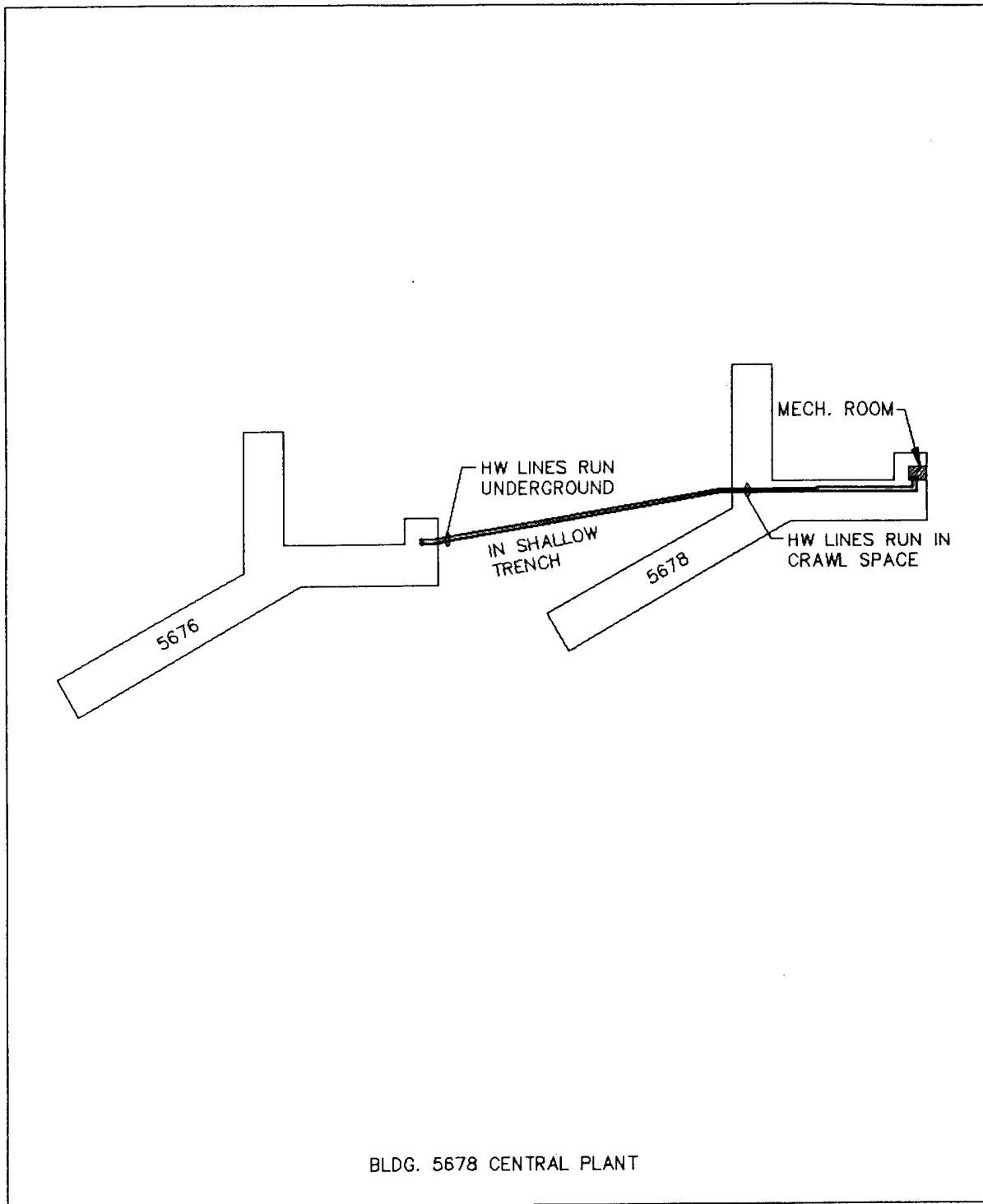
3. NON ENERGY SAVINGS(+) / COST(-)

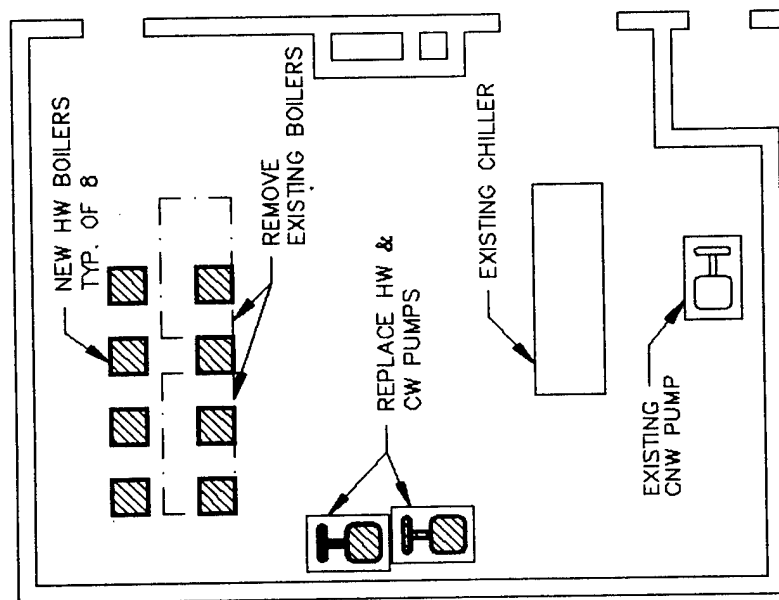
A. ANNUAL RECURRING (+/-)	\$ -3000.
(1) DISCOUNT FACTOR (TABLE A)	14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$ -43590.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$ -43590.
D. PROJECT NON ENERGY QUALIFICATION TEST	
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$ 67707.
A IF 3D1 IS = OR > 3C GO TO ITEM 4	
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)	_____
C IF 3D1B IS = > 1 GO TO ITEM 4	
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY	

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))	\$ 5632.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)	\$ 161581.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)=	.49
(IF < 1 PROJECT DOES NOT QUALIFY)	
7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4	58.03

SYMBOLS LEGEND

	ALARM CONTACT SIGNAL
	FLOW INDICATION
	PRESSURE INDICATION
	METER
	ON-OFF STATUS SIGNAL
	DIFFERENTIAL PRESSURE SWITCH
	START-UP INTERFACE
	TEMPERATURE INDICATION
	FLUE GAS ANALYSIS, OXYGEN
	KILOWATT METER
	EXISTING-TO-NEW





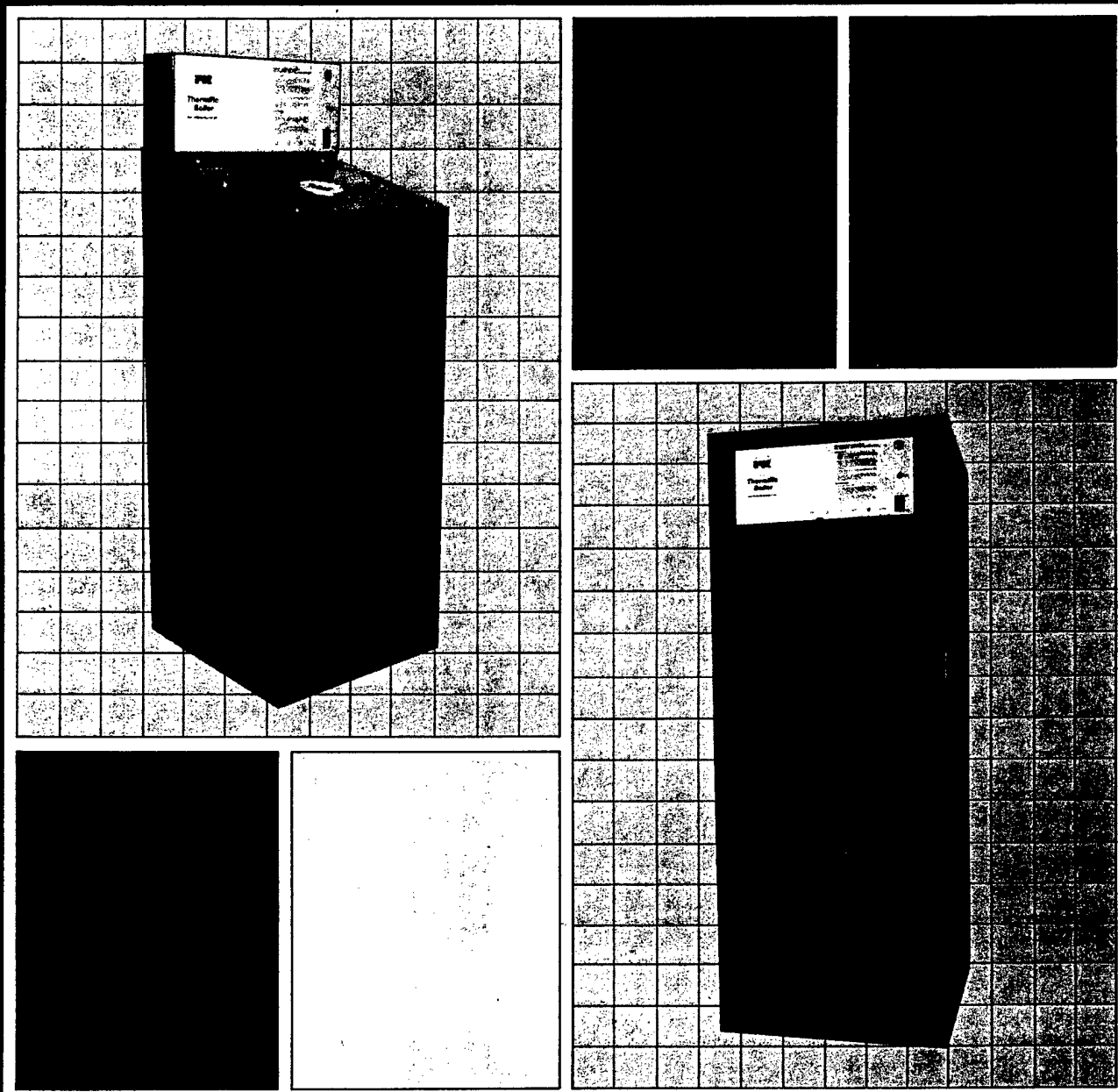
- NOTE:
1. REMOVE HW BOILERS, BLDG 5676.
 2. REMOVE DUAL TEMPERATURE PUMPS (DTP) BLDG 5676.
 3. INSTALL NEW DTP, BLDG 5676.

_____ NEW
 - - - - - REMOVE

NEW CENTRAL HEATING PLANT 5678, TO
SERVE BUILDINGS 5676 & 5678

P-K Thermific® Gas-Fired Boiler

A New Standard of Efficiency in Non-Condensing Boilers



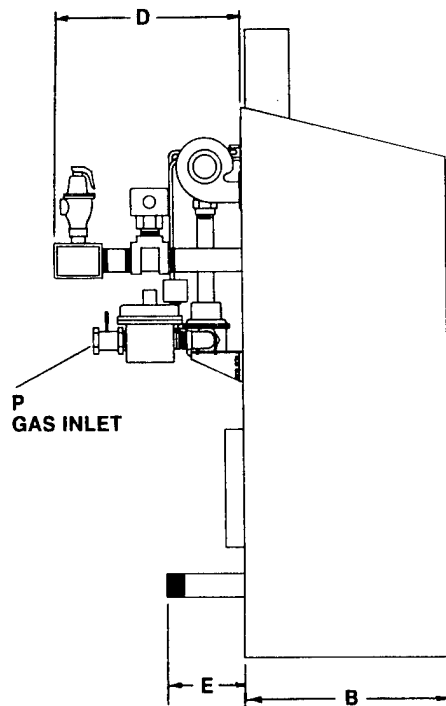
PATTERSON-KELLEY CO.

Division of HARSCO Corporation Phone: 717-421-7500
East Stroudsburg, PA 18301 Fax: 717-421-8735

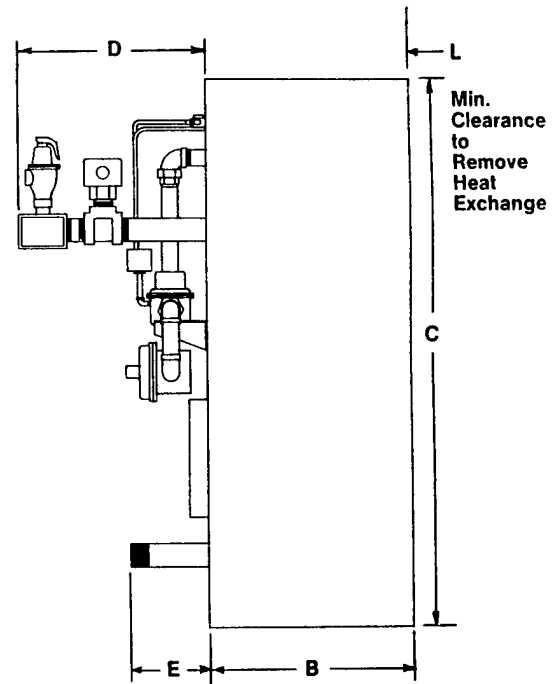
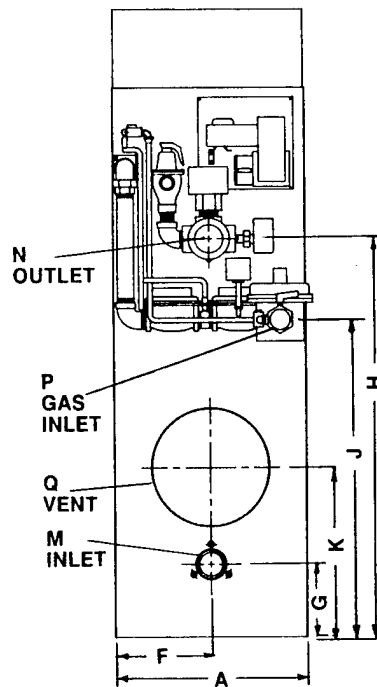


Water heaters • warm-air heaters • boilers • heat exchangers • blenders • dryers • fractionation internals • protective linings • wear-resistant steels

Capacities and Dimensions



Models: N-700, N-900, N-1200



Models: N-1500, N-1700, N-1900

Capacities and Dimensions

Dimensions in Inches

Model No.	BTU INPUT	BTU OUTPUT	A	B	C	D	E	F	G	H	J	K	L	M MPT	N FPT	P FPT	Q	Motor H.P.
N-700	700,000	595,000	19 ⁵ / ₈	21	56 ¹ / ₂	14	5 ¹ / ₄	9 ³ / ₄	8 ¹ / ₄	31 ³ / ₄	23 ³ / ₄	17 ¹ / ₈	24	2	2	1 ¹ / ₄	10	1/3
N-900	900,000	765,000	19 ⁵ / ₈	21	56 ¹ / ₂	14	5 ¹ / ₄	9 ³ / ₄	8 ¹ / ₄	31 ³ / ₄	23 ³ / ₄	17 ¹ / ₈	24	2	2	1 ¹ / ₄	10	1/3
N-1200	1,200,000	1,020,000	19 ⁵ / ₈	21	66 ⁷ / ₈	14	5 ¹ / ₄	9 ³ / ₄	8 ¹ / ₄	41 ¹ / ₄	22 ¹ / ₄	17 ¹ / ₈	24	2	2	1 ¹ / ₂	10	1/2
N-1500	1,500,000	1,275,000	25 ⁵ / ₈	26 ¹ / ₄	67	15	5 ¹ / ₂	12 ³ / ₄	8 ⁷ / ₈	47 ¹ / ₂	29	19 ¹ / ₈	29	2 ¹ / ₂	2 ¹ / ₂	2	12	3/4
N-1700	1,700,000	1,445,000	25 ⁵ / ₈	26 ¹ / ₄	67	15	5 ¹ / ₂	12 ³ / ₄	8 ⁷ / ₈	47 ¹ / ₂	29	19 ¹ / ₈	29	2 ¹ / ₂	2 ¹ / ₂	2	12	3/4
N-1900	1,900,000	1,615,000	25 ⁵ / ₈	26 ¹ / ₄	67	15	5 ¹ / ₂	12 ³ / ₄	8 ⁷ / ₈	47 ¹ / ₂	29	19 ¹ / ₈	29	2 ¹ / ₂	2 ¹ / ₂	2	12	3/4

A.G.A. Design-Certified for natural gas. ASME Certified for 160 PSIG, Section IV. National Board Registered.

Standard Features

- Pressure-temperature gauge
- Water flow switch
- ASME pressure relief valve
- Two diaphragm main gas valves
- Main gas pressure regulator (14" W.C. max. inlet)
- Low gas pressure switch (manual reset)
- Main gas plug cock
- Solenoid pilot gas valve
- Pilot gas filter
- Pilot gas pressure regulator
- Pilot gas cock
- Interrupted spark-ignited pilot
- Flame safe-guard programmer
- Hi-limit temperature control with manual reset
- Operating temperature control
- Differential air pressure switch
- Radial-fired power burner
- Interlocked, finned, copper water tubes
- Adjustable inlet air shutter
- Blower assembly with "C" frame motor
- Ten-point diagnostic annunciator control panel
- 16-gauge (min.) steel outer cabinet
- 16-gauge aluminum inner cabinet
- Baked epoxy finish
- Adjustable levelers



A.G.A. Design-Certified
Complies with ANSI Z21.13-1987
Low-Press. Boiler

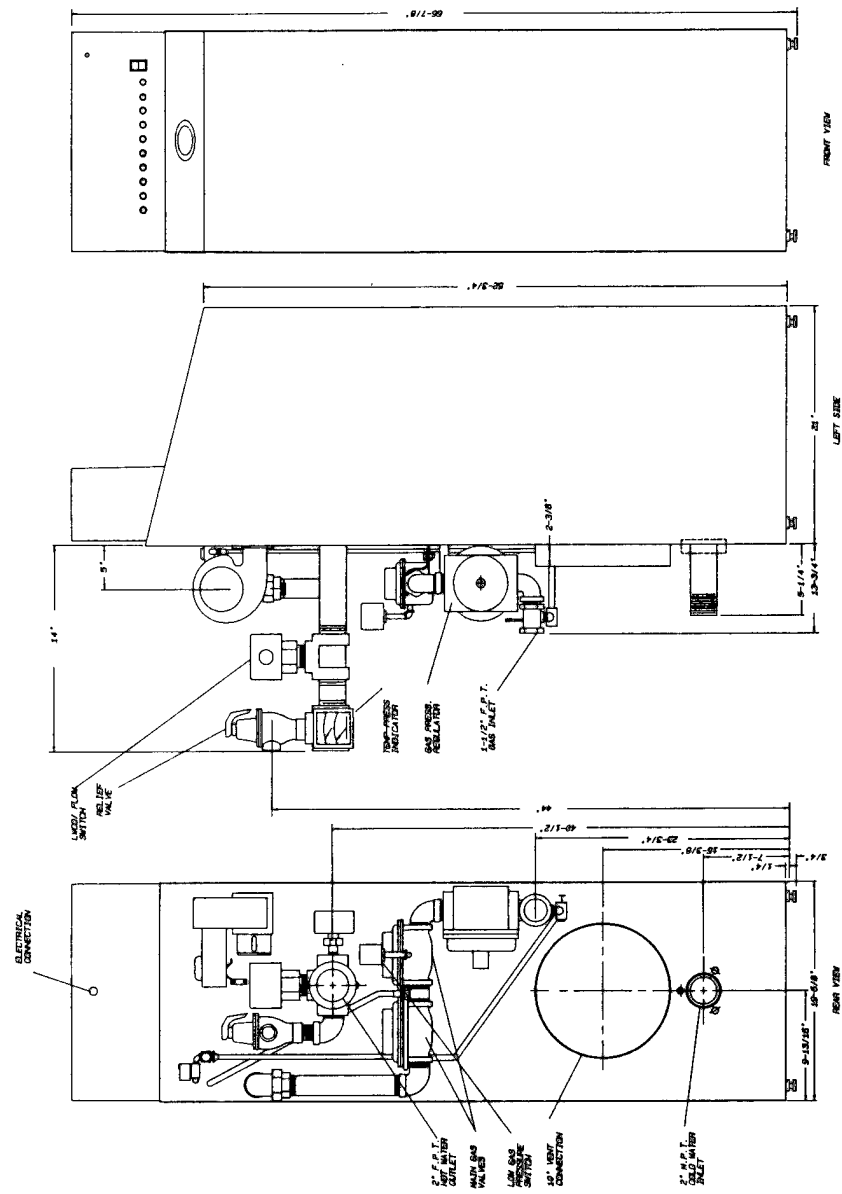


C.G.A. Approved
Complies with CAN1-3.1
Ind. & Comm. Boilers



ASME Code, Section IV
Certified by Patterson-Kelley Co.

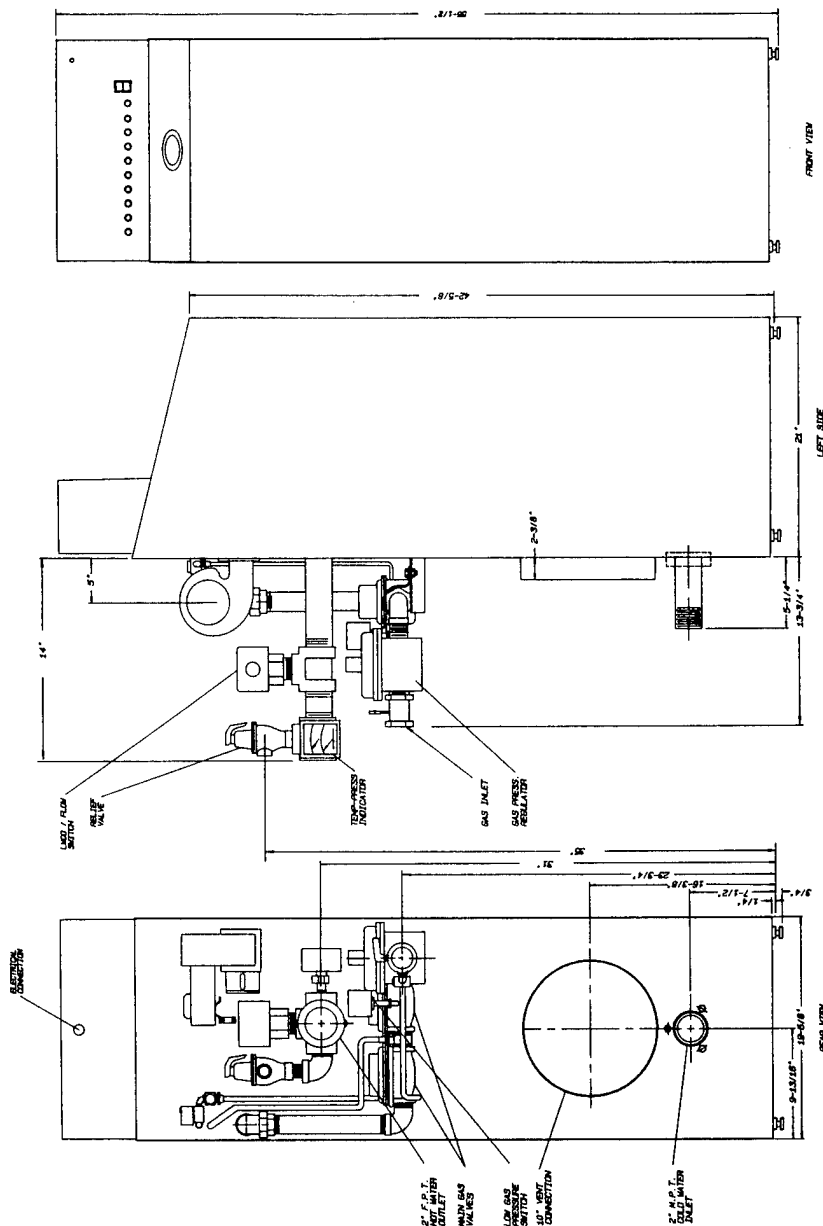
A.G.A. CERTIFIED RATINGS & CAPACITIES	
Fuel	Natural Gas
Input Btu/hr.	1,200,000
Output Btu/hr.	1,020,000
Boiler H.P.	30.5
Max. Inlet Gas Pressure	14" W.C.
Min. Inlet Gas Pressure	4" W.C.
Electrical Characteristics	120/1/60
Operating Weight	550 lbs.
ASME	
Design Data	Max. 160 psig & 250°F
ASME Sect. IV Htg. Surface	138 sq. ft.
BOILER TRIM & CONTROLS	
Relief Valve	3/4" x 1" set @ 100 psi
Press. & Temp. Gauge	Marshalltown 863560
Hi Limit	Honeywell L4008E1040
Operating Control	Honeywell L6008A1010
Flame Safeguard	Fireye TFM1D
Low Gas Press. Switch	LGP-A
Air Switch	Antunes FS4377-542
LWCO Flow Switch	F61KB
Main Gas Valve (2)	V48A2185
Main Gas Press. Reg.	RV81
Main Gas Lub. Cock	50-603-07
Pilot Valve	V4046C
Pilot Press. Reg.	RV20L
Pilot Cock	51-103-01
Blower Motor	1/2 hp
CODE OPTIONS	
Main Gas Valve	Honeywell V5055
Main Gas Actuator	Honeywell V4055
N.O. Vent Valve	ASCO 8215
Hi Gas Press. Switch	Antunes HGP-A
Flame Safeguard	Fireye TFM3



THERMIFIC MODEL N-1200

PATTERSON-KELLEY CO.
 1000 W. 10th St.
 Kansas City, Mo. 64101 (314) 421-7200

A.G.A. CERTIFIED RATINGS & CAPACITIES		
Fuel	Natural Gas	
Input Btu/hr.	900,000	
Output Btu/hr.	765,000	
Boiler H.P.	22.8	
Max. Inlet Gas Pressure	14" W.C.	
Min. Inlet Gas Pressure	4" W.C.	
Electrical Characteristics	120/1/60	
Operating Weight	455 lbs.	
ASME		
Design Data	Max. 160 psig & 250°F	
ASME Sect. IV Htg. Surface	94 sq. ft.	
BOILER TRIM & CONTROLS		
Relief Valve	¾" x ¾" set @ 100 psi	
Press. & Temp. Gauge	Marshalltown 863560	
Hi Limit	Honeywell L4008E1040	
Operating Control	Honeywell L6008A1010	
Flame Safeguard	Fireye TFM1D	
Low Gas Press. Switch	Antunes LGP-A	
Air Switch	Tridelta FS4377-542	
LWCO Flow Switch	Johnson F61KB	
Main Gas Valve (2)	1-1½" V48A2177	
Main Gas Press. Reg.	1-1½" RV60	
Main Gas Lub. Cock	1-½" 50-509-07	
Pilot Valve	½" V4046C	
Pilot Press. Reg.	¼" RV20L	
Pilot Cock	¼" 51-103-01	
Blower Motor	⅓ hp	
CODE OPTIONS		
Main Gas Valve	Honeywell V5055	
Main Gas Actuator	Honeywell V4055	
N.O. Vent Valve	ASCO 8215	
Hi Gas Press. Switch	Antunes HGP-A	
Flame Safeguard	Fireye TFM3	



THERMIFIC MODEL N-900

PATTERSON-KELLEY CO.
 Division of MARSCO Corporation
 East Stroudsburg, PA 18041 (717) 421-1400

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

JOB 3002-000

SHEET NO. _____ OF _____

CALCULATED BY KC DATE 9/23/91

CHECKED BY _____ DATE _____

SCALE _____

5676/78

NEW 4W PUMP

PIPING TO 5676

$$\frac{4,880,000 \text{ BTU/h}}{500 \cdot 60^\circ \Delta T} = 163 \text{ GPM}$$

$$1000', 163 \text{ GPM}, 4" \text{ LINE}, 3'/100 = 30' \text{ HD}$$

$$\begin{array}{l} 163 \text{ GPM} \\ 30' \text{ HD.} \end{array} \rightarrow \text{TO } 5676$$

$$2,272,000 \text{ BTU/h}$$

$$\frac{4544000}{500 \cdot 60^\circ \Delta T} = 151 \text{ GPM}$$

FOR 5678

$$2 \text{ PUMPS, } (163 + 151) / 2 = 157 \text{ GPM}$$

each

$$30' \text{ HD}$$

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

JOB 3002-000

SHEET NO.

OF

CALCULATED BY

KC

DATE

9/23/91

CHECKED BY

DATE

SCALE

NEW CHW PUMPS

5676/78

190 TONS EACH

GPM @ 15°ΔT

$$\frac{190 \times 12000}{500 \cdot 15} = 304 \text{ GPM} \leftarrow 2 @$$

PD, 15 FT EVAPORATOR

1000', 4" LINE, 5' / 100' = 50'

TOTAL 65' HD

NEW CNW PUMPS

$$190 \times \frac{3 \text{ GPM}}{\text{TON}} = 570 \text{ GPM} \leftarrow 2 @$$

PD = 15 FT CONDENSER

300', 5" LINE, 5' / 100 FT

15 FT TOTAL

HEAD 10 FT

TOTAL 40' LC

Series 1510 Pump Selection **304.0 gpm** **65.0 ft.**
Rank Selections by Efficiency or Cost (E/C)? E

Rank	Series	Size	Eff. (%)	Dia. (in.)	RPM	Mtr HP	NOL BHP
1	1510	2-1/2BB	75.2	8.875	1750	7.500	7.600
2	1510	3BB	74.3	8.750	1750	7.500	8.078
3	1510	3G	73.9	13.000	1150	7.500	8.405
4	1510	4G	72.1	12.500	1150	7.500	8.784
5	1510	2-1/2AB	69.6	5.000	3500	7.500	7.614
6	1510	4BC	67.6	8.375	1750	7.500	10.979
7	1510	5G	66.4	12.125	1150	7.500	13.298
8	1510	3AB	55.4	5.250	3550	10.000	9.829
9	1510	5BC	48.1	8.500	1750	15.000	15.080

<— View a pump in more detail
 <— Choose pumps to analyze further
 <— Select Triple Duty Valve <— Select Suction Diffuser
 <— Return to Select Pumps

Pump Selection: Series 1510
 Performance Rank: 1 Cost rank: 3

Pump Size: 2-1/2BB Pump speed: 1750 RPM
 Total Capacity: 304.0 GPM Total Head: 65.0'
 Efficiency: 75.22% NPSH req: 8.73'
 Discharge size: 2.500" Velocity: 20.37 FPS
 Suction size: 3.000" Velocity: 13.19 FPS
 Impeller Diameter: 8.875"
 End-of-curve BHP: 7.600 (at design: 70.2%)
 Pump power, BHP: 6.632 (4.946 Kw)
 Motor power, HP: 7.500 (BHP/HP = 0.88)

Motor: SE AC MOTOR 230/460V 213T-24 A 346257
 7.500 HP 1745 RPM 4 poles 60.000 HZ 3 phase

Voltage: 230/460 RPM: 1754.5 Eff: 85.44%
 AMP: 17.86/ 8.93 P.F.: 81.37% KVA: 7.114

Annual Operating Cost per pump = \$ 5070.98
 for 8760 hours annually at \$0.10 / kwh

Series 1510 Pump Selection 570.0 gpm 40.0 ft.
Rank Selections by Efficiency or Cost (E/C)? E

Rank	Series	Size	Eff. (%)	Dia. (in.)	RPM	Mtr HP	NOL BHP
1	1510	5E	84.6	10.250	1150	7.500	7.898
2	1510	4AC	84.0	7.000	1750	7.500	7.174
3	1510	4BC	80.9	7.375	1750	7.500	7.412
4	1510	5A	79.9	7.000	1750	7.500	7.832
5	1510	5G	78.7	10.500	1150	7.500	8.235
6	1510	6G	72.9	10.125	1150	10.000	11.137
7	1510	5BC	72.4	7.125	1750	10.000	8.581
8	1510	6E	68.8	10.250	1150	10.000	11.765
9	1510	3BB	57.5	9.375	1750	10.000	9.881
10	1510	3AB	55.2	5.375	3550	15.000	11.289

☐ View a pump in more detail
☐ Choose pumps to analyze further
☐ Select Triple Duty Valve ☐ Select Suction Diffuser
☐ Return to Select Pumps

Pump Selection: Series 1510
Performance Rank: 1 Cost rank: 7

Pump Size: 5E Pump speed: 1150 RPM
 Total Capacity: 570.0 GPM Total Head: 40.0'
 Efficiency: 84.55% NPSH req: 4.57'
 Discharge size: 5.000" Velocity: 9.14 FPS
 Suction size: 6.000" Velocity: 6.33 FPS
 Impeller Diameter: 10.250"
 End-of-curve BHP: 7.898 (at design: 61.3%)
 Pump power, BHP: 6.808 (5.077 Kw)
 Motor power, HP: 7.500 (BHP/HP = 0.91)

Motor: SE AC MOTOR 230/460V A 254-24 A 353117
 7.500 HP 1155 RPM 6 poles 60.000 HZ 3 phase

Voltage: 230/460 RPM: 1162.1 Eff: 85.76%
 AMP: 20.91/ 10.46 P.F.: 71.05% KVA: 8.331

Annual Operating Cost per pump = \$ 5185.32
 for 8760 hours annually at \$0.10 / kwh

Series 1510 Pump Selection 1576.0 gpm 30.0 ft.
 Rank Selections by Efficiency or Cost (E/C)? E

Rank	Series	Size	Eff. (%)	Dia. (in.)	RPM	Mtr HP	NOL BHP
1	1510	6E	80.7	10.875	1150	15.000	14.649
2	1510	6BC	72.7	7.750	1770	20.000	17.658
3	1510	6G	64.4	11.750	1150	20.000	18.827

☐ View a pump in more detail
☐ Choose pumps to analyze further
☐ Select Triple Duty Valve ☐ Select Suction Diffuser
☐ Return to Select Pumps

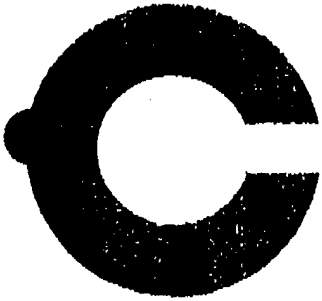
Pump Selection: Series 1510
 Performance Rank: 1 Cost rank: 2

Pump Size: 6E Pump speed: 1150 RPM
 Total Capacity: 1576.0 GPM Total Head: 30.0'
 Efficiency: 80.71% NPSH req: 10.80'
 Discharge size: 6.000" Velocity: 17.50 FPS
 Suction size: 8.000" Velocity: 10.11 FPS
 Impeller Diameter: 10.875"
 End-of-curve BHP: 14.649 (at design: 93.4%)
 Pump power, BHP: 14.789 (11.028 Kw)
 Motor power, HP: 15.000 (BHP/HP = 0.99)

Motor: SE AC MOTOR 230/460V 284-09 R 368454
 15.000 HP 1176 RPM 6 poles 60.000 HZ 3 phase

Voltage: 230/460 RPM: 1177.0 Eff: 87.71%
 AMP: 41.63/ 20.81 P.F.: 75.82% KVA: 16.582

Annual Operating Cost per pump = \$ 11014.19
 for 8760 hours annually at \$0.10 / kwh

**CLARY & ASSOCIATES, INC.**645 Dutch Valley Rd. N.E. • Atlanta, Georgia 30324
Area Code 404 Telephone 873-1861**FAX MESSAGE**TO: CARL LUNDSTROM DEPT: _____COMPANY: E.M.C. ENGINEERS, INC. FAX #: _____FROM: CHARLIE WHEELER DATE: 09/18/91SUBJECT: FT. SILL CENTRAL PLANTMESSAGE: CARL - HERE ARE THE BUDGET PRICES WHICH YOUREQUESTED. SHOULD YOU HAVE ANY QUESTIONS, PLEASECALL

THANKS,

Charlie Wheeler

CHARLIE WHEELER

REPLY: _____

CLARY & ASSOCIATES FAX # 404 873-1867

NUMBER OF PAGES INCLUDING THIS PAGE

product

J.R.48

3002.000

JOB

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

SHEET NO.

