(EEAP) BOILER AND CHILLER STUDY II

AT

FORT SAM HOUSTON

SAN ANTONIO, TEXAS

VOLUME I

PRE-FINAL REPORT

US ARMY CORPS OF ENGINEERS

Fort Worth Division

CONDUCTED BY:

HUITT ZOLLARS, INC.

CONSULTING ENGINEERS

FORT WORTH, TEXAS

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ABBREVIATIONS

A	Amperes
ACR	Air Cooled Reciprocating
AHU	Air Handling Unit
ASHRAE	American Society of Heating, Refrigeration & Air Conditioning Engineers
BTU	British Thermal Unit
BTUH	British Thermal Unit per Hour
CFM	Cubic Feet Per Minute
CHW	Chilled Water
CMU	Concrete Masonry Unit
CW	Condenser Water
COE	U.S. Army Corps of Engineers
CPS	City Public Service
DB	Dry Bulb Temperature
DCW	Domestic Cold Water
DDC	Direct Digital Control
DHW	Domestic Hot Water
DPW	Directorate of Public Works
DX	Direct Expansion
ECI	Energy Cost Index
ECO	Energy Conservation Opportunity
EER	Energy Efficiency Ratio, BTUs per Watt-Hr
EMS	Energy Management System
EUI	Energy Usage Index
°F	Degrees Fahrenheit
FCU	Fan Coil Unit
FSH	Fort Sam Houston
FT, ft	Feet
GPM, gpm	Gallons per Minute
HP	Horsepower
HRS, hrs	hours
HPS	High Pressure Steam
HTG	Heating
HVAC	Heating, Ventilating & Air Conditioning
HW	Heating Water
HZ	Huitt-Zollars, Inc.
IAQ	Indoor Air Quality
KGAL, kgal	Kilogallon
KW	Kilowatt
KWH	Kilowatt Hours
LCCID	Life Cycle Cost In Design
LPS	Low Pressure Steam
MBH	1,000 BTUH
MBTU	1,000 BTUs
MMBTU	1,000,000 BTUs
MCF	1,000 Cubic Feet (gas)
MH	Metal Halide
MISC, misc	Miscellaneous
M&O	Maintenance & Operations
MWH	Megawatt Hours
N/A	Not Available or Not Applicable
OA	Outside Air

RTU	Rooftop Unit
SZ	Single Zone
SQFT, sqft	Square Feet
TON, ton	12,000 BTUH
UPH	Unlisted Personnel Housing
USAED	U.S. Army Engineer District
V	Volts
VAV	Variable Air Volume
VFD	Variable Frequency Drive
W	Watt
WB	Wet Bulb Temperature
YR, yr	Year

(EEAP) Boiler/Chiller Study II
at
Fort Sam Houston
San Antonio, Texas

I. EXECUTIVE SUMMARY

A. Introduction

This energy conservation study was performed by Huitt-Zollars Inc, for the U.S. Army Engineer District (USAED), Fort Worth, under contract number DACAC63-94-D-0015. The study was conducted at Fort Sam Houston (FSH) in San Antonio, Texas, between September 28, 1995 and May 31, 1996. The site survey, data collection and analysis was performed by John Carter, E.I.T, Chris Pieper, P.E., and M. A. Shafiq, P.E.

The purpose of the study was to perform a limited site survey of specific buildings at the facility, identify specific Energy Conservation Opportunities (ECOs) that exist, and then evaluate these ECOs for technical and economic feasibility. These ECOs were limited to central boiler and chiller plant systems serving specific building groups at FSH.

This study is the second phase of a Boiler/Chiller study completed by Huitt-Zollars, Inc. for The Corp of Engineers on September 18, 1995. In addition to the work that was accomplished in that project, additional buildings for three of the areas analyzed previously and two new areas have been added to the Scope of Work for this phase. Therefore, much of the same data that was gathered for the first phase will again be used in this second phase to identify ECO's.

This survey was conducted with the assistance of many individuals at FSH. Special thanks are extended to all of them, including the following individuals:

David Brigham, Cultural Resources
Mike Brynes, Operations and Maintenance
Frank Carbonell, Engineering Services
Bill Coates, Operations and Maintenance
Guy Cox, Operations and Maintenance
Al Motz, Operations and Maintenance
Gene Rodriguez, Engineering Services

Other individuals who assisted in this study by providing equipment and cost data are listed as follows:

Tom McGreal and John Wright, York International, Dallas, TX
John Neal, Jr. and Gary Caffey, Neal and Associates, Dallas, TX
Joe Scolaro and Brian Mitchell, Mitchell Technical Sales, Dallas, TX
Preston Dickson, Timberlake and Woffard, Inc., Dallas, TX
Larry Carpenter, The Trane Company, Fort Worth, TX
David Recca, DynaService, Fort Worth, TX
Bob Stevens, City Public Service, San Antonio, TX

Any questions concerning this report should be directed to the Project Manager, Michael W. Elliott, P.E., CEM, at Huitt-Zollars Inc., 512 Main Street, Suite 1500, Fort Worth, Texas 76102. Phone 817-335-3000, extension 270.

B. Buildings Studied

This study was performed on five separate groups of buildings at the Fort Sam Houston installation in San Antonio, Texas. These groups were identified as Areas 100, 500, 1000, 1300, and 2200. Buildings in each of these areas are briefly described as follows:

Area 100: Thirty-eight buildings currently used as office buildings, barracks, and other miscellaneous usage.

Area 500: Buildings in this area consisted of three Unaccompanied Personnel Housing (UPH) barracks.

Area 1000: Buildings in this area consisted of two office buildings and the Brooke Army Medical Center.

Area 1300: Buildings in this area consisted of seven barracks, a dining hall, a theater, a chapel, a mini-mall and an Administrative office building.

Area 2200: Buildings in this area consisted of three barracks, a chapel, a theater, the military police station, and six Administrative office buildings.

C. Present Energy Consumption

Base Year Energy Consumption: The total metered electrical and gas consumption data for twelve consecutive months prior to the study were obtained from the facility and are referred to as "base year". This "base year" data represents the consumption for the entire installation, as well as the buildings in this study. Refer to Figure 1 for a summary of the monthly energy usage data shown on Page 18.

Figure 1. Base Year Energy Usage By Source

ENERGY SOURCE	ANNUAL USAGE		COST $
Electricity	153,580 MWH	524,169 MMBTU	6,567,101
Natural Gas	405,282 MCF	405,282 MMBTU	1,690,065
Total		929,451 MMBTU	8,257,166

The annual energy consumption for the boiler and chiller systems studied was calculated in Appendix H, using the Trane Trace 600 computer program to model buildings and existing HVAC systems. This consumption amounted to a total of 7.9% of the base energy usage and 7.5% of the energy costs. Refer to Figure 2 for a summary of the boiler and chiller systems energy consumption and demand data.

Figure 2. Annual Boiler and Chiller Energy Consumption Data

AREA	COOLING SYSTEM DEMAND $/YR	COOLING SYSTEM ELECT. KWH/YR	COOLING SYSTEM ELECT. $/YR	HEATING SYSTEM DEMAND $/YR	HEATING SYSTEM ELECT. KWH/YR	HEATING SYSTEM ELECT. $/YR	HEATING SYSTEM GAS MCF/YR	HEATING SYSTEM GAS $/YR
100	53,714	2,055,148	43,980	2,231	91,435	1,957	1,621	7,116
500	15,353	695,522	14,884	378	24,992	535	412	1,426
1000	46,120	3,631,430	77,713	16,517	165,582	3,543	13,652	47,236
1300	92,165	3,337,121	71,414	5,019	228,336	4,886	6,862	23,743
2200	57,276	2,229,966	47,721	6,027	82,596	1,768	4,134	14,304
SUBTOTALS	264,628	11,949,187	255,713	30,172	592,941	12,689	26,681	93,824
ANNUAL BOILER & CHILLER SYSTEM ENERGY				69,487	MMBTU/YR			
ANNUAL BOILER & CHILLER SYSTEM COST, $/YR				657,025	$/YR			

D. Energy Conservation Opportunity (ECO) Analysis

ECOs Rejected: After reviewing the data collected at the facility and considering allof the practical limitations involved, there were no potential ECOs which were rejected prior to performing calculations. Therefore, energy savings calculations were performed for all ECOs identified in the scope of work.

ECOs Recommended: Certain ECOs which were identified during the building survey have been evaluated for technical and economic feasibility and are recommended for implementation. Complete documentation of all calculations as well as information required for implementation is included in Appendix B. These recommended ECOs are summarized in order of descending Savings to Investment Ratio (SIR) in Table 1 on page 7 .

ECOs Not Recommended: Certain ECOs which were identified during the building surveyhave been evaluated for technical and economic feasibility but are not recommended for implementation. Complete documentation of all calculations are included in AppendixC. These non-recommended ECOs are summarized in order of order of descending SIR in Table 2 on page 8 .

Projects Developed: The Project Manager decided to that each of the two recommended ECOs would be implemented as an individual project. The projects that resulted from this process will be submitted for funding as ECIP projects. The projects are summarized as follows:

Project 1: Replacement of Existing Central Boilers with High Efficiency Modular Boilers (Area 2200) - ECO O.

Electrical Energy Savings	7	MMBTU/yr.
Electrical Demand Savings	-171	$/yr.
Natural Gas Energy Savings	803	MMBTU/yr.
Energy Cost Savings	2,651	$/yr.
Maintenance Savings	36,780	$/yr.
Total Cost Savings	39,431	$/yr.
Total Investment	311,340	$
Simple Payback	7.9	yrs.

SIR ?

Project 2: Retrofit Existing Individual Boilers with Central Boiler Plant (Area 100) - ECO C.

Electrical Energy Savings	57	MMBTU/yr.
Electrical Demand Savings	1,295	$/yr.
Natural Gas Energy Savings	314	MMBTU/yr.
Energy Cost Savings	3,031	$/yr.
Maintenance Savings	91,980	$/yr.
Total Cost Savings	95,011	$/yr.
Total Investment	945,482	$
Simple Payback	9.95	yrs.

SIR ?

E. Recommended Maintenance & Operations Practices

The following maintenance and operations (M&O) practices are recommended to help conserve boiler and chiller plant energy at FSH.

1. The Energy Coordinator and the FSH Director of Public Works should develop a master plan specification for all future central boiler and chiller plant maintenance and renovation projects.

2. All facility project managers, as well as any central plant maintenance contractors should be required to follow this specification.

3. The Energy Coordinator should review all new central boiler and chiller plant designs to check for compliance with the specifications. This would include primary equipment that is selected and designed to run at the optimum efficiency points based upon the percentage of full load.

4. The Energy Coordinator should attend training seminars for building energy conservation.

5. The installation should increase the size of their current maintenance staff by adding trained HVAC technicians.

6. The installation should provide technical training for it's current HVAC staff, especially in the area of HVAC controls.

7. Revise the current HVAC preventative maintenance program as needed to improve the overall condition of the existing systems and equipment. This includes the piping distribution systems and any leaks caused by age or wear and tear. The Energy Coordinator should be involved in this process to ensure that energy conservation concerns are addressed.

8. Add status, alarm, start and stop capabilities for all central boiler and chiller systems and auxiliaries to the post's existing building automation system. This will allow the maintenance staff to have better monitoring and control capabilities .

9. Develop a boiler maintenance program that would include, as a minimum, annual tube cleaning, annual or semi-annual burner tuning, and monthly flue stack temperature measurements. The Energy Coordinator should be involved in this process to ensure that energy conservation concerns are addressed.

10. Setback temperatures or shut-off equipment of areas that are unoccupied during the day. In many buildings, especially in Areas 100 and 2200, the air handling systems can be completely shut-off during unoccupied periods without the risk of having a large start-up load which happens in large spaces and buildings.

11. Repair all building temperature controls.

12. Repair all building air systems, cleaning coils and looking for leaks or other sources of inefficiencies within the secondary HVAC systems.

F. Energy and Cost Savings

Total Potential Energy and Cost Savings. The energy and cost savings as a result of the implementation of the ECIP projects was calculated as follows:

Electrical Energy Savings	64	MMBTU/yr.
Electrical Demand Savings	1,124	$/yr.
Natural Gas Energy Savings	1,117	MMBTU/yr.
Energy Cost Savings	5,682	$/yr.
Maintenance Savings	128,760	$/yr.
Total Cost Savings	134,442	$/yr.
Total Investment	1,256,822	$
Simple Payback	9.3	yrs.

SIR = ?

Energy Usage and Costs Before and After. Based on the base year electrical and gas energy consumption and cost data, and the potential savings calculated above, the FSH energy usage and costs before and after implementation of the ECIP project is as follows:

	Before	After
Electrical	153,580 MWH	153,561 MWH
Natural Gas	405,282 MCF	404,165 MCF
Total Cost	$8,257,166	$8,250,736

Percentage Saved. Based on the base year electrical and gas energy consumption and cost data, the percentage of savings from the implementation of the ECIP projects is as follows:

$$Electrical\ Energy\ Saved = \left[\frac{18.75\ MWH}{153{,}580\ MWH}\right] = 0.012\%$$

$$Natural\ Gas\ Energy\ Savings = \left[\frac{1{,}117\ MCF}{405{,}282\ MCF}\right] = 0.28\%$$

$$Energy\ Cost\ Savings = \left[\frac{\$6{,}430}{\$8{,}257{,}166}\right] = 0.078\%$$

TABLE 1. ENERGY CONSERVATION OPPORTUNITIES (ECOs) RECOMMENDED

ECO	Description	Electrical Energy Savings MMBTU/yr	Electrical Demand Savings $/yr	Gas Energy Savings MMBTU/yr	Total Energy Savings MMBTU/yr	Maint. Cost Savings $/yr	Total Cost Savings $/yr	Total Investment $	Simple Payback Yrs	SIR
	AREA 2200									
O	Replace Existing Boilers With High Efficiency Modular Boilers	7	-171	803	796	36,780	39,431	311,340	7.9	1.92
	AREA 100									
C	Retrofit Existing Individual Boilers With Central Boiler Plant	57	1,295	314	371	91,980	95,011	945,481	10.0	1.48
	Totals	64	1,124	1,117	1,167	128,760	134,442	1,256,821	9.3	

replace?

TABLE 2. ENERGY CONSERVATION OPPORTUNITIES (ECOs) NOT RECOMMENDED

ECO	Description	Electrical Energy Savings MMBTU/yr	Electrical Demand Savings $/yr	Gas Energy Savings MMBTU/yr	Total Energy Savings MMBTU/yr	Maint. Cost Savings $/yr	Total Cost Savings $/yr	Total Investment $	Simple Payback Yrs	SIR
H	AREA 1000 Retrofit Existing Individual Chillers With Central Chillers	1,016	3,865	0	1,016	27,480	37,885	480,090	12.7	1.18
K	AREA 1300 Replace Existing Individual Chillers With Central Chillers	4,393	43,719	0	4,393	20,243	95,249	1,441,745	13.0	1.17
B	AREA 100 Retrofit Existing Individual Chillers With Central Chiller Plant	4,350	37,558	0	4,350	26,773	91,649	1,646,927	18.0	0.83
I	AREA 1000 Retrofit Existing Individual Boilers With Central Boilers	-28	-158	80	52	10,380	10,323	186,539	18.1	0.83
N	AREA 2200 Replace Existing Chillers With Central Chillers	3,050	25,570	0	3,050	8,005	55,110	1,040,094	18.9	0.80
L	AREA 1300 Retrofit Existing Individual Boilers With Central Boilers	342	1,256	1,064	1,406	15,180	22,265	484,544	21.8	0.71
F	AREA 500 Retrofit Existing Individual Boilers With Central Boilers	-109	-329	79	-30	7,980	7,240	164,799	22.8	0.66
D	AREA 500 Install Energy Management (EMS) for HVAC System	1,957	-401	39	1,996	0	12,024	278,393	23.2	0.65
A	AREA 100 Install Energy Management (EMS) for HVAC System	5,928	-2,523	691	3,876	0	37,738	928,408	24.6	0.62
M	AREA 2200 Install Energy Management (EMS) for HVAC System	5,002	-1,740	124	5,126	0	30,102	889,460	29.6	0.51
E	AREA 500 Retrofit Existing Individual Chillers With Central Chillers	705	3,743	0	705	9,080	17,250	516,826	30.0	0.50
J	AREA 1300 Install Energy Management (EMS) for HVAC System	3,105	-471	915	4,020	0	22,194	970,739	43.7	0.36
G	AREA 1000 Install Energy Management (EMS) for HVAC System	832	149	-94	838	0	5,049	266,445	52.8	0.28
Totals		15,572	-842	1,636	14,565	9,080	112,333	3,571,878	31.8	

II. NARRATIVE REPORT

A. Entry Interview

Work Plan: An entry interview meeting was conducted at the Fort Sam Houston (FSH) facility on October 16, 1995. Present at the meeting were representatives of Huitt Zollars Inc. (HZ), Chris Pieper, P.E., *Project Manager*, John Carter, E.I.T., *Mechanical Engineer*, and M.A. Shafiq, P.E., *Mechanical Engineer*, as well as representatives from FSH, Frank Carbonell, *FSH Engineering Services Branch* and Mike Brynes, *FSH Maintenance and Operations*. During the meeting, a description of the work plan for this study was presented. The work plan was a summary of the individual tasks to be performed to complete the boiler & chiller study and the approximate date that each task was to begin. Each step of the work plan was described in detail to the FSH staff. The proposed work plan is shown in Figure 4.

Figure 4. Work Plan

10/16/95	Entry Interview
10/16/95	Building & Systems Data Collection
10/30/95	Formulate ECOs & Perform Calculations
1/29/96	Interim Findings Submittal
3/29/96	Pre-Final Report Submittal
5/31/96	Final Report Submittal

Data List: After discussing the work plan, the FSH staff was presented a list of data items to be collected by the study team, shown in Figure 5. This list was a summary of the information required by the surveyors. The study team and FSH staff discussed the methods by which all of the data on the list were to be obtained. The data concerning the existing boiler and chillersystems were to be collected from the buildings and recorded onto preprinted data forms. Building mechanical drawings were to be collected, information extracted, site verified, and included on individual building data forms. All data forms are included in Appendix G (Tab 7). The FSH personnel provided direction as to where to obtain information on the list. They also provided useful information on past energy conservation efforts and current design projects. One such project is the proposal to install a base wide EMS to control primary and secondary HVAC equipment in many of the buildings on post. This project has been designed but has not been implemented.

Figure 5. Data Acquisition List

1. Existing central boiler and chiller systems.
2. Existing auxiliary systems in central plants.
3. Existing plant and building control systems.
4. Building HVAC system types and operational schedules.
5. Building size, age, and remaining useful life.
6. Existing building operational schedules and area usage.
7. Facility 12 month gas billing history (August 93' - July 94').
8. Typical maintenance and retrofit procedures and costs.
9. Building envelope descriptions.
10. Building internal cooling loads.

ECO List: Following the discussion on the data list, the FSH personnel were presented a list of specific Energy Conservation Opportunities (ECOs) that were identified for evaluation in the Detailed Scope of Work (see Appendix D, Tab 4). This list is shown in Figure 6. The first ECO specified was the upgrade or replacement of existing central chillers with more efficient systems whichincludes possibly installing or upgrading the DDC control systems. The scope specifically called for the evaluation of gas enginevs. electrical

driven compressors, drive configuration, and variable speed drivers for the chillers. All of these types and configurations were evaluated as a means of saving energy and maintenance costs in the existing central chiller plants of areas 500, 1000, 1300 and 2200. The second ECO specified was the upgrade or replacement of existing central boilers with more efficient systems which includes possibly installing or upgrading the DDC control systems. Since no specific types were identified, the most efficient alternatives were selected and evaluated as a means of saving energy and maintenance costs in the existing central boiler plants of areas 500, 1000, 1300 and 2200. The third ECO specified was the installation of new central chiller plants to replace existing individual building chillers. These new central plant evaluations were similar to a 1986 central plant design for area 100 which was never implemented. The fourth ECO specified was the installation of new central boiler plants to replace the existing individual building boilers. In all ECOs, the annual energy consumption of the boilers, chillers and auxiliary equipment were calculated by computer simulations using the Trane Trace 600 program. Building data were used to accurately model each building such that a realistic load profile was created for simulating boiler and chiller operational patterns. In all ECO calculations, the required capacity of the existing central heating and cooling equipment was evaluated from the computer simulations and recommendations for proper sizing were made.

Figure 6. Specific ECO List

1. Chiller Replacement or retrofit with and without installing new control systems
2. Boiler upgrade or replacement with and without installing new control system.
3. Install central chiller plants with and without installing new control systems.
5. Install central boiler plants with and without installing new control systems.

B. Data Collection.

Following the entry interview, the study team began the task of collecting the required data. First, building mechanical plans were studied and data was extracted. Field surveys were made on all of the buildings in the study to verify and supplement data collected from the drawings. Al of the data obtained from drawings and field survey was documented in data sheets and included in Appendix G (Tab 7). The following summarizes the data collection phase of this study.

Building Data: This study was performed on five separate groups of buildings. These groups were identified as areas 100, 500, 1000, 1300, and 2200. Buildings in each of these areas are described as follows:

1. Area 100 - This area included buildings 122, 123, 124, 125, 126, 127, 128, 129, 131, 132, 133, 134, 135, 140, 141, 142, 143, 144, 145, 146, 147, 149, 151, 152, 154, 155, 156, 157, 158, 159, 197, 198, 199, 250, 260, 261, and 268. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. Most of the buildings in this area are historical landmarks which were built around the Second World War, and some as early as the First World War. The buildings built at that time consisted of wood framed structures with a brick veneer exteriors, pitched shingle roofs, and pier and beam foundations. Most of the buildings had basements and attic spaces. These buildings are currently used as office buildings, barracks, and other miscellaneous functions including a band rehearsal hall and museum. Each building is occupied by both Army and civilian personnel.

2. Area 500 - This area included Buildings 590, 591, and 592. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. These buildings are used for Unaccompanied Personnel Housing (UPH). Buildings 590 and 591 are exact replicas of each other. They both were built in 1956 with masonry structures, stucco exteriors, and a clay tile roof. The buildings are three stories with a gross area of 21,940 sqft. Building 592 also is used for UPH; however, it is larger than the other two, and built at a later date (1971). It is five stories and has a gross area of 127,537 sqft. Building 592 consists of two person rooms while the other two buildings are only one person rooms. The structure of building 592 consists of masonry walls with a brick exterior and a flat, built-up roof.

3. Area 1000 - This area included buildings 1000, 1001, and 1029. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. Buildings 1001 and 1029 are both office buildings. Building 1001 includes the Brooke Army Medical Center clinics, medical library, Emergency Transport Services (EMT), and pastoral care services. With the exception of the library and the EMT, it has a continuous occupancy between 7:30 A.M. and 5:00 P.M. Building 1029 is the Headquarters for Brooke Army Medical Center. It also has a continuous occupancy between 7:30 A.M. and 5:00 P.M. Both of these structures are four stories and have a brick exterior masonry wall. Building 1000 is the Brooke Army Medical Center. It is a seven story hospital built in the 1930's with a total gross area of 227,302 sqft. The existing structure is masonry with exterior brick walls. It is important to note that the functions within this building will eventually move to a new facility that is currently under construction. However, for the purposes of this study, we will model and analyze the building as it currently exists.

4. Area 1300 - This area included buildings 1350, 1374, 1375, 1379, 1380, 1382, 1384, 1385, 1387, 1396, and 1398. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. The buildings in this group consisted of seven barracks, one dining hall, one theater, one chapel, one mini-mall, and one administrative office building. Most of the buildings were constructed between 1971-1972 with the exception of buildings 1350 and 1387 which were built in 1983 and 1988 respectively. All of the barracks (Buildings 1350, 1374, 1375, 1379, 1380, 1382, and 1384) were multi-story structures while the remainder of the buildings were single story structures.

5. Area 2200 - This area included buildings 2200, 2244, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272, 2273, and 2288. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. The buildings in this group consisted of three barracks, one chapel, one theater, the military police station, and six administrative office buildings. Building 2288 is a building that has been committed by Congress for disposal within the year. Therefore, we will not recommend this building to be included in any ECO's developed for this area. All of these buildings are primarily masonry structures with brick stucco exteriors and pitched roofs.

Central Plant & HVAC Systems Data:

1. Area 100 - The buildings in this area have no central boiler or chiller plant. All of the buildings have stand alone primary heating and cooling systems that serve a maximum of two buildings each. The primary cooling systems consist of eighteen (18) ACR chillers, five (5) condensing units, sixty four (64) window units, and six (6) packaged AHU's with a total of approximately 835 tons. Most of the chillers appeared to be in good condition. However, the packaged systems and window units are in poor condition and need to be replaced. They are not only

a maintenance problem but they are also very inefficient.

The primary heating systems consisted of nineteen (19) HW boilers, two (2) steam boilers, seventeen (17) space heaters and furnaces, and forty seven (47) window units with a combined capacity of approximately 10,720 MBH. Most of the boilers appeared to be in good condition. However, the space heaters, window units and furnaces are in poor condition and need to be replaced. Additionally, the window units and some of the space heaters utilize electric resistance heat which is very inefficient and should be avoided because natural gas is available on site and is more economical to use.

Chilled water and hot water pumps are generally located within the buildingsthat they serve. Domestic Hot Water is generated by individual gas fired water heaters in each basement.

Secondary HVAC systems in these buildings consist of two-pipe and four-pipe multi-zone and single zone AHUs, FCUs, packaged systems, and window units located within the buildings. As described above for the primary equipment, there are both DX systems and CHW systems for cooling, and steam and HW for heating. Most of the air side equipment is located in mechanical rooms with the exception of a few areas where the units are hung above the ceiling.

With the multiplicity of air handling systems and renovations made to these systems, controls in this area are very difficult to maintain. Most of the single zone AHUs and FCUs that are served by CHW and HW have three way control valves serving the units. These are modulated, in some cases with face and bypass dampers, to maintain space temperature or leaving air temperature setpoints. Most of the multi-zone AHUs that are served by CHW and HW have three-way control valves that are modulated to maintain leaving air temperature setpoints. The zone dampers are then modulated to maintain space temperatures. The window units and packaged systems are typically controlled by manual on/off switches or thermostats. As mentioned above, many of the control valves for these units and thermostats are inoperable or appear to have been disconnected. Therefore, space temperatures are very difficult to maintain and the units currently operate when the buildings are unoccupied.

2. Area 500 - Each of the three buildings in this area has it's own primary chilled water system Buildings 590 and 591 are identical not only in architectural appearance but also in mechanical systems (with the exception of the size of the HW boiler). One (1) 60 ton air cooled reciprocating chiller located on the East side of each building serves three (3), four-pipe, multi-zone AHUs. Building 592, on the other hand, is served by one (1) R-123, 170 ton water cooled centrifugal chiller. This chiller serves five (5), four pipe, multi-zone AHUs.

Heating is provided by HW boilers located in each building. In buildings 590 and 591, 525 and 850 MBH water tube HW boilers, respectively, supply the three (3) AHUs. Building 592 has a 2,750 MBH water tube HW boiler supplying it's five (5) AHUs. All of the boilers have hot water reset control that has been de-activated.

Secondary systems in the buildings consist of four-pipe, multi-zone AHUs. These AHUs do not use ducted return but corridor return and/or plenum return above the corridor ceiling space. As a result, the mechanical rooms in the buildings are plenum spaces with return grilles in the doors or in the walls. Also, the units on the first floor are larger than the units on the rest of the floors because of the larger conditioned area.

The chilled water systems in Building 590 and 591 have very little control. It appears that the chillers are cycled on and off according to the chilled water return temperature. In the buildings, the three AHUs have no control on the chilled water coils, and thus run wild. The heating water system operates in a similar fashion but there is a three-way mixing valve on the primary side. This control valve and the boiler are modulated in sequence to maintain the heating water supply temperature. The heating water coils for the AHUs are also wild. Therefore, the face and bypass dampers are modulated to maintain the leaving air temperature setpoint while a controller modulates the zone dampers to maintain the space temperature setpoint. The air handling systems in Building 592 are controlled exactly like the other two buildings with the exception of three-way control valves on the HW coils. These control valves are modulated with the face and bypass dampers to maintain leaving air temperature. On the primary side, a water cooled centrifugal chiller is controlled to maintain chilled water supply temperature. The cooling tower fan is cycled, and the bypass valve is modulated to maintain condenser water temperature. The boiler is controlled similarly to the other two buildings.

3. Area 1000 - The three buildings in this area are all served by water cooled centrifugal chillers However, Building 1029 is the only one of the three that has it's own primary chilled water system. Building 1001 is served by one (1) R-11, 219 ton chiller and cooling tower located in Building 1002. Building 1000 has two (2), R-11, 400 ton centrifugal chillers located in the chiller plant, Building 1088, which are served by two (2) cooling towers located on the roof of that plant. Both of these chillers are approximately five years old and are in very good shape. Building 1029 is also served by a new chiller and it is one year old. This 160 ton chiller is served by an older cooling tower that appears to be undersized for the new chiller. The cooling tower is located on the roof of Building 1029.

Heating systems in Building 1000, the main hospital, consist of both steam and HW systems Three 15 psig, 5,223 MBH steam boilers serve radiators throughout the Hospital. These boilers are only operated in the winter period. Three 5,500 MBH flextube HW boilers provide heating for the remainder of the building. There are also two 60 psig, steam boilers that serve the sterilizers, kitchen equipment, and humidifiers in the building. The heating system serving Building 1001 consists of one 1,050 MBH steam boiler located in the basement. This is the only boiler out of three that is operating. Building 1029 is served by a 2,500 MBH HW boiler located in the basement of the building.

Secondary systems in the buildings include single zone and multi-zone AHUs in all of the buildings, and FCUs in Building. 1000. In Buildings 1001 and 1029, four-pipe multi-zone units serve the bottom floors and four-pipe single zone units serve the top floor. With Building 1000 being a hospital, the air handling systems are more complicated than would be for the typical office or barrack. For example, many of the unit types, as mentioned above, have humidifiers in the ductwork to maintain the humidity control in the critical spaces, ie. operating rooms, burn unit, etc... Also, there are three 100% outside air units that provide outside air to the 492 fan coil units located throughout the building. As mentioned above, there are steam convectors throughout the building to handle some of the heating load.

For CHW system controls in Buildings 1001 and 1029, all of the AHUs have wild CHW coils and face and bypass dampers. For the multi-zone units, the face and bypass dampers are modulated to maintain leaving air temperature setpoint, while the zone dampers are modulated to maintain space temperature setpoint. For the single zone units, the space temperature setpoint controls the operation of the face and bypass dampers. The primary heating systems in the two buildings consist of three-way control valves on the HW coils in Building 1001, and

two-way valves on the steam coils in Building 1029. In the winter, these valves are modulated in sequence with the face and bypass dampers, to maintain leaving air temperature for the multi-zone units. For the single zone units, the space temperature setpoint controls this sequence. The controls for Building 1000 have to maintain the strict requirements of a hospital so they are typically much more involved than previously described for other buildings. On the primary side, the chillers are operated to maintain the supply CHW temperature setpoint, and the cooling tower fans and bypass valve to maintain the condenser water supply temperature setpoint. The three boilers are staged and modulated in unison to maintain the heating water supply temperature setpoint. On the building side, the operating rooms are served by variable air volume AHUs which have two-way valves on the preheat, cooling, and heating coils that are generally controlled to maintain the leaving air temperature setpoint. Humidifiers are located in the AHU, and in the multiple zones. The humidifiers are cycled by a local humidistat to maintain the respective relative humidity setpoint. Space temperature and pressurization are maintained by controlling zone dampers and reheat coils. The critical care areas utilize the same control sequence, except enthalpy control is used to maintain a mixed air temperature entering the unit. The Lab multi-zone AHUs have both a cold deck and a hot deck. The two-way control valves are modulated to maintain the leaving coil temperature setpoint. The space thermostats modulate the zone mixing dampers to maintain setpoints. Enthalpy control is utilized to maintain a mixed air temperature setpoint and also modulates the heating coil valve to account for the variance in mixed air temperature. Overall, the primary equipment controls are in good condition; however, those controls are limited to generally the air handling equipment only. Therefore, there is no sequencing or load optimization of primary equipment other than what the manufacturer of the equipment provided. On the building side, many of the controls in Buildings 1001, and 1029 are de-activated , and need to be replaced or repaired. The controls for the air side systems in Building 1000 appear to be operating and in good condition for the age of the equipment.

4. Area 1300 - Eight of the buildings (1350, 1374, 1375, 1377, 1379, 1380, 1382, 1385) in this area are served by a central plant adjacent to Building 1377. The other four (4) buildings (1384, 1387, 1396, & 1398) are controlled by stand-alone systems. The primary cooling system in Building 1377's plant consist of two (2) centrifugal water cooled chillers, rated at a combined 986 tons, which are 23 years old and use R-11 refrigerant. These two chillers are piped in series and serve all of the buildings in that group except for 1350. This newer building is served by one (1) 438 ton, water cooled centrifugal chiller that is 12 years old and uses R-11 refrigerant. A 12 year old, single-cell cooling tower serves this chiller while a 23 year old, and one (1) two-cell tower serves the other two chillers. The older chillers and tower appeared to be in poor condition and nearing the end of useful life. The newer chiller and tower were in fair condition with some years of useful life remaining. For the other stand-alone buildings, one (1) R-11, 273 ton water cooled centrifugal chiller serves Building. 1384. This chiller is 23 years old, and is served by a cooling tower that appears to be 3 years old and in good shape. Building 1387 is served by 97 tons of split system heat pumps. These systems are approximately eight years old and are in good shape. Building 1396 is served by one (1) 50 ton packaged DX air handling unit with a remote condenser, and one (1) 7.5 ton split system. The packaged system is approximately 20 years old and is close to the end of it's useful life while the split system appears to be in good shape. Lastly, Building 1398 is served by one (1) 44 ton reciprocating chiller and remote condenser that is approximately 21 years old. This system also appears to be near the end of it's useful life.

The primary heating system in the first group of buildings consists of two (2) firetube, HW boilers which are 23 years old and have a combined output capacity of 11,824 MBH. These

two boilers serve all of the buildings except for Building 1350. This building is served by two (2) watertube, HW boilers which are 12 years old and have a combined output capacity of 9,653 MBH. The older boilers appeared to be in poor condition and are near the end of their useful life. The newer boiler was in fair condition with some years of useful life remaining Again, the four other buildings are served by isolated heating systems. Three of the buildings (1384, 1396, and 1398) are served by water tube HW boilers that total 4,445 MBH output capacity. All three of the boilers in this area appear to be approximately 10 years old and in good shape. The fourth building, as mentioned above, is equipped with air handling systems consisting of split system heat pumps with auxiliary electric resistance heat.

Secondary HVAC systems in these buildings consist of two pipe FCUs, heat pumps, two-pipe single zone AHUs, four-pipe multi-zone AHUs, and packaged AHUs . All of the buildings that are served by the central plant in Building 1377 have secondary CHW and HW pumps to circulate water from the central loops to all the FCUs and air handlers.

The primary chilled water system from the central plant in Building 1377 consists of two centrifugal chillers, piped in series, which are cycled on /off to maintain the CHW supply temperature setpoint of the respective chiller. Each chiller has it's own controller and operates independent of the other. The third chiller located in the addition to the plant is also cycled on / off to maintain the CHW supply temperature of the chiller. This chiller was designed to serve Building 1350 but is also connected to the other loop with crossover valves. This plant serves both two-way and three-way CHW valves on the air handling systems. Building 1350 is equipped with four-pipe, dual duct, variable air volume AHUs that have both a cold deck and hot deck controlled to maintain the leaving air temperatures of the respective coil. Zone dampers are modulated to maintain space temperatures. The remainder of the buildings served by this plant have multi-zone units that have three-way controlled HW coils, both three-way controlled and wild CHW coils, and some face and bypass dampers. For all the units, space temperature setpoints are maintained by modulating the zone dampers, and leaving coil temperature setpoints are maintained by modulating the HW or CHW valves, and face and bypass dampers (as applicable). Building 1384 has a primary CHW system that consists of a chiller that is controlled to maintain CHW supply temperature, and wild CHW coils throughout the system. The HW system consists of a boiler which is modulated in sequence with a three-way mixing valve to maintain HW supply temperature setpoint. Each AHU is equipped with three-way HW control valves on the coils. The control valves serving the coils are modulated to maintain the leaving air temperature setpoint while the space temperature is maintained by modulating the zone mixing dampers. Building 1387 has split DX heat pump systems. These units are cycled on /off by space thermostats. Building 1396 has one packaged system with a heating coil and a DX compressor. The compressor is staged to maintain supply air temperature and space temperature. The other split system AHU is controlled to maintain the space temperature setpoint. Building 1398 has a two-pipe system where the chiller and boiler are controlled to maintain the supply temperature setpoint. The two-pipe FCUs have mixing valves that are controlled by space thermostats. Overall HVAC system performance in this area is poor due largely to faulty or inadequate controls. Many of the controls have been disconnected or no longer operate correctly.

5. Area 2200 - Four of the buildings (2263, 2264, 2265, & 2266) in this area are served by a central CHW plant in the basement of Building 2265 while the other buildings are served by isolated systems. The central plant in Building 2265 consists of a single 650 ton centrifugal, water cooled chiller, which is 22 years old and uses R-11 refrigerant. A 23 year old, single cell, built-up cooling tower serves this chiller. The chiller and tower appear to be in poor

condition and nearing the end of useful service. The other buildings consist of 267 tons of air cooled chillers, window units, or open drive reciprocating chillers. Most of the air cooled chillers are in good shape, but the open drive reciprocating machines and window units are reaching the end of their useful service and need to be replaced.

The primary heating systems consist of nine watertube, HW boilers which have a combined rated capacity of 9,830 MBH, and one steam boiler serving Building 2247 with a capacity of 80 MBH. Most of these boilers, except the steam boiler, appeared to be in good condition with many years of useful life remaining. The steam boiler is not only very old, but it has been damaged by flood water from the sanitary sewer system. Therefore, this boiler needs to be replaced.

A variety of secondary systems serve the buildings studied in this area including single zone, multi-zone, DX, packaged AHUs, and FCUs. In addition, many of the buildings are either two-pipe or four-pipe, or combinations of the two. Several of the buildings' AHUs are located in areas that are difficult to access for maintenance. Buildings 2200 and 2247 are prime examples Building 2200 has AHUs located in the under-floor crawlspace and have very little clear space to access. Building 2247, on the other hand, has an AHU located above the ceiling space in the restroom, which requires part of the ceiling grid removed to maintain the equipment.

Both of the primary CHW and HW systems that serves Buildings 2263 through 2266 have three way control valves on the air handling unit coils. The centrifugal chiller is modulated to maintain the CHW supply temperature, while it appears the cooling tower fan and bypass valve are controlled to maintain CW supply and return water temperature setpoints respectively. The three HW boilers have primary mixing valves to maintain the HW supply setpoint. Also, each building has HW booster pumps in the loop. These four buildings are primarily served by single zone units with face and bypass dampers or multi- zone units. For the single zone units, the space thermostats modulated the three-way valve, depending on summer or winter operation, and face and bypass dampers to maintain space temperature setpoint. For the multi-zone units, the coil valves are modulated to maintain leaving air temperature from the coil, while the space temperature controls the zone dampers. The other buildings are served by individual air cooled chillers or DX systems. The systems are cycled on / off to maintain the CHW supply temperature setpoint. In addition, there are various control strategies used. All of the air cooled chiller systems have either wild CHW coils or three-way control valves on the coils, and the DX systems have two-way solenoid valves. For the HW loops, the primary equipment utilize both steam and HW boilers. All of the HW boilers maintain the HW supply temperature setpoint and have one firing rate. The steam boilers on the other hand appear to operate to maintain the steam pressure. For all HW systems, the individual boilers serve both three-way controlled coils and wild coils. The multi-zone or single zone units in these buildings operate similarly those mentioned above, and the FCUs have both wild coils with no thermostatic control and three-way coils controlled via space thermostats. Overall HVAC system performance in this area is poor due in part to faulty controls. As seen in all the areas, much of the controls have been de-activated or they appear to be malfunctioning.

Maintenance and Operations Data: Most of the HVAC system routine preventive maintenance is performed by post Civil Service personnel in the DPW. In general, post maintenance appears to be inadequate due to the lack of manpower in the maintenance department. For instance, some HVAC air filters appeared to be excessively dirty and/or installed backwards. Leaks were found in the HW coil of one air handler, and many actuators for dampers or valves have been broken off or disconnected. HVAC system controls also appeared to be inoperable or missing, adding to the inability of the systems

to maintain temperatures within the building spaces. In many buildings, the outside air dampers to the AHU's were either manually shut and disconnected or in some cases the outside air louvers were blocked off.

The maintenance department has a procedure to keep up with the general maintenance of the equipment For the CHW systems, a daily log is kept of the operation of the chillers. This log records temperatures, pressures, amperage, etc. Refer to Appendix F (Tab 6) for a typical chiller log. A complete walk-through of the system is performed once a month. This involves checking gages, valves, etc. Once a year, the maintenance department cleans and maintains the cooling towerswhich includes a thorough wash down, and a belt change. Also, once a year, the air cooled chillers have a complete wash down, and a preventive maintenance check. For the HW systems, most of the maintenance is done an as needed basis. However, there is an open and/or closed inspection of the boilers performed every six months which could then result in more detailed maintenance if needed. One of the drawbacks for not having a regular maintenance program for the boilers is that there is not a periodic recording of the flue stack temperatures, which is something that is recommended.

For specific annual maintenance on the water cooled chillers, the base has contracted an outside company (Gillette Corp.) to handle this work. This contract, known as the Gillette Contract, includes, among other items, cleaning the condenser coil, changing the oil and the filters, and inspecting the purge system. It also includes three (3) major overhauls per year. For a description of this maintenance program, refer to Appendix F (Tab 6). If there is any maintenance required (other than major overhauls) that is above the scope of the contract, FSH is only charged for the parts. However, for any *major overhauls* above the allotted amount in the contract, FSH is charged for both parts and labor. Currently, there are 15 chillers included in this contract with plans to add additional chillers (Buildings1029, and 592) once the warranty period from the manufacturer has expired. The total cost for maintaining these chillers during the 1994-1995 contract year was $148,000. This averages out to be approximately $12,150 for each chiller. There is a second contractor (Calgon Corporation) that maintains the water treatment for both the CHW and HW system. The details of these services can also be seen in Appendix F (Tab 6).

Most of the primary CHW and HW systems in the buildings studied are operated on a seasonally basis. The cooling season is typically from May to October and the heating season from November through April. This, however, varies from year to year according to the severity of the seasons. There are a few exceptions to this policy which include Buildings 268, 1000/1088, 2200, 2244, and 2247. In these buildings, the chilled water systems operate year round, and the heating water and HPS systems that serve building 1000 operate year round. For a large percentage of the buildings studied, the outside air intake has been significantly reduced or shut-off completely, and this is not in accordance with the ventilation requirements of ASHRAE Standard 62-89. Also, many of the automatic controls are no longer working. Of all the buildings studied that had outside air economizer control, it appeared to no longer work (except Building 1000). As a result, in most to all cases, it appeared that the air handling units operated without any shut-off, night setback, or economizer control.

Recommended Maintenance & Operations Practices: The following maintenance and operations (M&O) practices are recommended to help conserve boiler and chiller plant energy at FSH.

1. The Energy Coordinator and the FSH Director of Public Works should develop a master plan specification for all future central boiler and chiller plant maintenance and renovation projects

2. All facility project managers, as well as any central plant maintenance contractors should be required to follow this specification.

3. The energy coordinator should review all new central boiler and chiller plant designs to check for compliance with the specifications. This would include primary equipment that is selected and designed to run at the optimum efficiency points based upon the percentage of full load.

4. The energy coordinator should attend training seminars for building energy.

5. The installation should increase the size of their current maintenance staff by adding trained HVAC technicians.

6. The installation should provide technical training for it's current HVAC staff, especially in the area of HVAC controls.

7. Revise the current HVAC preventative maintenance program as needed to improve the overall condition of the existing systems and equipment. This includes the piping distribution systems and any leaks caused by age or wear and tear. The Energy Manager should be involved in this process to ensure that energy conservation concerns are addressed.

8. Add status, alarm, start and stop capabilities for all central boiler and chiller systems and auxiliaries to the post's existing building automation system. This will allow the maintenance staff to have better monitoring and control capabilities than they currently have.

9. Develop a boiler maintenance program that would include, as a minimum, annual tube cleaning, annual or semi-annual burner tuning, and monthly flue stack temperature measurements. The Energy Manager should be involved in this process to ensure that energy conservation concerns are addressed.

10. Setback temperatures or shut-off equipment of areas that are unoccupied during the day. In many buildings, especially in Areas 100 and 2200, the air side systems can be completely shut-off during unoccupied periods without the risk of having a large start-up load which happens in large spaces and buildings.

11. Repair all building temperature controls.

12. Repair all building air systems, cleaning coils and looking for leaks or other sources of inefficiencies within the secondary HVAC systems.

Utility Data: A 12 month utility billing history was obtained from the energy coordinator which covered the period from August, 1993 through July, 1994. This history included all of the metered electric and gas consumption for the installation. This history is shown in Figure 7. The total cost of electricity for the base year was $6.5 million and the total cost for gas was $1.7 million. It is important to note

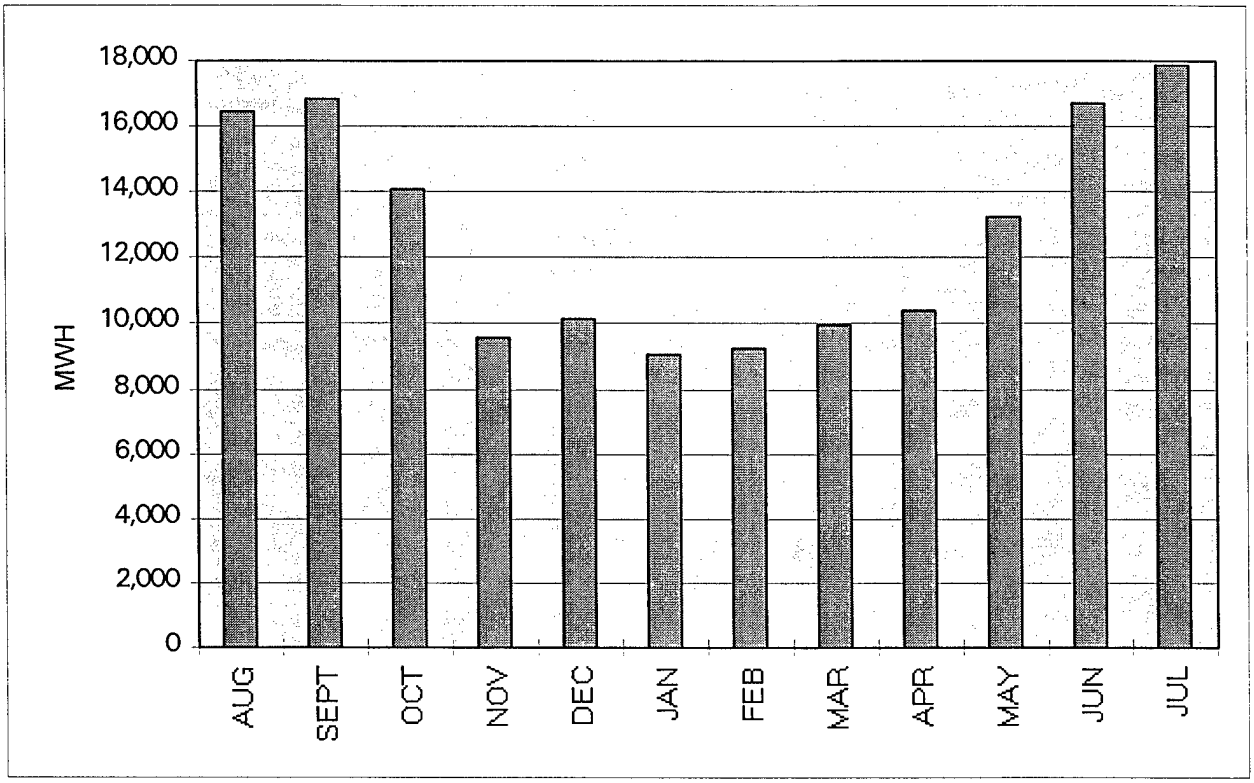
that the total cost indicated above includes only the consumption charges for both gas andelectricity and demand charges for electricity. The actual bills for these months were, in some instances, more than that charged just for electricity and gas usage. For instance, the total gas billing in June, 1994, was $20,730 more than the consumption for that month. However, the additional charges were due to construction cost for relocating some existing gas lines. Therefore, that additional cost for items other than energy usage was not included in the savings calculated for the ECOs.

Figure 7. Base Year Utility Data

Billing Period	Electrical			Natural Gas	
	Demand KW	Consumption MWH	Cost $	Consumption MCF	Cost $
AUG	30,576	16,464	$785,463	17,063	$75,149
SEPT	31,024	16,856	$795,130	15,835	$74,165
OCT	30,240	14,084	$706,204	16,447	$74,845
NOV	27,496	9,548	$464,806	52,235	$214,472
DEC	24,819	10,136	$464,187	47,671	$210,305
JAN	24,819	9,044	$379,870	73,604	$297,992
FEB	24,819	9,268	$391,687	61,755	$247,346
MAR	24,819	9,968	$459,976	44,290	$187,764
APR	24,819	10,416	$376,714	24,458	$99,261
MAY	27,160	13,216	$447,478	20,588	$81,904
JUN	31,752	16,716	$620,912	16,192	$63,594
JUL	32,872	17,864	$674,674	15,144	$63,268
Total	335,215	153,580	$6,567,101	405,282	$1,690,065

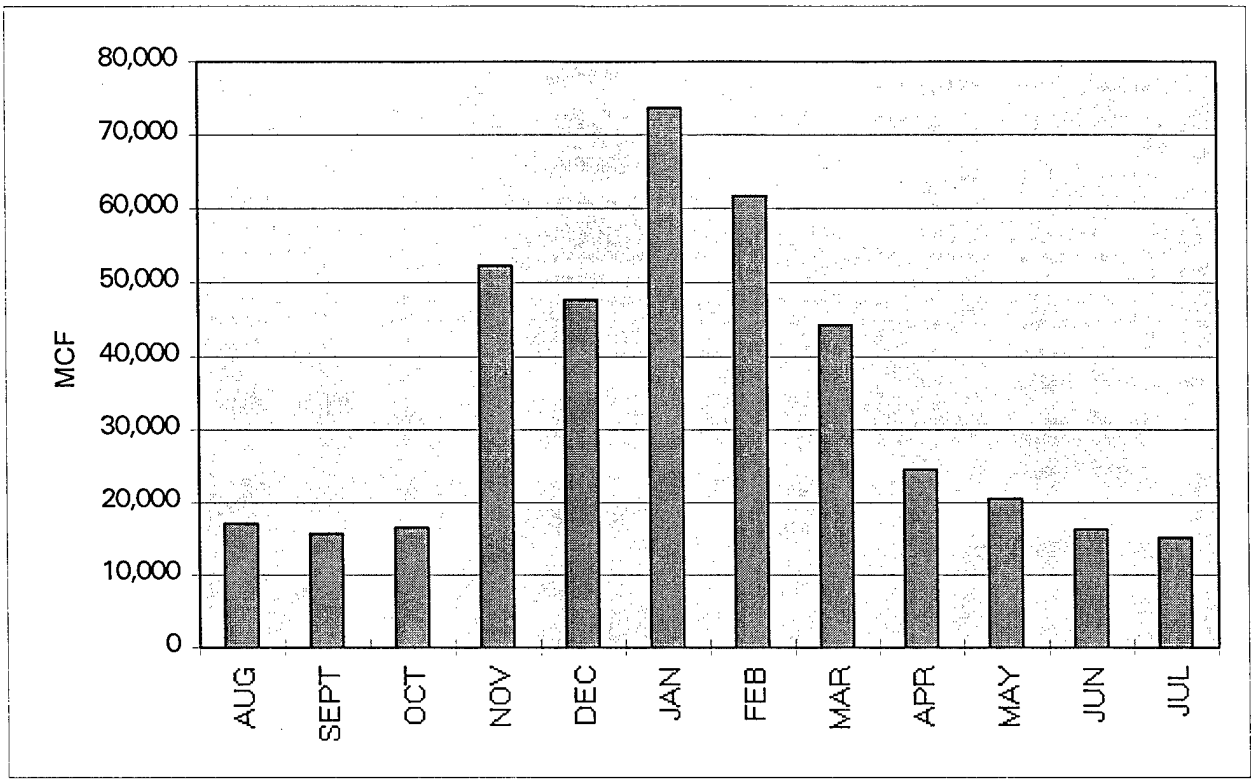
Charts of the base year energy usages were plotted and are shown in Figures 8 and 9. These charts give a visual representation of the installation's energy usage patterns for the year. Looking at Figure 5, it can be seen that the electrical usage never falls below 9,000 MWH per month. This is considered a 'baseline' of electrical energy use. It can be assumed that all energy usage above this baseline is consumed by cooling systems, based on the peaks and the months in which they occur.

Figure 8 - Base Year Electrical Usage Profile



Similar observations can be made about gas energy usage, shown in Figure 9. The baseline usage here is around 15,000 MCF of gas per month. Since gas is the primary source of heating at FSH, the obvious peak during the winter months can be considered heating energy. Therefore, all gas energy usage below the baseline is used for DHW and cooking equipment. This is a large amount of energy usage and should be considered a large target for potential energy savings.

Figure 9 - Base Year Gas Usage Profile



Based on the current gas and electric utility rates from the City Public Service (CPS) of San Antonio the current avoided costs for electrical savings are $0.021 per KWH, and $7.50 to $10.00 per KW demand savings, depending upon the time of year. For natural gas savings for rate G (Domestic and Commercial cooking, heating, and lighting purposes), the avoided cost is $4.39 per MCF. For rate B (Heating and Cooling plants), the avoided cost of gas savings is $3.64 perMCF. There are currently no rebates available from the CPS for boiler or chiller energy conservation projects.

Replacement Boiler Selection: Data on available replacement boilers were obtained from typical manufacturers in order to select representative boilers for ECO evaluations. This data included performance characteristics, physical dimensions and cost figures. The criteria for selecting new boiler systems for the ECOs are described below.

1. Efficiency. Replacement boilers that had the highest overall efficiency over the operating range were selected in each area. In most cases, this criteria was met by the high-efficiency modular boilers which were modeled in the ECOs. These are fully condensing, forced draft firetube units that have efficiencies in the 90% range over the entire range of operation. No other boiler type was found to match this performance.

2. Turn-down ratio. In order to limit the thermal shock and efficiency losses associated with cycling, replacement boilers for the ECOs needed to have a high turn-down ratio. The 14:1 ratio associated with the modular boilers used in most ECOs was as good or better than other available boilers with lower efficiencies. And the modular concept of using multiple boilers to match the heating loads, combined with this high turn-down ratio, minimizes the negative impacts of cycling.

3. Controls. In order to closely match the heating load requirements at any given time, all new boilers were selected with fully modulating controls. Two-position or multi-stage controls would increase the possibility of boiler cycling, as well as reduce the part load efficiency.

4. Physical size. In order to fit the new boilers into the buildings without modifying the existing boiler room openings, the small footprint and overall size of the modular boilers was the best choice for the ECOs. Other types of boilers were larger and would require more effort and cost to install in the buildings. This criteria was not a factor in areas 100 and the Quadrangle, where completely new central boiler plants were being considered.

5. First cost. The first cost of the modular boilers was greater than other types available. However, the efficiency improvements of these units justified the higher initial first costs in the Life Cycle Cost Analysis. In areas 100 and the Quadrangle, the first cost of the boilers selected was equivalent to or lower than most of the other boiler types available for the ECOs.

6. Maintenance requirements and costs. All types of replacement boilers would require annual cleaning of the heat exchanger surfaces, as well as optimization of the combustion systems. The boilers used in the ECOs appeared to be as good or better than all other boiler types in ease of maintenance. This is due to their small physical size and construction features. Maintenance cost estimates obtained from the local contractor were independent of boiler type. Therefore, all new boiler types available were assumed to be approximately equal in the area of maintenance costs.

Replacement Chiller Selection: Data on available replacement chillers were obtained from typical manufacturers in order to select representative chillers for ECO evaluations. This data included performance characteristics, physical dimensions and cost figures. The criteria for selecting new chiller systems for the ECOs are described below.

1. Manufacturer. The facility maintenance personnel requested that York chillers be used in this study as they preferred them to other manufacturer's products. Therefore, most new chillers used for analysis in the ECOs were made by York. In areas 100 and the Quadrangle, McQuay chillers were selected for reasons mentioned in the following text.

2. Machine Type. The scope of work generally identified the specific types of chillers to be compared in each area. These were the centrifugal, centrifugal with variable speed drive, screw and gas-engine driven centrifugal. Therefore, all four of these chiller types were compared in each ECO to determine the most economically beneficial retrofit for each area. In areas 100 and the Quadrangle, where new central plants were under consideration, only packaged air-cooled type chillers were considered. This was done to minimize the implementation costs in these areas.

3. Drive configuration. The new machines selected for ECO analysis all had open drives on the compressors. This increases the first cost somewhat, but decreases the long term maintenance costs.

4. Refrigerant. Replacement chillers were to all use either R-123 or R-134 refrigerant, as per the scope of work. This requirement was met in the study.

5. Efficiency. The full and part load efficiencies for all machines selected for evaluation were used in the ECOs. The relative effects of these efficiency differences are illustrated in the

life cycle cost analysis of each machine. In Area 100, the most efficient type of air cooled packaged chiller found was the single-screw unit from McQuay. Therefore, this machine was used in the ECO evaluations.

6. First cost. The first cost data for all machines selected for evaluation were used in the ECOs. The relative effects of these cost differences are illustrated in the life cycle cost analysis of each machine.