OF

CALCULATED BY

DATE

9/17/91

CHECKED BY

DATE

SCALE

Brief InformationGas Fired Boiler

Thermifire rate

765,000 BTU/HR

\$5430.00

"

"

1020,000 BTU/HR

\$6135.00

Pumps

Bldg.	gpm.	FL HD	BELL & GOSSET Pump #	DIAMETER	PRICE (\$)
3500	3442	157	183	1531-2AC, 15HP 6.875"	\$1138.00
1750	3442	147	30	1510-2AC, 2HP 6.0	\$995.00
1750	5678	309	65	1510-3BB, 10HP 6.875"	\$1450.00
1750	" "	570	40	1510-4AC, 7.5HP 10.25"	\$1475.00
1750	" "	1576	30	1510-6BC, 20HP 10.875"	\$1508.00
3500	2812	67	144	1531-1 1/4 AC, 7.5HP 5.875"	\$790.00
1750	" "	410	95	1531-3E, 20HP 10.5"	\$2275.00
1750	" "	1026	55	1531-5E 20HP 8.875"	\$2375.00

All Prices For Shipping Point And Are BUDGET PRICES ONLY

CHARLIE WHEELER

CLARK & ASSOC.

9/17/91

APPENDIX J.2
PC-CUBE BASERUN

BUILDING 5676

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

SYSTEM C1 NORMAL HEATING AND COOLING

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	1
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

			C1								
GENERATOR SYSTEM TYPE			0								
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2
GENERATOR START TIME	0	0	0								
GENERATOR STOP TIME	0	0	0								

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	1183000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	20.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.27			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	23.	0.	0.	0.
20	32.	0.	0.	0.
30	41.	0.	0.	0.
40	51.	0.	0.	0.
50	61.	0.	0.	0.
60	73.	0.	0.	0.
70	87.	0.	0.	0.
80	119.	0.	0.	0.
90	123.	0.	0.	0.
100	145.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	1800000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	533750.
20	671000.
30	994300.
40	1308450.
50	1616500.
60	1918450.
70	2211250.
80	2497950.
90	2775500.
100	3050000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	1710000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	506300.
20	646600.
30	963800.
40	1274900.
50	1582950.
60	1884900.
70	2183800.
80	2476600.
90	2766350.
100	3050000.

PC-CUBE

CENTRAL PLANT 5676 BASELINE

NUMBER OF EACH DAY TYPE PER MONTH

MONTH	DAY TYPE		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR

MONTH	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	3279.0	780.0	.0	.0	.0	.0	.0	.0
FEB	3279.0	553.0	.0	.0	.0	.0	.0	.0
MAR	3279.0	395.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	369.0	66.0	.0	.0	.0	.0
JUN	.0	.0	1582.0	141.0	.0	.0	.0	.0
JUL	.0	.0	1582.0	168.0	.0	.0	.0	.0
AUG	.0	.0	1582.0	168.0	.0	.0	.0	.0
SEP	.0	.0	1582.0	114.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	549.0	279.0	.0	.0	.0	.0	.0	.0
DEC	3279.0	596.0	.0	.0	.0	.0	.0	.0
TOTAL		2603.0		657.0		.0		.0

PC-CUBE

CENTRAL PLANT 5676 BASELINE

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
6	1.000	1.000	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
20	1.000	1.000	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
21	1.000	1.000	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION			
	HEATING	COOLING	ELECTRIC
START HOUR	0	0	0
END HOUR	24	24	0
NO DAY TYPES	2	2	0
ADJUST LIMIT	.30	.30	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	4780.
PEAK DAY GAS CONSUMP., 1000 CU FT	51.
ELECTRICAL CONSUMPTION, KWH	200468.
PEAK KW DEMAND (15 MIN BASIS)	165.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	200468.
ON-PEAK KW DEMAND (15 MIN BASIS)	165.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3391
BOILER 2	363
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 9

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	2380000.	3641	104
JUL	2380000.	4385	110
AUG	2380000.	5129	111
SEP	2380000.	5873	104
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	NORMAL HEATING AND COOLING										TOTAL
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	
1	3061	30	36	57	4	16	8	6	8	446	3672
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	848	1185	587	286	122	0	0	0	363	3391
2	0	0	0	0	0	11	64	51	229	8	363

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

		***** PURCHASED ELECTRICAL *****				*****					
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	51.	1406.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	41.	1001.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	29.	762.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	58.	30.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	165.	42.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	165.	43.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	165.	43.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	165.	42.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	20.	530.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	40.	1081.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	3279.	787.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	3279.	556.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	3279.	399.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	31.	5535.	0.	0.	58.	30.	0.	0.	0.	0.
C1	6	132.	12104.	0.	0.	165.	42.	0.	0.	0.	0.
C1	7	132.	14124.	0.	0.	165.	43.	0.	0.	0.	0.
C1	8	132.	14124.	0.	0.	165.	43.	0.	0.	0.	0.
C1	9	132.	11865.	0.	0.	165.	42.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	549.	278.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	3279.	600.	0.	0.	0.	0.	0.	0.

BUILDING 5678

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

SYSTEM C1 NORMAL HEATING AND COOLING

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	1
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

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CENTRAL PLANT 5678 BASELINE

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200	
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000	
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000	
STARTING MONTH FOR SUMMER GAS RATE	0	
ENDING MONTH FOR SUMMER GAS RATE	0	
AUXILIARY FUEL COST PER UNIT	.00000	

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	2188000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	25.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.21			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	22.	0.	0.	0.
20	31.	0.	0.	0.
30	42.	0.	0.	0.
40	53.	0.	0.	0.
50	65.	0.	0.	0.
60	77.	0.	0.	0.
70	88.	0.	0.	0.
80	101.	0.	0.	0.
90	116.	0.	0.	0.
100	130.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	1500000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	445880.
20	559480.
30	840640.
40	1124640.
50	1405800.
60	1689800.
70	1976640.
80	2263480.
90	2550320.
100	2840000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	1630000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	485640.
20	587880.
30	877560.
40	1164400.
50	1448400.
60	1732400.
70	2013560.
80	2289040.
90	2567360.
100	2840000.

PC-CUBE

CENTRAL PLANT 5678 BASELINE

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR						PROCESS	
	HEATING		COOLING		ELECTRIC		PEAK THOUSAND BTU/HR	LOAD MILLION BTU
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH		
JAN	3908.0	899.0	.0	.0	.0	.0	.0	.0
FEB	3908.0	637.0	.0	.0	.0	.0	.0	.0
MAR	3908.0	456.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	425.0	76.0	.0	.0	.0	.0
JUN	.0	.0	2056.0	162.0	.0	.0	.0	.0
JUL	.0	.0	2056.0	193.0	.0	.0	.0	.0
AUG	.0	.0	2056.0	194.0	.0	.0	.0	.0
SEP	.0	.0	2056.0	131.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	633.0	321.0	.0	.0	.0	.0	.0	.0
DEC	3908.0	687.0	.0	.0	.0	.0	.0	.0
TOTAL		3000.0		756.0		.0		.0

PC-CUBE

CENTRAL PLANT 5678 BASELINE

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
6	1.000	1.000	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
20	1.000	1.000	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
21	1.000	1.000	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	24	0	0
NO DAY TYPES	2	2	0	0
ADJUST LIMIT	.30	.30	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	5639.
PEAK DAY GAS CONSUMP., 1000 CU FT	61.
ELECTRICAL CONSUMPTION, KWH	190992.
PEAK KW DEMAND (15 MIN BASIS)	146.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	190992.
ON-PEAK KW DEMAND (15 MIN BASIS)	146.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3508
BOILER 2	473
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 9

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	4686000.	45	93
FEB	4686000.	765	84
MAR	4686000.	1461	93
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	4686000.	8061	93

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	NORMAL HEATING AND COOLING										TOTAL
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	2877	93	0	0	0	0	0	0	111	255	3672
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	511	573	920	442	290	184	59	19	510	3508
2	14	30	11	13	25	3	14	0	0	363	473

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

		GAS		***** PURCHASED ELECTRICAL *****							
		DEMAND	CONSUMP	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		MCF	MCF	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
				KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	61.	1677.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	49.	1187.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	32.	896.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	51.	32.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	146.	39.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	146.	40.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	146.	40.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	146.	39.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	23.	598.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	47.	1281.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVEL HEAT USED MMBTU	RECOVEL HEAT UNUSED MMBTU
C1	1	0.	0.	3908.	903.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	3908.	642.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	3908.	460.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	35.	6374.	0.	0.	51.	32.	0.	0.	0.	0.
C1	6	171.	15429.	0.	0.	146.	39.	0.	0.	0.	0.
C1	7	171.	16410.	0.	0.	146.	40.	0.	0.	0.	0.
C1	8	171.	16459.	0.	0.	146.	40.	0.	0.	0.	0.
C1	9	171.	15419.	0.	0.	146.	39.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	633.	320.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	3908.	693.	0.	0.	0.	0.	0.	0.

APPENDIX J.3
PC-CUBE ECO RUN

HEATING AND COOLING LOADS FOR CENTRAL PLANT 5678

25-Sep-91

PEAK HEATING (THOUSAND BTU)												
BLDG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5676	3,279	3,279	3,279	0	0	0	0	0	0	0	549	3,279
5678	3,908	3,908	3,908	0	0	0	0	0	0	0	633	3,908
Subtotal	7,187	7,187	7,187	0	0	0	0	0	0	0	1,182	7,187
Disp. Loss 10%	719	719	719	0	0	0	0	0	0	0	118	719
TOTAL	7,906	7,906	7,906	0	0	0	0	0	0	0	1,300	7,906

HEATING CONSUMPTION (MBTU)												
BLDG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5676	780	553	395	0	0	0	0	0	0	0	279	596
5678	899	637	456	0	0	0	0	0	0	0	321	687
Subtotal	1,679	1,190	851	0	0	0	0	0	0	0	600	1,283
Disp. Loss 10%	168	119	85	0	0	0	0	0	0	0	60	128
TOTAL	1,847	1,309	936	0	0	0	0	0	0	0	660	1,411

PEAK COOLING (THOUSAND BTU)												
BLDG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5676	0	0	0	0	369	1,582	1,582	1,582	1,582	0	0	0
5678	0	0	0	0	425	2,056	2,056	2,056	2,056	0	0	0
Subtotal	0	0	0	0	794	3,638	3,638	3,638	3,638	0	0	0
Disp. Loss 10%	0	0	0	0	79	364	364	364	364	0	0	0
TOTAL	0	0	0	0	873	4,002	4,002	4,002	4,002	0	0	0

COOLING CONSUMPTION (MBTU)												
BLDG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5676	0	0	0	0	66	141	168	168	114	0	0	0
5678	0	0	0	0	76	162	193	194	131	0	0	0
Subtotal	0	0	0	0	142	303	361	362	245	0	0	0
Disp. Loss 10%	0	0	0	0	14	30	36	36	25	0	0	0
TOTAL	0	0	0	0	156	333	397	398	270	0	0	0

* NOTE: FOR CENTRAL HEATING PLANT PROJECT, NO COOLING LOADS ARE NOT APPLICABLE.

PC/MS DOS VERSION 2.0.3 OF PC-CUBE
CENTRAL PLANT AND UTILITY REQUIREMENTS FOR BUILDING ENERGY SYSTEMS

THIS MICROCOMPUTER VERSION IS FURNISHED BY
ENERGY SYSTEMS ENGINEERS, INC.
2530 S. PARKER RD. SUITE 300
AURORA, CO 80014

PC-CUBE VERSION 2.0.3

CENTRAL HEATING PLANT 5678 FOR BLDG. 5676 AND 5678

SYSTEM C1 NEW BOILER AND CHILLER FOR NORMAL HEATING AND COOLING LO

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	0
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

BOILER/HEATER IDENTIFICATION NUMBERS

C1 1 2 2 2 1 2 2 2 0 0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL HEATING PLANT 5678 FOR BLDG. 5676 AND 5678

	C1								
GENERATOR SYSTEM TYPE	0								
DAYTYPE	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0						
GENERATOR STOP TIME	0	0	0						

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL HEATING PLANT 5678 FOR BLDG. 5676 AND 5678

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	1020000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	228000.
20	343200.
30	442800.
40	541200.
50	644400.
60	750000.
70	861600.
80	974400.
90	1087200.
100	1200000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	1020000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	228000.
20	343200.
30	442800.
40	541200.
50	644400.
60	750000.
70	861600.
80	974400.
90	1086000.
100	1200000.

PC-CUBE

CENTRAL HEATING PLANT 5678 FOR BLDG. 5676 AND 5678

NUMBER OF EACH DAY TYPE PER MONTH

MONTH	DAY TYPE		
	1	2	3

JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR

MONTH	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK	LOAD	PEAK	LOAD	DEMAND	LOAD	PEAK	LOAD
	THOUSAND BTU/HR	MILLION BTU	THOUSAND BTU/HR	MILLION BTU	KILOWATT	THOUSAND KWH	THOUSAND BTU/HR	MILLION BTU
JAN	7906.0	1847.0	.0	.0	.0	.0	.0	.0
FEB	7906.0	1309.0	.0	.0	.0	.0	.0	.0
MAR	7906.0	936.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	.0	.0	.0	.0	.0	.0
JUN	.0	.0	.0	.0	.0	.0	.0	.0
JUL	.0	.0	.0	.0	.0	.0	.0	.0
AUG	.0	.0	.0	.0	.0	.0	.0	.0
SEP	.0	.0	.0	.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	1300.0	660.0	.0	.0	.0	.0	.0	.0
DEC	7906.0	1411.0	.0	.0	.0	.0	.0	.0
TOTAL		6163.0		.0		.0		.0

PC-CUBE

CENTRAL HEATING PLANT 5678 FOR BLDG. 5676 AND 5678

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
6	1.000	1.000	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
20	1.000	1.000	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
21	1.000	1.000	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION							
		HEATING	COOLING			ELECTRIC	PROCESS
START HOUR	0		0			0	0
END HOUR	24		24			0	0
NO DAY TYPES	2		2			0	0
ADJUST LIMIT	.30		.30			.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL HEATING PLANT 5678 FOR BLDG. 5676 AND 5678

** TOTAL **

SYSTEM C1 NEW BOILER AND CHILLER FOR NORMAL HEATING AND COOLING LO

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7464.
PEAK DAY GAS CONSUMP., 1000 CU FT	82.
ELECTRICAL CONSUMPTION, KWH	0.
PEAK KW DEMAND (15 MIN BASIS)	0.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	0.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2062
BOILER 3	516
BOILER 4	363
BOILER 5	363
BOILER 6	363
BOILER 7	363
BOILER 8	279
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 7

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 8

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL HEATING PLANT 5678 FOR BLDG. 5676 AND 5678

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	NEW BOILER AND CHILLER FOR NORMAL HEATING AND COOLING LO											TOTAL
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100		
1	0	0	0	0	0	0	0	0	0	0		0
2	0	0	0	0	0	0	0	0	0	0		0
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100		TOTAL
1	0	0	127	319	190	55	63	224	227	2419		3624
2	326	311	259	173	91	79	88	112	47	576		2062
3	107	46	0	0	0	0	0	0	0	363		516
4	0	0	0	0	0	0	0	0	0	363		363
5	0	0	0	0	0	0	0	0	0	363		363
6	0	0	0	0	0	0	0	0	0	363		363
7	0	0	0	0	0	0	12	9	39	303		363
8	0	0	24	0	24	18	21	192	0	0		279

PC-CUBE VERSION 2.0.3

CENTRAL HEATING PLANT 5678 FOR BLDG. 5676 AND 5678

		GAS		***** PURCHASED ELECTRICAL *****		*****				AUX	
		DEMAND	CONSUMP	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	FUEL	FUEL
		MCF	MCF	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	CONSUMP	HRS
				KW	THOU KWH	KW	THOU KWH	KW	THOU KWH		
C1	1	82.	2213.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	66.	1589.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	42.	1160.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	31.	790.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	63.	1711.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL HEATING PLANT 5678 FOR BLDG. 5676 AND 5678

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	7906.	1854.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	7906.	1318.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	7906.	945.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	1300.	657.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	7906.	1422.	0.	0.	0.	0.	0.	0.

APPENDIX K

PROJECT 3 - REPLACE BOILERS 1 AND 2 IN CENTRAL PLANTS 2812 AND 5900

APPENDIX K.1 - PROJECT ANALYSIS

APPENDIX K.2 - PC-CUBE BASERUN

APPENDIX K.3 - PC-CUBE ECO RUN

APPENDIX K.1
PROJECT ANALYSIS

**ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA**

CENTRAL PLANT: 2812 AND 5900
ENERGY CONSERVATION OPPORTUNITY: PROJECT 3
SYSTEM MODIFICATION: REPLACE BOILER 1 AND 2 IN CENTRAL PLANT 2812 AND 5900
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for project 3, replace existing boilers with higher efficiency boilers. The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas (MMBtu)	Total Energy (MMBtu)
	Demand(kW)	Energy(kWh)		
Baseline	1,882	5,538,208	105,073	123,975
ECO	1,868	5,416,208	75,913	94,399
Savings (Baseline-ECO)	14	122,000	29,160	29,576

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	416 MMBtu/Yr	X	\$4.0141 /MMBtu	=	\$1,671 per year
Nat. Gas:	29160 MMBtu/Yr	X	\$2.92 /MMBtu	=	\$85,147 per year
Total Energy Cost Savings:			\$1,671 + \$85,147	=	\$86,819 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand:	14 kW/month	X	\$1.787 /kW	X	12 months/year
	= (+)		\$300 per year		
Maintenance:	= (-)		\$3,400 per year		
Total:	\$300	-	\$3,400	=	(\$3,100) per year

[ECO-SHT2.WK3]

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: PROJECT3
LCCID 1.062

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

INSTALLATION & LOCATION: FT. SILL, OKLA REGION NOS. 6 CENSUS: 3

PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS

FISCAL YEAR 1991 DISCRETE PORTION NAME: REPLACE BOILER 1&2 IN 5900&2812

ANALYSIS DATE: 04-07-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 467813.
B. SIOH	\$ 25730.
C. DESIGN COST	\$ 28069.
D. SALVAGE VALUE COST	-\$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ 521612.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 4.01	416.	\$ 1670.	15.61	26066.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 2.92	29160.	\$ 85147.	23.77	2023949.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		29576.	\$ 86817.		\$ 2050015.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$ -3100.
(1) DISCOUNT FACTOR (TABLE A)	14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$ -45043.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$ -45043.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 676505.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F) _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS\ ECONOMIC\ LIFE))$ \$ 83717.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 2004972.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 3.84
(IF < 1 PROJECT DOES NOT QUALIFY)

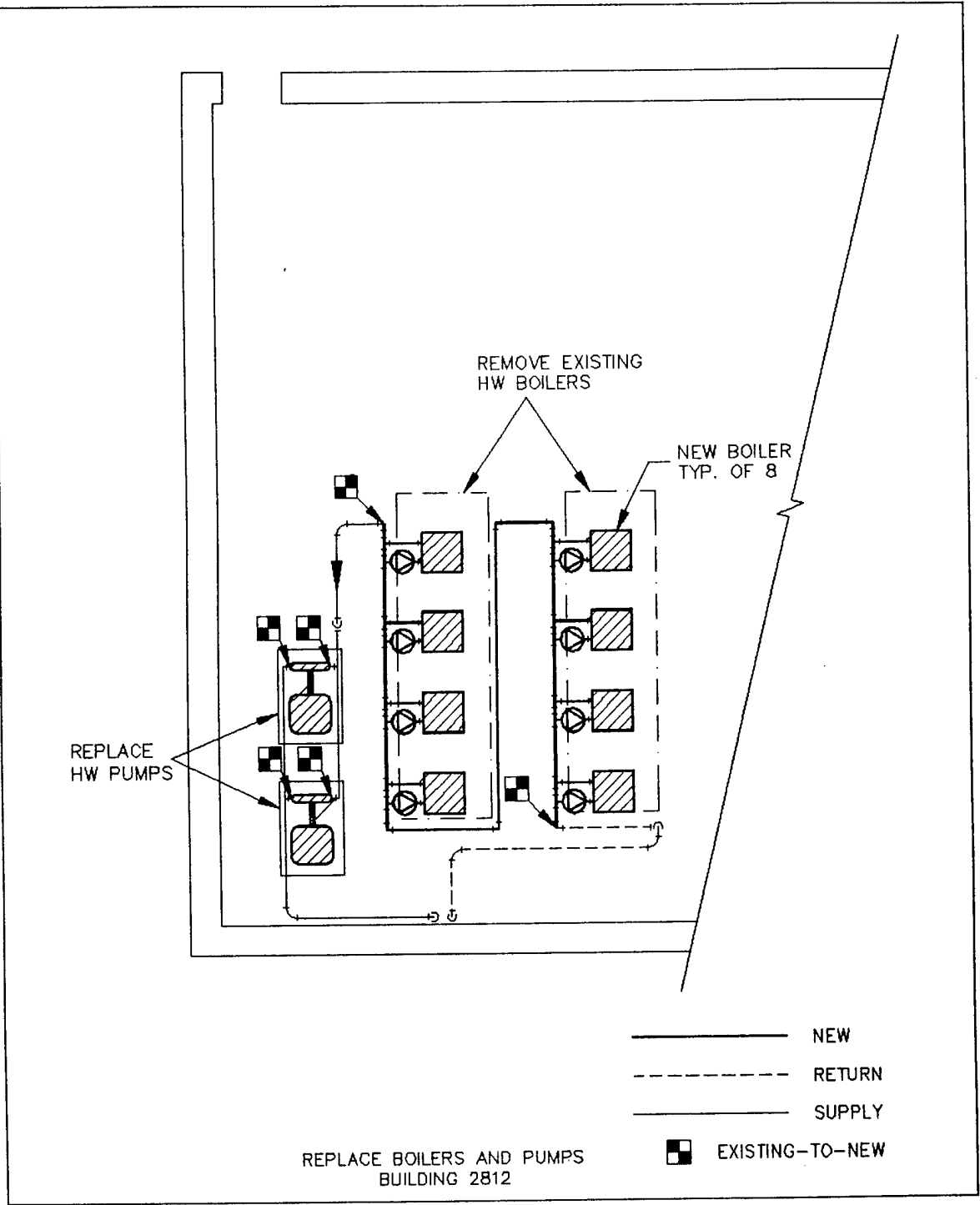
7. SIMPLE PAYBACK PERIOD (ESTIMATED) $SPB=1F/4$ 6.23

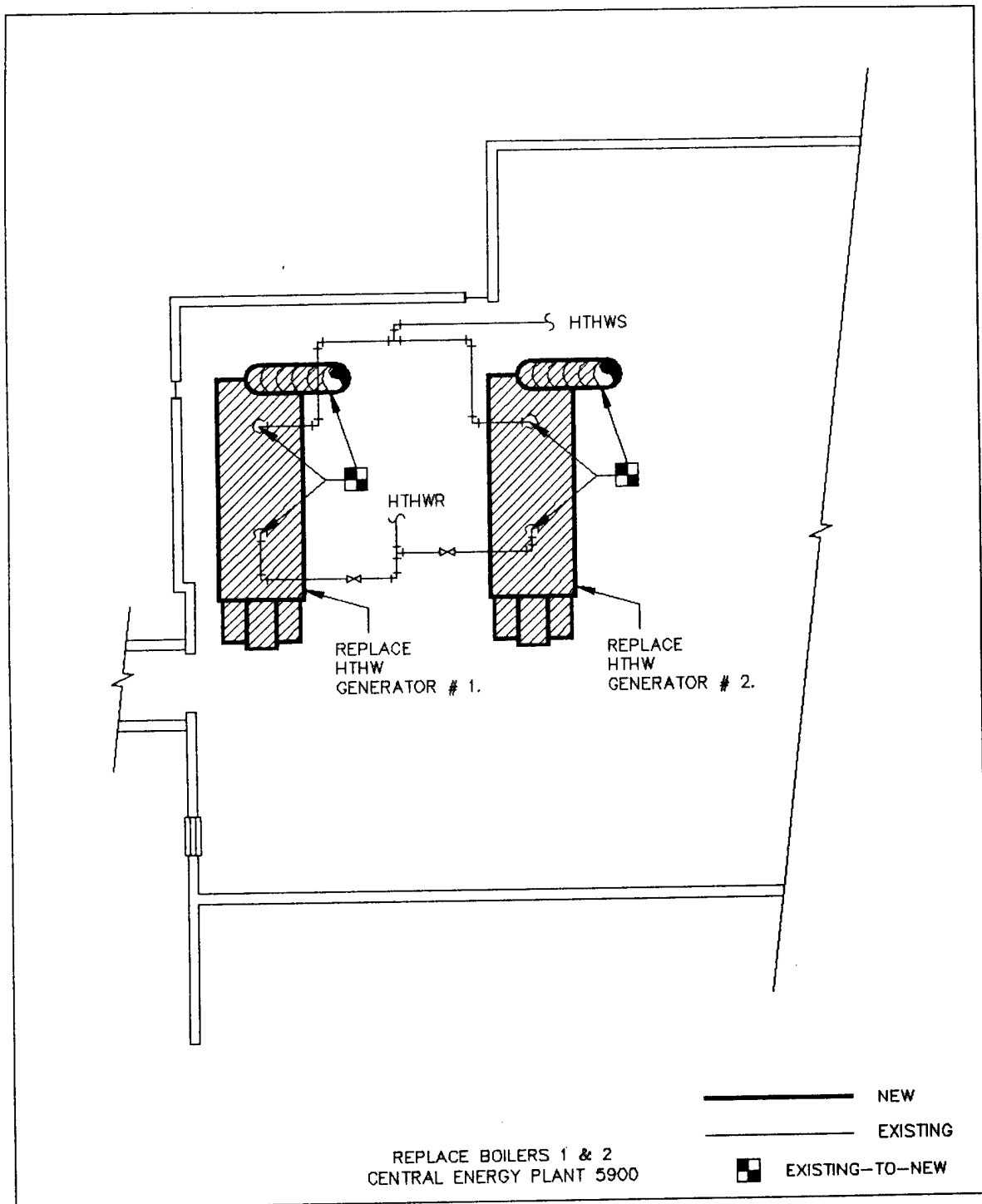
COST ESTIMATE ANALYSIS

PROJECT		LOCATION		INVITATION NO./CONTRACT NO.				EFFECTIVE PRICING		DATE PREPARED	
REPLACE BOILER 1 & 2, BLDG. 5900 & 6003		FT. SILL, OKLAHOMA		DACA 59-90-C-0087				DATE APR. 91		26-Sep-91	
				CODE A ☐ CODE B ☒ CODE C ☐				DRAWING NO.		SHT OF	
				OTHER				ESTIMATOR		CHECKED BY	
		Quantity		LABOR		EQUIPMENT		MATERIAL		SHIPPING	
		No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Wt	Total Wt
TASK DESCRIPTION											
REPLACE BOILERS, BLDG. 5900											
HTHW BOILER, 1 & 2		2	EA					40,000			80,000
PIPING, MISC.		1	LS					5,000			5,000
INSULATION		1	LS					500			500
START-UP		2	EA					5,000			10,000
CONTROLS		2	EA					20,000			40,000
DEMOLITION, REMOVAL, INSTL BOILERS		2	EA					25,000			50,000
STACK & BREACHING		2	EA					6,000			12,000
REPLACE BOILERS, BLDG. 2812											
HW BOILER		8	EA					9,000			72,000
HW PUMPS		2	EA					3,900			7,800
PIPING, MISC.		1	LS					4,000			4,000
INSULATION		1	LS					500			500
START-UP		1	EA					5,000			5,000
STARTERS		2	EA					300			600
DEMOLITION, BOILERS		2	EA					1,000			2,000
STACK & BREACHING		8	EA					1,000			8,000
CONTROLS		1	LS					12,000			12,000
SUBTOTAL											
OVERHEAD, BOND		16%									\$309,400
PROFIT		10%									\$49,504
COST SUB-TOTAL											\$389,844
CONTINGENCY		20%									\$77,969
SUBTOTAL											\$467,813
S&A		5.5%									\$25,730
TOTAL THIS SHEET											
											\$493,543

SYMBOLS LEGEND

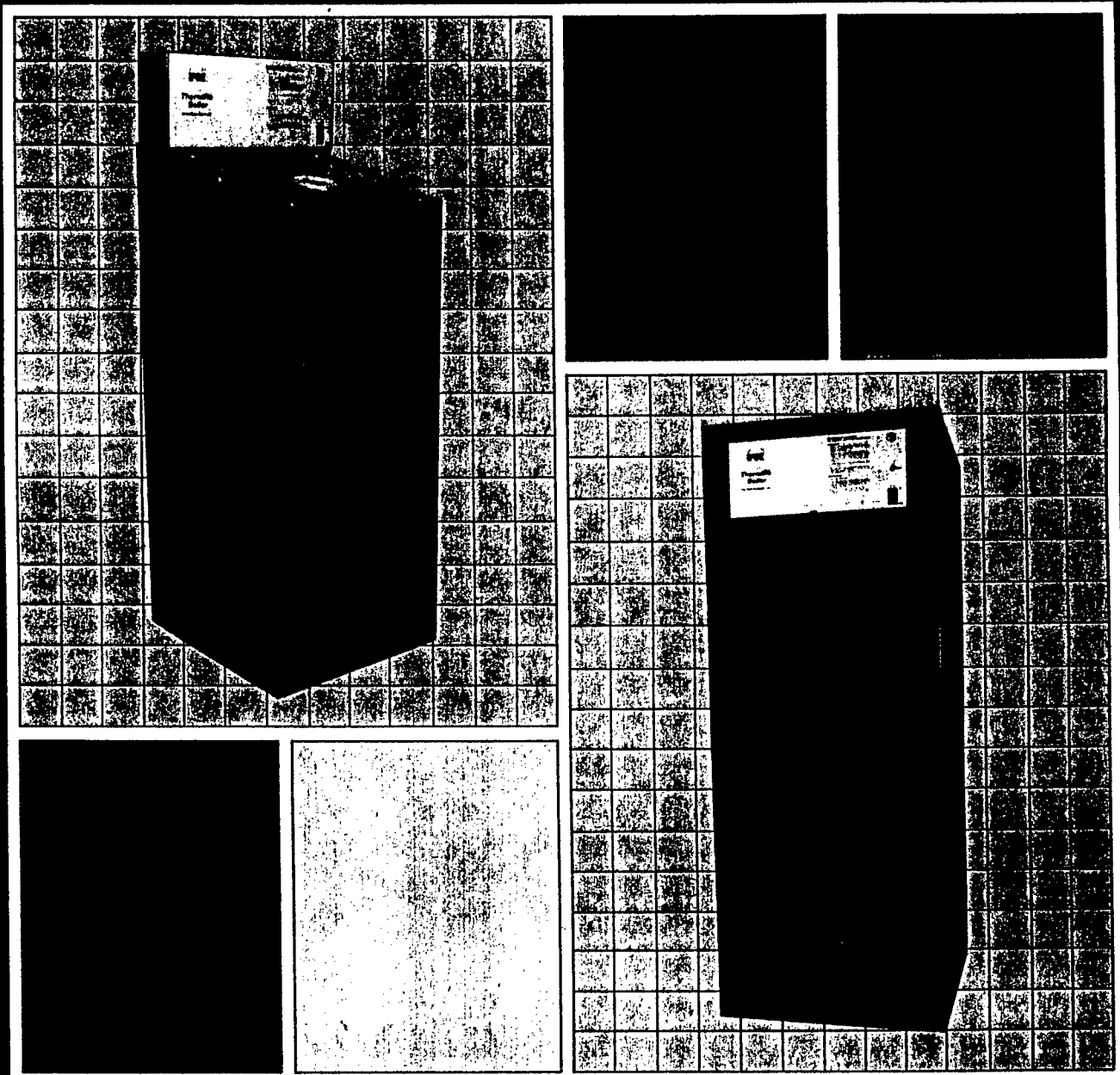
	ALARM CONTACT SIGNAL
	FLOW INDICATION
	PRESSURE INDICATION
	METER
	ON-OFF STATUS SIGNAL
	DIFFERENTIAL PRESSURE SWITCH
	START-UP INTERFACE
	TEMPERATURE INDICATION
	FLUE GAS ANALYSIS, OXYGEN
	KILOWATT METER
	EXISTING-TO-NEW





P-K Thermific® Gas-Fired Boiler

A New Standard of Efficiency in Non-Condensing Boilers

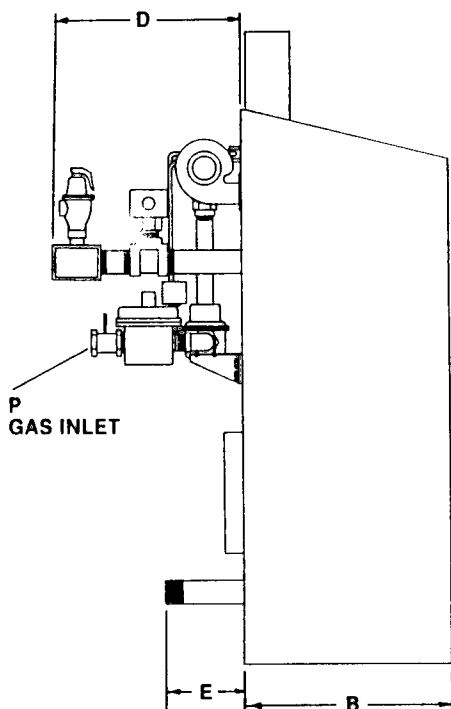


PATTERSON-KELLEY CO.

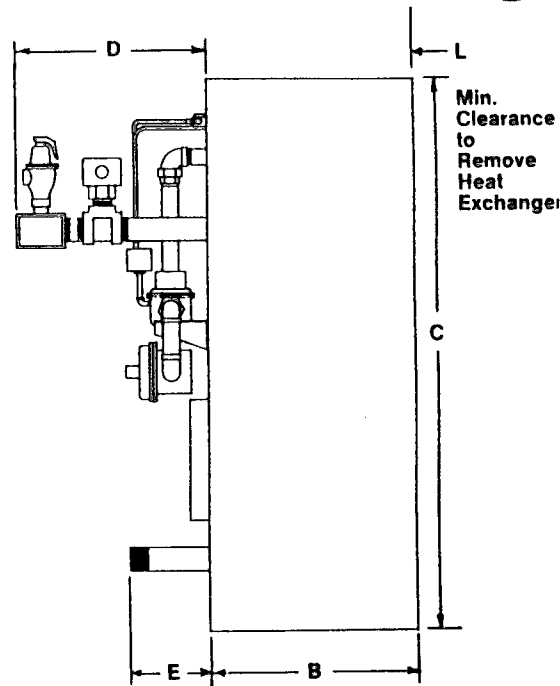
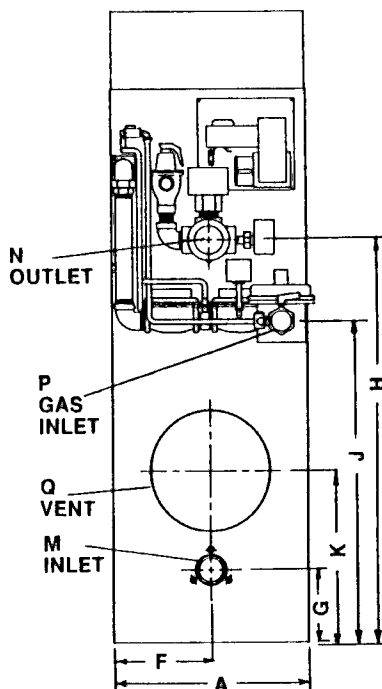
Division of HARSCO Corporation Phone: 717-421-7500
East Stroudsburg, PA 18301 Fax: 717-421-8735



Capacities and Dimensions



Models: N-700, N-900, N-1200



Models: N-1500, N-1700, N-1900

Capacities and Dimensions

Dimensions in Inches

Model No.	BTU INPUT	BTU OUTPUT	A	B	C	D	E	F	G	H	J	K	L	M MPT	N FPT	P FPT	Q	Motor H.P.
N-700	700,000	595,000	19 ⁵ / ₈	21	56 ¹ / ₂	14	5 ¹ / ₄	9 ³ / ₄	8 ¹ / ₄	31 ³ / ₄	23 ³ / ₄	17 ¹ / ₈	24	2	2	1 ¹ / ₄	10	1/3
N-900	900,000	765,000	19 ⁵ / ₈	21	56 ¹ / ₂	14	5 ¹ / ₄	9 ³ / ₄	8 ¹ / ₄	31 ³ / ₄	23 ³ / ₄	17 ¹ / ₈	24	2	2	1 ¹ / ₄	10	1/3
N-1200	1,200,000	1,020,000	19 ⁵ / ₈	21	66 ⁷ / ₈	14	5 ¹ / ₄	9 ³ / ₄	8 ¹ / ₄	41 ¹ / ₄	22 ¹ / ₄	17 ¹ / ₈	24	2	2	1 ¹ / ₂	10	1/2
N-1500	1,500,000	1,275,000	25 ⁵ / ₈	26 ¹ / ₄	67	15	5 ¹ / ₂	12 ³ / ₄	8 ⁷ / ₈	47 ¹ / ₂	29	19 ¹ / ₈	29	2 ¹ / ₂	2 ¹ / ₂	2	12	3/4
N-1700	1,700,000	1,445,000	25 ⁵ / ₈	26 ¹ / ₄	67	15	5 ¹ / ₂	12 ³ / ₄	8 ⁷ / ₈	47 ¹ / ₂	29	19 ¹ / ₈	29	2 ¹ / ₂	2 ¹ / ₂	2	12	3/4
N-1900	1,900,000	1,615,000	25 ⁵ / ₈	26 ¹ / ₄	67	15	5 ¹ / ₂	12 ³ / ₄	8 ⁷ / ₈	47 ¹ / ₂	29	19 ¹ / ₈	29	2 ¹ / ₂	2 ¹ / ₂	2	12	3/4

A.G.A. Design-Certified for natural gas. ASME Certified for 160 PSIG, Section IV. National Board Registered.

Standard Features

- Pressure-temperature gauge
- Water flow switch
- ASME pressure relief valve
- Two diaphragm main gas valves
- Main gas pressure regulator (14" W.C. max. inlet)
- Low gas pressure switch (manual reset)
- Main gas plug cock
- Solenoid pilot gas valve
- Pilot gas filter
- Pilot gas pressure regulator
- Pilot gas cock
- Interrupted spark-ignited pilot
- Flame safe-guard programmer
- Hi-limit temperature control with manual reset
- Operating temperature control
- Differential air pressure switch
- Radial-fired power burner
- Interlocked, finned, copper water tubes
- Adjustable inlet air shutter
- Blower assembly with "C" frame motor
- Ten-point diagnostic annunciator control panel
- 16-gauge (min.) steel outer cabinet
- 16-gauge aluminum inner cabinet
- Baked epoxy finish
- Adjustable levelers



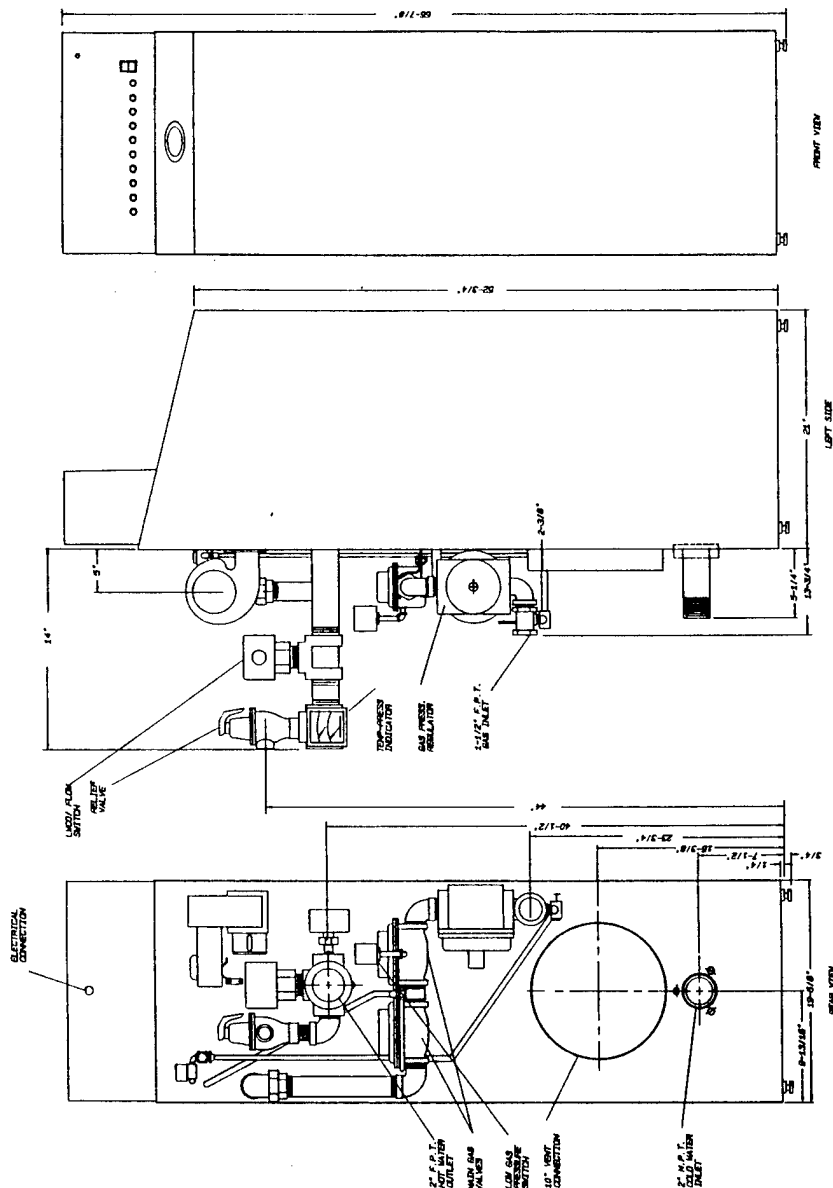
A.G.A. Design-Certified



C.G.A. Approved

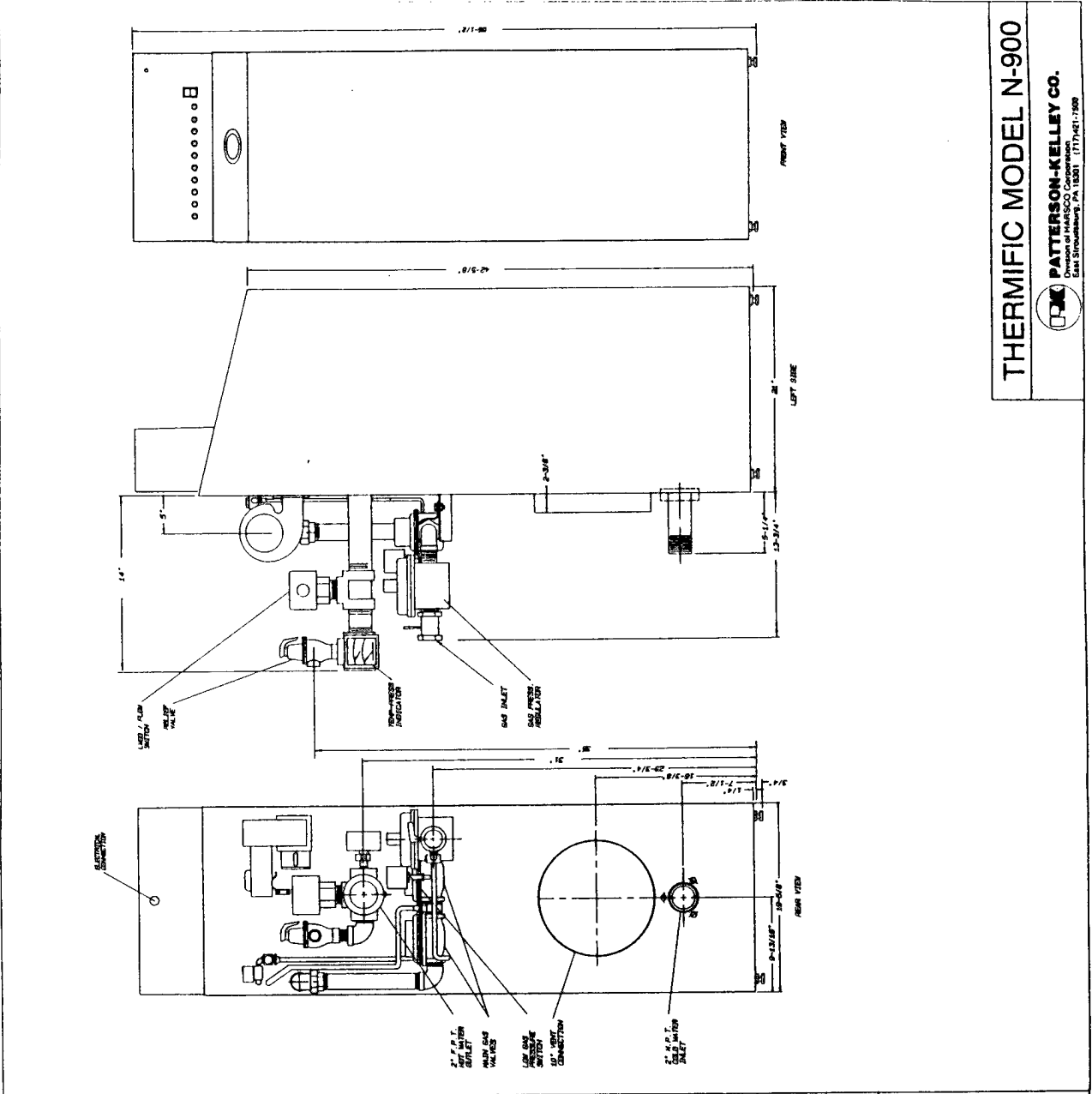


ASME Code, Section IV

[illegible]

PATTERSON-KELLEY CO.
Division of HARSCO Corporation
East Stroudsburg, PA 18301 (717)421-7500

A.G.A. CERTIFIED RATINGS & CAPACITIES	
Fuel	Natural Gas
Input Btu/hr.	900,000
Output Btu/hr.	765,000
Boiler H.P.	22.8
Max. Inlet Gas Pressure	14" W.C.
Min. Inlet Gas Pressure	4" W.C.
Electrical Characteristics	120/1/60
Operating Weight	455 lbs.
ASME	
Design Data	Max. 160 psig & 250°F
ASME Sect. IV Htg. Surface	94 sq. ft.
BOILER TRIM & CONTROLS	
Relief Valve	3/4" x 3/4" set @ 100 psi
Press. & Temp. Gauge	Marshalltown 863560
Hi Limit	Honeywell L4008E1040
Operating Control	Honeywell L6008A1010
Flame Safeguard	Fireye TFM1D
Low Gas Press. Switch	Antunes LGP-A
Air Switch	Tridelta FS4377-542
LWCO Flow Switch	Johnson F61KB
Main Gas Valve (2)	V48A2177
Main Gas Press. Reg.	RV60
Main Gas Lub. Cock	50-503-07
Pilot Valve	V4046C
Pilot Press. Reg.	RV20L
Pilot Cock	51-103-01
Blower Motor	1/3 hp
CODE OPTIONS	
Main Gas Valve	Honeywell V5055
Main Gas Actuator	Honeywell V4055
N.O. Vent Valve	ASCO 8215
Hi Gas Press. Switch	Antunes HGP-A
Flame Safeguard	Fireye TFM3



THERMIFLIC MODEL N-900

PATTERSON-KELLEY CO.
 Division of HARESCO Corporation
 1117 PAT-1-900
 1117 PAT-1-900

3002.000 FT. SILL C. PLANT STUDY

JOB

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

SHEET NO. 1

OF

CALCULATED BY CEL

DATE

CHECKED BY

DATE

SCALE

NONE

BUILDING 28128

NEW CHILLED WATER PUMP

342 TONS COOLING

20° ΔT , 60°F TO 40°F

410 GPM

95 FT. HD.

NEW CONDENSER WATER PUMP

1026 GPM, 85°F TO 95°F

55 FT. HD.

3002.000

JOB FT. SILL C. PLANT STUDY

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

SHEET NO. 2 OF _____

CALCULATED BY CEL DATE _____

CHECKED BY _____ DATE _____

SCALE NONE

BUILDING 2B12'

HW PUMP

67 GPM

44 HD FEET

Pump Selection: Series 1531
 Performance Rank: 1 Cost rank: 1

Pump Size: 5BC Pump speed: 1750 RPM
 Total Capacity: 1026.0 GPM Total Head: 55.0'
 Efficiency: 82.12% NPSH req: 13.09'
 Discharge size: 5.000" Velocity: 16.45 FPS
 Suction size: 6.000" Velocity: 11.39 FPS
 Impeller Diameter: 8.875"
 End-of-curve BHP: 17.768 (at design: 79.7%)
 Pump power, BHP: 17.350 (12.938 Kw)
 Motor power, HP: 20.000 (BHP/HP = 0.87)

Motor: SE AC MOTOR 230/460V 256-26 A 367369
 20.000 HP 1763 RPM 4 poles 60.000 HZ 3 phase

Voltage: 230/460 RPM: 1770.2 Eff: 88.47%
 AMP: 46.24/ 23.12 P.F.: 79.39% KVA: 18.421

Annual Operating Cost per pump = \$ 12810.45
 for 8760 hours annually at \$0.10 / kwh

Any Floor-Mounted Pump Selection 67.0 gpm 144.0 ft.
 Rank Selections by Efficiency or Cost (E/C)? E

Rank	Series	Size	Eff. (%)	Dia. (in.)	RPM	Mtr HP	NOL BHP
1	1531	1-1/4AC	56.6	5.875	3500	5.000	6.198
2	1510	1-1/4AC	56.6	5.875	3500	5.000	6.198
3	1531	1-1/2AB	52.8	5.875	3500	5.000	8.073
4	1510	1-1/2AB	52.8	5.875	3500	5.000	8.073
5	3531	1X1.5X6	52.3	6.000	3500	5.000	6.835
6	3510	1X1.5X6	52.3	6.000	3500	5.000	6.835
7	3531	1.25X1.5X6	52.3	6.000	3500	5.000	7.953
8	3510	1.25X1.5X6	52.3	6.000	3500	5.000	7.953
9	1531	2AC	45.0	6.125	3500	7.500	10.227
10	1510	2AC	45.0	6.125	3500	7.500	10.227

Pump Selection: Series 1531
 Performance Rank: 1 Cost rank: 3

Pump Size: 1-1/4AC Pump speed: 3500 RPM
 Total Capacity: 67.0 GPM Total Head: 144.0'
 Efficiency: 56.61% NPSH req: 8.54'
 Discharge size: 1.250" Velocity: 14.37 FPS
 Suction size: 1.500" Velocity: 10.56 FPS
 Impeller Diameter: 5.875"
 End-of-curve BHP: 6.198 (at design: 53.3%)
 Pump power, BHP: 4.303 (3.209 Kw)
 Motor power, HP: 5.000 (BHP/HP = 0.86)

Motor: SE AC MOTOR 230/460V 182T-31 A 354519
 5.000 HP 3504 RPM 2 poles 60.000 HZ 3 phase

Any Floor-Mounted Pump Selection 410.0 gpm 95.0 ft.
Rank Selections by Efficiency or Cost (E/C)? E

Rank	Series	Size	Eff. (%)	Dia. (in.)	RPM	Mtr HP	NOL BHP
1	1531	3E	76.9	10.500	1750	15.000	15.965
2	1510	3E	76.9	10.500	1750	15.000	15.965
3	1531	4E	75.5	10.250	1750	15.000	17.354
4	1510	4E	75.5	10.250	1750	15.000	17.354
5	1510	4G	72.6	10.250	1750	15.000	16.380
6	1510	3G	72.0	11.000	1750	15.000	15.827
7	VSCS	5X6X12L	68.7	9.625	1750	15.000	21.786
8	VSC	5X5X12L	68.2	9.750	1750	15.000	22.560
9	VSCS	6X8X12L	67.4	9.750	1750	15.000	25.037
10	VSC	6X6X12L	67.2	9.750	1750	15.000	23.450

☐ View a pump in more detail
☐ Choose pumps to analyze further
☐ Select Triple Duty Valve ☐ Select Suction Diffuser
☐ Return to Select Pumps

Pump Selection: Series 1531
Performance Rank: 1 Cost rank: 1

Pump Size: 3E Pump speed: 1750 RPM
 Total Capacity: 410.0 GPM Total Head: 95.0'
 Efficiency: 76.86% NPSH req: 7.89'
 Discharge size: 3.000" Velocity: 17.79 FPS
 Suction size: 4.000" Velocity: 10.33 FPS
 Impeller Diameter: 10.500"
 End-of-curve BHP: 15.965 (at design: 67.6%)
 Pump power, BHP: 12.794 (9.541 Kw)
 Motor power, HP: 15.000 (BHP/HP = 0.85)

Motor: SE AC MOTOR 230/460V A254-29 A 357416
15.000 HP 1752 RPM 4 poles 60.000 HZ 3 phase

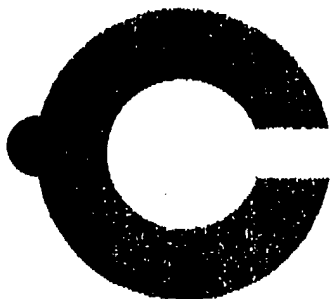
Voltage: 230/460 RPM: 1762.3 Eff: 89.96%
 AMP: 32.79/ 16.40 P.F.: 81.19% KVA: 13.063

Annual Operating Cost per pump = \$ 9290.60
for 8760 hours annually at \$0.10 / kwh

Any Floor-Mounted Pump Selection 1026.0 gpm 55.0 ft.
Rank Selections by Efficiency or Cost (E/C)? E

Rank	Series	Size	Eff. (%)	Dia. (in.)	RPM	Mtr HP	NOL BHP
1	1531	5BC	82.1	8.875	1750	20.000	17.768
2	1510	5BC	82.1	8.875	1750	20.000	17.768
3	VSCS	6X8X9-3/4L	80.8	8.625	1750	20.000	19.400
4	VSC	6X6X9-3/4L	77.9	8.875	1750	20.000	19.526
5	VSC	6X8X9-3/4HL	77.0	8.000	1750	20.000	23.047
6	VSCS	6X8X9-3/4HL	77.0	8.000	1750	20.000	23.047
7	1531	5E	76.8	9.125	1750	20.000	19.505
8	1510	5E	76.8	9.125	1750	20.000	19.505
9	VSCS	6X8X12L	70.1	9.250	1750	25.000	20.977
10	VSC	6X6X12L	69.9	9.375	1750	25.000	20.509

☐ View a pump in more detail

**CLARY & ASSOCIATES, INC.**645 Dutch Valley Rd. N.E. • Atlanta, Georgia 30324
Area Code 404 Telephone 873-1861**FAX MESSAGE**TO: CARL LUNDSTROM DEPT: _____COMPANY: E.M.C. ENGINEERS, INC. FAX #: _____FROM: CHARLIE WHEELER DATE: 09/18/91SUBJECT: FT. SILL CENTRAL PLANTMESSAGE: CARL - HERE ARE THE BUDGET PRICES WHICH YOUREQUESTED. SHOULD YOU HAVE ANY QUESTIONS, PLEASECALL.

THANKS,

Charlie Wheeler

CHARLIE WHEELER

REPLY: _____

CLARY & ASSOCIATES FAX # 404 873-1867

NUMBER OF PAGES INCLUDING THIS PAGE

product

K.D.Us

E. M. C. ENGINEERS, INC.
 Denver • Colorado Springs • Atlanta • West Germany

JOB 3002.000
 SHEET NO. _____ OF _____
 CALCULATED BY ✓✓ DATE 9/17/91
 CHECKED BY _____ DATE _____
 SCALE _____

Brief Information

Gas Fired Boiler

Thermifire rate 765,000 BTU/HR *5430.00
 " " 1020,000 BTU/HR *6135.00

Pumps

	Bldg.	gpm.	FL HD	BELL & GOSSET Pump #	DIAMETER	PRICE (C\$)
3500	3442	157	183	1531-2AC, 15HP	6.875"	\$1138.00
1750	3442	147	30	1510-2AC, 2HP	6.0	\$995.00
1750	5678	309	65	1510-3BB, 10HP	6.875	\$1450.00
1750	" "	570	40	1510-4AC, 7.5HP	10.25	\$1475.00
1750	" "	1576	30	1510-6BC, 20HP	10.875	\$1508.00
3500	2812	67	144	1531-1 1/4 AC, 7.5HP	5.875	\$790.00
1750	" "	410	95	1531-3E, 20HP	10.5	\$2275.00
1750	" "	1026	55	1531-5E 20HP	8.875	\$2375.00

ALL PRICES FOR SHIPPING POINT AND ARE BUDGET PRICES ONLY

CHARLIE WHEELER
 CLARY & ASSOC.
 9/17/91

APPENDIX K.2
PC-CUBE BASERUN

CENTRAL PLANT 2812

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	1
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4107000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	44.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.27			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	44.	0.	0.	0.
20	61.	0.	0.	0.
30	78.	0.	0.	0.
40	97.	0.	0.	0.
50	116.	0.	0.	0.
60	139.	0.	0.	0.
70	166.	0.	0.	0.
80	227.	0.	0.	0.
90	235.	0.	0.	0.
100	277.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	2770000.
ELECTRIC ACCESSORIES, KW	15.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	824980.
20	1067040.
30	1580800.
40	2089620.
50	2588560.
60	3077620.
70	3556800.
80	4026100.
90	4485520.
100	4940000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	2860000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	854620.
20	1096680.
30	1625260.
40	2134080.
50	2633020.
60	3117140.
70	3591380.
80	4050800.
90	4500340.
100	4940000.

PC-CUBE

CENTRAL PLANT 2812 BASELINE-1

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	DAY TYPE		
	1	2	3
JAN	23	8	0
FEB	22	6	0
MAR	23	8	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR						PROCESS	
	HEATING		COOLING		ELECTRIC		PEAK THOUSAND BTU/HR	LOAD MILLION BTU
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH		
JAN	7867.0	2049.0	.0	.0	.0	.0	.0	.0
FEB	7867.0	1558.0	.0	.0	.0	.0	.0	.0
MAR	7867.0	1304.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	846.0	129.0	.0	.0	.0	.0
JUN	.0	.0	4106.0	272.0	.0	.0	.0	.0
JUL	.0	.0	4106.0	327.0	.0	.0	.0	.0
AUG	.0	.0	4106.0	326.0	.0	.0	.0	.0
SEP	.0	.0	4106.0	218.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	3870.0	1090.0	.0	.0	.0	.0	.0	.0
DEC	7867.0	1719.0	.0	.0	.0	.0	.0	.0
TOTAL		7720.0		1272.0		.0		.0

PC-CUBE

CENTRAL PLANT 2812 BASELINE-1

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
6	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
20	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
21	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	24	0	0
NO DAY TYPES	2	2	0	0
ADJUST LIMIT	.30	.30	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

** TOTAL **

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT.	14107.
PEAK DAY GAS CONSUMP., 1000 CU FT	136.
ELECTRICAL CONSUMPTION, KWH	347034.
PEAK KW DEMAND (15 MIN BASIS)	93.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	347034.
ON-PEAK KW DEMAND (15 MIN BASIS)	93.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	456
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 9

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS										
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	2696	976	0	0	0	0	0	0	0	0	3672
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	0	0	51	211	568	672	586	471	1065	3624
2	219	237	0	0	0	0	0	0	0	0	456

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

		***** PURCHASED ELECTRICAL *****									
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	136.	3753.	15.	11.	0.	0.	0.	0.	0.	0.
C1	2	115.	2817.	15.	10.	0.	0.	0.	0.	0.	0.
C1	3	87.	2403.	15.	11.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	77.	57.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	89.	58.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	93.	61.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	93.	61.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	83.	56.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	77.	2026.	15.	11.	0.	0.	0.	0.	0.	0.
C1	12	114.	3108.	15.	11.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2012 BASELINE-1

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	3314.	2049.	15.	11.	0.	0.	0.	0.
C1	2	0.	0.	2817.	1558.	15.	10.	0.	0.	0.	0.
C1	3	0.	0.	2114.	1304.	15.	11.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	25.	10750.	0.	0.	77.	57.	0.	0.	0.	0.
C1	6	56.	22667.	0.	0.	89.	58.	0.	0.	0.	0.
C1	7	64.	27250.	0.	0.	93.	61.	0.	0.	0.	0.
C1	8	64.	27166.	0.	0.	93.	61.	0.	0.	0.	0.
C1	9	44.	18166.	0.	0.	83.	56.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	1849.	1090.	15.	11.	0.	0.	0.	0.
C1	12	0.	0.	2805.	1719.	15.	11.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-2

SYSTEM C1 SUMMER HW AND DISTRIBUTION LOSS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	0
DIFFERENT TYPE BOILERS OR HEATERS	1
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM	GENERATOR	CHILLER	PERCENTAGE	DIRECT FIRED	AF	PROC	STEAM		
ID	OPERATION	OPERATION	PROCESS HEAT	PROCESS HEAT	KEY	KEY	TURB	KEY	AUX FUEL
DESCRIPTION	SCHEDULE	SCHEDULE	DIRECT FIRED	EFFICIENCY					

C1	0	1	0.	100.	0	0	0		
1.									

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-2

			C1									
GENERATOR SYSTEM TYPE			0									
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-2

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	2770000.
ELECTRIC ACCESSORIES, KW	8.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	824980.
20	1067040.
30	1580800.
40	2089620.
50	2588560.
60	3077620.
70	3556800.
80	4026100.
90	4485520.
100	4940000.

PC-CUBE

CENTRAL PLANT 2812 BASELINE-2

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	DAY TYPE		
	1	2	3
JAN	23	8	0
FEB	22	6	0
MAR	23	8	0
APR	22	8	0
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	23	8	0
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR							
	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	.0	.0	.0	.0	.0	.0	.0	.0
FEB	.0	.0	.0	.0	.0	.0	.0	.0
MAR	.0	.0	.0	.0	.0	.0	.0	.0
APR	2257.0	539.0	.0	.0	.0	.0	.0	.0
MAY	2257.0	557.0	.0	.0	.0	.0	.0	.0
JUN	2257.0	539.0	.0	.0	.0	.0	.0	.0
JUL	2257.0	557.0	.0	.0	.0	.0	.0	.0
AUG	2257.0	557.0	.0	.0	.0	.0	.0	.0
SEP	2257.0	539.0	.0	.0	.0	.0	.0	.0
OCT	2257.0	557.0	.0	.0	.0	.0	.0	.0
NOV	.0	.0	.0	.0	.0	.0	.0	.0
DEC	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL		3845.0		.0		.0		.0

PC-CUBE

CENTRAL PLANT 2812 BASELINE-2

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
6	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
20	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
21	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	0	0	0
NO DAY TYPES	2	0	0	0
ADJUST LIMIT	.30	.00	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-2

** TOTAL **

SYSTEM C1 SUMMER HW AND DISTRIBUTION LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7348.
PEAK DAY GAS CONSUMP., 1000 CU FT	40.
ELECTRICAL CONSUMPTION, KWH	38520.
PEAK KW DEMAND (15 MIN BASIS)	8.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	38520.
ON-PEAK KW DEMAND (15 MIN BASIS)	8.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	5136
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 7

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 8

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-2

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	SUMMER HW AND DISTRIBUTION LOSS									
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	0	0	0	0	0	0	0	0	0
0										
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	465	2991	1680	0	0	0	0	0	0
5136										

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-2

		***** PURCHASED ELECTRICAL *****									
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	39.	1030.	8.	5.	0.	0.	0.	0.	0.	0.
C1	5	39.	1064.	8.	6.	0.	0.	0.	0.	0.	0.
C1	6	40.	1030.	8.	5.	0.	0.	0.	0.	0.	0.
C1	7	39.	1064.	8.	6.	0.	0.	0.	0.	0.	0.
C1	8	39.	1064.	8.	6.	0.	0.	0.	0.	0.	0.
C1	9	39.	1030.	8.	5.	0.	0.	0.	0.	0.	0.
C1	10	39.	1064.	8.	6.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-2

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	908.	539.	8.	5.	0.	0.	0.	0.
C1	5	0.	0.	901.	557.	8.	6.	0.	0.	0.	0.
C1	6	0.	0.	922.	539.	8.	5.	0.	0.	0.	0.
C1	7	0.	0.	901.	557.	8.	6.	0.	0.	0.	0.
C1	8	0.	0.	908.	557.	8.	6.	0.	0.	0.	0.
C1	9	0.	0.	908.	539.	8.	5.	0.	0.	0.	0.
C1	10	0.	0.	901.	557.	8.	6.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

CENTRAL PLANT 5900

(See Appendix I.2 for Central Plant 5900 PC-CUBE baserun)

APPENDIX K.3
PC-CUBE ECO RUN

CENTRAL PLANT 2812

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	1
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	2	2	1	2	2	2	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4107000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	44.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.27			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	44.	0.	0.	0.
20	61.	0.	0.	0.
30	78.	0.	0.	0.
40	97.	0.	0.	0.
50	116.	0.	0.	0.
60	139.	0.	0.	0.
70	166.	0.	0.	0.
80	227.	0.	0.	0.
90	235.	0.	0.	0.
100	277.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	1020000.
ELECTRIC ACCESSORIES, KW	3.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	200400.
20	259200.
30	384000.
40	507600.
50	628800.
60	747600.
70	864000.
80	978000.
90	1089600.
100	1200000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	1020000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	207600.
20	266400.
30	394800.
40	518400.
50	639600.
60	757200.
70	872400.
80	984000.
90	1093200.
100	1200000.

PC-CUBE

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

NUMBER OF EACH DAY TYPE PER MONTH

MONTH	DAY TYPE		
	1	2	3
JAN	23	8	0
FEB	22	6	0
MAR	23	8	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR

MONTH	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK	LOAD	PEAK	LOAD	DEMAND	LOAD	PEAK	LOAD
	THOUSAND BTU/HR	MILLION BTU	THOUSAND BTU/HR	MILLION BTU	KILOWATT	THOUSAND KWH	THOUSAND BTU/HR	MILLION BTU
JAN	7867.0	2049.0	.0	.0	.0	.0	.0	.0
FEB	7867.0	1558.0	.0	.0	.0	.0	.0	.0
MAR	7867.0	1304.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	846.0	129.0	.0	.0	.0	.0
JUN	.0	.0	4106.0	272.0	.0	.0	.0	.0
JUL	.0	.0	4106.0	327.0	.0	.0	.0	.0
AUG	.0	.0	4106.0	326.0	.0	.0	.0	.0
SEP	.0	.0	4106.0	218.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	3870.0	1090.0	.0	.0	.0	.0	.0	.0
DEC	7867.0	1719.0	.0	.0	.0	.0	.0	.0
TOTAL		7720.0		1272.0		.0		.0

PC-CUBE

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
6	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
20	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
21	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000

 PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS

START HOUR	0	0	0	0
END HOUR	24	24	0	0
NO DAY TYPES	2	2	0	0
ADJUST LIMIT	.30	.30	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0	0	0	0	0	0	0	0	0	0	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

** TOTAL **

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	9207.
PEAK DAY GAS CONSUMP., 1000 CU FT	89.
ELECTRICAL CONSUMPTION, KWH	304270.
PEAK KW DEMAND (15 MIN BASIS)	93.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	304270.
ON-PEAK KW DEMAND (15 MIN BASIS)	93.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3612
BOILER 3	1848
BOILER 4	219
BOILER 5	0
BOILER 6	0
BOILER 7	0
BOILER 8	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 9

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS										
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	2696	976	0	0	0	0	0	0	0	0	3672
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	0	0	0	0	0	0	0	0	3624	3624
2	51	74	86	87	199	249	255	276	213	2122	3612
3	154	238	78	173	164	310	275	109	73	274	1848
4	73	109	37	0	0	0	0	0	0	0	219
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

		GAS		PURCHASED ELECTRICAL		OFF-PK		OFF-PK		AUX	
		DEMAND	CONSUMP	ON-PK	ON-PK	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	CONSUMP	HRS
				KW	THOU KWH	KW	THOU KWH	KW	THOU KWH		
C1	1	89.	2437.	3.	2.	0.	0.	0.	0.	0.	0.
C1	2	76.	1858.	3.	2.	0.	0.	0.	0.	0.	0.
C1	3	57.	1554.	3.	2.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	77.	57.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	89.	58.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	93.	61.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	93.	61.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	83.	56.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	50.	1309.	3.	2.	0.	0.	0.	0.	0.	0.
C1	12	76.	2050.	3.	2.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	3314.	2049.	3.	2.	0.	0.	0.	0.
C1	2	0.	0.	2817.	1558.	3.	2.	0.	0.	0.	0.
C1	3	0.	0.	2114.	1304.	3.	2.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	25.	10750.	0.	0.	77.	57.	0.	0.	0.	0.
C1	6	56.	22667.	0.	0.	89.	58.	0.	0.	0.	0.
C1	7	64.	27250.	0.	0.	93.	61.	0.	0.	0.	0.
C1	8	64.	27166.	0.	0.	93.	61.	0.	0.	0.	0.
C1	9	44.	18166.	0.	0.	83.	56.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	1849.	1090.	3.	2.	0.	0.	0.	0.
C1	12	0.	0.	2805.	1719.	3.	2.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

SYSTEM C1 SUMMER HW AND DISTRIBUTION LOSS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	0
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL
DESCRIPTION								
C1	0	1	0.	100.	0	0	0	
1.								

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	2	2	1	2	2	2	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

BOILER/HEATER IDENT. NO. 1
MAXIMUM OUTPUT, BTU/HR 1020000.
ELECTRIC ACCESSORIES, KW 3.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	200400.
20	259200.
30	384000.
40	507600.
50	628800.
60	747600.
70	864000.
80	978000.
90	1089600.
100	1200000.

BOILER/HEATER IDENT. NO. 2
MAXIMUM OUTPUT, BTU/HR 1020000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	200400.
20	259200.
30	384000.
40	507600.
50	628800.
60	747600.
70	864000.
80	978000.
90	1089600.
100	1200000.