7. Maintenance requirements and costs. All types of replacement chillers would require periodic cleaning of the heat exchanger surfaces, as well as optimization of the compressor systems and controls. Maintenance cost estimates obtained from the local contractor were independent of chiller type. Therefore, all new chiller types available were assumed to be approximately equal in the area of maintenance costs.

C. Plan To Implement Projects

The analysis of all potential boiler and chiller ECOs at the facility has been completed and the grouping of the individual ECOs into projects has been determined. These projects were previously detailed in the Executive Summary. Below is an abbreviated plan for implementation of the recommended projects.

Funding: The forms DD-1391 and life cycle cost analysis summary sheets for the ECIP projects is provided on pages 24 through 40. These forms are to be submitted for project funding, along with the savings and cost estimates in Appendix B. Review the latest ECIP project documentation prior to submitting these forms.

Programming: An engineering design firm should be selected to produce construction contract drawings and specifications for all of the projects which are funded either through ECIP or other means. All of the savings calculations and cost estimates for the recommended ECOs in Appendix B should be supplied to the designers in order to inform them of the intent and projected budget for each ECO. The designers should use the equipment sizing criteria described in the ECOs as a guide only, and perform all calculations necessary to properly size all new equipment. These calculations should take into consideration all existing field conditions in the areas affected by the ECOs. It is recommended that existing auxiliary equipment be reused wherever possible to reduce the project first cost. The designer should field verify the condition of the existing equipment before specifying the disposition of the equipment. In the case of boiler retrofits, the designer should consider keeping some of the existing boilers in place for use a backup boilers. Where equipment is to be removed, the project specifications should include provisions for the possible salvage of the equipment. The facility Project Manager should ensure that all new central plant designs produced conform with the intent of each ECO, in order to realize the estimated savings. Prior to releasing construction bids, all construction drawings and specifications should be compared to the original ECOs to ensure compliance.

Construction. Once the project Contract Documents have been reviewed and approved, the facility Project Manager should release the Contract Documents for bid, using the normal construction procurement proceedings. Care should be taken to schedule all work to minimize the negative impact of the buildings served by the central plant equipment. Prior to construction, the facility should review all shop drawings and submittals to ensure compliance with original intent of each ECO.

1. COMPONENT	FY 1997 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		30 OCT 96

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
FORT SAM HOUSTON, SAN ANTONIO, TX.	ECIP

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			311.340

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
High Efficiency, Modular Boiler Retrofit - ECO 0	EA	1	311.34	311.34
ESTIMATED CONTRACT COST				278.405
CONTINGENCY (0%)				
SIOH				16.231
DESIGN				16.704
TOTAL REQUEST				311.340
TOTAL REQUEST (ROUNDED)				311.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Remove the existing boilers located in Buildings 2200, 2244, 2247, 2248, 2270 and 2272. Also, remove the three 15 HP heating water (HW) distribution pumps in building 2265. The existing building pumps will be reutilized as secondary pumps. Install 3 modular high efficiency 2000 MBH HW boilers and three 7.5 HP primary HW pumps (172 GPM at 110 ft hd) in an addition to the central plant serving building 2200. Provide stainless steel flues and gas regulators for each boiler. HW to all buildings listed above will be provided through two separate loops of direct buried primary HW piping. One 3" loop will branch from the 6" main in the boiler plant and serve buildings 2244, 2247, 2248, 2250, 2270, 2272, and 2273. The second 5" loop will also extend from the 6" main in the boiler plant and tap into the existing HW loop serving buildings 2263, 2264, 2265, and 2266 just outside of the existing chiller plant serving these buildings. Approximately 800 ft. of 3", and 400 ft of 5" under ground piping will be require for these loop. Expand the existing central plant of building 2200 from the north wall and add an additional 750 sq ft. space. All buildings AHUs and fan/coil units will be retrofitted with new two way control valves. A HW temperature reset controller will be installed in the plant to improve HW system efficiency. All new controls gas and electrical services will be installed for the new equipment in Building 2200 to serve the new boilers and pumps.

1. COMPONENT	FY 1997 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		30 OCT 96

3. INSTALLATION AND LOCATION
FORT SAM HOUSTON, SAN ANTONIO, TX.

4. PROJECT TITLE	5. PROJECT NUMBER
ECIP	

11. REQUIREMENT

This project is required to reduce the heating energy consumption in the distributed heating systems serving Area 2200 . The project provides new, more efficient primary heating systems, which will save heating energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these projects will result in the following:

Electrical Energy Savings	7	MMBTU/yr
Electrical Demand Savings	-171	$/yr
Gas Energy Savings	803	MMBTU/yr
Total Energy Savings	796	MMBTU/yr
Total Cost Savings	39,341	$/yr
Total Investment	311,340	$
Simple Payback	7.9	yrs
SIR	1.92	

CURRENT SITUATION:

All heating equipment is located in different locations with each being remote to the other. All of these boilers appear to be in fair condition. However, the cost of maintaining these boilers is excessive. Therefore, it is recommended that three 2,000 MBH high efficiency gas fired high efficiency modular HW boilers be installed. These boilers are 86% efficient under full load conditions, and reach up to 98% efficiency under part load conditions. Also, they have the capability to be staged to maintain these part load efficiencies by remote boiler control. In retrofit projects such as this, the size of these boilers make it very economical and justifiable because of their ease of installation. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. Three primary pumps will also provide additional flexibility in staging. Existing outside temperature reset controller and necessary three way mixing valves on each secondary HW loop will b calibrated to enhance HW system efficiency. All AHUs and fan/coil units three way control valves will be converted to two way valves. Computer simulations of the four buildings served by these boilers determined that the current combined capacity of 13,322 MBH is much more than the amount required to adequately heat the buildings[1]. The existing boilers are therefore operating at an inefficient, low load condition most of the time. Also, because of the constant flow rate requirements of the boilers, excessive pumping energy is expended. By staging three new high efficiency modular boilers to operate only as needed, a substantial energy savings can be obtained. Also, a decrease in the combined boiler output capacity to 4,695 MBH is recommended to more closely match the heating load in the buildings and reduce the associated pumping energy consumption.

IMPACT IF NOT PROVIDED:

If this project is not provided, the heating energy and cost savings mentioned above will continue to be wasted. There will be no contribution to the energy reduction goals established at the facility.

Life Cycle Cost Analysis Study: FSH-3.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-O
Analysis Date: 10/31/96 Economic Life: 20 years
Prepared by: JOHN CARTER

ECIP Summary Report

1. Investment

A. Construction Cost	$278,405
B. SIOH	$16,231
C. Design Cost	$16,704
D. Total Cost (1A+1B+1C)	$311,340
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$311,340

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	7	Mbtus	$44	15.08	$663
Elec. Deman					$0	14.88	$0
Natural Gas	$3.5	/Mbtus	803	Mbtus	$2,778	18.58	$51,622
TOTAL			810	Mbtus	$2,822		$52,285

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$36,780	Annual	14.88	$547,286
ANNUAL TOTAL	$36,780			$547,286
ONE TIME TOTAL	$0			$0
TOTAL	$36,780			$547,286

4. First Year Dollar Savings	$39,602
5. Simple Payback Period (Years)	7.86
6. Total Net Discounted Savings	$599,572
7. Savings to Investment Ratio	1.93
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	6.43%

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.60	**DATE:** 10/31/96
ECO NO. 0 Retrofit Individual Boilers AREA 2200	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
AREA 2200

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
REMOVE BOILER	7	EA	90.0	28.91	18,213	780.00	5,460	23,673
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
3"	800	LF	0.6	28.91	13,877	15.70	12,560	26,437
5"	400	LF	1.04	28.91	12,027	29.50	11,800	23,827
SCH 40 BKL STL PIPE W/ FTGS HNGRS & INSULATION								
2"	100	LF	0.5	28.91	1,446	7.05	705	2,151
1-1/2"	50	LF	0.4	28.91	578	5.05	253	831
1"	50	LF	0.3	28.91	434	4.38	219	653
3/4"	100	LF	0.3	28.91	954	2.75	275	1,229
				SUBTOTAL	47,528		31,272	78,800
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.60	**DATE:** 10/31/96
ECO NO. O Retrofit Individual Boilers AREA 2200	**BY :** KOTHMANN, K.	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
AREA 2200

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 3"	2	EA	7.0	28.91	405	475.00	950	1,355
SECTIONALIZING VALVE AND BOX 5"	2	EA	8.0	28.91	463	540.00	1,080	1,543
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	150.0	20.00	3,000	2,000.00	2,000	5,000
SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY AND CONNECT TO EXISTING HW PUMPS PER LOCATION								
2"	1	LOC	9.6	28.91	278	639.00	639	917
REPLACE 3-WAY CONTROL VALVES WITH 2-WAY	71	EA	4.0	28.91	8,210	350.00	24,850	33,060
SUBTOTAL					12,355		29,519	41,874
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO TEX	**PROJECT NO:** 03-185.60	**DATE:** 10/31/96
ECO NO. O **Retrofit Existing Boilers AREA 2200**	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
AREA 2200

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Install New Boiler AERCO # KC 2000 1830 MBH	3	EA	100.00	28.91	8,673	18500.00	55,500	64,173
Install New Pump 5 HP	1	EA	10.00	28.91	289	1100.00	1,100	1,389
Install New Pump 10 HP	3	EA	15.00	28.91	1,301	2800.00	8,400	9,701
pipe Assembly & valves Boiler	3	EA	28.00	28.91	2,428	2400.00	7,200	9,628
pipe Assembly & valves Pump	4	EA	7.00	28.91	809	600.00	2,400	3,209
Boiler Breaching	3	JOB	30.00	28.91	2,602	2000.00	6,000	8,602
Controls	1	JOB	90.00	28.91	2,602	3900.00	3,900	6,502
Electrical	1	JOB	80.00	28.91	2,313	3500.00	3,500	5,813
Test , Balance & Start-up	1	LS	80.00	28.91	2,313			2,313
				SUBTOTAL	23,330		88,000	111,330
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.60	DATE: 10/31/96
ECO NO. O Retrofit Existing Boilers AREA 2200	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
AREA 2200

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					47,528		31,272	78,800
SUB TOTAL FROM SHEET 2					12,355		29,519	41,874
SUB TOTAL FROM SHEET 3					23,330		88,000	111,330
SUBTOTAL					83,214		148,791	232,004
O & P @ 20%					16,643		29,758	46,401
SUBTOTAL					99,856		178,549	278,405
DESIGN @ 6%								16,704
SUBTOTAL								295,109
SIOH @ 5.5%								16,231
TOTAL								$311,340

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6MA	DATE: 10/31/96
ECO NO. 0 Retrofit Existing BOILERS	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 2200

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON								
OUTSIDE CONTRACT COSTS PER BOILER PER YEAR								
EXISTING BOILER	-10.	EA	100.0	30.00	-30,000	1,800.00	-18,000	-48,000
NEW EQUIPMENT								
AERCO MODULAR HIGH EFFICIENCY HW BOILER	3.	EA	80.0	30.00	7,200	1,500.00	4,020	11,220
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-22,800		-13,980	-36,780
PER YEAR								

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1. COMPONENT	FY 1997 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		30 OCT 96

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
FORT SAM HOUSTON, SAN ANTONIO, TX.	ECIP

5. PROGRAM ELEMENT	6. CATAGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
			945.482

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Central Plant Boiler Retrofit - ECO C	EA	1	945.5	945.5
ESTIMATED CONTRACT COST				845.463
CONTINGENCY (0%)				
SIOH				49.291
DESIGN				50.728
TOTAL REQUEST				945.482
TOTAL REQUEST (ROUNDED)				945.000

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Phase 1- Install a new central heating plant near Building 250 where the two existing 726 MBH steam boilers are located. Removal of these boilers will leave enough space where 2 high efficiency modular HW boilers with 2000 MBH capacity each can be installed. Remove the existing boilers identified in Table 1 on Page B-14 of the energy audit report. The secondary pumps serving these boilers are to be reutilized. All existing localized chemical treatment systems for each building will be removed. All existing building HW pumps will be reutilized as secondary pumps, and they will be connected to the new primary loop. A new central chemical treatment system will be installed at Building 250. All new controls and electrical services to serve the new boilers and new primary pumps should be installed at Building 250.

Phase 2 - Remove the existing window units and split system furnaces and install fan/coil units in their place. Also install new secondary pumps to serve the FCUs. Buildings with window units and liquid cooled package units will be retrofitted with new air handling units and fan/coil units (FCUs) having HW coils. New secondary HW pumps will be installed to serve them. There will be a total of 56 window units and 3 split systems will be removed from the buildings identified in Table-2. on Page B-15 of the energy audit report. There will be 56 FCUs and 3 AHUs installed to replace them. Building 123 is served by five gas fired space heaters. They will be removed and replaced with six FCUs. Install 11 new secondary pumps to serve new FCUs and AHUs installed as part of this project.

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PAGE NO.

1. COMPONENT	FY 1997 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		30 OCT 96

3. INSTALLATION AND LOCATION
FORT SAM HOUSTON, SAN ANTONIO, TX.

4. PROJECT TITLE	5. PROJECT NUMBER
ECIP	

11. REQUIREMENT

This project is required to reduce the heating energy consumption in the distributed heating systems serving Area 100 . The project provides a new, more efficient centralized heating system, which will save heating energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these projects will result in the following:

Electrical Energy Savings	57	MMBTU/yr
Electrical Demand Savings	1295	$/yr
Gas Energy Savings	314	MMBTU/yr
Total Energy Savings	371	MMBTU/yr
Total Cost Savings	95,011	$/yr
Total Investment	945,482	$
Simple Payback	9.95	yrs
SIR	1.48	

CURRENT SITUATION:

Phase I - All of the buildings to be renovated are historical buildings. Many of these buildings are served by HW boilers. Most of these boilers are natural draft fire tube boilers which are very inefficient. The efficiency of the boilers ranges from 60% to 70%. They generally appear to be in fair condition, but many older boilers show indications of rusting and leaks. Additionally, the cost of maintaining so many boilers is excessive and difficult for the maintenance staff. One reason is that these boilers are manufactured by several different manufacturers which require large PM and repair part inventory. It is recommended that a central boiler plant, consisting of two 2000 MBH high efficiency modular gas fired HW boilers will be installed. These boilers are 86% efficient under full load conditions, and reaching upwards to 98% efficiency under part load conditions. Moreover, these boilers have the capability to be staged to maintain these part load efficiencies by remote boiler control.

Phase II - Buildings indicated in Table-2 will be furnished with new FCUs and new secondary HW pumps. Their sizes are listed in Table 2. FCUs are selected over the AHUs because of the ease of construction and because of the historical significance of the area. Vertical convector type FCUs can be installed fairly easily in the place of the existing equipment without damaging the antiquity of the buildings. The DX coil split system will be removed from Buildings 127, 144 and 159. New horizontal ceiling mounted fan coils will replace the existing AHUs. Building 123 has five existing furnaces that will be replaced with six FCUs.

IMPACT IF NOT PROVIDED:

If this project is not provided, the heating energy and cost savings mentioned above will continue to be wasted. There will be no contribution to the energy reduction goals established at the facility.

Life Cycle Cost Analysis — Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS — Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-C
Analysis Date: 10/31/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

ECIP Summary Report

1. Investment

A. Construction Cost	$845,463
B. SIOH	$49,291
C. Design Cost	$50,728
D. Total Cost (1A+1B+1C)	$945,482
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$945,482

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	57	Mbtus	$358	15.08	$5,398
Elec. Deman					$0	14.88	$0
Natural Gas	$4.4	/Mbtus	314	Mbtus	$1,378	18.58	$25,612
TOTAL			371	Mbtus	$1,736		$31,010

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECU	$91,980	Annual	14.88	$1,368,662
ANNUAL TOTAL	$91,980			$1,368,662
ONE TIME TOTAL	$0			$0
TOTAL	$91,980			$1,368,662

4. First Year Dollar Savings	$93,716
5. Simple Payback Period (Years)	10.09
6. Total Net Discounted Savings	$1,399,672
7. Savings to Investment Ratio	1.48
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	5.04%

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. C Retrofit Existing Individual Boilers AREA 100

PROJECT NO: 03-185.6C

BY : KOTHMANN, K

DATE: 10/31/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
REMOVE BOILER UP TO 500 MBH	19	EA	24.0	28.91	13,183	500.00	9,500	22,683
REMOVE BOILER 500 MBH AND UP	7	EA	48.0	28.91	9,714	780.00	5,460	15,174
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
5"	6,000	LF	0.9	28.91	156,114	27.50	165,000	321,114
2-1/2"	120	LF	0.5	28.91	1,735	13.33	1,600	3,334
2"	1,520	LF	0.4	28.91	17,577	13.55	20,596	38,173
1-1/2"	540	LF	0.4	28.91	6,245	12.85	6,939	13,184
1"	640	LF	0.35	28.91	6,476	11.55	7,392	13,868
				SUBTOTAL	211,043		216,487	427,530
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.C6		**DATE:** 10/31/96
ECO NO. C Retrofit Existing Individual Boilers AREA 100	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 5"	8	EA	20.0	28.91	4,626	540.00	4,320	8,946
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	500.0	20.00	10,000	9,000.00	9,000	19,000
SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING HW PUMPS PER LOCATION								
2-1/2"	1	LOC	9.6	28.91	278	639.00	639	917
1-1/2" TO 1"	20	LOC	8.0	28.91	4,626	600.00	12,000	16,626
ALL AIR SIDE EQUIPMENT INCLUDED IN ECO B								
ADD PIPING ASSEMBLY &HOT WTR COIL								
VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY	6	EA	10.0	28.91	1,735	1,200.00	7,200	8,935
AHU W/ HW COIL 2-PIPE 2000 CFM	2	EA	14.5	28.91	838	1,100.00	2,200	3,038
				SUBTOTAL	22,102		35,359	57,461
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO TEX	**PROJECT NO:** 03-185.6C	**DATE:** 10/31/96
ECO NO. C Retrofit Individual Boilers AREA 100	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Install New Boiler AERCO # KC 2000 1830 MBH	2	EA	100.00	28.91	5,782	18500.00	37,000	42,782
Install New Pump 10 HP	2	EA	15.00	28.91	867	2800.00	5,600	6,467
pipe Assembly & valves Boiler	2	EA	28.00	28.91	1,619	2400.00	4,800	6,419
pipe Assembly & valves Pump	2	EA	12.00	28.91	694	1350.00	2,700	3,394
Boiler Breaching	1	JOB	50.00	28.91	1,446	2500.00	2,500	3,946
Controls	1	JOB	160.00	28.91	4,626	6900.00	6,900	11,526
Electrical	1	JOB	100.00	28.91	2,891	5900.00	5,900	8,791
Chemical Shot Feed	1	JOB	16.00	28.91	463	1500.00	1,500	1,963
Test , Balance & Start-up	1	LS	160.00	28.91	4,626			4,626
				SUBTOTAL	23,012		66,900	89,912
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6C	DATE: 10/31/96
ECO NO. C Retrofit Existing Individual Boilers AREA 100	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE TWO 52497 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE GAS FIRED SPACE HTR	5	EA	4.0	22.00	440	10.00	50	490
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
1"	1,100	LF	0.3	28.91	10,176	10.65	11,715	21,891
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	250	LF	0.5	28.91	3,614	7.05	1,763	5,376
1-1/2"	525	LF	0.4	28.91	6,071	5.05	2,651	8,722
1"	1,000	LF	0.3	28.91	8,673	4.38	4,380	13,053
3/4"	2,100	LF	0.3	28.91	18,213	2.75	5,775	23,988
SUBTOTAL					47,187		26,334	73,521
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6C | **DATE:** 10/31/96

ECO NO. C Retrofit Existing Individual Boilers AREA 100 | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE TWO 52497 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , HW ENTRY PIPING ASSEMBLY 1"	11	LOC	14.0	28.91	4,452	1,300.00	14,300	18,752
AND NEW HOT WTR PUMPS COST PER LOCATION								
ALL AIR SIDE EQUIPMENT INCLUDED IN ECO B								
ADD PIPING ASSEMBLY & HOT WTR COIL								
3/4" CONTROL VALVE 2- WAY	3	EA	4.0	28.91	347	595.00	1,785	2,132
1/2" " " 3-WAY	7	EA	4.0	28.91	809	475.00	3,325	4,134
1/2" " " 2 - WAY	55	EA	4.0	28.91	6,360	450.00	24,750	31,110
SUB TOTAL FROM SHEET 1					211,043		216,487	427,530
SUB TOTAL FROM SHEET 2					22,102		35,359	57,461
SUB TOTAL FROM SHEET 3					23,012		66,900	89,912
SUB TOTAL FROM SHEET 4					47,187		26,334	73,521
SUBTOTAL					315,313		389,239	704,553
O & P @ 20%					63,063		77,848	140,911
SUBTOTAL					378,376		467,087	845,463
DESIGN @ 6%								50,728
SUBTOTAL								896,191
SIOH @ 5.5%								49,291
TOTAL								$945,481

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6MA	DATE: 10/31/96
ECO NO. C Retrofit Existing BOILERS	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 100

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON								
OUTSIDE CONTRACT COSTS PER BOILER PER YEAR								
EXISTING BOILER	-21.	EA	100.0	30.00	-63,000	1,800.00	-37,800	-100,800
NEW EQUIPMENT								
AERCO MODULAR HIGH EFFICIENCY HW BOILER	2.	EA	80.0	30.00	4,800	1,500.00	4,020	8,820
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-58,200		-33,780	-91,980
PER YEAR								

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APPENDIX A
ENERGY COST ANALYSIS

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APPENDIX A
ENERGY COST ANALYSIS

A. Electrical Energy Cost Analysis

Electrical Rate Schedule: The post purchases it's electrical power from the City Public Service (CPS) of San Antonio, and is billed under the Super Large Power (SLP) rate. Service is provided through a single substation on the post, owned by the Army. The SLP rate has been in effect since January of 1994, and was created by the utility company to lower military base charges, thereby helping to avoid base closures. This rate has resulted in substantial cost decreases, even though the electrical usage on the post has increased. The monthly SLP billing rate components are as follows:

Service Availability Charge:	$1,000	
Energy Charge:	$0.024/KWH	
Demand Charge:	$10.00/KW billing demand	(June through September)
	$7.50/KW billing demand	(October through May)
where:	billing demand is the highest 15 minute metered KW demand during the month, or 5000 KW, or 80% of highest billing demand from previous June through September (applicable only from October through May), whichever is greatest	
Fuel Cost Adjustment:	calculated monthly, difference between actual fuel cost and $0.016/KWH (average variance from base year data is -$0.002566/KWH)	

Avoided Costs: In order to convert electric demand and energy savings into dollar savings, the avoided costs of demand and energy are determined. These are the marginal cost savings to be realized by the post, per unit of demand or energy saved. Using the above billing components, the *Avoided Cost of Demand* (C_{SD} & C_{WD}) and the *Avoided Cost of Energy* (C_E) are determined as follows:

$$C_{SD} = \frac{\$10.00}{KW} \quad (June\ through\ September)$$

$$C_{WD} = \frac{\$7.50}{KW} \quad (October\ through\ May)$$

$$C_E = (E + F) \times \frac{KWH}{3413\ BTU} \times \frac{1{,}000{,}000\ BTU}{MMBTU} \qquad \frac{\$}{MMBTU}$$

where,

E = energy charge = $0.024/KWH
F = fuel cost factor = -$0.002566/KWH

$$C_E = (0.024 - 0.002566) \times \frac{1{,}000{,}000}{3413} = \frac{\$6.28}{MMBTU}$$

Rebate Program: The City Public Service of San Antonio currently offers no cash incentives for energy conservation retrofits.

B. Natural Gas Energy Cost Analysis

Gas Rate Schedules: FSH is currently supplied natural gas by CPS through many meters distributed throughout the post. There are three primary rate structures that the CPS uses for billing at Fort Sam Houston and they are: rates G (04), B (10), and LVG (18). In general, the rates are tiered according to the capacity of the meter being served as follows:

Rate	Capacity (MCF)
G (04)	0-57
B (10)	57.1-500
LVG (18)	500.1& Above

For the purposes of this study, CPS currently bills all of the buildings included in this study on the first two (2) rates (G & B).

All of the buildings in the area 100 and bldgs. 1001, 1396, 1398, 2200, 2244, 2247, 2248, 2250, 2270, 2272, and 2273 have individual gas meters and are billed under the General Service Gas (G) rate # 04. The monthly G billing rate components are as follows:

Service Availability Charge:	$3.85
Energy Charge:	$4.38/MCF
Fuel Adjustment:	calculated monthly, difference between actual gas cost and $2.20/MCF (average variance from base year data is $0.0142/MCF)

The remainder of the buildings in this study are billed under a third rate (B) # 10 which is used for heating and cooling plants that do not fall under the LVG rate. The monthly B billing rate components are as follows:

Service Availability Charge:	$28.00
Energy Charge:	$3.94/MCF for first 600 MCF $3.45/MCF for all additional MCF
Fuel Adjustment:	calculated monthly, difference between actual gas cost and $2.20/MCF (average variance from base year data is $0.0142/MCF)

Avoided Costs: In order to convert gas energy savings or penalties into cost savings or penalties, the *Avoided Cost of Gas* (C_G) is determined for each area as described above as follows:

Area 100,

$$C_G = (E + F) x \frac{1\ MCF}{MMBTU} \quad \frac{\$}{MMBTU}$$

where,

E = energy charge = $4.38 MCF
F = fuel adjustment = $0.0142 per MCF (average from base year data)

$$C_G = (4.38 + 0.0142) = 4.39 \frac{\$}{MMBTU}$$

Area 500,

$$C_G = (E + F) x \frac{1\ MCF}{MMBTU} \quad \frac{\$}{MMBTU}$$

where,

E = energy charge = $3.45 MCF
F = fuel adjustment = $0.0142 per MCF (average from base year data)

$$C_G = (3.45 + 0.0142) = 3.46 \frac{\$}{MMBTU}$$

Note: The avoided cost for this area was calculated using the upper tier of the rate structure (consumption > 600 MCF) because it was determined from actual bills that the savings will occur in the upper tier.

Area 1000,

$$C_G = (E + F) x \frac{1\ MCF}{MMBTU} \quad \frac{\$}{MMBTU}$$

where,

E = energy charge = $3.45 MCF
F = fuel adjustment = $0.0142 per MCF (average from base year data)

$$C_G = (3.45 + 0.0142) = 3.46 \frac{\$}{MMBTU}$$

Note: The avoided cost for this area was calculated using the upper tier of

the rate structure (consumption > 600 MCF) because it was determined from actual bills that most of the savings will occur in the upper tier. There will be some savings associated with Rate G, but it is negligible compared to the total consumption savings.

Area 1300,

$$C_G = (E + F) x \frac{1\ MCF}{MMBTU} \quad \frac{\$}{MMBTU}$$

where,

E = energy charge = $3.45 MCF
F = fuel adjustment = $0.0142 per MCF (average from base year data)

$$C_G = (3.45 + 0.0142) = 3.46 \frac{\$}{MMBTU}$$

Note: The avoided cost for this area was calculated using the upper tier of the rate structure (consumption > 600 MCF) because it was determined from actual bills that most of the savings will occur in the upper tier. There will be some savings associated with Rate G, but it is negligible compared to the total consumption savings.

Area 2200,

$$C_G = (E + F) x \frac{1\ MCF}{MMBTU} \quad \frac{\$}{MMBTU}$$

where,

E = energy charge = $3.45 MCF
F = fuel adjustment = $0.0142 per MCF (average from base year data)

$$C_G = (3.45 + 0.0142) = 3.46 \frac{\$}{MMBTU}$$

Note: The avoided cost for this area was calculated using the upper tier of the rate structure (consumption > 600 MCF) because it was determined from actual bills that most of the savings will occur in the upper tier. There will be some savings associated with Rate G, but it is negligible compared to the total consumption savings.

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	O
DATE:	3/1/96
ECO TITLE:	Replace Existing Central Boilers With High Efficiency Modular Boilers
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 2200, Building 2265 (serving 2200, 2244, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272, and 2273)

A. Summary:

Electrical Energy Savings	7	MMBTU/yr
Electrical Demand Savings	-171	$/yr
Gas Energy Savings	803	MMBTU/yr
Total Energy Savings	796	MMBTU/yr
Total Cost Savings	39,431	$/yr
Total Investment	311,340	$
Simple Payback	7.9	yrs
SIR	1.92	

B. ECO Description:

Remove the existing boilers as listed below in Figure-1. Also, remove the three 15 HP heating water (HW) distribution pumps in building 2265. The existing building pumps will be reutilized as secondary pumps. Install 3 modular high efficiency 2000 MBH HW boilers and three 7.5 HP primary HW pumps (172 GPM at 110 ft hd) in an addition to the central plant serving building 2200. Along with the boilers, provide stainless steel flues and gas regulators for each boiler. HW to all buildings listed in Table 1 will be provided through two separate loops of direct buried primary HW piping. One 3" loop will branch from the 6" main in the boiler plant and serve buildings 2244, 2247, 2248, 2250, 2270, 2272, and 2273. The second 5" loop will also extend from the 6" main in the boiler plant and tap into the existing HW loop serving buildings 2263, 2264, 2265, and 2266 just outside of the existing chiller plant serving these buildings. Approximately 800 ft. of 3", and 400 ft of 5" under ground piping will be required for these loop. Expand the existing central plant of building 2200 from the north wall and add an additional 750 sq ft. space. All buildings AHUs and fan/coil units will be retrofitted with new two way control valves. A HW temperature reset controller will be installed in the plant to improve HW system efficiency. All new controls gas and electrical services will be installed for the new equipment in Building 2200 to serve the new boilers and pumps. Specific requirements in these areas should be determined by the design engineer responsible for this project. The boilers and pumps should be sequenced to operate only as needed to maintain the supply water temperature set-point of approximately 180°F. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing boilers and pumps, and installation of the new boilers, pumps, associated wiring and controls.

Figure 1

Bldg. #	Quantity	Description	Size MBH	Flow GPM	Estimated Pipe Size inches	Extimated Pipe Length Feet
2200	1	HW boiler	831.7	68	1.5	70
2244	1	HW boiler	112.2	15	1	70
2247	1	HW boiler	128.5	15	1	70
2248	1	HW boiler	679	60	1.5	70
2270	2	HW boiler	550	110	2	70
2272	1	HW boiler	388	120	2	70
Total	7	HW boiler	3239.4	388	N/A	N/A

C. Discussion:

All heating equipment is located in different locations with each being remote to the other. All of these boilers appear to be in fair condition. However, the cost of maintaining these boilers is excessive. Therefore, it is recommended that three 2,000 MBH high efficiency gas fired high efficiency modular HW boilers be installed. These boilers are 86% efficient under full load conditions, and reach up to 98% efficiency under part load conditions. Also, they have the capability to be staged to maintain these part load efficiencies by remote boiler control. In retrofit projects such as this, the size of these boilers make it very economical and justifiable because of their ease of installation. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. Three primary pumps will also provide additional flexibility in staging. Existing outside temperature reset controller and necessary three way mixing valves on each secondary HW loop will be calibrated to enhance HW system efficiency. All AHUs and fan/coil units three way control valves will be converted to two way valves. The central plant serving Building 2200 is centrally located to serve the rest of the buildings in this area. Therefore, the existing boiler room at Building 2200 will be expanded to house the new equipment. Computer simulations of the four buildings served by these boilers determined that the current combined capacity of 13,322 MBH is much more than the amount required to adequately heat the buildings[1]. The existing boilers are therefore operating at an inefficient, low load condition most of the time. Also, because of the constant flow rate requirements of the boilers, excessive pumping energy is expended. By staging three new high efficiency modular boilers to operate only as needed, a substantial energy savings can be obtained. Also, a decrease in the combined boiler output capacity to 4,695 MBH is recommended to more closely match the heating load in the buildings and reduce the associated pumping energy consumption.

D. Savings Calculations:

The monthly peak demand and energy consumptions of the existing and proposed boilers and HW pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3].

Full and part load performance data from Aerco International were used in the computer simulations of the new boiler energy usages[4]. An equipment list with specific data on the new boilers and pumps used in the computer simulation is shown on page B-4.

Once the computer simulations of the existing and new boiler systems were completed, the total annual demand cost and energy consumption of the new systems were compared with that of the existing systems to determine the annual savings[5]. These savings calculations are shown on pages B-5 through B-6. The demand and energy savings values were used in the life cycle cost analysis for this ECO.

E. Cost Estimates

The total installation costs for this ECO were estimated on pages B-7 through B-10. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page B-11. The data from the life cycle cost analysis were included in the summary on page B-1.

REFERENCES

1. See Appendix H for Area 2200 heating system load profile.

2. See Appendix H for computer model input assumptions and data, and energy consumption output data.

3. See Appendix G for building field data and existing HVAC system data.

4. See Appendix F for manufacturer's equipment performance data from Aerco International.

5. See Appendix A for utility cost analysis data, used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-O, FORT SAM HOUSTON, AREA 2200 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Hot Water Boiler	3	Aerco #KC-2000 GWB natural draft, watertube 1830 MBH output	Area 2200	New	2,000 MBH
Heating Water Pump	3	Bell and Gossett 172 gpm, 150 ft 15 HP	Area 2200	New	11.20 KW

ITEM	ECO O - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
HW boiler (2263) blr-1														1,568
HW pump (2263) blr-1	11.2	11.2	11.2	11.2							11.2	11.2	48653.0	
HW controls (2263) blr-1	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW pump (2263) blr-1	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
HW boiler (2263) blr-2														28
HW pump (2263) blr-2	11.2	11.2										11.2	1,154	
HW controls (2263) blr-2	0.1	0.1										0.1	13	
HW pump (2263) blr-2	0.6	0.6										0.6	70	
HW boiler (2263) blr-3														
HW pump (2263) blr-3														
HW controls (2263) blr-3														
HW pump (2263) blr-3	0.6	0.6										0.6	12	
HW boiler (2200)														727
HW controls (2200)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	543	
HW boiler (2244)														
HW controls (2244)														
Steam boiler (2247)														158
Steam boiler controls (2247)	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW boiler (2248,50)														144
HW controls (2248,50)	0.1	0.1	0.1	0.1							0.1	0.1	313	
HW boiler (2270) blr-1														1,396
HW controls (2270) blr-1	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW boiler (2270) blr-2														3
HW controls (2270) blr-2		0.1										0.1	11	
HW boiler (2272,73)														112
HW controls (2272,73)	0.1	0.1	0.1	0.1							0.1	0.1	317	
Totals	24.9	25.0	12.4	12.4	0.1	0.1	0.1	0.1	0.1	0.1	12.4	25.0	55,148	4,134
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	187	188	93	93	1	1	1	1	1	1	93	188		

Total Demand	846	$/yr	
Total Energy	188	MMBTU/yr	(electric)
Total Energy	4,134	MMBTU/yr	(gas)

ITEM	ECO-O: INSTALL HIGH EFFICIENCY MODULAR BOILERS MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
High % modular boiler														2,958
HW pump	11.2	11.2	11.2	11.2							11.2	11.2	48,653	
HW controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
High % modular boiler														365
HW pump	11.2	11.2										11.2	3,248	
HW controls	0.1	0.1										0.1	36	
High % modular boiler														8
HW pump	11.2	11.2										11.2	605	
HW controls	0.1	0.1										0.1	7	
Total (KW)	33.9	33.9	11.3	11.3							11.3	33.9	53,092	3,331
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	254	254	85	85							85	254		

Total Demand	1,017	$/yr	
Demand Savings	-171	$/yr	
Energy Savings	7	MMBTU/yr	(electric)
Energy Savings	803	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.60	**DATE:** 3/2/96
ECO NO. O Retrofit Individual Boilers AREA 2200	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
AREA 2200

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
REMOVE BOILER	7	EA	90.0	28.91	18,213	780.00	5,460	23,673
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
3"	800	LF	0.6	28.91	13,877	15.70	12,560	26,437
5"	400	LF	1.04	28.91	12,027	29.50	11,800	23,827
SCH 40 BKL STL PIPE W/ FTGS HNGRS & INSULATION								
2"	100	LF	0.5	28.91	1,446	7.05	705	2,151
1-1/2"	50	LF	0.4	28.91	578	5.05	253	831
1"	50	LF	0.3	28.91	434	4.38	219	653
3/4"	100	LF	0.3	28.91	954	2.75	275	1,229
				SUBTOTAL	47,528		31,272	78,800
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.60	**DATE:** 3/2/96
ECO NO. O Retrofit Individual Boilers AREA 2200	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
AREA 2200

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 3"	2	EA	7.0	28.91	405	475.00	950	1,355
SECTIONALIZING VALVE AND BOX 5"	2	EA	8.0	28.91	463	540.00	1,080	1,543
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	150.0	20.00	3,000	2,000.00	2,000	5,000
SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY AND CONNECT TO EXISTING HW PUMPS PER LOCATION								
2"	1	LOC	9.6	28.91	278	639.00	639	917
REPLACE 3-WAY CONTROL VALVES WITH 2-WAY	71	EA	4.0	28.91	8,210	350.00	24,850	33,060
SUBTOTAL					12,355		29,519	41,874
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO TEX	PROJECT NO: 03-185.60	DATE: 3/2/96
ECO NO. O Retrofit Existing Boilers AREA 2200	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
AREA 2200

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Install New Boiler AERCO # KC 2000 1830 MBH	3	EA	100.00	28.91	8,673	18500.00	55,500	64,173
Install New Pump 5 HP	1	EA	10.00	28.91	289	1100.00	1,100	1,389
Install New Pump 10 HP	3	EA	15.00	28.91	1,301	2800.00	8,400	9,701
pipe Assembly & valves Boiler	3	EA	28.00	28.91	2,428	2400.00	7,200	9,628
pipe Assembly & valves Pump	4	EA	7.00	28.91	809	600.00	2,400	3,209
Boiler Breaching	3	JOB	30.00	28.91	2,602	2000.00	6,000	8,602
Controls	1	JOB	90.00	28.91	2,602	3900.00	3,900	6,502
Electrical	1	JOB	80.00	28.91	2,313	3500.00	3,500	5,813
Test , Balance & Start-up	1	LS	80.00	28.91	2,313			2,313

SUBTOTAL	23,330		88,000	111,330
O & P @ 20%				
SUBTOTAL				
DESIGN @ 6%				
SUBTOTAL				
SIOH @ 5.5%				
TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.60	DATE: 3/2/96
ECO NO. O Retrofit Existing Boilers AREA 2200	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
AREA 2200

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					47,528		31,272	78,800
SUB TOTAL FROM SHEET 2					12,355		29,519	41,874
SUB TOTAL FROM SHEET 3					23,330		88,000	111,330
SUBTOTAL					83,214		148,791	232,004
O & P @ 20%					16,643		29,758	46,401
SUBTOTAL					99,856		178,549	278,405
DESIGN @ 6%								16,704
SUBTOTAL								295,109
SIOH @ 5.5%								16,231
TOTAL								$311,340

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6MA	DATE: 3/2/96
ECO NO. O Retrofit Existing BOILERS	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 2200

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON								
OUTSIDE CONTRACT COSTS PER BOILER PER YEAR								
EXISTING BOILER	-10.	EA	100.0	30.00	-30,000	1,800.00	-18,000	-48,000
NEW EQUIPMENT								
AERCO MODULAR HIGH EFFICIENCY HW BOILER	3.	EA	80.0	30.00	7,200	1,500.00	4,020	11,220
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-22,800		-13,980	-36,780
PER YEAR								

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Life Cycle Cost Analysis Study: FSH-3.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-O
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: JOHN CARTER

ECIP Summary Report

1. Investment

A. Construction Cost	$278,405
B. SIOH	$16,231
C. Design Cost	$16,704
D. Total Cost (1A+1B+1C)	$311,340
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$311,340

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	7	Mbtus	$44	15.08	$663
Elec. Deman					-$171	14.88	-$2,544
Natural Gas	$3.5	/Mbtus	803	Mbtus	$2,778	18.58	$51,622
TOTAL			810	Mbtus	$2,651		$49,741

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$36,780	Annual	14.88	$547,286
ANNUAL TOTAL	$36,780			$547,286
ONE TIME TOTAL	$0			$0
TOTAL	$36,780			$547,286

4. First Year Dollar Savings	$39,431
5. Simple Payback Period (Years)	7.9
6. Total Net Discounted Savings	$597,027
7. Savings to Investment Ratio	1.92
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	6.41%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	C
DATE:	3/1/96
ECO TITLE:	Retrofit Existing Individual Boilers With Central Boiler Plant
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 100 (serving buildings 122, 123, 124, 125, 126, 127, 128, 129, 131,133, 134, 135, 140, 141,142, 143, 144,145, 146, 147, 149, 151, 152, 154, 155, 156, 157, 158, 159, 197, 198, 199, 250, 260, and 261)

A. Summary:

Electrical Energy Savings	57	MMBTU/yr
Electrical Demand Savings	1295	$/yr
Gas Energy Savings	314	MMBTU/yr
Total Energy Savings	371	MMBTU/yr
Total Cost Savings	95,011	$/yr
Total Investment	945,482	$
Simple Payback	9.95	yrs
SIR	1.48	

B. ECO Description:

Phase 1- Install a new central heating plant near Building 250 where the two existing 726 MBH steam boilers are located. Removal of these boilers will leave enough space where 2 high efficiency modular HW boilers with 2000 MBH capacity each can be installed. New stainless steel flues will be installed to remove combustion gases from the boilers. Two 10 HP primary HW pumps selected at 172 GPM and 120 ft. Head will be installed to serve the buildings listed in Table 1. HW will be provide through a direct buried 5" primary HW supply and return piping loop from this plant. This primary HW loop will run parallel with the new primary CHW lines and split behind Building 155. The first branch will be extended up to Building 198, and the second branch be will be extended to Building 261. The estimated length of the distribution loop will be 6000 ft. Remove the boilers as listed in Table-1. The secondary pumps serving these boilers are to be reutilized and their approximate pipe sizes and estimated lengths are listed in Table-1. All existing localized chemical treatment systems for each building will be removed. All existing building HW pumps will be reutilized as secondary pumps, and they will be connected to the new primary loop. A new central chemical treatment system will be installed at Building 250. All new controls and electrical services to serve the new boilers and new primary pumps should be installed at Building 250. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new boilers and associated wiring and controls.

Table-1

Bldg. #	Quantity	Description	Size MBH	Flow GPM	Estimated Pipe Size inches	Extimated Pipe Length Feet
122	1	HW Boiler	618	62	1.5	60
126	1	HW Boiler	587	59	1.5	60
128	1	HW Boiler	109	11	1	70
129	1	HW Boiler	129	13	1	60
131	1	HW Boiler	201	21	1	60
133	1	HW Boiler	109	11	1	70
134	1	HW Boiler	596	60	1.5	60
142	1	HW Boiler	327	33	1.25	60
143	1	HW Boiler	596	60	1.5	60
144	1	HW Boiler	596	60	1.5	60
146	1	HW Boiler	596	60	1.5	60
147	1	HW Boiler	596	60	1.5	75
149	1	HW Boiler	596	60	1.5	60
155	1	HW Boiler	47.17	48	1.5	60
156	1	HW Boiler	125.1	13	1	60
197	1	HW Boiler	1400	140	2.5	60
198	1	HW Boiler	327	33	1	70
199	1	HW Boiler	145	15	1	70
250	2	Steam Boilers	726	73	1.5	80
260	1	HW Boiler	47.4	10	1	80
Total	21	HW Equipment	9200	975	N/A	N/A

Phase 2 - Remove the existing window units and split system furnaces as shown in Table-2 and install fan/coil units in their place. Also install new secondary pumps to serve the FCUs. Buildings with window units and liquid cooled package units will be retrofitted with new air handling units and fan/coil units (FCUs) having HW coils. New secondary HW pumps will be installed to serve them. There will be a total of 56 window units and 3 split systems will be removed from the buildings listed in Table-2. There will be 56 FCUs and 3 AHUs installed to replace them. Building 123 is served by five gas fired space heaters. They will be removed and replaced with six FCUs. Approximately 250 ft. of 2", 525 ft. of 1.5", 1000 ft. of 1.0" and 2100 ft. of 0.75" piping will be required to feed HW to these new FCUs and AHUs. Approximately 55 each ½" two way, 7 each ½" three way, 3 each 3/4" two way control valves and 62 electric thermostats will be required. Install 11 new secondary pumps to serve new FCUs and AHUs as indicated in Table-2.

Table-2

Bldg. #	Quantity	Description	Size MBH	Flow GPM	Estimated Secondary Pump Size GPM	HP
123	5	space heaters	700	70	70	1.5
127	1	furnace	33	4	4	0.125
141	2	window units	34.6	4	4	0.125
144	1	Terminal unit	40	4	4	0.125
145	23	window units	515.2	52	52	1.5
151	2	window units	34.6	4	4	0.125
155	8	window units	138.4	14	14	0.5
154	4	window units	69.2	8	8	0.25
157	2	window units	33.3	4	4	0.125
158	16	window units	149.2	15	15	0.5
159	1	furnace	16.7	3	3	0.125

This ECO includes the implementation of both Phases I and II. If Phase 2 is not implemented install piping stub outs with cutoff valves on the primary HW loop for future HW conversion of the listed buildings in Table 2.

A. Discussion:

Phase 1 - All of the above buildings are historical buildings. Many of these buildings are served by HW boilers. Most of these boilers are natural draft fire tube boilers which are very inefficient. The efficiency of the boilers ranges from 60% to 70%. They generally appear to be in fair condition, but many older boilers show indications of rusting and leaks. Additionally, the cost of maintaining so many boilers is excessive and difficult for the maintenance staff. One reason is that these boilers are manufactured by several different manufacturers which require large PM and repair part inventory. It is recommended that a central boiler plant, consisting of two 2000 MBH high efficiency modular gas fired HW boilers will be installed. These boilers are 86% efficient under full load conditions, and reaching upwards to 98% efficiency under part load conditions. Moreover, these boilers have the capability to be staged to maintain these part load efficiencies by remote boiler control. Another advantage of the modular boiler is its compactness. The size of the boilers make it very economical in replacement projects that require tight space constraints. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. This will save heating energy and greatly reduce the maintenance cost of the installation.

Phase II - Buildings indicated in Table-2 will be furnished with new FCUs and new secondary HW pumps. Their sizes are listed in Table 2. FCUs are selected over the AHUs because of the ease of construction and because of the historical significance of the area. Vertical convector type FCUs can be installed fairly easily in the place of the existing equipment without damaging the antiquity of the buildings.

The DX coil split system will be removed from Buildings 127, 144 and 159. New horizontal ceiling mounted fan coils will replace the existing AHUs. Building 123 has five existing furnaces that will be replaced with six FCUs.

Computer simulations of the buildings in this area determined that the current installed capacity of 11,089 MBH is more than required to adequately heat the buildings[1]. Therefore it is recommended that two new boilers rated at a combined 4,000 MBH to more closely match the heating load of the buildings be installed.

B. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed boilers and pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3].

The 2000 MBH high efficiency modular boilers have better part load performance ratings than larger firetube or watertube boilers. Moreover, the ease of retrofitting existing equipment with these smaller footprint boilers makes them very cost effective. Full and part load performance data from Aerco Incorporated were used in the computer simulations of the new boiler energy usage. An equipment list of the specific boiler and pumps modeled for the new central plant is shown on page B-18.

Once the computer simulations of the existing and new boiler plants were completed, the total annual energy consumption of the new central plant was compared with that of the existing individual systems to determine the annual savings for this ECO. These savings calculations are shown on pages B-19 through B-21. These energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of boilers, window units, unit heaters, and gas fired furnaces in this area down to two modular boilers. The total maintenance cost savings from this ECO is estimated to be $91,980 per year as shown on page B-27 . This figure was used in the life cycle cost analysis.

C. Cost Estimates:

The total installation costs for the new central chiller plant were estimated on pages B-22 through B-26. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page B-28. The data from the summary sheet were presented in the ECO summary on page B-13.

REFERENCES

1. See Appendix H for Area 100 heating system thermal profile.

2. See Appendix A for utility cost analysis data used in the savings calculations.

3. See Appendix G for building field data and existing HVAC field data.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-C, FORT SAM HOUSTON, AREA 100 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Hot Water Boiler	2	Aerco #KC-2000 GWB natural draft, watertube 1830 MBH output	Area 2200	New	2,000 MBH
Heating Water Pump	2	Bell & Gossett 172 gpm, 110 ft 10 HP	Area 2200	New	7.50 KW

ITEM	ECO C - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldgs. 122 & 140 Boiler														175
Bldgs. 122 & 140 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	372	
Bldgs. 124 & 125 Boiler														164
Bldgs. 124 & 125 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	369	
Bldg. 128 Boiler														0
Bldg. 128 HW Controls	0	0	0	0							0	0	0	
Bldg. 133 Boiler														160
Bldg. 133 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 133 Boiler Fan	3.7	3.7	3.7	3.7							3.7	3.7	16,203	
Bldgs. 134 & 135 Boiler														46
Bldgs. 134 & 135 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	218	
Bldg. 143 Boiler														96
Bldg. 143 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	322	
Bldg. 144 Boiler														96
Bldg. 144 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	322	
Bldg. 145 Furnace	13.7	14.6	9.3	1.5							8.3	13.9	8,840	
Bldg. 146 Boiler														91
Bldg. 146 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	305	
Bldg. 147 Boiler														52
Bldg. 147 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	211	
Bldg. 149 Boiler														52
Bldg. 149 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	211	
Bldg. 197 Boiler														67
Bldg. 197 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	134	
Bldg. 198 Boiler														29
Bldg. 198 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	180	
Bldg. 199 Boiler														86
Bldg. 199 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 127 Furnace														14
Bldg. 127 Furnace Fan	0.7	0.7	0.7	0.7							0.7	0.7	3,154	
Bldg. 250 Boiler														103
Bldg. 250 Boiler Controls	0.1	0.1	0.1	0.1							0.1	0.1	300	
Bldg. 142 Boiler														0
Bldg. 142 HW Controls	0.0	0.0	0.0	0.0							0.0	0.0	0	
Bldg. 123 Unit Heater														43
Bldg. 123 Unit Heater Fan	0.2	0.2	0.2	0.2							0.2	0.2	403	
Bldg. 126 Boiler														94
Bldg. 126 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	230	
Bldg. 131 Boiler														98
Bldg. 131 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 129 Boiler														40
Bldg. 129 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 151 Resistance Heater	3.4	3.6	1.3	0.2							1.5	3.4	2,866	
Bldg. 154 Resistance Heater	5.4	5.8	3.0	0.3						0.7	2.8	5.5	6,203	
Bldg. 156 Boiler														33
Bldg. 156 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	313	
Bldg. 157 Unit Heater														13

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ITEM	ECO C - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 157 Unit Heater Fan	15.0	13.0	15.0	14.0							14.0	15.0	87	
Bldg. 159 Unit Heater														0
Bldg. 159 Unit Heater Fan	0.0	0.0	0.0	0.0							0.0	0.0	0	
Bldg. 152 Unit Heater														89
Bldg. 152 Unit Heater Fan	0.1	0.1	0.1	0.1							0.1	0.1	599	
Bldg. 155 Boiler														32
Bldg. 155 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 158 Unit Heater														56
Bldg. 158 Unit Heater Fan	0.2	0.2	0.2	0.2							0.2	0.2	500	
Bldg. 141 Resistance Heater	3.7	3.7	2.1	0.2							2.1	3.7	4,295	
Bldgs. 260 & 261 Boiler														25
Bldgs. 260 & 261 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 268 Boiler														83
Bldg. 268 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Totals	48.1	47.6	37.6	23.1						0.7	35.6	48.4	50,438	1,835
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	361	357	282	173						5	267	363		

Total Demand	1,808	$/yr	
Total Energy	172	MMBTU/yr	(electric)
Total Energy	1,835	MMBTU/yr	(gas)

ITEM	ECO-C: NEW BOILER PLANT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
High % modular boiler														1,499
HW pump	7.5	7.5	7.5	7.5							7.5	7.5	32,580	
HW controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
High % modular boiler														21
HW pump	7.5	7.5										7.5	713	
HW controls	0.1	0.1										0.1	12	
Total (KW)	15.2	15.2	7.6	7.6							7.6	15.2	33,848	1,520
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	114	114	57	57							57	114		

Total Demand	513	$/yr	
Demand Savings	1,295	$/yr	
Energy Savings	57	MMBTU/yr	(electric)
Energy Savings	314	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6C		**DATE:** 9/18/96
ECO NO. C Retrofit Existing Individual Boilers AREA 100	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
REMOVE BOILER UP TO 500 MBH	19	EA	24.0	28.91	13,183	500.00	9,500	22,683
REMOVE BOILER 500 MBH AND UP	7	EA	48.0	28.91	9,714	780.00	5,460	15,174
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
5"	6,000	LF	0.9	28.91	156,114	27.50	165,000	321,114
2-1/2"	120	LF	0.5	28.91	1,735	13.33	1,600	3,334
2"	1,520	LF	0.4	28.91	17,577	13.55	20,596	38,173
1-1/2"	540	LF	0.4	28.91	6,245	12.85	6,939	13,184
1"	640	LF	0.35	28.91	6,476	11.55	7,392	13,868
				SUBTOTAL	211,043		216,487	427,530
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.C6		**DATE:** 9/18/96
ECO NO. C Retrofit Existing Individual Boilers AREA 100	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 5"	8	EA	20.0	28.91	4,626	540.00	4,320	8,946
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	500.0	20.00	10,000	9,000.00	9,000	19,000
SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING HW PUMPS PER LOCATION								
2-1/2"	1	LOC	9.6	28.91	278	639.00	639	917
1-1/2" TO 1"	20	LOC	8.0	28.91	4,626	600.00	12,000	16,626
ALL AIR SIDE EQUIPMENT INCLUDED IN ECO B								
ADD PIPING ASSEMBLY &HOT WTR COIL								
VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY	6	EA	10.0	28.91	1,735	1,200.00	7,200	8,935
AHU W/ HW COIL 2-PIPE 2000 CFM	2	EA	14.5	28.91	838	1,100.00	2,200	3,038
				SUBTOTAL	22,102		35,359	57,461
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO TEX	PROJECT NO: 03-185.6C	DATE: 9/18/96
ECO NO. C Retrofit Individual Boilers AREA 100	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Install New Boiler AERCO # KC 2000 1830 MBH	2	EA	100.00	28.91	5,782	18500.00	37,000	42,782
Install New Pump 10 HP	2	EA	15.00	28.91	867	2800.00	5,600	6,467
pipe Assembly & valves Boiler	2	EA	28.00	28.91	1,619	2400.00	4,800	6,419
pipe Assembly & valves Pump	2	EA	12.00	28.91	694	1350.00	2,700	3,394
Boiler Breaching	1	JOB	50.00	28.91	1,446	2500.00	2,500	3,946
Controls	1	JOB	160.00	28.91	4,626	6900.00	6,900	11,526
Electrical	1	JOB	100.00	28.91	2,891	5900.00	5,900	8,791
Chemical Shot Feed	1	JOB	16.00	28.91	463	1500.00	1,500	1,963
Test , Balance & Start-up	1	LS	160.00	28.91	4,626			4,626
SUBTOTAL					23,012		66,900	89,912
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6C	DATE: 9/18/96
ECO NO. C Retrofit Existing Individual Boilers AREA 100	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE TWO 52497 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 4	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE GAS FIRED SPACE HTR	5	EA	4.0	22.00	440	10.00	50	490
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
1"	1,100	LF	0.3	28.91	10,176	10.65	11,715	21,891
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	250	LF	0.5	28.91	3,614	7.05	1,763	5,376
1-1/2"	525	LF	0.4	28.91	6,071	5.05	2,651	8,722
1"	1,000	LF	0.3	28.91	8,673	4.38	4,380	13,053
3/4"	2,100	LF	0.3	28.91	18,213	2.75	5,775	23,988
SUBTOTAL					47,187		26,334	73,521
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6C | **DATE:** 9/18/96

ECO NO. C Retrofit Existing Individual Boilers AREA 100 | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE TWO 52497 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , HW ENTRY PIPING ASSEMBLY 1"	11	LOC	14.0	28.91	4,452	1,300.00	14,300	18,752
AND NEW HOT WTR PUMPS COST PER LOCATION								
ALL AIR SIDE EQUIPMENT INCLUDED IN ECO B								
ADD PIPING ASSEMBLY & HOT WTR COIL								
3/4" CONTROL VALVE 2- WAY	3	EA	4.0	28.91	347	595.00	1,785	2,132
1/2" " " 3-WAY	7	EA	4.0	28.91	809	475.00	3,325	4,134
1/2" " " 2 - WAY	55	EA	4.0	28.91	6,360	450.00	24,750	31,110
SUB TOTAL FROM SHEET 1					211,043		216,487	427,530
SUB TOTAL FROM SHEET 2					22,102		35,359	57,461
SUB TOTAL FROM SHEET 3					23,012		66,900	89,912
SUB TOTAL FROM SHEET 4					47,187		26,334	73,521
SUBTOTAL					315,313		389,239	704,553
O & P @ 20%					63,063		77,848	140,911
SUBTOTAL					378,376		467,087	845,463
DESIGN @ 6%								50,728
SUBTOTAL								896,191
SIOH @ 5.5%								49,291
TOTAL								$945,481

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6MA	DATE: 9/18/96
ECO NO. C Retrofit Existing BOILERS	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 100

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON								
OUTSIDE CONTRACT COSTS PER BOILER PER YEAR								
EXISTING BOILER	-21.	EA	100.0	30.00	-63,000	1,800.00	-37,800	-100,800
NEW EQUIPMENT								
AERCO MODULAR HIGH EFFICIENCY HW BOILER	2.	EA	80.0	30.00	4,800	1,500.00	4,020	8,820
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-58,200		-33,780	-91,980
PER YEAR								

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Life Cycle Cost Analysis Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-C
Analysis Date: 08/30/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., C.E.M.