PC-CUBE

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	1	2	3

JAN	23	8	0
FEB	22	6	0
MAR	23	8	0
APR	22	8	0
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	23	8	0
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR						PROCESS	
	HEATING		COOLING		ELECTRIC		PEAK THOUSAND BTU/HR	LOAD MILLION BTU
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH		
JAN	.0	.0	.0	.0	.0	.0	.0	.0
FEB	.0	.0	.0	.0	.0	.0	.0	.0
MAR	.0	.0	.0	.0	.0	.0	.0	.0
APR	2257.0	539.0	.0	.0	.0	.0	.0	.0
MAY	2257.0	557.0	.0	.0	.0	.0	.0	.0
JUN	2257.0	539.0	.0	.0	.0	.0	.0	.0
JUL	2257.0	557.0	.0	.0	.0	.0	.0	.0
AUG	2257.0	557.0	.0	.0	.0	.0	.0	.0
SEP	2257.0	539.0	.0	.0	.0	.0	.0	.0
OCT	2257.0	557.0	.0	.0	.0	.0	.0	.0
NOV	.0	.0	.0	.0	.0	.0	.0	.0
DEC	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL		3845.0		.0		.0		.0

PC-CUBE

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
6	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
20	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
21	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	0	0	0
NO DAY TYPES	2	0	0	0
ADJUST LIMIT	.30	.00	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

** TOTAL **

SYSTEM C1 SUMMER HW AND DISTRIBUTION LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	4629.
PEAK DAY GAS CONSUMP., 1000 CU FT	25.
ELECTRICAL CONSUMPTION, KWH	16435.
PEAK KW DEMAND (15 MIN BASIS)	3.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	16435.
ON-PEAK KW DEMAND (15 MIN BASIS)	3.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	5136
BOILER 2	0
BOILER 3	0
BOILER 4	0
BOILER 5	0
BOILER 6	0
BOILER 7	0
BOILER 8	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 7

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 8

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1 SUMMER HW AND DISTRIBUTION LOSS										
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
TOTAL										
1	0	0	0	0	0	0	0	0	0	0
0										
BLR										
TOTAL										
1	0	0	0	0	203	558	1101	1540	1716	18
5136										
2	0	0	0	0	0	0	0	0	0	0
0										
3	0	0	0	0	0	0	0	0	0	0
0										
4	0	0	0	0	0	0	0	0	0	0
0										
5	0	0	0	0	0	0	0	0	0	0
0										
6	0	0	0	0	0	0	0	0	0	0
0										
7	0	0	0	0	0	0	0	0	0	0
0										
8	0	0	0	0	0	0	0	0	0	0
0										

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

		GAS		ON-PK		ON-PK		PURCHASED ELECTRICAL		OFF-PK		OFF-PK		AUX		AUX	
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL		
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS		
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	4	24.	649.	3.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	5	24.	671.	3.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	6	25.	649.	3.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	7	24.	671.	3.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	8	24.	671.	3.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	9	24.	649.	3.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	10	24.	671.	3.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER REPLACEMENT ECO

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	908.	539.	3.	2.	0.	0.	0.	0.
C1	5	0.	0.	901.	557.	3.	2.	0.	0.	0.	0.
C1	6	0.	0.	922.	539.	3.	2.	0.	0.	0.	0.
C1	7	0.	0.	901.	557.	3.	2.	0.	0.	0.	0.
C1	8	0.	0.	908.	557.	3.	2.	0.	0.	0.	0.
C1	9	0.	0.	908.	539.	3.	2.	0.	0.	0.	0.
C1	10	0.	0.	901.	557.	3.	2.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

CENTRAL PLANT 5900

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	5
DIFFERENT TYPE BOILERS OR HEATERS	5
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	1	2	3	4	5	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	3	3	4	5	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.25			
MAXIMUM OUTPUT, BTU/HR	4440000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	76.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.25			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	54.	0.	0.	0.
20	75.	0.	0.	0.
30	95.	0.	0.	0.
40	119.	0.	0.	0.
50	142.	0.	0.	0.
60	170.	0.	0.	0.
70	203.	0.	0.	0.
80	278.	0.	0.	0.
90	288.	0.	0.	0.
100	339.	0.	0.	0.

CHILLER IDENTIFICATION NO.	2			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4032000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	76.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.19			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	51.	0.	0.	0.
20	70.	0.	0.	0.
30	88.	0.	0.	0.
40	111.	0.	0.	0.
50	133.	0.	0.	0.
60	158.	0.	0.	0.
70	190.	0.	0.	0.
80	259.	0.	0.	0.
90	269.	0.	0.	0.
100	316.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

CHILLER IDENTIFICATION NO.	3			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3552000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	80.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.18			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	40.	0.	0.	0.
20	55.	0.	0.	0.
30	70.	0.	0.	0.
40	88.	0.	0.	0.
50	105.	0.	0.	0.
60	126.	0.	0.	0.
70	151.	0.	0.	0.
80	206.	0.	0.	0.
90	213.	0.	0.	0.
100	251.	0.	0.	0.

CHILLER IDENTIFICATION NO.	4			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4752000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	101.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.20			
LOAD	ENERGY IN (BTU/HR OR KW)	RECOVERABLE HEAT (BTU/HR)	AUXILIARY FUEL IN (BTU/HR)	AF RECOVERABLE HEAT (BTU/HR)
10	59.	0.	0.	0.
20	82.	0.	0.	0.
30	104.	0.	0.	0.
40	130.	0.	0.	0.
50	156.	0.	0.	0.
60	186.	0.	0.	0.
70	223.	0.	0.	0.
80	304.	0.	0.	0.
90	315.	0.	0.	0.
100	371.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

CHILLER IDENTIFICATION NO.	5			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	3504000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	83.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.21			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	40.	0.	0.	0.
20	55.	0.	0.	0.
30	70.	0.	0.	0.
40	87.	0.	0.	0.
50	105.	0.	0.	0.
60	125.	0.	0.	0.
70	149.	0.	0.	0.
80	204.	0.	0.	0.
90	212.	0.	0.	0.
100	249.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	10000000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2375000.
20	3575000.
30	4612500.
40	5637500.
50	6712500.
60	7812500.
70	8975000.
80	10150000.
90	11325000.
100	12500000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	10000000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2375000.
20	3575000.
30	4612500.
40	5637500.
50	6712500.
60	7812500.
70	8975000.
80	10150000.
90	11325000.
100	12500000.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

BOILER/HEATER IDENT. NO. 3
MAXIMUM OUTPUT, BTU/HR 7610000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2268310.
20	2583690.
30	3796690.
40	4961170.
50	6077130.
60	7290130.
70	8430350.
80	9631220.
90	10819960.
100	12130000.

BOILER/HEATER IDENT. NO. 4
MAXIMUM OUTPUT, BTU/HR 6220000.
ELECTRIC ACCESSORIES, KW 0.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	1900000.
20	2180000.
30	3220000.
40	4240000.
50	5230000.
60	6220000.
70	7240000.
80	8200000.
90	8140000.
100	10000000.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

BOILER/HEATER IDENT. NO.	5
MAXIMUM OUTPUT, BTU/HR	8880000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2646000.
20	3052000.
30	4508000.
40	5936000.
50	7140000.
60	8526000.
70	9870000.
80	11242000.
90	12600000.
100	14000000.

PC-CUBE
CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

MONTH	NUMBER OF EACH DAY TYPE PER MONTH		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR							
	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	57938.0	11818.0	.0	.0	.0	.0	.0	.0
FEB	57938.0	9046.0	.0	.0	.0	.0	.0	.0
MAR	57938.0	7725.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	5212.0	7368.0	.0	.0	.0	.0
JUN	.0	.0	18384.0	30305.0	.0	.0	.0	.0
JUL	.0	.0	18384.0	8487.0	.0	.0	.0	.0
AUG	.0	.0	18384.0	8494.0	.0	.0	.0	.0
SEP	.0	.0	18384.0	7888.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	21864.0	6339.0	.0	.0	.0	.0	.0	.0
DEC	57938.0	9820.0	.0	.0	.0	.0	.0	.0
TOTAL		44748.0		62542.0		.0		.0

PC-CUBE

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
2	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
3	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
4	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
5	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
6	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
7	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
8	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
9	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
10	.600	.700	.000	.300	.300	.000	.700	.700	.700	.500	.300	.300
11	.600	.700	.000	.300	.300	.000	.700	.700	.700	.700	.300	.300
12	.600	.700	.000	.300	.300	.000	.700	.700	.700	.700	.300	.300
13	.400	.500	.000	.500	.500	.000	.700	.700	.700	.700	.300	.300
14	.400	.500	.000	.600	.500	.000	.700	.700	.700	.700	.300	.300
15	.400	.500	.000	.700	.500	.000	.700	.700	.700	.700	.300	.300
16	.400	.500	.000	.600	.500	.000	.700	.700	.700	.700	.300	.300
17	.400	.500	.000	.600	.500	.000	.700	.700	.700	.700	.300	.300
18	.400	.700	.000	.500	.500	.000	.700	.700	.700	.500	.300	.300
19	.600	.700	.000	.500	.500	.000	.700	.700	.700	.500	.300	.300
20	.600	.700	.000	.500	.500	.000	.500	.500	.500	.500	.300	.300
21	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
22	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
23	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300
24	.600	.700	.000	.300	.300	.000	.500	.500	.500	.300	.300	.300

 PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS

START HOUR	0	0	0	0
END HOUR	24	24	24	24
NO DAY TYPES	2	2	3	1
ADJUST LIMIT	.30	.20	.30	.30

HOURS OF AUXILIARY FUEL IN EACH MONTH

0	0	0	0	0	0	0	0	0	0	0	0	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	57673.
PEAK DAY GAS CONSUMP., 1000 CU FT	624.
ELECTRICAL CONSUMPTION, KWH	4113574.
PEAK KW DEMAND (15 MIN BASIS)	1781.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	4113574.
ON-PEAK KW DEMAND (15 MIN BASIS)	1781.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
CHILLER 3	2512
CHILLER 4	1456
CHILLER 5	934
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2554
BOILER 3	57
BOILER 4	0
BOILER 5	0
BOILER 6	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 13

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 14

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	NORMAL HEATING AND COOLING LOADS										TOTAL
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	
1	0	0	0	0	0	0	0	0	0	3672	3672
2	42	702	0	0	0	0	0	0	112	2816	3672
3	240	208	192	240	144	32	0	0	0	1456	2512
4	0	0	36	64	84	112	156	25	12	967	1456
5	48	47	32	84	723	0	0	0	0	0	934
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	0	0	0	0	66	100	175	287	2996	3624
2	327	380	297	341	400	229	172	258	55	95	2554
3	19	38	0	0	0	0	0	0	0	0	57
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

		***** PURCHASED ELECTRICAL *****									
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	624.	15093.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	518.	11672.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	400.	10102.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	547.	406.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	1781.	1280.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	1781.	827.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	1781.	827.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	1781.	774.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	352.	8113.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	504.	12693.	0.	0.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER REPLACEMENT (BOILER 1 AND 2)

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	21302.	11818.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	17970.	9046.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	13558.	7725.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	434.	320682.	0.	0.	547.	406.	0.	0.	0.	0.
C1	6	1532.	1099390.	0.	0.	1781.	1280.	0.	0.	0.	0.
C1	7	1532.	702426.	0.	0.	1781.	827.	0.	0.	0.	0.
C1	8	1532.	703110.	0.	0.	1781.	827.	0.	0.	0.	0.
C1	9	1532.	654209.	0.	0.	1781.	774.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	11589.	6339.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	17455.	9820.	0.	0.	0.	0.	0.	0.

APPENDIX L

PROJECT 4 - REPLACE A CHILLER IN CENTRAL PLANT 2812

APPENDIX L.1 - PROJECT ANALYSIS
APPENDIX L.2 - PC-CUBE BASERUN
APPENDIX L.3 - PC-CUBE ECO RUN

APPENDIX L.1
PROJECT ANALYSIS

**ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA**

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: PROJECT 4
SYSTEM MODIFICATION: INSTALL NEW CHILLER
SYSTEMS TO MODIFY: CHILLER 1

CALCULATION DESCRIPTION:

Hand calculation sheet was prepared to determine the energy savings for Project 4, replace an existing chiller with a higher efficiency chiller. It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas (MMBtu)	Total Energy (MMBtu)
	Demand(kW)	Energy(kWh)		
Baseline	101	386,000	--	1,317
ECO	78	308,000	--	1,051
Savings (Baseline-ECO)	23	78,000	0	266

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 266 MMBtu/Yr X \$4.0141 /MMBtu = \$1,069 per year
 Nat. Gas: 0 MMBtu/Yr X \$2.92 /MMBtu = \$0 per year
Total Energy Cost Savings: \$1,069 + \$0 = \$1,069 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 23 kW/month X \$1.787 /kW X 12 months/year
 = (+) \$493 per year
 Maintenance: = (-) \$2,600 per year
Total: \$493 - \$2,600 = (\$2,107) per year

[ECO-SHT2.WK3]

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: PROJECT4

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3

PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS

FISCAL YEAR 1991 DISCRETE PORTION NAME: INSTALL NEW CHILLER IN 2812

ANALYSIS DATE: 09-25-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 207384.
B. SIOH	\$ 11407.
C. DESIGN COST	\$ 12443.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$ 208111.
E. SALVAGE VALUE COST	-\$ 0.
F. TOTAL INVESTMENT (1D-1E)	\$ 208111.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 4.01	266.	\$ 1068.	11.37	12140.
B. DIST	\$.00	0.	\$ 0.	17.06	0.
C. RESID	\$.00	0.	\$ 0.	16.85	0.
D. NAT G	\$ 2.92	0.	\$ 0.	17.52	0.
E. COAL	\$.00	0.	\$ 0.	13.34	0.
F. TOTAL		266.	\$ 1068.		\$ 12140.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A)	11.65	\$ -2107.
(2) DISCOUNTED SAVING/COST (3A X 3A1)		\$ -24547.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) \$ -24547.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 4006.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F) = _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) \$ -1039.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ -12407.

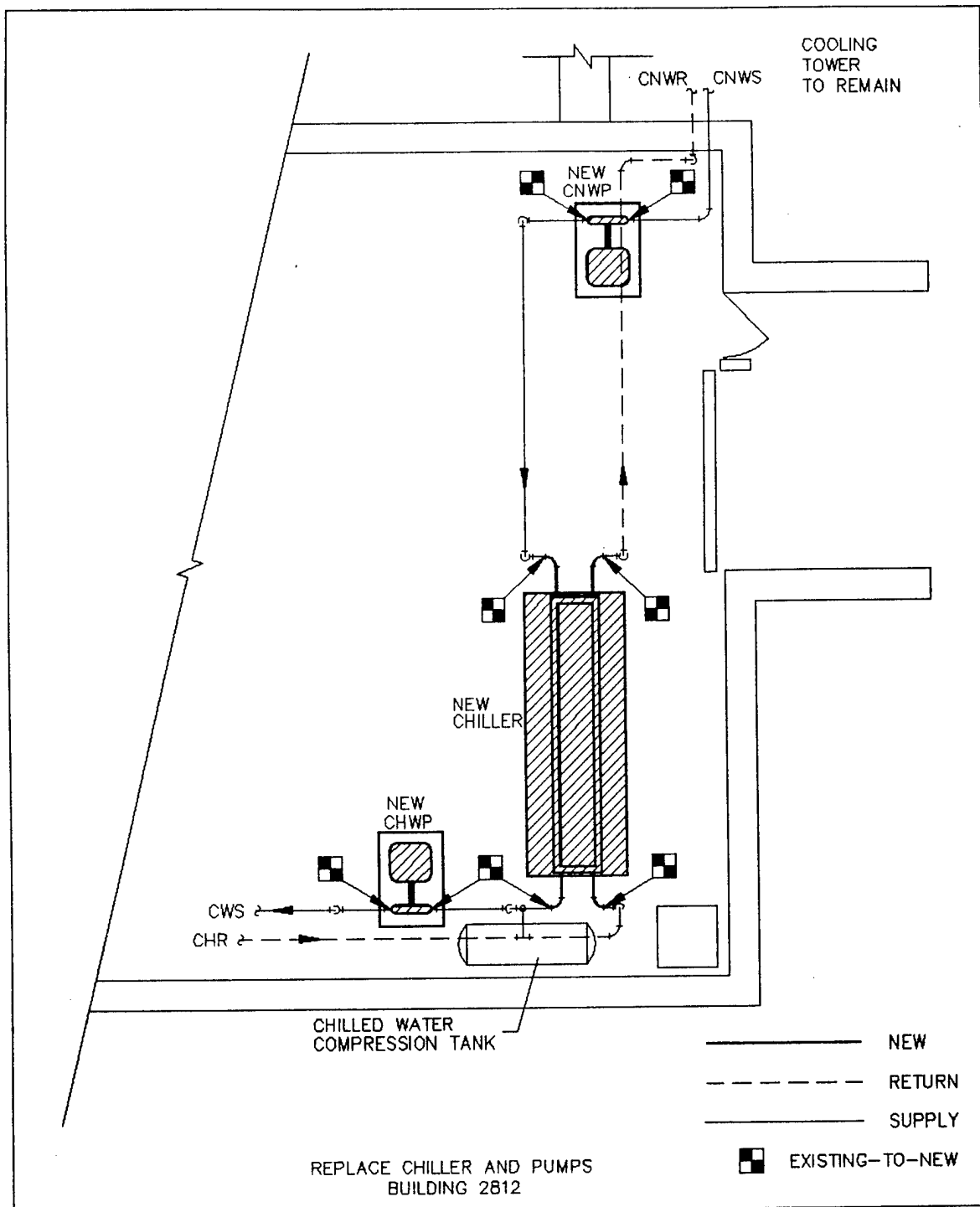
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.06
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 *****

[illegible]

SYMBOLS LEGEND

	ALARM CONTACT SIGNAL
	FLOW INDICATION
	PRESSURE INDICATION
	METER
	ON-OFF STATUS SIGNAL
	DIFFERENTIAL PRESSURE SWITCH
	START-UP INTERFACE
	TEMPERATURE INDICATION
	FLUE GAS ANALYSIS, OXYGEN
	KILOWATT METER
	EXISTING--TO--NEW



APPENDIX L.2

PC-CUBE BASERUN

(See Appendix K.2 for Central Plant 2812 PC-CUBE baserun)

APPENDIX L.3
PC-CUBE ECO RUN

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

SYSTEM C1 REPACE AN EXISTING CHILLER WITH A NEW CHILLER

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	1
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

CHILLER IDENTIFICATION NUMBERS

C1	1	0	0	0	0	0	0	0	0	0

BOILER/HEATER IDENTIFICATION NUMBERS

C1	1	2	0	0	0	0	0	0	0	0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

OPERATION SCHEDULE NO 1

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND PICKS UP THE REMAINDER OF THE LOAD, ETC.

OPERATION SCHEDULE NO 2

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND BOTH THE FIRST AND SECOND SHARE THE LOAD EQUALLY, ETC.

OPERATION SCHEDULE NO 3

ALL UNITS ARE TURNED ON AND SHARE THE LOAD EQUALLY.

OPERATION SCHEDULE NO 4

THE FIRST UNIT CARRIES THE LOAD UNTIL ITS CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) IS REACHED.
THE SECOND UNIT IS THEN STARTED AND THE FIRST UNIT IS STOPPED. WHEN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF THE SECOND UNIT IS REACHED, A THIRD UNIT IS STARTED AND SHARES THE LOAD EQUALLY WITH THE SECOND. IF THE LOAD IS GREATER THAN THE CAPACITY (OR CAPACITY TIMES SWITCHOVER FACTOR) OF BOTH UNITS, THE FIRST IS RESTARTED AND CARRIES THE EXCESS LOAD.

GENERATOR TYPES

- 1 = RECIPROCATING ENGINE
- 2 = GAS TURBINE
- 3 = STEAM TURBINE

CHILLER TYPES

- 1 = ABSORPTION
- 2 = STEAM TURBINE
- 3 = ENGINE
- 4 = ELECTRIC MOTOR

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

CHILLER IDENTIFICATION NO.	1			
CHILLER TYPE	4 ** ELECTRIC MOTOR **			
PERCENT OF MAX OUTPUT TO START	.00			
MAXIMUM OUTPUT, BTU/HR	4104000.			
PILOT FUEL IN, BTU/HR	0.			
ELECTRIC ACCESSORIES, KW	23.			
STEAM ACCESSORIES BTU/HR	0.			
PERCENT ACCESSORY LOAD TO VARY	.27			
LOAD	ENERGY IN	RECOVERABLE HEAT	AUXILIARY FUEL IN	AF RECOVERABLE HEAT
	(BTU/HR OR KW)	(BTU/HR)	(BTU/HR)	(BTU/HR)
10	39.	0.	0.	0.
20	54.	0.	0.	0.
30	69.	0.	0.	0.
40	86.	0.	0.	0.
50	103.	0.	0.	0.
60	123.	0.	0.	0.
70	148.	0.	0.	0.
80	202.	0.	0.	0.
90	209.	0.	0.	0.
100	246.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	2770000.
ELECTRIC ACCESSORIES, KW	15.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	824980.
20	1067040.
30	1580800.
40	2089620.
50	2588560.
60	3077620.
70	3556800.
80	4026100.
90	4485520.
100	4940000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	2860000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	854620.
20	1096680.
30	1625260.
40	2134080.
50	2633020.
60	3117140.
70	3591380.
80	4050800.
90	4500340.
100	4940000.

PC-CUBE

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

MONTH	DAY TYPE		
	1	2	3

JAN	23	8	0
FEB	22	6	0
MAR	23	8	0
APR	0	0	30
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	0	0	31
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR							
	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	7867.0	2049.0	.0	.0	.0	.0	.0	.0
FEB	7867.0	1558.0	.0	.0	.0	.0	.0	.0
MAR	7867.0	1304.0	.0	.0	.0	.0	.0	.0
APR	.0	.0	.0	.0	.0	.0	.0	.0
MAY	.0	.0	846.0	129.0	.0	.0	.0	.0
JUN	.0	.0	4106.0	272.0	.0	.0	.0	.0
JUL	.0	.0	4106.0	327.0	.0	.0	.0	.0
AUG	.0	.0	4106.0	326.0	.0	.0	.0	.0
SEP	.0	.0	4106.0	218.0	.0	.0	.0	.0
OCT	.0	.0	.0	.0	.0	.0	.0	.0
NOV	3870.0	1090.0	.0	.0	.0	.0	.0	.0
DEC	7867.0	1719.0	.0	.0	.0	.0	.0	.0
TOTAL		7720.0		1272.0		.0		.0

PC-CUBE

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
4	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
5	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
6	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
7	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
20	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.000	.000
21	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	24	0	0
NO DAY TYPES	2	2	0	0
ADJUST LIMIT	.30	.30	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

** TOTAL **

SYSTEM C1 REPACE AN EXISTING CHILLER WITH A NEW CHILLER

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	14107.
PEAK DAY GAS CONSUMP., 1000 CU FT	136.
ELECTRICAL CONSUMPTION, KWH	269860.
PEAK KW DEMAND (15 MIN BASIS)	70.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	269860.
ON-PEAK KW DEMAND (15 MIN BASIS)	70.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	456
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 9

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 10

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	744
JUN	720
JUL	744
AUG	744
SEP	720
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	REPACE AN EXISTING CHILLER WITH A NEW CHILLER										
CHR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	2696	976	0	0	0	0	0	0	0	0	3672
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	0	0	51	211	568	672	586	471	1065	3624
2	219	237	0	0	0	0	0	0	0	0	456

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

		***** PURCHASED ELECTRICAL *****									
		GAS	GAS	ON-PK	ON-PK	MID-PK	MID-PK	OFF-PK	OFF-PK	AUX	AUX
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS
C1	1	136.	3753.	15.	11.	0.	0.	0.	0.	0.	0.
C1	2	115.	2817.	15.	10.	0.	0.	0.	0.	0.	0.
C1	3	87.	2403.	15.	11.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	57.	42.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	66.	42.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	70.	45.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	70.	45.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	61.	41.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	77.	2026.	15.	11.	0.	0.	0.	0.	0.	0.
C1	12	114.	3108.	15.	11.	0.	0.	0.	0.	0.	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER REPLACEMENT ECO

		COOLING	COOLING	HEAT	HEAT	ELECT	ELECT	GEN	SOLD	RECOVBL	RECOVBL
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	ELECT	ELECT	HEAT	HEAT
		TONS	TON-HRS	MBH	MMBTU	KW	THOU KWH	THOU KWH	THOU KWH	USED	UNUSED
										MMBTU	MMBTU
C1	1	0.	0.	3314.	2049.	15.	11.	0.	0.	0.	0.
C1	2	0.	0.	2817.	1558.	15.	10.	0.	0.	0.	0.
C1	3	0.	0.	2114.	1304.	15.	11.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	25.	10750.	0.	0.	57.	42.	0.	0.	0.	0.
C1	6	56.	22667.	0.	0.	66.	42.	0.	0.	0.	0.
C1	7	64.	27250.	0.	0.	70.	45.	0.	0.	0.	0.
C1	8	64.	27166.	0.	0.	70.	45.	0.	0.	0.	0.
C1	9	44.	18166.	0.	0.	61.	41.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	1849.	1090.	15.	11.	0.	0.	0.	0.
C1	12	0.	0.	2805.	1719.	15.	11.	0.	0.	0.	0.

APPENDIX M

PROJECT 5A - LOCAL HOT WATER IN BARRACKS

- APPENDIX M.1 - PROJECT ANALYSIS FOR LOCAL BOILERS
- APPENDIX M.2 - PROJECT ANALYSIS FOR CENTRAL HEATING PLANT
- APPENDIX M.3 - PC-CUBE BASERUN FOR BARRACKS WITH MESS HALL
- APPENDIX M.4 - PC-CUBE BASERUN FOR BARRACKS WITHOUT MESS HALL
- APPENDIX M.5 - PC-CUBE CENTRAL HEATING PLANT ECO RUN

APPENDIX M.1
PROJECT ANALYSIS FOR LOCAL BOILERS

**ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA**

CENTRAL PLANT:

ENERGY CONSERVATION OPPORTUNITY: PROJECT 5A
SYSTEM MODIFICATION: INSTALL NEW BOILERS IN BARRACKS
SYSTEMS TO MODIFY: BOILERS AND PUMPS

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for Project 5A, install new hot water boilers and hot water pumps in barracks. The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas (MMBtu)	Total Energy (MMBtu)
	Demand(kW)	Energy(kWh)		
Baseline	NA	NA	NA	NA
Case Study	0	0	73,543	73,543
Energy Consumptions	0	0	73,543	73,543

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 0 MMBtu/Yr X \$4.0141 /MMBtu = \$0 per year
 Nat. Gas: 73543 MMBtu/Yr X \$2.92 /MMBtu = \$214,746 per year
 Total Energy Cost Savings: \$0 + \$214,746 = \$214,746 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X \$1.787 /kW X 12 months/year
 = (+) \$0 per year
 Maintenance: = (-) \$0 per year
 Total: \$0 - \$0 = \$0 per year

[ECO-SHT2.WK3]

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: PROJECT5

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3

PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS

FISCAL YEAR 1991 DISCRETE PORTION NAME: INSTALL NEW BOILER IN BARRACKS

ANALYSIS DATE: 09-26-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 840985.
B. SIOH	\$ 46255.
C. DESIGN COST	\$ 50459.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$ 843929.
E. SALVAGE VALUE COST	-\$ 0.
F. TOTAL INVESTMENT (1D-1E)	\$ 843929.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 4.01	0.	\$ 0.	11.37	0.
B. DIST	\$.00	0.	\$ 0.	17.06	0.
C. RESID	\$.00	0.	\$ 0.	16.85	0.
D. NAT G	\$ 2.92	73543.	\$ 214746.	17.52	3762342.
E. COAL	\$.00	0.	\$ 0.	13.34	0.
F. TOTAL		73543.	\$ 214746.		\$ 3762342.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A)	11.65	\$ 0.
(2) DISCOUNTED SAVING/COST (3A X 3A1)		\$ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) \$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 1241573.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F) = _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) \$ 214746.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 3762342.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 4.46

(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 3.93

DATE PREPARED	EFFECTIVE PRICING
11/11/2019	11/11/2019

DATE	APR 91	24-Sep-91
DRAWING NO.		SHT 2 OF 2

[illegible]

ENERGY CONSUMPTION FOR BARRACKS
LOCAL BOILERS IN BARRACKS OPTION

N. GAS CONSUMPTION (MCF)												
BLDG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
3411	475	396	362	230	232	230	232	231	230	232	318	415
Simmlar Bldg 12	5700	4752	4344	2760	2784	2760	2784	2772	2760	2784	3816	4980
3412	411	331	293	163	164	163	164	164	163	164	250	347
Simmlar Bldg 11	4521	3641	3223	1793	1804	1793	1804	1804	1793	1804	2750	3817
TOTAL	10,221	8,393	7,567	4,553	4,588	4,553	4,588	4,576	4,553	4,588	6,566	8,797
											TOTAL	73,543 MCF
											or	73,543 MMBtu

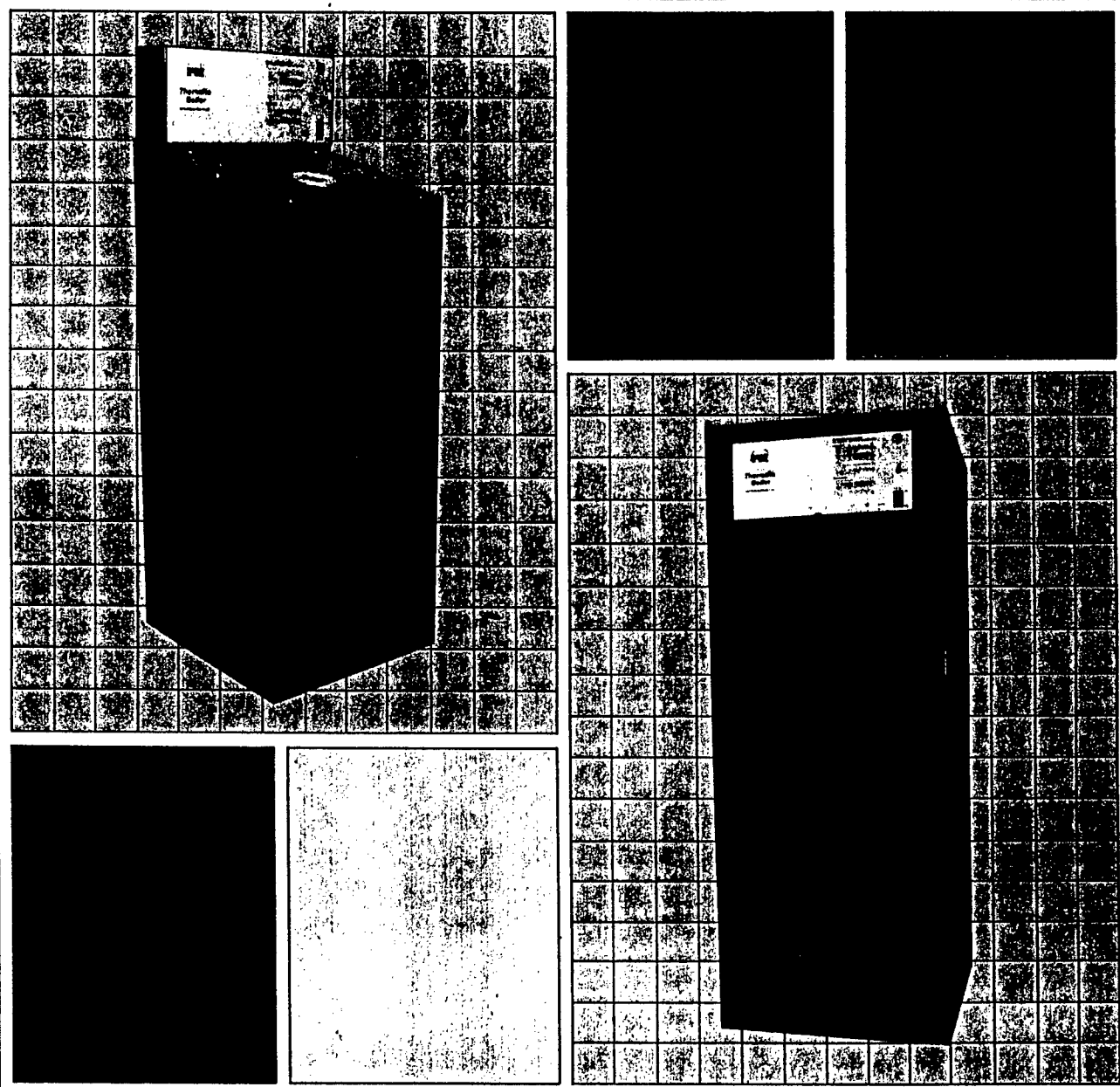
ELECTRICAL DEMAND (KW)												
BLDG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
3411	2	2	2	2	2	2	2	2	2	2	2	2
Simmlar Bldg 12	24	24	24	24	24	24	24	24	24	24	24	24
3412	2	2	2	2	2	2	2	2	2	2	2	2
Simmlar Bldg 11	22	22	22	22	22	22	22	22	22	22	22	22
TOTAL	46	46	46	46	46	46	46	46	46	46	46	46

ELECTRICAL CONSUMPTION (THOUSAND KWH)												
BLDG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
3411	1	1	1	1	1	1	1	1	1	1	1	1
Simmlar Bldg 12	12	12	12	12	12	12	12	12	12	12	12	12
3412	1	1	1	1	1	1	1	1	1	1	1	1
Simmlar Bldg 11	11	11	11	11	11	11	11	11	11	11	11	11
TOTAL	23	23	23	23	23	23	23	23	23	23	23	23
											TOTAL	276,000 kWH
											or	942 MMBtu

No electrical consumption for the comparison analysis with local boilers beacuse in either case HWP's are required.

P-K Thermific® Gas-Fired Boiler

A New Standard of Efficiency in Non-Condensing Boilers



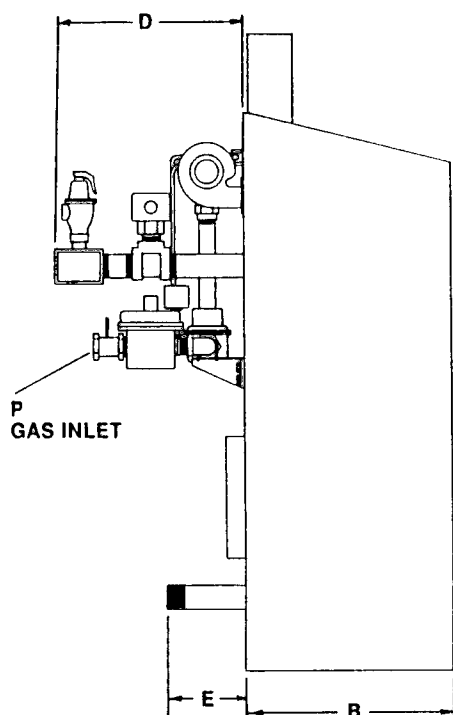
PATTERSON-KELLEY CO.