ECIP Summary Report

1. Investment

A. Construction Cost	$845,463
B. SIOH	$49,291
C. Design Cost	$50,728
D. Total Cost (1A+1B+1C)	$945,482
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$945,482

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	57	Mbtus	$358	15.08	$5,398
Elec. Deman					$1,295	14.88	$19,270
Natural Gas	$4.4	/Mbtus	314	Mbtus	$1,378	18.58	$25,612
TOTAL			371	Mbtus	$3,031		$50,279

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$91,980	Annual	14.88	$1,368,662
ANNUAL TOTAL	$91,980			$1,368,662
ONE TIME TOTAL	$0			$0
TOTAL	$91,980			$1,368,662

4. First Year Dollar Savings	$95,011
5. Simple Payback Period (Years)	9.95
6. Total Net Discounted Savings	$1,418,942
7. Savings to Investment Ratio	1.5
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	5.11%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	A
DATE:	3/1/96
ECO TITLE:	Install Energy Management System (EMS) For HVAC System
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 100 (serving buildings 122, 123, 124, 125, 126, 127, 128, 129, 131,133, 134, 135, 140, 141,142, 143, 144,145, 146, 147, 149, 151, 152, 154, 155, 156, 157, 158, 159, 197, 198, 199, 250, 260, 261 and 268)

A. Summary:

Electrical Energy Savings	5928	MMBTU/yr
Electrical Demand Savings	-2523	$/yr
Gas Energy Savings	691	MMBTU/yr
Total Energy Savings	6619	MMBTU/yr
Total Cost Savings	37,738	$/yr
Total Investment	928,408	$
Simple Payback	24.6	yrs
SIR	0.62	

B. ECO Description:

Install an Energy Management System (EMS) at the central maintenance facility. The EMS will accomplish the following tasks for the equipment listed in Table-1 for all of the above mentioned buildings.

1. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps. These units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, the equipment can be started as late as possible, and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature.

2. A night / day setback program will be provided to control window units and fan coil units, and split systems. The program will set back the temperature of the controlled space to a predetermined set-point during periods of no occupancy. Several space or unit mounted temperature sensors will be installed to control the units that currently are controlled under manual operation or no control.

Table-1

Building #	Equipment To Be Controlled
122	Chiller, CHW pump, AHUs, Boiler and HW pump.
123	Cooling tower, CND pump, 6 water cooled package units, 5 space heaters.
124	Chiller, 2 CHW pumps, AHUs, Boiler and 2 HW pumps.
125	AHU
126	Chiller, CHW pump, AHU, Boiler and HW pump.
127	A split system and furnace.
128	Chiller, CHW pump, AHU, Boiler and HW pump.
129	Chiller, CHW pump, AHU, Boiler and HW pump. (computer rm. units not included)
131	Chiller, CHW pump, 2 AHUs, Boiler HW pump, Side wall exh. and supply fans, 1 FCU
133	Chiller, CHW pump, AHUs, Boiler and HW pump.
135	AHUs
140	AHU
141	2 window units
142	Chiller, CHW pump, AHUs, Boiler and HW pump.
143	Chiller, CHW pump, AHUs, Boiler and HW pump.
144	Chiller, CHW pump, AHUs, Boiler and HW pump. (computer rm. units not included)
145	23 window units
146	Chiller, CHW pump, AHUs, Boiler and HW pump.
147	Chiller, CHW pump, AHUs, Boiler and HW pump.
149	AHUs, Boiler and HW pump.
151	2 window units
152	2 window units, 10 gas fired space heaters.
154	4 window units
155	Chiller, CHW pump, AHUs, Boiler, HW pump and a FCU
156	4 window units. Boiler and HW pump.
157	2 window units, 2 gas fired space heaters.
158	8 window units, 8 gas fired floor furnaces.
159	1 window units, 1 gas fired space heaters. 1 split system.
197	Chiller, CHW pump, AHUs, Boiler and HW pump.
198	Chiller, CHW pump, AHUs, Boiler and HW pump.
199	Chiller, CHW pump, AHUs, Boiler and HW pump.
250	Chiller, CHW pump, AHUs, 2 Boilers.
260 & 261	Chiller, CHW pump, 10 FCUs, Boiler and HW pump.
268	Chiller, CHW pump, 3 FCUs, 1 AHU, Boiler and HW pump.

3. All multi-zone units and all single zone units with or without reheat coils in their branches will have a cooling side discharge air temperature reset. All branch thermostats and zone supply air temperatures after the reheat coil (RH) will be monitored. The cooling coil leaving air temperature will be reset sufficiently to satisfy at least one zone thermostat without reheat.

4. All multi-zone units will have air side temperature reset. AHU heating leaving air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full

5. All chillers will have water temperature reset. The leaving CHW temperature will be reset to satisfy varying load conditions.

C. Discussion:

1. Generally most buildings in this area are occupied from 7:30 a.m. to 4:30 p.m. daily with some exceptions. The facility remains unoccupied during the weekends and holidays. Regardless of occupancy hours, all AHU's are operated 24 hours per day, 365 days per year to maintain space temperature. However, the chillers operate only during the cooling season (with the exception of building 268) as do the boilers in the heating season. Depending on occupancy schedules, ambient conditions and building thermal characteristics, most AHU's and their associated chillers, boilers , CHW and HW pumps will be turned off daily in the evening. The equipment will be stopped as early as possible and turned back on as late as possible every weekday without sacrificing occupant comfort. These AHU's will remain off during weekends and holidays.

   Several temperature sensors will be installed in the spaces served by these AHU's. These sensors will monitor the space temperature during unoccupied hours. During the cooling season when the space temperature exceeds 85°F, the AHU's and their associated cooling auxiliaries serving that space will energize to cool the space below 85°F. When the space temperature reaches 80°F, they will cycle off. Similarly, the winter time unoccupied period space temperature will be maintained at 65 F.

   The EMS system will have the capability to manually override this operation with a change in schedule. All AHU's serving the critical areas such as computer room unit will operate as usual, and they will not be connected to the new start/stop program. However, if desired, their current operation and performance can be monitored by the new EMS system.

2. During periods when the facility remains unoccupied, the window units, fan coil units and split systems that serve non-critical areas will be reset to an "unoccupied" space temperature condition. Temperature sensors will monitor the space temperature at all times, and when the program determines the unoccupied periods, the temperature setpoint will rise from 78°F to 85°F for summer cooling conditions and from 70°F to 65°F for winter heating conditions. When the space temperature exceeds 85°F during unoccupied periods, then it will energize the unit and its associated auxiliary cooling equipment. Similarly, when the space temperature falls below 65°F during unoccupied periods, then it will energize the unit and its associated auxiliary heating equipment.

3. The EMS will have the capability to override this operation with a change in schedule or function. Also, this will not apply to window units, fan coil units, and split systems serving critical areas such as computer rooms. These units will operate as usual, and they will connected to the new start stop program unless their operation and performance needs to be monitored.

   Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's. (For all boilers and chillers that have a seasonal operation, the hot and cold

the AHU's. (For all boilers and chillers that have a seasonal operation, the hot and cold air mixing never occurs. Return air mixes with the cold air in summer and with hot air in the winter.) In both cases cooling energy is wasted. To reduce this waste, currently the hot air plenum is acting as a return air plenum. Our observations indicate that all zones are mixing cold supply and return air to maintain the room or designated zone area temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur.

In multi-zone units, cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air temperature will be increased to minimize mixing. This process will continue until one of the zones requires no mixing. A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Our observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. Heating supply air temperature will be lowered until at least one zone damper is fully open to satisfy the room or area heating demand. Many partially open heating dampers indicate a higher than necessary heating deck temperature. Lowering this temperature will save heating energy.

5. Chillers at Building 250 will be furnished with chilled water temperature reset controls. Upon a decrease in ambient temperature, the leaving CHW temperature will increase. An increase in leaving CHW temperature decreases the KW/ton which will reduce the electrical energy required. Application of this type of controls on smaller chillers (50 ton or less) will be uneconomical. Also, a few of the small reciprocating chillers are equipped with water cooled condensers. Economics makes condenser water reset similar to that of chilled water not feasible. The chillers at Building 250 are air cooled.

   The EMS system will be controlled by a personal computer (PC) located at the central maintenance facility building. All other building control panels will be connected to the central EMS system PC in the building via telephone lines.

   Bin temperature data for San Antonio, Texas, S.A. and R.A. temperatures, and CHW temperature data were entered in the Trace 600 computer program to calculate energy savings through this option (ref. Appendix H for data input and page C-6 for the estimated EMS point list.).

D. Savings Calculations:

   1. *Energy Consumption And Savings*

      The monthly peak demand and energy consumption of the existing system and the proposed EMS system were calculated using the Trace 600 computer program [1]. The buildings served by the existing chillers were modeled by the computer to provide a

realistic load profile. Field data obtained from the buildings were used to create these computer building models [2].

Once the computer simulations of the existing and new EMS systems were completed, the total annual demand cost and energy consumption were compared with that of the existing and new systems to determine the annual savings for this ECO [3]. These savings calculations are shown starting on pages C-8. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings associated with this ECO.

E. Cost Estimates:

The total installation costs for the new EMS system is estimated on page C-18. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-21. The data from the summary sheet were presented in the ECO summary on page C-1.

REFERENCES

1. See Appendix H for computer model input assumptions, data, and energy consumption output from Trace 600.

2. See Appendix G for building field data and existing HVAC system data.

3. See Appendix A for utility cost analysis data used in the savings calculations.

AREA: 100	HARDWARE																																
	OUTPUT								INPUT																								
	DIGITAL					ANALOG			DIGITAL											ANALOG												
ECO A: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	DIFFERENITAL PRESSURE	GAGE PRESSURE		POSITION	FLOW	O2 AND CO ANALYZERS	STATUS FAILURE
OCCUPANCY TIME: VARIES																															
GRAPHIC DISPLAY ●																															
POINT DESCRIPTION																															
A/C CHILLERS ●																															
CHILLER					19																										
CHW PUMP	23														23																)
CHW SUPPLY HEADER																		19													
CHW RETURN HEADER																		19													
COOLING TOWER																															
TWR. FAN	1														1																)
CW PUMP	1														1																)
HW BOILERS ●																															
BOILER					21							21																			
HW PUMP	25														25																)
HW SUPPLY HEADER																		21													
HW RETURN HEADER																		21													
STEAM BOILERS ●																															
BOILER					2							2																			
STEAM SUPPLY HEADER																							2								
STEAM RETURN HEADER																							2								
AHU-SZ ●																															
SUPPLY FAN	10														10																
CHW COIL VALVE						10												10													
HW COIL VALVE						10												10													
RETURN AIR																															
FILTER										10																					
ZONE TEMPERATURE																		10													
OUTSIDE AIR																															
AHU-CLG ONLY SZ ●																															
SUPPLY FAN	1														1																
COLD DECK TEMP.						1												1													
RETURN AIR																															
ZONE TEMPERATURE																															
FILTER										1																					
OUTSIDE AIR																															

(1)

|)WARE | | | | SOFTWARE | | | |

SOFTWARE																														
APPLICATION PROGRAMS																														
	SCHEDULED START / STOP	OPTIMUM START / STOP	DUTY CYCLING	DEMAND LIMITING	DAY / NIGHT SETBACK	ECONOMIZER	VENTILATION / RECIRCULATION	HOT / COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HW BOILER SELECTION	HW O.A. RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER CONTROL	RUN TIME	KW	KWH	CFM			REMARKS
		X												X		X			X										
		X																	X										
														X																
														X																
		X																	X										
		X																												
		X																	X										
		X																												
		X																	X										all valves, dampers, thermostats, and actuators are existing.
		X																												
		X																	X										
		X																												



AREA: 100	HARDWARE																																	
	OUTPUT									INPUT																								
	DIGITAL					ANALOG				DIGITAL									ANALOG															
ECO A: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY	LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	DIFFERENITAL PRESSURE	GAGE PRESSURE		POSITION	FLOW	O2 AND CO ANALYZERS	STATUS FAILURE	MAINTENANCE FLAG						
OCCUPANCY TIME: VARIES																																	
GRAPHIC DISPLAY ●																																	
POINT DESCRIPTION																																	
AHU (MZ) ●																																	
SUPPLY FAN	28														28																		
COLD DECK TEMP.						28											28																
HOT DECK TEMP.						28											28																
RETURN AIR																	28																
ZONE DAMPERS							56																										
ZONE TEMPERATURE																	56																
FILTER										28																							X
FAN COIL UNIT ●																																	
ZONE TEMPERATURE																	20																
PACKAGED AHU ●																																	
ZONE TEMPERATURE																	6																
PACKAGED WINDOW UNIT ●																																	
ZONE TEMPERATURE																	56																
OUTSIDE AIR ●																	1	1															

TOTAL AO POINTS =	131
TOTAL DO POINTS =	133
TOTAL AI POINTS =	151
TOTAL DI POINTS =	339
GRAND TOTAL POINTS =	754

| | SOFTWARE | | |

SOFTWARE																															
APPLICATION PROGRAMS																															
		SCHEDULED START / STOP	OPTIMUM START / STOP	DUTY CYCLING	DEMAND LIMITING	DAY / NIGHT SETBACK	ECONOMIZER	VENTILATION / RECIRCULATION	HOT / COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HW BOILER SELECTION	HW O.A. RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER CONTROL	RUN TIME	KW	KWH	CFM			REMARKS
			X																	X									all valves, dampers, thermostats, and actuators are existing.
									X																					
									X																					
			X																											
						X																								
						X																								
						X																								

(3)

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldgs. 122 & 140 Chiller					53.2	59.2	63.7	62.9	53.4	38.7			105,589	
Bldgs. 122 & 140 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldgs. 122 & 140 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 122 & 140 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldgs. 124 & 125 Chiller					58.7	65.2	69.7	68.4	58.3	42.8			114,027	
Bldgs. 124 & 125 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldgs. 124 & 125 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 124 & 125 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldg. 128 Chiller					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 128 CHW Pump					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 128 CHW Controls					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 133 Chiller					36.9	41.7	44.8	44.4	38.3	27.1			79,446	
Bldg. 133 CHW Pump					1.1	1.1	1.1	1.1	1.1	1.1			4,946	
Bldg. 133 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 134 & 135 Chiller					49.6	51.8	53.8	53.3	49.8	45.5			109,087	
Bldgs. 134 & 135 CHW Pump					0.4	0.4	0.4	0.4	0.4	0.4			1,634	
Bldgs. 134 & 135 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 143 Chiller					56.9	61.9	66.7	67.5	58.5	45.7			106,683	
Bldg. 143 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldg. 143 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 144 Chiller					4.4	4.5	4.5	4.7	4.9	3.4			10,120	
Bldg. 144 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			8,732	
Bldg. 144 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			3,898	
Bldg. 144 Chiller					52.3	56.8	61.2	61.9	53.7	41.9			83,823	
Bldg. 144 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			5,952	
Bldg. 144 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			2,657	
Bldg. 145 Window Units					51.9	54.0	56.0	55.5	52.0	48.6			48,756	
Bldg. 145 Window Unit Fans					4.8	5.2	7.4	7.4	5.0	3.8			7,225	
Bldg. 145 Window Unit Controls					1.0	1.0	1.0	1.0	1.0	1.0			442	
Bldg. 146 Chiller					54.7	59.5	64.2	64.9	56.2	44.1			106,939	
Bldg. 146 CHW Pump					1.1	1.1	1.1	1.1	1.1	1.1			4,946	
Bldg. 146 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 147 & 149 Chiller					81.0	86.4	89.6	88.9	82.6	70.8			176,040	
Bldgs. 147 & 149 CHW Pump					3.7	3.7	3.7	3.7	3.7	3.7			16,472	
Bldgs. 147 & 149 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 197 Chiller					56.1	61.1	65.6	65.9	57.7	45.7			106,257	
Bldg. 197 CHW Pump					1.5	1.5	1.5	1.5	1.5	1.5			6,580	
Bldg. 197 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 198 Condenser					13.2	14.1	14.7	14.5	13.6	10.1			20,362	
Bldg. 198 Condenser Fans					1.7	1.8	1.8	1.8	1.8	1.4			2,731	
Bldg. 198 CHW Pump					1.1	1.1	1.1	1.1	1.1	1.1			4,946	
Bldg. 198 Condenser Controls					0.3	0.3	0.3	0.3	0.3	0.3			1,325	
Bldg. 199 Chiller					21.6	24.1	26.4	26.6	22.7	16.4			46,260	
Bldg. 199 CHW Pump					1.5	1.5	1.5	1.5	1.5	1.5			6,580	
Bldg. 199 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 127 Condenser					6.6	6.9	7.1	7.1	6.6	6.1			10,166	
Bldg. 127 Condenser Fans					0.6	0.6	0.6	0.6	0.6	0.4			956	
Bldg. 127 Condenser Controls					0.3	0.3	0.3	0.3	0.3	0.3			1,325	
Bldg. 250 Chiller					140.8	150.4	162.3	166.0	145.0	110.5			315,629	
Bldg. 250 CHW Pump					5.6	5.6	5.6	5.6	5.6	5.6			24,730	

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 250 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 122 Fans	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	71,832	
Bldg. 140 Fans	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	6,132	
Bldg. 124 Fans	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	71,832	
Bldg. 125 Fans	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	134,200	
Bldg. 128 Fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	65,700	
Bldg. 133 Fans	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	71,832	
Bldg. 134 Fans	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	147,220	
Bldg. 135 Fans	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	147,220	
Bldg. 143 Fans	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	143,500	
Bldg. 144 Fans	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	151,469	
Bldg. 145 Fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	65,700	
Bldg. 146 Fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	65,700	
Bldg. 147 Fans	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	58,692	
Bldg. 149 Fans	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	43,540	
Bldg. 197 Fans	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	62,401	
Bldg. 198 Fans	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	28,035	
Bldg. 199 Fans	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	19,272	
Bldg. 127 Fans	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	28,649	
Bldg. 250 Fans	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	49,056	
Bldg. 250 Fans	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	297,840	
Bldgs. 122 & 140 Boiler														175
Bldgs. 122 & 140 HW Pump	1.1	1.1	1.1	1.1							1.1	1.1	3,335	
Bldgs. 122 & 140 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	372	
Bldgs. 122 & 140 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	9,557	
Bldgs. 124 & 125 Boiler														164
Bldgs. 124 & 125 HW Pump	1.1	1.1	1.1	1.1							1.1	1.1	3,308	
Bldgs. 124 & 125 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	369	
Bldgs. 124 & 125 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	9,557	
Bldg. 128 Boiler														0
Bldg. 128 HW Pump	0	0	0	0							0	0	0	
Bldg. 128 HW Controls	0	0	0	0							0	0	0	
Bldg. 133 Boiler														160
Bldg. 133 HW Pump	0.4	0.4	0.4	0.4							0.4	0.4	1,607	
Bldg. 133 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 133 Boiler Fan	3.7	3.7	3.7	3.7							3.7	3.7	16,203	
Bldgs. 134 & 135 Boiler														46
Bldgs. 134 & 135 HW Pump	0.4	0.4	0.4	0.4							0.4	0.4	646	
Bldgs. 134 & 135 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	218	
Bldg. 143 Boiler														96
Bldg. 143 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,932	
Bldg. 143 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	322	
Bldg. 144 Boiler														96
Bldg. 144 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,932	
Bldg. 144 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	322	
Bldg. 145 Furnace	13.7	14.6	9.3	1.5							8.3	13.9	8,840	
Bldg. 146 Boiler														91
Bldg. 146 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,932	
Bldg. 146 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	305	
Bldg. 147 Boiler														52

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 147 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,264	
Bldg. 147 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	211	
Bldg. 149 Boiler														52
Bldg. 149 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,264	
Bldg. 149 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	211	
Bldg. 197 Boiler														67
Bldg. 197 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	802	
Bldg. 197 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	134	
Bldg. 198 Boiler														29
Bldg. 198 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	804	
Bldg. 198 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	180	
Bldg. 199 Boiler														86
Bldg. 199 HW Pump	1.1	1.1	1.1	1.1							1.1	1.1	4,865	
Bldg. 199 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 127 Furnace														14
Bldg. 127 Furnace Fan	0.7	0.7	0.7	0.7							0.7	0.7	3,154	
Bldg. 250 Boiler														103
Bldg. 250 Boiler Controls	0.1	0.1	0.1	0.1							0.1	0.1	300	
Bldg. 142 Chiller					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 142 Chiller					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 142 CHW Pump					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 142 CHW Controls					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 123 Chiller					13.1	13.3	14.1	14.5	13.4	10.2			34,487	
Bldg. 123 Cooling Tower Fans					1.5	1.5	1.5	1.5	1.5	1.5			5,893	
Bldg. 123 CND Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,093	
Bldg. 123 CHW Controls					0.1	0.1	0.1	0.1	0.1	0.1			413	
Bldg. 123 Humidifier					6.0	6.0	6.0	6.0	6.0	6.0			3,997	
Bldg. 126 Chiller					40.4	43.8	47.1	47.9	43.3	35.0			86,201	
Bldg. 126 CHW Pump					1.5	1.5	1.5	1.5	1.5	1.5			6,580	
Bldg. 126 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 131 Chiller					32.7	35.7	38.3	38.2	35.4	27.8			69,516	
Bldg. 131 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldg. 131 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 129 Chiller					4.9	5.2	5.7	5.9	5.6	4.9			13,350	
Bldg. 129 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 129 Chiller					36.7	39.3	42.8	44.3	42.0	37.1			72,266	
Bldg. 129 CHW Pump					2.4	2.4	2.4	2.4	2.4	2.4			7,866	
Bldg. 129 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			3,305	
Bldg. 151 Window Units	3.6	3.6	3.6	3.7	4.0	4.1	4.3	4.2	4.0	4	4	3.6	5,685	
Bldg. 151 Window Unit Fans	0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.5	0.4	0.3	0.2	0.1	733	
Bldg. 151 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	434	
Bldg. 154 Window Units	7.0	7.0	7.0	7.3	7.7	8.1	8.3	8.3	7.8	7.3	7.0	7.0	7,197	
Bldg. 154 Window Unit Fans	0.1	0.0	0.2	0.4	0.5	0.6	1.0	1.0	0.6	0.3	0.2	0.1	978	
Bldg. 154 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	379	
Bldg. 156 Window Units	0.0	0.0	13.1	13.8	14.6	15.2	15.8	15.7	14.7	13.7	13.1	0.0	7,055	
Bldg. 156 Window Unit Fans	0.0	0.0	0.2	0.3	0.5	0.5	1.8	1.8	0.5	0.3	0.2	0.0	986	
Bldg. 156 Window Unit Controls	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	358	
Bldg. 157 Window Units	3.1	3.1	3.1	3.3	3.5	3.6	3.8	3.7	3.5	3.3	3.1	3.1	6,357	
Bldg. 157 Window Unit Fans	0.1	0.1	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.1	876	
Bldg. 157 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	514	

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 159 Condenser					3.6	3.7	3.8	3.8	3.4	2.3			10,476	
Bldg. 159 Condenser Fans					0.5	0.5	0.5	0.5	0.5	0.4			1,501	
Bldg. 159 Condenser Controls					0.3	0.3	0.3	0.3	0.3	0.3			1,325	
Bldg. 152 Window Units	11.9	11.9	11.9	12.4	13.2	13.8	14.3	14.1	13.2	12.4	11.9	11.9	18,405	
Bldg. 152 Window Unit Fans	0.3	0.3	0.8	1.2	1.6	1.8	1.9	1.9	1.7	1.2	0.8	0.4	2,716	
Bldg. 152 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	484	
Bldg. 155 Condenser	8.2	8.3	6.6	6.4	8.1	10.0	9.9	9.3	9.0	7.8	7.8	8.3	22,335	
Bldg. 155 Condenser Fans	0.6	0.4	0.7	0.7	0.8	1.0	1.0	1.0	0.9	0.8	0.7	0.5	2,305	
Bldg. 155 CHW Pump	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	2,719	
Bldg. 155 Condenser Controls	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1,457	
Bldg. 155 Window Units	14.2	14.2	14.2	14.9	15.8	16.5	17.1	17.0	15.9	14.9	14.2	14.2	16,295	
Bldg. 155 Window Unit Fans	0.6	0.5	1.1	1.4	1.6	1.7	2.0	2.0	1.7	1.3	1.1	0.6	2,065	
Bldg. 155 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	193	
Bldg. 158 Window Units	9.5	9.5	9.5	9.9	10.6	11.0	11.4	11.3	10.6	9.9	9.5	9.5	17,371	
Bldg. 158 Window Unit Fans	0.3	0.2	0.7	1.0	1.3	1.3	1.3	1.3	1.3	0.9	0.6	0.3	2,214	
Bldg. 158 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	450	
Bldg. 141 Window Units	3.1	3.1	3.1	3.3	3.5	3.6	3.8	3.7	3.5	3.3	3.1	3.1	8,248	
Bldg. 141 Window Unit Fans	0.1	0.1	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.1	1,133	
Bldg. 141 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	512	
Bldgs. 260 & 261 Chiller					18.3	19.9	21.1	20.9	18.3	14.6			35,084	
Bldgs. 260 & 261 CHW Pump					0.4	0.4	0.4	0.4	0.4	0.4			1,445	
Bldgs. 260 & 261 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			3,906	
Bldgs. 260 & 261 CHW Pump					0.4	0.4	0.4	0.4	0.4	0.4			1,445	
Bldg. 268 Chiller	11.3	11.3	13.3	15.9	19.2	21.3	22.9	23.2	20.0	14.8	12.9	11.3	48,278	
Bldg. 268 CHW Pump	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	2,981	
Bldg. 268 CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	5,323	
Bldg. 142 Fans	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	43,389	
Bldg. 123 Fans	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	21,024	
Bldg. 126 Fans	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	32,412	
Bldg. 131 Fans	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	98,112	
Bldg. 129 Fans	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	117,384	
Bldg. 151 Fans	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	14,795	
Bldg. 154 Fans	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	12,463	
Bldg. 156 Fans	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	10,540	
Bldg. 157 Fans	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	22,914	
Bldg. 159 Fans	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	20,644	
Bldg. 152 Fans	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	43,967	
Bldg. 155 Fans	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	94,395	
Bldg. 158 Fans	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	48,515	
Bldg. 141 Fans	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	22,342	
Bldg. 260 Fans	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	6,132	
Bldg. 261 Fans	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	6,132	
Bldg. 268 Fans	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	55,188	
Bldg. 142 Boiler														0
Bldg. 142 HW Pump	0.0	0.0	0.0	0.0							0.0	0.0	0	
Bldg. 142 HW Controls	0.0	0.0	0.0	0.0							0.0	0.0	0	
Bldg. 123 Unit Heater														43
Bldg. 123 Unit Heater Fan	0.2	0.2	0.2	0.2							0.2	0.2	403	
Bldg. 126 Boiler														94
Bldg. 126 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,379	

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 126 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	230	
Bldg. 131 Boiler														98
Bldg. 131 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
Bldg. 131 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 131 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
Bldg. 129 Boiler														40
Bldg. 129 HW Pump	2.4	2.4	2.4	2.4							2.4	2.4	10,339	
Bldg. 129 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 151 Resistance Heater	3.4	3.6	1.3	0.2							1.5	3.4	2,866	
Bldg. 154 Resistance Heater	5.4	5.8	3.0	0.3						0.7	2.8	5.5	6,203	
Bldg. 156 Boiler														33
Bldg. 156 HW Pump	0.2	0.2	0.2	0.2							0.2	0.2	475	
Bldg. 156 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	313	
Bldg. 157 Unit Heater														13
Bldg. 157 Unit Heater Fan	15.0	13.0	15.0	14.0							14.0	15.0	87	
Bldg. 159 Unit Heater														0
Bldg. 159 Unit Heater Fan	0.0	0.0	0.0	0.0							0.0	0.0	0	
Bldg. 152 Unit Heater														89
Bldg. 152 Unit Heater Fan	0.1	0.1	0.1	0.1							0.1	0.1	599	
Bldg. 155 Boiler														32
Bldg. 155 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
Bldg. 155 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 158 Unit Heater														56
Bldg. 158 Unit Heater Fan	0.2	0.2	0.2	0.2							0.2	0.2	500	
Bldg. 141 Resistance Heater	3.7	3.7	2.1	0.2							2.1	3.7	4,295	
Bldgs. 260 & 261 Boiler														25
Bldgs. 260 & 261 HW Pump	0.4	0.4	0.4	0.4							0.4	0.4	1,607	
Bldgs. 260 & 261 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldgs. 260 & 261 HW Pump	0.4	0.4	0.4	0.4							0.4	0.4	1,607	
Bldg. 268 Boiler														83
Bldg. 268 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
Bldg. 268 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Totals	420.0	419.1	425.4	418.0	1347.5	1426.5	1500.0	1503.7	1377.3	1177.4	424.1	420.4	4,735,758	1,835
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	3,150	3,143	3,191	3,135	10,106	14,265	15,000	15,037	13,773	8,831	3,181	3,153		

Total Demand 95,964 $/yr

Total Energy 16,163 MMBTU/yr (electric)

Total Energy 1,835 MMBTU/yr (gas)

ITEM	ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldgs. 122 & 140 Chiller					59.1	61.8	64.1	63.6	59.4	51.6			73,523	
Bldgs. 122 & 140 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldgs. 122 & 140 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 122 & 140 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldgs. 124 & 125 Chiller					62.4	65.7	68.5	67.9	62.8	51.7			79,658	
Bldgs. 124 & 125 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldgs. 124 & 125 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 124 & 125 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldg. 128 Chiller					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 128 CHW Pump					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 128 CHW Controls					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 133 Chiller					37.9	43.2	44.8	44.4	41.5	36.1			47,534	
Bldg. 133 CHW Pump					1.1	1.1	1.1	1.1	1.1	1.1			4,946	
Bldg. 133 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 134 & 135 Chiller					49.6	51.8	53.8	53.3	49.8	45.9			86,869	
Bldgs. 134 & 135 CHW Pump					0.4	0.4	0.4	0.4	0.4	0.4			1,634	
Bldgs. 134 & 135 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 143 Chiller					62.2	65.0	67.4	66.8	62.4	54.3			81,071	
Bldg. 143 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldg. 143 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 144 Chiller					4.3	4.5	4.6	4.6	4.3	3.7			5,181	
Bldg. 144 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			3,356	
Bldg. 144 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			1,498	
Bldg. 144 Chiller					56.5	59.1	61.2	60.7	56.7	49.3			64,917	
Bldg. 144 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			3,275	
Bldg. 144 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			1,462	
Bldg. 145 Window Units					51.9	54.0	56.0	55.5	52.0	48.6			36,804	
Bldg. 145 Window Unit Fans					4.8	5.5	7.4	7.4	5.2	3.8			5,607	
Bldg. 145 Window Unit Controls					0.1	0.1	0.1	0.1	0.1	0.1			442	
Bldg. 146 Chiller					60.3	63.0	65.3	64.8	60.5	52.6			78,227	
Bldg. 146 CHW Pump					1.1	1.1	1.1	1.1	1.1	1.1			4,946	
Bldg. 146 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 147 & 149 Chiller					81.0	86.4	89.6	88.9	82.6	75.1			128,244	
Bldgs. 147 & 149 CHW Pump					3.7	3.7	3.7	3.7	3.7	3.7			16,472	
Bldgs. 147 & 149 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 197 Chiller					59.3	62.0	64.2	63.7	59.5	51.7			81,229	
Bldg. 197 CHW Pump					1.5	1.5	1.5	1.5	1.5	1.5			6,580	
Bldg. 197 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 198 Condenser					13.5	14.1	14.7	14.5	13.6	11.8			18,317	
Bldg. 198 Condenser Fans					1.8	1.8	1.8	1.8	1.8	1.8			2,457	
Bldg. 198 CHW Pump					1.1	1.1	1.1	1.1	1.1	1.1			4,946	
Bldg. 198 Condenser Controls					0.3	0.3	0.3	0.3	0.3	0.3			1,325	
Bldg. 199 Chiller					24.8	25.9	26.9	26.7	24.9	21.6			32,063	
Bldg. 199 CHW Pump					1.5	1.5	1.5	1.5	1.5	1.5			6,580	
Bldg. 199 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 127 Condenser					6.6	6.9	7.1	7.1	6.6	6.1			8,033	
Bldg. 127 Condenser Fans					0.6	0.6	0.6	0.6	0.6	0.6			760	
Bldg. 127 Condenser Controls					0.3	0.3	0.3	0.3	0.3	0.3			1,325	
Bldg. 250 Chiller					142.6	149.5	161.4	164.8	143.7	125.7			244,189	
Bldg. 250 CHW Pump					5.6	5.6	5.6	5.6	5.6	5.6			24,730	

ITEM	ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 250 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 122 Fans	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	23,915	
Bldg. 140 Fans	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	2,105	
Bldg. 124 Fans	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	23,924	
Bldg. 125 Fans	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	46,642	
Bldg. 128 Fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	21,675	
Bldg. 133 Fans	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	25,242	
Bldg. 134 Fans	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	51,263	
Bldg. 135 Fans	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	51,263	
Bldg. 143 Fans	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	143,500	
Bldg. 144 Fans	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	52,706	
Bldg. 145 Fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	38,325	
Bldg. 146 Fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	38,325	
Bldg. 147 Fans	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	20,528	
Bldg. 149 Fans	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	15,061	
Bldg. 197 Fans	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	20,800	
Bldg. 198 Fans	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	28,035	
Bldg. 199 Fans	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	6,571	
Bldg. 127 Fans	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	9,563	
Bldg. 250 Fans	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	17,230	
Bldg. 250 Fans	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	173,740	
Bldgs. 122 & 140 Boiler														94
Bldgs. 122 & 140 HW Pump	1.1	1.1	1.1	1.1							1.1	1.1	2,614	
Bldgs. 122 & 140 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	292	
Bldgs. 122 & 140 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	9,557	
Bldgs. 124 & 125 Boiler														90
Bldgs. 124 & 125 HW Pump	1.1	1.1	1.1	1.1							1.1	1.1	2,614	
Bldgs. 124 & 125 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	292	
Bldgs. 124 & 125 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	9,557	
Bldg. 128 Boiler														0
Bldg. 128 HW Pump	0	0	0	0							0	0	0	
Bldg. 128 HW Controls	0	0	0	0							0	0	0	
Bldg. 133 Boiler														84
Bldg. 133 HW Pump	0.4	0.4	0.4	0.4							0.4	0.4	1,607	
Bldg. 133 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 133 Boiler Fan	3.7	3.7	3.7	3.7							3.7	3.7	16,203	
Bldgs. 134 & 135 Boiler														31
Bldgs. 134 & 135 HW Pump	0.4	0.4	0.4	0.4							0.4	0.4	554	
Bldgs. 134 & 135 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	187	
Bldg. 143 Boiler														53
Bldg. 143 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,683	
Bldg. 143 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	281	
Bldg. 144 Boiler														53
Bldg. 144 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,683	
Bldg. 144 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	281	
Bldg. 145 Furnace	21.9	21.9	21.0	1.5							19.4	21.9	6,465	
Bldg. 146 Boiler														54
Bldg. 146 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,655	
Bldg. 146 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	276	
Bldg. 147 Boiler														47

ITEM	ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 147 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,192	
Bldg. 147 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	199	
Bldg. 149 Boiler														47
Bldg. 149 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,192	
Bldg. 149 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	199	
Bldg. 197 Boiler														44
Bldg. 197 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	595	
Bldg. 197 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	99	
Bldg. 198 Boiler														17
Bldg. 198 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	641	
Bldg. 198 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	143	
Bldg. 199 Boiler														45
Bldg. 199 HW Pump	1.1	1.1	1.1	1.1							1.1	1.1	4,865	
Bldg. 199 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 127 Furnace														9
Bldg. 127 Furnace Fan	0.7	0.7	0.7	0.7							0.7	0.7	3,154	
Bldg. 250 Boiler														80
Bldg. 250 Boiler Controls	0.1	0.1	0.1	0.1							0.1	0.1	278	
Bldg. 142 Chiller					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 142 Chiller					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 142 CHW Pump					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 142 CHW Controls					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 123 Chiller	9.2	9.2	9.3	11.0	12.5	13.3	14.1	14.5	13.4	10.2	9.4	9.2	38,895	
Bldg. 123 Cooling Tower Fans	0.1	0.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.3	6,780	
Bldg. 123 CND Pump	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	10,822	
Bldg. 123 CHW Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	492	
Bldg. 123 Humidifier	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	5,480	
Bldg. 126 Chiller					45.1	47.2	48.9	48.5	45.3	39.4			57,356	
Bldg. 126 CHW Pump					1.5	1.5	1.5	1.5	1.5	1.5			6,580	
Bldg. 126 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 131 Chiller					35.5	37.1	38.5	38.2	35.7	31.0			48,099	
Bldg. 131 CHW Pump					2.2	2.2	2.2	2.2	2.2	2.2			9,892	
Bldg. 131 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 129 Chiller					5.6	5.8	6.0	6.0	5.6	4.9			15,466	
Bldg. 129 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 129 Chiller					42.0	43.9	45.5	45.1	42.2	37.1			49,313	
Bldg. 129 CHW Pump					2.4	2.4	2.4	2.4	2.4	2.4			3,477	
Bldg. 129 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			1,461	
Bldg. 151 Window Units	3.6	3.6	3.6	3.7	4.0	4.1	4.3	4.2	4.0	3.7	3.6	3.6	3,942	
Bldg. 151 Window Unit Fans	0.1	0.1	0.2	0.3	0.4	0.5	0.5	0.5	0.4	0.3	0.2	0.1	512	
Bldg. 151 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	233	
Bldg. 154 Window Units	7.0	7.0	7.0	7.3	7.7	8.1	8.3	8.3	7.8	7.3	7.0	7.0	4,639	
Bldg. 154 Window Unit Fans	0.1	0.0	0.2	0.4	0.5	0.6	1.0	1.0	0.6	0.3	0.2	0.1	639	
Bldg. 154 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	193	
Bldg. 156 Window Units	0.0	0.0	13.1	13.8	14.6	15.2	15.8	15.7	14.7	13.7	13.1	0.0	4,352	
Bldg. 156 Window Unit Fans	0.0	0.0	0.2	0.3	0.5	0.6	1.8	1.8	0.6	0.3	0.2	0.0	631	
Bldg. 156 Window Unit Controls	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	178	
Bldg. 157 Window Units	3.1	3.1	3.1	3.3	3.5	3.6	3.8	3.7	3.5	3.3	3.1	3.1	4,893	
Bldg. 157 Window Unit Fans	0.1	0.1	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.1	683	
Bldg. 157 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	387	

ITEM	ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 159 Condenser					3.6	3.7	3.8	3.8	3.4	2.3			10,476	
Bldg. 159 Condenser Fans					0.5	0.5	0.5	0.5	0.5	0.4			1,501	
Bldg. 159 Condenser Controls					0.3	0.3	0.3	0.3	0.3	0.3			1,325	
Bldg. 152 Window Units	11.9	11.9	11.9	12.4	13.2	13.8	14.3	14.1	13.2	12.4	11.9	11.9	11,767	
Bldg. 152 Window Unit Fans	0.3	0.3	0.8	1.2	1.6	1.8	1.9	1.9	1.8	1.2	0.8	0.4	1,769	
Bldg. 152 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	468	
Bldg. 155 Condenser	7.7	8.3	7.6	7.7	8.7	9.6	9.4	9.4	8.8	7.6	7.8	8.4	15,325	
Bldg. 155 Condenser Fans	0.4	0.4	0.5	0.9	0.9	1.0	1.0	1.0	0.9	0.8	0.7	0.5	1,439	
Bldg. 155 CHW Pump	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1,412	
Bldg. 155 Condenser Controls	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	757	
Bldg. 155 Window Units	14.2	14.2	14.2	14.9	15.8	16.5	17.1	17.0	15.9	14.9	14.2	14.2	22,797	
Bldg. 155 Window Unit Fans	0.6	0.6	1.1	1.7	1.8	1.8	2.0	2.0	1.8	1.7	1.1	0.7	2,660	
Bldg. 155 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	219	
Bldg. 158 Window Units	9.5	9.5	9.5	9.9	10.6	11.0	11.4	11.3	10.6	9.9	9.5	9.5	12,359	
Bldg. 158 Window Unit Fans	0.3	0.2	0.7	1.0	1.3	1.3	1.3	1.3	1.3	0.9	0.6	0.3	1,606	
Bldg. 158 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	345	
Bldg. 141 Window Units	3.1	3.1	3.1	3.3	3.5	3.6	3.8	3.7	3.5	3.3	3.1	3.1	6,489	
Bldg. 141 Window Unit Fans	0.1	0.1	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.1	890	
Bldg. 141 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	486	
Bldgs. 260 & 261 Chiller					18.3	19.9	21.1	20.9	18.3	17.3			24,678	
Bldgs. 260 & 261 CHW Pump					0.4	0.4	0.4	0.4	0.4	0.4			925	
Bldgs. 260 & 261 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			2,500	
Bldgs. 260 & 261 CHW Pump					0.4	0.4	0.4	0.4	0.4	0.4			925	
Bldg. 268 Chiller	11.3	12.3	14.0	19.0	20.9	22.8	23.6	23.4	21.9	19.0	17.5	14.2	33,891	
Bldg. 268 CHW Pump	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1,365	
Bldg. 268 CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2,437	
Bldg. 142 Fans	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	15,644	
Bldg. 123 Fans	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	21,024	
Bldg. 126 Fans	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	10,942	
Bldg. 131 Fans	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	33,149	
Bldg. 129 Fans	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	40,457	
Bldg. 151 Fans	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	14,795	
Bldg. 154 Fans	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	12,463	
Bldg. 156 Fans	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	10,540	
Bldg. 157 Fans	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	22,914	
Bldg. 159 Fans	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	20,644	
Bldg. 152 Fans	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	43,967	
Bldg. 155 Fans	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	31,288	
Bldg. 158 Fans	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	48,515	
Bldg. 141 Fans	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	22,342	
Bldg. 260 Fans	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	6,132	
Bldg. 261 Fans	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	6,132	
Bldg. 268 Fans	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	18,040	
Bldg. 142 Boiler														0
Bldg. 142 HW Pump	0.0	0.0	0.0	0.0							0.0	0.0	0	
Bldg. 142 HW Controls	0.0	0.0	0.0	0.0							0.0	0.0	0	
Bldg. 123 Unit Heater														46
Bldg. 123 Unit Heater Fan	0.2	0.2	0.2	0.2							0.2	0.2	395	
Bldg. 126 Boiler														60
Bldg. 126 HW Pump	0.8	0.8	0.8	0.8							0.8	0.8	1,136	

ITEM	ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 126 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	189	
Bldg. 131 Boiler														55
Bldg. 131 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
Bldg. 131 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 131 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
Bldg. 129 Boiler														33
Bldg. 129 HW Pump	2.4	2.4	2.4	2.4							2.4	2.4	10,339	
Bldg. 129 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 151 Resistance Heater	4.4	4.4	0.3	0.2							3.7	4.4	2,041	
Bldg. 154 Resistance Heater	8.7	8.9	7.7	0.3							7.7	8.9	4,218	
Bldg. 156 Boiler														22
Bldg. 156 HW Pump	0.2	0.2	0.2	0.2							0.2	0.2	390	
Bldg. 156 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	257	
Bldg. 157 Unit Heater														9
Bldg. 157 Unit Heater Fan	0.0	0.0	0.0	0.0							0.0	0.0	87	
Bldg. 159 Unit Heater														0
Bldg. 159 Unit Heater Fan	0.0	0.0	0.0	0.0							0.0	0.0	0	
Bldg. 152 Unit Heater														62
Bldg. 152 Unit Heater Fan	0.1	0.1	0.1	0.1							0.1	0.1	599	
Bldg. 155 Boiler														24
Bldg. 155 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
Bldg. 155 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 158 Unit Heater														39
Bldg. 158 Unit Heater Fan	0.2	0.2	0.2	0.2							0.2	0.2	453	
Bldg. 141 Resistance Heater	3.7	3.7	2.1	0.2							3.7	3.7	2,939	
Bldgs. 260 & 261 Boiler														17
Bldgs. 260 & 261 HW Pump	0.4	0.4	0.4	0.4							0.4	0.4	1,607	
Bldgs. 260 & 261 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldgs. 260 & 261 HW Pump	0.4	0.4	0.4	0.4							0.4	0.4	1,607	
Bldg. 268 Boiler														29
Bldg. 268 HW Pump	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
Bldg. 268 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Total (KW)	434.3	435.8	446.3	429.6	1396.2	1452.5	1503.5	1499.3	1408.0	1279.4	453.6	438.6	2,998,823	1,144
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	3,257	3,269	3,347	3,222	10,472	14,525	15,035	14,993	14,080	9,596	3,402	3,290		

Total Demand	98,487	$/yr	
Demand Savings	-2,523	$/yr	
Energy Savings	5,928	MMBTU/yr	(electric)
Energy Savings	691	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX
ECO NO. A AREA 100
PROJECT NO: 03-0185.06A
BY : KOTHMANN, K
DATE: 2/28/96
CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
311,884 Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	HRS/ UNIT	Rate	Total	Unit Price	Total	
EMCS COSTS BASED ON DDC ALL ELECTRIC								
DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE								
DIGITAL OUTPUT DEVICE :								
START-STOP MOTOR	89	EA	10.2	28.91	26,244	175.74	15,641	41,885
ENABLE/DISABLE APPARATUS RELAY	42	EA	4.5	28.91	5,464	49.00	2,058	7,522
ANALOG OUTPUT:								
CONTROL VALVE (COIL/AHU ACTUATOR ONLY)	77	EA	11.9	28.91	26,535	571.00	43,967	70,502
DAMPER ACTUATOR & MOTOR	86	EA	11.9	28.91	29,636	340.00	29,240	58,876
DIGITAL INPUT:								
DIFFERENTIAL PRESSURE SWITCH	39	EA	10.1	28.91	11,388	227.30	8,865	20,252
AUXILIARY CONTACT	23	EA	4.5	28.91	2,992	49.00	1,127	4,119
CURRENT SENSING RELAY	89	EA	4.5	28.91	11,578	49.00	4,361	15,939
SHEET 1								
				SUBTOTAL	113,838		105,259	219,096
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.06A	DATE: 2/28/96
ECO NO. A AREA 100	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
311,884 Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
ANALOG INPUT:								
TEMP. SENSER & THERMO WELL	180	EA	17.0	28.91	88,465	426.42	76,756	165,220
TEMP. SENSER AIR DUCT	78	EA	12.0	28.91	27,060	450.00	35,100	62,160
TEMP. SENSER OUTSIDE AIR	1	EA	12.0	28.91	347	550.00	550	897
TEMP. SENSER ZONE	148	EA	12.0	28.91	51,344	556.00	82,288	133,632
RELATIVE HUMIDITY %	1	EA	13.0	28.91	376	615.00	615	991
GAUGE PRESSURE BOILER	50	EA	8.0	28.91	11,564	197.00	9,850	21,414
EQUIPMENT FAILURE ALARM	27	EA	2.6	28.91	2,029	108.00	2,916	4,945
FILTER ALARM	78	EA	4.5	28.91	10,147	227.00	17,706	27,853
HIGH & LOW LIMIT (HYDRONIC)	84	PR	2.0	28.91	4,857	170.00	14,280	19,137
SHEET 2								
SUBTOTAL					196,189		240,061	436,250
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.06A	DATE: 2/28/96
ECO NO. A AREA 100	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
311,884 Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
OPERATORS' CONSOLE CONTROL UNIT	1	SUM				13,184.00	13,184	13,184
INCLUDING MODEM & REMOTE PANEL								
SUBMITTALS, TRAINING & START-UP	1	JOB				8,300.00	8,300	8,300
SOFTWARE	1	LS				15,000.00	15,000	15,000
SUB TOTAL FROM SHEET 1					113,838		105,259	219,096
SUB TOTAL FROM SHEET 2					196,189		240,061	436,250
SUBTOTAL					310,027		381,803	691,830
O & P @ 20%					62,005		76,361	138,366
SUBTOTAL					372,032		458,164	830,196
DESIGN @ 6%								49,812
SUBTOTAL								880,008
SIOH @ 5.5%								48,400
TOTAL								$928,408

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Life Cycle Cost Analysis Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-A
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

ECIP Summary Report

1. Investment

A. Construction Cost	$830,196
B. SIOH	$48,400
C. Design Cost	$49,812
D. Total Cost (1A+1B+1C)	$928,408
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$928,408

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	5,928	Mbtus	$37,228	15.08	$561,396
Elec. Deman					-$2,523	14.88	-$37,542
Natural Gas	$4.4	/Mbtus	691	Mbtus	$3,033	18.58	$56,362
TOTAL			6,619	Mbtus	$37,738		$580,216

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL TOTAL	$0			$0
ONE TIME TOTAL	$0			$0
TOTAL	$0			$0

4. First Year Dollar Savings	$37,738
5. Simple Payback Period (Years)	24.6
6. Total Net Discounted Savings	$580,216
7. Savings to Investment Ratio	.62
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	.61%

ENERGY CONSERVATION OPPORTUNITY (EC0)

ECO NO:	B
DATE:	3/1/96
ECO TITLE:	Retrofit Existing Individual Chillers With Central Chiller Plant
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 100 (serving buildings 122, 123, 124, 125, 126, 127, 128, 129, 131,133, 134, 135, 140, 141,142, 143, 144,145, 146, 147, 149, 151, 152, 154, 155, 156, 157, 158, 159, 197, 198, 199, 250, 260, and 261)

A. Summary:

Electrical Energy Savings	4350	MMBTU/yr
Electrical Demand Savings	37,558	$/yr
Gas Energy Savings	0	MMBTU/yr
Total Energy Savings	4350	MMBTU/yr
Total Cost Savings	91,649	$/yr
Total Investment	1,646,927	$
Simple Payback	18.0	yrs
SIR	0.83	

B. ECO Description:

Phase 1 - Install a new central cooling plant near Building 250 where the existing 100 ton reciprocating. chiller and an empty concrete pad for future chiller is located. A plant with an approximate 1000 sq ft. or an area large enough to house two centrifugal chillers, two CND and two CHW pumps and their electrical panels will be erected. CHW will be provided through a direct buried 6" primary CHW supply and return piping loop from this plant. This primary CHW loop will split behind Building 155. The first branch will be extended up to Building 198, and the second branch be will be extended up to Building 261. The estimated length of loop will be 6000 ft.. This loop will be served by one new 1175 GPM, 50 HP primary CHW pump at 125 ft. head, and a second new 408 GPM, 20 HP primary pump at 125 ft. Head. All of the existing building CHW pumps will be reutilized as secondary pumps. The chillers to be removed and the secondary pumps to be reutilized are listed in Figure-1. Approximate piping sizes required to connect these pumps with the primary CHW loop are also listed in Figure-1. A new water cooled 480 ton centrifugal R-123 chiller rated at 0.55 KW/ton will be installed. A second 170 ton chiller will be relocated from building 592 along with it's cooling tower and condenser water pump. All new controls and electrical services should be installed at Building 250 to serve the new chillers and pumps. At Building 123 convert the existing CND pump to a secondary CHW pump. Remove the existing cooling tower and 6 water cooled package units. Replace these units with 6 new vertical floor mounted AHUs. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new chiller, cooling tower, associated wiring and controls.

Figure 1

Bldg. #	Quantity	Description	Size	Flow	Estimated Pipe Size	Extimated Pipe Length
			Tons	GPM	inches	Feet
122	1	Chiller	40	96	2.5	60
123	6	Packaged Units	30	72	2	70
124	1	Chiller	50	120	3	60
126	1	Chiller	40	96	2.5	60
128	1	Chiller	40	96	2.5	70
129	1	Chiller	25	60	2	60
131	1	Chiller	29	70	2	60
133	1	Chiller	25	60	2	70
134	1	Chiller	30	72	2	60
142	1	Chiller	10	24	1.5	60
143	1	Chiller	45	108	2.5	60
144	1	Chiller	45	108	2.5	60
146	1	Chiller	40	96	2.5	60
147	1	Chiller	50	120	3	75
155	1	Condensing Unit	10	24	1.5	60
197	1	Chiller	50	120	3	60
198	1	Chiller	10	24	1.5	70
199	1	Chiller	15	36	1.5	70
250	1	Chiller	100	240	4	80
260	1	Chiller	15	36	1.5	80
Total	25	CHW Equipment	699	1678	N/A	N/A

Phase 2 - Buildings with window units and liquid cooled package units will be retrofitted with new air handling units and fan coil units having chilled water coils. New secondary CHW pumps will be installed to serve them. There will be a total of 56 window units and 3 split systems will be removed from the buildings listed in Figure-2. A total of 56 FCUs and 3 AHUs will be installed to replace them. Approx. 200 ft. of 2", 500 ft. of 1.5", 1000 ft. of 1.0" and 2000 ft. of 0.75" piping will be required to feed CHW to these new FCUs and AHUs. Approximately 50 each ½" two way, 6 each ½" three way, 3 each 3/4" two way control valves and 59 electric thermostats will be required. Install 11 new secondary pumps to serve new FCUs and AHUs as indicated in Figure 2.

Currently this ECO includes both Phase I and Phase II. However, if Phase 2 is not implemented, install piping stub outs with cutoff valves on the primary CHW loop for future CHW conversion of the listed buildings in Figure 2.

C. Discussion:

Phase I - This ECO includes all buildings beside building 268. This being the only building in the area that requires year round cooling, it was not cost effective for two reasons. One being the first cost of providing piping to the building which transverses across a street. The second being the operating cost of running a central plant at such low loads for six months out of the year just to serve one building are too high to justify. As listed in Figure-1, most of the other buildings are served by 21 liquid chillers. These chillers generally appear to be in fair to poor condition. Moreover, the cost of maintaining so many chillers is excessive and difficult for the maintenance staff. All of the above chillers are reciprocating air cooled chillers. Generally the chiller efficiency varies between 1.3 KW/ton to 1.8 KW/ton depending on the age and design conditions of the chiller. Therefore it is recommended that a central chiller plant, consisting of two water cooled centrifugal chillers be installed to serve these buildings. Computer simulations of the buildings in this area determined that the current installed capacity of 699 tons is more than required to adequately cool the buildings (Refer to Appendix H for computer modeling simulation). Therefore it is recommended that two new chillers rated at a combined 650 tons to serve the buildings. The 170 ton unit will be operated under a low load condition. Once the load has exceeded the smaller chiller, the second chiller will cycle on while the first chiller cycles off. Finally, once the load rises above the second chiller's capacity, the smaller chiller will cycle on together with the larger chiller. Six existing water cooled package units will be removed from the Museum (Building 123). Six AHUs with chilled water coils and a secondary CHW pump will be installed. The existing CW pump and CW water piping will be reutilized to serve as CHW piping.

Phase 2 - Buildings indicated in Table-2 will be furnished with new FCUs and new secondary CHW pumps. Their sizes are listed in Figure-2. FCUs are selected over the AHUs because of the ease of construction and because of the historical significance of the area. Vertical convector type FCUs can be installed fairly easily in the place of the existing equipment without damaging the antiquity of the buildings. The DX coil split systems will be removed from Buildings 127, 144 and 159, and new horizontal ceiling mounted fan coils will replace the existing AHUs.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed chillers and pumps were calculated using the Trace 600 computer program [1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models [2].

Several types of chillers were modeled including water cooled centrifugal, water cooled centrifugal with VFD drive, water cooled screw, and gas engine driven machines. Full load data was obtained from York International and input into the user defined equipment

associated with Trace 600. Water cooled R-123 centrifugal drives have more efficient full load KW/ton ratings over the screw or gas engine driven machines, while the screw machines were approximately 10% more efficient in the part load range between 25% - 50% full load. These full load performance data from York International was used in the computer simulations of the new chiller energy usage, while part load data was available from equipment supplied with Trace 600. An equipment list of the specific chillers and pumps modeled for the proposed equipment are shown on pageS C-27 through C-30.

The monthly peak demand and energy consumption of the existing and proposed chillers and pumps were calculated using the Trace 600 computer program. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models.

Once the computer simulations of the existing and new chiller plants were completed, the total annual demand cost and energy consumption of the new central plant was compared with that of the existing individual systems to determine the annual savings for this ECO [3]. These savings calculations are shown on pages C-31 through C-34. These demand and energy savings values were used in the life cycle cost analysis. The results of these savings calculations were as follows:

Alternative	Chiller Type	Demand Savings $/yr	Electrical Savings MMBTU/yr	Gas Savings MMBTU/yr
B1	Electric Centrifugal	37,558	4350	0
B2	Electric Centrifugal & VFD	37,077	4495	0
B3	Electric Screw	35,298	4244	0
B4	Gas Driven Centrifugal	50,662	5595	-4022

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water cooled chillers, split systems, window units, packaged units, and condensers in this area to two water cooled chillers. The total maintenance cost savings from this ECO is estimated to be $26,773 per year as seen on page C-59. This figure was used in the life cycle cost analysis.

E. Cost Estimates:

The total installation costs for each alternative chiller mentioned in this ECO were estimated on pages C-35 through C-58. These costs were used in the life cycle cost analysis for each alternative. The results of the costs estimates were as follows:

Alternative	Chiller Type	Estimated Cost
B1	Electric Centrifugal	$1,646,927
B2	Electric Centrifugal & VFD	$1,669,966
B3	Electric Screw	$1,675,914
B4	Gas Driven Centrifugal	$2,009,310

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for each life cycle cost analysis is shown on pages C-60 through C-63. The results of the alternative life cycle cost analysis were as follows:

Alternative	Chiller Type	Payback Years	SIR
B1	Electric Centrifugal	18.0	0.83
B2	Electric Centrifugal & VFD	18.1	0.82
B3	Electric Screw	18.9	0.79
B4	Gas Driven Centrifugal	21.2	0.67

Since the electric centrifugal chiller has the highest SIR, it is recommended as the most economical choice to replace the existing machine. The data from the life cycle cost analysis for this alternative were included in the summary on page C-22.