Division of HARSCO Corporation Phone: 717-421-7500
East Stroudsburg, PA 18301 Fax: 717-421-8735

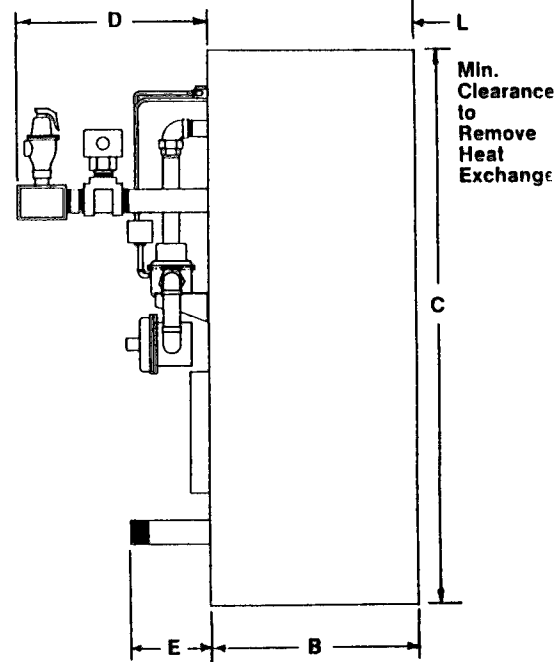
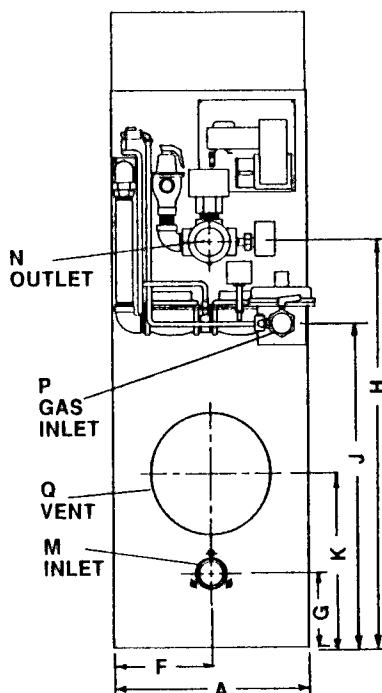


Water heaters • warm-air heaters • boilers • heat exchangers • blenders • dryers • fractionation internals • protective linings • wear-resistant steels

Capacities and Dimensions



Models: N-700, N-900, N-1200



Models: N-1500, N-1700, N-1900

Capacities and Dimensions

Dimensions in Inches

Model No.	BTU INPUT	BTU OUTPUT	A	B	C	D	E	F	G	H	J	K	L	M MPT	N FPT	P FPT	Q	Motor H.P.
N-700	700,000	595,000	19 ⁵ / ₈	21	56 ¹ / ₂	14	5 ¹ / ₄	9 ³ / ₄	8 ¹ / ₄	31 ³ / ₄	23 ³ / ₄	17 ¹ / ₈	24	2	2	1 ¹ / ₄	10	¹ / ₃
N-900	900,000	765,000	19 ⁵ / ₈	21	56 ¹ / ₂	14	5 ¹ / ₄	9 ³ / ₄	8 ¹ / ₄	31 ³ / ₄	23 ³ / ₄	17 ¹ / ₈	24	2	2	1 ¹ / ₄	10	¹ / ₃
N-1200	1,200,000	1,020,000	19 ⁵ / ₈	21	66 ⁷ / ₈	14	5 ¹ / ₄	9 ³ / ₄	8 ¹ / ₄	41 ¹ / ₄	22 ¹ / ₄	17 ¹ / ₈	24	2	2	1 ¹ / ₂	10	¹ / ₂
N-1500	1,500,000	1,275,000	25 ⁵ / ₈	26 ¹ / ₄	67	15	5 ¹ / ₂	12 ³ / ₄	8 ⁷ / ₈	47 ¹ / ₂	29	19 ¹ / ₈	29	2 ¹ / ₂	2 ¹ / ₂	2	12	³ / ₄
N-1700	1,700,000	1,445,000	25 ⁵ / ₈	26 ¹ / ₄	67	15	5 ¹ / ₂	12 ³ / ₄	8 ⁷ / ₈	47 ¹ / ₂	29	19 ¹ / ₈	29	2 ¹ / ₂	2 ¹ / ₂	2	12	³ / ₄
N-1900	1,900,000	1,615,000	25 ⁵ / ₈	26 ¹ / ₄	67	15	5 ¹ / ₂	12 ³ / ₄	8 ⁷ / ₈	47 ¹ / ₂	29	19 ¹ / ₈	29	2 ¹ / ₂	2 ¹ / ₂	2	12	³ / ₄

A.G.A. Design-Certified for natural gas. ASME Certified for 160 PSIG, Section IV. National Board Registered.

Standard Features

- Pressure-temperature gauge
- Water flow switch
- ASME pressure relief valve
- Two diaphragm main gas valves
- Main gas pressure regulator (14" W.C. max. inlet)
- Low gas pressure switch (manual reset)
- Main gas plug cock
- Solenoid pilot gas valve
- Pilot gas filter
- Pilot gas pressure regulator
- Pilot gas cock
- Interrupted spark-ignited pilot
- Flame safe-guard programmer
- Hi-limit temperature control with manual reset
- Operating temperature control
- Differential air pressure switch
- Radial-fired power burner
- Interlocked, finned, copper water tubes
- Adjustable inlet air shutter
- Blower assembly with "C" frame motor
- Ten-point diagnostic annunciator control panel
- 16-gauge (min.) steel outer cabinet
- 16-gauge aluminum inner cabinet
- Baked epoxy finish
- Adjustable levelers



A.G.A. Design-Certified



A.G.A. Approved



ASME Code, Section IV

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Series 1510 Pump Selection 147.0 gpm 30.0 ft.
 Rank Selections by Efficiency or Cost (E/C)? E

Rank	Series	Size	Eff. (%)	Dia. (in.)	RPM	Mtr HP	NOL BHP
1	1510	2-1/2AB	72.2	6.000	1750	2.000	1.889
2	1510	2-1/2BB	72.1	8.625	1150	2.000	2.066
3	1510	3BB	71.2	8.625	1150	2.000	2.220
4	1510	2BC	66.3	9.125	1150	2.000	1.936
5	1510	2E	65.5	9.250	1150	2.000	1.944
6	1510	2AC	63.2	6.625	1750	2.000	1.864
7	1510	3AB	59.3	6.250	1750	2.000	2.547
8	1510	4BC	55.1	8.625	1150	3.000	3.353
9	1510	4AC	49.5	5.875	1750	3.000	3.599

☐ View a pump in more detail
☐ Choose pumps to analyze further
☐ Select Triple Duty Valve ☐ Select Suction Diffuser
☐ Return to Select Pumps
 Pump Selection: Series 1510
 Performance Rank: 1 Cost rank: 2

Pump Size: 2-1/2AB Pump speed: 1750 RPM
 Total Capacity: 147.0 GPM Total Head: 30.0'
 Efficiency: 72.15% NPSH req: 3.53'
 Discharge size: 2.500" Velocity: 9.85 FPS
 Suction size: 3.000" Velocity: 6.38 FPS
 Impeller Diameter: 6.000"
 End-of-curve BHP: 1.889 (at design: 62.8%)
 Pump power, BHP: 1.543 (1.151 Kw)
 Motor power, HP: 2.000 (BHP/HP = 0.77)

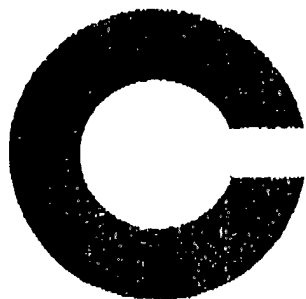
Motor: SE AC MOTOR 230/460V 145-12 D 367304
 2.000 HP 1736 RPM 4 poles 60.000 HZ 3 phase

Voltage: 230/460 RPM: 1754.2 Eff: 80.06%
 AMP: 5.49/ 2.75 P.F.: 65.71% KVA: 2.187

Annual Operating Cost per pump = \$ 1258.97
 for 8760 hours annually at \$0.10 / kwh

14WP FOR BARRACKS IN 3400 AREA

147 GPM @ 30' HD



CLARY & ASSOCIATES, INC.

545 Dutch Valley Rd. N.E. • Atlanta, Georgia 30324
Area Code 404 Telephone 873-1861

FAX MESSAGE

TO: CARL LUNDSTROM DEPT: _____

COMPANY: E.M.C. ENGINEERS, INC. FAX #: _____

FROM: CHARLIE WHEELER DATE: 09/18/91

SUBJECT: FT. SILL CENTRAL PLANT

MESSAGE: CARL - HERE ARE THE BUDGET PRICES WHICH YOU

REQUESTED. SHOULD YOU HAVE ANY QUESTIONS, PLEASE

CALL.

THANKS,

Charlie Wheeler

CHARLIE WHEELER

REPLY: _____

CLARY & ASSOCIATES FAX # 404 873-1867

NUMBER OF PAGES INCLUDING THIS PAGE

product

MP1061

E M C ENGINEERS, INC.
 Denver • Colorado Springs • Atlanta • West Germany

JOB 3002.000

SHEET NO. _____ OF _____

CALCULATED BY ✓✓ DATE 9/17/91

CHECKED BY _____ DATE _____

SCALE _____

Brief Information

Gas Fired Boiler

Thermifire rate	765,000 BTU/HR	*5430.00
"	1020,000 BTU/HR	*6135.00

Pumps

	Bldg.	gpm.	FL HD	BELL & GOSSET Pump #	DIAMETER	PRICE (C\$)
500	3442	157	183	1531-2AC, 15HP	6.875	\$1138.00
1750	3442	147	30	1510-2AC, 2HP	6.0	\$995.00
1750	5678	309	65	1510-3BB, 10HP	6.875	\$1450.00
1750	" "	570	40	1510-4AC, 7.5HP	10.25	\$1475.00
1750	" "	1576	30	1510-6BC, 20HP	10.875	\$1508.00
3500	2812	67	144	1531-1 1/4 AC, 7.5HP	5.875	\$790.00
1750	" "	410	95	1531-3E, 20HP	10.5	\$2275.00
1750	" "	1026	55	1531-5E 20HP	8.875	\$2375.00

All Prices For Shipping Point And Are BUDGET PRICES ONLY

CHARLIE WHEELER
 CLARY & Assoc.
 9/17/91

APPENDIX M.2

PROJECT ANALYSIS FOR CENTRAL HEATING PLANT

**ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA**

CENTRAL PLANT: 3442
ENERGY CONSERVATION OPPORTUNITY: PROJECT 5B
SYSTEM MODIFICATION: CONSTRUCT NEW CENTRAL HEATING PLANT
SYSTEMS TO MODIFY: BOILERS AND PUMPS

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for Project 5B, construct new central heating plant, addition to existing central cooling plant. The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas (MMBtu)	Total Energy (MMBtu)
	Demand(kW)	Energy(kWh)		
Baseline	NA	NA	NA	NA
Case Study	0	78,000	75,555	75,821
Energy Consumptions	0	78,000	75,555	75,821

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 266 MMBtu/Yr X \$4.0141 /MMBtu = \$1,069 per year
 Nat. Gas: 75555 MMBtu/Yr X \$2.92 /MMBtu = \$220,621 per year
 Total Energy Cost Savings: \$1,069 + \$220,621 = \$221,689 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X \$1.787 /kW X 12 months/year
 = (+) \$0 per year
 Maintenance: = (-) \$0 per year
 Total: \$0 - \$0 = \$0 per year

[ECO-SHT2.WK3]

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: PROJECT5

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3

PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS

FISCAL YEAR 1991 DISCRETE PORTION NAME: NEW CENTRAL PLANT

ANALYSIS DATE: 09-26-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 1979797.
B. SIOH	\$ 108889.
C. DESIGN COST	\$ 118788.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$ 1986727.
E. SALVAGE VALUE COST	-\$ 0.
F. TOTAL INVESTMENT (1D-1E)	\$ 1986727.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 4.01	266.	\$ 1068.	11.37	12140.
B. DIST	\$.00	0.	\$ 0.	17.06	0.
C. RESID	\$.00	0.	\$ 0.	16.85	0.
D. NAT G	\$ 2.92	75555.	\$ 220621.	17.52	3865273.
E. COAL	\$.00	0.	\$ 0.	13.34	0.
F. TOTAL		75821.	\$ 221688.		\$ 3877413.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$ 0.
(1) DISCOUNT FACTOR (TABLE A)	11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$ 0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)	\$ 0.
D. PROJECT NON ENERGY QUALIFICATION TEST	
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$ 1279546.
A IF 3D1 IS = OR > 3C GO TO ITEM 4	
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F) = _____	
C IF 3D1B IS = > 1 GO TO ITEM 4	
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY	

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(\text{YEARS ECONOMIC LIFE}))$ \$ 221688.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 3877413.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.95
(IF < 1 PROJECT DOES NOT QUALIFY)
7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 8.96

COST ESTIMATE ANALYSIS

PROJECT		INVITATION NO./CONTRACT NO.				EFFECTIVE PRICING		DATE PREPARED		
CENTRAL PLANT ADDITION, BLDG. 3442		DACA 59-90-C-0087				DATE APR. 91		24-Sep-91		
LOCATION FT. SILL, OKLAHOMA		CODE A ☐ CODE B ☒ CODE C ☐		DRAWING NO.		SHT		OF		
		OTHER				ESTIMATOR		KC		
TASK DESCRIPTION	Quantity		LABOR		EQUIPMENT		MATERIAL		TOTAL	
	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Wt	Total Wt
CENTRAL PLANT ADDITION, BLDG. 3442										
PLUMBING	4,800	SF					6			28,800
H&V	4,800	SF					5			24,000
ELECTRICAL	4,800	SF					7			31,200
PROJECT COST (BLDG. ADDITION)	96,000	CF					4			384,000
BOILERS, HTHW	3	EA					40,000			120,000
PUMPS, HTHW	3	EA					4,500			13,500
EXPANSION TANK	1	LS					13,000			13,000
CONTROLS	3	LS					20,000			60,000
PIPING, 4"	300	FT					25			7,500
UTILITIES, (sewage, water, gas)	1	LS					5,000			5,000
HTHW TO HW CONVERTERS	23	EA					8,600			197,800
INSULATION, 4"	300	FT					5			1,500
FANS, FLUE	3	LS					4,000			12,000
PIPING DISTRIBUTION TO 3400 AREA										
2" STEEL PIPE	5,200	LF					13			67,600
3" STEEL PIPE	3,800	LF					21			79,800
4" STEEL PIPE	3,400	LF					25			85,000
SIDEWALK CUTS	24	EA					200			4,800
DRIVEWAY CUTS	24	EA					500			12,000
INSULATION 4"	3,400	LF					4			14,280
INSULATION 3"	3,800	LF					4			13,300
INSULATION 2"	5,200	LF					3			15,080
TEST & START - UP	1	LS					9,600			9,600
CONCRETE TRENCH	6,200	LF					11			68,200
TRENCH	6,200	LF					2			13,950
BACKFILL, SEED	6,200	LF					2			9,300
DTM	9.4	CLF					1934			18,180
SUBTOTAL										
OVERHEAD, BOND	16%									\$1,309,390
PROFIT	10%									\$209,502
COST SUB-TOTAL										\$1,649,831
CONTINGENCY	20%									\$329,966
SUBTOTAL										\$1,979,797
S&A	5.5%									\$108,889
TOTAL THIS SHEET										
\$2,088,686										

HEATING LOAD FOR HEATING PLANT 3442
CENTRAL HEATING PLANT OPTION

25-Sep-91

PEAK HEATING (THOUSAND BTU)													
BLDG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
3411	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3413	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3415	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3417	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3419	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3422	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3424	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3426	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3428	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3430	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3440	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
2470	1,668	1,668	1,668	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,598	1,668	
3412	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
3414	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
3416	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
3418	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
3420	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
3421	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
3423	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
3425	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
3427	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
3429	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
2471	1,292	1,292	1,292	646	646	646	646	646	646	646	1,224	1,292	
Subtotal	34,228	34,228	34,228	19,358	19,358	19,358	19,358	19,358	19,358	19,358	32,640	34,228	
Disp. Loss													
10%	3,423	3,423	3,423	1,936	1,936	1,936	1,936	1,936	1,936	1,936	3,264	3,423	
TOTAL	37,651	37,651	37,651	21,294	21,294	21,294	21,294	21,294	21,294	21,294	35,904	37,651	

HEATING CONSUMPTION (MBTU)													
BLDG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
3411	369	300	253	134	134	134	134	134	134	134	212	308	
3413	369	300	253	134	134	134	134	134	134	134	212	308	
3415	369	300	253	134	134	134	134	134	134	134	212	308	
3417	369	300	253	134	134	134	134	134	134	134	212	308	
3419	369	300	253	134	134	134	134	134	134	134	212	308	
3422	369	300	253	134	134	134	134	134	134	134	212	308	
3424	369	300	253	134	134	134	134	134	134	134	212	308	
3426	369	300	253	134	134	134	134	134	134	134	212	308	
3428	369	300	253	134	134	134	134	134	134	134	212	308	
3430	369	300	253	134	134	134	134	134	134	134	212	308	
3440	369	300	253	134	134	134	134	134	134	134	212	308	
2470	369	300	253	134	134	134	134	134	134	134	212	308	
3412	328	259	212	93	93	93	93	93	93	93	171	267	
3414	328	259	212	93	93	93	93	93	93	93	171	267	
3416	328	259	212	93	93	93	93	93	93	93	171	267	
3418	328	259	212	93	93	93	93	93	93	93	171	267	
3420	328	259	212	93	93	93	93	93	93	93	171	267	
3421	328	259	212	93	93	93	93	93	93	93	171	267	
3423	328	259	212	93	93	93	93	93	93	93	171	267	
3425	328	259	212	93	93	93	93	93	93	93	171	267	
3427	328	259	212	93	93	93	93	93	93	93	171	267	
3429	328	259	212	93	93	93	93	93	93	93	171	267	
2471	328	259	212	93	93	93	93	93	93	93	171	267	
Subtotal	8,036	6,449	5,368	2,631	2,631	2,631	2,631	2,631	2,631	2,631	4,425	6,633	
Disp. Loss													
10%	804	645	537	263	263	263	263	263	263	263	443	663	
TOTAL	8,840	7,094	5,905	2,894	2,894	2,894	2,894	2,894	2,894	2,894	4,868	7,296	

PUMPING C. PLANT 3442
HEATING

FROM	TO	BLDG LOAD (BTUH*1000)	TOTAL LOAD (BTUH*1000)	GPM @ 160oT (GPM)	LINE SIZE (INCHES)	P.D. FT HD PER 100 (FT HD)	EQUIV LENGTH (FT)	P.D. FT HD
3442	3419	1668	16468	206	4	3.5	300	10.5
3419	3418	1292	14800	185	4	3	300	9
3418	3417	1668	13508	169	4	2	300	6
3417	3416	1292	11840	148	3	5	300	15
3416	3414	1292	10548	132	3	4	300	12
3414	3415	1668	9256	116	3	3.2	400	12.8
3415	2470	1668	2960	37	2	3.5	500	17.5
2470	2471	1292	1292	16	1.5	2.5	350	8.75
							TOTAL	91.55
3414	3413	1668					TOTAL*2	183.1
3413	3412	1292						
3412	3411	1668						

Any Floor-Mounted Pump Selection 157.0 gpm 183.0 ft.
 Rank Selections by Efficiency or Cost (E/C)? E

Rank	Series	Size	Eff. (%)	Dia. (in.)	RPM	Mtr HP	NOL BHP
1	1531	2AC	68.1	6.875	3500	15.000	15.875
2	1510	2AC	68.1	6.875	3500	15.000	15.875
3	3510	1.5X2X8	65.7	6.625	3500	15.000	15.929
4	3531	1.5X2X8	65.7	6.625	3500	15.000	15.929
5	1510	1-1/2AB	63.0	6.875	3500	15.000	14.574
6	1531	1-1/2AB	63.0	6.875	3500	15.000	14.574
7	3510	1.25X1.5X8	60.7	7.250	3500	15.000	13.198
8	3531	1.25X1.5X8	60.7	7.250	3500	15.000	13.198
9	1531	2-1/2AB	60.1	6.750	3500	15.000	20.495
10	1510	2-1/2AB	60.1	6.750	3500	15.000	20.495

☐ View a pump in more detail
☐ Choose pumps to analyze further
☐ Select Triple Duty Valve ☐ Select Suction Diffuser
☐ Return to Select Pumps

Pump Selection: Series 1531
 Performance Rank: 1 Cost rank: 4

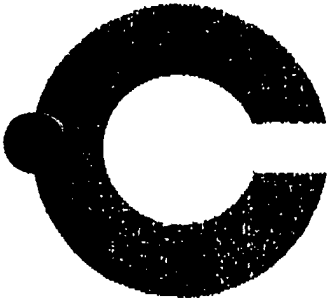
Pump Size: 2AC Pump speed: 3500 RPM
 Total Capacity: 157.0 GPM Total Head: 183.0'
 Efficiency: 68.07% NPSH req: 10.22'
 Discharge size: 2.000" Velocity: 15.01 FPS
 Suction size: 3.000" Velocity: 6.81 FPS
 Impeller Diameter: 6.875"
 End-of-curve BHP: 15.875 (at design: 43.9%)
 Pump power, BHP: 10.656 (7.946 Kw)
 Motor power, HP: 15.000 (BHP/HP = 0.71)

Motor: SE AC MOTOR 230/460V 215T-35 A 299496
 15.000 HP 3485 RPM 2 poles 60.000 HZ 3 phase

Voltage: 230/460 RPM: 3529.4 Eff: 88.38%
 AMP: 25.83/ 12.92 P.F.: 87.38% KVA: 10.290

Annual Operating Cost per pump = \$ 7876.17
 for 8760 hours annually at \$0.10 / kwh

HWP FOR CENTRAL HEATING PLANT 3442
 157 GPM @ 183' HD.



CLARY & ASSOCIATES, INC.

545 Dutch Valley Rd. N.E. • Atlanta, Georgia 30324
Area Code 404 Telephone 873-1861

FAX MESSAGE

TO: CARL LUNDSTROM DEPT:

COMPANY: E.M.C. ENGINEERS, INC. FAX #: _____

FROM: CHARLIE WHEELER DATE: 09/18/91

SUBJECT: FT. SILL CENTRAL PLANT

MESSAGE: CARL - HERE ARE THE BUDGET PRICES WHICH YOU

REQUESTED. SHOULD YOU HAVE ANY QUESTIONS, PLEASE _____

CALL

THANKS,

Charlie White

CHARLIE WHEELER

REPLY:

CLARY & ASSOCIATES FAX # 404 873-1867

NUMBER OF PAGES INCLUDING THIS PAGE

product

MP2U8

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

JCB 3002.000

SHEET NO. _____ OF _____

CALCULATED BY ✓✓ DATE 9/17/91

CHECKED BY _____ DATE _____

SCALE _____

Boiler InformationGas Fired BoilerThermifire rate
" "765,000 BTU/HR *5430.00
1020,000 BTU/HR *6135.00Pumps

	Bldg.	gpm.	FL HD	BELL & GOSSET Pump #	DIAMETER	PRICE (C\$)
3500	3442	157	183	1531-2AC, 15HP	6.875"	\$1138.00
1750	3442	147	30	1510-2AC, 2HP	6.0	\$995.00
1750	5678	309	65	1510-3BB, 10HP	6.875	\$1450.00
1750	" "	570	40	1510-4AC, 7.5HP	10.25	\$1475.00
1750	" "	1576	30	1510-6BC, 20HP	10.875	\$2508.00
3500	2812	67	144	1531-1 1/4 AC, 7.5HP	5.875	\$790.00
1750	" "	410	95	1531-3E, 20HP	10.5	\$2275.00
1750	" "	1026	55	1531-5E 20HP	8.875	\$2375.00

All Prices For Shipping Point And Are BUDGET PRICES ONLYCHARLIE WHEELER
CLARY & Assoc.
9/17/91

APPENDIX M.3

PC-CUBE BASERUN FOR BARRACKS WITH MESS HALL

PC-CUBE VERSION 2.0.3

BUILDING 3411 LOCAL BOILER (BARRACK W/MESS)

SYSTEM C1 HEATING, DOMESTIC HW, AND MESS HALL LOADS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	0
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

BOILER/HEATER IDENTIFICATION NUMBERS

C1 1 1 0 0 0 0 0 0 0 0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

BUILDING 3411 LOCAL BOILER (BARRACK W/MESS)

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

BUILDING 3411 LOCAL BOILER (BARRACK W/MESS)

BOILER/HEATER IDENT. NO.	1
MAXIMUM OUTPUT, BTU/HR	1020000.
ELECTRIC ACCESSORIES, KW	1.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)

10	228000.
20	343200.
30	442800.
40	541200.
50	644400.
60	750000.
70	864000.
80	974400.
90	1087200.
100	1200000.

BOILER/HEATER IDENT. NO.	2
MAXIMUM OUTPUT, BTU/HR	1020000.
ELECTRIC ACCESSORIES, KW	1.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)

10	229200.
20	343200.
30	442800.
40	541200.
50	644400.
60	750000.
70	861600.
80	974400.
90	1087200.
100	1200000.

PC-CUBE

BUILDING 3411 LOCAL BOILER (BARRACK W/MESS)

NUMBER OF EACH DAY TYPE PER MONTH

MONTH	DAY TYPE		
	1	2	3
JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	22	8	0
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	23	8	0
NOV	21	9	0
DEC	22	9	0

INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR

MONTH	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK	LOAD	PEAK	LOAD	DEMAND	LOAD	PEAK	LOAD
	THOUSAND BTU/HR	MILLION BTU	THOUSAND BTU/HR	MILLION BTU	KILOWATT	THOUSAND KWH	THOUSAND BTU/HR	MILLION BTU
JAN	1668.0	369.0	.0	.0	.0	.0	.0	.0
FEB	1668.0	300.0	.0	.0	.0	.0	.0	.0
MAR	1668.0	253.0	.0	.0	.0	.0	.0	.0
APR	1021.0	134.0	.0	.0	.0	.0	.0	.0
MAY	1021.0	134.0	.0	.0	.0	.0	.0	.0
JUN	1021.0	134.0	.0	.0	.0	.0	.0	.0
JUL	1021.0	134.0	.0	.0	.0	.0	.0	.0
AUG	1021.0	134.0	.0	.0	.0	.0	.0	.0
SEP	1021.0	134.0	.0	.0	.0	.0	.0	.0
OCT	1021.0	134.0	.0	.0	.0	.0	.0	.0
NOV	1598.0	212.0	.0	.0	.0	.0	.0	.0
DEC	1668.0	308.0	.0	.0	.0	.0	.0	.0
TOTAL		2380.0		.0		.0		.0

PC-CUBE

BUILDING 3411 LOCAL BOILER (BARRACK W/MESS)

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
4	.800	.800	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
5	.900	.900	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
6	1.000	1.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
7	.800	.800	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
20	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
21	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS

START HOUR	0	0	0	0
END HOUR	24	24	0	0
NO DAY TYPES	2	2	0	0
ADJUST LIMIT	.30	.30	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0	0	0	0	0	0	0	0	0	0	0

PC-CUBE VERSION 2.0.3

BUILDING 3411 LOCAL BOILER (BARRACK W/MESS)

** TOTAL **

SYSTEM C1 HEATING, DOMESTIC HW, AND MESS HALL LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	3582.
PEAK DAY GAS CONSUMP., 1000 CU FT	17.
ELECTRICAL CONSUMPTION, KWH	8859.
PEAK KW DEMAND (15 MIN BASIS)	2.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	8859.
ON-PEAK KW DEMAND (15 MIN BASIS)	2.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	8607
BOILER 2	252
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 7

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

BUILDING 3411 LOCAL BOILER (BARRACK W/MESS)

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	HEATING, DOMESTIC HW, AND MESS HALL LOADS										
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	4837	1288	1083	818	202	14	0	42	323	8607
2	101	0	0	5	32	41	73	0	0	0	252

PC-CUBE VERSION 2.0.3

BUILDING 3411 LOCAL BOILER (BARRACK W/MESS)

		GAS		ON-PK		ON-PK		PURCHASED ELECTRICAL		OFF-PK		OFF-PK		AUX		AUX	
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL		
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS		
C1	1	17.	475.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	2	16.	396.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	3	13.	362.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	4	8.	230.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	5	8.	232.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	6	9.	230.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	7	8.	232.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	8	8.	231.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	9	8.	230.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	10	8.	232.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	11	12.	318.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	12	15.	415.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		

PC-CUBE VERSION 2.0.3

BUILDING 3411 LOCAL BOILER (BARRACK W/MESS)

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	1668.	370.	2.	1.	0.	0.	0.	0.
C1	2	0.	0.	1668.	301.	2.	1.	0.	0.	0.	0.
C1	3	0.	0.	1668.	254.	2.	1.	0.	0.	0.	0.
C1	4	0.	0.	1021.	135.	2.	1.	0.	0.	0.	0.
C1	5	0.	0.	1021.	135.	2.	1.	0.	0.	0.	0.
C1	6	0.	0.	1021.	135.	2.	1.	0.	0.	0.	0.
C1	7	0.	0.	1021.	135.	2.	1.	0.	0.	0.	0.
C1	8	0.	0.	1021.	135.	2.	1.	0.	0.	0.	0.
C1	9	0.	0.	1021.	135.	2.	1.	0.	0.	0.	0.
C1	10	0.	0.	1021.	135.	2.	1.	0.	0.	0.	0.
C1	11	0.	0.	1598.	213.	2.	1.	0.	0.	0.	0.
C1	12	0.	0.	1668.	309.	2.	1.	0.	0.	0.	0.

APPENDIX M.4

PC-CUBE BASERUN FOR BARRACKS WITHOUT MESS HALL

PC-CUBE VERSION 2.0.3

BUILDING 3412 LOCAL BOILER (BARRACK WO/MESS)

SYSTEM C1 HEATING AND DOMESTIC HW LOADS

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	0
DIFFERENT TYPE BOILERS OR HEATERS	2
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

BOILER/HEATER IDENTIFICATION NUMBERS

C1 2 2 0 0 0 0 0 0 0 0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED
DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

BUILDING 3412 LOCAL BOILER (BARRACK WO/MESS)

	C1											
GENERATOR SYSTEM TYPE	0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3
GENERATOR START TIME	0	0	0									
GENERATOR STOP TIME	0	0	0									

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

BUILDING 3412 LOCAL BOILER (BARRACK WO/MESS)

BOILER/HEATER IDENT. NO. 1
MAXIMUM OUTPUT, BTU/HR 765000.
ELECTRIC ACCESSORIES, KW 1.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	171000.
20	257400.
30	332100.
40	405900.
50	483300.
60	562500.
70	648000.
80	730800.
90	815400.
100	900000.

BOILER/HEATER IDENT. NO. 2
MAXIMUM OUTPUT, BTU/HR 765000.
ELECTRIC ACCESSORIES, KW 1.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	171900.
20	257400.
30	332100.
40	405900.
50	483300.
60	562500.
70	646200.
80	730800.
90	815400.
100	900000.

PC-CUBE

BUILDING 3412 LOCAL BOILER (BARRACK WO/MESS)

MONTH	DAY TYPE			NUMBER OF EACH DAY TYPE PER MONTH
	1	2	3	
JAN	23	8	0	
FEB	20	8	0	
MAR	21	10	0	
APR	22	8	0	
MAY	23	8	0	
JUN	20	10	0	
JUL	23	8	0	
AUG	22	9	0	
SEP	22	8	0	
OCT	23	8	0	
NOV	21	9	0	
DEC	22	9	0	

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR							
	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	1292.0	328.0	.0	.0	.0	.0	.0	.0
FEB	1292.0	259.0	.0	.0	.0	.0	.0	.0
MAR	1292.0	212.0	.0	.0	.0	.0	.0	.0
APR	646.0	93.0	.0	.0	.0	.0	.0	.0
MAY	646.0	93.0	.0	.0	.0	.0	.0	.0
JUN	646.0	93.0	.0	.0	.0	.0	.0	.0
JUL	646.0	93.0	.0	.0	.0	.0	.0	.0
AUG	646.0	93.0	.0	.0	.0	.0	.0	.0
SEP	646.0	93.0	.0	.0	.0	.0	.0	.0
OCT	646.0	93.0	.0	.0	.0	.0	.0	.0
NOV	1224.0	171.0	.0	.0	.0	.0	.0	.0
DEC	1292.0	267.0	.0	.0	.0	.0	.0	.0
TOTAL		1888.0		.0		.0		.0

PC-CUBE

BUILDING 3412 LOCAL BOILER (BARRACK WO/MESS)

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
4	.800	.800	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
5	.900	.900	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
6	1.000	1.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
7	.800	.800	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
8	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
9	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
10	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
11	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
12	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
13	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
14	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
15	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
16	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
17	.500	.500	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
18	.500	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
19	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
20	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
21	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
22	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
23	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
24	.700	.700	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION

	HEATING	COOLING	ELECTRIC	PROCESS
START HOUR	0	0	0	0
END HOUR	24	24	0	0
NO DAY TYPES	2	2	0	0
ADJUST LIMIT	.30	.30	.00	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

BUILDING 3412 LOCAL BOILER (BARRACK WO/MESS)

** TOTAL **

SYSTEM C1 HEATING AND DOMESTIC HW LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	2777.
PEAK DAY GAS CONSUMP., 1000 CU FT	15.
ELECTRICAL CONSUMPTION, KWH	8650.
PEAK KW DEMAND (15 MIN BASIS)	2.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	8650.
ON-PEAK KW DEMAND (15 MIN BASIS)	2.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	8499
BOILER 2	151
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 7

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 8

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

BUILDING 3412 LOCAL BOILER (BARRACK WO/MESS)

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	HEATING AND DOMESTIC HW LOADS										
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	4701	858	968	848	527	209	86	151	151	8499
2	0	0	0	1	28	37	85	0	0	0	151

PC-CUBE VERSION 2.0.3

BUILDING 3412 LOCAL BOILER (BARRACK WO/MESS)

		GAS		ON-PK		ON-PK		PURCHASED ELECTRICAL		OFF-PK		OFF-PK		AUX		AUX	
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL		
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS		
C1	1	15.	411.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	2	13.	331.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	3	10.	293.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	4	6.	163.	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	5	6.	164.	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	6	6.	163.	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	7	6.	164.	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	8	6.	164.	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	9	6.	163.	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	10	6.	164.	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	11	9.	250.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	12	12.	347.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		

PC-CUBE VERSION 2.0.3

BUILDING 3412 LOCAL BOILER (BARRACK WO/MESS)

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVBL HEAT USED MMBTU	RECOVBL HEAT UNUSED MMBTU
C1	1	0.	0.	1292.	330.	2.	1.	0.	0.	0.	0.
C1	2	0.	0.	1292.	259.	2.	1.	0.	0.	0.	0.
C1	3	0.	0.	1292.	213.	2.	1.	0.	0.	0.	0.
C1	4	0.	0.	646.	94.	1.	1.	0.	0.	0.	0.
C1	5	0.	0.	646.	94.	1.	1.	0.	0.	0.	0.
C1	6	0.	0.	646.	94.	1.	1.	0.	0.	0.	0.
C1	7	0.	0.	646.	94.	1.	1.	0.	0.	0.	0.
C1	8	0.	0.	646.	94.	1.	1.	0.	0.	0.	0.
C1	9	0.	0.	646.	94.	1.	1.	0.	0.	0.	0.
C1	10	0.	0.	646.	94.	1.	1.	0.	0.	0.	0.
C1	11	0.	0.	1224.	172.	2.	1.	0.	0.	0.	0.
C1	12	0.	0.	1292.	267.	2.	1.	0.	0.	0.	0.