REFERENCES

1. See Appendix B for computer model input assumptions, data, and energy consumption output data.

2. See Appendix C for building field data and existing HVAC system data.

3. See appendix A for utility cost analysis data used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-B1, FORT SAM HOUSTON, AREA 100 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York YT water cooled, centrifugal, 480 tons, R-123	Area 100	New	264 KW
Chilled Water Pump	1	Bell & Gossett 1175 gpm, 125 ft 50 HP	Area 100	New	37.30 KW
Condenser Water Pump	1	Bell & Gossett 1440 gpm, 65 ft 40 HP	Area 100	New	29.80 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 25 HP fan	Area 100	New	18.60 KW
Water Chiller	1	Trane CVHE 250 water cooled, centrifugal, 170 tons, R-123	Currently serves bldg. 592, but relocate to serve Area 100	1995	105 KW
Chilled Water Pump	1	Bell & Gossett 408 gpm, 125 ft 20 HP	Area 100	New	14.90 KW
Condenser Water Pump	1	Bell & Gossett 600 gpm, 65 ft 15 HP	Currently serves bldg. 592 Chiller, but relocate to serve Area 100	1987	11.20 KW
Cooling Tower	1	Marley single speed, approximately 20 HP	Currently serves bldg. 592 Chiller, but relocate to serve Area 100	1988	14.90 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-B2, FORT SAM HOUSTON, AREA 100 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York YT with VFD water cooled, centrifugal, 480 tons, R-123	Area 100	New	264 KW
Chilled Water Pump	1	Bell & Gossett 1175 gpm, 125 ft 50 HP	Area 100	New	37.30 KW
Condenser Water Pump	1	Bell & Gossett 1440 gpm, 65 ft 40 HP	Area 100	New	29.80 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 25 HP fan	Area 100	New	18.60 KW
Water Chiller	1	Trane CVHE 250 water cooled, centrifugal, 170 tons, R-123	Currently serves bldg. 592, but relocate to serve Area 100	1995	105 KW
Chilled Water Pump	1	Bell & Gossett 408 gpm, 125 ft 20 HP	Area 100	New	14.90 KW
Condenser Water Pump	1	Bell & Gossett 600 gpm, 65 ft 15 HP	Currently serves bldg. 592 Chiller, but relocate to serve Area 100	1987	11.20 KW
Cooling Tower	1	Marley single speed, approximately 20 HP	Currently serves bldg. 592 Chiller, but relocate to serve Area 100	1988	14.90 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-B3, FORT SAM HOUSTON, AREA 100 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York YS water cooled screw 480 tons, R-123	Area 100	New	307 KW
Chilled Water Pump	1	Bell & Gossett 1175 gpm, 125 ft 50 HP	Area 100	New	37.30 KW
Condenser Water Pump	1	Bell & Gossett 1440 gpm, 65 ft 40 HP	Area 100	New	29.80 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 25 HP fan	Area 100	New	18.60 KW
Water Chiller	1	Trane CVHE 250 water cooled, centrifugal, 170 tons, R-123	Currently serves bldg. 592, but relocate to serve Area 100	1995	105 KW
Chilled Water Pump	1	Bell & Gossett 408 gpm, 125 ft 20 HP	Area 100	New	14.90 KW
Condenser Water Pump	1	Bell & Gossett 600 gpm, 65 ft 15 HP	Currently serves bldg. 592 Chiller, but relocate to serve Area 100	1987	11.20 KW
Cooling Tower	1	Marley single speed, approximately 20 HP	Currently serves bldg. 592 Chiller, but relocate to serve Area 100	1988	14.90 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-B4, FORT SAM HOUSTON, AREA 100 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York, gas engine driven water cooled, centrifugal 480 tons, R-134a	Area 100	New	3,168 MBH
Chilled Water Pump	1	Bell & Gossett 1175 gpm, 125 ft 50 HP	Area 100	New	37.30 KW
Condenser Water Pump	1	Bell & Gossett 1584 gpm, 65 ft 40 HP	Area 100	New	29.80 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 30 HP fan	Area 100	New	22.40 KW
Water Chiller	1	Trane CVHE 250 water cooled, centrifugal, 170 tons, R-123	Currently serves bldg. 592, but relocate to serve Area 100	1995	105 KW
Chilled Water Pump	1	Bell & Gossett 408 gpm, 125 ft 20 HP	Area 100	New	14.90 KW
Condenser Water Pump	1	Bell & Gossett 600 gpm, 65 ft 15 HP	Currently serves bldg. 592 Chiller, but relocate to serve Area 100	1987	11.20 KW
Cooling Tower	1	Marley single speed, approximately 20 HP	Currently serves bldg. 592 Chiller, but relocate to serve Area 100	1988	14.90 KW

ITEM	ECO B - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldgs. 122 & 140 Chiller					53.2	59.2	63.7	62.9	53.4	38.7			105,589	
Bldgs. 122 & 140 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 124 & 125 Chiller					58.7	65.2	69.7	68.4	58.3	42.8			114,027	
Bldgs. 124 & 125 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 128 Chiller					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 128 CHW Controls					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 133 Chiller					36.9	41.7	44.8	44.4	38.3	27.1			79,446	
Bldg. 133 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 134 & 135 Chiller					49.6	51.8	53.8	53.3	49.8	45.5			109,087	
Bldgs. 134 & 135 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 143 Chiller					56.9	61.9	66.7	67.5	58.5	45.7			106,683	
Bldg. 143 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 144 Chiller					4.4	4.5	4.5	4.7	4.9	3.4			10,120	
Bldg. 144 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			3,898	
Bldg. 144 Chiller					52.3	56.8	61.2	61.9	53.7	41.9			83,823	
Bldg. 144 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			2,657	
Bldg. 145 Window Units					51.9	54.0	56.0	55.5	52.0	48.6			48,756	
Bldg. 145 Window Unit Fans					4.8	5.2	7.4	7.4	5.0	3.8			7,225	
Bldg. 145 Window Unit Controls					1.0	1.0	1.0	1.0	1.0	1.0			442	
Bldg. 146 Chiller					54.7	59.5	64.2	64.9	56.2	44.1			106,939	
Bldg. 146 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldgs. 147 & 149 Chiller					81.0	86.4	89.6	88.9	82.6	70.8			176,040	
Bldgs. 147 & 149 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 197 Chiller					56.1	61.1	65.6	65.9	57.7	45.7			106,257	
Bldg. 197 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 198 Condenser					13.2	14.1	14.7	14.5	13.6	10.1			20,362	
Bldg. 198 Condenser Fans					1.7	1.8	1.8	1.8	1.8	1.4			2,731	
Bldg. 198 Condenser Controls					0.3	0.3	0.3	0.3	0.3	0.3			1,325	
Bldg. 199 Chiller					21.6	24.1	26.4	26.6	22.7	16.4			46,260	
Bldg. 199 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 127 Condenser					6.6	6.9	7.1	7.1	6.6	6.1			10,166	
Bldg. 127 Condenser Fans					0.6	0.6	0.6	0.6	0.6	0.4			956	
Bldg. 127 Condenser Controls					0.3	0.3	0.3	0.3	0.3	0.3			1,325	
Bldg. 250 Chiller					140.8	150.4	162.3	166.0	145.0	110.5			315,629	
Bldg. 250 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 142 Chiller					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 142 Chiller					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 142 CHW Controls					0.0	0.0	0.0	0.0	0.0	0.0			0	
Bldg. 123 Chiller					13.1	13.3	14.1	14.5	13.4	10.2			34,487	
Bldg. 123 Cooling Tower Fans					1.5	1.5	1.5	1.5	1.5	1.5			5,893	
Bldg. 123 CHW Controls					0.1	0.1	0.1	0.1	0.1	0.1			413	
Bldg. 126 Chiller					40.4	43.8	47.1	47.9	43.3	35.0			86,201	
Bldg. 126 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 131 Chiller					32.7	35.7	38.3	38.2	35.4	27.8			69,516	
Bldg. 131 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 129 Chiller					4.9	5.2	5.7	5.9	5.6	4.9			13,350	
Bldg. 129 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 129 Chiller					36.7	39.3	42.8	44.3	42.0	37.1			72,266	
Bldg. 129 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			3,305	
Bldg. 151 Window Units	3.6	3.6	3.6	3.7	4.0	4.1	4.3	4.2	4.0	4	4	3.6	5,685	

ITEM	ECO B - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 151 Window Unit Fans	0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.5	0.4	0.3	0.2	0.1	733	
Bldg. 151 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	434	
Bldg. 154 Window Units	7.0	7.0	7.0	7.3	7.7	8.1	8.3	8.3	7.8	7.3	7.0	7.0	7,197	
Bldg. 154 Window Unit Fans	0.1	0.0	0.2	0.4	0.5	0.6	1.0	1.0	0.6	0.3	0.2	0.1	978	
Bldg. 154 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	379	
Bldg. 156 Window Units	0.0	0.0	13.1	13.8	14.6	15.2	15.8	15.7	14.7	13.7	13.1	0.0	7,055	
Bldg. 156 Window Unit Fans	0.0	0.0	0.2	0.3	0.5	0.5	1.8	1.8	0.5	0.3	0.2	0.0	986	
Bldg. 156 Window Unit Controls	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	358	
Bldg. 157 Window Units	3.1	3.1	3.1	3.3	3.5	3.6	3.8	3.7	3.5	3.3	3.1	3.1	6,357	
Bldg. 157 Window Unit Fans	0.1	0.1	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.1	876	
Bldg. 157 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	514	
Bldg. 159 Condenser					3.6	3.7	3.8	3.8	3.4	2.3			10,476	
Bldg. 159 Condenser Fans					0.5	0.5	0.5	0.5	0.5	0.4			1,501	
Bldg. 159 Condenser Controls					0.3	0.3	0.3	0.3	0.3	0.3			1,325	
Bldg. 152 Window Units	11.9	11.9	11.9	12.4	13.2	13.8	14.3	14.1	13.2	12.4	11.9	11.9	18,405	
Bldg. 152 Window Unit Fans	0.3	0.3	0.8	1.2	1.6	1.8	1.9	1.9	1.7	1.2	0.8	0.4	2,716	
Bldg. 152 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	484	
Bldg. 155 Condenser	8.2	8.3	6.6	6.4	8.1	10.0	9.9	9.3	9.0	7.8	7.8	8.3	22,335	
Bldg. 155 Condenser Fans	0.6	0.4	0.7	0.7	0.8	1.0	1.0	1.0	0.9	0.8	0.7	0.5	2,305	
Bldg. 155 Condenser Controls	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1,457	
Bldg. 155 Window Units	14.2	14.2	14.2	14.9	15.8	16.5	17.1	17.0	15.9	14.9	14.2	14.2	16,295	
Bldg. 155 Window Unit Fans	0.6	0.5	1.1	1.4	1.6	1.7	2.0	2.0	1.7	1.3	1.1	0.6	2,065	
Bldg. 155 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	193	
Bldg. 158 Window Units	9.5	9.5	9.5	9.9	10.6	11.0	11.4	11.3	10.6	9.9	9.5	9.5	17,371	
Bldg. 158 Window Unit Fans	0.3	0.2	0.7	1.0	1.3	1.3	1.3	1.3	1.3	0.9	0.6	0.3	2,214	
Bldg. 158 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	450	
Bldg. 141 Window Units	3.1	3.1	3.1	3.3	3.5	3.6	3.8	3.7	3.5	3.3	3.1	3.1	8,248	
Bldg. 141 Window Unit Fans	0.1	0.1	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.1	1,133	
Bldg. 141 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	512	
Bldgs. 260 & 261 Chiller					18.3	19.9	21.1	20.9	18.3	14.6			35,084	
Bldgs. 260 & 261 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			3,906	
Bldg. 268 Chiller	11.3	11.3	13.3	15.9	19.2	21.3	22.9	23.2	20.0	14.8	12.9	11.3	48,278	
Bldg. 268 CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	5,323	
Totals	76.1	75.7	92.0	99.1	1025.7	1104.7	1178.2	1181.9	1055.5	854.9	92.7	76.2	2,036,210	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	571	568	690	743	7,693	11,047	11,782	11,819	10,555	6,412	695	572		

Total Demand	63,146	$/yr	
Total Energy	6,950	MMBTU/yr	(electric)
Total Energy		MMBTU/yr	(gas)

ITEM	ECO-B1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (170 TON)					92.3	98.7	97.2	102.2	91.0	85.4			102,000	
Cooling Tower					14.9	14.9	14.9	14.9	14.9	14.9			27,588	
CHW Pump					14.9	14.9	14.9	14.9	14.9	14.9			32,303	
CND Pump					11.2	11.2	11.2	11.2	11.2	11.2			24,282	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			2,168	
Water Chiller (480 TON)					233.2	249.9	245.0	257.1	245.0	208.9			367,084	
Cooling Tower					18.6	18.6	18.6	18.6	18.6	18.6			44,249	
CHW Pump					37.3	37.3	37.3	37.3	37.3	37.3			88,737	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			70,894	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			2,379	
Total (KW)					454.2	477.3	470.9	488.0	464.7	423.0			761,684	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)					3,407	4,773	4,709	4,880	4,647	3,173				

Total Demand	25,588	$/yr	
Demand Savings	37,558	$/yr	
Energy Savings	4,350	MMBTU/yr	(electric)
Energy Savings		MMBTU/yr	(gas)

ITEM	ECO-B2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (170 TON)					92.3	98.7	97.2	102.2	91.0	85.4			102,000	
Cooling Tower					14.9	14.9	14.9	14.9	14.9	14.9			27,588	
CHW Pump					14.9	14.9	14.9	14.9	14.9	14.9			32,303	
CND Pump					11.2	11.2	11.2	11.2	11.2	11.2			24,282	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			2,168	
Water Chiller (480 TON)					264.0	263.9	252.5	256.3	253.6	234.0			351,164	
Cooling Tower					12.1	13.5	16.5	18.6	14.4	9.5			17,581	
CHW Pump					37.3	37.3	37.3	37.3	37.3	37.3			88,737	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			70,894	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			2,379	
Total (KW)					478.5	486.2	476.3	487.2	469.1	439.0			719,096	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)					3,589	4,862	4,763	4,872	4,691	3,293				

Total Demand	26,069	$/yr	
Demand Savings	37,077	$/yr	
Energy Savings	4,495	MMBTU/yr	(electric)
Energy Savings		MMBTU/yr	(gas)

ITEM	ECO-B3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (170 TON)					92.3	98.7	97.2	102.2	91.0	85.4			102,000	
Cooling Tower					14.9	14.9	14.9	14.9	14.9	14.9			27,588	
CHW Pump					14.9	14.9	14.9	14.9	14.9	14.9			32,303	
CND Pump					11.2	11.2	11.2	11.2	11.2	11.2			24,282	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			2,168	
Water Chiller (480 TON)					274.1	292.0	286.2	299.1	286.2	247.3			397,991	
Cooling Tower					18.6	18.6	18.6	18.6	18.6	18.6			44,249	
CHW Pump					37.3	37.3	37.3	37.3	37.3	37.3			88,737	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			70,894	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			2,379	
Total (KW)					495.1	519.4	512.1	530.0	505.9	461.4			792,591	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)					3,713	5,194	5,121	5,300	5,059	3,461				

Total Demand	27,848	$/yr	
Demand Savings	35,298	$/yr	
Energy Savings	4,244	MMBTU/yr	(electric)
Energy Savings		MMBTU/yr	(gas)

ITEM	ECO-B4: NEW GAS ENGINE DRIVEN CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (170 TON)					92.3	98.7	95.8	99.8	91.0	85.4			94,971	
Cooling Tower					14.9	14.9	14.9	14.9	14.9	14.9			27,588	
CHW Pump					14.9	14.9	14.9	14.9	14.9	14.9			32,303	
CND Pump					11.2	11.2	11.2	11.2	11.2	11.2			24,282	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			2,168	
Water Chiller (480 TON)														4,022
Cooling Tower					22.4	22.4	22.4	22.4	22.4	22.4			53,290	
CHW Pump					37.3	37.3	37.3	37.3	37.3	37.3			88,737	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			70,894	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			2,379	
Heater for 480 ton chiller					0.2	0.2	0.2	0.2	0.2	0.2			307	
Total (KW)					225.0	231.4	228.5	232.5	223.7	218.1			396,919	4,022
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)					1,688	2,314	2,285	2,325	2,237	1,636				

Total Demand	12,484	$/yr	
Demand Savings	50,662	$/yr	
Energy Savings	5,595	MMBTU/yr	(electric)
Energy Savings	-4,022	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6B1	**DATE:** 3/2/96
ECO NO. B-1 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER UP TO 100 TON	100	TON	1.5	28.91	4,452	25.00	2,500	6,952
RMV CHILLER UP TO 50 TON	614	TON	1.6	28.91	28,579	25.00	15,350	43,929
RMV WTR COOLED PACKAGE UNIT AND FLUID COOLER	6	EA	8.9	28.91	1,544	50.00	300	1,844
RMV DIRECT EXPANSION CONDENSER & AHU	2	EA	5.0	28.91	289	50.00	100	389
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	6,000	LF	1.0	28.91	180,398	29.50	177,000	357,398
4"	160	LF	0.8	28.91	3,469	19.55	3,128	6,597
3"	400	LF	0.6	28.91	6,938	15.70	6,280	13,218
2-1/2"	1,340	LF	0.5	28.91	18,595	13.33	17,862	36,457
2"	640	LF	0.4	28.91	7,401	13.55	8,672	16,073
1-1/2"	680	LF	0.4	28.91	7,077	12.85	8,738	15,815
				SUBTOTAL	258,743		239,930	498,673
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6B1	DATE: 3/2/96
ECO NO. B-1 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 6"	8	EA	2.1	28.91	481	590.00	4,720	5,201
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	500.0	20.00	10,000	9,000.00	9,000	19,000
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	3	LOC	10.7	28.91	924	717.00	2,151	3,075
2-1/2"	7	LOC	9.6	28.91	1,943	639.00	4,473	6,416
2"	5	LOC	9.6	28.91	1,388	639.00	3,195	4,583
1-1/2"	5	LOC	8.0	28.91	1,156	600.00	3,000	4,156
ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE,								
PIPING ASSEMBLY & ELECTRICAL								
VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY	6	EA	10.0	28.91	1,735	3,900.00	23,400	25,135
AHU W/ CHW COIL 2-PIPE 2000 CFM	2	EA	14.5	28.91	838	3,400.00	6,800	7,638
				SUBTOTAL	18,916		57,774	76,690
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B1	**DATE:** 3/2/96
ECO NO. B-1 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
CONSTRUCT CENTRAL PLANT BASE BUILDING	1,000	BSF				75.00	75,000	75,000
HISTORICLY COMPATABLE								
COOLING TOWER ENCLOSURE	1	SUM	1.0	9,000.00	9,000	12,000.00	12,000	21,000
CENTRAL PLANT ELECTRICAL SYSTEM	1,000	BSF				34.00	34,000	34,000
CHILLER (YORK YT) WITH PIPING & VESELS	480	TON	3.2	28.91	44,406	371.00	178,080	222,486
RELOCATE CHILLER FROM BLDG 592	170	TON	4.7	28.91	23,099	75.00	12,750	35,849
PRIMARY PUMPS 50 HP	1	EA	100.0	28.91	2,891	8,200.00	8,200	11,091
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	500	TON	0.6	28.91	8,673	92.00	46,000	54,673
RELOCATE COOLING TOWER AND PUMPS FROM BLDG 592	170	TON	1.2	28.91	5,898	35.00	5,950	11,848
				SUBTOTAL	93,966		371,980	465,946
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6B1	DATE: 3/2/96
ECO NO. B-1 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED	59	EA	1.5	22.00	1,947	10.00	590	2,537
REMOVE PACKAGE UNIT 4 TON	1	EA	8.9	28.91	257	25.00	25	282
REMOVE SPLIT SYSTEM 3-4 TON EQUIPMENT	2	EA	10.0	28.91	578	50.00	100	678
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
3"	100	LF	0.6	28.91	1,735	15.70	1,570	3,305
2"	100	LF	0.4	28.91	1,156	13.35	1,335	2,491
1-1/2"	240	LF	0.4	28.91	2,498	12.85	3,084	5,582
1-1/4"	320	LF	0.4	28.91	3,238	11.90	3,808	7,046
1"	100	LF	0.3	28.91	925	10.65	1,065	1,990
SUBTOTAL					12,334		11,577	23,911
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6B1	DATE: 3/2/96
ECO NO. B-1 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 5	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND NEW CHW PUMPS COST PER LOCATION								
3"	1	LOC	21.2	28.91	613	2,417.00	2,417	3,030
2"	1	LOC	19.2	28.91	555	1,639.00	1,639	2,194
1-1/2"	3	LOC	16.0	28.91	1,388	1,400.00	4,200	5,588
1-1/4"	4	LOC	16.0	28.91	1,850	1,400.00	5,600	7,450
1"	2	LOC	14.0	28.91	809	1,300.00	2,600	3,409
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	200	EA	0.5	28.91	2,891	7.05	1,410	4,301
1-1/2"	500	EA	0.4	28.91	5,782	5.05	2,525	8,307
1"	1,000	EA	0.3	28.91	8,673	4.38	4,380	13,053
3/4"	2,000	EA	0.3	28.91	17,346	2.75	5,500	22,846
				SUBTOTAL	39,907		30,271	70,178
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B1		**DATE:** 3/2/96
ECO NO. B-1 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY,	56	EA	4.8	28.91	7,690	1,375.00	77,000	84,690
CONTROL VALVE AND ELECTRIC CIRCUIT								
AHU 2-PIPE W/ COIL, PIPING AND CONTROL VALVE								
4,5 TON	1	EA	14.5	28.91	419	3,400.00	3,400	3,819
3 TON	1	EA	12.0	28.91	347	3,000.00	3,000	3,347
SUB TOTAL FROM SHEET 1					258,743		239,930	498,673
SUB TOTAL FROM SHEET 2					18,916		57,774	76,690
SUB TOTAL FROM SHEET 3					93,966		371,980	465,946
SUB TOTAL FROM SHEET 4					12,334		11,577	23,911
SUB TOTAL FROM SHEET 5					39,907		30,271	70,178
SUBTOTAL					432,323		794,932	1,227,255
O & P @ 20%					86,465		158,986	245,451
SUBTOTAL					518,787		953,919	1,472,706
DESIGN @ 6%								88,362
SUBTOTAL								1,561,068
SIOH @ 5.5%								85,859
TOTAL								$1,646,927

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B2	**DATE:** 3/2/96
ECO NO. B- 2 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE ONE250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER UP TO 100 TON	100	TON	1.5	28.91	4,452	25.00	2,500	6,952
RMV CHILLER UP TO 50 TON	614	TON	1.6	28.91	28,579	25.00	15,350	43,929
RMV WTR COOLED PACKAGE UNIT AND FLUID COOLER	6	EA	8.9	28.91	1,544	50.00	300	1,844
RMV DIRECT EXPANSION CONDENSER & AHU	2	EA	5.0	28.91	289	50.00	100	389
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	6,000	LF	1.0	28.91	180,398	29.50	177,000	357,398
4"	160	LF	0.8	28.91	3,469	19.55	3,128	6,597
3"	400	LF	0.6	28.91	6,938	15.70	6,280	13,218
2-1/2"	1,340	LF	0.5	28.91	18,595	13.33	17,862	36,457
2"	640	LF	0.4	28.91	7,401	13.55	8,672	16,073
1-1/2"	680	LF	0.4	28.91	7,077	12.85	8,738	15,815
				SUBTOTAL	258,743		239,930	498,673
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B2		**DATE:** 3/2/96
ECO NO. B Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 6"	8	EA	2.1	28.91	481	590.00	4,720	5,201
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	500.0	20.00	10,000	9,000.00	9,000	19,000
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	3	LOC	10.7	28.91	924	717.00	2,151	3,075
2-1/2"	7	LOC	9.6	28.91	1,943	639.00	4,473	6,416
2"	5	LOC	9.6	28.91	1,388	639.00	3,195	4,583
1-1/2"	5	LOC	8.0	28.91	1,156	600.00	3,000	4,156
ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE,								
PIPING ASSEMBLY & ELECTRICAL								
VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY	6	EA	10.0	28.91	1,735	3,900.00	23,400	25,135
AHU W/ CHW COIL 2-PIPE 2000 CFM	2	EA	14.5	28.91	838	3,400.00	6,800	7,638
				SUBTOTAL	18,916		57,774	76,690
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6B2	DATE: 3/2/96
ECO NO. B-2 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE ONE 250923Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
CONSTRUCT CENTRAL PLANT BASE BUILDING	1,000	BSF				75.00	75,000	75,000
HISTORICLY COMPATABLE								
COOLING TOWER ENCLOSURE	1	SUM	1.0	9,000.00	9,000	12,000.00	12,000	21,000
CENTRAL PLANT ELECTRICAL SYSTEM	1,000	BSF				34.00	34,000	34,000
CHILLER (YORK YT) WITH PIPING & VESELS	480	TON	3.2	28.91	44,406	371.00	178,080	222,486
RELOCATE CHILLER FROM BLDG 592	170	TON	4.7	28.91	23,099	75.00	12,750	35,849
PRIMARY PUMPS 50 HP	1	EA	100.0	28.91	2,891	8,200.00	8,200	11,091
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	500	TON	0.6	28.91	8,673	92.00	46,000	54,673
RELOCATE COOLING TOWER AND PUMPS FROM BLDG 592	170	TON	1.2	28.91	5,898	35.00	5,950	11,848
ADD FOR VFD AT PRIMARY CHILLER	100	HP	0.8	28.91	2,168	150.00	15,000	17,168
SUBTOTAL					96,135		386,980	483,115
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B2		**DATE:** 3/2/96
ECO NO. B Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE TWO 52497 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED	59	EA	1.5	22.00	1,947	10.00	590	2,537
REMOVE PACKAGE UNIT 4 TON	1	EA	8.9	28.91	257	25.00	25	282
REMOVE SPLIT SYSTEM 3-4 TON EQUIPMENT	2	EA	10.0	28.91	578	50.00	100	678
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
3"	100	LF	0.6	28.91	1,735	15.70	1,570	3,305
2"	100	LF	0.4	28.91	1,156	13.35	1,335	2,491
1-1/2"	240	LF	0.4	28.91	2,498	12.85	3,084	5,582
1-1/4"	320	LF	0.4	28.91	3,238	11.90	3,808	7,046
1"	100	LF	0.3	28.91	925	10.65	1,065	1,990
SUBTOTAL					12,334		11,577	23,911
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B2	**DATE:** 3/2/96
ECO NO. B Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE TWO 52497 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 5	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND NEW CHW PUMPS COST PER LOCATION								
3"	1	LOC	21.2	28.91	613	2,417.00	2,417	3,030
2"	1	LOC	19.2	28.91	555	1,639.00	1,639	2,194
1-1/2"	3	LOC	16.0	28.91	1,388	1,400.00	4,200	5,588
1-1/4"	4	LOC	16.0	28.91	1,850	1,400.00	5,600	7,450
1"	2	LOC	14.0	28.91	809	1,300.00	2,600	3,409
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	200	EA	0.5	28.91	2,891	7.05	1,410	4,301
1-1/2"	500	EA	0.4	28.91	5,782	5.05	2,525	8,307
1"	1,000	EA	0.3	28.91	8,673	4.38	4,380	13,053
3/4"	2,000	EA	0.3	28.91	17,346	2.75	5,500	22,846
				SUBTOTAL	39,907		30,271	70,178
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B2		**DATE:** 3/2/96
ECO NO. B Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE TWO 52497 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY,	56	EA	4.8	28.91	7,690	1,375.00	77,000	84,690
CONTROL VALVE AND ELECTRIC CIRCUIT								
AHU 2-PIPE W/ COIL, PIPING AND CONTROL VALVE								
4,5 TON	1	EA	14.5	28.91	419	3,400.00	3,400	3,819
3 TON	1	EA	12.0	28.91	347	3,000.00	3,000	3,347
SUB TOTAL FROM SHEET 1					258,743		239,930	498,673
SUB TOTAL FROM SHEET 2					18,916		57,774	76,690
SUB TOTAL FROM SHEET 3					96,135		386,980	483,115
SUB TOTAL FROM SHEET 4					12,334		11,577	23,911
SUB TOTAL FROM SHEET 5					39,907		30,271	70,178
SUBTOTAL					434,491		809,932	1,244,423
O & P @ 20%					86,898		161,986	248,885
SUBTOTAL					521,389		971,919	1,493,308
DESIGN @ 6%								89,598
SUBTOTAL								1,582,906
SIOH @ 5.5%								87,060
TOTAL								$1,669,966

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6B3	**DATE:** 3/2/96
ECO NO. B-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER UP TO 100 TON	100	TON	1.5	28.91	4,452	25.00	2,500	6,952
RMV CHILLER UP TO 50 TON	614	TON	1.6	28.91	28,579	25.00	15,350	43,929
RMV WTR COOLED PACKAGE UNIT AND FLUID COOLER	6	EA	8.9	28.91	1,544	50.00	300	1,844
RMV DIRECT EXPANSION CONDENSER & AHU	2	EA	5.0	28.91	289	50.00	100	389
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	6,000	LF	1.0	28.91	180,398	29.50	177,000	357,398
4"	160	LF	0.8	28.91	3,469	19.55	3,128	6,597
3"	400	LF	0.6	28.91	6,938	15.70	6,280	13,218
2-1/2"	1,340	LF	0.5	28.91	18,595	13.33	17,862	36,457
2"	640	LF	0.4	28.91	7,401	13.55	8,672	16,073
1-1/2"	680	LF	0.4	28.91	7,077	12.85	8,738	15,815
				SUBTOTAL	258,743		239,930	498,673
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B3		**DATE:** 3/2/96
ECO NO. B-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 6"	8	EA	2.1	28.91	481	590.00	4,720	5,201
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	500.0	20.00	10,000	9,000.00	9,000	19,000
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	3	LOC	10.7	28.91	924	717.00	2,151	3,075
2-1/2"	7	LOC	9.6	28.91	1,943	639.00	4,473	6,416
2"	5	LOC	9.6	28.91	1,388	639.00	3,195	4,583
1-1/2"	5	LOC	8.0	28.91	1,156	600.00	3,000	4,156
ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE,								
PIPING ASSEMBLY & ELECTRICAL								
VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY	6	EA	10.0	28.91	1,735	3,900.00	23,400	25,135
AHU W/ CHW COIL 2-PIPE 2000 CFM	2	EA	14.5	28.91	838	3,400.00	6,800	7,638
				SUBTOTAL	18,916		57,774	76,690
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B3		**DATE:** 3/2/96
ECO NO. B-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
CONSTRUCT CENTRAL PLANT BASE BUILDING	1,000	BSF				75.00	75,000	75,000
HISTORICLY COMPATABLE								
COOLING TOWER ENCLOSURE	1	SUM	1.0	9,000.00	9,000	12,000.00	12,000	21,000
CENTRAL PLANT ELECTRICAL SYSTEM	1,000	BSF				34.00	34,000	34,000
CHILLER (YORK YS) WITH PIPING & VESELS	480	TON	3.2	28.91	44,406	416.00	199,680	244,086
RELOCATE CHILLER FROM BLDG 592	170	TON	4.7	28.91	23,099	75.00	12,750	35,849
PRIMARY PUMPS 50 HP	1	EA	100.0	28.91	2,891	8,200.00	8,200	11,091
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	500	TON	0.6	28.91	8,673	92.00	46,000	54,673
RELOCATE COOLING TOWER AND PUMPS FROM BLDG 592	170	TON	1.2	28.91	5,898	35.00	5,950	11,848
SUBTOTAL					93,966		393,580	487,546
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B3	**DATE:** 3/2/96
ECO NO. B-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED	59	EA	1.5	22.00	1,947	10.00	590	2,537
REMOVE PACKAGE UNIT 4 TON	1	EA	8.9	28.91	257	25.00	25	282
REMOVE SPLIT SYSTEM 3-4 TON EQUIPMENT	2	EA	10.0	28.91	578	50.00	100	678
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
3"	100	LF	0.6	28.91	1,735	15.70	1,570	3,305
2"	100	LF	0.4	28.91	1,156	13.35	1,335	2,491
1-1/2"	240	LF	0.4	28.91	2,498	12.85	3,084	5,582
1-1/4"	320	LF	0.4	28.91	3,238	11.90	3,808	7,046
1"	100	LF	0.3	28.91	925	10.65	1,065	1,990
SUBTOTAL					12,334		11,577	23,911
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6B3	DATE: 3/2/96
ECO NO. B-3 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 5	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND NEW CHW PUMPS COST PER LOCATION								
3"	1	LOC	21.2	28.91	613	2,417.00	2,417	3,030
2"	1	LOC	19.2	28.91	555	1,639.00	1,639	2,194
1-1/2"	3	LOC	16.0	28.91	1,388	1,400.00	4,200	5,588
1-1/4"	4	LOC	16.0	28.91	1,850	1,400.00	5,600	7,450
1"	2	LOC	14.0	28.91	809	1,300.00	2,600	3,409
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	200	EA	0.5	28.91	2,891	7.05	1,410	4,301
1-1/2"	500	EA	0.4	28.91	5,782	5.05	2,525	8,307
1"	1,000	EA	0.3	28.91	8,673	4.38	4,380	13,053
3/4"	2,000	EA	0.3	28.91	17,346	2.75	5,500	22,846
				SUBTOTAL	39,907		30,271	70,178
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B3	**DATE:** 3/2/96
ECO NO. B-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY,	56	EA	4.8	28.91	7,690	1,375.00	77,000	84,690
CONTROL VALVE AND ELECTRIC CIRCUIT								
AHU 2-PIPE W/ COIL, PIPING AND CONTROL VALVE								
4,5 TON	1	EA	14.5	28.91	419	3,400.00	3,400	3,819
3 TON	1	EA	12.0	28.91	347	3,000.00	3,000	3,347
SUB TOTAL FROM SHEET 1					258,743		239,930	498,673
SUB TOTAL FROM SHEET 2					18,916		57,774	76,690
SUB TOTAL FROM SHEET 3					93,966		393,580	487,546
SUB TOTAL FROM SHEET 4					12,334		11,577	23,911
SUB TOTAL FROM SHEET 5					39,907		30,271	70,178
SUBTOTAL					432,323		816,532	1,248,855
O & P @ 20%					86,465		163,306	249,771
SUBTOTAL					518,787		979,839	1,498,626
DESIGN @ 6%								89,918
SUBTOTAL								1,588,543
SIOH @ 5.5%								87,370
TOTAL								$1,675,913

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6B4	DATE: 3/2/96
ECO NO. B-4 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A PHASE ONE 250923
Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER UP TO 100 TON	100	TON	1.5	28.91	4,452	25.00	2,500	6,952
RMV CHILLER UP TO 50 TON	614	TON	1.6	28.91	28,579	25.00	15,350	43,929
RMV WTR COOLED PACKAGE UNIT AND FLUID COOLER	6	EA	8.9	28.91	1,544	50.00	300	1,844
RMV DIRECT EXPANSION CONDENSER & AHU	2	EA	5.0	28.91	289	50.00	100	389
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	6,000	LF	1.0	28.91	180,398	29.50	177,000	357,398
4"	160	LF	0.8	28.91	3,469	19.55	3,128	6,597
3"	400	LF	0.6	28.91	6,938	15.70	6,280	13,218
2-1/2"	1,340	LF	0.5	28.91	18,595	13.33	17,862	36,457
2"	640	LF	0.4	28.91	7,401	13.55	8,672	16,073
1-1/2"	680	LF	0.4	28.91	7,077	12.85	8,738	15,815
				SUBTOTAL	258,743		239,930	498,673
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO:	03-185.6B4	DATE: 3/2/96
ECO NO. B-4 Retrofit Existing Individual Chillers	BY : KOTHMANN, K		CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 6"	8	EA	2.1	28.91	481	590.00	4,720	5,201
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	500.0	20.00	10,000	9,000.00	9,000	19,000
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	3	LOC	10.7	28.91	924	717.00	2,151	3,075
2-1/2"	7	LOC	9.6	28.91	1,943	639.00	4,473	6,416
2"	5	LOC	9.6	28.91	1,388	639.00	3,195	4,583
1-1/2"	5	LOC	8.0	28.91	1,156	600.00	3,000	4,156
ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE,								
PIPING ASSEMBLY & ELECTRICAL								
VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY	6	EA	10.0	28.91	1,735	3,900.00	23,400	25,135
AHU W/ CHW COIL 2-PIPE 2000 CFM	2	EA	14.5	28.91	838	3,400.00	6,800	7,638
				SUBTOTAL	18,916		57,774	76,690
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6B4	DATE: 3/2/96
ECO NO. B-4 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
CONSTRUCT CENTRAL PLANT BASE BUILDING	1,000	BSF				75.00	75,000	75,000
HISTORICLY COMPATABLE								
COOLING TOWER ENCLOSURE	1	SUM	1.0	9,000.00	9,000	12,000.00	12,000	21,000
CENTRAL PLANT ELECTRICAL SYSTEM	1,000	BSF				34.00	34,000	34,000
CHILLER WITH PIPING & VESELS	480	TON	4.5	28.91	62,446	896.00	430,080	492,526
GAS ENGINE DRIVEN R 134a								
RELOCATE CHILLER FROM BLDG 592	170	TON	4.7	28.91	23,099	75.00	12,750	35,849
PRIMARY PUMPS 50 HP	1	EA	100.0	28.91	2,891	8,200.00	8,200	11,091
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	500	TON	0.6	28.91	8,673	92.00	46,000	54,673
RELOCATE COOLING TOWER AND PUMPS FROM BLDG 592	170	TON	1.2	28.91	5,898	35.00	5,950	11,848
SUBTOTAL					112,006		623,980	735,986
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6B4		DATE: 3/2/96
ECO NO. B-4 Retrofit Existing Individual Chillers	BY : KOTHMANN, K		CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED	59	EA	1.5	22.00	1,947	10.00	590	2,537
REMOVE PACKAGE UNIT 4 TON	1	EA	8.9	28.91	257	25.00	25	282
REMOVE SPLIT SYSTEM 3-4 TON EQUIPMENT	2	EA	10.0	28.91	578	50.00	100	678
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
3"	100	LF	0.6	28.91	1,735	15.70	1,570	3,305
2"	100	LF	0.4	28.91	1,156	13.35	1,335	2,491
1-1/2"	240	LF	0.4	28.91	2,498	12.85	3,084	5,582
1-1/4"	320	LF	0.4	28.91	3,238	11.90	3,808	7,046
1"	100	LF	0.3	28.91	925	10.65	1,065	1,990
SUBTOTAL					12,334		11,577	23,911
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6B4		DATE: 3/2/96
ECO NO. B-4 Retrofit Existing Individual Chillers	BY : KOTHMANN, K		CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION SHEET 5	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND NEW CHW PUMPS COST PER LOCATION								
3"	1	LOC	21.2	28.91	613	2,417.00	2,417	3,030
2"	1	LOC	19.2	28.91	555	1,639.00	1,639	2,194
1-1/2"	3	LOC	16.0	28.91	1,388	1,400.00	4,200	5,588
1-1/4"	4	LOC	16.0	28.91	1,850	1,400.00	5,600	7,450
1"	2	LOC	14.0	28.91	809	1,300.00	2,600	3,409
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	200	EA	0.5	28.91	2,891	7.05	1,410	4,301
1-1/2"	500	EA	0.4	28.91	5,782	5.05	2,525	8,307
1"	1,000	EA	0.3	28.91	8,673	4.38	4,380	13,053
3/4"	2,000	EA	0.3	28.91	17,346	2.75	5,500	22,846
				SUBTOTAL	39,907		30,271	70,178
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6B4		**DATE:** 3/2/96
ECO NO. B-4 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY,	56	EA	4.8	28.91	7,690	1,375.00	77,000	84,690
CONTROL VALVE AND ELECTRIC CIRCUIT								
AHU 2-PIPE W/ COIL, PIPING AND CONTROL VALVE								
4,5 TON	1	EA	14.5	28.91	419	3,400.00	3,400	3,819
3 TON	1	EA	12.0	28.91	347	3,000.00	3,000	3,347
SUB TOTAL FROM SHEET 1					258,743		239,930	498,673
SUB TOTAL FROM SHEET 2					18,916		57,774	76,690
SUB TOTAL FROM SHEET 3					112,006		623,980	735,986
SUB TOTAL FROM SHEET 4					12,334		11,577	23,911
SUB TOTAL FROM SHEET 5					39,907		30,271	70,178
SUBTOTAL					450,363		1,046,932	1,497,295
O & P @ 20%					90,073		209,386	299,459
SUBTOTAL					540,435		1,256,319	1,796,754
DESIGN @ 6%								107,805
SUBTOTAL								1,904,559
SIOH @ 5.5%								104,751
TOTAL								$2,009,310

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6MA		**DATE:** 3/2/96
ECO NO. B Retrofit Existing Chillers	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 100

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON EXISTING								
OUTSIDE CONTRACT COSTS PER CHILLER PER YEAR								
EXISTING WATER COOLEDCHILLERS		EA	200.0	30.00		6,150.00		
EXISTING AIR COOLED CHILLERS	-699.	TON	0.7	30.00	-14,679	29.00	-20,271	-34,950
EXISTING WINDOW UNITS	-59.	EA	3.0	30.00	-5,310	20.00	-1,180	-6,490
EXISTING DX SYSTEM	-21.5	TON	1.0	30.00	-645	5.00	-108	-753
NEW EQUIPMENT								
NEW WATER COOLED CHILLERS	2.	EA	190.0	30.00	11,400	6,150.00	4,020	15,420
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-9,234		-17,539	-26,773
PER YEAR								

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Life Cycle Cost Analysis — Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS — Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-B1
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

ECIP Summary Report

1. Investment

A. Construction Cost	$1,472,706
B. SIOH	$85,859
C. Design Cost	$88,362
D. Total Cost (1A+1B+1C)	$1,646,927
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,646,927

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	4,350	Mbtus	$27,318	15.08	$411,955
Elec. Deman					$37,558	14.88	$558,863
Natural Gas	$4.4	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			4,350	Mbtus	$64,876		$970,819

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURR	$26,773	Annual	14.88	$398,382
ANNUAL TOTAL	$26,773			$398,382
ONE TIME TOTAL	$0			$0
TOTAL	$26,773			$398,382

4. First Year Dollar Savings	$91,649
5. Simple Payback Period (Years)	17.97
6. Total Net Discounted Savings	$1,369,201
7. Savings to Investment Ratio	.83
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	2.05%

Life Cycle Cost Analysis Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-B2
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

ECIP Summary Report

1. Investment

A. Construction Cost	$1,493,308
B. SIOH	$87,060
C. Design Cost	$89,598
D. Total Cost (1A+1B+1C)	$1,669,966
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,669,966

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	4,495	Mbtus	$28,229	15.08	$425,687
Elec. Deman					$37,077	14.88	$551,706
Natural Gas	$4.4	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			4,495	Mbtus	$65,306		$977,393

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURR	$26,773	Annual	14.88	$398,382
ANNUAL TOTAL	$26,773			$398,382
ONE TIME TOTAL	$0			$0
TOTAL	$26,773			$398,382

4. First Year Dollar Savings	$92,079
5. Simple Payback Period (Years)	18.14
6. Total Net Discounted Savings	$1,375,775
7. Savings to Investment Ratio	.82
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	2.01%

Life Cycle Cost Analysis Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-B3
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

ECIP Summary Report

1. Investment

A. Construction Cost	$1,498,626
B. SIOH	$87,370
C. Design Cost	$89,918
D. Total Cost (1A+1B+1C)	$1,675,914
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,675,914

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	4,244	Mbtus	$26,652	15.08	$401,917
Elec. Deman					$35,298	14.88	$525,234
Natural Gas	$4.4	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			4,244	Mbtus	$61,950		$927,151

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURR	$26,773	Annual	14.88	$398,382
ANNUAL TOTAL	$26,773			$398,382
ONE TIME TOTAL	$0			$0
TOTAL	$26,773			$398,382

4. First Year Dollar Savings	$88,723
5. Simple Payback Period (Years)	18.89
6. Total Net Discounted Savings	$1,325,534
7. Savings to Investment Ratio	.79
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	1.8%

Life Cycle Cost Analysis Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-B4
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

ECIP Summary Report

1. Investment

A. Construction Cost	$1,796,754
B. SIOH	$104,751
C. Design Cost	$107,805
D. Total Cost (1A+1B+1C)	$2,009,310
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$2,009,310

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	5,595	Mbtus	$35,137	15.08	$529,860
Elec. Deman					$50,662	14.88	$753,851
Natural Gas	$4.4	/Mbtus	-4,022	Mbtus	-$17,657	18.58	-$328,059
TOTAL			1,573	Mbtus	$68,142		$955,651

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURR	$26,773	Annual	14.88	$398,382
ANNUAL TOTAL	$26,773			$398,382
ONE TIME TOTAL	$0			$0
TOTAL	$26,773			$398,382

4. First Year Dollar Savings	$94,915
5. Simple Payback Period (Years)	21.17
6. Total Net Discounted Savings	$1,354,034
7. Savings to Investment Ratio	.67
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	.99%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	D
DATE:	3/1/96
ECO TITLE:	Install Energy Management System (EMS) For HVAC System
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 500 (serving buildings 590, 591, 592)

A. Summary:

Electrical Energy Savings	1957	MMBTU/yr
Electrical Demand Savings	-401	$/yr
Gas Energy Savings	39	MMBTU/yr
Total Energy Savings	1996	MMBTU/yr
Total Cost Savings	12,024	$/yr
Total Investment	278,393	$
Simple Payback	23.2	yrs
SIR	0.65	

B. ECO Description:

Install Energy Management System (EMS) at Building 592. The EMS will accomplish the following tasks for the equipment listed in Table-1 for all of the above mentioned buildings.

1. All AHU's serving buildings in the table below will be furnished with all necessary controls to facilitate an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode, which will save thermal cooling energy. (several damaged OA dampers require repairs).

2. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps. These units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, the equipment can be started as late as possible, and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature.

3. All multi-zone units and all single zone units with reheat or without coils in their branches will have a cooling side discharge air temperature reset. All branch thermostats and zone supply air temperatures after the reheat coil will be monitored. The cooling coil leaving air temperature will be reset to satisfy at least one zone thermostat without reheat.

4. All multi-zone units will have air side temperature reset. AHU heating supply air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full heat (at least one zone damper will be fully open).

5. Buildings 590, 591 and 592 chillers will have water temperature reset. The leaving CHW temperature will be reset to control varying load.

6. Building 592's chiller will have condenser water temperature reset. The CW leaving temperature will be maintained as low as OA conditions permit in the summer season.

Table-1

Building #	Equipment To Be Controlled
590	Chiller, CHW pump, 3 AHUs, Boiler and HW pump
591	Chiller, CHW pump, 3 AHUs, Boiler and HW pump.
592	Chiller, CHW pump, cooling tower, CND pump, 5 AHUs, Boiler and HW pump.

C. Discussion:

1. Generally, the ambient condition in the San Antonio area is warm and humid. Annual free cooling hours will be limited. A large number of AHUs are equipped with necessary dampers to support an economizer cycle. This indicates that the original HVAC system was designed to have an economizer cycle or a smoke purge system. All OA and RA dampers will be repaired and retrofitted with necessary controls to support an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode. When the enthalpy of the OA will drops below that of RA, the OA damper will open, and the RA damper will close. This action will reduce the cooling energy required. The benefit of this system will occur in both the heating and cooling season. In the heating season when the ambient temperature falls below the temperature needed to maintain the supply air at design conditions, the OA damper will remain in the preset minimum open position to permit necessary ventilation.

2. Currently the facility occupancy is 24 hours per day, 365 days per year. These barracks type housing facilities remain occupied during the weekends and on holidays. Due to the consistent occupancy, the optimum start / stop option has no opportunity and was not evaluated.

3. Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's. (Boilers and chillers have a seasonal operation, hot and cold air mixing never occurs, return air mixes with cold air in the summer and with hot air in winter.) In both cases cooling and heating energy is wasted. Currently the hot air plenum is acting as a return air plenum. Our observations indicate that all zones are mixing cold supply and return air to maintain the room or zone temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur. The same control sequence will be applied to the hot deck temperature control.

   In multi-zone units cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air

temperature will be increased to minimize mixing. This process will continue until one of the zones requires no mixing. (A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.)

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Field observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. Heating supply air temperature will be lowered until at least one zone damper remains fully open position to satisfy the room or an area heating demand. Many partially open heating dampers indicate a higher than necessary heating deck temperature. Lowering the temperature will save heating energy.

5. Chillers at all buildings will be furnished with chilled water temperature reset controls. Upon a decrease in ambient load, the leaving CHW temperature will increase. An increase in leaving CHW temperature decreases the KW/ton which will reduce the electrical energy required. The entering condenser water temperature will be reduced in certain weather conditions to further enhance the chiller efficiency.

6. Chillers at Building 592 will be furnished with condenser water temperature reset controls. As the differential pressure between the evaporator and condenser decreases, the energy required to operate the chiller compressor decreases. Therefore, a reduction in condenser water temperature will save energy. However, the cooling tower fan energy will increase to produce a lower condenser water temperature. Multi-step thermostats, monitoring devices, and controls will be installed to operate the condenser water reset option. The EMS system will monitor and activate the reset program when atmospheric conditions permit, and when the energy savings from the chiller compressor exceed the additional cooling tower fan energy required to produce a lower condenser water temperature.

   The EMS system will be controlled by a personal computer (PC) located in the central maintenance building. All other buildings control panels will be connected to the central EMS system PC in the Building via telephone lines.

D. Savings Calculations:

1. *Energy Consumption And Savings*

   The monthly peak demand and energy consumption of the existing and proposed EMS system were calculated using the Trace 600 computer program [1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

   Once the computer simulations of the existing and new EMS system were completed, the total annual demand cost and energy consumption were compared with that of the

existing and new systems to determine the annual savings for this ECO. These savings calculations are shown on pages C-69 and C-70. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings with this retrofit.

E. Cost Estimates:

The total installation costs for the new EMS system are estimated on pages C-71 Through C-73. These costs were generated from the I/O point list shown on page C-68. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-74. The data from the summary sheet were presented in the ECO summary on page C-64.

REFERENCES

1. Refer to Appendix A for utility cost analysis data used in the savings calculations.

2. Refer to Appendix G for building field data and existing HVAC equipment data.

AREA: 500	HARDWARE																					
	OUTPUT								INPUT													
	DIGITAL					ANALOG			DIGITAL													
ECO D: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS
OCCUPANCY TIME:																						
GRAPHIC DISPLAY ●																						
POINT DESCRIPTION																						
W/C CHILLERS ●																						
CHILLER					1																	1
CHW PUMP	1														1							
CW PUMP	1														1							
TWR. FAN	1														1							
CHW SUPPLY HEADER																		1				
CHW RETURN HEADER																		1				
CW SUPPLY HEADER																		1				
CW RETURN HEADER																		1				
TWR. BYPASS VALVE								1														
A/C CHILLERS ●																						
CHILLER					2																	
CHW PUMP	2														2							
CHW SUPPLY HEADER																		2				
CHW RETURN HEADER																		2				
HW BOILERS ●																						
BOILER					3							3										
HW PUMP	3														3							
HW SUPPLY HEADER																						
HW RETURN HEADER																						
AHU (MZ) ●																						
SUPPLY FAN	11														11							
COLD DECK TEMP.						11												11				
HOT DECK TEMP.						11												11				
RETURN AIR							11											11				
ZONE DAMPERS							47															
OUTSIDE AIR							11															
ZONE TEMPERATURE																		47				
FILTER										11												
OUTSIDE AIR ●																		1	1			

TOTAL AO POINTS =	25
TOTAL DO POINTS =	92
TOTAL AI POINTS =	33
TOTAL DI POINTS =	92
GRAND TOTAL POINTS =	242

| | SOFTWARE | | |

RUN TIME	KW	KWH	CFM			REMARKS
X	X	X				
X						
X						
X						
X						
X						
X						
						all valves, dampers, thermostats, and
X						actuators are existing.

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 590 Chiller					73.2	73.1	78.5	78.2	69.6	55.0			144,252	
Bldg. 590 CHW Pump					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
Bldg. 590 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 591 Chiller					73.2	73.1	78.5	78.2	69.6	55.0			144,252	
Bldg. 591 CHW Pump					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
Bldg. 591 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 592 Chiller					99.6	101.1	104.1	105.4	102.5	72.0			202,124	
Bldg. 592 Cooling Tower Fans					14.9	14.9	14.9	14.9	14.9	14.9			60,050	
Bldg. 592 CHW Pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 592 CND Pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 592 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 590 Airside Fans	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	98,112	
Bldg. 591 Airside Fans	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	98,112	
Bldg. 592 Airside Fans	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	98,112	
Bldg. 592 Airside Fans	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	391,572	
Bldg. 590 Boiler														97
Bldg. 590 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	9,557	
Bldg. 590 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 591 Boiler														96
Bldg. 591 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	5,676	
Bldg. 591 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	322	
Bldg. 592 Boiler														219
Bldg. 592 HW Pump	3.7	3.7	3.7	3.7							3.7	3.7	8,603	
Bldg. 592 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	291	
Totals	86.7	86.7	86.7	86.7	372.0	373.3	387.1	387.8	367.7	308.0	86.7	86.7	1,406,422	412
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	650	650	650	650	2,790	3,733	3,871	3,878	3,677	2,310	650	650		

Total Demand	24,161	$/yr	
Total Energy	4,800	MMBTU/yr	(electric)
Total Energy	412	MMBTU/yr	(gas)

ITEM	ECO D - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 590 Chiller					77.1	80.7	83.8	83.5	77.5	42.1			107,153	
Bldg. 590 CHW Pump					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
Bldg. 590 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 591 Chiller					77.1	80.7	83.8	83.5	77.5	42.1			107,153	
Bldg. 591 CHW Pump					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
Bldg. 591 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 592 Chiller					99.6	102.7	104.1	105.4	102.5	71.7			173	
Bldg. 592 Cooling Tower Fans					14.9	14.9	14.9	14.9	14.9	14.9			65,798	
Bldg. 592 CHW Pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 592 CND Pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 592 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 590 Airside Fans	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	57,232	
Bldg. 591 Airside Fans	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	57,232	
Bldg. 592 Airside Fans	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	40,612	
Bldg. 592 Airside Fans	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	228,417	
Bldg. 590 Boiler														89
Bldg. 590 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	9,557	
Bldg. 590 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 591 Boiler														88
Bldg. 591 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	5,401	
Bldg. 591 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	307	
Bldg. 592 Boiler														197
Bldg. 592 HW Pump	3.7	3.7	3.7	3.7							3.7	3.7	8,443	
Bldg. 592 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	285	
Totals	86.7	86.7	86.7	86.7	379.8	390.1	397.7	398.4	383.5	281.9	86.7	86.7	833,150	373
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	650	650	650	650	2,849	3,901	3,977	3,984	3,835	2,114	650	650		

Total Demand	24,561	$/yr	
Demand Savings	-401	$/yr	
Energy Savings	1,957	MMBTU/yr	(electric)
Energy Savings	39	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	**PROJECT NO:** 03-0185.06D		**DATE:** 9/18/96
ECO NO. D AREA 500	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	HRS/ UNIT	Rate	Total	Unit Price	Total	
EMCS COSTS BASED ON DDC ALL ELECTRIC								
DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE								
DIGITAL OUTPUT DEVICE :								
START-STOP MOTOR	19	EA	10.2	28.91	5,603	175.74	3,339	8,942
ENABLE/DISABLE APPARATUS RELAY	6	EA	4.5	28.91	781	49.00	294	1,075
ANALOG OUTPUT:								
CONTROL VALVE (COIL/AHU ACTUATOR ONLY)	23	EA	11.9	28.91	7,926	571.00	13,133	21,059
DAMPER ACTUATOR & MOTOR	58	EA	11.9	28.91	19,987	340.00	19,720	39,707
DIGITAL INPUT:								
DIFFERENTIAL PREASURE SWITCH	11	EA	10.1	28.91	3,212	227.30	2,500	5,712
AUXILIARY CONTACT	3	EA	4.5	28.91	390	49.00	147	537
CURRENT SENSING RELAY	19	EA	4.5	28.91	2,472	49.00	931	3,403
SHEET 1								
				SUBTOTAL	40,371		40,064	80,435
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	**PROJECT NO:** 03-0185.06D	**DATE:** 9/18/96
ECO NO. D **AREA** 500	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	UNIT MEAS.	Hrs / Unit	Rate	Total	Unit Price	Total	
ANALOG INPUT:								
TEMP. SENSER & THERMO WELL	30	EA	17.0	28.91	14,744	426.42	12,793	27,537
TEMP. SENSER AIR DUCT	11	EA	12.0	28.91	3,816	450.00	4,950	8,766
TEMP. SENSER OUTSIDE AIR	1	EA	12.0	28.91	347	550.00	550	897
TEMP. SENSER ZONE	47	EA	12.0	28.91	16,305	556.00	26,132	42,437
RELATIVE HUMIDITY %	1	EA	13.0	28.91	376	615.00	615	991
AMPERES	1	EA	7.0	28.91	202	219.00	219	421
GAUGE PRESURE BOILER		EA	8.0	28.91		197.00		
FLOW STATUS / RATE	1	EA	17.0	28.91	491	410.00	410	901
EQUIPMENT FAILURE ALARM	8	EA	2.6	28.91	601	108.00	864	1,465
FILTER ALARM	11	EA	4.5	28.91	1,431	227.00	2,497	3,928
HIGH & LOW LIMIT (HYDRONIC)	14	PR	2.0	28.91	809	170.00	2,380	3,189
SHEET 2								
				SUBTOTAL	39,124		51,410	90,534
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	**PROJECT NO:** 03-0185.06D	**DATE:** 9/18/96
ECO NO. D AREA 500	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
OPERATORS' WORKSTATION UNIT	1	SUM				13,184.00	13,184	13,184
INCLUDING MODEM & REMOTE PANEL								
SUBMITTALS, TRAINING & START-UP	1	JOB				8,300.00	8,300	8,300
SOFTWARE	1	LS				15,000.00	15,000	15,000
SUB TOTAL FROM SHEET 1					40,371		40,064	80,435
SUB TOTAL FROM SHEET 2					39,124		51,410	90,534
SUBTOTAL					79,494		127,958	207,452
O & P @ 20%					15,899		25,592	41,490
SUBTOTAL					95,393		153,550	248,943
DESIGN @ 6%								14,937
SUBTOTAL								263,879
SIOH @ 5.5%								14,513
TOTAL								$278,393

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Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-D
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$248,943
B. SIOH	$14,513
C. Design Cost	$14,937
D. Total Cost (1A+1B+1C)	$278,393
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$278,393

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	1,957	Mbtus	$12,290	15.08	$185,333
Elec. Deman					-$401	14.88	-$5,967
Natural Gas	$3.5	/Mbtus	39	Mbtus	$135	18.58	$2,507
TOTAL			1,996	Mbtus	$12,024		$181,873

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL TOTAL	$0			$0
ONE TIME TOTAL	$0			$0
TOTAL	$0			$0

4. First Year Dollar Savings	$12,024
5. Simple Payback Period (Years)	23.15
6. Total Net Discounted Savings	$181,873
7. Savings to Investment Ratio	.65
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	.83%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	E
DATE:	3/1/96
ECO TITLE:	Retrofit Existing Individual Chillers With Central Chillers
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 500, Buildings 590, 591, 592

A. Summary:

Electrical Energy Savings	705	MMBTU/yr
Electrical Demand Savings	3743	$/yr
Gas Energy Savings	0	MMBTU/yr
Total Energy Savings	705	MMBTU/yr
Total Cost Savings	17,250	$/yr
Total Investment	516,826	$
Simple Payback	30.0	yrs
SIR	0.50	

A. ECO Description:

All of these buildings are equipped with dedicated liquid chillers for cooling. Buildings 590 and 591 have air cooled reciprocating chillers. Both of these reciprocating chillers will be removed. The water cooled centrifugal chiller, cooling tower, and condenser water pump serving building 592 will be removed and turned over to the owner for relocation. A new R-123, 300 ton water cooled centrifugal chiller with 0.57 KW/ton will be installed in it's place. One new 25 HP primary CHW pump selected at 600 GPM and 110 ft head and a new 20 HP CW pump selected at 900 GPM and 60 ft. hd be installed. Also, a new crossflow, induced draft cooling tower with a 15 HP motor will be installed to support the new chiller. The cooling tower will be installed on the existing pad and basin but the existing CW piping with 8" steel pipe will be replaced.

Primary CHW will be pumped through a direct buried 6" primary CHW supply and return piping loop to Building 590 and 591. Primary CHW piping will split into two 3" branches under the parking lot of Building 591 (approximately 1000 ft. of 5" and 1200 ft. of 3" piping will be required). These branches will be connected with the existing CHW pumps of the Building 590 and 591. The existing CHW pumps for Buildings 590, 591 and 592 will be reutilized as secondary CHW pumps. All AHU, CHW coil three way control valves will be converted to two way valves to minimize pumping energy. The existing controls and electrical service should be reutilized wherever possible, and new controls and electrical services should be installed at Building 592 to serve the new CHW pump. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new chiller, cooling tower, associated wiring and controls.

B. Discussion:

Buildings 590 and 591 are served by two 66.5 ton air cooled reciprocating liquid chillers. Both were installed in 1986. Generally the reciprocating chiller efficiency remains around 1.2 KW/ton.

as these are 10 year old chillers, they could have an efficiency of 1.35 to as high as 1.5 KW/ton. Therefore a single 300 ton, R-123 centrifugal chiller will be installed at Building 592. A 170 ton R-123, centrifugal chiller at Building 592 was installed in 1995. This chiller is in very good condition and will be removed along with it's cooling tower and condenser water pump and relocated if needed. The primary factor for replacing these chillers with a central chiller is due to the added maintenance cost associated with maintaining both air cooled and water cooled chillers and with the part load efficiency of the air cooled machines. Therefore it is recommended that a central chiller plant, consisting of a new 300 ton water cooled chiller be installed to serve these buildings. Computer simulations of the buildings in this area determined that the current installed capacity of 320 tons is more than adequate to handle the load for the buildings; therefore, we recommend installing a 300 ton machine. All AHU, CHW coil three way control valves will be converted to two way valves to minimize the pumping energy and for better distribution of CHW flow through the AHU coils.

C. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed chillers and pumps were calculated using the Trace 600 computer program[1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

There were several types of chillers modeled including centrifugal, screw, variable speed driven centrifugal, and gas engine driven. Water cooled R-123 centrifugal machines are more efficient in their full load KW/ton ratings over the screw or gas engine driven machines, while the screw machines were approximately 10% more efficient in the part load range between 25% -50%. Full load performance data from York International was used in the computer simulations of the new chiller energy usage, while part load data was available from equipment supplied with Trace 600. An equipment list of the specific chillers and pumps modeled for the new chiller are shown on pages C-79 through C-81. Once the computer simulations of the existing and new chiller plants were completed, the total annual demand cost and energy consumption of each chiller was compared with that of the existing chiller to determine the annual savings for this ECO[3]. These savings calculations are shown on pages C-82 and C-83. These demand and energy savings values were used in the life cycle cost analysis. The results of these savings calculations were as follows:

Alternative	Chiller Type	Demand Savings $/yr	Electrical Savings MMBTU/yr	Gas Savings MMBTU/yr
E1	Electric Centrifugal	3832	477	0
E2	Electric Centrifugal & VFD	3743	705	0
E3	Electric Screw	3122	485	0

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water and air cooled chillers in this area down to one water cooled chiller. The total maintenance cost savings from this ECO is estimated to be $9,080 per year as calculated on page C-93. This figure was used in the life cycle cost analysis.

D. Cost Estimates:

The total installation costs for the new central chiller plant were estimated on pages C-84 through C-92. These costs were used in the life cycle cost analysis and are summarized below:

Alternative	Chiller Type	Estimated Cost
E1	Electric Centrifugal	$509,725
E2	Electric Centrifugal & VFD	$524,826
E3	Electric Screw	$527,841

E. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A one time savings of $8,000 was included for the salvage value of the chiller serving building 592. This cost was estimated from information supplied by Entech Sales ad Service located in Dallas, Texas. The summary sheets for the life cycle cost analysis of each alternative are shown on pages C-94 through C-96. The results of the alternative life cycle cost analysis were as follows:

Alternative	Chiller Type	Payback Years	SIR
E1	Electric Centrifugal	31.5	0.47
E2	Electric Centrifugal & VFD	30.0	0.50
E3	Electric Screw	34.1	0.44

Since the electric centrifugal chiller and VFD has the highest SIR, it is recommended as the most economical choice to replace the existing machine. The data from the life cycle cost analysis for this alternative were included in the summary on page C-75.

REFERENCES

1. Refer to Appendix H for the system thermal load profile.

2. Refer to Appendix G for building field data and existing HVAC equipment consumption data.

3. Refer to Appendix A for utility analysis and avoided cost calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-E1, FORT SAM HOUSTON, AREA 500 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York YT water cooled, centrifugal, 300 tons, R-123	Area 500	New	171 KW
Chilled Water Pump	1	Bell & Gossett 600 gpm, 110 ft 25 HP	Area 500	New	18.60 KW
Condenser Water Pump	1	Bell & Gossett 900 gpm, 60 ft 20 HP	Area 500	New	14.90 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 15 HP fan	Area 100	New	11.20 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-E2, FORT SAM HOUSTON, AREA 500 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York YT with VFD water cooled, centrifugal, 300 tons, R-123	Area 500	New	171 KW
Chilled Water Pump	1	Bell & Gossett 600 gpm, 110 ft 25 HP	Area 500	New	18.60 KW
Condenser Water Pump	1	Bell & Gossett 900 gpm, 60 ft 20 HP	Area 500	New	14.90 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 15 HP fan	Area 100	New	11.20 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-E3, FORT SAM HOUSTON, AREA 500 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York YS water cooled screw 300 tons, R-123	Area 100	New	186 KW
Chilled Water Pump	1	Bell & Gossett 600 gpm, 110 ft 25 HP	Area 500	New	18.60 KW
Condenser Water Pump	1	Bell & Gossett 900 gpm, 60 ft 20 HP	Area 500	New	14.90 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 15 HP fan	Area 100	New	11.20 KW

ITEM	ECO E - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 590 Chiller					73.2	73.1	78.5	78.2	69.6	55.0			144,252	
Bldg. 590 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 591 Chiller					73.2	73.1	78.5	78.2	69.6	55.0			144,252	
Bldg. 591 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 592 Chiller					99.6	101.1	104.1	105.4	102.5	72.0			202,124	
Bldg. 592 Cooling Tower Fans					14.9	14.9	14.9	14.9	14.9	14.9			60,050	
Bldg. 592 CND Pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 592 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Totals					275.1	276.4	290.2	290.9	270.8	211.1			613,385	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)					2,063	2,764	2,902	2,909	2,708	1,583				

Total Demand 14,930 $/yr

Total Energy 2,093 MMBTU/yr (electric)

Total Energy MMBTU/yr (gas)

ITEM	ECO-E1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (300 TON)					162.2	160.9	168.4	171.7	159.8	101.3			276,223	
Cooling Tower					11.2	11.2	11.2	11.2	11.2	11.2			45,078	
CHW Pump					18.6	18.6	18.6	18.6	18.6	18.6			82,138	
CND Pump					14.9	14.9	14.9	14.9	14.9	14.9			65,798	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Total (KW)					207.9	206.6	214.1	217.4	205.5	147.0			473,653	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)					1,559	2,066	2,141	2,174	2,055	1,103				

Total Demand 11,098 $/yr

Demand Savings 3,832 $/yr

Energy Savings 477 MMBTU/yr (electric)

Energy Savings MMBTU/yr (gas)

ITEM	ECO-E2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (300 TON)					171.0	168.3	171.0	172.0	162.7	106.2			246,700	
Cooling Tower					8.2	8.4	10.1	11.2	9.1	2.7			7,754	
CHW Pump					18.6	18.6	18.6	18.6	18.6	18.6			82,138	
CND Pump					14.9	14.9	14.9	14.9	14.9	14.9			65,798	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Total (KW)					213.7	211.2	215.6	217.7	206.3	143.4			406,806	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)					1,603	2,112	2,156	2,177	2,063	1,076				

Total Demand	11,186	$/yr	
Demand Savings	3,743	$/yr	
Energy Savings	705	MMBTU/yr	(electric)
Energy Savings		MMBTU/yr	(gas)

ITEM	ECO-E3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (300 TON)					177.3	175.8	183.3	186.0	174.4	102.6			273,868	
Cooling Tower					11.2	11.2	11.2	11.2	11.2	11.2			45,063	
CHW Pump					18.6	18.6	18.6	18.6	18.6	18.6			82,138	
CND Pump					14.9	14.9	14.9	14.9	14.9	14.9			65,798	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Total (KW)					223.0	221.5	229.0	231.7	220.1	148.3			471,283	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)					1,673	2,215	2,290	2,317	2,201	1,112				

Total Demand	11,808	$/yr	
Demand Savings	3,122	$/yr	
Energy Savings	485	MMBTU/yr	(electric)
Energy Savings		MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6E1		**DATE:** 9/18/96
ECO NO. E-1 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER UP TO 100 TON	133	TON	1.5	28.91	5,921	25.00	3,325	9,246
RMV CHILLER OVER 100 TON	170	TON	1.3	28.91	6,389	25.00	4,250	10,639
RMV COOLING TOWER	1	EA	60.0	28.91	1,735	550.00	550	2,285
RMV CONDENSER PUMP & LOOP	1	EA	820.0	28.91	23,706	300.00	300	24,006
DISCOUNT FOR SALVAGE	1	EA						-8,000
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	1,000	LF	1.0	28.91	30,066	29.50	29,500	59,566
8"	160	LF	1.5	28.91	6,938	40.00	6,400	13,338
3"	1,200	LF	0.6	28.91	20,815	15.70	18,840	39,655
SECTIONALIZING VALVE AND BOX 6"	2	EA	2.1	28.91	120	5,902.00	11,804	11,924
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
3"	3	LOC	10.7	28.91	928	717.00	2,151	3,079
				SUBTOTAL	96,620		77,120	165,740
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-185.6E1 **DATE:** 9/18/96

ECO NO. E-1 **Retrofit Existing Individual Chillers**

BY : KOTHMANN, K **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	200.0	20.00	4,000	3,000.00	3,000	7,000
CHILLER (YORK YT) WITH PIPING & VESELS	300	TON	3.2	28.91	27,754	371.00	111,300	139,054
PRIMARY PUMPS 20 HP	1	EA	16.0	28.91	463	825.00	825	1,288
PRIMARY PUMPS 25 HP	1	EA	16.0	28.91	463	825.00	825	1,288
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	300	TON	0.6	28.91	5,204	92.00	27,600	32,804
CONTROLS	1	JOB	200.0	28.91	5,782	10,500.00	10,500	16,282
ELECTRICAL	1	JOB	80.0	28.91	2,313	2,400.00	2,400	4,713
TEST BALANCE AND START-UP	1	JOB	120.0	28.91	3,469	200.00	200	3,669
				SUBTOTAL	49,447		156,650	206,097
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6E1	DATE: 9/18/96
ECO NO. E-1 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: 1 NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					96,620		77,120	173,740
SUB TOTAL FROM SHEET 2					49,447		156,650	206,097
SUBTOTAL					146,066		233,770	379,836
O & P @ 20%					29,213		46,754	75,967
SUBTOTAL					175,279		280,524	455,803
DESIGN @ 6%								27,348
SUBTOTAL								483,151
SIOH @ 5.5%								26,573
TOTAL								$509,725

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6E1	DATE: 9/18/96
ECO NO. E-2 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER UP TO 100 TON	133	TON	1.5	28.91	5,921	25.00	3,325	9,246
RMV CHILLER OVER 100 TON	170	TON	1.3	28.91	6,389	25.00	4,250	10,639
RMV COOLING TOWER	1	EA	60.0	28.91	1,735	550.00	550	2,285
RMV CONDENSER PUMP & LOOP	1	EA	820.0	28.91	23,706	300.00	300	24,006
DISCOUNT FOR SALVAGE	1	EA						-8,000
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	1,000	LF	1.0	28.91	30,066	29.50	29,500	59,566
8"	160	LF	1.5	28.91	6,938	40.00	6,400	13,338
3"	1,200	LF	0.6	28.91	20,815	15.70	18,840	39,655
SECTIONALIZING VALVE AND BOX 6"	2	EA	2.1	28.91	120	5,902.00	11,804	11,924
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
3"	3	LOC	10.7	28.91	928	717.00	2,151	3,079
				SUBTOTAL	96,620		77,120	165,740
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. E-2 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6E2

BY : KOTHMANN, K

DATE: 9/18/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	200.0	20.00	4,000	3,000.00	3,000	7,000
CHILLER (YORK YT) WITH PIPING & VESELS	300	TON	3.2	28.91	27,754	371.00	111,300	139,054
ADD FOR VFD	65	HP	0.8	28.91	1,503	150.00	9,750	11,253
PRIMARY PUMPS 20 HP	1	EA	16.0	28.91	463	825.00	825	1,288
PRIMARY PUMPS 25 HP	1	EA	16.0	28.91	463	825.00	825	1,288
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	300	TON	0.6	28.91	5,204	92.00	27,600	32,804
CONTROLS	1	JOB	200.0	28.91	5,782	10,500.00	10,500	16,282
ELECTRICAL	1	JOB	80.0	28.91	2,313	2,400.00	2,400	4,713
TEST BALANCE AND START-UP	1	JOB	120.0	28.91	3,469	200.00	200	3,669
SUBTOTAL					50,950		166,400	217,350
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6E2	DATE: 9/18/96
ECO NO. E-2 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: 1 NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					96,620		77,120	173,740
SUB TOTAL FROM SHEET 2					50,950		166,400	217,350
SUBTOTAL					147,569		243,520	391,089
O & P @ 20%					29,514		48,704	78,218
SUBTOTAL					177,083		292,224	469,307
DESIGN @ 6%								28,158
SUBTOTAL								497,466
SIOH @ 5.5%								27,361
TOTAL								$524,826

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6E3	**DATE:** 9/18/96
ECO NO. E-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER UP TO 100 TON	133	TON	1.5	28.91	5,921	25.00	3,325	9,246
RMV CHILLER OVER 100 TON	170	TON	1.3	28.91	6,389	25.00	4,250	10,639
RMV COOLING TOWER	1	EA	60.0	28.91	1,735	550.00	550	2,285
RMV CONDENSER PUMP & LOOP	1	EA	820.0	28.91	23,706	300.00	300	24,006
DISCOUNT FOR SALVAGE	1	EA						-8,000
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	1,000	LF	1.0	28.91	30,066	29.50	29,500	59,566
8"	160	LF	1.5	28.91	6,938	40.00	6,400	13,338
3"	1,200	LF	0.6	28.91	20,815	15.70	18,840	39,655
SECTIONALIZING VALVE AND BOX 6"	2	EA	2.1	28.91	120	5,902.00	11,804	11,924
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
3"	3	LOC	10.7	28.91	928	717.00	2,151	3,079
				SUBTOTAL	96,620		77,120	165,740
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6E3	**DATE:** 9/18/96
ECO NO. E-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	200.0	20.00	4,000	3,000.00	3,000	7,000
CHILLER (YORK YS) WITH PIPING & VESELS	300	TON	3.2	28.91	27,754	416.00	124,800	152,554
PRIMARY PUMPS 20 HP	1	EA	16.0	28.91	463	825.00	825	1,288
PRIMARY PUMPS 25 HP	1	EA	16.0	28.91	463	825.00	825	1,288
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	300	TON	0.6	28.91	5,204	92.00	27,600	32,804
CONTROLS	1	JOB	200.0	28.91	5,782	10,500.00	10,500	16,282
ELECTRICAL	1	JOB	80.0	28.91	2,313	2,400.00	2,400	4,713
TEST BALANCE AND START-UP	1	JOB	120.0	28.91	3,469	200.00	200	3,669
SUBTOTAL					49,447		170,150	219,597
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6E3	DATE: 9/18/96
ECO NO. E-3 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: 1 NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL SCREW R-123
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					96,620		77,120	173,740
SUB TOTAL FROM SHEET 2					49,447		170,150	219,597
SUBTOTAL					146,066		247,270	393,336
O & P @ 20%					29,213		49,454	78,667
SUBTOTAL					175,279		296,724	472,003
DESIGN @ 6%								28,320
SUBTOTAL								500,323
SIOH @ 5.5%								27,518
TOTAL								$527,841

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6MA	DATE: 9/18/96
ECO NO. E Retrofit Existing Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 500

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON EXISTING								
OUTSIDE CONTRACT COSTS PER CHILLER PER YEAR								
EXISTING WATER COOLEDCHILLERS	-1.	EA	200.0	30.00	-6,000	6,150.00	-6,150	-12,150
EXISTING AIR COOLED CHILLERS	-133.	TON	0.7	30.00	-2,793	29.00	-3,857	-6,650
EXISTING WINDOW UNITS		EA	3.0	30.00		20.00		
EXISTING DX SYSTEM		TON	1.0	30.00		5.00		
NEW EQUIPMENT								
NEW WATER COOLED CHILLERS	1.	EA	190.0	30.00	5,700	6,150.00	4,020	9,720
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-3,093		-5,987	-9,080
PER YEAR								

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Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-E1
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$455,803
B. SIOH	$26,573
C. Design Cost	$27,348
D. Total Cost (1A+1B+1C)	$509,724
E. Salvage Value of Existing Equip.	8000
F. Public Utility Company Rebate	0
G. Total Investment (1D-1E-1F)	$501,724

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	477	Mbtus	$2,996	15.08	$45,173
Elec. Deman					$3,832	14.88	$57,020
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			477	Mbtus	$6,828		$102,193

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECUR	$9,080	Annual	14.88	$135,110
ANNUAL TOTAL	$9,080			$135,110
ONE TIME TOTAL	$0			$0
TOTAL	$9,080			$135,110

4. First Year Dollar Savings	$15,908
5. Simple Payback Period (Years)	31.54
6. Total Net Discounted Savings	$237,304
7. Savings to Investment Ratio	.47
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	-.78%

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-E2
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$469,307
B. SIOH	$27,361
C. Design Cost	$28,158
D. Total Cost (1A+1B+1C)	$524,826
E. Salvage Value of Existing Equip.	8000
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$516,826

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	705	Mbtus	$4,427	15.08	$66,765
Elec. Deman					$3,743	14.88	$55,696
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			705	Mbtus	$8,170		$122,461

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECUR	$9,080	Annual	14.88	$135,110
ANNUAL TOTAL	$9,080			$135,110
ONE TIME TOTAL	$0			$0
TOTAL	$9,080			$135,110

4. First Year Dollar Savings	$17,250
5. Simple Payback Period (Years)	29.96
6. Total Net Discounted Savings	$257,571
7. Savings to Investment Ratio	.5
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	-.52%

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-E3
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$472,003
B. SIOH	$27,518
C. Design Cost	$28,320
D. Total Cost (1A+1B+1C)	$527,841
E. Salvage Value of Existing Equip.	8000
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$519,841

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	485	Mbtus	$3,046	15.08	$45,931
Elec. Deman					$3,122	14.88	$46,455
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			485	Mbtus	$6,168		$92,386

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECUR	$9,080	Annual	14.88	$135,110
ANNUAL TOTAL	$9,080			$135,110
ONE TIME TOTAL	$0			$0
TOTAL	$9,080			$135,110

4. First Year Dollar Savings	$15,248
5. Simple Payback Period (Years)	34.09
6. Total Net Discounted Savings	$227,496
7. Savings to Investment Ratio	.44
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	-1.17%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	F
DATE:	3/1/96
ECO TITLE:	Retrofit Existing Individual HW Boilers With Central HW Boilers
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 500 (serving buildings 590, 591, 592)

A. Summary:

Electrical Energy Savings	-109	MMBTU/yr
Electrical Demand Savings	-329	$/yr
Gas Energy Savings	79	MMBTU/yr
Total Energy Savings	-30	MMBTU/yr
Total Cost Savings	7240	$/yr
Total Investment	164,799	$
Simple Payback	22.8	yrs
SIR	0.66	

B. ECO Description:

Remove the existing boilers or heating equipment as shown in Table-1. In building 592, the removal of this boiler will leave enough space where one 2,000 MBH modular high efficiency HW boiler will be installed. A new stainless steel flue will be installed to remove the combustion gases from the boiler in the place of the existing flue. One 10 HP primary HW pump selected at 172 GPM and 120 ft. hd.. will be installed to serve the buildings listed in table 1. For the distribution loop, provide a direct buried 3" primary HW supply and return piping loop to Buildings 590 and 591. This primary HW loop will run parallel (if necessary) with new primary CHW lines and split into two 2" branches, under the parking lot of the Building 591. The one branch will be extended up to Building 591, and the second branch be will be extended up to Building 590. An estimated 1000 ft of 3" and 1200 ft. of 2" pipes will be required to complete this loop. All existing building HW pumps will be reutilized as secondary pumps and they will be connected to the new primary loop. All existing localized chemical treatment systems for each building except building 592 will be removed. Utilize existing chemical treatment in Building 592 to serve new boiler. Utilize existing electrical service, and provide new controls in Building 592. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new boilers and associated wiring and controls.

Table-1

Bldg. #	Quantity	Description	Size Tons	Flow GPM	Estimated Pipe Size inches	Extimated Pipe Length Feet
590	1	HW boiler	381.8	52	2	600
591	1	HW boiler	623.9	55	2	600
592	1	HW boiler	2037	280	3	60
Total	3	HW Equipment	3043	387	N/A	N/A

C. Discussion:

Buildings 590, 591 and 592 are served by three natural draft gas fired boilers. All boilers are located in three different locations, remote to each other. They generally appear to be in fair condition, but they show indications of rusting and leaks. However, the cost of maintaining these boilers is excessive and difficult for the maintenance staff. Moreover, these older natural draft boilers are very inefficient. Their efficiency is between the range of 62% to 70%. It is recommended that in central boiler plant, one 2000 MBH high efficiency gas fired high efficiency modular HW boilers be installed. These boilers are 86% efficient under full load conditions, and reach upwards to 98% efficiency under part load conditions. Moreover, these boilers have the capability to be staged to maintain these part load efficiencies by remote boiler control. Another advantage of the modular boiler is its compactness. The size of the boilers make it very economical in retrofit projects because of their small footprint. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. This will save heating energy and greatly reduce the maintenance cost of the installation. Computer simulations of the buildings in this area determined that the current installed capacity of 3040 MBH is more than required to adequately heat the buildings. Therefore it is recommended that one new 2000 MBH boiler be installed to more closely match the existing system.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed boilers and pumps were calculated using the Trace 600 computer program[1]. The buildings served by the existing boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

The 2000 MBH high efficiency modular boiler has better part load performance ratings than common firetube or watertube boilers. Moreover, the ease of retrofitting existing equipment with these smaller footprint boilers makes them very cost effective. Full and part load performance data from Aerco Incorporated was used in the computer simulations of the new boiler energy usage. An equipment list of the proposed boiler and pumps modeled for the new central plant is shown on page C-100.

Once the computer simulations of the existing and new boiler plants were completed, the total annual energy consumption of the new central plant was compared with that of the existing individual systems to determine the annual savings for this ECO[3]. These savings

calculations are shown on page C-101. These energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of boilers to one modular boiler. The total maintenance cost savings from this ECO is estimated to be $7,980 per year as calculated on page C-106. This figure was used in the life cycle cost analysis.

E. Cost Estimates:

The total installation costs for the new central chiller plant were estimated on pages C-102 through C-105. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-107. The data from the summary sheet were presented in the ECO summary on page C-97.

REFERENCES

1. Refer to Appendix H for the system thermal load profile.

2. Refer to Appendix G for building field data and existing HVAC equipment. data.

3. Refer to Appendix A for utility cost analysis and avoided cost calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-F, FORT SAM HOUSTON, AREA 500 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Hot Water Boiler	1	Aerco #KC-2000 GWB natural draft, watertube 1830 MBH output	Area 2200	New	2,000 MBH
Heating Water Pump	1	Bell & Gossett 172 gpm, 120 ft 10 HP	Area 2200	New	7.50 KW

ITEM	ECO-F EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 590 Boiler														97
Bldg. 590 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 591 Boiler														96
Bldg. 591 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	322	
Bldg. 592 Boiler														219
Bldg. 592 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	291	
Totals	0.3	0.3	0.3	0.3							0.3	0.3	1,156	412
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	2	2	2	2							2	2		

Total Demand 14 $/yr

Total Energy 4 MMBTU/yr (electric)

Total Energy 412 MMBTU/yr (gas)

ITEM	ECO-F: INSTALL CENTRAL BOILER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
High % modular boiler														333
HW pump	7.5	7.5	7.5	7.5							7.5	7.5	32,580	
HW controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Total (KW)	7.6	7.6	7.6	7.6							7.6	7.6	33,123	333
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	57	57	57	57							57	57		

Total Demand 342 $/yr

Demand Savings -329 $/yr

Energy Savings -109 MMBTU/yr (electric)

Energy Savings 79 MMBTU/yr (gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:**	03-185.6F	**DATE:** 9/18/96
ECO NO. F Retrofit Existing Individual Boilers AREA 500	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
REMOVE BOILER 500 MBH AND UP	1	EA	90.0	28.91	2,602	780.00	780	3,382
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
3"	1,000	LF	0.6	28.91	17,346	15.70	15,700	33,046
2"	1,200	LF	0.4	28.91	13,877	13.55	16,260	30,137
SUBTOTAL					33,825		32,740	66,565
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6F	DATE: 9/18/96
ECO NO. F Retrofit Existing Individual Boilers AREA 500	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 3"	2	EA	7.0	28.91	405	475.00	950	1,355
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	150.0	20.00	3,000	2,000.00	2,000	5,000
SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING HW PUMPS PER LOCATION								
2"	2	LOC	9.6	28.91	555	639.00	1,278	1,833
3"	1	LOC	10.7	28.91	309	717.00	717	1,026
SUBTOTAL					4,269		4,945	9,214
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO TEX	PROJECT NO: 03-185.6F	DATE: 9/18/96
ECO NO. F Retrofit Existing Individual Boilers AREA 500	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Install New Boiler AERCO # KC 2000 1830 MBH	1	EA	100.00	28.91	2,891	18500.00	18,500	21,391
Install New Pump 10 HP	1	EA	15.00	28.91	434	2800.00	2,800	3,234
pipe Assembly & valves Boiler	1	EA	28.00	28.91	809	2400.00	2,400	3,209
pipe Assembly & valves Pump	1	EA	12.00	28.91	347	1350.00	1,350	1,697
Boiler Breaching	1	JOB	30.00	28.91	867	2000.00	2,000	2,867
Controls	1	JOB	90.00	28.91	2,602	3900.00	3,900	6,502
Electrical	1	JOB	80.00	28.91	2,313	3500.00	3,500	5,813
Test , Balance & Start-up	1	LS	80.00	28.91	2,313			2,313
SUBTOTAL					12,576		34,450	47,026
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. F Retrofit Existing Individual Boilers AREA 500

PROJECT NO: 03-185.6F

BY : KOTHMANN, K

DATE: 9/18/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
116351 Bldg SF Condition Space AREA 500

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					33,825		32,740	66,565
SUB TOTAL FROM SHEET 2					4,269		4,945	9,214
SUB TOTAL FROM SHEET 3					12,576		34,450	47,026
SUBTOTAL					50,670		72,135	122,805
O & P @ 20%					10,134		14,427	24,561
SUBTOTAL					60,804		86,562	147,366
DESIGN @ 6%								8,842
SUBTOTAL								156,208
SIOH @ 5.5%								8,591
TOTAL								$164,799

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6MA	DATE: 9/18/96
ECO NO. F Retrofit Existing BOILERS	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 500

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON								
OUTSIDE CONTRACT COSTS PER BOILER PER YEAR								
EXISTING BOILER	-3.	EA	100.0	30.00	-9,000	1,800.00	-5,400	-14,400
NEW EQUIPMENT								
AERCO MODULAR HIGH EFFICIENCY HW BOILER	1.	EA	80.0	30.00	2,400	1,500.00	4,020	6,420
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-6,600		-1,380	-7,980
PER YEAR								

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Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-F
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$147,366
B. SIOH	$8,591
C. Design Cost	$8,842
D. Total Cost (1A+1B+1C)	$164,799
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	0
G. Total Investment (1D-1E-1F)	$164,799

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	-109	Mbtus	-$685	15.08	-$10,323
Elec. Deman					-$329	14.88	-$4,896
Natural Gas	$3.5	/Mbtus	79	Mbtus	$273	18.58	$5,079
TOTAL			-30	Mbtus	-$740		-$10,139

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECUR	$7,980	Annual	14.88	$118,742
ANNUAL TOTAL	$7,980			$118,742
ONE TIME TOTAL	$0			$0
TOTAL	$7,980			$118,742

4. First Year Dollar Savings	$7,240
5. Simple Payback Period (Years)	22.76
6. Total Net Discounted Savings	$108,603
7. Savings to Investment Ratio	.66
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	.87%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	G
DATE:	3/1/96
ECO TITLE:	Install Energy Management System (EMS) For HVAC System
INSTALLATION:	Fort Sam Houston, San Antonio, Texas,
LOCATION:	Area 1000 (serving buildings 1000, 1001, 1029, 1088)

A. Summary:

Electrical Energy Savings	832	MMBTU/yr
Electrical Demand Savings	149	$/yr
Gas Energy Savings	-94	MMBTU/yr
Total Energy Savings	838	MMBTU/yr
Total Cost Savings	5049	$/yr
Total Investment	266,445	$
Simple Payback	52.8	yrs
SIR	0.28	

B. ECO Description:

Install an Energy Management System (EMS) at the central maintenance facility. The EMS will accomplish the following tasks for the equipment listed in Table-1 in all of the above mentioned buildings:

1. All AHU's serving buildings 1001 and 1029 in the table below will be furnished with all necessary controls to facilitate an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode., which will save thermal cooling energy. (several damaged OA dampers will require repairs).

2. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps for Buildings 1001 and 1029. At Building 1029 only three AHUs located on second floor through fourth floor are included in this option. (Building 1000 is not included in this option.) Chillers, boilers, and their associated auxiliaries and the first floor AHU will be operated as usual. All other units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, equipment can be started as late as possible and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature.

3. All multi-zone units and all single zone units with or without reheat coils in their branches will have a cooling side discharge air temperature reset at Building 1001. Three AHUs located on the first through third floors will have this option. All other

AHUs at Buildings 1000 and 1029 are not included. All branch thermostats and zone supply air temperatures after the reheat coil will be monitored. The cooling coil leaving air temperature will be reset to satisfy at least one zone thermostat without reheat.

4. All multi-zone units will have air side temperature reset. AHU heating supply air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full heat (at least one zone damper will be fully open). At Building 1001, three AHUs located on the first through third floors will have this option. All other AHUs at Buildings 1000 and 1029 are not included.

5. All HW boilers will have water temperature reset. The HW boiler leaving temperature will be controlled with varying OA conditions in the winter season. Buildings 1000 and 1029 are included in this option. Building 1001 is not included.

6. Chiller serving Buildings 1000 and 1029 will have chilled water temperature reset. The leaving CHW temperature will be reset to maintain varying load conditions.

7. Building 1000, and 1029 chillers will have condenser water temperature reset. The CW leaving temperature will be maintained as low as OA conditions permit in summer season.

Table-1

Building #	Equipment To Be Controlled
1000	2 Chillers, 2 CND & CHW pumps , 2 cooling towers, 3 HW Boilers, 3 HW pumps
1001	4 AHUs.
1029	Chiller, 1 CHW & CND pump, cooling tower, 8 AHUs, HW Boiler, HW pump

C. Discussion:

1 Generally, the ambient condition in the San Antonio area is warm and humid. Annual free cooling hours will be limited. A large number of AHUs are equipped with necessary dampers to support an economizer cycle. This indicating that the original HVAC system was designed to have an economizer cycle or a smoke purge system. All OA and RA dampers will be repaired and retrofitted with necessary controls to support an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode. When the enthalpy of the OA drops below that of RA, then the OA damper will open, and the RA damper will close. This action will reduce the cooling energy required. The benefit of this system will occur in both the heating and cooling season. In the heating season when the ambient temperature falls below the temperature needed to maintain the supply air at design conditions, the OA damper will remain in the preset minimum open position to permit necessary ventilation. Building 1000 is a hospital, it is served by over 400 FCUs, single zone and multi-zone units. This building will not be retrofitted with this option because most to all of the units that would benefit from having economizer control currently operate with it. Therefore, this control

option was not modeled in the simulation of the existing system serving building 1000.

2. Generally Buildings 1001 and 1029 are occupied from 7:30 a.m. to 5:00 p.m. daily with the exceptions of the library and emergency transport system (EMT) located on the basement and first floor of the Building 1001, which remains occupied at all times. All other areas of this building follow the above schedule. With the exceptions of the library and EMT, the facility remains unoccupied during the weekends and holidays. Moreover, because building 1000 is a hospital and operates continuously, it will not be retrofitted with this option. The primary CHW equipment serving Building 1001 also serves Building 1002, a military barrack, which is occupied 24 hours per day, 365 days per year. Therefore Building 1001 primary cooling system is also not retrofitted with this option.

   Regardless of occupancy hours, all AHU's in buildings 1001 and 1029 are operated 24 hours per day, 365 days per year to maintain space temperature. However, the chillers operate only during the cooling season as do the boilers in the heating season. Depending on occupancy schedules, ambient conditions and building thermal characteristics, most AHU's and their associated chillers, boilers , CHW and HW pumps will be turned off daily in the evening. The equipment will be stopped as early as possible and turned back on as late as possible every weekday without sacrificing occupant comfort. These AHU's will remain off during weekends and holidays.

   Several temperature sensors will be installed in the spaces served by these AHU's. These sensors will monitor the space temperature during unoccupied hours. During the cooling season when the space temperature exceeds 85 F, the AHUs and their associated cooling auxiliaries serving that space will energize to cool the space below 85 F. When the space temperature reaches 84 F, they will cycle off. Similarly, the winter time unoccupied period space temperature will be maintained at 65 F.

3. Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's (The boiler and chiller have a seasonal operation which means hot and cold air mixing never occurs. It is actually return air mixing with cold air in the summer and with hot air in winter.). In both cases, cooling and heating energy is wasted. Currently, the hot air plenum is acting as a return air plenum. Field observations indicate that all zones are mixing cold supply and return air to maintain the room or zone temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur. The same control sequence will be applied to the hot deck temperature control.

   In multi-zone units cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air temperature will be increased to minimize mixing. This process will continue until one of the zones requires no mixing. (A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.) The fourth floor AHU at

Building 1001 and all AHUs at Building 1029 are single zone units without reheat coils, They are not included in this option. Building 1000 will not be retrofitted with this option because of the strict temperature and humidity requirements in the spaces being served by the air handling units. The potential savings that would result from those units would be minimal compared to the cost of retrofitting them.

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Field observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. The heating supply air temperature will be lowered until at least one zone damper will remain in the fully open position to satisfy the room or an area heating demand. Many partially open heating dampers indicate a higher than necessary heating deck temperature. Therefore, lowering the temperature will save heating energy. The fourth floor AHU at Building 1001 and all AHUs at Building 1029 are single zone units without reheat coils, and they are not included in this option. Building 1000 is a hospital will also not be retrofitted with this option for the same reasons as described in Option 3.

5. Currently most HW boilers maintain a preset boiler leaving water temperature. A HW reset supply temperature controller will be installed to linearly reset the HW supply temperature with the change in the outside air temperature. As the outside air temperature rises from 32 °F to 65°F, the HW supply temperature will be reset from the design temperature to the boiler minimum required temperature. Maintaining a higher leaving HW temperature than necessary wastes heating energy, therefore, lowering this supply temperature will save heating energy. Building 1001 has steam boilers, and is not included in this option.

6. Chillers at all buildings except the one serving building 1001 will be furnished with chilled water temperature reset controls. Upon a decrease in ambient temperature, the leaving CHW temperature will increase. An increase in leaving CHW temperature decreases the KW/ton which will reduce the electrical energy required. The entering condenser water temperature will be reduced in certain weather conditions to further enhance the chiller efficiency.

7. Chillers at all buildings will be furnished with condenser water temperature reset controls. As the differential pressure between the evaporator and condenser decreases, the energy required to operate the chiller compressor decreases. Therefore, a reduction in condenser water temperature will save energy. However, the cooling tower fan energy will increase to produce a lower condenser water temperature. Multi-step thermostats monitoring devices and controls will be installed to operate the condenser water reset option. The EMS system will monitor and activate the reset program when atmospheric conditions permit, and when the energy savings from the chiller's compressor exceed the additional cooling tower fan energy consumption.

The EMS system will be controlled by a personal computer (PC) located in the central maintenance building. All other buildings control panels will be connected to the central EMS system PC in the building via telephone lines.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed EMS system were calculated using the Trace 600 computer program[1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

Once the computer simulations of the existing and new EMS system were completed, the total annual demand cost and energy consumption were compared with that of the existing and new systems to determine the annual savings for this ECO[3]. These savings calculations are shown on pages C-115 through C-118. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings associated with this retrofit.

E. Cost Estimates:

The total installation costs for the new EMS system are estimated on pages C-119 through C-121. This cost was estimated using an I/O point summary shown on pages C-113 through C-114. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-122. The data from the summary sheet were presented in the ECO summary on page C-108.

REFERENCES

1. Refer to appendix H for computer modeling assumptions, data, and output.

2. Refer to Appendix G for building and equipment HVAC system data.

3. Refer to Appendix A for utility cost analysis and avoided cost calculations.

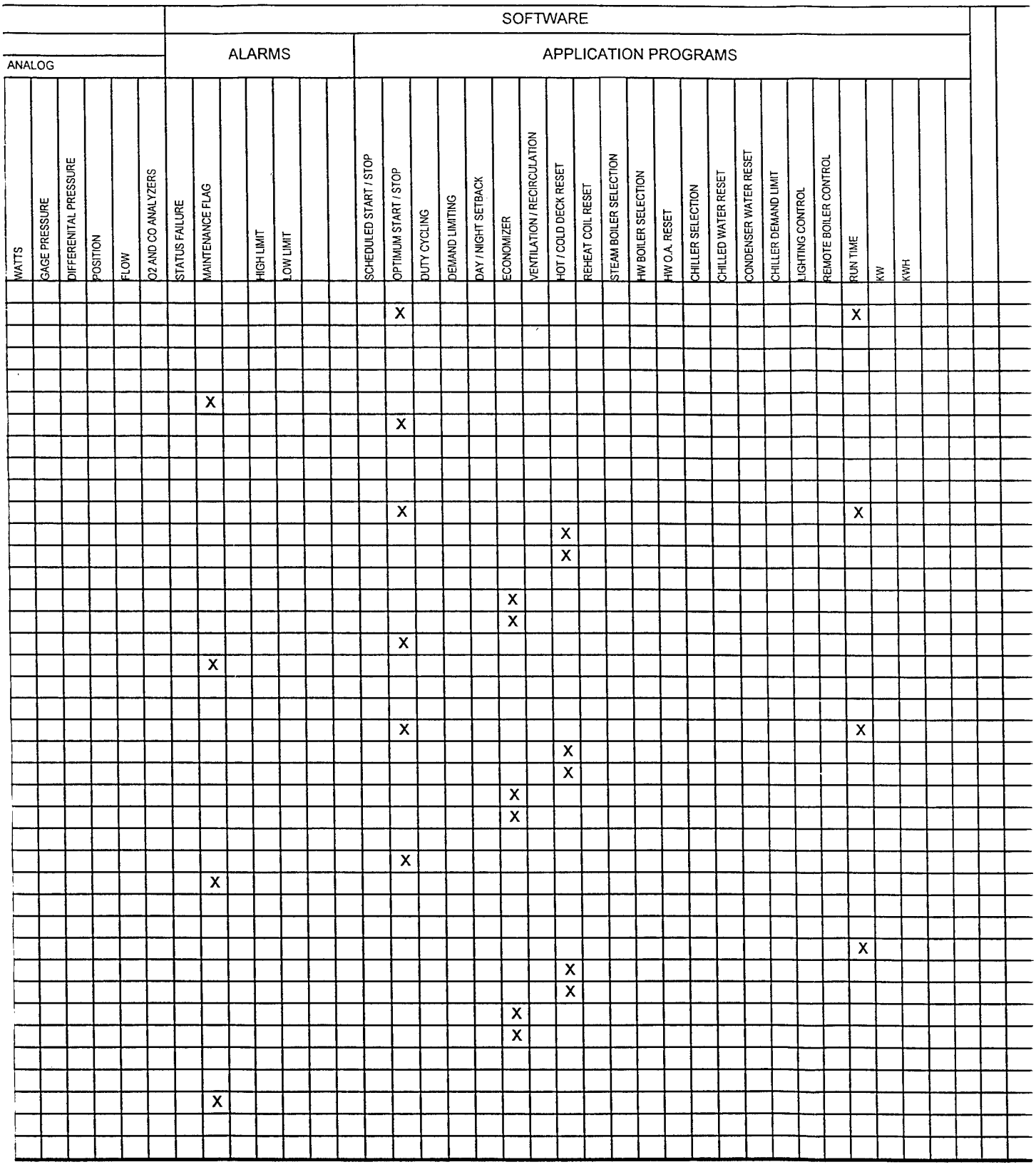
AREA: 1000	HARDWARE																										
	OUTPUT								INPUT																		
	DIGITAL					ANALOG			DIGITAL										ANALOG								
ECO G: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	WATTS	GAGE PRESSURE	DIFFERENITAL PRESSURE	POSITION		
OCCUPANCY TIME: VARIES																										
GRAPHIC DISPLAY ●																										
POINT DESCRIPTION																										
W/C CHILLERS ●																										
CHILLER					2																2					
CHW PUMP	2														2											
CW PUMP	2														2											
TWR. FAN	2														2											
CHW SUPPLY HEADER																		2								
CHW RETURN HEADER																		2								
CW SUPPLY HEADER																		2								
CW RETURN HEADER																		2								
TWR. BYPASS VALVE								1																		
W/C CHILLER ●																										
CHILLER					1																1					
CHW PUMP	1														1											
CW PUMP	1														1											
TWR. FAN	1														1											
CHW SUPPLY HEADER																		1								
CHW RETURN HEADER																		1								
CW SUPPLY HEADER																		1								
CW RETURN HEADER																		1								
TWR. BYPASS VALVE								1																		
HW BOILERS ●																										
BOILER					3							3														
HW PUMP	3														3											
HW SUPPLY HEADER																		3								
HW RETURN HEADER																		3								
HW BOILER ●																										
BOILER					1							1														
HW PUMP	1														1											
HW SUPPLY HEADER																		1								
HW RETURN HEADER																		1								
STEAM BOILER ●																										
BOILER					3							3														
STEAM SUPPLY HEADER																							3			
STEAM RETURN HEADER																							3			
STEAM BOILER ●																										
BOILER					3							3														
STEAM SUPPLY HEADER																							3			
STEAM RETURN HEADER																							3			

| SOFTWARE | | |

REMOTE BOILER CONTROL	RUN TIME	KW	KWH				REMARKS
							bldg. 1000 chlrs
	X	X	X				
	X						
	X						
	X						
							bldg. 1029 chlr
	X	X	X				
	X						
	X						
	X						
							bldg. 1000 hw blrs
	X						
							bldg. 1029 hw blr
	X						
							bldg. 1000 lps blr serving convectors
							bldg. 1001 steam blrs

AREA: 1000	HARDWARE																										
	OUTPUT								INPUT																		
	DIGITAL					ANALOG			DIGITAL											ANALOG							
ECO G: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	WATTS	GAGE PRESSURE	DIFFERENITAL PRESSURE	POSITION	
OCCUPANCY TIME: VARIES																										
GRAPHIC DISPLAY ●																										
POINT DESCRIPTION																										
AHU-SZ ●																										
SUPPLY FAN	1														1											
CHW COIL VALVE						1												1								
HW COIL VALVE						1												1								
RETURN AIR																										
FILTER										1																
ZONE TEMPERATURE																		1								
OUTSIDE AIR																										
AHU (FACE AND BYPASS-SZ) ●																										
SUPPLY FAN	7														7											
COLD DECK TEMP.						7												7								
HOT DECK TEMP.						7												7								
BYPASS DAMPER							7																			
RETURN AIR																		7								
OUTSIDE AIR							7																			
ZONE TEMPERATURE																		7								
FILTER										7																
AHU (MZ) ●																										
SUPPLY FAN	2														2											
COLD DECK TEMP.						2												2								
HOT DECK TEMP.						2												2								
RETURN AIR																		2								
OUTSIDE AIR							2																			
ZONE DAMPERS							8																			
ZONE TEMPERATURE																		8								
FILTER										2																
AHU (MZ) ●																										
SUPPLY FAN	1														1											
COLD DECK TEMP.						1												1								
HOT DECK TEMP.						1												1								
RETURN AIR																		1								
OUTSIDE AIR							1																			
ZONE DAMPERS							4																			
ZONE TEMPERATURE																		4								
FILTER										1																
OUTSIDE AIR ●																		1	1							

TOTAL AO POINTS =	37
TOTAL DO POINTS =	53
TOTAL AI POINTS =	45
TOTAL DI POINTS =	96
GRAND TOTAL POINTS =	231


SOFTWARE
ANALOG
ALARMS
APPLICATION PROGRAMS
WATTS
GAGE PRESSURE
DIFFERENITAL PRESSURE
POSITION
FLOW
O2 AND CO ANALYZERS
STATUS FAILURE
MAINTENANCE FLAG
HIGH LIMIT
LOW LIMIT
SCHEDULED START / STOP
OPTIMUM START / STOP
DUTY CYCLING
DEMAND LIMITING
DAY / NIGHT SETBACK
ECONOMIZER
VENTILATION / RECIRCULATION
HOT / COLD DECK RESET
REHEAT COIL RESET
STEAM BOILER SELECTION
HW BOILER SELECTION
HW O.A. RESET
CHILLER SELECTION
CHILLED WATER RESET
CONDENSER WATER RESET
CHILLER DEMAND LIMIT
LIGHTING CONTROL
REMOTE BOILER CONTROL
RUN TIME
KW
KWH

REMOTE BOILER CONTROL	RUN TIME	KW	KWH				REMARKS
							bldg. 1029 4th floor ahu
	X						
							bldg. 1029 1st - 3rd floor ahus
	X						and bldg. 1001 4th floor ahu
							all valves, dampers, thermostats, and
							actuators are existing.
							bldg. 1001 2nd - 3rd floor ahus
	X						
							all valves, dampers, thermostats, and
							actuators are existing.
							bldg. 1001 1st floor ahu
	X						
							all valves, dampers, thermostats, and
							actuators are existing.

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1000 Chiller (CHLR-1)	90.5	57.9	203.2	208.4	185.3	212.4	223.3	233.8	206.8	213.1	212.1	99.5	994,677	
Bldg. 1000 Cooling Tower Fans	11.4	2.8	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	13.7	106,916	
Bldg. 1000 CHW Pump	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	326,748	
Bldg. 1000 CND Pump	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	261,048	
Bldg. 1000 CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	8,760	
Bldg. 1000 Chiller (CHLR-2)			120.6	163.1	203.7	233.5	245.4	256.9	227.3	146.9	127.9		897,779	
Bldg. 1000 Cooling Tower Fans			18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6		93,878	
Bldg. 1000 CHW Pump			37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3		188,738	
Bldg. 1000 CND Pump			29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8		150,788	
Bldg. 1000 CHW Controls			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		5,060	
Bldg. 1001 Window Units	6.4	6.4	6.4	6.7	7.2	7.5	7.7	7.7	7.2	6.7	6.4	6.4	10,623	
Bldg. 1001 Window Unit Fans	0.0	0.0	0.0	0.0	0.7	0.8	1.0	1.0	0.7	0.6	0.0	0.0	1,412	
Bldg. 1001 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	876	
Bldg. 1001 Chiller					60.1	61.2	63.8	63.9	57.6	40.6			121,332	
Bldg. 1001 Cooling Tower Fans					11.2	11.2	11.2	11.2	11.2	11.2			45,605	
Bldg. 1001 CHW Pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 1001 CND Pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 1001 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1029 Chiller					62.2	62.7	65.8	68.1	64.7	49.6			115,128	
Bldg. 1029 Cooling Tower Fans					7.5	7.5	7.5	7.5	7.5	7.5			30,036	
Bldg. 1029 CHW Pump					18.6	18.6	18.6	18.6	18.6	18.6			82,138	
Bldg. 1029 CND Pump					18.6	18.6	18.6	18.6	18.6	18.6			82,138	
Bldg. 1029 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1000 Fan	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	176,076	
Bldg. 1000 Fan	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	113,880	
Bldg. 1000 Fan	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	179,580	
Bldg. 1000 Fan	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	261,048	
Bldg. 1000 Fan	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	49,056	
Bldg. 1000 Fan	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	19,272	
Bldg. 1001 Fan	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	32,412	
Bldg. 1001 Fan	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	147,168	
Bldg. 1029 Fan	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	150,672	
Bldg. 1000 Boiler														10,809
Bldg. 1000 HW Pump	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	162,936	
Blodg. 1000 HW Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1,095	
Bldg. 1000 Boiler														0
Bldg. 1000 HW Pump	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	
Bldg. 1000 HW Controls	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1000 LPS Boiler														2,591
Bldg. 1000 LPS Boiler Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 1001 LPS Boiler														123
Bldg. 1001 LPS Boiler Controls	0.1	0.1	0.1	0.1							0.1	0.1	288	
Bldg. 1029 Boiler														130
Bldg. 1029 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	3,520	
Bldg. 1029 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	200	
Totals	326.6	285.4	653.8	701.8	920.6	979.5	1008.4	1032.8	965.7	858.9	670.0	337.9	4,929,176	13,652
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	2,450	2,141	4,904	5,264	6,905	9,795	10,084	10,328	9,657	6,442	5,025	2,534		

Total Demand 75,527 $/yr

Total Energy 16,823 MMBTU/yr (electric)

Total Energy 13,652 MMBTU/yr (gas)

ITEM	ECO G - INSTALL EMS AIRSIDE SYSTEMS MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1000 Chiller (CHLR-1)	79.7	51.2	202.4	207.6	181.6	209.9	221.3	232.3	204.0	213.1	212.0	89.7	957,825	
Bldg. 1000 Cooling Tower Fans	18.6	17.7	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	146,283	
Bldg. 1000 CHW Pump	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	326,748	
Bldg. 1000 CND Pump	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	261,048	
Bldg. 1000 CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	8,760	
Bldg. 1000 Chiller (CHLR-2)			115.2	158.0	199.6	230.7	243.3	255.4	224.3	141.6	122.4		874,932	
Bldg. 1000 Cooling Tower Fans			18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6		94,116	
Bldg. 1000 CHW Pump			37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3		188,738	
Bldg. 1000 CW Pump			29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8		150,788	
Bldg. 1000 CHW Controls			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		5,060	
Bldg. 1001 Window Units	6.4	6.4	6.4	6.7	7.2	7.5	7.7	7.7	7.2	6.7	6.4	6.4	9,968	
Bldg. 1001 Window Unit Fans	0.0	0.0	0.0	0.0	0.8	0.8	1.0	1.0	0.8	0.6	0.0	0.0	1,338	
Bldg. 1001 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	876	
Bldg. 1001 Chiller					63.7	63.1	64.6	65.5	63.3	40.5			118,358	
Bldg. 1001 Cooling Tower Fans					11.2	11.2	11.2	11.2	11.2	11.2			44,891	
Bldg. 1001 CHW Pump					11.2	11.2	11.2	11.2	11.2	11.2			45,136	
Bldg. 1001 CW Pump					11.2	11.2	11.2	11.2	11.2	11.2			45,136	
Bldg. 1001 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,030	
Bldg. 1029 Chiller					65.9	67.0	69.1	70.1	67.9	47.3			99,585	
Bldg. 1029 Cooling Tower Fans					7.5	7.5	7.5	7.5	7.5	7.5			32,943	
Bldg. 1029 CHW Pump					18.6	18.6	18.6	18.6	18.6	18.6			82,138	
Bldg. 1029 CW Pump					18.6	18.6	18.6	18.6	18.6	18.6			82,138	
Bldg. 1029 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1000 Fan	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	176,076	
Bldg. 1000 Fan	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	113,880	
Bldg. 1000 Fan	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	179,580	
Bldg. 1000 Fan	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	261,048	
Bldg. 1000 Fan	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	49,056	
Bldg. 1000 Fan	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	19,272	
Bldg. 1001 Fan	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	32,412	
Bldg. 1001 Fan	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	49,457	
Bldg. 1029 Fan	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	50,933	
Bldg. 1000 Boiler														10,809
Bldg. 1000 HW Pump	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	162,936	
Blodg. 1000 HW Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1,095	
Bldg. 1000 Boiler														0
Bldg. 1000 HW Pump	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	
Bldg. 1000 HW Controls	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	

ITEM	ECO G - INSTALL EMS AIRSIDE SYSTEMS MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1000 LPS Boiler														2,591
Bldg. 1000 LPS Boiler Controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 1001 LPS Boiler														149
Bldg. 1001 LPS Boiler Controls	0.1	0.1	0.1	0.1							0.1	0.1	281	
Bldg. 1029 Boiler														198
Bldg. 1029 HW Pump	2.2	2.2	2.2	2.2							2.2	2.2	3,379	
Bldg. 1029 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	192	
Total (KW)	323.0	293.6	647.6	695.9	920.2	980.4	1008.4	1033.4	968.9	851.2	664.4	333.0	4,685,391	13,747
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	2,423	2,202	4,857	5,219	6,902	9,804	10,084	10,334	9,689	6,384	4,983	2,498		

Total Demand	75,378	$/yr	
Demand Savings	149	$/yr	
Energy Savings	832	MMBTU/yr	(electric)
Energy Savings	-94	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX

ECO NO. G **AREA 1000**

PROJECT NO: 03-0185.06G

DATE: 9/18/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
EMCS COSTS BASED ON DDC ALL ELECTRIC								
DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE								
DIGITAL OUTPUT DEVICE :								
START-STOP MOTOR	24	EA	10.2	28.91	7,077	175.74	4,218	11,295
ENABLE/DISABLE APPARATUS RELAY	13	EA	4.5	28.91	1,691	49.00	637	2,328
ANALOG OUTPUT:								
CONTROL VALVE (COIL/AHU ACTUATOR ONLY)	24	EA	11.9	28.91	8,271	571.00	13,704	21,975
DAMPER ACTUATOR & MOTOR	30	EA	11.9	28.91	10,338	340.00	10,200	20,538
DIGITAL INPUT:								
DIFFERENTIAL PREASURE SWITCH	11	EA	10.1	28.91	3,212	227.30	2,500	5,712
AUXILIARY CONTACT	10	EA	4.5	28.91	1,301	49.00	490	1,791
CURRENT SENSING RELAY	24	EA	4.5	28.91	3,122	49.00	1,176	4,298
SHEET 1								
				SUBTOTAL	35,012		32,925	67,937
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	**PROJECT NO:** 03-0185.06G	**DATE:** 9/18/96
ECO NO. G AREA 1000	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
ANALOG INPUT:								
TEMP. SENSER & THERMO WELL	22	EA	17.0	28.91	10,812	426.42	9,381	20,194
TEMP. SENSER AIR DUCT	31	EA	12.0	28.91	10,755	450.00	13,950	24,705
TEMP. SENSER OUTSIDE AIR	1	EA	12.0	28.91	347	550.00	550	897
TEMP. SENSER ZONE	19	EA	12.0	28.91	6,591	556.00	10,564	17,155
RELATIVE HUMIDITY %	1	EA	13.0	28.91	376	615.00	615	991
AMPERES	3	EA	7.0	28.91	607	219.00	657	1,264
GAUGE PRESURE BOILER	12	EA	8.0	28.91	2,775	197.00	2,364	5,139
FLOW STATUS / RATE	7	EA	17.0	28.91	3,440	410.00	2,870	6,310
EQUIPMENT FAILURE ALARM	13	EA	2.6	28.91	977	108.00	1,404	2,381
FILTER ALARM	11	EA	4.5	28.91	1,431	227.00	2,497	3,928
HIGH & LOW LIMIT (HYDRONIC)	49	PR	2.0	28.91	2,833	170.00	8,330	11,163
SHEET 2								
				SUBTOTAL	40,945		53,182	94,127
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	PROJECT NO: 03-0185.06G	DATE: 9/18/96
ECO NO. G AREA 1000	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
OPERATORS' WORKSTATION	1	SUM				13,184.00	13,184	13,184
INCLUDING MODEM & REMOTE PANEL								
SUBMITTALS, TRAINING & START-UP	1	JOB				8,300.00	8,300	8,300
SOFTWARE	1	LS				15,000.00	15,000	15,000
SUB TOTAL FROM SHEET 1					35,012		32,925	67,937
SUB TOTAL FROM SHEET 2					40,945		53,182	94,127
SUBTOTAL					75,958		122,591	198,549
O & P @ 20%					15,192		24,518	39,710
SUBTOTAL					91,149		147,110	238,259
DESIGN @ 6%								14,296
SUBTOTAL								252,554
SIOH @ 5.5%								13,890
TOTAL								$266,445

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Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-G
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment	
A. Construction Cost	$238,259
B. SIOH	$13,890
C. Design Cost	$14,296
D. Total Cost (1A+1B+1C)	$266,445
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$266,445

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	832	Mbtus	$5,225	15.08	$78,792
Elec. Deman					$149	14.88	$2,217
Natural Gas	$3.5	/Mbtus	-94	Mbtus	-$325	18.58	-$6,043
TOTAL			738	Mbtus	$5,049		$74,967

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL TOTAL	$0			$0
ONE TIME TOTAL	$0			$0
TOTAL	$0			$0

4. First Year Dollar Savings	$5,049
5. Simple Payback Period (Years)	52.77
6. Total Net Discounted Savings	$74,967
7. Savings to Investment Ratio	.28
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	-3.33%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	H
DATE:	3/1/96
ECO TITLE:	Retrofit Existing Individual Chillers With Central Chillers
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 1000, buildings 1000, 1001, 1029, 1088

A. Summary:

Electrical Energy Savings	1016	MMBTU/yr
Electrical Demand Savings	3865	$/yr
Gas Energy Savings	0	MMBTU/yr
Total Energy Savings	1016	MMBTU/yr
Total Cost Savings	37,885	$/yr
Total Investment	480,090	$
Simple Payback	12.7	yrs
SIR	1.18	

A. ECO Description:

Remove the existing 160 ton chiller (120 GPM) from Building 1029. The two 400 ton chillers located in Building 1000's central cooling plant and the chiller serving Building 1001 (located in Building 1002) will remain. This plant serving Building 1000 is located on the North side of the building in building 1088. A section of the west wall of building 1088 will be removed and approximately 500 additional sq ft. will be added to this plant. A new chiller and pump pads will be constructed to install a new R-123, 315 ton water cooled centrifugal chiller with 0.57 KW/ton efficiency. The two existing CHW pumps will remain but they will need to have the impeller retrofitted to the next size up (if possible). The two CW pumps will remain as is. Install one 30 HP CHW pump selected at 630 GPM and 110 ft. hd, and one 20 HP CW pump selected at 940 GPM and 60 ft. Hd. A new cooling tower with a 20 HP two speed motor will be installed to support the new chiller, and it will be installed on the roof of the new addition to the plant. These towers will be piped in such a way that they shall be capable of serving any of the three chillers. The new and existing 400 ton centrifugal chillers at the central plant will be retrofitted to the low pressure refrigerant (R-123). Provide 12" CHW supply and return headers for all three chillers. Provide a 4" take-off for building 1001, and the existing CHW system for Building 1001 will be connected to this primary CHW loop. Similarly, a 3" primary loop will be constructed and connected to the existing CHW system of Building 1029. Approximately 150 ft. of 5", 100 ft. of 4" and 450 ft of 3" piping for the over-head piping and 800 ft of 4" and 800 ft. of 3" under ground piping will be required for these loops. The existing CHW pumps for Buildings 1001, (1002 which is not included in this project, but its cooling is served by Building 1001 chiller) and 1029 will be reutilized as secondary CHW pumps. All AHU, CHW coil three way control valves will be converted to two way valves to minimize pumping energy. A 2.5" by-pass control valve will be installed in the plant between the CHW supply and return lines to maintain a minimum CHW differential pressure and flow through the system for safe operation of the chillers. Utilize existing controls for the existing chillers and pumps and install new controls and electrical services at Building 1000 to serve the new chiller and pumps. Other specific requirements should

be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new chiller, cooling tower, associated wiring and controls.