APPENDIX M.5

PC-CUBE CENTRAL HEATING PLANT ECO RUN

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 3442 HEATING

SYSTEM C1 PLANT 3442; CENTRAL HEATING DISTRIBUTION FOR 3400 BARRAC

NUMBER OF SYSTEMS	1
DIFFERENT TYPE GENERATORS	0
DIFFERENT TYPE CHILLERS	0
DIFFERENT TYPE BOILERS OR HEATERS	3
NATURAL GAS HIGHER HEATING VALUE	1000.
NATURAL GAS LOWER HEATING VALUE	951.
AUXILIARY FUEL	
AUXILIARY FUEL HEATING VALUE	1.
KILOWATT DEMAND BILLING BASIS (MINUTES)	15
DEMAND FACTOR* (TIMES HOURLY KILOWATT AVERAGE)	1.00

SYSTEM ID	GENERATOR OPERATION SCHEDULE	CHILLER OPERATION SCHEDULE	PERCENTAGE PROCESS HEAT DIRECT FIRED	DIRECT FIRED PROCESS HEAT EFFICIENCY	AF KEY	PROC KEY	STEAM TURB KEY	AUX FUEL DESCRIPTION
C1	0	1	0.	100.	0	0	0	1.

BOILER/HEATER IDENTIFICATION NUMBERS

C1 1 2 3 0 0 0 0 0 0 0

* NOTE- DEMAND FACTOR = ESTIMATED RATIO OF THE MAXIMUM DEMAND THAT WILL BE RECORDED DURING THE BILLING PERIOD TO THE MAXIMUM HOURLY DEMAND COMPUTED.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 3442 HEATING

			C1											
GENERATOR SYSTEM TYPE			0											
DAYTYPE	1	2	3	1	2	3	1	2	3	1	2	3		
GENERATOR START TIME	0	0	0											
GENERATOR STOP TIME	0	0	0											

ELECTRIC COST PER KWH	.01370
ELECTRIC DEMAND COST PER KW	1.78700
MINIMUM DEMAND FRACTION	1.00000

GAS COST PER CUBIC FOOT	.29200
GAS COST ADJUSTMENT PER CUBIC FOOT	.00000
WINTER GAS RATE MULTIPLIER FOR SUMMER RATES	.00000
STARTING MONTH FOR SUMMER GAS RATE	0
ENDING MONTH FOR SUMMER GAS RATE	0
AUXILIARY FUEL COST PER UNIT	.00000

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 3442 HEATING

BOILER/HEATER IDENT. NO. 1
MAXIMUM OUTPUT, BTU/HR 10000000.
ELECTRIC ACCESSORIES, KW 8.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2436750.
20	3667950.
30	4732425.
40	5784075.
50	6887025.
60	8015625.
70	9208350.
80	10413900.
90	11619450.
100	12825000.

BOILER/HEATER IDENT. NO. 2
MAXIMUM OUTPUT, BTU/HR 10000000.
ELECTRIC ACCESSORIES, KW 8.
STEAM ACCESSORIES, BTU/HR 0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2436750.
20	3667950.
30	4732425.
40	5784075.
50	6887025.
60	8015625.
70	9208350.
80	10413900.
90	11619450.
100	12825000.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 3442 HEATING

BOILER/HEATER IDENT. NO.	3
MAXIMUM OUTPUT, BTU/HR	10000000.
ELECTRIC ACCESSORIES, KW	0.
STEAM ACCESSORIES, BTU/HR	0.

LOAD	ENERGY IN (BTU/HR OR KW)
10	2436750.
20	3667950.
30	4732425.
40	5784075.
50	6887025.
60	8015625.
70	9208350.
80	10413900.
90	11619450.
100	12825000.

PC-CUBE

CENTRAL PLANT 3442 HEATING

MONTH	DAY TYPE		
	1	2	3

JAN	23	8	0
FEB	20	8	0
MAR	21	10	0
APR	22	8	0
MAY	23	8	0
JUN	20	10	0
JUL	23	8	0
AUG	22	9	0
SEP	22	8	0
OCT	23	8	0
NOV	21	9	0
DEC	22	9	0

MONTH	INPUT ENERGY LOADS FOR SYNTHETIC LOADS GENERATOR							
	HEATING		COOLING		ELECTRIC		PROCESS	
	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	PEAK THOUSAND BTU/HR	LOAD MILLION BTU	DEMAND KILOWATT	LOAD THOUSAND KWH	PEAK THOUSAND BTU/HR	LOAD MILLION BTU
JAN	37651.0	8840.0	.0	.0	.0	.0	.0	.0
FEB	37651.0	7094.0	.0	.0	.0	.0	.0	.0
MAR	37651.0	5905.0	.0	.0	.0	.0	.0	.0
APR	21294.0	2894.0	.0	.0	.0	.0	.0	.0
MAY	21294.0	2894.0	.0	.0	.0	.0	.0	.0
JUN	21294.0	2894.0	.0	.0	.0	.0	.0	.0
JUL	21294.0	2894.0	.0	.0	.0	.0	.0	.0
AUG	21294.0	2894.0	.0	.0	.0	.0	.0	.0
SEP	21294.0	2894.0	.0	.0	.0	.0	.0	.0
OCT	21294.0	2894.0	.0	.0	.0	.0	.0	.0
NOV	35904.0	4868.0	.0	.0	.0	.0	.0	.0
DEC	37228.0	7296.0	.0	.0	.0	.0	.0	.0
TOTAL		54261.0		.0		.0		.0

PC-CUBE

CENTRAL PLANT 3442 HEATING

INPUT LOAD PROFILES

HOUR	HEATING DAY TYPE			COOLING DAY TYPE			ELECTRIC DAY TYPE			PROCESS DAY TYPE		
	1	2	3	1	2	3	1	2	3	1	2	3
1	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
2	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
3	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
4	.800	.800	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
5	.900	.900	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
6	1.000	1.000	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
7	.800	.800	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
8	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
9	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
10	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
11	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
12	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
13	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.300	.000
14	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.300	.000
15	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.300	.000
16	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.300	.000
17	.500	.500	.000	.700	.700	.000	.000	.000	.000	.000	.300	.000
18	.500	.700	.000	.700	.700	.000	.000	.000	.000	.000	.300	.000
19	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.300	.000
20	.700	.700	.000	.700	.700	.000	.000	.000	.000	.000	.300	.000
21	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
22	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
23	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000
24	.700	.700	.000	.300	.300	.000	.000	.000	.000	.000	.300	.000

PROFILE ADJUSTMENT START AND STOP TIME, NUMBER OF DAY TYPES TO ADJUST AND LIMIT OF RANDOM VARIATION			
	HEATING	COOLING	ELECTRIC
START HOUR	0	1	0
END HOUR	24	24	0
NO DAY TYPES	2	2	0
ADJUST LIMIT	.30	.30	.00

HOURS OF AUXILIARY FUEL IN EACH MONTH

0 0 0 0 0 0 0 0 0 0 0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 3442 HEATING

** TOTAL **

SYSTEM C1 PLANT 3442; CENTRAL HEATING DISTRIBUTION FOR 3400 BARRAC

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	75554.
PEAK DAY GAS CONSUMP., 1000 CU FT	432.
ELECTRICAL CONSUMPTION, KWH	80504.
PEAK KW DEMAND (15 MIN BASIS)	16.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	80504.
ON-PEAK KW DEMAND (15 MIN BASIS)	16.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	8760
BOILER 2	1303
BOILER 3	329
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT COOLING LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 8

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT HEATING LOAD EXCEEDED EQUIPMENT CAPACITY

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	37651000.	30	31
FEB	37651000.	750	28
MAR	37651000.	1446	31
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	35904000.	7326	30
DEC	37228000.	8046	31

MONTHLY MAXIMUMS AND COUNT OF HOURS THAT ELECTRICAL LOAD EXCEEDED EQUIPMENT CAPACITY

PAGE NO. 9

SYSTEM C1

MAXIMUM LOAD AT HR COUNT

JAN	0.	0	0
FEB	0.	0	0
MAR	0.	0	0
APR	0.	0	0
MAY	0.	0	0
JUN	0.	0	0
JUL	0.	0	0
AUG	0.	0	0
SEP	0.	0	0
OCT	0.	0	0
NOV	0.	0	0
DEC	0.	0	0

COUNT OF COOLING LOAD HOURS

JAN	0
FEB	0
MAR	0
APR	0
MAY	0
JUN	0
JUL	0
AUG	0
SEP	0
OCT	0
NOV	0
DEC	0

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 3442 HEATING

ANNUAL NUMBER OF HOURS AT 10 PERCENT INCREMENTS OF LOAD

SYSTEM C1	PLANT 3442; CENTRAL HEATING DISTRIBUTION FOR 3400 BARRAC										
BLR	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	TOTAL
1	0	0	1649	2953	593	358	620	465	399	1723	8760
2	338	219	204	48	28	24	17	9	56	360	1303
3	47	129	2	0	0	0	0	0	0	151	329

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 3442 HEATING

		GAS		ON-PK		ON-PK		PURCHASED ELECTRICAL		OFF-PK		OFF-PK		AUX		AUX	
		DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	DEMAND	CONSUMP	FUEL	FUEL		
		MCF	MCF	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	KW	THOU KWH	CONSUMP	HRS		
C1	1	432.	11888.	16.	10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	2	397.	9360.	16.	7.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	3	287.	7812.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	4	159.	4317.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	5	154.	4360.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	6	161.	4318.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	7	154.	4360.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	8	155.	4360.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	9	159.	4317.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	10	154.	4360.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	11	248.	6576.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		
C1	12	357.	9527.	16.	7.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.		

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 3442 HEATING

		COOLING DEMAND TONS	COOLING CONSUMP TON-HRS	HEAT DEMAND MBH	HEAT CONSUMP MMBTU	ELECT DEMAND KW	ELECT CONSUMP THOU KWH	GEN ELECT THOU KWH	SOLD ELECT THOU KWH	RECOVL HEAT USED MMBTU	RECOVL HEAT UNUSED MMBTU
C1	1	0.	0.	37651.	8917.	16.	10.	0.	0.	0.	0.
C1	2	0.	0.	37651.	7106.	16.	7.	0.	0.	0.	0.
C1	3	0.	0.	37651.	5932.	16.	6.	0.	0.	0.	0.
C1	4	0.	0.	21294.	2913.	16.	6.	0.	0.	0.	0.
C1	5	0.	0.	21294.	2915.	16.	6.	0.	0.	0.	0.
C1	6	0.	0.	21294.	2913.	16.	6.	0.	0.	0.	0.
C1	7	0.	0.	21294.	2915.	16.	6.	0.	0.	0.	0.
C1	8	0.	0.	21294.	2915.	16.	6.	0.	0.	0.	0.
C1	9	0.	0.	21294.	2913.	16.	6.	0.	0.	0.	0.
C1	10	0.	0.	21294.	2915.	16.	6.	0.	0.	0.	0.
C1	11	0.	0.	35904.	4900.	16.	6.	0.	0.	0.	0.
C1	12	0.	0.	37228.	7312.	16.	7.	0.	0.	0.	0.

APPENDIX N

**DISTRIBUTION LOSS CALCULATIONS
FOR CENTRAL PLANTS 5900 AND 6003**

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

JOB 300 2.000

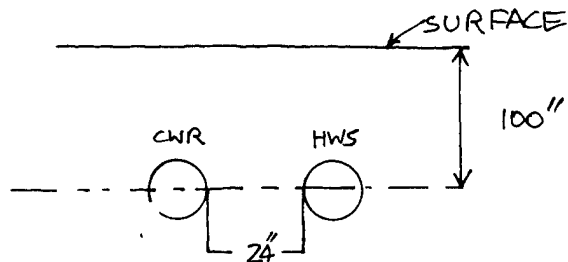
SHEET NO. _____ OF _____

CALCULATED BY KC DATE 4-1-92

CHECKED BY _____ DATE _____

SCALE _____

CENTRAL PLANT 5900 & 6003

DISTRIBUTION SYSTEM 5900

CW PIPES ARE PVC WITH 2" URETHANE FOAM
 THERMAL CONDUCTIVITY $0.16 \text{ Btu} \cdot \text{IN} / \text{ft}^2 \cdot \text{h} \cdot ^\circ\text{F} \times 2 = 0.32$
 CWS TEMP $\approx 45^\circ\text{F}$ CWR TEMP $\approx 55^\circ\text{F}$

HW PIPES ARE STEEL WITH 2" OF CALCIUM SILICATE
 THERMAL CONDUCTIVITY $= 0.46 \text{ Btu} \cdot \text{IN} / \text{ft}^2 \cdot \text{h} \cdot ^\circ\text{F} \times 2 = 0.92$
 HWS TEMP $\approx 300^\circ\text{F}$ HWR TEMP $= 250^\circ\text{F}$

DISTRIBUTION SYSTEM 6003

SAME CONDITION AS ABOVE EXCEPT NO HW; 6003 PROVIDES
 12 PSIG STEAM.

- PIPE TEMP FOR STEAM $\approx 243^\circ\text{F}$ (SEE ATTACHMENT)
- CONDENSATE RETURN

CENTRAL PLANT 6003

CWS/R (INCH.)	STM (INCH.)	CR (INCH.)	LENGTH (FT.)	TOTAL (FT.)
8	10	3	210	210
6	8	2.5	150	150
6	6	2.5	150	150
5	6	2	275	275
5	5	1.5	150	
5	5	1.5	150	300
3	8	2	50	50
3	4	1.25	1,750	1,750
3	3	2	700	
3	3	1	150	850
3	2.5	1.5	75	75
3	2	1.25	410	
3	2	1.25	140	550
2	3	1	150	150
2	2.5	1.25	275	275
2	2	1	150	150

CENTRAL PLANT 5900

CWS/R (INCH.)	HWS/R (INCH.)	LENGTH (FT.)	TOTAL (FT.)
12	8	900	
12	8	800	
12	8	950	2,650
11	9	975	
11	9	200	1,175
10	8	325	325
10	6	1,075	1,075
8	5	1,050	
8	5	1,350	
8	5	1,225	
8	5	1,200	4,825
8	4	350	350

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

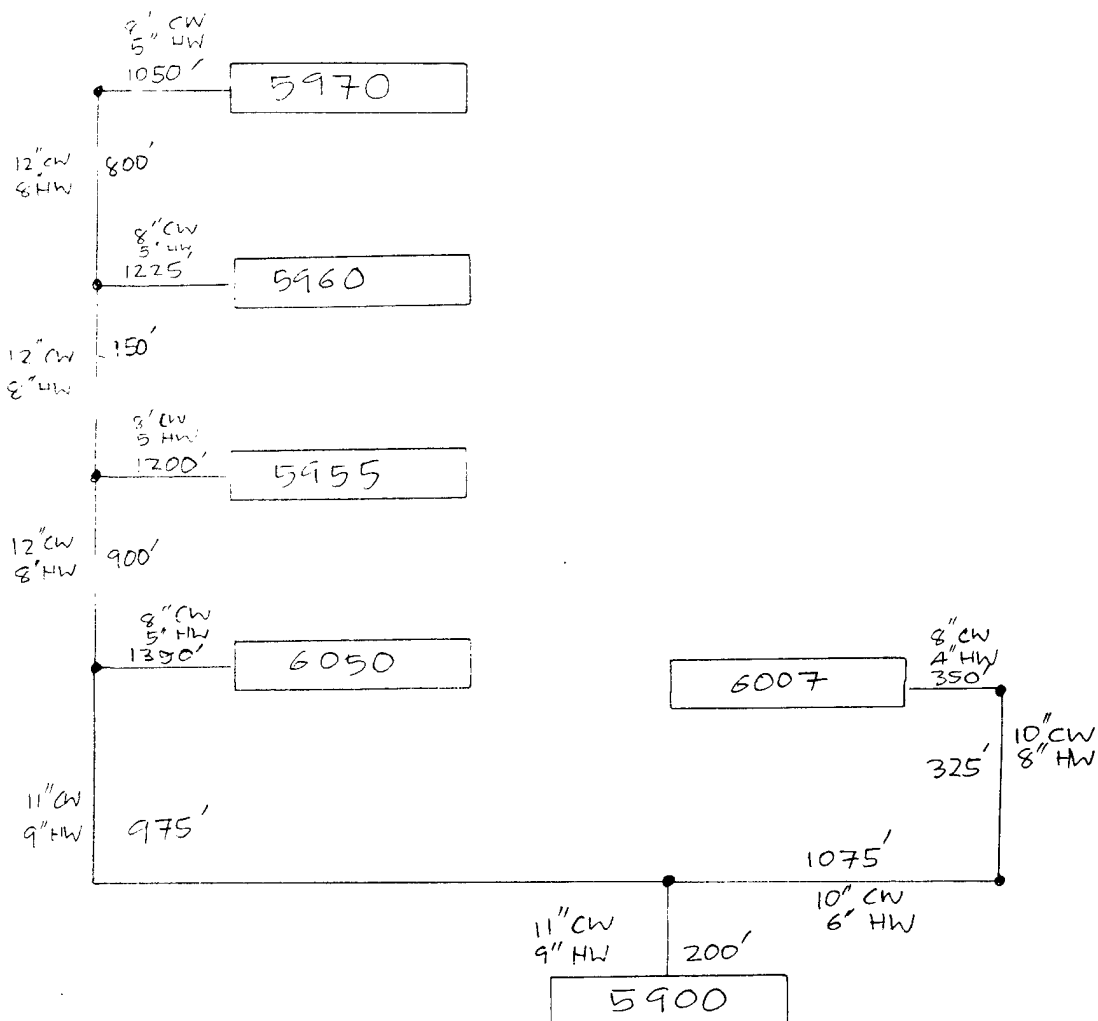
JOB 3002 .000

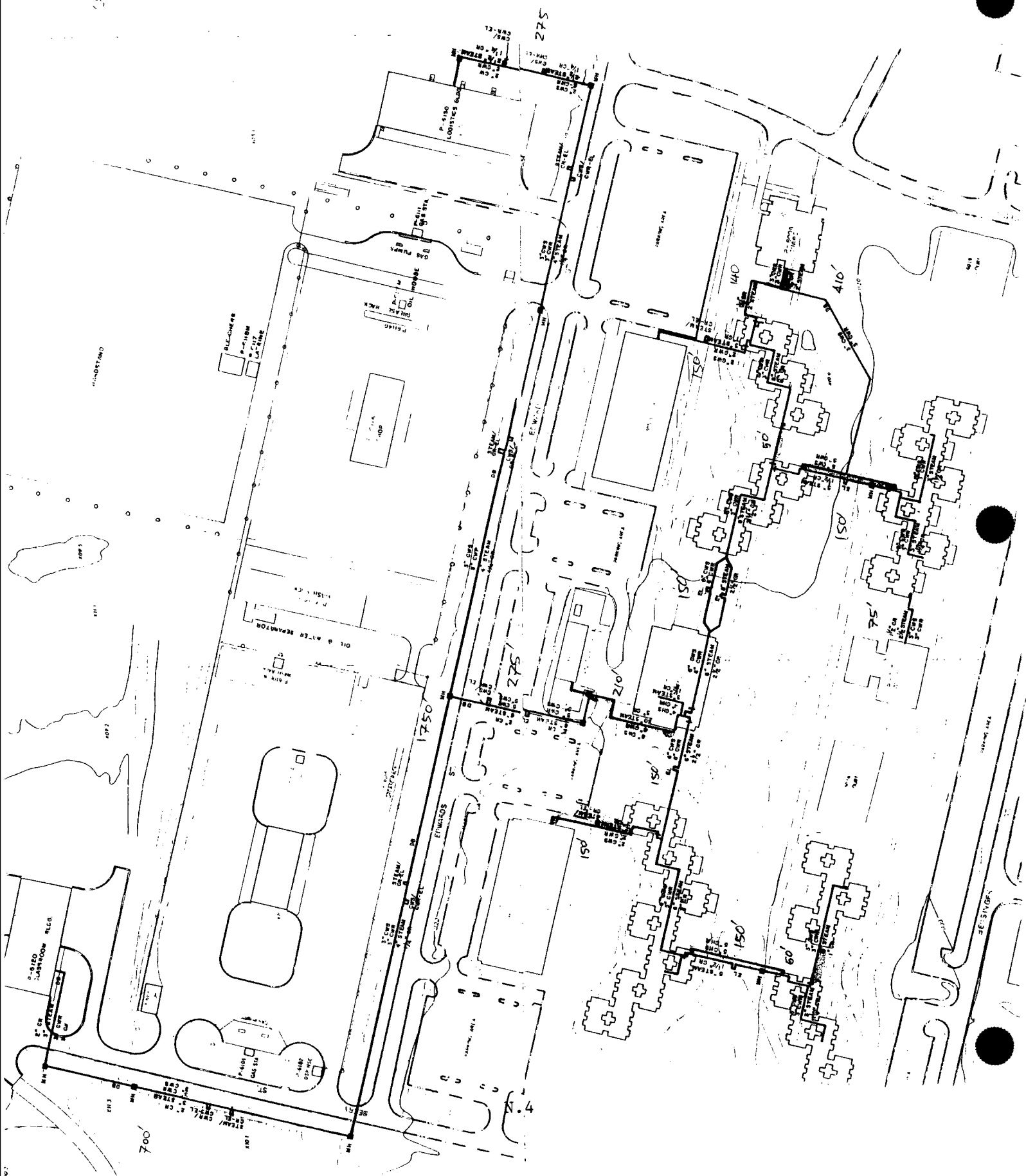
SHEET NO. _____ OF _____

CALCULATED BY KC DATE 3-31-92

CHECKED BY _____ DATE _____

SCALE _____





foaming took place. Foam in trenches should have a density high enough to provide a parallel compressive strength of 40 psi (267 kPa) and should never be used at temperatures over 240 to 250°F (116 to 121°C), or 210°F (99°C) if any ground moisture is present. A combination of water and temperature above 210°F (99°C) quickly destroys the urethane.

Froth-pour or direct spray are the two application methods. For froth-pour techniques, simple forms are erected to contain the foam, which has a final density of about 2.0 to 2.5 lb/ft³ (32 to 40 kg/m³) and compressive strength after 24 hours from 25 to 40 psi (172 to 275 kPa). The direct spray method is more rapid, eliminates the need for side forms, and usually provides a denser material, from 2.2 to 3.0 lb/ft³ (35 to 48 kg/m³), with somewhat greater compressive strength. Voids are required for expansion-contraction movement of the spray material.

INSULATED PIPING SYSTEM DESIGN

General Considerations

An underground heat or chilled-water distribution piping system should provide efficient long-term operation (25 to 40 years) through structural soundness and protection from corrosion and other deterioration. To achieve this goal, it is necessary to design a system with the following characteristics:

1. Protection of a metallic carrier pipe from corrosion by cathodic protection or other means.
2. An insulation of the required thermal efficiency that is durable and can accommodate expansion of the piping system, and can tolerate occasional contact with the fluid being piped or ground water.
3. A protective casing that resists ground water infiltration, mechanical or structural damage, and corrosion; as well as other causes of deterioration.
4. A system that can be restored to its original condition by drying in the event of occasional flooding, or limits flooding to one pipe length.

HEAT TRANSFER COMPUTATIONS

Heat transfer in a piping system is not related to the load factor and can be a large part of the total load. Several factors affect the heat transfer, the main one being the difference between earth and fluid temperatures. For example, the extremes might be a 6 in. (150 mm) insulated 400°F (204°C) water line in 40°F (4.4°C) earth with 100 to 200 Btu/h · lin ft (96 to 192 W/m) loss, and a 6 in. (150 mm) uninsulated 55°F (12.8°C) chilled water return in 60°F (15.6°C) earth with 10 Btu/h · lin ft (9.6 W/m) gain. The former requires analysis to determine the insulation needs and effect on the total heating system; the latter suggests analysis and insulation needs might be minimal. Other factors that affect heat transfer, but to a lesser extent than soil temperature are (1) depth of burial, which is related to the earth temperature, (2) soil conductivity, which is related to moisture content, and (3) distance between adjacent pipes.

There are several methods to compute heat gains or losses in underground piping systems. Since the heat transfer process from underground heat distribution systems is a transient phenomenon, the best method is a computerized, iterative process and finite difference or finite element technique that calculates thermal conductivity and thermal gradient as each changes with respect to the other. Simple analytical equations are available, however, to determine pipe-ground heat exchange under steady-state conditions. Steady-state calculations for a one-pipe system can be done without a computer, but it becomes increasingly difficult for a two-, three- or fourpipe system unless a computer is used.

The following computation methods developed by the Federal Construction Council (1975) and Kusuda and Powell (1970) provide a steady-state heat transfer analysis of simple underground systems. The magnitude of error depends on the difference between the chosen parameters (such as temperatures and thermal conductivity of surrounding soil and insulation materials) and the actual values. Since the earth around the pipe is heterogeneous, its thermal properties and temperature are difficult to define. The handbook data is more useful for a consistent comparative analysis rather than for absolute accuracy of computation. Earth temperatures and earth thermal conductivity factors are listed immediately after the computation methods.

Required Data for Figure 1:

d = depth of burial, in. (mm).

r = radius of the system (to the exterior surface of the system), in. (mm).

T_G = earth temperature, °F (°C).

K_s = earth thermal conductivity, Btu · in./h · ft² · °F (W/m² · K).

C = system thermal conductance, Btu/h · °F · ft (W/°C · m) of pipe.

t_f = temperature of fluid being distributed, °F (°C).

Calculations (Figure 1):

1. System or Pipe Heat Transfer Factor:

$$\frac{1}{k_p} = \frac{1}{C} + \frac{12}{2\pi K_s} \ln \left\{ \frac{d}{r} + \sqrt{\left(\frac{d}{r}\right)^2 - 1} \right\}$$

or, when $\frac{d}{r} \gg 1$

$$\frac{1}{k_p} = \frac{1}{C} + \frac{12}{2\pi K_s} \ln \left(\frac{2d}{r} \right)$$

2. System or Pipe Heat Loss:

$$C = K_p (T_f - T_G)$$

Required Data for Figure 2:

d_1 = depth of burial, Pipe No. 1, in. (mm).

d_2 = depth of burial, Pipe No. 2, in. (mm).

r_1 = radius of the system, Pipe No. 1, in. (mm).

r_2 = radius of the system, Pipe No. 2, in. (mm).

T_G = earth temperature, °F (°C).

K_s = earth thermal conductivity, Btu · in./h · ft² · °F (W/m² · K).

C = system thermal conductance, Btu/h · °F · ft (W/°C · m) of pipe.

T_{f1} = temperature of fluid being carried in Pipe No. 1, °F (°C).

T_{f2} = temperature of fluid being carried in Pipe No. 2, °F (°C).

a = center distance between pipes (No. 1 and 2), in. (mm).

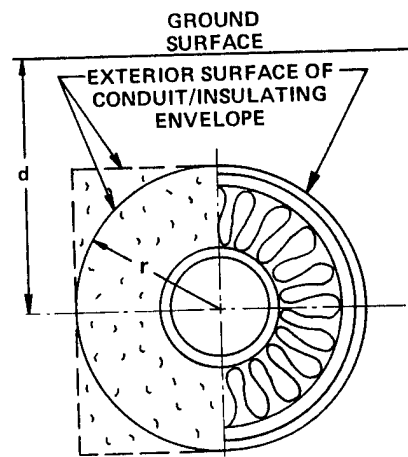


Fig. 1 Heat Loss from Single-Pipe System

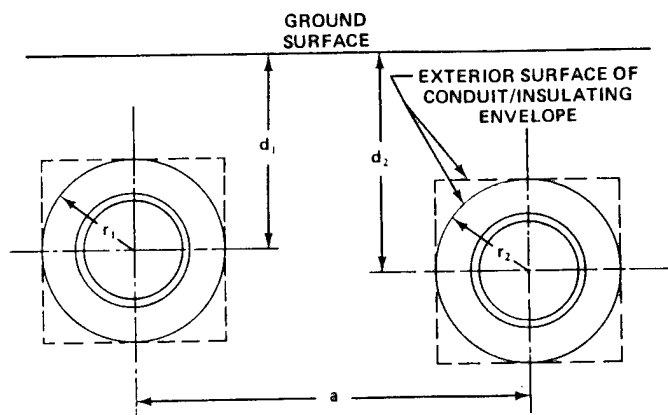


Fig. 2 Heat Loss from Two-Pipe System with Pipes in Separate Conduit/Envelope

Calculations (Figure 2):

1. Let:

$$P_{11} = 1 + \frac{12C_1}{2\pi K_s} \ln \left(\frac{2d_1}{r_1} \right)$$

$$P_{12} = 1 + \frac{12C_2}{2\pi K_s} \ln \sqrt{\frac{a^2 + (d_1 + d_2)^2}{a^2 + (d_1 - d_2)^2}}$$

$$P_{21} = 1 + \frac{12C_1}{2\pi K_s} \ln \sqrt{\frac{a^2 + (d_1 + d_2)^2}{a^2 + (d_1 - d_2)^2}}$$

$$P_{22} = 1 + \frac{12C_2}{2\pi K_s} \ln \left(\frac{2d_2}{r_2} \right)$$

and

$$\Delta = P_{12} P_{21} - P_{11} P_{22}$$

2. Pipe Heat Transfer Factors:

$$K_{p1} = \frac{C_1}{\Delta} (P_{12} - P_{22})$$

and

$$K_{p2} = \frac{C_2}{\Delta} (P_{21} - P_{11})$$

3. Equivalent Pipe Temperatures:

$$T_{p1} = \frac{P_{12} T_{f2} - P_{22} T_{f1}}{P_{12} - P_{22}}$$

and

$$T_{p2} = \frac{P_{21} T_{f1} - P_{11} T_{f2}}{P_{21} - P_{11}}$$

4. Pipe Heat Loss, Btu/h • ft (W/m):

$$Q_1 = K_{p1} (T_{p1} - T_G)$$

and

$$Q_2 = K_{p2} (T_{p2} - T_G)$$

Required Data for Figure 3:

d = depth of burial, in. (mm).

r = radius of the system (to the exterior surface of the system), in. (mm).

T_G = earth temperature, °F (°C).

K_s = earth thermal conductivity, Btu/h • in. • °F (W/mm • °C).

C_a = thermal conductance of conduit air space, Btu/h • °F • ft (W/°C • m) of pipe, normally 3.0 (0.42).

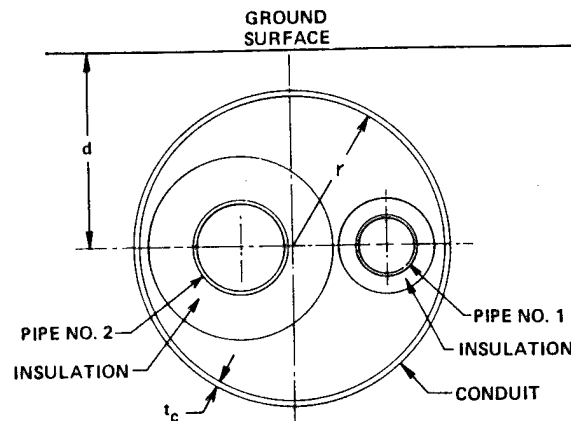


Fig. 3 Heat Loss from Two-Pipe System with Pipes in Same Conduit/Envelope

C_1 = thermal conductance of Pipe No. 1 plus insulation, Btu/h • °F • ft (W/°C • m) of pipe.

C_2 = thermal conductance of Pipe No. 2 insulation, Btu/h • °F • ft (W/°C • m) of pipe.

t_c = conduit wall thickness, in. (mm).

K_c = conduit wall thermal conductivity, Btu/h • in. (W/mm).

T_{f1} = temperature of fluid being carried in Pipe No. 1, °F (°C).

T_{f2} = temperature of fluid being carried in Pipe No. 2, °F (°C).

Calculations (Figure 3):

1. Let:

$$\frac{1}{P_0} = \frac{12}{2\pi} \left[\frac{1}{K_c} \ln \left(\frac{r}{r - t_c} \right) + \frac{1}{K_s} \ln \left\{ \frac{d}{r} + \sqrt{\left(\frac{d}{r} \right)^2 - 1} \right\} \right]$$

$$\frac{1}{P_1} = \frac{1}{C_1} + \frac{1}{C_a}$$

$$\frac{1}{P_2} = \frac{1}{C_2} + \frac{1}{C_a}$$

or, when $\frac{d}{r} \gg 1$

$$\left\{ \frac{d}{r} + \sqrt{\left(\frac{d}{r} \right)^2 - 1} \right\} = \left(\frac{2d}{r} \right)$$

2. Pipe Heat Transfer Factors:

$$K_{p1} = \frac{P_1 P_0}{P_0 + P_1 + P_2}$$

and

$$K_{p2} = \frac{P_2 P_0}{P_0 + P_1 + P_2}$$

3. Equivalent Pipe Temperatures:

$$T_{p1} = \left(1 + \frac{P_2}{P_0} \right) T_{f1} - \frac{P_2}{P_0} T_{f2}$$

and

$$T_{p2} = \left(1 + \frac{P_1}{P_0} \right) T_{f2} - \frac{P_1}{P_0} T_{f1}$$

4. Pipe Heat Loss:

$$Q_1 = K_{p1} (T_{p1} - T_G)$$

and

$$N.6 \quad Q_2 = K_{p2} (T_{p2} - T_G)$$

EARTH THERMAL CONDUCTIVITY FACTORS

If soil type, sieve analysis, density, and moisture content are known, soil conductivities can be chosen from Table 9 of Chapter 23 of the 1985 FUNDAMENTALS Volume. Otherwise, the following earth thermal conductivity factor (K_s) in $\text{Btu} \cdot \text{in.} / \text{h} \cdot \text{ft}^2 \cdot ^\circ\text{F}$ ($\text{W} / \text{m}^2 \cdot \text{K}$) can be used in the preceding equations.

The values listed in Table 2 are averages calculated by various researchers. They are considered accurate enough for these calculation methods. Dry soil is very rare in most parts of the United States, and a low moisture content should be assumed only where it can be proven valid. Values of 10 to 12 $\text{Btu} \cdot \text{in.} / \text{h} \cdot \text{ft}^2 \cdot ^\circ\text{F}$ (0.14 to 0.17 $\text{W} / \text{m}^2 \cdot \text{K}$) are commonly used where soil moisture content is not known. Because moisture migrates toward chilled pipe, it is suggested that a K_s factor of 15 (0.22) be used as an average value for these types of systems.

HEAT LOSS FROM PIPES IN NONCIRCULAR SYSTEMS

Many underground systems install non-circular insulations and casings that complicate the heat transfer analysis. For a first order assumption, these non-circular systems might be simplified by an equivalent circular envelope concept. The assumed circular structure should have a circumference equal to the total length of the enclosing sides of the non-circular structure. The heat loss can then be approximated using the methods described above. An additional complication arises if the enclosing structure is of two different materials or of varying thicknesses. Finding a circular conduit of equivalent size and equivalent conductivity is more difficult, and increases the potential inaccuracy of the final results.

Among other methods is field potential plotting or heat flux plotting. This involves plotting a two-dimensional system of isotherms and adiabatics intersecting orthogonally to form, in the case of heat flow through the ground, a network of curvilinear squares. The rate of heat flow between isothermal boundaries can be obtained directly from the network.

None of the suggested calculation procedures except that of finite differences deals with the transient aspect of heat transfer to consider the changing pipe, climatic and soil conditions. The soil temperature data to be used for the calculations of underground systems (Table 3) are important. Although it is recommended that average surface temperatures be used for the calculations, the best temperature data consistent with the steady-state heat transfer theory are the average, normal, undisturbed earth temperatures surrounding the pipe.

WATER HAMMER SURGE

In most small hot water or chilled water systems, the potential for excessive surge is usually negligible. However, the designer should be aware of the factors contributing to an excessive surge, which can rupture the pipeline or damage connected equipment. These factors are: unusually long pipelines, more like transmission than distribution lines; higher-than-normal flow velocities; high operating pressures; rapid valve closing operations; air pockets in pipelines; and improper filling of pipeline. If any of

these (or particularly a combination of these) are present, the severity of the surge must be ascertained so the necessary preventive or protective measures can be designed into the system.

Crocker and King (1967), Parmakian (1963), and Streeter and Wylie (1967) give further details on valve operations, pump stoppage, and other design considerations. In a steam line, (Crocker and King 1967) the only consideration is the formation of excessive condensate. To prevent surge, the line should be pitched, preferably in the direction of steam flow, at least 1 in. in 50 ft (1.67 mm/m), and trapped often enough to minimize condensate.

PIPE SYSTEM MOVEMENT

Thermal Expansion and Contraction

Thermal expansion and contraction cause piping systems to move. Similar movement can also occur in attached machinery and structures. This movement must be accommodated to prevent damage to structures and system elements. The movement can be accommodated by using the inherent flexibility of the piping system as laid out, by designing loops into the system where needed, by expansion joints, or by special couplings. The method or devices selected depend on force limitations, available space, installed cost, serviceability, maintenance cost, length of life, and type of system selected.

Couplings

Many systems have couplings that absorb expansion and contraction. Elastomer-gasketed couplings or those applied to grooved end pipe are commonly used in systems operating within the temperature and pressure limits of the elastomer selected. When these are used, no other expansion devices are needed. However, pressure can force these joints to separate longitudinally near a change of direction. Controlling this movement is discussed in the section "Pipe Anchors."

Inherent Piping Flexibility

The Code for Power Piping (ANSI/ASME B31.1) states that thermal expansion and contraction should be provided for by pipe bends, elbows, offsets, or changes in direction of the pipeline. If a line is routed with enough changes of direction to provide pipe flexibility, no additional accommodation for expansion is needed. For long straight lines of pipe, expansion loops or a combination of loops and changes of direction must be added.

Pipe Bends and Loops

In the simplest case, axial movement in each of two pipe segments connected through a 90° elbow is accommodated by bending in each segment (Figure 4A). The addition of pipe segments results in a Z-bend (Figure 4B), and ultimately in a loop (Figure 4C). Various charts and calculation methods are available to simplify the design of these three basic pipe configurations. It is important that the method selected recognizes the restraints on the system. For complicated piping arrangements in a two-plane configuration, many commercial computer programs are available that give accurate design information such as stresses and deflections at any point in the line, as well as anchor forces.

Stresses on the pipe, amount of pipe movement, anchor forces, and available expansion space dictate acceptable design. As a general rule, anchor forces from flexible piping systems are lower than any other type of expansion compensation. It is important to provide space for lateral and longitudinal pipe move-

Table 2 Soil Conductivities K_s

Soil Moisture Content, % by weight (mass)	Conductivity, $\text{Btu} \cdot \text{in.} / \text{h} \cdot \text{ft}^2 \cdot ^\circ\text{F}$ ($\text{W} / \text{m}^2 \cdot \text{K}$)		
	Sand	Silt	Clay
Low, <4%	2 (0.29)	1 (0.14)	1 (0.14)
Medium, 4 to 20%	13 (1.87)	9 (1.30)	7 (1.01)
High, >20%	15 (2.16)	15 (2.16)	15 (2.16)

Table 3 Average Earth Temperature from 0 to 10 ft (0 to 3 m) Below Surface (Continued)

Location	Winter °F (°C)	Spring °F (°C)	Summer °F (°C)	Autumn °F (°C)	Annual °F (°C)
Maryland	45 (7.2)	49 (9.4)	65 (18.3)	61 (16.1)	55 (12.8)
Massachusetts					51 (10.6)
Boston	41 (5.0)	44 (6.7)	61 (16.1)	57 (13.9)	47 (8.3)
Worcester	36 (2.2)	40 (4.4)	58 (14.4)	54 (12.2)	
Michigan					43 (6.1)
Alpena	33 (0.6)	37 (2.8)	54 (12.2)	50 (10.0)	49 (9.4)
Detroit City	38 (3.3)	43 (6.1)	60 (15.6)	56 (13.3)	42 (5.5)
Escanaba	30 (-1.1)	35 (1.7)	53 (11.7)	49 (9.4)	47 (8.3)
Grand Rapids	36 (2.2)	40 (4.4)	58 (14.4)	54 (12.2)	
Minnesota					38 (3.3)
Duluth	25 (-3.9)	30 (-1.1)	52 (11.1)	47 (8.3)	46 (7.8)
Minneapolis	32 (0.0)	37 (2.8)	60 (15.6)	54 (12.2)	65 (18.3)
Mississippi	57 (13.9)	61 (16.1)	73 (22. 8)	70 (21.1)	
Missouri					56 (13.3)
Kansas City	44 (6.7)	49 (9.4)	68 (20.0)	64 (17.8)	56 (13.3)
Saint Louis	45 (7.2)	49 (9.4)	67 (19.4)	63 (17.8)	56 (13.3)
Springfield	45 (7.2)	49 (9.4)	66 (18 .9)	62 (16.7)	
Montana					47 (8.3)
Billings	35 (1.7)	40 (4.4)	59 (15.0)	55 (12.8)	38 (3.3)
Butte	27 (-2.8)	31 (-0.6)	50 (10.0)	45 (7.2)	45 (7.2)
Great Falls	34 (1.1)	38 (3.3)	56 (13.3)	52 (11.1)	
Nebraska					49 (9.4)
North Platte	37 (2.8)	42 (5.5)	62 (16.7)	57 (13.9)	52 (11.1)
Omaha	39 (3.9)	44 (6.7)	65 (18.3)	60 (15.6)	48 (8.9)
Scotts Bluff	36 (2.2)	41 (5.0)	60 (15.6)	56 (13.3)	
Nevada					67 (19.4)
Las Vegas	56 (13.3)	60 (15.6)	78 (25.6)	74 (23.3)	49 (9.4)
Reno	40 (4.4)	44 (6.7)	58 (14.4)	55 (12.8)	49 (9.4)
Winnemucca	38 (3.3)	42 (5.5)	60 (15.6)	56 (13.3)	45 (7.2)
New Hampshire	33 (0.6)	38 (3.3)	56 (13.3)	52 (11.1)	
New Jersey					54 (12.2)
Atlantic City	45 (7.2)	49 (9.4)	63 (17.2)	60 (15.6)	53 (11.7)
Newark	43 (6.1)	47 (8.3)	63 (17.2)	59 (15.0)	
New Mexico					57 (13.9)
Albuquerque	46 (7.8)	50 (10.0)	67 (19.4)	63 (17.2)	48 (8.9)
Raton	38 (3.3)	42 (5.5)	58 (14.4)	54 (12.2)	60 (15.6)
Roswell	51 (10.6)	54 (12.2)	69 (20.6)	66 (18.9)	
New York					47 (8.3)
Albany	36 (2.2)	40 (4.4)	59 (15.0)	54 (12.2)	47 (8.3)
Buffalo	37 (2.8)	41 (5.0)	58 (14.4)	54 (12.2)	53 (11.7)
New York	44 (6.7)	47 (8.3)	63 (17.2)	59 (15.0)	
North Carolina					56 (13.3)
Asheville	48 (8.9)	51 (10.6)	64 (17.8)	61 (16.1)	60 (15.6)
Raleigh	51 (10.6)	55 (12.8)	69 (20.6)	65 (20.0)	41 (5.0)
North Dakota	26 (-3.3)	32 (0.0)	56 (13.3)	50 (10.0)	
Ohio					55 (12.8)
Cincinnati	45 (7.2)	49 (9.4)	65 (18.3)	61 (16.1)	51 (10.6)
Cleveland	40 (4.4)	44 (6.7)	61 (16.1)	57 (13.9)	52 (11.1)
Columbus	41 (5.0)	46 (7.8)	62 (16.7)	59 (15.0)	49 (9.4)
Toledo	38 (3.3)	43 (6.1)	60 (15.6)	56 (13.3)	60 (15.6)
Oklahoma	50 (10.0)	54 (12.2)	71 (21.7)	67 (19.4)	
Oregon					46 (7.8)
Baker	36 (2.2)	40 (4.4)	56 (13.3)	52 (11.1)	52 (11.1)
Eugene	46 (7.8)	48 (8.9)	59 (15.0)	47 (8.3)	53 (11.7)
Portland	46 (7.8)	49 (9.4)	60 (15.6)	57 (13.9)	
Pennsylvania					48 (8.9)
Erie	38 (3.3)	42 (5.5)	58 (14.4)	55 (12.8)	54 (12.2)
Philadelphia	44 (6.7)	48 (8.9)	64 (17.8)	61 (16.1)	51 (10.6)
Pittsburgh	40 (4.4)	44 (6.7)	61 (16.1)	57 (13.9)	50 (10.0)
Scranton	40 (4.4)	44 (6.7)	61 (16.1)	57 (13.9)	49 (9.4)
Rhode Island	39 (3.9)	43 (6.1)	59 (15.0)	56 (13.3)	
South Carolina					65 (15.6)
Charleston	58 (14.4)	61 (16.1)	72 (22.2)	70 (21.1)	64 (17.8)
Columbia	56 (13.3)	59 (15.0)	72 (22.2)	69 (20.6)	46 (7.8)
South Dakota	32 (0.0)	37 (2.8)	60 (15.6)	55 (12.8)	

Table 1 Comparison of Commonly Used Insulations in Underground Piping Systems^a

Item	Calcium Silicate	Urethane Foam	Cellular Glass	Preformed Glass Fiber	Loose Glass Fiber	Insulating Concrete	Hydrocarbon Powder	Hydrophobic Powder
2" INSULATION $K_p = 0.21$								
Thermal conductivity, $\text{Btu} \cdot \text{in.} / (\text{ft}^2 \cdot \text{h} \cdot ^\circ\text{F})$ ($\text{W} \cdot \text{m} / \text{m}^2 \cdot ^\circ\text{C}$)								
at 100 F (37.8°C)	0.33 (47.5)	0.15 (21.6)	0.39 (56.2)	0.26 (37.4)	0.32 (46.1)	0.6-4 (86.4-576)	0.6-0.8 (86.4-115.2)	0.53-0.8 (76.3-115.2)
at 200 F (93.3°C)	0.37 (53.3)	0.17 (24.5)	0.47 (67.7)	0.30 (43.2)	—	—	—	0.6-0.81 (86.4-116.6)
at 300 F (148.9°C)	0.41 (59.0)	—	0.55 (79.2)	0.33 (47.5)	—	—	—	0.66-0.85 (95.1-22.4)
at 400 F (204.4°C)	0.46 (66.2)	—	0.64 (92.2)	—	—	—	—	—
Density, lb / ft^3 (kg / m^3)	10-14 (160-224)	1.5-4 (24-64)	9-10 (144-160)	3-7 (48-112)	2-11 (32-176)	20-30 (320-480)	45-55 (720-880)	35-65 (560-1040)
Max. temperature, $^\circ\text{F}$ ($^\circ\text{C}$)	1200 (649)	260 (127)	800 (427)	170-500 (188-260)	1000 (538)	1800 (982)	300-450 (149-232)	500 (260)
Compressive strength, psi (Pa)	75-165 (517-1137)	20-50 (138-345)	1-100 (689)	5 (34)	0 (0)	100-150 (689-1034)	70-85 (482-586)	70-85 (482-586)
@ % compression	5%	5%	—	—	—	—	5%	5%
Moisture absorption	Great	Slight	Nil	Great	Great	Moderate	Moderate	Nil
Effect on k factor	Large	Slight	Slight	Large	Large	Slight	Large	Slight
Resistance to boiling	Good	Poor	Fair	Good	Good	Good	Poor	Poor
Recovery-drying	Good	Poor	Good	Good	Good	Good	Poor	Poor
Resistance to abrasion	Fair	Fair	Fair	Poor	Nil	Good	Poor	Good
Resistance to vibration	Fair	Good	Poor	Good	Poor	Fair	Fair	Good
Stability: shrink, shock	Good	Good	Fair	Excellent	Excellent	Good	Good	Good
Combustible	No	Yes	No	Yes	No	No	Yes	No

^aThe descriptive terms in this table are only approximations because any insulation and the conditions under which it is used vary.

The thermal conductivities for these materials, and for urethane foam used in the trench, are for dry material. Since foam may absorb ground water, and water vapor may eventually enter the interstices between powder particles, the eventual k values are difficult to estimate.

moisture propagation should the underground piping system outer casing break.

Field-Fabricated Systems

In these systems, the carrier pipe, insulation, and casing are assembled on-site and are built in several ways. The most common design consists of a concrete slab base with embedded supports for the insulated pipe. The system is protected by half-rounds of clay or concrete pipe placed over the carrier pipe and resting on the slab. Caulking and other construction methods prevent ground water entrance. The slab must be poured to grade, and adequate drainage is essential to minimize corrosion of the carrier pipes.

Formed insulation placed on the pipe or a bulk insulation placed inside the casing fill as much of the system around the carrier pipe as possible. However, bulk insulation may restrict drainage and is subject to wetting, which can reduce thermal efficiency and promote corrosion. A second type of system temporarily supports the assembled pipe off the trench bottom to allow the application of insulation and waterproof coverings over the insulation. It is imperative to have supplemental drainage systems outside the enclosed pipe structure to keep ground water away from the structure.

Poured Envelope Systems

These systems are constructed by assembling the pipe in the trench, supporting it on blocks above the trench bottom, and then pouring the insulation material into the trench to encase the pipe completely. The supporting blocks should be removed as the pouring progresses down the trench to achieve complete encasement and to prevent concentrated corrosion at the point of contact with the pipe, or the supports must be bitumastic coated to prevent capillarity between support and insulation. Poured envelope systems are initially less expensive than other types of systems.

In all other systems, there is a specific barrier to the entrance of ground water, and the system need only be designed and installed properly to maintain the integrity of that barrier. Poured envelope systems depend on using the insulation itself as a water barrier. In low temperature applications, poured envelopes may lose thermal efficiency because of moisture migration and condensation.

A good drainage system is recommended to minimize deterioration of the insulating quality. The four types of envelope

materials are (1) insulating concrete, (2) hydrocarbon powder, (3) hydrophobic powder, and (4) polyurethane foam.

Insulating concrete is a Portland cement-bound, lightweight aggregate with additives, which gives the designer substantial latitude in selecting the desirable degree of structural strength and thermal efficiency. This system resists superimposed loads and gives continuous support and alignment for the piping. Concrete encasement should not be used with any piping system jointed with rubber ring couplings because the concrete may interfere with rubber ring operation.

In welded systems, a parting agent is placed around the piping to allow free longitudinal movement. Anchors are steel plates embedded in the thickened and reinforced concrete base slab and welded to the piping. Expansion voids are built into the conduit at corners and loops, using internal blockouts to provide the space for pipe movements. Anchoring is the same as for any other welded steel system. A properly designed system must have internal emergency drains and vents to remove accidental and residual construction water and serve as leak detectors.

Any crack that develops in the concrete endangers the entire system. Once ground water gets to the pipe, the water follows the pipe-concrete interface and can eventually cause corrosion anywhere along the pipeline.

Hydrocarbon powders are thermoplastic materials composed of lightweight aggregate with asphalt binders. These can be poured directly into the trench; but it is better to pour the hydrocarbon powders over a structural concrete base pad with either temporary or permanent pipe support. A continuous waterproof membrane covering the entire system keeps water away from the system. These materials should never be used with any rubber ring jointing system since the hydrocarbons harm the rubber rings. Provision for thermal expansion and anchoring should be the same as for other welded steel systems. Expansion is limited because repeated cycling hardens the mass and causes additional resistance to transverse pipe movements.

Hydrophobic powders are treated to be water repellent. The non-wettability characteristic prevents water from dampening the powder, causing loss of thermal efficiency. The installation methods are identical for hydrocarbon powders, except that compaction of the material is required only for chilled water and cryogenic applications.

Polyurethane foam insulation efficiency may vary considerably over a long time span with the amount and pressure of the moisture, temperature, age, density, and cell size. Density and cell size vary with the control of conditions under which the

Table 8 Typical Thermal Conductivity (k) for Industrial Insulations at Various Mean Temperatures - Design Values^a (Concluded)

Material	Accepted Max. Temp. for Use ^b , °F	Typical Density, lb/ft ³	Typical Conductivity k in Btu·in/h·ft ² ·°F at Mean Temp., °F													
			-100	-75	-50	-25	0	25	50	75	100	200	300	500	700	900
RIGID POLYSTYRENE																
Extruded (CFC-12 exp.) (smooth skin surface)	165	1.8-3.5	0.16	0.16	0.17	0.16	0.17	0.18	0.19	0.20						
Molded beads	165	1	0.17	0.19	0.20	0.21	0.22	0.24	0.25	0.26	0.28					
		1.25	0.17	0.18	0.19	0.20	0.22	0.23	0.24	0.25	0.27					
		1.5	0.16	0.17	0.19	0.20	0.21	0.22	0.23	0.24	0.26					
		1.75	0.16	0.17	0.18	0.19	0.20	0.22	0.23	0.24	0.25					
		2.0	0.15	0.16	0.18	0.19	0.20	0.21	0.22	0.23	0.24					
RIGID POLYURETHANE/ POLYISOCYANURATE ^{c,d}																
Unfaced (CFC-11 exp.)	210	1.5-2.5	0.16	0.17	0.18	0.18	0.18	0.17	0.16	0.17						
RIGID POLYISOCYANURATE ^c																
Gas-impermeable facers (CFC-11 exp.)	250	2.0							0.12	0.13	0.14	0.15				
RIGID PHENOLIC																
Closed cell (CFC-11, CFC-113 exp.)		3.0							0.11	0.115	0.12	0.125				
RUBBER, Rigid Foamed	150	4.5							0.20	0.21	0.22	0.23				
VEGETABLE AND ANIMAL FIBER																
Wool felt (pipe insulation)	180	20							0.28	0.30	0.31	0.33				
INSULATING CEMENTS																
MINERAL FIBER (Rock, slag, or glass)																
With colloidal clay binder	1800	24-30											0.49	0.55	0.61	0.73 0.85
With hydraulic setting binder	1200	30-40											0.75	0.80	0.85	0.95
LOOSE FILL																
Cellulose insulation (milled pulverized paper or wood pulp)		2.5-3											0.26	0.27	0.29	
Mineral fiber, slag, rock, or glass		2-5						0.19	0.21	0.23	0.25	0.26	0.28	0.31		
Perlite (expanded)		3-5	0.22	0.24	0.25	0.27	0.28	0.30	0.31	0.33	0.35					
Silica aerogel		7.6						0.13	0.14	0.15	0.15	0.16	0.17	0.18		
Vermiculite (expanded)		7-8.2						0.39	0.40	0.42	0.44	0.45	0.47	0.49		
		4-6						0.34	0.35	0.38	0.40	0.42	0.44	0.46		

2" INSULATION
Kp = 0.080

^aRepresentative values for dry materials, which are intended as design (not specification) values for materials in normal use. Insulation materials in actual service may have thermal values that vary from design values depending on their in-situ properties (e.g., density and moisture content). For properties of a particular product, use the value supplied by the manufacturer or by unbiased tests.

^bThese temperatures are generally accepted as maximum. When operating temperature approaches these limits follow the manufacturer's recommendations.

^cSome polyurethane foams are formed by means that produce a stable product (with respect to k), but most are blown with refrigerant and will change with time.

^dSee Table 4, footnote h.

^eSee Table 4, footnote i.

From Figure 6, at 117.4 Btu/h·ft², $R_s = 0.56$. The mean temperature of the mineral fiber block is:

$$4.5/0.6 = 7.50; 7.50/2 = 3.75$$

$$1100 - [(3.75/8.69)(1020)] = 1100 - 440 = 660^\circ\text{F}$$

and the mean temperature of the insulating cement is:

$$0.5/0.79 = 0.63; 0.63/2 = 0.31; 7.50 + 0.31 = 7.81$$

$$1100 - [(7.81/8.69)(1020)] = 1100 - 917 = 183^\circ\text{F}$$

From Table 8, at 660°F, $k_1 = 0.60$; at 183°F, $k_2 = 0.79$.

Since R_s , k_1 and k_2 do not change at these values, $q_s = 117.4$ Btu/h·ft².

Example 9. Compute heat loss per square foot of outer surface of insulation if pipe temperature is 1200°F and ambient still air temperature is 80°F. The pipe is nominal 6-in. steel pipe, insulated with a nominal 3-in. thick diatomaceous silica as the inner layer and a nominal 2-in. thick calcium silicate as the outer layer.

Solution: From Chapter 33 of the 1988 EQUIPMENT Volume, $r_o = 3.31$ in. A nominal 3-in. thick diatomaceous silica insulation to fit a nominal 6-in. steel pipe is 3.02 in. thick. A nominal 2-in. thick calcium silicate insulation to fit over the 3.02-in. diatomaceous silica is 2.08 in. thick. Therefore, $r_i = 6.33$ in. and $r_s = 8.41$ in.

Assume that the mean temperature of the diatomaceous silica is 600°F, the mean temperature of the calcium silicate is 250°F and the surface resistance, R_s is 0.50. From Table 8, $k_1 = 0.66$; $k_2 = 0.42$. By Equation (10) from Chapter 20:

$$q_s = \frac{1200 - 80}{[8.41 \ln(6.33/3.31)/0.66] + [8.41 \ln(8.41/6.33)/0.40] + 0.50}$$

$$= \frac{1120}{(5.45/0.66) + (2.39/0.40) + 0.50} = 76.0 \text{ Btu/h·ft}^2$$

From Figure 6, at 76.0 Btu/h·ft², $R_s = 0.60$. The mean temperature of the diatomaceous silica is:

$$5.45/0.66 = 8.26; 8.26/2 = 4.13$$

$$1200 - [(4.13/14.83)(1120)] = 1200 - 312 = 888^\circ\text{F}$$

and the mean temperature of the calcium silicate is:

$$2.39/0.40 = 5.98; 5.98/2 = 2.99; 8.26 + 2.99 = 11.25$$

$$1200 - [(11.25/14.83)(1120)] = 1200 - 850 = 350^\circ\text{F}$$

From Table 8, $k_1 = 0.72$; $k_2 = 0.46$. Recalculating:

$$q_s = \frac{1120}{(5.45/0.72) + (2.39/0.46) + 0.60} = 83.8 \text{ Btu/h·ft}^2$$

From Figure 6 at 83.8 Btu/h·ft², $R_s = 0.59$. The mean temperature of the diatomaceous silica is:

$$5.45/0.72 = 7.57; 7.57/2 = 3.78$$

$$1200 - [(3.78/13.36)(1120)] = 1200 - 317 = 883^\circ\text{F}$$

and the mean temperature of the calcium silicate is:

$$2.39/0.46 = 5.20; 5.20/2 = 2.60; 7.57 + 2.60 = 10.17$$

$$1200 - [(10.17/13.36)(1120)] = 1200 - 853 = 347^\circ\text{F}$$

From Table 8, $k_1 = 0.72$; $k_2 = 0.46$. Recalculating:

$$q_s = \frac{1120}{(5.45/0.72) + (2.39/0.46) + 0.59} = 83.8 \text{ Btu/h·ft}^2$$

Since R_s , k_1 , and k_2 do not change at 83.8 Btu/h·ft², this is q_s .

The heat flow per ft² of the inner surface of the insulation is:

$$q_o = q_s(r_s/r_o) = 83.8(8.41/3.31) = 213 \text{ Btu/h·ft}^2$$

2" INSULATION
 $K_p = 0.080$

THERMODYNAMIC PROPERTIES OF STEAM

Table 1. Saturation: Temperatures

Temp. Fahr. t	Abs. Pressure		Specific Volume			Enthalpy			Entropy			Temp. Fahr. t
	Lb. Sq. In. P	In. Hg.	Sat. Liquid v _f	Evap. v _{fg}	Sat. Vapor v _g	Sat. Liquid h _f	Evap. h _{fg}	Sat. Vapor h _g	Sat. Liquid s _f	Evap. s _{fg}	Sat. Vapor s _g	
200°	11.526	23.467	0.01663	33.62	33.64	167.99	977.9	1145.9	0.2938	1.4824	1.7762	200°
202	12.011	24.455	0.01665	32.35	32.37	170.00	976.6	1146.6	0.2969	1.4760	1.7729	202
204	12.512	25.475	0.01666	31.14	31.15	172.02	975.4	1147.4	0.2999	1.4697	1.7696	204
206	13.031	26.531	0.01667	29.97	29.99	174.03	974.2	1148.2	0.3029	1.4634	1.7663	206
208	13.568	27.625	0.01669	28.86	28.88	176.04	972.9	1148.9	0.3059	1.4571	1.7630	208
210°	14.123	28.755	0.01670	27.80	27.82	178.05	971.6	1149.7	0.3090	1.4508	1.7598	210°
212	14.696	29.922	0.01672	26.78	26.80	180.07	970.3	1150.4	0.3120	1.4446	1.7566	212
214	15.289	31.129	0.01673	25.81	25.83	182.08	969.0	1151.1	0.3149	1.4385	1.7534	214
216	15.901	32.375	0.01674	24.88	24.90	184.10	967.8	1151.9	0.3179	1.4323	1.7502	216
218	16.533	33.662	0.01676	23.99	24.01	186.11	966.5	1152.6	0.3209	1.4262	1.7471	218
220°	17.186	34.992	0.01677	23.13	23.15	188.13	965.2	1153.4	0.3239	1.4201	1.7440	220°
222	17.861	36.365	0.01679	22.31	22.33	190.15	963.9	1154.1	0.3268	1.4141	1.7409	222
224	18.557	37.782	0.01680	21.53	21.55	192.17	962.6	1154.8	0.3298	1.4080	1.7378	224
226	19.275	39.244	0.01682	20.78	20.79	194.18	961.3	1155.5	0.3328	1.4020	1.7348	226
228	20.016	40.753	0.01683	20.06	20.07	196.20	960.1	1156.3	0.3357	1.3961	1.7318	228
230°	20.780	42.308	0.01684	19.365	19.382	198.23	958.8	1157.0	0.3387	1.3901	1.7288	230°
232	21.567	43.911	0.01686	18.703	18.720	200.25	957.4	1157.7	0.3416	1.3842	1.7258	232
234	22.379	45.564	0.01688	18.067	18.084	202.27	956.1	1158.4	0.3444	1.3784	1.7228	234
236	23.217	47.269	0.01689	17.456	17.473	204.29	954.8	1159.1	0.3473	1.3725	1.7199	236
238	24.080	49.027	0.01691	16.869	16.886	206.32	953.5	1159.8	0.3502	1.3667	1.7169	238
240°	24.969	50.837	0.01692	16.306	16.323	208.34	952.2	1160.5	0.3531	1.3609	1.7140	240°
242	25.884	52.701	0.01694	15.765	15.782	210.37	950.8	1161.2	0.3560	1.3551	1.7111	242
244	26.827	54.620	0.01696	15.245	15.262	212.39	949.5	1161.9	0.3589	1.3494	1.7083	244
246	27.798	56.597	0.01697	14.745	14.762	214.42	948.2	1162.6	0.3618	1.3436	1.7054	246
248	28.797	58.631	0.01699	14.265	14.282	216.45	946.8	1163.3	0.3647	1.3379	1.7026	248
250°	29.825	60.725	0.01700	13.804	13.821	218.48	945.5	1164.0	0.3675	1.3323	1.6998	250°
252	30.884	62.880	0.01702	13.360	13.377	220.51	944.2	1164.7	0.3704	1.3266	1.6970	252
254	31.973	65.098	0.01704	12.933	12.950	222.54	942.8	1165.3	0.3732	1.3210	1.6942	254
256	33.093	67.378	0.01705	12.522	12.539	224.58	941.4	1166.0	0.3761	1.3154	1.6915	256
258	34.245	69.723	0.01707	12.127	12.144	226.61	940.1	1166.7	0.3789	1.3099	1.6888	258
260°	35.429	72.134	0.01709	11.746	11.763	228.64	938.7	1167.3	0.3817	1.3043	1.6860	260°
262	36.646	74.612	0.01710	11.379	11.396	230.68	937.3	1168.0	0.3845	1.2988	1.6833	262
264	37.897	77.159	0.01712	11.026	11.043	232.72	936.0	1168.7	0.3874	1.2933	1.6807	264
266	39.182	79.775	0.01714	10.687	10.704	234.76	934.5	1169.3	0.3902	1.2878	1.6780	266
268	40.502	82.463	0.01715	10.359	10.376	236.80	933.2	1170.0	0.3930	1.2824	1.6753	268
270°	41.858	85.225	0.01717	10.044	10.061	238.84	931.8	1170.6	0.3958	1.2769	1.6727	270°
272	43.252	88.062	0.01719	9.739	9.756	240.88	930.3	1171.2	0.3986	1.2715	1.6701	272
274	44.682	90.974	0.01721	9.446	9.463	242.92	929.0	1171.9	0.4014	1.2661	1.6675	274
276	46.150	93.963	0.01722	9.163	9.181	244.96	927.5	1172.5	0.4041	1.2608	1.6649	276
278	47.657	97.031	0.01724	8.891	8.908	247.01	926.1	1173.1	0.4069	1.2554	1.6623	278
280°	49.203	100.18	0.01726	8.628	8.645	249.06	924.7	1173.8	0.4096	1.2501	1.6597	280°
282	50.790	103.41	0.01728	8.374	8.391	251.10	923.3	1174.4	0.4124	1.2448	1.6572	282
284	52.418	106.72	0.01730	8.129	8.146	253.15	921.8	1175.0	0.4152	1.2395	1.6547	284
286	54.088	110.12	0.01732	7.892	7.910	255.20	920.4	1175.6	0.4179	1.2343	1.6522	286
288	55.800	113.61	0.01733	7.664	7.682	257.26	918.9	1176.2	0.4207	1.2290	1.6497	288
290°	57.556	117.19	0.01735	7.444	7.461	259.31	917.5	1176.8	0.4234	1.2238	1.6472	290°
292	59.356	120.85	0.01737	7.231	7.248	261.36	916.0	1177.4	0.4261	1.2186	1.6447	292
294	61.201	124.61	0.01739	7.025	7.043	263.42	914.6	1178.0	0.4288	1.2134	1.6422	294
296	63.091	128.46	0.01741	6.827	6.844	265.48	913.1	1178.6	0.4315	1.2083	1.6398	296
298	65.028	132.40	0.01743	6.635	6.652	267.53	911.6	1179.1	0.4343	1.2031	1.6374	298
300°	67.013	136.44	0.01745	6.449	6.466	269.59	910.1	1179.7	0.4369	1.1980	1.6350	300°
302	69.046	140.58	0.01747	6.269	6.287	271.66	908.6	1180.3	0.4397	1.1929	1.6326	302
304	71.127	144.82	0.01749	6.096	6.114	273.72	907.2	1180.9	0.4424	1.1878	1.6302	304
306	73.259	149.16	0.01751	5.928	5.946	275.78	905.6	1181.4	0.4450	1.1828	1.6278	306
308	75.442	153.60	0.01753	5.766	5.783	277.85	904.1	1182.0	0.4477	1.1777	1.6254	308

12 PSIG STM

14.123 + 12

= 26.123 PSIG

∴ TEMP ≈ 240°

SUMMER				WINTER	
CENTRAL PLANT	HEAT LOSS (Btu/h)	HEAT GAIN (Btu/h)	HEAT GAIN (Btu/h)	HEAT LOSS (Btu/h)	HEAT GAIN
6003	19,056	117,953		47,409	
	18,784	70,549		32,297	
	18,245	69,979		30,542	
	37,736	115,889		55,993	
	40,295	125,370		59,109	
	6,716	20,895		10,766	
	276,571	564,345		376,802	
	129,102	268,485		154,054	
	11,113	23,374		13,227	
	79,109	168,599		93,946	
	24,705	40,212		27,186	
	37,440	98,200		48,498	
	23,311	38,898		25,622	
Total	722,183	1,722,748		975,451	
	0.72	144		0.98	
	(MMBtuh)	(tons)		(MMBtuh)	
5900	70,630	2,586,405	358,639	748,728	
	67,469	1,053,467	174,253	340,333	
	27,965	269,783	53,759	91,825	
	91,660	895,013	177,819	287,017	
	636,245	3,361,829	1,083,999	1,246,104	
	45,282	242,234	78,632	86,991	
Total	939,251	8,408,731	1,927,101	2,800,998	
	0.94	701	161	2.80	
	(MMBtuh)	(tons)	(tons)	(MMBtuh)	
		31.85%	7.30%		

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes ☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	5 inch	Radius of pipe no. 1 (heating)
r2 =	5 inch	Radius of pipe no. 2 (cooling)
a =	34 inch	Distance between 2 pipes
Pipe length =		210 ft

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 40 \text{ Btu/h} \cdot ^\circ\text{F}$$

$$C2 = 40 \text{ Btu/h} \cdot ^\circ\text{F}$$

Factors:

$$P11 = 22.44$$

$$P12 = 11.38$$

$$P21 = 11.38$$

$$P22 = 22.44$$

$$\Delta = -374.08$$

Pipe heat transfer factors:

$$Kp1 = 1.17$$

$$Kp2 = 1.17$$

Equivalent pipe temperature:

$$Tp1 = 243 \text{ } ^\circ\text{F}$$

$$Tp2 = 243 \text{ } ^\circ\text{F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 226 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = 226 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 47,409 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = 47,409 \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes ☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft²•°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	32 inch	Distance between 2 pipes
Pipe length =	150 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 40 \text{ Btu/h} \cdot ^\circ\text{F}$$

$$C2 = 40 \text{ Btu/h} \cdot ^\circ\text{F}$$

Factors:

$$P11 = 23.74$$

$$P12 = 11.73$$

$$P21 = 11.73$$

$$P22 = 23.74$$

$$\Delta = -426.05$$

Pipe heat transfer factors:

$$Kp1 = 1.12$$

$$Kp2 = 1.12$$

Equivalent pipe temperature:

$$Tp1 = 243 \text{ } ^\circ\text{F}$$

$$Tp2 = 243 \text{ } ^\circ\text{F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 215 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = 215 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 32,297 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = 32,297 \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes ☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	3 inch	Radius of pipe no. 1 (heating)
r2 =	3 inch	Radius of pipe no. 2 (cooling)
a =	30 inch	Distance between 2 pipes
Pipe length =		150 ft

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C_1 = 40 \text{ Btu/h} \cdot \text{°F}$$

$$C_2 = 40 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P_{11} = 25.41$$

$$P_{12} = 12.09$$

$$P_{21} = 12.09$$

$$P_{22} = 25.41$$

$$\Delta = -499.51$$

Pipe heat transfer factors:

$$K_{p1} = 1.05$$

$$K_{p2} = 1.05$$

Equivalent pipe temperature:

$$T_{p1} = 243 \text{ °F}$$

$$T_{p2} = 243 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q_1 = 204 \text{ Btu/h} \cdot \text{ft}$$

$$Q_2 = 204 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 30,542 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = 30,542 \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	3 inch	Radius of pipe no. 1 (heating)
r2 =	3 inch	Radius of pipe no. 2 (cooling)
a =	30 inch	Distance between 2 pipes
Pipe length =	275 ft	

Pipe heat loss:

C = Kp (Tf - Tg)

C1 = 40 Btu/h•°F

C2 = 40 Btu/h•°F

Factors:

P11 = 25.41

P12 = 12.09

P21 = 12.09

P22 = 25.41

Delta = -499.51

Pipe heat transfer factors:

Kp1 = 1.05

Kp2 = 1.05

Equivalent pipe temperature:

Tp1 = 243 °F

Tp2 = 243 °F

Heat loss in pipe, Btu/h•ft

Q1 = 204 Btu/h•ft

Q2 = 204 Btu/h•ft

Total heat loss in pipe 1 (heating) = 55,993 Btu/h

Total heat loss in pipe 2 (cooling) = 55,993 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	2.5 inch	Radius of pipe no. 1 (heating)
r2 =	2.5 inch	Radius of pipe no. 2 (cooling)
a =	29 inch	Distance between 2 pipes
Pipe length =		300 ft