B. Discussion:

Building 1000 is served by two 400 ton water cooled centrifugal liquid chillers. Both were installed in 1993. They are in excellent condition. Although they are R-11 chillers, it is not cost effective to replace them. However, it is recommended to retrofit them with R-123 refrigerant. Currently, there is no more R-11 being manufactured in the United States. Even though the refrigerant is readily available, as time goes on; the supply of this refrigerant will become scarce and more expensive. At the time of this report, R-11 refrigerant is available for $9.00 per pound of refrigerant as opposed to $3.50 per pound for R-123 refrigerant. Moreover, many vendors are buying CFC refrigerant from owners to stockpile. As a result, there is a refrigerant reclaim cost of $2.00 per pound associated with this old refrigerant that was included in the life cycle cost analysis. In converting the chillers to an approved refrigerant, there is a reduction of 5% in the tonnage of the equipment, and a reduction of 3% in efficiency. This was included in the equipment simulation for the two existing chillers.

Building 1001 is served by a 219 ton centrifugal chiller, which was installed in 1974. The no-longer manufactured R-11 refrigerant, age, inefficiency, and added maintenance justify its removal. However, this chiller is located and also serves Building 1002 which is not included in the Scope of Work for this project; therefore, we will not include the replacement of this chiller in this ECO. Building 1029 is served by a new 160 ton, R-123 centrifugal chiller which was installed in 1995. All chiller auxiliaries except the cooling tower were also replaced at the same time. The chiller, CW pump and cooling tower will be removed and stored for future use. The CHW pump will be reutilized as a secondary CHW pump. All chillers are in different locations and are remote to each other. With the exception of the chiller serving Building 1001, all are in excellent condition. The primary factor for replacing these chillers with a central chiller plant is due to the added maintenance cost associated with maintaining multiple water cooled chillers and with the inefficiency of the older machines.

Therefore, it is recommended that a central chiller plant, consisting of a new 235 ton and two existing 400 ton water cooled chillers be installed to serve these buildings. The existing chiller plant for building 1000 does not have sufficient room to house a new chiller and its pumps and therefore it must be expanded. The only expansion possibility for this plant is on the west wall adjacent to the parking lot. Since the existing plant cooling towers are on the roof, the new cooling tower will be installed on roof of this new expansion. The chillers will be connected to the new CHW loops. All existing building CHW pumps will be reutilized as secondary pumps. With a CHW header configuration, under low cooling load conditions fewer chillers will operate. Particularly when Buildings 1001 and 1029 have very light occupancy during night hours. Only Building 1000, a hospital remains occupied after hours. Currently Building 1001's and 1029's chillers operate at low load conditions and are very inefficient at these low loads. A central cooling plant operation will eliminate this low load condition, operate fewer chillers at a higher load, and improve cooling efficiency. This will save energy and greatly reduce the maintenance cost of the installation.

Maintaining the accessibility for the emergency entrance and support service area behind the hospital poses a problem for construction and providing an underground primary CHW piping loop . Therefore a portion of the CHW supply and return piping will be constructed above

ground, alongside existing above ground piping, in the back of the hospital. The remainder of the piping can be installed under ground. Computer simulations of the buildings in this area determined that the current installed capacity of 1056 tons is more than required to adequately cool the buildings[1]. Therefore it is recommended that one new chiller and two existing chillers rated at a total of 995 tons be installed to more closely match the cooling load of the buildings.

Building 1001 is served by four AHUs with wild CHW coils. New two way CHW control valves will be installed on these coils. All other buildings AHU, CHW coil three way control valves will be converted to two way valves to minimize pumping energy and provide better distribution of CHW flow to the AHU coils.

C. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed chillers and pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3].

There were several types of chillers modeled including centrifugal, screw, variable speed driven centrifugal, and gas engine driven. Water cooled R-123 centrifugal machines are more efficient in their full load KW/ton ratings over the screw or gas engine driven machines, while the screw machines were approximately 10% more efficient in the part load range between 25% -50%. Full load performance data from York International was used in the computer simulations of the new chiller energy usage, while part load data was available from equipment supplied with Trace 600. Equipment lists of the specific chillers and pumps modeled for the proposed chiller alternatives are shown on pages C-128 Through C-134.

In this particular area, the proposed electric driven alternatives were modeled together with the already existing chillers. However, the gas engine chillers were selected to handle the entire load. The reason for this was to utilize the electric demand savings available, and because the gas engine chillers are more readily available at larger loads and have a history of being more economical at larger loads.

Once the computer simulations of the existing and new chiller plants were completed, the total annual demand cost and energy consumption of each chiller was compared with that of the existing chiller to determine the annual savings for this ECO. These savings calculations are shown on pages C-135 and C-137. These demand and energy savings values were used in the life cycle cost analysis. The results of these savings calculations were as follows:

Alternative	Chiller Type	Demand Savings $/yr	Electrical Savings MMBTU/yr	Gas Savings MMBTU/yr
H1	Electric Centrifugal	3865	1016	0
H2	Electric Centrifugal & VFD	2229	1118	0
H3	Electric Screw	2517	1012	0
H4	Gas Driven Centrifugal	47,597	8940	-18260

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water cooled chillers in this area down to three water cooled chillers. The total maintenance cost savings from this ECO is estimated to be $27,480 per year as calculated on page C-156. This figure was used in the life cycle cost analysis.

D. Cost Estimates:

The total installation costs for the new central chiller plant were estimated on pages C-138 through C-155. These costs were used in the life cycle cost analysis. The results of the costs estimates were as follows:

Alternative	Chiller Type	Estimated Cost
H1	Electric Centrifugal	$480,090
H2	Electric Centrifugal & VFD	$491,707
H3	Electric Screw	$494,282
H4	Gas Driven Centrifugal	$1,872,481

E. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. An item for R-11 refrigerant reclaim cost was input into the program based on $2.00 per pound and 2 pound per ton of chillers. Also, in alternatives H1, H2, and H3 there was a salvage value of $8,000 associated with the one centrifugal chiller serving building 1029. This costs were obtained from Entech Sales and Service in Dallas, Texas. However, on alternative H4, the installation will save the cost of not having to retrofit the existing R-11 machines to R-123, so there was a one time savings of $50,000 for both chillers ($25,000 per chiller) serving building 1000 along with the salvage value of building 1029's chiller. The summary sheets for the life cycle cost analysis of

each alternative are shown on pages C-157 through C-160. The results of the alternative life cycle cost analysis were as follows:

Alternative	Chiller Type	Payback Years	SIR
H1	Electric Centrifugal	12.7	1.18
H2	Electric Centrifugal & VFD	13.3	1.12
H3	Electric Screw	13.5	1.10
H4	Gas Driven Centrifugal	26.5	0.45

Since the electric centrifugal chiller has the highest SIR, it is recommended as the most economical choice to replace the existing machine. The data from the life cycle cost analysis for this alternative were included in the summary on page C-123.

REFERENCES

1. Refer to Appendix H for the system thermal load profile for this area.

2. Refer to Appendix H for the computer modeling input assumptions, data, and consumption output.

3. Refer to Appendix G for building field data and existing HVAC equipment data.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H1, FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller CH-1	1	York YT water cooled, centrifugal, 235 tons, R-123	Area 1000	New	141 KW
Chilled Water Pump	1	Bell & Gossett 470 gpm, 110 ft 20 HP	Area 1000	New	14.90 KW
Condenser Water Pump	1	Bell & Gossett 705 gpm, 60 ft 15 HP	Area 1000	New	11.20 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 15 HP fan	Area 1000	New	11.20 KW
Water Chiller CH-2	1	York (centrifugal) # YTG3H3E1CND, R-123 380 tons	Currently serves bldg. 1000, retrofit to R-123	1993	260 KW
Chilled Water Pump	1	TACO, 50 HP 960 GPM, 110 ft head 50 HP	Currently serves bldg. 1000 CH-1 increase impeller to next size up	1993	37.29 KW
Cond. Water Pump	1	TACO, 40 HP 1132 GPM, 66 ft head	Currently serves bldg. 1000 CH-1	1993	29.83 KW
Cooling Tower	1	Marley, 25 HP single speed motor	Bldg. 1000 (CH-1)	1993	18.64 KW
Water Chiller CH-3	1	York (centrifugal) # YTG3H3E1CND, R-123 380 tons	Currently serves bldg. 1000, retrofit to R-123	1993	286 KW
Chilled Water Pump	1	TACO, 50 HP 960 GPM, 110 ft head	Currently serves bldg. 1000 CH-1 increase impeller to next size up	1993	37.29 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H1, FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
Cond. Water Pump	1	TACO, 40 HP 1132 GPM, 66 ft head	Currently serves bldg. 1000 CH-1	1993	29.83 KW
Cooling Tower	1	Marley, 25 HP single speed motor	Bldg. 1000 (CH-2)	1993	18.64 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H2, FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller CH-1	1	York YT with VFD water cooled, centrifugal, 235 tons, R-123	Area 1000	New	141 KW
Chilled Water Pump	1	Bell & Gossett 470 gpm, 110 ft 20 HP	Area 1000	New	14.90 KW
Condenser Water Pump	1	Bell & Gossett 705 gpm, 60 ft 15 HP	Area 1000	New	11.20 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 15 HP fan	Area 1000	New	11.20 KW
Water Chiller CH-2	1	York (centrifugal) # YTG3H3E1CND, R-123 380 tons	Currently serves bldg. 1000, retrofit to R-123	1993	260 KW
Chilled Water Pump	1	TACO, 50 HP 960 GPM, 110 ft head 50 HP	Currently serves bldg. 1000 CH-1 increase impeller to next size up	1993	37.29 KW
Cond. Water Pump	1	TACO, 40 HP 1132 GPM, 66 ft head	Currently serves bldg. 1000 CH-1	1993	29.83 KW
Cooling Tower	1	Marley, 25 HP single speed motor	Bldg. 1000 (CH-1)	1993	18.64 KW
Water Chiller CH-3	1	York (centrifugal) # YTG3H3E1CND, R-123 380 tons	Currently serves bldg. 1000, retrofit to R-123	1993	286 KW
Chilled Water Pump	1	TACO, 50 HP 960 GPM, 110 ft head	Currently serves bldg. 1000 CH-1 increase impeller to next size up	1993	37.29 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H2, FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
Cond. Water Pump	1	TACO, 40 HP 1132 GPM, 66 ft head	Currently serves bldg. 1000 CH-1	1993	29.83 KW
Cooling Tower	1	Marley, 25 HP single speed motor	Bldg. 1000 (CH-2)	1993	18.64 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H3, FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller CH-1	1	York YS water cooled screw 235 tons, R-123	Area 1000	New	146 KW
Chilled Water Pump	1	Bell & Gossett 470 gpm, 110 ft 20 HP	Area 1000	New	14.90 KW
Condenser Water Pump	1	Bell & Gossett 705 gpm, 60 ft 15 HP	Area 1000	New	11.20 KW
Cooling Tower	1	Evapco AT crossflow, induced draft 15 HP fan	Area 1000	New	11.20 KW
Water Chiller CH-2	1	York (centrifugal) # YTG3H3E1CND, R-123 380 tons	Currently serves bldg. 1000, retrofit to R-123	1993	260 KW
Chilled Water Pump	1	TACO, 50 HP 960 GPM, 110 ft head 50 HP	Currently serves bldg. 1000 CH-1 increase impeller to next size up	1993	37.29 KW
Cond. Water Pump	1	TACO, 40 HP 1132 GPM, 66 ft head	Currently serves bldg. 1000 CH-1	1993	29.83 KW
Cooling Tower	1	Marley, 25 HP single speed motor	Bldg. 1000 (CH-1)	1993	18.64 KW
Water Chiller CH-3	1	York (centrifugal) # YTG3H3E1CND, R-123 380 tons	Currently serves bldg. 1000, retrofit to R-123	1993	286 KW
Chilled Water Pump	1	TACO, 50 HP 960 GPM, 110 ft head	Currently serves bldg. 1000 CH-1 increase impeller to next size up	1993	37.29 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H3, FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Cond. Water Pump	1	TACO, 40 HP 1132 GPM, 66 ft head	Currently serves bldg. 1000 CH-1	1993	29.83 KW
Cooling Tower	1	Marley, 25 HP single speed motor	Bldg. 1000 (CH-2)	1993	18.64 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H4, FORT SAM HOUSTON, AREA 1000
MARCH 1, 1996

ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	2	York, gas engine driven YG water cooled, centrifugal 500 tons, R-134a	Area 1000	New	3,284 MBH
Chilled Water Pump	2	Bell & Gossett 1000 gpm, 110 ft 40 HP	Area 1000	New	29.80 KW
Condenser Water Pump	2	Bell & Gossett 1650 gpm, 60 ft 30 HP	Area 1000	New	22.40 KW
Cooling Tower	2	Evapco AT crossflow, induced draft 25 HP fan	Area 1000	New	18.60 KW

1000 AREA

ITEM	ECO H - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1000 Chiller (CHLR-1)	90.5	57.9	203.2	208.4	185.3	212.4	223.3	233.8	206.8	213.1	212.1	99.5	994,677	
Bldg. 1000 Cooling Tower Fans	11.4	2.8	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	13.7	106,916	
Bldg. 1000 CHW Pump	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	326,748	
Bldg. 1000 CND Pump	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	261,048	
Bldg. 1000 CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	8,760	
Bldg. 1000 Chiller (CHLR-2)			120.6	163.1	203.7	233.5	245.4	256.9	227.3	146.9	127.9		897,779	
Bldg. 1000 Cooling Tower Fans			18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6		93,878	
Bldg. 1000 CHW Pump			37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3		188,738	
Bldg. 1000 CND Pump			29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8		150,788	
Bldg. 1000 CHW Controls			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		5,060	
Bldg. 1001 Window Units	6.4	6.4	6.4	6.7	7.2	7.5	7.7	7.7	7.2	6.7	6.4	6.4	10,623	
Bldg. 1001 Window Unit Fans	0.0	0.0	0.0	0.0	0.7	0.8	1.0	1.0	0.7	0.6	0.0	0.0	1,412	
Bldg. 1001 Window Unit Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	876	
Bldg. 1001 Chiller					60.1	61.2	63.8	63.9	57.6	40.6			121,332	
Bldg. 1001 Cooling Tower Fans					11.2	11.2	11.2	11.2	11.2	11.2			45,605	
Bldg. 1001 CND Pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 1001 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1029 Chiller					62.2	62.7	65.8	68.1	64.7	49.6			115,128	
Bldg. 1029 Cooling Tower Fans					7.5	7.5	7.5	7.5	7.5	7.5			30,036	
Bldg. 1029 CND Pump					18.6	18.6	18.6	18.6	18.6	18.6			82,138	
Bldg. 1029 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Totals	176.5	135.3	503.7	551.7	743.2	802.1	831.0	855.4	788.3	681.5	519.9	187.8	3,499,833	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	1,324	1,015	3,778	4,138	5,574	8,021	8,310	8,554	7,883	5,111	3,899	1,409		

Total Demand 59,015 $/yr

Total Energy 11,945 MMBTU/yr (electric)

Total Energy MMBTU/yr (gas)

1000 AREA

ITEM	ECO-H1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller # 1	86.9	49.8	112..4	113.9	122.7	122.2	126.1	131.7	128.0	119.5	96.7	100.5	627,525	
Cooling Tower Fans	10.2	6.4	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	69,469	
CHW Pump	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	130,524	
CND Pump	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	98,112	
CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	8,760	
Water Chiller # 2			155.3	214.3	230.7	229.5	233.2	242.9	240.1	226.7	165.3		930,753	
Cooling Tower Fans			18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6		98,040	
CHW Pump			37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3		197,130	
CND Pump			29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8		157,493	
CHW Controls			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		5,285	
Water Chiller # 3					214.7	228.3	256.6	267.2	238.0	161.1			604,890	
Cooling Tower Fans					18.6	18.6	18.6	18.6	18.6	18.6			58,813	
CHW Pump					37.3	37.3	37.3	37.3	37.3	37.3			117,943	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			94,228	
CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			3,162	
Total (KW)	124.2	83.3	280.3	453.2	779.8	791.7	827.6	853.5	817.8	719.0	387.0	138.8	3,202,127	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	932	625	2,102	3,399	5,849	7,917	8,276	8,535	8,178	5,393	2,903	1,041		

Total Demand 55,150 $/yr

Demand Savings 3,865 $/yr

Energy Savings 1,016 MMBTU/yr (electric)

Energy Savings MMBTU/yr (gas)

ITEM	ECO-H2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller # 1	102.9	53.7	139.4	120.3	135.0	134.5	121.0	126.9	141.0	140.7	111.7	120.9	635,507	
Cooling Tower Fans	8.0	3.9	8.6	6.5	6.8	8.1	9.8	10.5	8.7	7.9	7.1	8.3	31,563	
CHW Pump	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	130,524	
CND Pump	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	98,112	
CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	8,760	
Water Chiller # 2			155.3	214.3	230.7	229.5	233.2	242.9	240.1	226.7	165.3		930,753	
Cooling Tower Fans			18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6		98,040	
CHW Pump			37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3		197,130	
CND Pump			29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8		157,493	
CHW Controls			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		5,285	
Water Chiller # 3					214.7	228.3	256.6	267.2	238.0	161.1			604,890	
Cooling Tower Fans					18.6	18.6	18.6	18.6	18.6	18.6			58,813	
CHW Pump					37.3	37.3	37.3	37.3	37.3	37.3			117,943	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			94,228	
CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			3,162	
Total (KW)	138.0	84.7	417.1	454.9	787.7	800.9	821.1	848.0	828.3	736.9	397.9	156.3	3,172,203	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	1,035	635	3,128	3,412	5,908	8,009	8,211	8,480	8,283	5,527	2,984	1,172		

Total Demand 56,786 $/yr

Demand Savings 2,229 $/yr

Energy Savings 1,118 MMBTU/yr (electric)

Energy Savings MMBTU/yr (gas)

1000 AREA

ITEM	ECO-H3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller # 1	91.9	47.1	119.6	119.3	128.5	127.9	130.7	136.3	133.8	125.9	102.6	107.4	628,893	
Cooling Tower Fans	10.2	6.3	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	69,432	
CHW Pump	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	130,524	
CND Pump	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	98,112	
CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	8,760	
Water Chiller # 2			155.3	214.3	230.7	229.5	233.2	242.9	240.1	226.7	165.3		930,753	
Cooling Tower Fans			18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6		98,040	
CHW Pump			37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3		197,130	
CND Pump			29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8		157,493	
CHW Controls			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		5,285	
Water Chiller # 3					214.7	228.3	256.6	267.2	238.0	161.1			604,890	
Cooling Tower Fans					18.6	18.6	18.6	18.6	18.6	18.6			58,813	
CHW Pump					37.3	37.3	37.3	37.3	37.3	37.3			117,943	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			94,228	
CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			3,162	
Total (KW)	129.2	80.5	399.9	458.6	785.6	797.4	832.2	858.1	823.6	725.4	392.9	145.7	3,203,458	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	969	604	2,999	3,440	5,892	7,974	8,322	8,581	8,236	5,441	2,947	1,093		

Total Demand 56,498 $/yr

Demand Savings 2,517 $/yr

Energy Savings 1,012 MMBTU/yr (electric)

Energy Savings MMBTU/yr (gas)

ITEM	ECO-H4: NEW GAS ENGINE DRIVEN CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller # 1														10,985
Cooling Tower Fans	9.2	1.7	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	11.6	105,997	
CHW Pump	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	261,048	
CND Pump	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	196,224	
CHW Controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	8,760	
Water Chiller # 2														7,275
Cooling Tower Fans				18.6	18.6	18.6	18.6	18.6	18.6	18.6			79,924	
CHW Pump				29.8	29.8	29.8	29.8	29.8	29.8	29.8			128,051	
CND Pump				22.4	22.4	22.4	22.4	22.4	22.4	22.4			96,253	
CHW Controls				1.0	1.0	1.0	1.0	1.0	1.0	1.0			4,297	
Total (KW)	62.4	54.9	71.8	143.6	143.6	143.6	143.6	143.6	143.6	143.6	71.8	64.8	880,554	18,260
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	468	412	539	1,077	1,077	1,436	1,436	1,436	1,436	1,077	539	486		

Total Demand 11,418 $/yr

Demand Savings 47,597 $/yr

Energy Savings 8,940 MMBTU/yr (electric)

Energy Savings -18,260 MMBTU/yr (gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6H1	**DATE:** 9/18/96
ECO NO. H-1 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	379	TON	1.5	28.91	16,874	25.00	9,475	26,349
RMN COOLING TOWER	2	EA	150.0	28.91	8,673	1,900.00	3,800	12,473
DISCOUNT FOR SALVAGE	1	EA						-8,000
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET DIRECT BURY WITH TRENCH AND BACKFILL								
4"	800	LF	0.8	28.91	17,346	19.55	15,640	32,986
3"	800	LF	0.6	28.91	13,877	15.70	12,560	26,437
SUBTOTAL					56,769		41,475	90,244
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6H1	DATE: 9/18/96
ECO NO. H-1 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 2	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	120.0	20.00	2,400	2,500.00	2,500	4,900
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	1	LOC	10.7	28.91	308	717.00	717	1,025
CHANGEALL AHU EQUIPMENT CONTROL VALVE PIPING ASSEMBLY & ELECTRICAL	1	JOB	64.0	28.91	1,850	8,000.00	8,000	9,850
SUBTOTAL					5,009		12,252	17,261
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

HUITT-ZOLLARS, INC.
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512 MAIN STREET, SUITE 1500
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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6H1	**DATE:** 9/18/96
ECO NO. H-1 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
CONSTRUCT CENTRAL PLANT BASE BUILDING	500	BSF				80.00	40,000	40,000
CENTRAL PLANT ELECTRICAL SYSTEM	500	BSF				34.00	17,000	17,000
CHILLER (YORK YT) WITH PIPING & VESELS	235	TON	3.2	28.91	21,740	371.00	87,185	108,925
PRIMARY PUMPS 20 HP	1	EA	22.0	28.91	636	3,900.00	3,900	4,536
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	235	TON	0.6	28.91	4,076	92.00	21,620	25,696
MODIFY EXISTING CHW PUMPS	2	EA	12.0	28.91	694	300.00	600	1,294
12" CHILLER PLANT MANIFOLD & VALVES	1	JOB	133.0	28.91	3,845	9,600.00	9,600	13,445
CENTRAL PLANT CONTROLS	1	JOB	300.0	28.91	8,673	6,000.00	6,000	14,673
				SUBTOTAL	39,665		185,905	225,570
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-1 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6H1

BY : KOTHMANN, K

DATE: 9/18/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
5"	150	LF	.82	28.91	3,556	24.25	3,638	7,193
4"	100	LF	.64	28.91	1,850	15.05	1,505	3,355
3"	450	LF	.57	28.91	7,415	10.39	4,676	12,091
SUBTOTAL					12,822		9,818	22,640
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6H1	DATE: 9/18/96
ECO NO. H-1 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: 1 NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					56,769		41,475	98,244
SUB TOTAL FROM SHEET 2					5,009		12,252	17,261
SUB TOTAL FROM SHEET 3					39,665		185,905	225,570
SUB TOTAL FROM SHEET 4					12,822		9,818	22,640
SUBTOTAL					114,265		249,450	363,715
O & P @ 20%					22,853		49,890	72,743
SUBTOTAL					137,118		299,340	436,458
DESIGN @ 6%								26,187
SUBTOTAL								462,645
SIOH @ 5.5%								25,445
TOTAL								$488,091

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6H2	DATE: 9/18/96
ECO NO. H-2 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	379	TON	1.5	28.91	16,874	25.00	9,475	26,349
RMN COOLING TOWER	2	EA	150.0	28.91	8,673	1,900.00	3,800	12,473
DISCOUNT FOR SALVAGE	1	EA						-8,000
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
4"	800	LF	0.8	28.91	17,346	19.55	15,640	32,986
3"	800	LF	0.6	28.91	13,877	15.70	12,560	26,437
SUBTOTAL					56,769		41,475	90,244
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6H2	DATE: 9/18/96
ECO NO. H-2 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 2	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	120.0	20.00	2,400	2,500.00	2,500	4,900
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	1	LOC	10.7	28.91	308	717.00	717	1,025
CHANGEALL AHU EQUIPMENT CONTROL VALVE PIPING ASSEMBLY & ELECTRICAL	1	JOB	64.0	28.91	1,850	8,000.00	8,000	9,850
SUBTOTAL					5,009		12,252	17,261
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6H2	**DATE:** 9/18/96
ECO NO. H-2 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
CONSTRUCT CENTRAL PLANT BASE BUILDING	500	BSF				80.00	40,000	40,000
HISTORICLY COMPATABLE								
CENTRAL PLANT ELECTRICAL SYSTEM	500	BSF				34.00	17,000	17,000
CHILLER (YORK YT) WITH PIPING & VESELS	235	TON	3.2	28.91	21,740	371.00	87,185	108,925
ADD FOR VFD	50	HP	0.8	28.91	1,156	150.00	7,500	8,656
PRIMARY PUMPS 20 HP	1	EA	22.0	28.91	636	3,900.00	3,900	4,536
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	235	TON	0.6	28.91	4,076	92.00	21,620	25,696
MODIFY EXISTING CHW PUMPS	2	EA	12.0	28.91	694	300.00	600	1,294
12" CHILLER PLANT MANIFOLD & VALVES	1	JOB	133.0	28.91	3,845	9,600.00	9,600	13,445
CENTRAL PLANT CONTROLS	1	JOB	300.0	28.91	8,673	6,000.00	6,000	14,673
				SUBTOTAL	40,821		193,405	234,226
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6H2	DATE: 9/18/96
ECO NO. H-2 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
5"	150	LF	.82	28.91	3,556	24.25	3,638	7,193
4"	100	LF	.64	28.91	1,850	15.05	1,505	3,355
3"	450	LF	.57	28.91	7,415	10.39	4,676	12,091
				SUBTOTAL	12,822		9,818	22,640
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6H2	DATE: 9/18/96
ECO NO. H-2 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: 1 NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					56,769		41,475	98,244
SUB TOTAL FROM SHEET 2					5,009		12,252	17,261
SUB TOTAL FROM SHEET 3					40,821		193,405	234,226
SUB TOTAL FROM SHEET 4					12,822		9,818	22,640
SUBTOTAL					115,421		256,950	372,371
O & P @ 20%					23,084		51,390	74,474
SUBTOTAL					138,505		308,340	446,845
DESIGN @ 6%								26,811
SUBTOTAL								473,656
SIOH @ 5.5%								26,051
TOTAL								$499,707

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6H3	**DATE:** 9/18/96
ECO NO. H-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	379	TON	1.5	28.91	16,874	25.00	9,475	26,349
RMV COOLING TOWER	2	EA	150.0	28.91	8,673	1,900.00	3,800	12,473
DISCOUNT FOR SALVAGE	1	EA						-8,000
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
4"	800	LF	0.8	28.91	17,346	19.55	15,640	32,986
3"	800	LF	0.6	28.91	13,877	15.70	12,560	26,437
SUBTOTAL					56,769		41,475	90,244
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-3 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6H3

BY : KOTHMANN, K

DATE: 9/18/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	120.0	20.00	2,400	2,500.00	2,500	4,900
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	1	LOC	10.7	28.91	308	717.00	717	1,025
CHANGEALL AHU EQUIPMENT CONTROL VALVE	1	JOB	64.0	28.91	1,850	8,000.00	8,000	9,850
PIPING ASSEMBLY & ELECTRICAL								
				SUBTOTAL	5,009		12,252	17,261
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6H3	**DATE:** 9/18/96
ECO NO. H-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
CONSTRUCT CENTRAL PLANT BASE BUILDING	500	BSF				80.00	40,000	40,000
HISTORICLY COMPATABLE								
CENTRAL PLANT ELECTRICAL SYSTEM	500	BSF				34.00	17,000	17,000
CHILLER (YORK YS) WITH PIPING & VESELS	235	TON	3.2	28.91	21,740	416.00	97,760	119,500
PRIMARY PUMPS 20 HP	1	EA	22.0	28.91	636	3,900.00	3,900	4,536
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	235	TON	0.6	28.91	4,076	92.00	21,620	25,696
MODIFY EXISTING CHW PUMPS	2	EA	12.0	28.91	694	300.00	600	1,294
12" CHILLER PLANT MANIFOLD & VALVES	1	JOB	133.0	28.91	3,845	9,600.00	9,600	13,445
CENTRAL PLANT CONTROLS	1	JOB	300.0	28.91	8,673	6,000.00	6,000	14,673
				SUBTOTAL	39,665		196,480	236,145
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-185.6H3

DATE: 9/18/96

ECO NO. H-3 Retrofit Existing Individual Chillers

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
5"	150	LF	.82	28.91	3,556	24.25	3,638	7,193
4"	100	LF	.64	28.91	1,850	15.05	1,505	3,355
3"	450	LF	.57	28.91	7,415	10.39	4,676	12,091
SUBTOTAL					12,822		9,818	22,640
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6H3	DATE: 9/18/96
ECO NO. H-3 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					56,769		41,475	98,244
SUB TOTAL FROM SHEET 2					5,009		12,252	17,261
SUB TOTAL FROM SHEET 3					39,665		196,480	236,145
SUB TOTAL FROM SHEET 4					12,822		9,818	22,640
SUBTOTAL					114,265		260,025	374,290
O & P @ 20%					22,853		52,005	74,858
SUBTOTAL					137,118		312,030	449,148
DESIGN @ 6%								26,949
SUBTOTAL								476,096
SIOH @ 5.5%								26,185
TOTAL								$502,282

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6H4	DATE: 9/18/96
ECO NO. H-4 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant GAS ENGINE DRIVEN R-134a
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	1,179	TON	1.1	28.91	37,493	20.00	23,580	61,073
RMV COOLING TOWER	3	EA	120.0	28.91	10,408	1,900.00	5,700	16,108
DISCOUNT FOR SALVAGE	1	EA						-8,000
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
4"	800	LF	0.8	28.91	17,346	19.55	15,640	32,986
3"	800	LF	0.6	28.91	13,877	15.70	12,560	26,437
SUBTOTAL					79,124		57,480	128,604
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6H4	DATE: 9/18/96
ECO NO. H-4 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant GAS ENGINE DRIVEN R-134a
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	120.0	20.00	2,400	2,500.00	2,500	4,900
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	1	LOC	10.7	28.91	308	717.00	717	1,025
8"	1	LOC	30.0	28.91	867	1,900.00	1,900	2,767
CHANGE ALL AHU EQUIPMENT CONTROL VALVES	1	JOB	64.0	28.91	1,850	8,000.00	8,000	9,850
PIPING ASSEMBLY & ELECTRICAL								
SUBTOTAL					5,876		14,152	20,028
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6H4	**DATE:** 9/18/96
ECO NO. H-4 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant GAS ENGINE DRIVEN R-134a
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
CONSTRUCT CENTRAL PLANT BASE BUILDING	500	BSF				80.00	40,000	40,000
HISTORICLY COMPATABLE								
CENTRAL PLANT ELECTRICAL SYSTEM	500	BSF				34.00	17,000	17,000
CHILLER (YORK YG) WITH PIPING & VESELS	1,000	TON	4.5	28.91	130,095	896.00	896,000	1,026,095
PRIMARY PUMPS 40 HP	2	EA	33.0	28.91	1,908	6,500.00	13,000	14,908
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	1,000	TON	0.6	28.91	17,346	92.00	92,000	109,346
CENTRAL PLANT CONTROLS	1	JOB	300.0	28.91	8,673	6,000.00	6,000	14,673
				SUBTOTAL	158,022		1,064,000	1,222,022
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6H4	**DATE:** 9/18/96
ECO NO. H-4 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: NEW Central Plant GAS ENGINE DRIVEN R-134a
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
5"	150	LF	.82	28.91	3,556	24.25	3,638	7,193
4"	100	LF	.64	28.91	1,850	15.05	1,505	3,355
3"	450	LF	.57	28.91	7,415	10.39	4,676	12,091
SUB TOTAL FROM SHEET 1					79,124		57,480	136,604
SUB TOTAL FROM SHEET 2					5,876		14,152	20,028
SUB TOTAL FROM SHEET 3					158,022		1,064,000	1,222,022
SUBTOTAL					255,844		1,145,450	1,401,294
O & P @ 20%					51,169		229,090	280,259
SUBTOTAL					307,013		1,374,540	1,681,553
DESIGN @ 6%								100,893
SUBTOTAL								1,782,446
SIOH @ 5.5%								98,035
TOTAL								$1,880,480

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Life Cycle Cost Analysis — Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS — Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-H1
Analysis Date: 09/18/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment	
A. Construction Cost	$436,458
B. SIOH	25445
C. Design Cost	26187
D. Total Cost (1A+1B+1C)	$488,090
E. Salvage Value of Existing Equip.	8000
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$480,090

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	1,016	Mbtus	$6,380	15.08	$96,218
Elec. Deman					$3,865	14.88	$57,511
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			1,016	Mbtus	$10,245		$153,729

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$27,480	Annual	14.88	$408,902
ANNUAL TOTAL	$27,480			$408,902
REFRIGERANT RECL	$3,200	0	1.0	$3,200
ONE TIME TOTAL	$3,200			$3,200
TOTAL	$30,680			$412,102

4. First Year Dollar Savings	$37,885
5. Simple Payback Period (Years)	12.67
6. Total Net Discounted Savings	$565,831
7. Savings to Investment Ratio	1.18
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	3.85%

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-H2
Analysis Date: 09/18/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$446,845
B. SIOH	$26,051
C. Design Cost	$26,811
D. Total Cost (1A+1B+1C)	$499,707
E. Salvage Value of Existing Equip.	8000
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$491,707

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	1,118	Mbtus	$7,021	15.08	$105,877
Elec. Deman					$2,229	14.88	$33,168
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			1,118	Mbtus	$9,250		$139,045

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$27,480	Annual	14.88	$408,902
ANNUAL TOTAL	$27,480			$408,902
REFRIGERANT RECL	$3,200	0	1.0	$3,200
ONE TIME TOTAL	$3,200			$3,200
TOTAL	$30,680			$412,102

4. First Year Dollar Savings	$36,890
5. Simple Payback Period (Years)	13.33
6. Total Net Discounted Savings	$551,147
7. Savings to Investment Ratio	1.12
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	3.59%

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-H3
Analysis Date: 09/18/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$449,148
B. SIOH	$26,185
C. Design Cost	$26,949
D. Total Cost (1A+1B+1C)	$502,282
E. Salvage Value of Existing Equip.	8000
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$494,282

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	1,012	Mbtus	$6,355	15.08	$95,839
Elec. Deman					$2,517	14.88	$37,453
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			1,012	Mbtus	$8,872		$133,292

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$27,480	Annual	14.88	$408,902
ANNUAL TOTAL	$27,480			$408,902
REFRIGERANT RECL	$3,200	0	1.0	$3,200
ONE TIME TOTAL	$3,200			$3,200
TOTAL	$30,680			$412,102

4. First Year Dollar Savings	$36,512
5. Simple Payback Period (Years)	13.54
6. Total Net Discounted Savings	$545,394
7. Savings to Investment Ratio	1.1
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	3.51%

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-H4
Analysis Date: 09/18/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$1,681,553
B. SIOH	98035
C. Design Cost	100893
D. Total Cost (1A+1B+1C)	$1,880,481
E. Salvage Value of Existing Equip.	8000
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,872,481

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	8,940	Mbtus	$56,143	15.08	$846,640
Elec. Deman					$47,597	14.88	$708,243
Natural Gas	$3.5	/Mbtus	-18,260	Mbtus	-$63,180	18.58	-$1,173,877
TOTAL			-9,320	Mbtus	$40,561		$381,006

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$27,480	Annual	14.88	$408,902
ANNUAL TOTAL	$27,480			$408,902
REFRIGERANT RECL	$3,200	0	1.0	$3,200
CHILLER RETROFIT	$50,000	0	1.0	$50,000
ONE TIME TOTAL	$53,200			$53,200
TOTAL	$80,680			$462,102

4. First Year Dollar Savings	$70,701
5. Simple Payback Period (Years)	26.48
6. Total Net Discounted Savings	$843,108
7. Savings to Investment Ratio	.45
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	-1.03%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	I
DATE:	3/1/96
ECO TITLE:	Retrofit Existing Individual HW Boilers With Central HW Boilers
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 1000, Buildings 1000, 1001, 1029, 1088

A. Summary:

Electrical Energy Savings	-28	MMBTU/yr
Electrical Demand Savings	-158	$/yr
Gas Energy Savings	80	MMBTU/yr
Total Energy Savings	52	MMBTU/yr
Total Cost Savings	10,323	$/yr
Total Investment	186,539	$
Simple Payback	18.07	yrs
SIR	0.83	

A. ECO Description:

Remove the existing boilers in Buildings 1001 and 1029 as indicated in Table-1. The three HW flex-tube boilers in the boiler plant behind Building 1000 are to remain. Provide necessary controls and gas train accessories to retrofit these three Bryan FlexTube HW boilers from two-stage firing to full modulation firing. From the above-ground 8" HW supply and return mains that extend out from the boiler plant, provide 3" take-offs and extend over to Building 1001 through a direct buried HW supply and return loop. Similarly, Provide a second set of 3" HW supply and return take-offs that extend over to Building 1029 through direct buried pipe. Approximately 800 ft of 3" piping for the over head and 1600 ft. of 3" under ground piping will be required for these loops. Replace the steam coils in the four air handlers serving building 1001 with new HW coils of similar heating capacity and two way control valves. Reutilize existing steam piping in Building 1001. A new 180 GPM, 40 ft. head, 5 HP secondary pump will be installed to serve these new HW coils. All other AHU, HW coil three way control valves will be converted to two way valves to minimize pumping energy. The existing HW system for Building 1029 will be connected to this primary HW loop and the existing building HW pump will be reutilized as a secondary pump. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment, and installation of the new boiler and its associated wiring and controls.

B. Discussion:

Building 1000 has three 5,500 MBH gas fired boilers which have a two position firing rate (high/low). One of these boilers appears more than capable of handling the HW load of the hospital, while the third boiler is a stand-by boiler. Building 1001 has three natural draft gas fired, low pressure steam boilers. Two of the boilers have been abandoned in place. Moreover, the high temperature of a steam boiler, steam traps, condensate return pumps, and boiler

blowdown in this building increase the maintenance cost and inefficiency of the heating system. Building 1029 has a single natural draft gas fired HW boiler installed in 1990. It is in good condition, but there is no primary bypass on the loop. With both steam and HW systems, it is difficult for the maintenance staff to maintain.

Because the HW boilers serving Building 1002 were installed in 1992, they are in good condition. Moreover, these boilers have the capacity to handle the load of all three buildings. Therefore, it is recommended that these boilers be used to serve the heating loads for all three buildings. In addition, to take advantage of the varying loads imposed on the boilers, the boiler controls should be converted from a two position firing rate to a full modulation firing rate. The manufacturer should be consulted in verifying type of burner and accessories. As noted above, Building 1001 has four AHUs with steam heating coils. With the elimination of the steam boilers, replacement of the steam coils will be necessary. These steam coils will be replaced with new HW coils of similar heating capacity and two way control valves. A new 180 GPM, 5 HP secondary pump will be installed in the basement to serve these new HW coils. Computer simulations of the buildings in this area determined that the current installed capacity of 12,690 MBH serving Building 1000 is more than required to adequately heat all three buildings[1]. Therefore, it is recommended that these boilers be retrofitted to serve all three buildings. All other buildings AHU, HW coil three way control valves will be converted to two way valves to minimize pumping energy and provide better distribution of the HW flow through AHU coils.

C. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed boilers and pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3], and the three boilers were modeled with full modulation firing. An equipment list of the specific boiler and pumps modeled for the proposed central boiler plant is shown on page C-164.

Once the computer simulations of the existing and proposed boiler plants were completed, the total annual energy consumption of the proposed central plant was compared with that of the existing individual systems to determine the annual savings for this ECO[4]. This savings calculations is shown on page C-165. These energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of steam and HW boilers in this area down to the three existing boilers. The total maintenance cost savings from this ECO as calculated on page C-170 is estimated to be $10,380 per year. This figure was used in the life cycle cost analysis..

D. Cost Estimates:

The total installation costs for the retrofitting the boiler plant were estimated on pages C-166 through C-169. These costs were used in the life cycle cost analysis.

E. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-171. The data from the summary sheet were presented in the ECO summary on page C-161.

REFERENCES

1. Refer to Appendix H for system thermal load profile.

2. Refer to Appendix H for computer model input assumptions, data, and energy consumption data.

3. Refer to Appendix G for building data and existing HVAC equipment data.

4. Refer to Appendix A for utility cost analysis and avoided cost calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-I, FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
HW Boiler # 1	1	Bryan, # K550WGT, high/low fire rate 5000/2500 MBH, 120 HP, flex tube 20 f, delta t, 4230 MBH out	served bldg. 1000 proposed area 1000 blr retrofit to full modulation	1992	5,500 MBH
HW Pump	1	TACO # 1030 4x5x12, 25 HP 400 GPM, head unknown (90ft. approx.)	Boiler # 1	1992	18.64 KW
HW Boiler # 2	1	Bryan, # K550WGT, high/low fire rate 5000/2500 MBH, 120 HP, flex tube 20 f, delta t, 4230 MBH out	served bldg. 1000 proposed area 1000 blr retrofit to full modulation	1992	5,500 MBH
HW Pump	1	TACO # 1030 4x5x12, 25 HP 400 GPM, head unknown (90ft. approx.)	Boiler # 2	1992	18.64 KW
HW Boiler # 3	1	Bryan, # K550WGT, high/low fire rate 5000/2500 MBH, 120 HP, flex tube 20 f, delta t, 4230 MBH out	served bldg. 1000 proposed area 1000 blr retrofit to full modulation	1992	5,500 MBH
HW Pump	1	TACO # 1030 4x5x12, 25 HP 400 GPM, head unknown (90ft. approx.)	Boiler # 3	1992	18.64 KW
HW Pump	1	Bell and Gossett 180 GPM, 40 ft. 5 HP	Secondary pump for bldg. 1001	New	3.73 KW

1000 AREA

ITEM	ECO I - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1000 Boiler														10,809
Bldg. 1000 HW Pump	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	162,936	
Blodg. 1000 HW Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1,095	
Bldg. 1000 Boiler														0
Bldg. 1000 HW Pump	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	
Bldg. 1000 HW Controls	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	
Bldg. 1001 LPS Boiler														123
Bldg. 1001 LPS Boiler Controls	0.1	0.1	0.1	0.1							0.1	0.1	288	
Bldg. 1029 Boiler														130
Bldg. 1029 HW Controls	0.1	0.1	0.1	0.1							0.1	0.1	200	
Totals	18.9	18.9	18.9	18.9	18.7	18.7	18.7	18.7	18.7	18.7	18.9	18.9	164,519	11,062
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	142	142	142	142	140	187	187	187	187	140	142	142		

Total Demand 1,879 $/yr

Total Energy 562 MMBTU/yr (electric)

Total Energy 11,062 MMBTU/yr (gas)

ITEM	ECO-I: RETROFIT EXISTING BOILER PLANT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
HW Boiler # 1														10,982
HW Pump	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	162,936	
HW Controls	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1,095	
HW Pump	3.7	3.7	3.7	3.7							3.7	3.7	8,706	
HW Boiler # 2														
HW Pump														
HW Controls														
HW Boiler # 3														
HW Pump														
HW Controls														
Total (KW)	22.4	22.4	22.4	22.4	18.7	18.7	18.7	18.7	18.7	18.7	22.4	22.4	172,737	10,982
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	168	168	168	168	140	187	187	187	187	140	168	168		

Total Demand 2,037 $/yr

Demand Savings -158 $/yr

Energy Savings -28 MMBTU/yr (electric)

Energy Savings 80 MMBTU/yr (gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.61	**DATE:** 9/19/96
ECO NO. I Retrofit Existing Individual Boilers AREA 1000	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
REMOVE BOILER	4	EA	90.0	28.91	10,408	780.00	3,120	13,528
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
3"	1,600	LF	0.6	28.91	27,754	15.70	25,120	52,874
SCH 40 BKL STL PIPE W/ FTGS HNGRS & INSULATION								
3"	800	LF	1.1	28.91	25,441	11.55	9,240	34,681
				SUBTOTAL	63,602		37,480	101,082
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.61	DATE: 9/19/96
ECO NO. 1 Retrofit Existing Individual Boilers AREA 1000	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX 3"	2	EA	7.0	28.91	405	475.00	950	1,355
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	150.0	20.00	3,000	2,000.00	2,000	5,000
SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY AND CONNECT TO EXISTING HW PUMPS PER LOCATION								
3"	1	LOC	10.7	28.91	309	717.00	717	1,026
REPLACE STEAM COILS AND VALVES	4	SET	16.0	28.91	1,850	1,900.00	7,600	9,450
REPLACE 3-WAY CONTROL VALVES WITH 2-WAY	1	JOB	240.0	28.91	6,938	9,000.00	9,000	15,938
				SUBTOTAL	12,503		20,267	32,770
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO TEX	PROJECT NO: 03-185.61	DATE: 9/19/96
ECO NO. 1 Retrofit Existing Boilers AREA 1000	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
MODIFY EXISTING BOILER FOR FULL FIRING	3	EA	12.00	28.91	1,041	600.00	1,800	2,841
Test , Balance & Start-up	1	LS	80.00	28.91	2,313			2,313
SUBTOTAL					3,354		1,800	5,154
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO:	03-185.61	DATE: 9/19/96
ECO NO. 1 Retrofit Existing Boilers AREA 1000	BY : KOTHMANN, K		CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
245156 Bldg SF Condition Space AREA 1000

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					63,602		37,480	101,082
SUB TOTAL FROM SHEET 2					12,503		20,267	32,770
SUB TOTAL FROM SHEET 3					3,354		1,800	5,154
SUBTOTAL					79,458		59,547	139,005
O & P @ 20%					15,892		11,909	27,801
SUBTOTAL					95,350		71,456	166,806
DESIGN @ 6%								10,008
SUBTOTAL								176,815
SIOH @ 5.5%								9,725
TOTAL								$186,540

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6MA	DATE: 9/19/96
ECO NO. I Retrofit Existing BOILERS	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 1000

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON								
OUTSIDE CONTRACT COSTS PER BOILER PER YEAR								
EXISTING BOILER	-4.	EA	100.0	30.00	-12,000	1,800.00	-7,200	-19,200
NEW EQUIPMENT								
AERCO MODULAR HIGH EFFICIENCY HW BOILER	2.	EA	80.0	30.00	4,800	1,500.00	4,020	8,820
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-7,200		-3,180	-10,380
PER YEAR								

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-I
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$166,806
B. SIOH	$9,725
C. Design Cost	$10,008
D. Total Cost (1A+1B+1C)	$186,539
E. Salvage Value of Existing Equip.	0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$186,539

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	-28	Mbtus	-$176	15.08	-$2,652
Elec. Deman					-$158	14.88	-$2,351
Natural Gas	$3.5	/Mbtus	80	Mbtus	$277	18.58	$5,143
TOTAL			52	Mbtus	-$57		$140

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRIN	$10,380	Annual	14.88	$154,454
ANNUAL TOTAL	$10,380			$154,454
ONE TIME TOTAL	$0			$0
TOTAL	$10,380			$154,454

4. First Year Dollar Savings	$10,323
5. Simple Payback Period (Years)	18.07
6. Total Net Discounted Savings	$154,595
7. Savings to Investment Ratio	.83
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	2.04%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	J
DATE:	3/1/96
ECO TITLE:	Install Energy Management System (EMS) For HVAC System
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 1300, Buildings 1350, 1374, 1375, 1377, 1379, 1380, 1382, 1384, 1385, 1387, 1396, and 1398

A. Summary:

Electrical Energy Savings	3105	MMBTU/yr
Electrical Demand Savings	-471	$/yr
Gas Energy Savings	915	MMBTU/yr
Total Energy Savings	4020	MMBTU/yr
Total Cost Savings	22,194	$/yr
Total Investment	970,739	$
Simple Payback	43.7	yrs
SIR	0.36	

B. ECO Description:

Install Energy Management System (EMS) at the central maintenance facility. The EMS will accomplish the following tasks for all of the equipment listed in Table-1 in all of the above mentioned buildings.

1. All AHU's serving buildings in the table below will be furnished with all necessary controls to facilitate an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode, which will save thermal cooling energy. (several damaged OA dampers require repairs). Buildings 1387, 1396 and 1398 are not included in this option.

2. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps. These units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, the equipment can be started as late as possible, and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature. Building 1384 is the only building that will not have this option. All other buildings are included.

3. All multi-zone units and all single zone units with or without reheat coils in their branches will have a cooling side discharge air temperature reset. All branch thermostats and zone supply air temperatures after the reheat coil will be monitored. The cooling coil

leaving air temperature will be reset to satisfy at least one zone thermostat without reheat. Buildings 1377, 1387, 1396 and 1398 are not included in this option.

4. All multi-zone units will have air side temperature reset. AHU heating supply air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full heat (at least one zone damper will be fully open). Buildings 1377, 1387, 1396 and 1398 are not included in this option.

5. A night / day setback program will be provided to control window units and fan coil units, and split systems. The program will set back the temperature of the controlled space to a predetermined set-point during periods of no occupancy. Several space or unit mounted temperature sensors will be installed to control the units that currently are controlled under manual operation or no control.

6. Chillers serving Buildings 1377 and 1384 chillers will have chilled water temperature reset. The leaving CHW temperature will be reset to maintain varying load conditions.

7. Buildings 1377 and 1384 chillers will have condenser water temperature reset. The CW leaving temperature will be maintained as low as OA conditions permit in the summer season.

Table-1

Building #	Equipment To Be Controlled
1350	7 AHUs and 20 FCUs1374,1375, 1379,1380
1374,75,79,80	6 AHUs each bldg.
1382	2 AHUs
1384	5 AHUs, Chiller, CHW pump, Boiler and HW pump.
1385	1 AHU
1377	2 AHUs. (All area 1300 chillers and boilers are located in this building.)
1374,75,79,80	3 Chillers, 2 Cooling Towers and 3 HW Boilers.
1387	7 Heat Pumps and 7 AHUs
1396	3 Air cooled CND, 2 DX coil units, HW Boiler and 3 HW pumps
1398	1 Air cooled Cnd, HW Boiler and 1 HW /CHW pump and 20 FCUs

C. Discussion:

1. Generally, the ambient condition in San Antonio area is warm and humid. Annual free cooling hours will be limited. A large number of AHUs are equipped with necessary dampers to support an economizer cycle. This indicates that the original HVAC system was designed to have an economizer cycle. All OA and RA dampers will be repaired and retrofitted with necessary controls to support an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode. When the enthalpy of the OA will drops below that of RA, then the OA damper will open, and the RA damper will close. This action will reduce the cooling energy required. The benefit of this system will occur in both the heating and cooling season. In the heating season when the ambient temperature falls below the temperature needed to maintain the supply air at design conditions, the OA damper will remain in the preset minimum open position to permit necessary ventilation.

2. Regardless of occupancy hours, all AHU's are operated 24 hours per day, 365 days per year to maintain space temperature. However, the chillers operate only during the cooling season do as boilers in the heating season. Depending on occupancy schedules, ambient conditions and building thermal characteristics, most AHU's and their associated chillers, boilers , CHW and HW pumps will be turned off daily in the evening. The equipment will be stopped as early as possible and turned back on as late as possible every weekday without sacrificing occupant comfort. These AHU's will remain off during weekends and holidays.

   Several temperature sensors will be installed in the spaces served by these AHU's. These sensors will monitor the space temperature during unoccupied hours. During the cooling season when the space temperature exceeds 85 F, the AHU's and their associated cooling auxiliaries serving that space will energize to cool the space below 85 F. When the space temperature reaches 84 F, they will cycle off. Similarly, the winter time unoccupied period space temperature will be maintained at 65 F.

   The EMS system will have the capability to manually override this operation with a change in schedule. All AHU's serving the critical areas such as the computer room unit will operate as usual and will not be connected to the new start/stop program. However, if desired, their current operation and performance can be monitored by the new EMS system.

3. Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's. (Boilers and chillers have a seasonal operation, hot and cold air mixing never occurs return air mixes with cold air in the summer and with hot air in winter.) In both cases, cooling and heating energy is wasted. Our observations indicate that all zones are mixing cold supply and return air to maintain the room or zone temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur. The same control sequence will be applied to the hot deck temperature control.