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 40 \text{ Btu/h} \cdot \text{°F}$$

$$C2 = 40 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P11 = 26.47$$

$$P12 = 12.28$$

$$P21 = 12.28$$

$$P22 = 26.47$$

$$\Delta = -549.79$$

Pipe heat transfer factors:

$$Kp1 = 1.02$$

$$Kp2 = 1.02$$

Equivalent pipe temperature:

$$Tp1 = 243 \text{ °F}$$

$$Tp2 = 243 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 197 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = 197 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 59,109 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = 59,109 \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes ☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	32 inch	Distance between 2 pipes
Pipe length =	50 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 40 \text{ Btu/h} \cdot ^\circ\text{F}$$

$$C2 = 40 \text{ Btu/h} \cdot ^\circ\text{F}$$

Factors:

$$P11 = 23.74$$

$$P12 = 11.73$$

$$P21 = 11.73$$

$$P22 = 23.74$$

$$\Delta = -426.05$$

Pipe heat transfer factors:

$$Kp1 = 1.12$$

$$Kp2 = 1.12$$

Equivalent pipe temperature:

$$Tp1 = 243 \text{ } ^\circ\text{F}$$

$$Tp2 = 243 \text{ } ^\circ\text{F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 215 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = 215 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 10,766 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = 10,766 \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	32 inch	Distance between 2 pipes
Pipe length =		1750 ft

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 40 \text{ Btu/h} \cdot \text{°F}$$

$$C2 = 40 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P11 = 23.74$$

$$P12 = 11.73$$

$$P21 = 11.73$$

$$P22 = 23.74$$

$$\Delta = -426.05$$

Pipe heat transfer factors:

$$Kp1 = 1.12$$

$$Kp2 = 1.12$$

Equivalent pipe temperature:

$$Tp1 = 243 \text{ °F}$$

$$Tp2 = 243 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 215 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = 215 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 376,802 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = 376,802 \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1.5 inch	Radius of pipe no. 1 (heating)
r2 =	1.5 inch	Radius of pipe no. 2 (cooling)
a =	27 inch	Distance between 2 pipes
Pipe length =		850 ft

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	40 Btu/h•°F
C2 =	40 Btu/h•°F

Factors:	
P11 =	29.44
P12 =	12.69
P21 =	12.69
P22 =	29.44
Delta =	-705.63

Pipe heat transfer factors:	
Kp1 =	0.94
Kp2 =	0.94

Equivalent pipe temperature:	
Tp1 =	243 °F
Tp2 =	243 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	181 Btu/h•ft
Q2 =	181 Btu/h•ft

Total heat loss in pipe 1 (heating) =	154,054 Btu/h
Total heat loss in pipe 2 (cooling) =	154,054 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1.25 inch	Radius of pipe no. 1 (heating)
r2 =	1.25 inch	Radius of pipe no. 2 (cooling)
a =	26.5 inch	Distance between 2 pipes
Pipe length =		75 ft

Pipe heat loss:

C = Kp (Tf - Tg)

C1 = 40 Btu/h•°F

C2 = 40 Btu/h•°F

Factors:

P11 = 30.50

P12 = 12.80

P21 = 12.80

P22 = 30.50

Delta = -766.43

Pipe heat transfer factors:

Kp1 = 0.91

Kp2 = 0.91

Equivalent pipe temperature:

Tp1 = 243 °F

Tp2 = 243 °F

Heat loss in pipe, Btu/h•ft

Q1 = 176 Btu/h•ft

Q2 = 176 Btu/h•ft

Total heat loss in pipe 1 (heating) = 13,227 Btu/h

Total heat loss in pipe 2 (cooling) = 13,227 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes ☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1 inch	Radius of pipe no. 1 (heating)
r2 =	1 inch	Radius of pipe no. 2 (cooling)
a =	26 inch	Distance between 2 pipes
Pipe length =	550 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 40 \text{ Btu/h} \cdot \text{°F}$$

$$C2 = 40 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P11 = 31.80$$

$$P12 = 12.91$$

$$P21 = 12.91$$

$$P22 = 31.80$$

$$\Delta = -844.44$$

Pipe heat transfer factors:

$$Kp1 = 0.89$$

$$Kp2 = 0.89$$

Equivalent pipe temperature:

$$Tp1 = 243 \text{ °F}$$

$$Tp2 = 243 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 171 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = 171 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 93,946 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = 93,946 \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes ☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1.5 inch	Radius of pipe no. 1 (heating)
r2 =	1.5 inch	Radius of pipe no. 2 (cooling)
a =	27 inch	Distance between 2 pipes
Pipe length =	150 ft	

Pipe heat loss:

C = Kp (Tf - Tg)
C1 = 40 Btu/h•°F
C2 = 40 Btu/h•°F

Factors:

P11 = 29.44
P12 = 12.69
P21 = 12.69
P22 = 29.44
Delta = -705.63

Pipe heat transfer factors:

Kp1 = 0.94
Kp2 = 0.94

Equivalent pipe temperature:

Tp1 = 243 °F
Tp2 = 243 °F

Heat loss in pipe, Btu/h•ft

Q1 = 181 Btu/h•ft
Q2 = 181 Btu/h•ft

Total heat loss in pipe 1 (heating) =	27,186 Btu/h
Total heat loss in pipe 2 (cooling) =	27,186 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1.25 inch	Radius of pipe no. 1 (heating)
r2 =	1.25 inch	Radius of pipe no. 2 (cooling)
a =	26.5 inch	Distance between 2 pipes
Pipe length =		275 ft

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C_1 = 40 \text{ Btu/h} \cdot ^\circ\text{F}$$

$$C_2 = 40 \text{ Btu/h} \cdot ^\circ\text{F}$$

Factors:

$$P_{11} = 30.50$$

$$P_{12} = 12.80$$

$$P_{21} = 12.80$$

$$P_{22} = 30.50$$

$$\Delta = -766.43$$

Pipe heat transfer factors:

$$K_{p1} = 0.91$$

$$K_{p2} = 0.91$$

Equivalent pipe temperature:

$$T_{p1} = 243 \text{ } ^\circ\text{F}$$

$$T_{p2} = 243 \text{ } ^\circ\text{F}$$

Heat loss in pipe, Btu/h•ft

$$Q_1 = 176 \text{ Btu/h} \cdot \text{ft}$$

$$Q_2 = 176 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 48,498 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = 48,498 \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	243 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1 inch	Radius of pipe no. 1 (heating)
r2 =	1 inch	Radius of pipe no. 2 (cooling)
a =	26 inch	Distance between 2 pipes
Pipe length =	150 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	40 Btu/h•°F
C2 =	40 Btu/h•°F

Factors:	
P11 =	31.80
P12 =	12.91
P21 =	12.91
P22 =	31.80
Delta =	-844.44

Pipe heat transfer factors:	
Kp1 =	0.89
Kp2 =	0.89

Equivalent pipe temperature:	
Tp1 =	243 °F
Tp2 =	243 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	171 Btu/h•ft
Q2 =	171 Btu/h•ft

Total heat loss in pipe 1 (heating) =	25,622 Btu/h
Total heat loss in pipe 2 (cooling) =	25,622 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	5 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	33 inch	Distance between 2 pipes
Pipe length =	210 ft	

Pipe heat loss:

$$C = Kp (Tf - Tg)$$

$$C1 = 35 \text{ Btu/h} \cdot \text{°F}$$

$$C2 = -2 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P11 = 20.11$$

$$P12 = 0.45$$

$$P21 = 10.40$$

$$P22 = -0.20$$

$$\Delta = 8.56$$

Pipe heat transfer factors:

$$Kp1 = 2.64$$

$$Kp2 = 2.36$$

Equivalent pipe temperature:

$$Tp1 = 105.39 \text{ °F}$$

$$Tp2 = -167.2 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 91 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = -562 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 19,056 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (117,953) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	3 inch	Radius of pipe no. 2 (cooling)
a =	31 inch	Distance between 2 pipes
Pipe length =	150 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C_1 = 35 \text{ Btu/h} \cdot \text{°F}$$

$$C_2 = -2 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P_{11} = 21.26$$

$$P_{12} = 0.43$$

$$P_{21} = 10.72$$

$$P_{22} = -0.28$$

$$\Delta = 10.60$$

Pipe heat transfer factors:

$$K_{p1} = 2.36$$

$$K_{p2} = 2.07$$

Equivalent pipe temperature:

$$T_{p1} = 124.01 \text{ °F}$$

$$T_{p2} = -156.3 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q_1 = 125 \text{ Btu/h} \cdot \text{ft}$$

$$Q_2 = -470 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 18,784 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (70,549) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes ☐ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	3 inch	Radius of pipe no. 1 (heating)
r2 =	3 inch	Radius of pipe no. 2 (cooling)
a =	30 inch	Distance between 2 pipes
Pipe length =		150 ft

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 35 \text{ Btu/h} \cdot \text{°F}$$

$$C2 = -2 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P11 = 22.76$$

$$P12 = 0.42$$

$$P21 = 10.88$$

$$P22 = -0.28$$

$$\Delta = 10.99$$

Pipe heat transfer factors:

$$Kp1 = 2.25$$

$$Kp2 = 2.25$$

Equivalent pipe temperature:

$$Tp1 = 125.12 \text{ °F}$$

$$Tp2 = -136.6 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 122 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = -467 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 18,245 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (69,979) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	3 inch	Radius of pipe no. 1 (heating)
r2 =	2.5 inch	Radius of pipe no. 2 (cooling)
a =	29.5 inch	Distance between 2 pipes
Pipe length =	275 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C_1 = 35 \text{ Btu/h} \cdot ^\circ\text{F}$$

$$C_2 = -2 \text{ Btu/h} \cdot ^\circ\text{F}$$

Factors:

$$P_{11} = 22.76$$

$$P_{12} = 0.41$$

$$P_{21} = 10.97$$

$$P_{22} = -0.34$$

$$\Delta = 12.23$$

Pipe heat transfer factors:

$$K_{p1} = 2.16$$

$$K_{p2} = 2.00$$

Equivalent pipe temperature:

$$T_{p1} = 134.4 \text{ } ^\circ\text{F}$$

$$T_{p2} = -139.3 \text{ } ^\circ\text{F}$$

Heat loss in pipe, Btu/h•ft

$$Q_1 = 137 \text{ Btu/h} \cdot \text{ft}$$

$$Q_2 = -421 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 37,736 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (115,889) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions:

☐

CW and HW pipes

☒

CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	2.5 inch	Radius of pipe no. 1 (heating)
r2 =	2.5 inch	Radius of pipe no. 2 (cooling)
a =	29 inch	Distance between 2 pipes
Pipe length =	300 ft	

Pipe heat loss:

C = Kp (Tf - Tg)

C1 = 35 Btu/h•°F

C2 = -2 Btu/h•°F

Factors:

P11 = 23.70

P12 = 0.41

P21 = 11.06

P22 = -0.34

Delta = 12.53

Pipe heat transfer factors:

Kp1 = 2.10

Kp2 = 2.10

Equivalent pipe temperature:

Tp1 = 135.01 °F

Tp2 = -128.2 °F

Heat loss in pipe, Btu/h•ft

Q1 = 134 Btu/h•ft

Q2 = -418 Btu/h•ft

Total heat loss in pipe 1 (heating) = 40,295 Btu/h

Total heat loss in pipe 2 (cooling) = (125,370) Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes ☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	2.5 inch	Radius of pipe no. 1 (heating)
r2 =	2.5 inch	Radius of pipe no. 2 (cooling)
a =	29 inch	Distance between 2 pipes
Pipe length =	50 ft	

Pipe heat loss:	
$C = K_p (T_f - T_g)$	
C1 =	35 Btu/h•°F
C2 =	-2 Btu/h•°F

Factors:	
P11 =	23.70
P12 =	0.41
P21 =	11.06
P22 =	-0.34
Delta =	12.53

Pipe heat transfer factors:	
Kp1 =	2.10
Kp2 =	2.10

Equivalent pipe temperature:	
Tp1 =	135.01 °F
Tp2 =	-128.2 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	134 Btu/h•ft
Q2 =	-418 Btu/h•ft

Total heat loss in pipe 1 (heating) =	6,716 Btu/h
Total heat loss in pipe 2 (cooling) =	(20,895)Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	2 inch	Radius of pipe no. 1 (heating)
r2 =	1.5 inch	Radius of pipe no. 2 (cooling)
a =	27.5 inch	Distance between 2 pipes
Pipe length =		1750 ft

Pipe heat loss:

C = Kp (Tf - Tg)

C1 = 35 Btu/h•°F

C2 = -2 Btu/h•°F

Factors:

P11 = 24.86

P12 = 0.39

P21 = 11.33

P22 = -0.50

Delta = 16.73

Pipe heat transfer factors:

Kp1 = 1.87

Kp2 = 1.68

Equivalent pipe temperature:

Tp1 = 155.66 °F

Tp2 = -120.8 °F

Heat loss in pipe, Btu/h•ft

Q1 = 158 Btu/h•ft

Q2 = -322 Btu/h•ft

Total heat loss in pipe 1 (heating) = 276,571 Btu/h

Total heat loss in pipe 2 (cooling) = (564,345)Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1.5 inch	Radius of pipe no. 1 (heating)
r2 =	1.5 inch	Radius of pipe no. 2 (cooling)
a =	27 inch	Distance between 2 pipes
Pipe length =	850 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 35 \text{ Btu/h} \cdot \text{°F}$$

$$C2 = -2 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P11 = 26.35$$

$$P12 = 0.39$$

$$P21 = 11.42$$

$$P22 = -0.50$$

$$\Delta = 17.45$$

Pipe heat transfer factors:

$$Kp1 = 1.78$$

$$Kp2 = 1.78$$

Equivalent pipe temperature:

$$Tp1 = 156.35 \text{ °F}$$

$$Tp2 = -106.5 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 152 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = -316 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 129,102 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (268,485) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions:

☐

CW and HW pipes

☒

CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1.25 inch	Radius of pipe no. 1 (heating)
r2 =	1.5 inch	Radius of pipe no. 2 (cooling)
a =	26.75 inch	Distance between 2 pipes
Pipe length =	75 ft	

Pipe heat loss:

$C = K_p (T_f - T_g)$

C1 = 35 Btu/h•°F

C2 = -2 Btu/h•°F

Factors:

P11 = 27.29

P12 = 0.38

P21 = 11.47

P22 = -0.50

Delta = 17.90

Pipe heat transfer factors:

Kp1 = 1.73

Kp2 = 1.84

Equivalent pipe temperature:

Tp1 = 156.7 °F

Tp2 = -98.5 °F

Heat loss in pipe, Btu/h•ft

Q1 = 148 Btu/h•ft

Q2 = -312 Btu/h•ft

Total heat loss in pipe 1 (heating) = 11,113 Btu/h

Total heat loss in pipe 2 (cooling) = (23,374) Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1 inch	Radius of pipe no. 1 (heating)
r2 =	1.5 inch	Radius of pipe no. 2 (cooling)
a =	26.5 inch	Distance between 2 pipes
Pipe length =	550 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 35 \text{ Btu/h} \cdot \text{°F}$$

$$C2 = -2 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P11 = 28.45$$

$$P12 = 0.38$$

$$P21 = 11.52$$

$$P22 = -0.50$$

$$\Delta = 18.46$$

Pipe heat transfer factors:

$$Kp1 = 1.67$$

$$Kp2 = 1.91$$

Equivalent pipe temperature:

$$Tp1 = 157.06 \text{ °F}$$

$$Tp2 = -89.66 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 144 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = -307 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 79,109 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (168,599) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1.5 inch	Radius of pipe no. 1 (heating)
r2 =	1 inch	Radius of pipe no. 2 (cooling)
a =	26.5 inch	Distance between 2 pipes
Pipe length =	150 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 35 \text{ Btu/h} \cdot \text{°F}$$

$$C2 = -2 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P11 = 26.35$$

$$P12 = 0.38$$

$$P21 = 11.52$$

$$P22 = -0.62$$

$$\Delta = 20.68$$

Pipe heat transfer factors:

$$Kp1 = 1.70$$

$$Kp2 = 1.49$$

Equivalent pipe temperature:

$$Tp1 = 167.72 \text{ °F}$$

$$Tp2 = -108.7 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 165 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = -268 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 24,705 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (40,212) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1.25 inch	Radius of pipe no. 1 (heating)
r2 =	2 inch	Radius of pipe no. 2 (cooling)
a =	27.25 inch	Distance between 2 pipes
Pipe length =	275 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C_1 = 35 \text{ Btu/h} \cdot ^\circ\text{F}$$

$$C_2 = -2 \text{ Btu/h} \cdot ^\circ\text{F}$$

Factors:

$$P_{11} = 27.29$$

$$P_{12} = 0.39$$

$$P_{21} = 11.37$$

$$P_{22} = -0.41$$

$$\Delta = 15.53$$

Pipe heat transfer factors:

$$K_{p1} = 1.81$$

$$K_{p2} = 2.13$$

Equivalent pipe temperature:

$$T_{p1} = 146.38 \text{ } ^\circ\text{F}$$

$$T_{p2} = -96.47 \text{ } ^\circ\text{F}$$

Heat loss in pipe, Btu/h•ft

$$Q_1 = 136 \text{ Btu/h} \cdot \text{ft}$$

$$Q_2 = -357 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 37,440 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (98,200) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 6003

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☐ CW and HW pipes

☒ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	243 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	1 inch	Radius of pipe no. 1 (heating)
r2 =	1 inch	Radius of pipe no. 2 (cooling)
a =	26 inch	Distance between 2 pipes
Pipe length =	150 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	35 Btu/h•°F
C2 =	-2 Btu/h•°F

Factors:	
P11 =	28.45
P12 =	0.37
P21 =	11.61
P22 =	-0.62
Delta =	21.95

Pipe heat transfer factors:	
Kp1 =	1.60
Kp2 =	1.60

Equivalent pipe temperature:	
Tp1 =	168.43 °F
Tp2 =	-91.58 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	155 Btu/h•ft
Q2 =	-259 Btu/h•ft

Total heat loss in pipe 1 (heating) =	23,311 Btu/h
Total heat loss in pipe 2 (cooling) =	(38,898)Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	6 inch	Radius of pipe no. 2 (cooling)
a =	34 inch	Distance between 2 pipes
Pipe length =		2650 ft

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C_1 = 47 \text{ Btu/h} \cdot \text{°F}$$

$$C_2 = -2 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P_{11} = 27.98$$

$$P_{12} = 0.45$$

$$P_{21} = 13.32$$

$$P_{22} = -0.07$$

$$\Delta = 8.05$$

Pipe heat transfer factors:

$$K_{p1} = 3.07$$

$$K_{p2} = 3.79$$

Equivalent pipe temperature:

$$T_{p1} = 79.694 \text{ °F}$$

$$T_{p2} = -186.7 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q_1 = 27 \text{ Btu/h} \cdot \text{ft}$$

$$Q_2 = -976 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 70,630 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (2,586,405) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4.5 inch	Radius of pipe no. 1 (heating)
r2 =	5.5 inch	Radius of pipe no. 2 (cooling)
a =	34 inch	Distance between 2 pipes
Pipe length =	1175 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C_1 = 47 \text{ Btu/h} \cdot \text{°F}$$

$$C_2 = -2 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P_{11} = 27.17$$

$$P_{12} = 0.45$$

$$P_{21} = 13.32$$

$$P_{22} = -0.10$$

$$\Delta = 8.71$$

Pipe heat transfer factors:

$$K_{p1} = 2.98$$

$$K_{p2} = 3.31$$

Equivalent pipe temperature:

$$T_{p1} = 90.3 \text{ °F}$$

$$T_{p2} = -200.2 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q_1 = 57 \text{ Btu/h} \cdot \text{ft}$$

$$Q_2 = -897 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 67,469 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (1,053,467) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	5 inch	Radius of pipe no. 2 (cooling)
a =	33 inch	Distance between 2 pipes
Pipe length =	325 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C_1 = 47 \text{ Btu/h} \cdot ^\circ\text{F}$$

$$C_2 = -2 \text{ Btu/h} \cdot ^\circ\text{F}$$

Factors:

$$P_{11} = 27.98$$

$$P_{12} = 0.45$$

$$P_{21} = 13.52$$

$$P_{22} = -0.13$$

$$\Delta = 9.58$$

Pipe heat transfer factors:

$$K_{p1} = 2.81$$

$$K_{p2} = 3.14$$

Equivalent pipe temperature:

$$T_{p1} = 101.67 \text{ } ^\circ\text{F}$$

$$T_{p2} = -193.4 \text{ } ^\circ\text{F}$$

Heat loss in pipe, Btu/h•ft

$$Q_1 = 86 \text{ Btu/h} \cdot \text{ft}$$

$$Q_2 = -830 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 27,965 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (269,783) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	3 inch	Radius of pipe no. 1 (heating)
r2 =	5 inch	Radius of pipe no. 2 (cooling)
a =	32 inch	Distance between 2 pipes
Pipe length =	1075 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	47 Btu/h•°F
C2 =	-2 Btu/h•°F

Factors:	
P11 =	29.96
P12 =	0.44
P21 =	13.73
P22 =	-0.13
Delta =	9.80

Pipe heat transfer factors:	
Kp1 =	2.70
Kp2 =	3.45

Equivalent pipe temperature:	
Tp1 =	102.59 °F
Tp2 =	-170.5 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	85 Btu/h•ft
Q2 =	-833 Btu/h•ft

Total heat loss in pipe 1 (heating) =	91,660 Btu/h
Total heat loss in pipe 2 (cooling) =	(895,013)Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	2.5 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	30.5 inch	Distance between 2 pipes
Pipe length =	4825 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 47 \text{ Btu/h} \cdot ^\circ\text{F}$$

$$C2 = -2 \text{ Btu/h} \cdot ^\circ\text{F}$$

Factors:

$$P11 = 31.22$$

$$P12 = 0.42$$

$$P21 = 14.05$$

$$P22 = -0.20$$

$$\Delta = 12.03$$

Pipe heat transfer factors:

$$Kp1 = 2.41$$

$$Kp2 = 2.97$$

Equivalent pipe temperature:

$$Tp1 = 125.74 \text{ } ^\circ\text{F}$$

$$Tp2 = -163.6 \text{ } ^\circ\text{F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 132 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = -697 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 636,245 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (3,361,829) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	2 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	30 inch	Distance between 2 pipes
Pipe length =	350 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C1 = 47 \text{ Btu/h} \cdot \text{°F}$$

$$C2 = -2 \text{ Btu/h} \cdot \text{°F}$$

Factors:

$$P11 = 32.76$$

$$P12 = 0.42$$

$$P21 = 14.16$$

$$P22 = -0.20$$

$$\Delta = 12.31$$

Pipe heat transfer factors:

$$Kp1 = 2.34$$

$$Kp2 = 3.14$$

Equivalent pipe temperature:

$$Tp1 = 126.39 \text{ °F}$$

$$Tp2 = -149.1 \text{ °F}$$

Heat loss in pipe, Btu/h•ft

$$Q1 = 129 \text{ Btu/h} \cdot \text{ft}$$

$$Q2 = -692 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 45,282 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = (242,234) \text{ Btu/h}$$

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions:



CW and HW pipes



CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	300 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	32 inch	Distance between 2 pipes
Pipe length =	2650 ft	

Pipe heat loss:

C = Kp (Tf - Tg)

C1 = 51 Btu/h•°F

C2 = 51 Btu/h•°F

Factors:

P11 = 30.45

P12 = 14.89

P21 = 14.89

P22 = 30.45

Delta = -705.68

Pipe heat transfer factors:

Kp1 = 1.13

Kp2 = 1.13

Equivalent pipe temperature:

Tp1 = 300 °F

Tp2 = 300 °F

Heat loss in pipe, Btu/h•ft

Q1 = 283 Btu/h•ft

Q2 = 283 Btu/h•ft

Total heat loss in pipe 1 (heating) = 748,728 Btu/h

Total heat loss in pipe 2 (cooling) = 748,728 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK EMC # 3002.000

Descriptions: ☒ CW and HW pipes ☐ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	300 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4.5 inch	Radius of pipe no. 1 (heating)
r2 =	4.5 inch	Radius of pipe no. 2 (cooling)
a =	33 inch	Distance between 2 pipes
Pipe length =	1175 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	51 Btu/h•°F
C2 =	51 Btu/h•°F

Factors:	
P11 =	29.57
P12 =	14.67
P21 =	14.67
P22 =	29.57
Delta =	-659.12

Pipe heat transfer factors:	
Kp1 =	1.16
Kp2 =	1.16

Equivalent pipe temperature:	
Tp1 =	300 °F
Tp2 =	300 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	290 Btu/h•ft
Q2 =	290 Btu/h•ft

Total heat loss in pipe 1 (heating) =	340,333 Btu/h
Total heat loss in pipe 2 (cooling) =	340,333 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT, 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	300 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	32 inch	Distance between 2 pipes
Pipe length =	325 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	51 Btu/h•°F
C2 =	51 Btu/h•°F

Factors:	
P11 =	30.45
P12 =	14.89
P21 =	14.89
P22 =	30.45
Delta =	-705.68

Pipe heat transfer factors:	
Kp1 =	1.13
Kp2 =	1.13

Equivalent pipe temperature:	
Tp1 =	300 °F
Tp2 =	300 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	283 Btu/h•ft
Q2 =	283 Btu/h•ft

Total heat loss in pipe 1 (heating) =	91,825 Btu/h
Total heat loss in pipe 2 (cooling) =	91,825 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☒ CW and HW pipes ☐ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu·in/h·ft²·°F	Earth thermal conductivity
kp1 =	0.21 Btu/h·°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h·°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	300 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	3 inch	Radius of pipe no. 1 (heating)
r2 =	3 inch	Radius of pipe no. 2 (cooling)
a =	30 inch	Distance between 2 pipes
Pipe length =	1075 ft	

Pipe heat loss:

C = Kp (Tf - Tg)
C1 = 51 Btu/h·°F
C2 = 51 Btu/h·°F

Factors:

P11 = 32.62
P12 = 15.37
P21 = 15.37
P22 = 32.62
Delta = -827.94

Pipe heat transfer factors:

Kp1 = 1.07
Kp2 = 1.07

Equivalent pipe temperature:

Tp1 = 300 °F
Tp2 = 300 °F

Heat loss in pipe, Btu/h·ft

Q1 = 267 Btu/h·ft
Q2 = 267 Btu/h·ft

Total heat loss in pipe 1 (heating) = 287,017 Btu/h
Total heat loss in pipe 2 (cooling) = 287,017 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	300 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	2.5 inch	Radius of pipe no. 1 (heating)
r2 =	2.5 inch	Radius of pipe no. 2 (cooling)
a =	29 inch	Distance between 2 pipes
Pipe length =	4825 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	51 Btu/h•°F
C2 =	51 Btu/h•°F

Factors:	
P11 =	33.99
P12 =	15.62
P21 =	15.62
P22 =	33.99
Delta =	-911.64

Pipe heat transfer factors:	
Kp1 =	1.03
Kp2 =	1.03

Equivalent pipe temperature:	
Tp1 =	300 °F
Tp2 =	300 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	258 Btu/h•ft
Q2 =	258 Btu/h•ft

Total heat loss in pipe 1 (heating) =	1,246,104 Btu/h
Total heat loss in pipe 2 (cooling) =	1,246,104 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3032.000

Descriptions: ☒ CW and HW pipes ☐ CW and Steam pipes

Tg =	50 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.21 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.21 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	300 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	300 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	2 inch	Radius of pipe no. 1 (heating)
r2 =	2 inch	Radius of pipe no. 2 (cooling)
a =	28 inch	Distance between 2 pipes
Pipe length =	350 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	51 Btu/h•°F
C2 =	51 Btu/h•°F

Factors:	
P11 =	35.67
P12 =	15.88
P21 =	15.88
P22 =	35.67
Delta =	-1020.54

Pipe heat transfer factors:	
Kp1 =	0.99
Kp2 =	0.99

Equivalent pipe temperature:	
Tp1 =	300 °F
Tp2 =	300 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	249 Btu/h•ft
Q2 =	249 Btu/h•ft

Total heat loss in pipe 1 (heating) =	86,991 Btu/h
Total heat loss in pipe 2 (cooling) =	86,991 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

(BASED ON 1987 ASHRAE HANDBOOK - THERMAL ENVIRONMENT)

CENTRAL PLANT 5900 Ft. Sill, OK EMC # 3002:0004
 Descriptions: ☒ CW and HW pipes ☐ CW and Steam pipes

Tg =	71°F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu·in/h·ft ² ·°F	Earth thermal conductivity
kp1 =	0.08 Btu/h·°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h·°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	45°F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45°F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	6 inch	Radius of pipe no. 1 (heating)
r2 =	6 inch	Radius of pipe no. 2 (cooling)
a =	36 inch	Distance between 2 pipes
Pipe length =	2650 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	-2 Btu/h·°F
C2 =	-2 Btu/h·°F

Factors:	
P11 =	-0.07
P12 =	0.47
P21 =	-0.47
P22 =	-0.07
Delta =	0.22

Pipe heat transfer factors:	
Kp1 =	-5.21
Kp2 =	-5.21

Equivalent pipe temperature:	
Tp1 =	45 °F
Tp2 =	45 °F

Heat loss in pipe, Btu/h·ft	
Q1 =	135 Btu/h·ft
Q2 =	135 Btu/h·ft

Total heat loss in pipe 1 (heating) =	358,639 Btu/h
Total heat loss in pipe 2 (cooling) =	358,639 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions:



CW and HW pipes



CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.08 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	45 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	5.5 inch	Radius of pipe no. 1 (heating)
r2 =	5.5 inch	Radius of pipe no. 2 (cooling)
a =	35 inch	Distance between 2 pipes
Pipe length =	1175 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	-2 Btu/h•°F
C2 =	-2 Btu/h•°F

Factors:	
P11 =	-0.10
P12 =	0.46
P21 =	0.46
P22 =	-0.10
Delta =	0.20

Pipe heat transfer factors:	
Kp1 =	-5.70
Kp2 =	-5.70

Equivalent pipe temperature:	
Tp1 =	45 °F
Tp2 =	45 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	148 Btu/h•ft
Q2 =	148 Btu/h•ft

Total heat loss in pipe 1 (heating) =	174,253 Btu/h
Total heat loss in pipe 2 (cooling) =	174,253 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions:



CW and HW pipes



CW and Steam pipes

Tg =	71°F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.08 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	45°F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45°F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	5 inch	Radius of pipe no. 1 (heating)
r2 =	5 inch	Radius of pipe no. 2 (cooling)
a =	34 inch	Distance between 2 pipes
Pipe length =	325 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	-2 Btu/h•°F
C2 =	-2 Btu/h•°F

Factors:	
P11 =	-0.13
P12 =	0.45
P21 =	0.45
P22 =	-0.13
Delta =	0.19

Pipe heat transfer factors:	
Kp1 =	-6.36
Kp2 =	-6.36

Equivalent pipe temperature:	
Tp1 =	45°F
Tp2 =	45°F

Heat loss in pipe, Btu/h•ft	
Q1 =	165 Btu/h•ft
Q2 =	165 Btu/h•ft

Total heat loss in pipe 1 (heating) =	53,759 Btu/h
Total heat loss in pipe 2 (cooling) =	53,759 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.08 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	45 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	5 inch	Radius of pipe no. 1 (heating)
r2 =	5 inch	Radius of pipe no. 2 (cooling)
a =	34 inch	Distance between 2 pipes
Pipe length =	1075 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	-2 Btu/h•°F
C2 =	-2 Btu/h•°F

Factors:	
P11 =	-0.13
P12 =	0.45
P21 =	0.45
P22 =	-0.13
Delta =	0.19

Pipe heat transfer factors:	
Kp1 =	-6.36
Kp2 =	-6.36

Equivalent pipe temperature:	
Tp1 =	45 °F
Tp2 =	45 °F

Heat loss in pipe, Btu/h•ft	
Q1 =	165 Btu/h•ft
Q2 =	165 Btu/h•ft

Total heat loss in pipe 1 (heating) =	177,819 Btu/h
Total heat loss in pipe 2 (cooling) =	177,819 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHARE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK

EMC # 3002.000

Descriptions:



CW and HW pipes



CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu·in/h·ft ² ·°F	Earth thermal conductivity
kp1 =	0.08 Btu/h·°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h·°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	45 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	32 inch	Distance between 2 pipes
Pipe length =	4825 ft	

Pipe heat loss:	
C = Kp (Tf - Tg)	
C1 =	-2 Btu/h·°F
C2 =	-2 Btu/h·°F

Factors:	
P11 =	-0.20
P12 =	0.44
P21 =	0.44
P22 =	-0.20
Delta =	0.15

Pipe heat transfer factors:	
Kp1 =	-8.64
Kp2 =	-8.64

Equivalent pipe temperature:	
Tp1 =	45 °F
Tp2 =	45 °F

Heat loss in pipe, Btu/h·ft	
Q1 =	225 Btu/h·ft
Q2 =	225 Btu/h·ft

Total heat loss in pipe 1 (heating) =	1,083,999 Btu/h
Total heat loss in pipe 2 (cooling) =	1,083,999 Btu/h

HEAT LOSS FROM UNDERGROUND TWO-PIPE SYSTEM

[ASHRAE 1987 HVAC SYSTEM, CHAPTER 12, PAGE 12.5]

CENTRAL PLANT 5900

Ft. Sill, OK EMC # 3002.000

Descriptions: ☒ CW and HW pipes

☐ CW and Steam pipes

Tg =	71 °F	Earth temp. (summer = 71°F; winter = 50°F)
Ks =	13 Btu•in/h•ft ² •°F	Earth thermal conductivity
kp1 =	0.08 Btu/h•°F	Pipe 1 thermal conductivity (heating)
kp2 =	0.08 Btu/h•°F	Pipe 2 thermal conductivity (cooling)
Tf1 =	45 °F	Temp. of fluid in pipe no. 1 (heating)
Tf2 =	45 °F	Temp. of fluid in pipe no. 2 (cooling)
d1 =	100 inch	Dept of barrier for pipe 1
d2 =	100 inch	Dept of barrier for pipe 2
r1 =	4 inch	Radius of pipe no. 1 (heating)
r2 =	4 inch	Radius of pipe no. 2 (cooling)
a =	32 inch	Distance between 2 pipes
Pipe length =	350 ft	

Pipe heat loss:

$$C = K_p (T_f - T_g)$$

$$C_1 = -2 \text{ Btu/h} \cdot ^\circ\text{F}$$

$$C_2 = -2 \text{ Btu/h} \cdot ^\circ\text{F}$$

Factors:

$$P_{11} = -0.20$$

$$P_{12} = 0.44$$

$$P_{21} = 0.44$$

$$P_{22} = -0.20$$

$$\Delta = 0.15$$

Pipe heat transfer factors:

$$K_{p1} = -8.64$$

$$K_{p2} = -8.64$$

Equivalent pipe temperature:

$$T_{p1} = 45 \text{ } ^\circ\text{F}$$

$$T_{p2} = 45 \text{ } ^\circ\text{F}$$

Heat loss in pipe, Btu/h•ft

$$Q_1 = 225 \text{ Btu/h} \cdot \text{ft}$$

$$Q_2 = 225 \text{ Btu/h} \cdot \text{ft}$$

$$\text{Total heat loss in pipe 1 (heating)} = 78,632 \text{ Btu/h}$$

$$\text{Total heat loss in pipe 2 (cooling)} = 78,632 \text{ Btu/h}$$