   In multi-zone units, cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air temperature will be increased to minimize mixing. This process will continue until one of the zones doesn't require mixing. (A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.). Buildings 1377, 1387, 1396 and 1398 are not included in this option as they do not have a multi-zone system.

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Our observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. Heating supply air temperature will be lowered until at least one zone damper remains fully open to satisfy the room or area heating demand. Many of the partially open heating dampers indicate a higher than necessary heating deck temperature. Therefore, lowering the temperature will save heating energy. Buildings

1377, 1387, 1396 and 1398 are not included in this option as they do not have a multi-zone system.

5. During periods when the facility remains unoccupied, the window units, fan coil units and split systems that serve non-critical areas will be reset to an "unoccupied" space temperature condition. Temperature sensors will monitor the space temperature at all times, and when the program determines the unoccupied periods, the temperature set point will rise from 78°F to 85°F for summer cooling conditions and from 70°F to 65°F for winter cooling conditions. When the space temperature exceeds 85°F during unoccupied periods, then it will energize the unit and its associated auxiliary cooling equipment. Similarly, when the space temperature falls below 65°F during unoccupied periods, then it will energize the unit and its associated auxiliary heating equipment.

   The EMS will have the capability to override this operation with a change in schedule or function. Also, this will not apply to window units, fan coil units, and split systems serving critical areas such as computer rooms. These units will operate as usual, and they will connected to the new start stop program unless their operation and performance needs to be monitored.

6. Retrofit the chillers at Buildings 1377 and 1384 with chilled water temperature reset controls. Upon a decrease in ambient temperature, the leaving CHW temperature will increase. An increase in leaving CHW temperature decreases the KW/ton which will reduce the electrical energy required.

7. Chillers at Buildings 1377 and 1384 will be furnished with condenser water temperature reset controls. As the differential pressure between the evaporator and condenser decreases, the energy required to operate the chiller compressor decreases. Therefore, a reduction in condenser water temperature will save energy. However, the cooling tower fan energy will increase to produce a lower condenser water temperature. Therefore, multi-step thermostats monitoring devices and controls will be installed to operate the condenser water reset option. The EMS system will monitor and activate the reset program when atmospheric conditions permit, and when the energy savings from the chiller's compressor exceed the additional cooling tower fan energy required to produce a lower condenser water temperature.

   The EMS system will be controlled by a personal computer (PC) located in the central maintenance building. All other building control panels will be connected to the central EMS system PC in the Building via telephone lines.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed EMS system were calculated using the Trace 600 computer program[1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

Once the computer simulations of the existing and new EMS system were completed, the total annual demand cost and energy consumption were compared with that of the existing and new

systems to determine the annual savings for this ECO[3]. These savings calculations are shown on pages C-179 through C-182. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings with this retrofit.

E. Cost Estimates:

The total installation costs for the new EMS system are estimated on pages C-183 through C-185. These costs were obtained using an estimated IO point list as shown on pages C-177 through C-178. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-186. The data from the summary sheet were presented in the ECO summary on page C-172.

REFERENCES

1. Refer to Appendix H for system thermal load profile.

2. Refer to Appendix G building field data and existing HVAC equipment data.

3. Refer to Appendix A for utility cost analysis and avoided cost calculations.

AREA: 1300

ECO J: INSTALL EMS FOR HVAC EQUIPMENT

OCCUPANCY TIME: VARIES

	HARDWARE																												
	OUTPUT								INPUT																				
	DIGITAL					ANALOG			DIGITAL											ANALOG								
GRAPHIC DISPLAY ●	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	WATTS	GAGE PRESSURE	DIFFERENTIAL PRESSURE					
POINT DESCRIPTION																													
W/C CHILLERS ●																					3								
CHILLER					3										3														
CHW PUMP	3														3														
CW PUMP	3														3														
TWR. FAN	3																	3											
CHW SUPPLY HEADER																		3											
CHW RETURN HEADER																		3											
CW SUPPLY HEADER																		3											
CW RETURN HEADER																		3											
TWR. BYPASS VALVE								3																					
W/C CHILLERS ●																						1							
CHILLER					1																								
CHW PUMP	1														1														
CW PUMP	1														1														
TWR. FAN	1														1														
CHW SUPPLY HEADER																		1											
CHW RETURN HEADER																		1											
CW SUPPLY HEADER																		1											
CW RETURN HEADER																		1											
TWR. BYPASS VALVE									1																				
CONDENSERS ●															2														
CND. FAN	2																												
CW SUPPLY HEADER																													
CW RETURN HEADER																													
HW BOILERS ●																													
BOILER						5							5																
HW PUMP	5														5														
HW SUPPLY HEADER																			5										
HW RETURN HEADER																			5										
HW BOILER ●																													
BOILER						1							1																
HW PUMP	1														1														
HW SUPPLY HEADER																													
HW RETURN HEADER																													
AHU (FACE AND BYPASS-SZ) ●																													
SUPPLY FAN	2														2														
COLD DECK TEMP.							2												2										
HOT DECK TEMP.							2												2										
BYPASS DAMPER								2																					
RETURN AIR								2											2										
OUTSIDE AIR								2																					
ZONE TEMPERATURE																			2										

| | SOFTWARE | | |

LIGHTING CONTROL	REMOTE BOILER CONTROL	RUN TIME	KW	KWH				REMARKS
		X	X	X				three (3) chillers serving bldgs. 1350, 1374
		X						1375, 1379, 1380, 1385, 1382, & 1377
		X						
		X						
								one (1) chiller serving bldg. 1384
		X	X	X				
		X						
		X						
		X						
								bldg. 1396 & 1398 condensers
		X						
								four (4) boilers serving bldgs. 1350, 1374
	X							1375, 1379, 1380, 1385, 1382, & 1377
		X						and one (1) boiler serving bldg. 1384
								two (2) boilers serving bldgs. 1396 & 1398
	X							
		X						
								two (2) AHUs serving bldg. 1377
		X						
								all valves, dampers, thermostats, and
								actuators are existing.

AREA: 1300	HARDWARE																								
	OUTPUT								INPUT																
	DIGITAL					ANALOG			DIGITAL										ANAL					
ECO J: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	WATTS			
OCCUPANCY TIME: VARIES																								
GRAPHIC DISPLAY ●																								
POINT DESCRIPTION																								
AHU (MZ) ●																								
SUPPLY FAN	32														32									
COLD DECK TEMP.						32												32						
HOT DECK TEMP.						32												32						
RETURN AIR							32											32						
OUTSIDE AIR							32																	
ZONE DAMPERS							136																	
ZONE TEMPERATURE																		136						
FILTER										32														
AHU (VAV) ●																								
SUPPLY FAN	7														7									
RETURN FAN	7														7									
COLD DECK TEMP.						7												7						
HOT DECK TEMP.						7												7						
RETURN AIR							7											7						
OUTSIDE AIR							7																	
ZONE DAMPERS							35																	
ZONE TEMPERATURE																		35						
FILTER										7														
FAN COIL UNIT ●																								
ZONE TEMPERATURE																		57						
PACKAGED AHU ●																								
ZONE TEMPERATURE																		1						
OUTSIDE AIR ●																		1	1					

TOTAL AO POINTS =	78
TOTAL DO POINTS =	341
TOTAL AI POINTS =	115
TOTAL DI POINTS =	395
GRAND TOTAL POINTS =	929

NOTES:

1. BUILDING 1387 WAS NOT INCLUDED IN THE EMS BECAUSE THE BUILDING IS SERVED BY ALL ELECTRIC HEAT PU

| T | ANALOG | | | | | | | | | SOFTWARE | | | | | | | | |

LIGHTING CONTROL	REMOTE BOILER CONTROL	RUN TIME	KW	KWH				REMARKS
								ahus serving bldgs. 1374, 1375, 1379, 1380,
		X						1382, 1384, & 1385
								all valves, dampers, thermostats, and
								actuators are existing.
								bldg. 1350 ahus
		X						
		X						all valves, dampers, thermostats, and
								actuators are existing.

ITEM	EXISTING BUILDING SYSTEMS MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1350 Chiller					315.0	311.6	326.8	330.2	321.9	230.6			548,265	
Bldg. 1350 Cooling Tower Fans					14.9	14.9	14.9	14.9	14.9	14.9			60,178	
Bldg. 1350 CHW Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
Bldg. 1350 CW Pump					22.4	22.4	22.4	22.4	22.4	22.4			98,918	
Bldg. 1350 CHWControls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1377 Plant Chiller (CHLR-1)					481.2	496.7	503.9	510.2	495.7	411.0			1,212,362	
CHLR-1 Cooling Tower Fans					52.2	52.2	52.2	52.2	52.2	52.2			210,623	
CHLR-1 CHW pump					18.7	18.7	18.7	18.7	18.7	18.7			82,579	
CHLR-1 CW pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CHW (CHLR-1) Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
CHLR-1 CHW pump # 2					18.7	18.7	18.7	18.7	18.7	18.7			82,579	
Bldg. 1377 Plant Chiller (CHLR-2)					273.4	344.6	499.0	510.2	378.4				99,925	
CHLR-2 CW pump					29.8	29.8	29.8	29.8	29.8				24,558	
CHW (CHLR-2) Controls					1.0	1.0	1.0	1.0	1.0				823	
Bldg. 1384 Chiller					204.0	195.4	206.9	215.1	194.1	140.9			376,812	
Bldg. 1384 Cooling Tower Fans					14.9	14.9	14.9	14.9	14.9	14.9			59,652	
Bldg. 1384 CHW pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 1384 CW pump					14.9	14.9	14.9	14.9	14.9	14.9			65,798	
Bldg. 1384 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1387 Heat Pumps - cooling	84.5	87.3	84.4	84.4	96.4	106.6	118.7	123.0	103.2	70.1	84.4	84.4	333,506	
Heat Pumps Fans - cooling					7.1	7.7	11.8	11.8	7.7	5.0			11,209	
Heat Pumps Controls - cooling	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	434	
Bldg. 1396 split system - cooling					8.4	9.6	10.2	10.1	9.4	7.5			8,987	
Bldg. 1396 condenser fans					0.9	1.0	1.0	1.0	1.0	0.7			966	
Bldg. 1396 split system controls					0.3	0.3	0.3	0.3	0.3	0.3			979	
Bldg. 1396 packaged unit - cooling					54.3	60.8	64.3	63.8	59.4	32.5			42,379	
Bldg. 1396 condenser fans					3.3	3.6	3.7	3.7	3.6	2.0			2,733	
Bldg. 1396 CHW controls					0.3	0.3	0.3	0.3	0.3	0.3			556	
Bldg. 1398 recip chiller- cooling					61.2	66.1	69.9	70.7	68.9	37.4			62,597	
Bldg. 1398 condenser fans					5.4	5.6	5.6	5.6	5.6	3.4			5,481	
Bldg. 1398 CHW pump					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
Bldg. 1396 CHW controls					0.1	0.1	0.1	0.1	0.1	0.1			442	
Bldg. 1350 fans	134.2	134.2	134.2	134.2	134.2	128.2	130.3	131.5	134.0	133.4	134.2	134.2	648,613	
Bldg. 1374 fans	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	294,336	
Bldg. 1375 fans	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	294,336	
Bldg. 1379 fans	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	294,336	
Bldg. 1380 fans	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	294,336	
Bldg. 1385 fans	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	19,272	
Bldg. 1382 fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	65,700	
Bldg. 1377 fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	65,700	
Bldg. 1384 fans	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	620,208	
Bldg. 1384 fans	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	32,412	
Bldg. 1387 fans	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	159,561	
Bldg. 1396 fans	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	81,468	
Bldg. 1398 fans	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	16,644	
Bldg. 1398 fans	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	3,504	

ITEM	EXISTING BUILDING SYSTEMS MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1350 HW blr (BLR-1)														20.5
Bldg. 1350 HW pump (BLR-1)	29.8	29.8											1,192	
Bldg. 1350 BLR-1 controls	0.1	0.1											5	
Bldg. 1350 HW blr (BLR-2)														
Bldg. 1350 HW pump (BLR-2)														
Bldg. 1350 BLR-2 controls														
Bldg. 1377 Plant HW blr (BLR-1)														5,371.3
HW pump (BLR-1)	11.2	11.2	11.2	11.2							11.2	11.2	48,653	
BLR-1 controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW pump (BLR-1)	11.2	11.2	11.2	11.2							11.2	11.2	48,653	
HW blr f.d. fan (BLR-1)	7.5	7.5	7.5	7.5							7.5	7.5	32,580	
Bldg. 1377 Plant HW blr (BLR-2)														
HW pump (BLR-2)														
HW blr f.d. fan (BLR-2)														
BLR-2 controls														
Bldg. 1384 HW boiler														208.5
Bldg. 1384 HW pump	5.6	5.6	5.6	5.6							5.6	5.6	8,394	
Bldg. 1384 HW controls	0.1	0.1	0.1	0.1							0.1	0.1	187	
Bldg. 1387 Electric Heat	87.8	87.3	54.8	4.5							49.6	85.4	69,232	
Bldg. 1396 HW boiler														636.5
Bldg. 1396 HW pump	0.2	0.2	0.2	0.2							0.2	0.2	869	
Bldg. 1396 HW controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 1396 HW pump	0.2	0.2	0.2	0.2							0.2	0.2	869	
Bldg. 1398 HW boiler														445.2
Bldg. 1398 HW pump	3.7	3.7	3.7	3.7							3.7	3.7	16,073	
Bldg. 1398 HW controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Totals	632.4	634.7	569.4	519.1	2,166.5	2,259.2	2,473.8	2,508.6	2,304.6	1,565.4	564.2	600.0	6,854,343	6,682.0
Rate ($/KW)	7.5	7.5	7.5	7.5	7.5	10.0	10.0	10.0	10.0	7.5	7.5	7.5		
Cost ($)	4,743.0	4,760.3	4,270.5	3,893.3	16,248.8	22,592.0	24,738.0	25,086.0	23,046.0	11,740.5	4,231.5	4,500.0		

Total Demand	149,849.8	$/yr	
Total Energy	23,393.9	MMBTU/yr	(electric)
Total Energy	6,682.0	MMBTU/yr	(gas)

ITEM	ECO J - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1350 Chiller					312	322	327	330	322	291			527,062	
Bldg. 1350 Cooling Tower Fans					14.9	14.9	14.9	14.9	14.9	14.9			65,887	
Bldg. 1350 CHW Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
Bldg. 1350 CND Pump					22.4	22.4	22.4	22.4	22.4	22.4			98,918	
Bldg. 1350 CHWControls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1377 Plant Chiller (CHLR-1					481.2	496.7	503.9	510.2	495.7	425.7			1,211,446	
CHLR-1 Cooling Tower Fans					52.2	52.2	52.2	52.2	52.2	52.2			230,604	
CHLR-1 CHW pump					18.7	18.7	18.7	18.7	18.7	18.7			82,579	
CHLR-1 CND pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CHW (CHLR-1) Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1377 CHLR-1 CHW pump					18.7	18.7	18.7	18.7	18.7	18.7			82,579	
Bldg. 1377 Plant Chiller (CHLR-2					281.5	391.4	503.9	510.2	394.1				211,152	
Bldg. 1377 CHLR-2 CND pump					29.8	29.8	29.8	29.8	29.8				34,435	
CHW (CHLR-2) Controls					1.0	1.0	1.0	1.0	1.0				1,154	
Bldg. 1384 Chiller					201.4	192.3	204.1	212.6	190.8	135.2			338,034	
Bldg. 1384 Cooling Tower Fans					14.9	14.9	14.9	14.9	14.9	14.9			65,798	
Bldg. 1384 CHW pump					11.2	11.2	11.2	11.2	11.2	11.2			49,459	
Bldg. 1384 CND pump					14.9	14.9	14.9	14.9	14.9	14.9			65,798	
Bldg. 1384 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1387 Heat Pumps - cooling	93.8	92.6	84.4	84.4	100.9	107.7	119.7	123.6	104.0	70.1	84.4	88.7	329,687	
Heat Pumps Fans - cooling					8.3	8.3	11.8	11.8	8.3	5.0			11,196	
Heat Pumps Controls - cooling	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	434	
Bldg. 1396 split system - cooling					8.9	9.8	10.1	10.0	9.4	5.2			7,088	
Bldg. 1396 condenser fans					0.9	1.0	1.0	1.0	1.0	0.6			782	
Bldg. 1396 split system controls					0.3	0.3	0.3	0.3	0.3	0.3			839	
Bldg. 1396 packaged unit - coolin					56.9	61.7	64.0	63.5	59.4	34.5			42,172	
Bldg. 1396 condenser fans					3.5	3.7	3.7	3.7	3.6	2.2			2,554	
Bldg. 1396 CHW controls					0.3	0.3	0.3	0.3	0.3	0.3			341	
Bldg. 1398 recip chiller- cooling					67.0	68.0	69.9	70.7	68.9	41.0			73,971	
Bldg. 1398 condenser fans					5.6	5.6	5.6	5.6	5.6	3.8			6,757	
Bldg. 1398 CHW pump					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
Bldg. 1396 CHW controls					0.1	0.1	0.1	0.1	0.1	0.1			442	
Bldg. 1350 fans	130.0	121.8	134.2	134.2	124.6	129.2	131.0	132.5	134.2	134.2	134.2	134.2	389,017	
Bldg. 1374 fans	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	168,298	
Bldg. 1375 fans	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	168,298	
Bldg. 1379 fans	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	168,343	
Bldg. 1380 fans	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	168,342	
Bldg. 1385 fans	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	6,954	
Bldg. 1382 fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	38,693	
Bldg. 1377 fans	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	39,420	
Bldg. 1384 fans	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	620,208	
Bldg. 1384 fans	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	32,412	
Bldg. 1387 fans	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	95,736	
Bldg. 1396 fans	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	22,636	
Bldg. 1398 fans	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	5,542	

ITEM	ECO J - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1398 fans	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1,264	
Bldg. 1350 HW blr (BLR-1)														65.3
Bldg. 1350 HW pump (BLR-1)	29.8	29.8											2,682	
Bldg. 1350 BLR-1 controls	0.1	0.1											11	
Bldg. 1350 HW blr (BLR-2)														
Bldg. 1350 HW pump (BLR-2)														
Bldg. 1350 BLR-2 controls														
Bldg. 1377 Plant HW blr (BLR-1)														5,149.7
HW pump (BLR-1)	11.2	11.2	11.2	11.2							11.2	11.2	48,653	
BLR-1 controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW pump (BLR-1)	11.2	11.2	11.2	11.2							11.2	11.2	48,653	
HW blr f.d. fan (BLR-1)	7.5	7.5	7.5	7.5							7.5	7.5	32,580	
Bldg. 1377 Plant HW blr (BLR-2)														
HW pump (BLR-2)														
HW blr f.d. fan (BLR-2)														
BLR-2 controls														
Bldg. 1384 HW boiler														248.5
Bldg. 1384 HW pump	5.6	5.6	5.6	5.6							5.6	5.6	10,198	
Bldg. 1384 HW controls	0.1	0.1	0.1	0.1							0.1	0.1	228	
Bldg. 1387 Electric Heat	69.0	82.7	4.5	4.5							4.5	81.2	22,957	
Bldg. 1396 HW boiler														152.8
Bldg. 1396 HW pump	0.2	0.2	0.2	0.2							0.2	0.2	869	
Bldg. 1396 HW controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 1396 HW pump	0.2	0.2	0.2	0.2							0.2	0.2	869	
Bldg. 1398 HW boiler														151.2
Bldg. 1398 HW pump	3.7	3.7	3.7	3.7							3.7	3.7	16,073	
Bldg. 1398 HW controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Totals	618.7	623.0	519.1	519.1	2,174.0	2,319.3	2,477.2	2,507.3	2,319.1	1,639.1	519.1	600.1	5,944,514	5,767.5
Rate ($/KW)	7.5	7.5	7.5	7.5	7.5	10.0	10.0	10.0	10.0	7.5	7.5	7.5		
Cost ($)	4,640.3	4,672.5	3,893.3	3,893.3	16,305.0	23,193.0	24,772.0	25,073.0	23,191.0	12,293.3	3,893.3	4,500.8		

Total Demand	150,320.5	$/yr	
Demand Savings	-470.8	$/yr	
Energy Savings	3,105.2	MMBTU/yr	(electric)
Energy Savings	914.5	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	**PROJECT NO:** 03-0185.06J	**DATE:** 9/19/96
ECO NO. J AREA 1300	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	HRS/ UNIT	Rate	Total	Unit Price	Total	
EMCS COSTS BASED ON DDC ALL ELECTRIC								
DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE								
DIGITAL OUTPUT DEVICE :								
START-STOP MOTOR	68	EA	10.2	28.91	20,052	175.74	11,950	32,002
ENABLE/DISABLE APPARATUS RELAY	10	EA	4.5	28.91	1,301	49.00	490	1,791
ANALOG OUTPUT:								
CONTROL VALVE (COIL/AHU ACTUATOR ONLY)	86	EA	11.9	28.91	29,636	571.00	49,106	78,742
DAMPER ACTUATOR & MOTOR	255	EA	11.9	28.91	87,875	340.00	86,700	174,575
DIGITAL INPUT:								
DIFFERENTIAL PREASURE SWITCH	41	EA	10.1	28.91	11,972	227.30	9,319	21,291
AUXILIARY CONTACT	6	EA	4.5	28.91	781	49.00	294	1,075
CURRENT SENSING RELAY	68	EA	4.5	28.91	8,846	49.00	3,332	12,178
SHEET 1								
SUBTOTAL					160,463		161,192	321,654
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	**PROJECT NO:** 03-0185.06J	**DATE:** 9/19/96
ECO NO. J **AREA** 1300	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	UNIT MEAS	Hrs / Unit	Rate	Total	Unit Price	Total	
ANALOG INPUT:								
TEMP. SENSER & THERMO WELL	26	EA	17.0	28.91	12,778	426.42	11,087	23,865
TEMP. SENSER AIR DUCT	123	EA	12.0	28.91	42,671	450.00	55,350	98,021
TEMP. SENSER OUTSIDE AIR	1	EA	12.0	28.91	347	550.00	550	897
TEMP. SENSER ZONE	231	EA	12.0	28.91	80,139	556.00	128,436	208,575
RELATIVE HUMIDITY %	1	EA	13.0	28.91	376	615.00	615	991
AMPERES	4	EA	7.0	28.91	809	219.00	876	1,685
GAUGE PRESURE BOILER								
FLOW STATUS / RATE	9	EA	17.0	28.91	4,423	410.00	3,690	8,113
EQUIPMENT FAILURE ALARM	20	EA	2.6	28.91	1,503	108.00	2,160	3,663
FILTER ALARM	41	EA	4.5	28.91	5,334	227.00	9,307	14,641
HIGH & LOW LIMIT (HYDRONIC)	21	PR	2.0	28.91	1,214	170.00	3,570	4,784
SHEET 2								
				SUBTOTAL	149,595		215,641	365,236
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	**PROJECT NO:** 03-0185.06J		**DATE:** 9/19/96
ECO NO. J AREA 1300	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
OPERATORS' WORKSTATION	1	SUM				13,184.00	13,184	13,184
INCLUDING MODEM & REMOTE PANEL SUBMITTALS, TRAINING & START-UP	1	JOB				8,300.00	8,300	8,300
SOFTWARE	1	LS				15,000.00	15,000	15,000
SUB TOTAL FROM SHEET 1					160,463		161,192	321,654
SUB TOTAL FROM SHEET 2					149,595		215,641	365,236
SUBTOTAL					310,057		413,317	723,374
O & P @ 20%					62,011		82,663	144,675
SUBTOTAL					372,069		495,980	868,049
DESIGN @ 6%								52,083
SUBTOTAL								920,132
SIOH @ 5.5%								50,607
TOTAL								$970,739

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Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-J
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment	
A. Construction Cost	$868,049
B. SIOH	$50,607
C. Design Cost	$52,083
D. Total Cost (1A+1B+1C)	$970,739
E. Salvage Value of Existing Equip.	0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$970,739

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	3,105	Mbtus	$19,501	15.08	$294,070
Elec. Deman					-$471	14.88	-$7,008
Natural Gas	$3.5	/Mbtus	915	Mbtus	$3,164	18.58	$58,790
TOTAL			4,020	Mbtus	$22,194		$345,852

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL TOTAL	$0			$0
ONE TIME TOTAL	$0			$0
TOTAL	$0			$0

4. First Year Dollar Savings	$22,194
5. Simple Payback Period (Years)	43.74
6. Total Net Discounted Savings	$345,852
7. Savings to Investment Ratio	.36
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	-2.18%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	K
DATE:	3/1/96
ECO TITLE:	Replace Existing Central Chillers With New Electric Centrifugal Chiller
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 1300, Building 1377 (serves buildings 1350, 1374, 1375, 1377, 1379, 1380, 1382, 1385, 1385, 1396, and 1398)

A. Summary:

Electrical Energy Savings	4393	MMBTU/yr
Electrical Demand Savings	43,719	$/yr
Gas Energy Savings	0	MMBTU/yr
Total Energy Savings	4393	MMBTU/yr
Total Cost Savings	95,249	$/yr
Total Investment	1,441,745	$
Simple Payback	13.0	yrs
SIR	1.17	

B. ECO Description:

Remove the two 600 ton, R-11 centrifugal chillers in Building 1377 which were installed in 1972, and replace them with two R-123 centrifugal chillers, rated at 570 tons each. The two existing chilled water pumps and condenser water pumps serving the existing chillers should be removed. Remove the 273 ton, R-11 centrifugal chiller serving Building 1384, and associated controls and CW water equipment. Remove the condenser and reciprocating chiller serving Building 1398 and the condenser serving building 1396. Replace the 50 ton packaged unit serving Building 1396 with an AHU with CHW coil and a two-way control valve. CHW pump in Building 1398 shall remain and be used as a secondary pump. Install new 40 HP CHW and CW pump to serve the new chillers and a new 3 HP CH pump to provide secondary water in Building 1386. The new chillers should be connected into the distribution piping at locations of the existing to be removed chillers. New chilled water supply and return headers should be installed to join together the existing distribution systems serving Building 1350 and the other buildings in the 1300 area. This will create a single chilled water distribution system to be served by the new chillers and the existing 438 ton chiller which was installed in 1983 to serve building 1350. A new 6" direct buried primary CHW supply and return piping loop will be constructed and connected with the three primary pumps. This loop will require a 2.5" take-off that is capped that will serve Building 1387 in the future. The loop will have approximately 200 ft. of 6", 900 ft. of 4", 800 ft. of 2.5", 1800 ft. of 3" and 400 ft of 2.0" piping to complete this primary loop. All existing controls and electrical services should be reconnected where possible. Specific requirements in these areas should be determined by the design engineer responsible for this project. To meet the current ASHRAE Standard 15, a refrigerant detection and ventilation system should be installed. This project will require engineering drawings and specifications, demolition and removal of the existing chillers and pumps, and installation of the new chillers, pumps, associated wiring and controls.

C. Discussion:

There are currently two primary independent chilled water distribution systems serving the 1300 area, one for Building 1350 and the other for Buildings 1374, 1375, 1377, 1379, 1380, 1382, and

1385. These two systems should be combined into one system to conserve energy in the central plant. This can be accomplished by installing common CHW supply and return headers in the central plant. In addition, Buildings 1384, 1396, and 1398 have individual cooling equipment that serves each building separately. The existing centrifugal chiller serving Building 1350 was installed in 1983, is rated at 438 tons and appears to be in good condition. The two existing centrifugal chillers serving the other seven buildings were installed in 1972, are rated at 600 tons each, and appear to be near the end of their useful life. The centrifugal chiller serving Building 1384 was installed in 1973 and also appears to be reaching the end of it's expected life. Buildings 1396 and 1398 are served by DX packaged systems and water cooled reciprocating chillers respectively. Building 1387 is served by all electric heat pumps that were installed in 1988. These units appear to be in good shape, and thus it does not appear advantageous to retrofit this building with water cooled equipment at this time.

The three chillers located in the central plant adjacent to Building 1377 and the chiller serving building 1384 have R-11 refrigerant, which is no longer be manufactured as of January 1, 1996[1]. To avoid the anticipated increasing operational costs over the life of these machines, they should either be retrofitted to use an approved refrigerant or replaced with new machines that operate on one. The existing centrifugal machines can be retrofitted to an approved refrigerant by modifying the impeller, gears, etc... However, a retrofit to the older chillers will cause an approximate degradation in tonnage of 5%-7% and a 3%-5% efficiency loss because the technology is not available to match these impellers yet. With the case of the Carrier chiller serving Building 1350, this can be done with no loss in capacity of efficiency with the onset of new technology of redesigning the impellers for existing chillers. One company which produces these new impellers for existing R-11 centrifugal machines has provided cost estimates[2]. Therefore, since the older machines are already over twenty years old and retrofitting them would create a greater loss in efficiency, it is recommended that the facility replace them instead. A life cycle cost analysis performed on four different types of replacement chillers available determined that a single electric centrifugal chiller using R-134 would be the most economical choice over the life of the machine. Computer simulations of the buildings served by this machine determined that the current installed capacity of 1,790 tons is more than what is required to adequately cool the buildings[3]. Therefore, the new combined capacity is recommended to be 1,575 tons to more nearly match the building cooling load.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumptions of the existing and proposed alternative chillers and auxiliary equipment were calculated using the Trace 600 computer program[4]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[5].

The two 570 ton chiller alternatives which were compared included an electric centrifugal machine, an electric centrifugal with a variable frequency drive, a dual screw machine and a gas driven centrifugal machine. All proposed machines used R-134 or R-123. Full load performance data from York International were used in the computer simulations of the new chiller energy usages. Equipment lists of the specific chillers and auxiliaries for each alternative modeled by the computer are shown on pages C-191 to C-194

Once the computer simulations were completed, the total annual demand cost and energy consumption of each alternative were compared with that of the existing systems to determine the annual savings for each[6]. These savings calculations are shown on pages C-195 through C-197. The demand and energy savings values were used in the life cycle cost analysis for each alternative. The results of these savings calculations were as follows:

Alternative	Chiller Type	Demand Savings $/yr	Electrical Savings MMBTU/yr	Gas Savings MMBTU/yr
K1	Electric Centrifugal	43,719	4393	0
K2	Electric Centrifugal & VFD	42,465	4721	0
K3	Electric Screw	28,829	3169	0
K4	Gas Driven Centrifugal	74,012	9083	-15,872

2. *Maintenance Cost Savings*:

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water cooled chillers in this area down to three water cooled chillers. The total maintenance cost savings from this ECO is estimated to be $20,243 per year as shown on page C-210. This figure was used in the life cycle cost analysis.

E. Cost Estimates

The total installation costs for each alternative chiller mentioned in this ECO were estimated on pages C-198 through C-209. These costs were used in the life cycle cost analysis for each alternative. The results of the costs estimates were as follows:

Alternative	Chiller Type	Estimated Cost
K1	Electric Centrifugal	$1,237,515
K2	Electric Centrifugal & VFD	$1,295,598
K3	Electric Screw	$1,609,265
K4	Gas Driven Centrifugal	$2,098,173

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on each chiller alternative for this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. By installing two new centrifugal chillers alongside an existing centrifugalchiller in the place of the existing equipment, the installation will save the cost of retrofitting the twoother R-11 machines for the HCFC-123 refrigerant as mentioned previously. The cost of this retrofit was estimated to be

$35,000 per chiller and shown as a non-recurring cost associated with this ECO. Moreover, there is a second non-recurring cost associated with the reclaim value of the refrigerant R-11. This cost was estimated at $2.00 per pound of R-11 and 2 pounds per ton for a total cost of $3,944. A summary sheet for each life cycle cost analysis is shown on pages C-211 through C-214. The results of the alternative life cycle cost analysis were as follows:

Alternative	Chiller Type	Payback Years	SIR
K1	Electric Centrifugal	13.0	1.17
K2	Electric Centrifugal & VFD	13.5	1.12
K3	Electric Screw	22.2	0.69
K4	Gas Driven Centrifugal	21.0	0.63

Since the electric centrifugal chillers have the highest SIR, they are recommended as the most economical choice to replace the existing machines. The data from the life cycle cost analysis for this alternative were included in the summary on page C-187.

REFERENCES

1. Per current EPA regulations on CFC refrigerants.
2. See Appendix F for chiller retrofit information from Northeastern Research And Engineering Corporation.
3. See Appendix H for Area 1300 cooling system load profile.
4. See Appendix H for computer model input assumptions and data, and energy consumption output data.
5. See Appendix G for building field data and existing HVAC system data.
6. See Appendix A for utility cost analysis data, used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-K1, FORT SAM HOUSTON, AREA 1300 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	2	York YT water cooled, centrifugal, 570 tons, R-123	Area 1300	New	313 KW
Chilled Water Pump	2	Bell & Gossett 1140 gpm, 115 ft 40 HP	Area 1300	New	29.80 KW
Condenser Water Pump	2	Bell & Gossett 1710 gpm, 70 ft 40 HP	Area 1300	New	29.80 KW
Cooling Tower	1	Marley #324T induced draft, 2-35 HP fans	served two existing chlrs in series, now serves new chillers	1972	52.22 KW
Water Chiller	1	Carrier #19DK 78942P water cooled, centrifugal, 438 tons, R-123	Retrofitted to R-123 served bldg. 1350, now serves all of 1300	1983	334.5 KW
Chilled Water Pump	1	Allis Chalmers 775 gpm, 114 ft 40 HP	served bldg. 1350, now serves all of 1300	1983	29.84 KW
Condenser Water Pump	1	Allis Chalmers 1314 gpm, 30 ft 30 HP	served bldg. 1350, now serves all of 1300	1983	22.38 KW
Cooling Tower	1	Marley induced draft, 20 HP fan	served bldg. 1350, now serves all of 1300	1983	14.92 KW
Chilled Water Pump	1	Bell & Gossett 96 GPm, 30' hd 3 HP	secondary pump for building 1396	New	2.20 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-K2, FORT SAM HOUSTON, AREA 1300
MARCH 1, 1996

ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	2	York YT with VFD water cooled, centrifugal, 570 tons, R-123	Area 1300	New	313 KW
Chilled Water Pump	2	Bell & Gossett 1140 gpm, 115 ft 40 HP	Area 1300	New	29.80 KW
Condenser Water Pump	2	Bell & Gossett 1710 gpm, 70 ft 40 HP	Area 1300	New	29.80 KW
Cooling Tower	1	Marley #324T induced draft, 2-35 HP fans	served two existing chlrs in series, now serves new chillers	1972	52.22 KW
Water Chiller	1	Carrier #19DK 78942P water cooled, centrifugal, 438 tons, R-123	Retrofitted to R-123 served bldg. 1350, now serves all of 1300	1983	334.5 KW
Chilled Water Pump	1	Allis Chalmers 775 gpm, 114 ft 40 HP	served bldg. 1350, now serves all of 1300	1983	29.84 KW
Condenser Water Pump	1	Allis Chalmers 1314 gpm, 30 ft 30 HP	served bldg. 1350, now serves all of 1300	1983	22.38 KW
Cooling Tower	1	Marley induced draft, 20 HP fan	served bldg. 1350, now serves all of 1300	1983	14.92 KW
Chilled Water Pump	1	Bell & Gossett 96 GPm, 30' hd 3 HP	secondary pump for building 1396	New	2.20 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-K3, FORT SAM HOUSTON, AREA 1300 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	2	York YS water cooled screw 570 tons, R-123	Area 1300	New	365 KW
Chilled Water Pump	2	Bell & Gossett 1140 gpm, 115 ft 40 HP	Area 1300	New	29.80 KW
Condenser Water Pump	2	Bell & Gossett 1710 gpm, 70 ft 40 HP	Area 1300	New	29.80 KW
Cooling Tower	1	Marley #324T induced draft, 2-35 HP fans	served two existing chlrs in series, now serves new chillers	1972	52.22 KW
Water Chiller	1	Carrier #19DK 78942P water cooled, centrifugal, 438 tons, R-123	Retrofitted to R-123 served bldg. 1350, now serves all of 1300	1983	334.5 KW
Chilled Water Pump	1	Allis Chalmers 775 gpm, 114 ft 40 HP	served bldg. 1350, now serves all of 1300	1983	29.84 KW
Condenser Water Pump	1	Allis Chalmers 1314 gpm, 30 ft 30 HP	served bldg. 1350, now serves all of 1300	1983	22.38 KW
Cooling Tower	1	Marley induced draft, 20 HP fan	served bldg. 1350, now serves all of 1300	1983	14.92 KW
Chilled Water Pump	1	Bell & Gossett 96 GPm, 30' hd 3 HP	secondary pump for building 1396	New	2.20 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-K4, FORT SAM HOUSTON, AREA 1300 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	2	York, gas engine driven YG water cooled, centrifugal 570 tons, R-134a	Area 1300	New	3,762 MBH
Chilled Water Pump	2	Bell & Gossett 1140 gpm, 115 ft 40 HP	Area 1300	New	29.80 KW
Condenser Water Pump	2	Bell & Gossett 1710 gpm, 70 ft 40 HP	Area 1300	New	29.80 KW
Cooling Tower	1	Marley #324T induced draft, 2-35 HP fans	served two existing chlrs in series, now serves new chillers	1972	52.22 KW
Water Chiller	1	Carrier #19DK 78942P water cooled, centrifugal, 438 tons, R-123	Retrofitted to R-123 served bldg. 1350, now serves all of 1300	1983	334.5 KW
Chilled Water Pump	1	Allis Chalmers 775 gpm, 114 ft 40 HP	served bldg. 1350, now serves all of 1300	1983	29.84 KW
Condenser Water Pump	1	Allis Chalmers 1314 gpm, 30 ft 30 HP	served bldg. 1350, now serves all of 1300	1983	22.38 KW
Cooling Tower	1	Marley induced draft, 20 HP fan	served bldg. 1350, now serves all of 1300	1983	14.92 KW
Chilled Water Pump	1	Bell & Gossett 96 GPm, 30' hd 3 HP	secondary pump for building 1396	New	2.20 KW

ITEM	ECO K - EXISTING BUILDING SYSTEMS MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1350 Chiller					315.0	311.6	326.8	330.2	321.9	230.6			548,265	
Bldg. 1350 Cooling Tower Fans					14.9	14.9	14.9	14.9	14.9	14.9			60,178	
Bldg. 1350 CHW Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
Bldg. 1350 CND Pump					22.4	22.4	22.4	22.4	22.4	22.4			98,918	
Bldg. 1350 CHWControls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1377 Plant Chiller (CH-1)					481.2	496.7	503.9	510.2	495.7	411.0			1,212,362	
CHLR-1 Cooling Tower Fans					52.2	52.2	52.2	52.2	52.2	52.2			210,623	
CHLR-1 CHW pump					18.7	18.7	18.7	18.7	18.7	18.7			82,579	
CHLR-1 CND pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CHW (CHLR-1) Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
CHLR-1 CHW pump # 2					18.7	18.7	18.7	18.7	18.7	18.7			82,579	
Bldg. 1377 Plant Chiller (CH-2)					273.4	344.6	499.0	510.2	378.4				99,925	
CHLR-2 CND pump					29.8	29.8	29.8	29.8	29.8				24,558	
CHW (CHLR-2) Controls					1.0	1.0	1.0	1.0	1.0				823	
Bldg. 1384 Chiller					204.0	195.4	206.9	215.1	194.1	140.9			376,812	
Bldg. 1384 Cooling Tower					14.9	14.9	14.9	14.9	14.9	14.9			59,652	
Bldg. 1384 CND pump					14.9	14.9	14.9	14.9	14.9	14.9			65,798	
Bldg. 1384 CHW Controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 1396 split system - clg					8.4	9.6	10.2	10.1	9.4	7.5			8,987	
Bldg. 1396 condenser fans					0.9	1.0	1.0	1.0	1.0	0.7			966	
Bldg. 1396 split system controls					0.3	0.3	0.3	0.3	0.3	0.3			979	
Bldg. 1396 packaged unit - clg					54.3	60.8	64.3	63.8	59.4	32.5			42,379	
Bldg. 1396 condenser fans					3.3	3.6	3.7	3.7	3.6	2.0			2,733	
Bldg. 1396 CHW controls					0.3	0.3	0.3	0.3	0.3	0.3			556	
Bldg. 1398 recip chiller- clg					61.2	66.1	69.9	70.7	68.9	37.4			62,597	
Bldg. 1398 condenser fans					5.4	5.6	5.6	5.6	5.6	3.4			5,481	
Bldg. 1396 CHW controls					0.1	0.1	0.1	0.1	0.1	0.1			442	
Totals					1,657.9	1,745.8	1,942.1	1,971.4	1,788.8	1,086.0			3,324,634	
Rate ($/KW)	7.5	7.5	7.5	7.5	7.5	10.0	10.0	10.0	10.0	7.5	7.5	7.5		
Cost ($)					12,434.3	17,458.0	19,421.0	19,714.0	17,888.0	8,145.0				

Total Demand 95,060.3 $/yr

Total Energy 11,347.0 MMBTU/yr (electric)

Total Energy MMBTU/yr (gas)

ITEM	ECO-K1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (CH-1)					286.9	298.2	303.4	308.0	297.0	254.7			989,061	
Cooling Tower Fans					52.2	52.2	52.2	52.2	52.2	52.2			212,341	
CHW Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Water Chiller (CH-2)					286.9	292.5	303.4	308.0	297.4				384,949	
CHW Pump					29.8	29.8	29.8	29.8	29.8				65,620	
CND Pump					29.8	29.8	29.8	29.8	29.8				65,620	
CHW controls					1.0	1.0	1.0	1.0	1.0				2,202	
Existing Chiller (CH-3)						324.3	332.3	335.7					27,486	
Cooling Tower Fans						14.9	14.9	14.9					4,939	
CHW Pump						29.8	29.8	29.8					9,864	
CND Pump						22.4	22.4	22.4					7,414	
CHWControls						1.0	1.0	1.0					331	
Total (KW)					747.2	1,156.5	1,180.6	1,193.2	767.8	367.5			2,037,437	
Rate ($/KW)	7.5	7.5	7.5	7.5	7.5	10.0	10.0	10.0	10.0	7.5	7.5	7.5		
Cost ($)					5,604.0	11,565.0	11,806.0	11,932.0	7,678.0	2,756.3				

Total Demand 51,341.3 $/yr

Demand Savings 43,719.0 $/yr

Energy Savings 4,393.2 MMBTU/yr (electric)

Energy Savings MMBTU/yr (gas)

ITEM	ECO-K2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (CH-1)					313.0	313.0	313.0	313.0	313.0	313.0			1,052,304	
Cooling Tower Fans					38.2	43.5	47.4	52.2	44.1	23.6			67,085	
CHW Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Water Chiller (CH-2)					313.0	313.0	313.0	313.0	313.0				370,906	
CHW Pump					29.8	29.8	29.8	29.8	29.8				65,620	
CND Pump					29.8	29.8	29.8	29.8	29.8				65,620	
CHW controls					1.0	1.0	1.0	1.0	1.0				2,202	
Existing Chiller (CH-3)						324.3	332.3	335.7					27,486	
Cooling Tower Fans						14.9	14.9	14.9					4,939	
CHW Pump						29.8	29.8	29.8					9,864	
CND Pump						22.4	22.4	22.4					7,414	
CHWControls						1.0	1.0	1.0					331	
Total (KW)					785.4	1,183.1	1,195.0	1,203.2	791.3	397.2			1,941,381	
Rate ($/KW)	7.5	7.5	7.5	7.5	7.5	10.0	10.0	10.0	10.0	7.5	7.5	7.5		
Cost ($)					5,890.5	11,831.0	11,950.0	12,032.0	7,913.0	2,979.0				

Total Demand 52,595.5 $/yr

Demand Savings 42,464.8 $/yr

Energy Savings 4,721.0 MMBTU/yr (electric)

Energy Savings MMBTU/yr (gas)

ITEM	ECO-K3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (CH-1)					337.4	349.2	354.8	359.5	348.4	304.7			1,163,188	
Cooling Tower Fans					52.2	52.2	52.2	52.2	52.2	52.2			211,288	
CHW Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Water Chiller (CH-2)					337.4	348.0	354.8	359.5	348.4	304.7			441,162	
CHW Pump					29.8	29.8	29.8	29.8	29.8	29.8			74,530	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			74,530	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			2,501	
Existing Chiller (CH-3)					320.2	324.3	332.3	335.7	327.8				116,280	
Cooling Tower Fans					14.9	14.9	14.9	14.9	14.9				9,892	
CHW Pump					29.8	29.8	29.8	29.8	29.8				19,757	
CND Pump					22.4	22.4	22.4	22.4	22.4				14,851	
CHWControls					1.0	1.0	1.0	1.0	1.0				663	
Total (KW)					1,236.5	1,263.0	1,283.4	1,296.2	1,266.1	782.8			2,396,252	
Rate ($/KW)	7.5	7.5	7.5	7.5	7.5	10.0	10.0	10.0	10.0	7.5	7.5	7.5		
Cost ($)					9,273.8	12,630.0	12,834.0	12,962.0	12,661.0	5,871.0				

Total Demand	66,231.8	$/yr	
Demand Savings	28,828.5	$/yr	
Energy Savings	3,168.6	MMBTU/yr	(electric)
Energy Savings		MMBTU/yr	(gas)

ITEM	ECO-K4: NEW GAS ENGINE CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (CH-1)														11,618.8
Cooling Tower Fans					52.2	52.2	52.2	52.2	52.2	52.2			212,322	
CHW Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CND Pump					29.8	29.8	29.8	29.8	29.8	29.8			131,597	
CHW controls					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Water Chiller (CH-2)														4,253.4
CHW Pump					29.8	29.8	29.8	29.8	29.8				65,620	
CND Pump					29.8	29.8	29.8	29.8	29.8				65,620	
CHW controls					1.0	1.0	1.0	1.0	1.0				2,202	
Existing Chiller (CH-3)						324.3	332.3	335.7					27,486	
Cooling Tower Fans						14.9	14.9	14.9					4,939	
CHW Pump						29.8	29.8	29.8					9,864	
CND Pump						22.4	22.4	22.4					7,414	
CHWControls						1.0	1.0	1.0					331	
Total (KW)					173.4	565.8	573.8	577.2	173.4	112.8			663,408	15,872.2
Rate ($/KW)	7.5	7.5	7.5	7.5	7.5	10.0	10.0	10.0	10.0	7.5	7.5	7.5		
Cost ($)					1,300.5	5,658.0	5,738.0	5,772.0	1,734.0	846.0				

Total Demand	21,048.5	$/yr	
Demand Savings	74,011.8	$/yr	
Energy Savings	9,082.8	MMBTU/yr	(electric)
Energy Savings	-15,872.2	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6K1	**DATE:** 9/19/96
ECO NO. K-1 Replace Existing Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW CHILLERS and HVAC Equipment WATER COOLED CENTRIFUGAL
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	1,483	TON	1.1	28.91	47,161	20.00	29,660	76,821
RMV PUMP	4	EA	6.0	28.91	694	50.00	200	894
RMV COOLING TOWER	1	EA	150.0	28.91	4,337	1,900.00	1,900	6,237
RMV PACKAGE UNIT	50	TON	1.5	28.91	2,168	500.00	25,000	27,168
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	200	LF	1.0	28.91	5,782	29.50	5,900	11,682
4"	900	LF	0.8	28.91	19,514	19.55	17,595	37,109
3"	1,800	LF	0.6	28.91	31,223	15.70	28,260	59,483
2-1/2"	800	LF	0.5	28.91	11,564	13.33	10,664	22,228
2"	400	LF	0.4	28.91	4,626	13.33	5,332	9,958
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	120.0	20.00	2,400	2,500.00	2,500	4,900
				SUBTOTAL	129,468		127,011	256,479
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6k1 | **DATE:** 9/19/96

ECO NO. K-1 **Replace Existing Chillers** | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	1	LOC	10.7	28.91	308	717.00	717	1,025
CHILLER (YORK YT) WITH PIPING & VESELS	1,140	TON	3.2	28.91	105,464	371.00	422,940	528,404
AHU CH 2-PIPE WITH VALVES & PIPING	50	TON	2.9	28.91	4,120	660.00	33,000	37,120
PRIMARY PUMPS 40 HP	2	EA	60.0	28.91	3,469	6,900.00	13,800	17,269
CNDNSR PUMP 40 HP	2	EA	60.0	28.91	3,469	6,900.00	13,800	17,269
RETROFIT EXISTING CHILLER TO R-123	1	JOB				35,000.00	35,000	35,000
CHILLER PLANT MANIFOLD & VALVES	1	JOB	133.0	28.91	3,845	9,600.00	9,600	13,445
CENTRAL PLANT CONTROLS	1	JOB	300.0	28.91	8,673	6,000.00	6,000	14,673
				SUBTOTAL	129,799		535,892	665,691
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6k1	DATE: 9/19/96
ECO NO. K-1 Replace Existing Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: 1 NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					129,468		127,011	256,479
SUB TOTAL FROM SHEET 2					129,799		535,892	665,691
SUBTOTAL					259,267		662,903	922,170
O & P @ 20%					51,853		132,581	184,434
SUBTOTAL					311,120		795,484	1,106,604
DESIGN @ 6%								66,396
SUBTOTAL								1,173,000
SIOH @ 5.5%								64,515
TOTAL								$1,237,515

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6K2	**DATE:** 9/19/96
ECO NO. K-2 Replace Existing Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW CHILLERS and HVAC Equipment WATER COOLED CENTRIFUGAL W/ VFD
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	1,483	TON	1.1	28.91	47,161	20.00	29,660	76,821
RMV PUMP	4	EA	6.0	28.91	694	50.00	200	894
RMV COOLING TOWER	1	EA	150.0	28.91	4,337	1,900.00	1,900	6,237
RMV PACKAGE UNIT	50	TON	1.5	28.91	2,168	500.00	25,000	27,168
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	200	LF	1.0	28.91	5,782	29.50	5,900	11,682
4"	900	LF	0.8	28.91	19,514	19.55	17,595	37,109
3"	1,800	LF	0.6	28.91	31,223	15.70	28,260	59,483
2-1/2"	800	LF	0.5	28.91	11,564	13.33	10,664	22,228
2"	400	LF	0.4	28.91	4,626	13.33	5,332	9,958
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	120.0	20.00	2,400	2,500.00	2,500	4,900
				SUBTOTAL	129,468		127,011	256,479
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6K2 | **DATE:** 9/19/96

ECO NO. K-2 Replace Existing Chillers | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL W/ VFD
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	1	LOC	10.7	28.91	308	717.00	717	1,025
CHILLER (YORK YT) WITH PIPING & VESELS	1,140	TON	3.2	28.91	105,464	371.00	422,940	528,404
ADD FOR VFD	250	HP	0.8	28.91	5,782	150.00	37,500	43,282
PRIMARY PUMPS 40 HP	2	EA	60.0	28.91	3,469	6,900.00	13,800	17,269
CNDNSR PUMP 40 HP	2	EA	60.0	28.91	3,469	6,900.00	13,800	17,269
AHU CH 2-PIPE WITH VALVES & PIPING	50	TON	2.9	28.91	4,120	660.00	33,000	37,120
RETROFIT EXISTING CHILLER TO R-123	1	JOB				35,000.00	35,000	35,000
CHILLER PLANT MANIFOLD & VALVES	1	JOB	133.0	28.91	3,845	9,600.00	9,600	13,445
CENTRAL PLANT CONTROLS	1	JOB	300.0	28.91	8,673	6,000.00	6,000	14,673
				SUBTOTAL	135,581		573,392	708,973
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. K-2 Replace Existing Chillers

PROJECT NO: 03-185.6K2

BY : KOTHMANN, K

DATE: 9/19/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: 1 NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL W/ VFD
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					129,468		127,011	256,479
SUB TOTAL FROM SHEET 2					135,581		573,392	708,973
SUBTOTAL					265,049		700,403	965,452
O & P @ 20%					53,010		140,081	193,090
SUBTOTAL					318,059		840,484	1,158,542
DESIGN @ 6%								69,513
SUBTOTAL								1,228,055
SIOH @ 5.5%								67,543
TOTAL								$1,295,598

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. K-3 **Replace Existing Chillers**

PROJECT NO: 03-0185.6K3 **DATE:** 9/19/96

BY : KOTHMANN, K **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW CHILLERS and HVAC Equipment WATER COOLED SCREW
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	1,483	TON	1.1	28.91	47,161	20.00	29,660	76,821
RMV PUMP	4	EA	6.0	28.91	694	50.00	200	894
RMV COOLING TOWER	1	EA	150.0	28.91	4,337	1,900.00	1,900	6,237
RMV PACKAGE UNIT	50	TON	1.5	28.91	2,168	500.00	25,000	27,168
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	200	LF	1.0	28.91	5,782	29.50	5,900	11,682
4"	900	LF	0.8	28.91	19,514	19.55	17,595	37,109
3"	1,800	LF	0.6	28.91	31,223	15.70	28,260	59,483
2-1/2"	800	LF	0.5	28.91	11,564	13.33	10,664	22,228
2"	400	LF	0.4	28.91	4,626	13.33	5,332	9,958
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	120.0	20.00	2,400	2,500.00	2,500	4,900
				SUBTOTAL	129,468		127,011	256,479
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6k3 | DATE: 9/19/96

ECO NO. K-3 Replace Existing Chillers | BY : KOTHMANN, K | CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	1	LOC	10.7	28.91	308	717.00	717	1,025
CHILLER (YORK YS) WITH PIPING & VESELS	1,140	TON	3.2	28.91	105,464	614.00	699,960	805,424
AHU CH 2-PIPE WITH VALVES & PIPING	50	TON	2.9	28.91	4,120	660.00	33,000	37,120
PRIMARY PUMPS 40 HP	2	EA	60.0	28.91	3,469	6,900.00	13,800	17,269
CNDNSR PUMP 40 HP	2	EA	60.0	28.91	3,469	6,900.00	13,800	17,269
RETROFIT EXISTING CHILLER TO R-123	1	JOB				35,000.00	35,000	35,000
CHILLER PLANT MANIFOLD & VALVES	1	JOB	133.0	28.91	3,845	9,600.00	9,600	13,445
CENTRAL PLANT CONTROLS	1	JOB	300.0	28.91	8,673	6,000.00	6,000	14,673
				SUBTOTAL	129,799		812,912	942,711
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6K3	DATE: 9/19/96
ECO NO. K-3 Replace Existing Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: 1 NEW Central Plant and HVAC Equipment WATER COOLED SCREW
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					129,468		127,011	256,479
SUB TOTAL FROM SHEET 2					129,799		812,912	942,711
SUBTOTAL					259,267		939,923	1,199,190
O & P @ 20%					51,853		187,985	239,838
SUBTOTAL					311,120		1,127,908	1,439,028
DESIGN @ 6%								86,342
SUBTOTAL								1,525,369
SIOH @ 5.5%								83,895
TOTAL								$1,609,265

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-0185.6K4 | **DATE:** 9/19/96

ECO NO. K-4 Replace Existing Chillers | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW CHILLERS and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	1,483	TON	1.1	28.91	47,161	20.00	29,660	76,821
RMV PUMP	4	EA	6.0	28.91	694	50.00	200	894
RMV COOLING TOWER	1	EA	150.0	28.91	4,337	1,900.00	1,900	6,237
RMV PACKAGE UNIT	50	TON	1.5	28.91	2,168	500.00	25,000	27,168
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
6"	200	LF	1.0	28.91	5,782	29.50	5,900	11,682
4"	900	LF	0.8	28.91	19,514	19.55	17,595	37,109
3"	1,800	LF	0.6	28.91	31,223	15.70	28,260	59,483
2-1/2"	800	LF	0.5	28.91	11,564	13.33	10,664	22,228
2"	400	LF	0.4	28.91	4,626	13.33	5,332	9,958
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	120.0	20.00	2,400	2,500.00	2,500	4,900
				SUBTOTAL	129,468		127,011	256,479
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6k4	**DATE:** 9/19/96
ECO NO. K-4 Replace Existing Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	1	LOC	10.7	28.91	308	717.00	717	1,025
CHILLER (YORK YG) WITH PIPING & VESELS	1,140	TON	4.5	28.91	148,308	896.00	1,021,440	1,169,748
AHU CH 2-PIPE WITH VALVES & PIPING	50	TON	2.9	28.91	4,120	660.00	33,000	37,120
PRIMARY PUMPS 40 HP	2	EA	60.0	28.91	3,469	6,900.00	13,800	17,269
CNDNSR PUMP 40 HP	2	EA	60.0	28.91	3,469	6,900.00	13,800	17,269
RETROFIT EXISTING CHILLER TO R-123	1	JOB				35,000.00	35,000	35,000
CHILLER PLANT MANIFOLD & VALVES	1	JOB	133.0	28.91	3,845	9,600.00	9,600	13,445
CENTRAL PLANT CONTROLS	1	JOB	300.0	28.91	8,673	6,000.00	6,000	14,673
				SUBTOTAL	172,643		1,134,392	1,307,035
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6K4	DATE: 9/19/96
ECO NO. K-4 Replace Existing Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: 1 NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SUB TOTAL FROM SHEET 1					129,468		127,011	256,479
SUB TOTAL FROM SHEET 2					172,643		1,134,392	1,307,035
SUBTOTAL					302,111		1,261,403	1,563,514
O & P @ 20%					60,422		252,281	312,703
SUBTOTAL					362,534		1,513,684	1,876,217
DESIGN @ 6%								112,573
SUBTOTAL								1,988,790
SIOH @ 5.5%								109,383
TOTAL								$2,098,174

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6MA	DATE: 9/19/96
ECO NO. K Retrofit Existing Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 1300

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON EXISTING								
OUTSIDE CONTRACT COSTS PER CHILLER PER YEAR								
EXISTING WATER COOLEDCHILLERS	-3.	EA	200.0	30.00	-18,000	6,150.00	-18,450	-36,450
EXISTING AIR COOLED CHILLERS	-44.	TON	0.7	30.00	-924	29.00	-1,276	-2,200
EXISTING WINDOW UNITS		EA	3.0	30.00		20.00		
EXISTING DX SYSTEM	-77.5	TON	1.0	30.00	-2,325	5.00	-388	-2,713
NEW EQUIPMENT								
NEW WATER COOLED CHILLERS	3.	EA	190.0	30.00	17,100	6,150.00	4,020	21,120
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-4,149		-16,094	-20,243
PER YEAR								

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Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-K1
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$1,106,604
B. SIOH	$64,515
C. Design Cost	$66,396
D. Total Cost (1A+1B+1C)	$1,237,515
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,237,515

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	4,393	Mbtus	$27,589	15.08	$416,047
Elec. Deman					$43,719	14.88	$650,539
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			4,393	Mbtus	$71,308		$1,066,585

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRI	$20,243	Annual	14.88	$301,216
ANNUAL TOTAL	$20,243			$301,216
REFRIGERANT RE	$3,944	0	1.0	$3,944
CHILLER RETROF	$70,000	0	1.0	$70,000
ONE TIME TOTAL	$73,944			$73,944
TOTAL	$94,187			$375,160

4. First Year Dollar Savings	$95,249
5. Simple Payback Period (Years)	12.99
6. Total Net Discounted Savings	$1,441,745
7. Savings to Investment Ratio	1.17
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	3.79%

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-K2
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$1,158,542
B. SIOH	$67,543
C. Design Cost	$69,513
D. Total Cost (1A+1B+1C)	$1,295,598
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,295,598

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	4,721	Mbtus	$29,648	15.08	$447,090
Elec. Deman					$42,465	14.88	$631,879
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			4,721	Mbtus	$72,113		$1,078,969

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRI	$20,243	Annual	14.88	$301,216
ANNUAL TOTAL	$20,243			$301,216
REFRIGERANT RE	$3,944	0	1.0	$3,944
CHILLER RETROF	$70,000	0	1.0	$70,000
ONE TIME TOTAL	$73,944			$73,944
TOTAL	$94,187			$375,160

4. First Year Dollar Savings	$96,053
5. Simple Payback Period (Years)	13.49
6. Total Net Discounted Savings	$1,454,129
7. Savings to Investment Ratio	1.12
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	3.6%

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-K3
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$1,439,028
B. SIOH	$83,895
C. Design Cost	$86,342
D. Total Cost (1A+1B+1C)	$1,609,265
E. Salvage Value of Existing Equip.	0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,609,265

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	3,169	Mbtus	$19,899	15.08	$300,074
Elec. Deman					$28,829	14.88	$428,976
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			3,169	Mbtus	$48,728		$729,050

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRI	$20,243	Annual	14.88	$301,216
ANNUAL TOTAL	$20,243			$301,216
REFRIGERANT RE	$3,944	0	1.0	$3,944
CHILLER RETROF	$70,000	0	1.0	$70,000
ONE TIME TOTAL	$73,944			$73,944
TOTAL	$94,187			$375,160

4. First Year Dollar Savings	$72,668
5. Simple Payback Period (Years)	22.15
6. Total Net Discounted Savings	$1,104,209
7. Savings to Investment Ratio	.69
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	1.08%

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-K4
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$1,876,217
B. SIOH	$109,383
C. Design Cost	$112,573
D. Total Cost (1A+1B+1C)	$2,098,173
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	0
G. Total Investment (1D-1E-1F)	$2,098,173

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	9,083	Mbtus	$57,040	15.08	$860,163
Elec. Deman					$74,012	14.88	$1,101,299
Natural Gas	$3.5	/Mbtus	-15,872	Mbtus	-$54,918	18.58	-$1,020,373
TOTAL			-6,789	Mbtus	$76,134		$941,089

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRI	$20,243	Annual	14.88	$301,216
ANNUAL TOTAL	$20,243			$301,216
REFRIGERANT RE	$3,944	0	1.0	$3,944
CHILLER RETROF	$70,000	0	1.0	$70,000
ONE TIME TOTAL	$73,944			$73,944
TOTAL	$94,187			$375,160

4. First Year Dollar Savings	$100,074
5. Simple Payback Period (Years)	20.97
6. Total Net Discounted Savings	$1,316,248
7. Savings to Investment Ratio	.63
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	.63%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	L
DATE:	3/1/95
ECO TITLE:	Replace Existing Central Boilers With High Efficiency Modular Boilers
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 1300, Building 1377 (serves buildings 1350, 1374, 1375, 1377, 1379, 1380, 1382, 1385, 1385, 1396, and 1398)

A. Summary:

Electrical Energy Savings	342	MMBTU/yr
Electrical Demand Savings	1256	$/yr
Gas Energy Savings	1064	MMBTU/yr
Total Energy Savings	1406	MMBTU/yr
Total Cost Savings	22,265	$/yr
Total Investment	484,544	$
Simple Payback	21.8	yrs
SIR	0.71	

B. ECO Description:

Remove the existing boilers as listed in Table-1. Also remove the one 40 HP (serving Building 1350), and two 15 HP (serving Buildings 1374,75,79, 80, 82, and 85) HW distribution pumps in building 1377. Connect the two separate distribution loops together in Building 1377 with new HW supply and return headers to make a single HW distribution system. Install four new modular high efficiency boilers (rated at 1830 MBH-output), stainless steel flue stacks, and regulator valve each and four new 7 ½ HP distribution pumps to serve this single system. The existing HW pumps of Buildings 1384, 1396, and 1398 will be reutilized as secondary pumps. A new 4" direct buried primary CHW supply and return piping loop will be constructed and connected with the new 470 gpm primary pump. This loop will require a 2.0" capped take-off that will serve Building 1387 (if needed for future use). The loop will have approximately 200 ft. of 4", 900 ft. of 3", 800 ft. of 2.0", 1800 ft. of 2.5" and 400 ft of 1.5" piping to complete this primary loop. All other building AHUs, HW coil three way control valves will be converted to two way valves to minimize pumping energy. The existing electrical service and controls should be reused as much as possible. Specific requirements in these areas should be determined by the design engineer responsible for this project. The boilers and pumps should be sequenced to operate only as needed to maintain the supply water temperature set point of approximately 180°F. Specific requirements in these areas should be determined by the design engineer responsible for this project. This project will require engineering drawings and specifications, demolition and removal of the existing chillers and pumps, and installation of the new chillers, pumps, associated wiring and controls.

Table-1

Bldg. #	Quantity	Description	Size MBH	Flow GPM	Estimated Pipe Size inches	Extimated Pipe Length Feet
1377	2	HW boiler	11824	886		
1377	1	HW boiler	5317	530		
1377	1	HW boiler	4336	440		
1384	1	HW boiler	3636	265	4	30
1396	1	HW boiler	427.1	60	2	800
1398	1	HW boile	381.8	45	1.5	800
1387	7	heat pumps	900	100		
Total	14	HW boiler	26822	2326	N/A	N/A

C. Discussion:

The two existing watertube boilers serving building 1350 were installed in 1983 and are rated at 5,317 MBH and 4,336 MBH output capacity. The single 40 HP pump circulates HW from these boilers through building 1350. The two existing firetube boilers serving the other buildings in the 1300 area were installed in 1972 and are rated at 5,912 MBH output capacity each. Two 15 HP pumps circulate HW from these boilers to the seven other buildings listed above. Building1384 has a gas fired boiler which was installed in 1984. Building 1396 and 1398 each have a natural draft gas fired boilers installed in 1986. All these boilers appear to be in fair condition. However, the cost of maintaining these boilers is excessive. Therefore, it is recommended that four 2,000 MBH gas fired high efficiency modular HW boilers be installed. These boilers are 86% efficient under full load conditions, and reach upwards to 98% efficiency under part load conditions. Also, they have the capability to be staged to maintain these part load efficiencies by remote boiler control. In retrofit projects such as this, the size of the boilers make it very economical and justifiable because of their ease of installation. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. Four primary pumps will provide an additional flexibility in staging. Computer simulations of the buildings served by these bolers determined that the current combined capacity of 27,796 MBH is much more than is required to adequately heat the buildings[1]. The existing boilers are therefore operating at an inefficient, low load condition most of the time. Also, because of the constant flow rate requirements of the large boilers, excessive pumping energy is expended. By combining the two distribution systems together and staging the four new high efficiency modular boilers to operate only as needed, a substantial energy savings can be realized. Also, a decrease in the combined boiler output capacity to 6,800 MBH is recommended to more closely match the heating load in the eight buildings and reduce the associated pumping energy consumption. All other building AHUs, HW coil three way control valves will be converted to two way valves to minimize the pumping energy and for better distribution of the HW flow through the AHU coils.

D. Savings Calculations:

1. *Energy Consumption and Savings:*

The monthly peak demand and energy consumptions of the existing and proposed boilers and HW pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing

boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3].

The four new high efficiency, modular type boilers modeled were rated at 1,830 MBH output each. Full and part load performance data from Aerco International were used in the computer simulations of the new boiler energy usages[4]. An equipment list with specific data on the new boilers and pumps used in the computer simulation is shown on page C-218.

Once the computer simulations of the existing and new boiler systems were completed, the total annual demand cost and energy consumption of the new systems were compared with that of the existing systems to determine the annual savings[5]. These savings calculations are shown on page C-219 Through C-220. The demand and energy savings values were used in the life cycle cost analysis for this ECO.

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of boilers, to four modular boilers. The total maintenance cost savings from this ECO is estimated to be $15,180 per year as shown on page C-225. This figure was used in the life cycle cost analysis.

E. Cost Estimates

The total installation costs for this ECO were estimated on page C-221 through C-224 . These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the Life Cyde Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-226. The data from the life cycle cost analysis were included in the summary on page C-215.

REFERENCES

1. See Appendix H for Area 1300 heating system load profile.

2. See Appendix H for computer model input assumptions and data, and energy consumption output data.

3. See Appendix G for building field data and existing HVAC system data.

4. See Appendix F for manufacturer's equipment performance data from Aerco International.

5. See Appendix A for utility cost analysis data, used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-L, FORT SAM HOUSTON, AREA 1300 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Hot Water Boiler	4	Aerco #KC-2000 GWB natural draft, watertube 1830 MBH output	Area 1300	New	2,000 MBH
Heating Water Pump	4	Bell & Gossett 160 gpm, 120 ft 7.5 HP	Area 1300	New	5.60 KW

ITEM	ECO-L EXISTING BUILDING SYSTEMS MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Bldg. 1350 HW blr (BLR-1)														20.5
Bldg. 1350 HW pump (BLR-1)	29.8	29.8											1,192	
Bldg. 1350 BLR-1 controls	0.1	0.1											5	
Bldg. 1350 HW blr (BLR-2)														
Bldg. 1350 HW pump (BLR-2)														
Bldg. 1350 BLR-2 controls														
Bldg. 1377 Plant HW BLR-1														5,371.3
HW pump (BLR-1)	11.2	11.2	11.2	11.2							11.2	11.2	48,653	
BLR-1 controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW pump (BLR-1)	11.2	11.2	11.2	11.2							11.2	11.2	48,653	
HW blr f.d. fan (BLR-1)	7.5	7.5	7.5	7.5							7.5	7.5	32,580	
Bldg. 1377 Plant HW BLR-2														
HW pump (BLR-2)														
HW blr f.d. fan (BLR-2)														
BLR-2 controls														
Bldg. 1384 HW boiler														208.5
Bldg. 1384 HW controls	0.1	0.1	0.1	0.1							0.1	0.1	187	
Bldg. 1396 HW boiler														636.5
Bldg. 1396 HW controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Bldg. 1398 HW boiler														445.2
Bldg. 1398 HW controls	0.1	0.1	0.1	0.1							0.1	0.1	543	
Totals	60.2	60.2	30.3	30.3							30.3	30.3	132,899	6,682.0
Rate ($/KW)	7.5	7.5	7.5	7.5	7.5	10.0	10.0	10.0	10.0	7.5	7.5	7.5		
Cost ($)	451.5	451.5	227.3	227.3							227.3	227.3		

Total Demand 1,812.0 $/yr

Total Energy 453.6 MMBTU/yr (electric)

Total Energy 6,682.0 MMBTU/yr (gas)

ITEM	ECO-L: INSTALL HIGH EFFICIENCY MODULAR BOILERS MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
High % modular boiler # 1														3,744
HW pump	5.6	5.6	5.6	5.6								5.6	24,326	
HW controls	0.1	0.1	0.1	0.1								0.1	543	
High % modular boiler # 2														1,343
HW pump	5.6	5.6										5.6	4,878	
HW controls	0.1	0.1										0.1	109	
High % modular boiler # 3														523
HW pump	5.6	5.6										5.6	2,430	
HW controls	0.1	0.1										0.1	54	
High % modular boiler # 4														8
HW pump	5.6	5.6											252	
HW controls	0.1	0.1											6	
Total (KW)	22.8	22.8	5.7	5.7								17.1	32,598	5,618
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	171	171	43	43								128		

Total Demand	556	$/yr	
Demand Savings	1,256	$/yr	
Energy Savings	342	MMBTU/yr	(electric)
Energy Savings	1,064	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6L		**DATE:** 9/19/96
ECO NO. L Replace Existing Central Boilers AREA 1300	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDING ELECTRICAL AND ASSOCIATED PIPING								
REMOVE BOILER	5	EA	160.0	28.91	23,128	780.00	3,900	27,028
RMV HW PUMPS	4	EA	5.0	28.91	578	50.00	200	778
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
4"	200	LF	0.8	28.91	4,626	19.55	3,910	8,536
3"	900	LF	0.6	28.91	15,611	15.70	14,130	29,741
2"	800	LF	0.4	28.91	9,251	13.33	10,664	19,915
2-1/2"	1,800	LF	0.5	28.91	26,019	13.33	23,994	50,013
1-1/2"	400	LF	0.4	28.91	4,626	12.85	5,140	9,766
				SUBTOTAL	83,839		61,938	145,777
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6L	**DATE:** 9/19/96
ECO NO. L Replace Existing Central Boilers AREA 1300	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX	2	EA	10.0	28.91	578	540.00	1,080	1,658
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	120.0	20.00	2,400	2,500.00	2,500	4,900
SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING HW PUMPS PER LOCATION								
2-1/2"	3	LOC	9.6	28.91	833	639.00	1,917	2,750
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	100	LF	0.5	28.91	1,446	7.05	705	2,151
ALL AIR SIDE EQUIPMENT INCLUDED IN ECO K								
ADD PIPING ASSEMBLY &HOT WTR COIL								
AHU 2-PIPE	1	EA	30.0	28.91	867	3,500.00	3,500	4,367
CHANGE ALL 3-WAY CONTROL VALVES TO 2-WAY	1	JOB	300.0	28.91	8,673	16,000.00	16,000	24,673
				SUBTOTAL	14,797		25,702	40,499
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO TEX	PROJECT NO: 03-185.6L	DATE: 9/19/96
ECO NO. L Replace Existing Central Boilers AREA 1300	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
Install New Boiler AERCO # KC 2000 1830 MBH	4	EA	100.00	28.91	11,564	18500.00	74,000	85,564
BOILER ROOM PIPING AND VALVES	1	JOB	240.00	28.91	6,938	5600.00	5,600	12,538
Install New Pump 7.5 HP	4	EA	15.00	28.91	1,735	2800.00	11,200	12,935
pipe Assembly & valves Boiler	4	EA	28.00	28.91	3,238	2400.00	9,600	12,838
pipe Assembly & valves Pump	4	EA	12.00	28.91	1,388	1350.00	5,400	6,788
Boiler Breaching	4	JOB	50.00	28.91	5,782	2500.00	10,000	15,782
Controls	1	JOB	160.00	28.91	4,626	6900.00	6,900	11,526
Electrical	1	JOB	100.00	28.91	2,891	5900.00	5,900	8,791
Test , Balance & Start-up	1	LS	160.00	28.91	4,626			4,626
SUBTOTAL					42,787		128,600	171,387
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6L	**DATE:** 9/19/96
ECO NO. L Replace Existing Central Boilers AREA 1300	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
705164 Bldg SF Condition Space AREA 1300

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , HW ENTRY PIPING ASSEMBLY 1"	2	LOC	14.0	28.91	809	1,300.00	2,600	3,409
AND NEW HOT WTR PUMPS COST PER LOCATION								
ALL AIR SIDE EQUIPMENT INCLUDED IN ECO K								
SUB TOTAL FROM SHEET 1					83,839		61,938	145,777
SUB TOTAL FROM SHEET 2					14,797		25,702	40,499
SUB TOTAL FROM SHEET 3					42,787		128,600	171,387
SUBTOTAL					142,232		218,840	361,072
O & P @ 20%					28,446		43,768	72,214
SUBTOTAL					170,678		262,608	433,286
DESIGN @ 6%								25,997
SUBTOTAL								459,283
SIOH @ 5.5%								25,261
TOTAL								$484,544

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ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-0185.6MA	DATE: 9/19/96
ECO NO. L Retrofit Existing BOILERS	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 1300

ANNUAL COSTS

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	TOTAL PER YR	Unit Price	TOTAL PER YR	
EXISTING EQUIPMENT								
MAINTENANCE COSTS ARE BASED ON								
OUTSIDE CONTRACT COSTS PER BOILER PER YEAR								
EXISTING BOILER	-6.	EA	100.0	30.00	-18,000	1,800.00	-10,800	-28,800
NEW EQUIPMENT								
AERCO MODULAR HIGH EFFICIENCY HW BOILER	4.	EA	80.0	30.00	9,600	1,500.00	4,020	13,620
COSTS ARE PRORATED OVER TEN YEARS								
TO INCLUDE WARRANTY PERIOD								
NET SAVINGS					-8,400		-6,780	-15,180
PER YEAR								

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Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-L
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$433,286
B. SIOH	$25,261
C. Design Cost	$25,997
D. Total Cost (1A+1B+1C)	$484,544
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$484,544

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	342	Mbtus	$2,148	15.08	$32,388
Elec. Deman					$1,256	14.88	$18,689
Natural Gas	$3.5	/Mbtus	1,064	Mbtus	$3,681	18.58	$68,401
TOTAL			1,406	Mbtus	$7,085		$119,479

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURR	$15,180	Annual	14.88	$225,878
ANNUAL TOTAL	$15,180			$225,878
ONE TIME TOTAL	$0			$0
TOTAL	$15,180			$225,878

4. First Year Dollar Savings	$22,265
5. Simple Payback Period (Years)	21.76
6. Total Net Discounted Savings	$345,357
7. Savings to Investment Ratio	.71
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	1.27%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	M
DATE:	3/1/96
ECO TITLE:	Install Energy Management System (EMS) For HVAC System
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 2200, (serves Buildings 2200, 2244, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272, and 2273)

A. Summary:

Electrical Energy Savings	5002	MMBTU/yr
Electrical Demand Savings	-1740	$/yr
Gas Energy Savings	124	MMBTU/yr
Total Energy Savings	5126	MMBTU/yr
Total Cost Savings	30,102	$/yr
Total Investment	889,460	$
Simple Payback	29.6	yrs
SIR	0.51	

B. ECO Description:

Install an Energy Management System (EMS) at the central maintenance facility. The EMS will accomplish the following tasks for the equipment listed in Table-1 in all of the buildings as listed above:

1. All AHU's serving buildings in the table below will be furnished with all necessary controls to facilitate an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode, which will save thermal cooling energy. (several damaged OA dampers require repairs). Buildings 2200, 2263, 2264, 2265 and 2266 are included in this option.

2. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps. These units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, the equipment can be started as late as possible, and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature. Building 2200, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272 and 2273 will have this option. All other buildings are not included.

3. All multi-zone units and all single zone units with or without reheat coils in their branches will have a cooling side discharge air temperature reset. All branch thermostats and zone supply air temperatures after the reheat coil will be monitored. The cooling coil

leaving air temperature will be reset to satisfy at least one zone thermostat without reheat. Buildings 2263, 2264, 2265 and 2266 are included in this option.

4. All multi-zone units will have air side temperature reset. AHU heating supply air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full heat (at least one zone damper will be fully open). Buildings 2263, 2264, 2265 and 2266 are included in this option.

5. A night / day setback program will be provided to control window units and fan coil units, and split systems. The program will set back the temperature of the controlled space to a predetermined set-point during periods of no occupancy. Several space or unit mounted temperature sensors will be installed to control the units that currently are controlled under manual operation or no control.

Table-1

Building Number	Equipment To Be Controlled
2200	4 AHUs and 12 FCUs, Chiller, CHW pump, Boiler and HW pump.
2244	1 DX AHU, 1 Condenser
2247	1 AHU, A/C comp, CW pump, Boiler and HW pump CLG. tower and 2 window units.
2248	1 AHUs and 7 FCUs, Chiller, CHW pump, Boiler and HW pump.
2250	2 AHUs and HW pump.
2263	8 AHUs, 14 FCUs
2264	10 AHUs.
2265	10 AHUs. (Chiller, boiler, CW, CHW, HW, boiler circulation pumps are located in this building.)
2266	10 AHUs
2270	1 AHU, 3 A/C comp, CW pump, 2 Boilers, HW pump and CLG. tower.
2272	1 AHUs, Chiller, CHW pump, Boiler and HW pump.
2273	20 FCUs

C. Discussion:

1. Generally, the ambient condition in San Antonio area is warm and humid. Annual free cooling hours will be limited. A large number of AHUs are equipped with necessary dampers to support an economizer cycle. The original HVAC system was designed to have an economizer cycle, or a smoke purge system. All OA and RA dampers will be repaired and retrofitted with necessary controls to support an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode. When the enthalpy of the OA drops below the RA, then the OA damper will open, and the RA damper will close. This action will reduce the cooling energy required. The benefit of this system will occur only in the cooling mode. In the heating mode, the OA damper will remain in the preset minimum open position to permit necessary ventilation. Buildings 2200, 2263, 2264, 2265 and 2266 are included in this option. Four AHUs in Building 2200 will be retrofitted in this Option. Due to existing conditions and locations of AHUs in rest of the buildings, they will not be retrofitted in this option.

2. Regardless of occupancy hours, all AHU's are operated 24 hours per day, 365 days per year to maintain space temperature. However, the chillers operate only during the cooling season as do the boilers in the heating season. Depending on occupancy schedules, ambient conditions and building thermal characteristics, most AHU's and their associated chillers, boilers , CHW and HW pumps will be turned off daily in the evening. The equipment will be stopped as early as possible and turned back on as late as possible every weekday without sacrificing occupant comfort. These AHU's will remain off during weekends and holidays.

   Several temperature sensors will be installed in the spaces served by these AHU's. These sensors will monitor the space temperature during unoccupied hours. During the cooling season when the space temperature exceeds 85 F, the AHU's and their associated cooling auxiliaries serving that space will energize to cool the space below 85 F. When the space temperature reaches 84 F, they will cycle off. Similarly, the winter time unoccupied period space temperature will be maintained at 65 F.

   The EMS system will have the capability to manually override this operation with a change in schedule. All AHU's serving the critical areas such as the computer room will operate as usual, and they will not be connected to the new start/stop program. However, if desired, their current operation and performance can be monitored by the new EMS system.

3. Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's. (Boiler and chiller have a seasonal operation, hot and cold air mixing never occurs, return air mixes with cold air in the summer and with hot air in winter.) In both cases, cooling and heating energy is wasted. To reduce this waste currently the hot air plenum is acting as a return air plenum. Our observations indicate that all zones are mixing cold supply and return air to maintain the room or zone temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur. The same control sequence will be applied to the hot deck temperature control.

   In multi-zone units, cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air temperature will be increased to minimize mixing. This process will continue until one of the zones requires no mixing. (A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.). The space humidity also will be monitored. When the humidity exceeds its upper limit, the cooling supply air temperature will be decreased to provide dehumidification. Buildings 2263, 2264, 2265 and 2266 are included in this option as they have a multi-zone system.

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Our observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. Heating supply air temperature will be lowered until at least one zone

damper will remains fully open to satisfy the room or area heating demand. Many partially open heating dampers indicate a higher than necessary heating deck temperature. Lowering the temperature will save heating energy. Buildings 2263, 2264, 2265 and 2266 are included in this option as they have a multi-zone system.

5. During periods when the facility remains unoccupied, the window units, fan coil units and split systems that serve non-critical areas will be reset to an "unoccupied" space temperature condition. Temperature sensors will monitor the space temperature at all times, and when the program determines the unoccupied periods, the temperature set point will rise from 78°F to 85°F for summer cooling conditions and from 70°F to 65°F for winter cooling conditions. When the space temperature exceeds 85°F during unoccupied periods, then it will energize the unit and its associated auxiliary cooling equipment. Similarly, when the space temperature falls below 65°F during unoccupied periods, then it will energize the unit and its associated auxiliary heating equipment.

   The EMS will have the capability to override this operation with a change in schedule or function. Also, this will not apply to window units, fan coil units, and split systems serving critical areas such as computer rooms. These units will operate as usual, and they will connected to the new start stop program unless their operation and performance needs to be monitored.

   The EMS system will be controlled by a personal computer (PC) located in the central maintenance building. All other buildings control panels will be connected to the central EMS system PC in the Building via telephone lines.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed EMS system were calculated using the Trace 600 computer program[1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

Once the computer simulations of the existing and new EMS system were completed, the total annual demand cost and energy consumption were compared with that of the existing and new systems to determine the annual savings for this ECO[3]. These savings calculations are shown on pages C-234 and C-237. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings by this retrofit.

E. Cost Estimates:

The total installation costs for the new EMS system are estimated on pages C-238 through C-240. These costs were estimated from the I/O point list shown on pages C-232 through C-233 and used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-241. The data from the summary sheet were presented in the ECO summary on page C-227.

REFERENCES

1. Refer to Appendix H for system thermal load profile, input assumptions, and computer model output.

2. Refer to Appendix G for building data and existing HVAC equipment data.

3. Refer to Appendix A for utility cost analysis and avoided costs calculations.

AREA: 2200	HARDWARE																								
	OUTPUT								INPUT																
	DIGITAL					ANALOG			DIGITAL									ANALOG						
ECO M: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	WATTS	GAGE PRESSURE	
OCCUPANCY TIME: VARIES																								
GRAPHIC DISPLAY ●																								
POINT DESCRIPTION																								
W/C CHILLER ●																								
CHILLER					1															1				
CHW PUMP	1														1									
CW PUMP	1														1									
TWR. FAN	1														1									
CHW SUPPLY HEADER																								
CHW RETURN HEADER																								
CW SUPPLY HEADER																								
CW RETURN HEADER																								
TWR. BYPASS VALVE																								
A/C CHILLERS ●																								
CHILLER					3															3				
CHW PUMP	3														3									
CHW SUPPLY HEADER																		3						
CHW RETURN HEADER																		3						
CONDENSER / FLUID COOLER ●																								
FAN	3														3									
CW SUPPLY HEADER																								
CW RETURN HEADER																								
HW BOILERS ●																								
BOILER					4							4												
HW PUMP	4														4									
HW SUPPLY HEADER																		4						
HW RETURN HEADER																		4						
HW BOILERS ●																								
BOILER					6							6												
HW PUMP	6														6									
HW SUPPLY HEADER																		1						
HW RETURN HEADER																		1						
AHU-SZ ●																								
SUPPLY FAN	18														18									
CHW COIL VALVE						18												18						
HW COIL VALVE						18												18						
RETURN AIR							18											18						
FILTER										18														
ZONE TEMPERATURE																		18						
OUTSIDE AIR							18																	

ANALOG							SOFTWARE																																				
							ALARMS							APPLICATION PROGRAMS																														
WATTS	GAGE PRESSURE	DIFFERENITAL PRESSURE	POSITION	FLOW	O2 AND CO ANALYZERS	STATUS FAILURE	[illegible]		HIGH LIMIT	LOW LIMIT			SCHEDULED START / STOP	OPTIMUM START / STOP	DUTY CYCLING	[illegible]	[illegible]	[illegible]	VENTILATION / RECIRCULATION	HOT / COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HW BOILER SELECTION	HW O.A. RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER CONTROL	RUN TIME	KW	KWH								
																																X										
						X																									X										
						X																									X										
						X																									X										

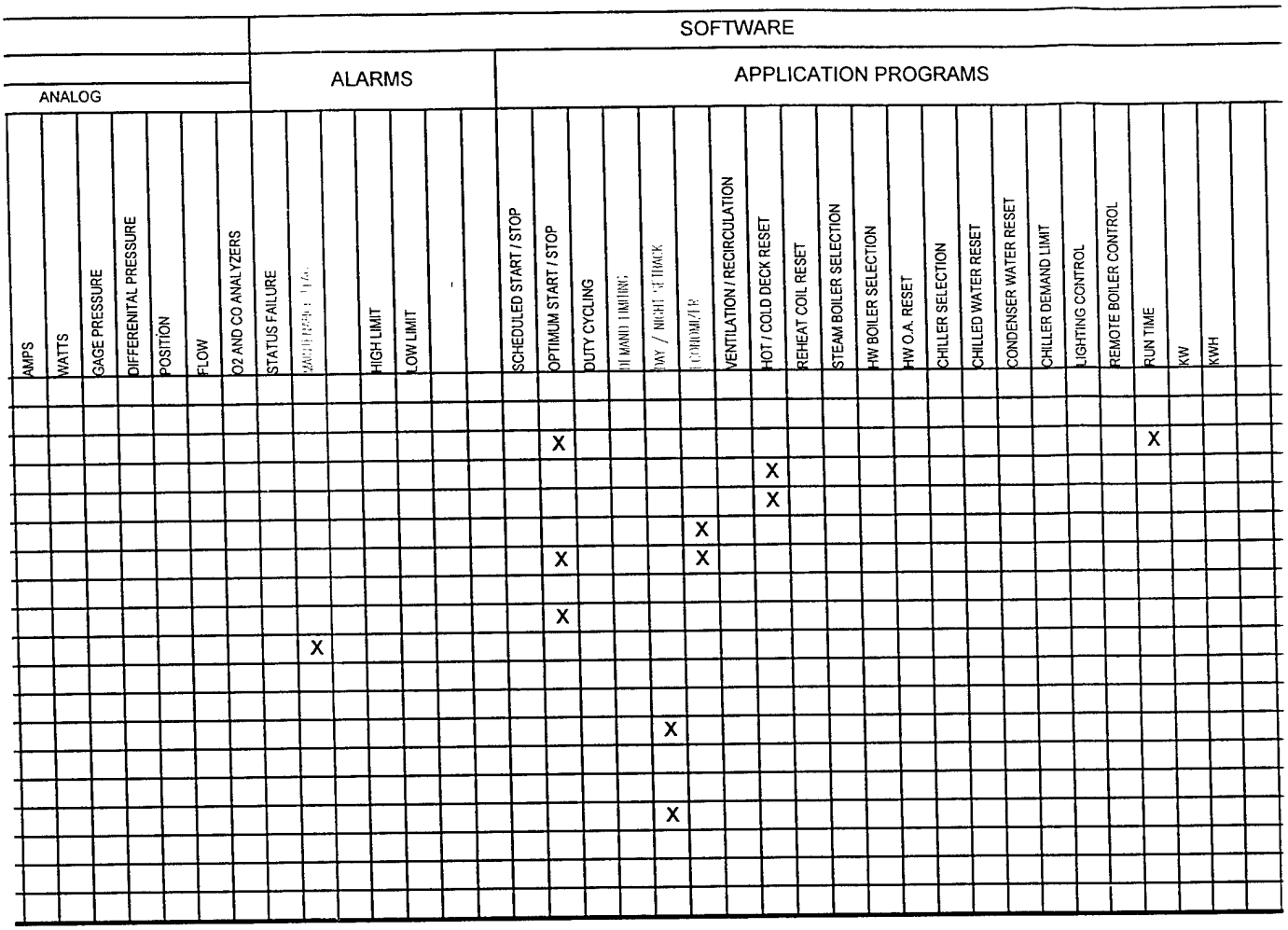
REMOTE BOILER CONTROL	RUN TIME	KW	KWH				REMARKS
							one chiller serving bldgs. 2263, 2264, 2265,
	X						& 2266
	X						
	X						with the age of this chiller, it is not advisable
	X						to add any controls to the CHW system
							serves bldgs. 2200, 2248, 2250, 2272, &
	X						2273
	X						
							serves bldgs. 2244, 2247, & 2270
	X						
							serves bldgs. 2263, 2264, 2265, & 2266
	X						
							serves bldgs. 2200, 2244, 2247, 2248, 2270,
							2272, & 2273
	X						with the age of the boilers, it is not advisable
							to add any controls to the HW system for
							the boilers serving the following bldgs.
							2244, 2247, 2248, 2270, 2272, 2273
	X						all valves, dampers, thermostats, and
							actuators are existing.

AREA: 2200	HARDWARE																								
	OUTPUT								INPUT																
	DIGITAL					ANALOG			DIGITAL									ANALOG						
ECO M: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	WATTS	GAGE PRESSURE	
OCCUPANCY TIME: VARIES																								
GRAPHIC DISPLAY ●																								
POINT DESCRIPTION																								
AHU (MZ) ●																								
SUPPLY FAN	30														30									
COLD DECK TEMP.						30												30						
HOT DECK TEMP.						30												30						
RETURN AIR							30											30						
OUTSIDE AIR							30																	
ZONE DAMPERS							120																	
ZONE TEMPERATURE																		120						
FILTER										30														
FAN COIL UNIT ●																								
ZONE TEMPERATURE																		43						
PACKAGED AHU ●																								
ZONE TEMPERATURE																		2						
OUTSIDE AIR ●																		1	1					

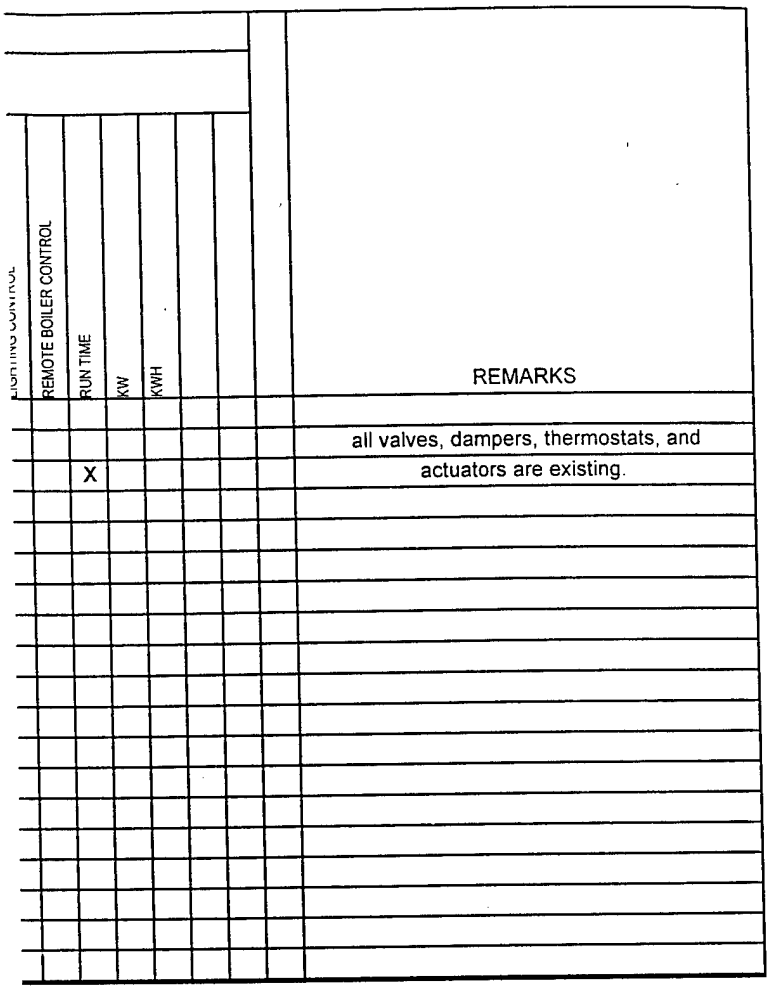
TOTAL AO POINTS =	81
TOTAL DO POINTS =	312
TOTAL AI POINTS =	125
TOTAL DI POINTS =	354
GRAND TOTAL POINTS =	872

NOTES:

1. It is not recommended to install any controls for steam boiler serving 2247 due to the age and deterioration of the equipment.


SOFTWARE
ANALOG
ALARMS
APPLICATION PROGRAMS
AMPS
WATTS
GAGE PRESSURE
DIFFERENTIAL PRESSURE
POSITION
FLOW
O2 AND CO ANALYZERS
STATUS FAILURE
HIGH LIMIT
LOW LIMIT
SCHEDULED START / STOP
OPTIMUM START / STOP
DUTY CYCLING
DAY / NIGHT SETBACK
VENTILATION / RECIRCULATION
HOT / COLD DECK RESET
REHEAT COIL RESET
STEAM BOILER SELECTION
HW BOILER SELECTION
HW O.A. RESET
CHILLER SELECTION
CHILLED WATER RESET
CONDENSER WATER RESET
CHILLER DEMAND LIMIT
LIGHTING CONTROL
REMOTE BOILER CONTROL
RUN TIME
KW
KWH

pment.


EXISTING CONTROL
REMOTE BOILER CONTROL
RUN TIME
KW
KWH
REMARKS
all valves, dampers, thermostats, and
actuators are existing.
X

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (2263-2266)					538.1	573.9	594.1	600.1	581.7	410.6			908,553	
Cooling Tower (2263-2266)					29.8	29.8	29.8	29.8	29.8	29.8			120,368	
CHW Pump (2263-2266)					74.6	74.6	74.6	74.6	74.6	74.6			329,433	
CW Pump (2263-2266)					37.3	37.3	37.3	37.3	37.3	37.3			164,717	
CHW controls (2263-2266)					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
A/C chiller (2200)	28.3	28.3	36.8	54.5	75.0	78.8	81.6	81.0	75.7	49.6	36.3	28.3	118,315	
CHW pump (2200)	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	10,705	
CHW controls (2200)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4,866	
CHW Condensing unit (2244)	13.9	13.4	17.0	19.7	24.2	26.9	29.2	29.0	25.8	20.0	165.7	13.6	88,789	
CHW Condenser fans (2244)	0.7	0.6	1.3	1.6	1.9	2.1	2.9	2.9	2.0	1.7	1.3	0.7	6,705	
CHW controls (2244)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	2,485	
CHW Condensing unit (2247)	19.8	19.3	25.5	30.2	34.2	34.7	35.5	35.8	35.0	29.1	25.5	20.3	72,917	
CHW Condenser fans (2247)	0.9	0.8	1.2	1.4	1.5	1.5	1.5	1.5	1.5	1.4	1.2	0.9	2,891	
CW pump (2247)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	8,079	
CHW controls (2247)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	539	
A/C chiller (2248)					60.6	67.0	72.2	71.5	62.5	47.4			122,882	
CHW pump (2248)					3.0	3.0	3.0	3.0	3.0	3.0			13,248	
CHW controls (2248)					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
CHW pump (2248)					1.5	1.5	1.5	1.5	1.5	1.5			6,624	
CHW Condensing unit (2270)					80.7	82.6	83.7	84.5	82.6	45.0			125,222	
CHW Condenser fans (2270)					2.2	2.2	2.2	2.2	2.2	1.1			3,063	
CW pump (2270)					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
CHW controls (2270)					0.1	0.1	0.1	0.1	0.1	0.1			442	
A/C chiller (2272,73)					35.6	38.9	42.0	41.9	37.9	31.0			73,197	
CHW pump (2272, 73)					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
CHW controls (2272, 73)					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 2263 fans	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	261,048	
Bldg. 2264 fans	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	552,324	
Bldg. 2265 fans	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	689,253	
Bldg. 2266 fans	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	689,253	
Bldg. 2200 fans	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	30,762	
Bldg. 2200 fans	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	131,292	
Bldg. 2244 fans	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	19,272	
Bldg. 2247 fans	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	109,051	
Bldg. 2248 fans	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	45,552	
Bldg. 2250 fans	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	45,552	
Bldg. 2270 fans	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	130,524	
Bldg. 2272 fans	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	103,821	
Bldg. 2273 fans	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	5,256	
HW boiler (2263) blr-1														1,568
HW pump (2263) blr-1	11.2	11.2	11.2	11.2							11.2	11.2	48653.0	
HW controls (2263) blr-1	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW pump (2263) blr-1	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
HW boiler (2263) blr-2														28
HW pump (2263) blr-2	11.2	11.2										11.2	1,154	
HW controls (2263) blr-2	0.1	0.1										0.1	13	

ITEM	EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
HW pump (2263) blr-2	0.6	0.6										0.6	70	
HW boiler (2263) blr-3														
HW pump (2263) blr-3														
HW controls (2263) blr-3														
HW pump (2263) blr-3	0.6	0.6										0.6	12	
HW boiler (2200)														727
HW pump (2200)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	6,516	
HW controls (2200)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	543	
HW boiler (2244)														
HW pump (2244)														
HW controls (2244)														
HW pump (2244)														
Steam boiler (2247)														158
Steam boiler controls (2247)	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW boiler (2248,50)														144
HW pump (2248,50)	0.2	0.2	0.2	0.2							0.2	0.2	501	
HW controls (2248,50)	0.1	0.1	0.1	0.1							0.1	0.1	313	
HW pump (2248,50)	0.3	0.3	0.3	0.3							0.3	0.3	1,303	
HW boiler (2270) blr-1														1,396
HW pump (2270) blr-1	2.2	2.2	2.2	2.2							2.2	2.2	9,557	
HW controls (2270) blr-1	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW boiler (2270) blr-2														3
HW pump (2270) blr-2		2.2										2.2	191	
HW controls (2270) blr-2		0.1										0.1	11	
HW boiler (2272,73)														112
HW pump (2272,73)	3.7	3.7	3.7	3.7							3.7	3.7	9,380	
HW controls (2272,73)	0.1	0.1	0.1	0.1							0.1	0.1	317	
Totals	422.7	423.8	428.4	454.0	1338.6	1393.2	1429.5	1435.0	1391.5	1121.5	576.6	425.2	5,125,522	4,134
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	3,170	3,179	3,213	3,405	10,040	13,932	14,295	14,350	13,915	8,411	4,325	3,189		

Total Demand 95,423 $/yr

Total Energy 17,493 MMBTU/yr (electric)

Total Energy 4,134 MMBTU/yr (gas)

ITEM	ECO M - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (2263-2266)					572.0	579.7	594.1	600.1	586.1	418.5			1,089,786	
Cooling Tower (2263-2266)					29.8	29.8	29.8	29.8	29.8	29.8			120,817	
CHW Pump (2263-2266)					74.6	74.6	74.6	74.6	74.6	74.6			329,433	
CND Pump (2263-2266)					37.3	37.3	37.3	37.3	37.3	37.3			164,717	
CHW controls (2263-2266)					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
A/C chiller (2200)	26.2	26.2	34.7	55.3	75.4	78.8	81.6	81.0	75.7	51.6	37.6	26.2	78,396	
CHW pump (2200)	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	10,597	
CHW controls (2200)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4,817	
CHW Condensing unit (2244)	13.9	13.4	17.0	19.7	24.2	26.9	29.2	29.0	25.8	20.0	16.7	13.6	88,789	
CHW Condenser fans (2244)	0.7	0.6	1.3	1.6	1.9	2.1	2.9	2.9	2.0	1.7	1.3	0.7	6,705	
CHW controls (2244)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	2,485	
CHW Condensing unit (2247)	19.8	22.4	27.5	31.9	34.2	34.7	35.5	35.8	35.0	31.5	29.5	24.0	61,080	
CHW Condenser fans (2247)	0.9	0.8	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.9	2,622	
CND pump (2247)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	8,037	
CHW controls (2247)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	536	
A/C chiller (2248)					66.5	69.5	72.1	71.5	66.8	58.1			84,785	
CHW pump (2248)					3.0	3.0	3.0	3.0	3.0	3.0			13,248	
CHW controls (2248)					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
CHW pump (2248)					1.5	1.5	1.5	1.5	1.5	1.5			6,624	
CHW Condensing unit (2270)					80.7	82.6	83.7	84.5	82.6	42.4			61,043	
CHW Condenser fans (2270)					2.2	2.2	2.2	2.2	2.2	1.0			1,667	
CND pump (2270)					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
CHW controls (2270)					0.1	0.1	0.1	0.1	0.1	0.1			442	
A/C chiller (2272,73)					34.7	37.8	41.0	40.9	37.0	33.2			48,189	
CHW pump (2272, 73)					3.7	3.7	3.7	3.7	3.7	3.7			16,339	
CHW controls (2272, 73)					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Bldg. 2263 fans	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	96,075	
Bldg. 2264 fans	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	344,421	
Bldg. 2265 fans	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	347,659	
Bldg. 2266 fans	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	347,659	
Bldg. 2200 fans	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	11,322	
Bldg. 2200 fans	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	43,284	
Bldg. 2244 fans	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	19,272	
Bldg. 2247 fans	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	35,799	
Bldg. 2248 fans	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	15,688	
Bldg. 2250 fans	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	15,688	
Bldg. 2270 fans	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	35,815	
Bldg. 2272 fans	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	34,449	
Bldg. 2273 fans	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1,728	
HW boiler (2263) blr-1	30.0	30.0	21.8	1.8							21.0	30.0		3,051
HW pump (2263) blr-1	11.2	11.2	11.2	11.2							11.2	11.2	48,653	
HW controls (2263) blr-1	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW pump (2263) blr-1	0.6	0.6	0.6	0.6							0.6	0.6	2,433	
HW boiler (2263) blr-2	24.2	25.0										23.6		48
HW pump (2263) blr-2	11.2	11.2										11.2	224	
HW controls (2263) blr-2	0.1	0.1										0.1	3	

ITEM	ECO M - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
HW pump (2263) blr-2	0.6	0.6										0.6	13	
HW boiler (2263) blr-3														
HW pump (2263) blr-3														
HW controls (2263) blr-3														
HW pump (2263) blr-3		0.6											2	
HW boiler (2200)	5.6	6.2	2.5	0.2							2.2	6.2		226
HW pump (2200)	1.5	1.5	1.5	1.5							1.5	1.5	6,516	
HW controls (2200)	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW boiler (2244)														
HW pump (2244)														
HW controls (2244)														
HW pump (2244)														
Steam boiler (2247)	2.0	2.0	0.2	0.2							0.7	2.0		94
Steam boiler controls (2247)	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW boiler (2248,50)	4.2	4.2	0.2	0.2							1.4	4.2		99
HW pump (2248,50)	0.2	0.2	0.2	0.2							0.2	0.2	448	
HW controls (2248,50)	0.1	0.1	0.1	0.1							0.1	0.1	280	
HW pump (2248,50)	0.3	0.3	0.3	0.3							0.3	0.3	1,303	
HW boiler (2270) blr-1	7.5	7.5	5.1	0.4							5.6	7.5		427
HW pump (2270) blr-1	2.2	2.2	2.2	2.2							2.2	2.2	9,557	
HW controls (2270) blr-1	0.1	0.1	0.1	0.1							0.1	0.1	543	
HW boiler (2270) blr-2	1.6	2.5										2.4		4
HW pump (2270) blr-2	2.2	2.2										2.2	51	
HW controls (2270) blr-2	0.1	0.1										0.1	3	
HW boiler (2272,73)	2.6	2.6	1.7	0.2							2.2	2.6		62
HW pump (2272,73)	3.7	3.7	3.7	3.7							3.7	3.7	8,281	
HW controls (2272,73)	0.1	0.1	0.1	0.1							0.1	0.1	280	
Totals	500.0	504.8	459.9	459.6	1376.3	1398.8	1426.8	1432.4	1397.7	1142.5	466.3	504.7	3,659,819	4,010
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	3,750	3,786	3,449	3,447	10,322	13,988	14,268	14,324	13,977	8,569	3,497	3,785		

Total Demand	97,163	$/yr	
Demand Savings	-1,740	$/yr	
Energy Savings	5,002	MMBTU/yr	(electric)
Energy Savings	124	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	**PROJECT NO:** 03-0185.06M	**DATE:** 9/19/96
ECO NO. M AREA 2200	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	HRS/ UNIT	Rate	Total	Unit Price	Total	
EMCS COSTS BASED ON DDC ALL ELECTRIC								
DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE								
DIGITAL OUTPUT DEVICE :								
START-STOP MOTOR	67	EA	10.2	28.91	19,757	175.74	11,775	31,532
ENABLE/DISABLE APPARATUS RELAY	14	EA	4.5	28.91	1,821	49.00	686	2,507
ANALOG OUTPUT:								
CONTROL VALVE (COIL/AHU ACTUATOR ONLY)	96	EA	11.9	28.91	33,082	571.00	54,816	87,898
DAMPER ACTUATOR & MOTOR	216	EA	11.9	28.91	74,435	340.00	73,440	147,875
DIGITAL INPUT:								
DIFFERENTIAL PREASURE SWITCH	48	EA	10.1	28.91	14,016	227.30	10,910	24,926
AUXILIARY CONTACT	10	EA	4.5	28.91	1,301	49.00	490	1,791
CURRENT SENSING RELAY	67	EA	4.5	28.91	8,716	49.00	3,283	11,999
SHEET 1								
				SUBTOTAL	153,129		155,400	308,529
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX

ECO NO. M **AREA** 2200

PROJECT NO: 03-0185.06M

BY : KOTHMANN, K

DATE: 9/19/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units		Hrs / Unit	Rate	Total	Unit Price	Total	
ANALOG INPUT:								
TEMP. SENSER & THERMO WELL	52	EA	17.0	28.91	25,556	426.42	22,174	47,730
TEMP. SENSER AIR DUCT	108	EA	12.0	28.91	37,467	450.00	48,600	86,067
TEMP. SENSER OUTSIDE AIR	1	EA	12.0	28.91	347	550.00	550	897
TEMP. SENSER ZONE	183	EA	12.0	28.91	63,486	556.00	101,748	165,234
RELATIVE HUMIDITY %	1	EA	13.0	28.91	376	615.00	615	991
AMPERES	4	EA	7.0	28.91	809	219.00	876	1,685
GAUGE PRESURE BOILER				28.91				
FLOW STATUS / RATE	4	EA	17.0	28.91	1,966	410.00	1,640	3,606
EQUIPMENT FAILURE ALARM	19	EA	2.6	28.91	1,428	108.00	2,052	3,480
FILTER ALARM	1	EA	4.5	28.91	130	227.00	227	357
HIGH & LOW LIMIT (HYDRONIC)	34	PR	2.0	28.91	1,966	170.00	5,780	7,746
SHEET 2								
SUBTOTAL					133,532		184,262	317,794
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX	PROJECT NO: 03-0185.06M	DATE: 9/19/96
ECO NO. M AREA 2200	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
OPERATORS' WORKSTATION	1	SUM				13,184.00	13,184	13,184
INCLUDING MODEM & REMOTE PANEL								
SUBMITTALS, TRAINING & START-UP	1	JOB				8,300.00	8,300	8,300
SOFTWARE	1	LS				15,000.00	15,000	15,000
SUB TOTAL FROM SHEET 1					153,129		155,400	308,529
SUB TOTAL FROM SHEET 2					133,532		184,262	317,794
SUBTOTAL					286,661		376,146	662,807
O & P @ 20%					57,332		75,229	132,561
SUBTOTAL					343,993		451,375	795,368
DESIGN @ 6%								47,722
SUBTOTAL								843,090
SIOH @ 5.5%								46,370
TOTAL								$889,460

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Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-M
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment	
A. Construction Cost	$795,368
B. SIOH	$46,370
C. Design Cost	$47,722
D. Total Cost (1A+1B+1C)	$889,460
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$889,460

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	5,002	Mbtus	$31,413	15.08	$473,701
Elec. Deman					-$1,740	14.88	-$25,891
Natural Gas	$3.5	/Mbtus	124	Mbtus	$429	18.58	$7,972
TOTAL			5,126	Mbtus	$30,102		$455,782

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL TOTAL	$0			$0
ONE TIME TOTAL	$0			$0
TOTAL	$0			$0

4. First Year Dollar Savings	$30,102
5. Simple Payback Period (Years)	29.55
6. Total Net Discounted Savings	$455,782
7. Savings to Investment Ratio	.51
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	-.39%

ENERGY CONSERVATION OPPORTUNITY (ECO)

ECO NO:	N
DATE:	3/1/95
ECO TITLE:	Replace Existing Central Chillers With New Electric Centrifugal Chillers
INSTALLATION:	Fort Sam Houston, San Antonio, Texas
LOCATION:	Area 2200, Building 2265 (serves buildings 2200, 2244, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272, and 2273)

A. Summary:

Electrical Energy Savings	3050	MMBTU/yr
Electrical Demand Savings	25,570	$/yr
Gas Energy Savings	0	MMBTU/yr
Total Energy Savings	3050	MMBTU/yr
Total Cost Savings	55,110	$/yr
Total Investment	1,040,094	$
Simple Payback	18.9	yrs
SIR	0.80	

B. ECO Description:

Remove the existing 675 ton, R-11 centrifugal chiller in building 2265 and associated CHW pump, CW pump, and cooling tower. Remove the air cooled chillers serving Buildings 2200, 2248/2250, and 2272/2273. Remove the water cooled reciprocating chiller, condenser, and two window units from Building 2247 and replace air handling equipment with two 1.5 ton CHW fan/coil units. Building 2270's condenser pump and existing cooling tower will be removed and the AHU DX coil unit will be retrofitted with a CHW coil, and a new secondary CHW pump. Also, the DX coil serving Building 2244 will need to be retrofitted to CHW, and the condenser removed. The existing central plant of Building 2200 will be expanded. The north wall will be removed and additional 750 sq ft. space will be added. Install two new water cooled centrifugal R-123 refrigerant chillers including one 270 ton, and one 545 ton chiller. Also provide one 20 HP (fan), and one 25 HP (fan) cooling tower. The chillers will be on a common 10" supply header, and switch-over control will be utilized to maintain maximum efficiency. Provide two 40 HP CHW pumps, one 20 HP CW pump, and one 40 HP CW pump. A new CHW distribution loop will need to be constructed which includes installing two separate loops. One 10" branch take-off from the CHW supply and return headers will be routed underground (direct buried) to the existing loop mains serving buildings 2263, 2264, 2265, and 2266 which are outside of the mechanical room in building 2265. A second 3" take-off will be extended underground from the plant to remainder of the buildings . Approximately 100 ft. of 10", 700 ft. of 3", and 400 ft of 2.5" under ground piping will be required for these loop. The 4" main piping will split into two 3" branches. All existing building CHW pumps will be reutilized as secondary pumps All new CHW coils will be retrofitted with new two way control valves. A 2.5" by-pass valve will be installed in the plant to maintain a set minimum deferential pressure between CHW supply and return lines and to insure the safe operation of the chiller. All existing controls and electrical services should be reconnected where possible. Specific requirements in these areas should be determined by the design engineer responsible for this project. To meet the current ASHRAE Standard 15, a refrigerant detection and ventilation system should be installed. This project will require engineering drawings and specifications, demolition and removal of the existing chiller and installation of the new chiller, associated wiring and controls.

C. Discussion:

All cooling equipment is located at different locations, remote to each other. Buildings 2247 and 2270 cooling systems are very old and poor condition; and thus, require frequent maintenance. They all are reciprocating chillers. Chillers at the other buildings beside Building2265, 2247 and 2270 appear to be in fair condition. The existing water cooled, centrifugal chiller located in Building 2265 was installed in 1973 and appears to be in poor condition. All of the existingwater cooled equipment except Building 2247 (R-12) utilizes R-11 as it's refrigerant, which willno longer be manufactured as of January 1, 1996[1]. To avoid the anticipated increasing operational costs over the life of this machine, they should either be retrofitted to use an approved refrigerant or replaced with a new machine that operates on one. The existing centrifugal machines can be retrofitted to an approved refrigerant by modifying the impeller, gears, etc... However, the technology is not currently available to retrofit these units without a 3%-5% loss in efficiency and 5%-7% loss in tonnage. Moreover,the cost of maintaining these smaller older building systems is excessive. Therefore, since the older machines are already over twenty years old and retrofitting them would create a greater loss in efficiency, it is recommended that the facility replace them instead. A life cycle cost analysis performed on four different types of replacement chillers available determined that an electric centrifugal chiller using R-134a would be the most economical choice over the life of the new machine. Computer simulations of the buildings served by this machine determined that the current installed capacity of 904 tons is more than what is required to adequately cool the buildings[2]. Therefore, the new chillers should be sized for a total load of 815 tons to more closely match the cooling load of the buildings.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumptions of the existing and proposed alternative chillers and auxiliary equipment were calculated using the Trace 600 computer program[3]. The buildings served by the existing chiller were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[4].

The multiple chiller alternatives which were compared included an electric centrifugal machine, an electric centrifugal with a variable frequency drive, a screw machine and a gas driven centrifugal machine. All proposed machines used R-123 or R-134a. Full load performance data from York International, and default part load curves were used in the computer simulations of the new chiller energy usages. Equipment lists of the specific chillers and auxiliaries for each alternative modeled by the computer are shown on pages C-246 To C-249.

Once the computer simulations were completed, the total annual demand cost and energy consumption of each alternative were compared with that of the existing systems to determine the annual savings for each[5]. These savings calculations are shown on pages C-250 through C-252. The demand and energy savings values were used in the life cycle cost analysis for each alternative. The results of these savings calculations were as follows:

Alternative	Chiller Type	Demand Savings $/yr	Electrical Savings MMBTU/yr	Gas Savings MMBTU/yr
N1	Electric Centrifugal	25,570	3050	0
N2	Electric Centrifugal & VFD	25,345	3370	0
N3	Electric Screw	22,010	2842	0
N4	Gas Driven Centrifugal	49,038	4826	-8229

2. *Maintenance Cost Savings*:

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water cooled chillers in this area to three water cooled chillers. The total maintenance cost savings for this ECO as shown on page C-273 is estimated to be $8005 per year. This figure was used in the life cycle cost analysis.

E. Cost Estimates

The total installation costs for each alternative chiller mentioned in this ECO were estimated on pages C-253 through C-272. These costs were used in the life cycle cost analysis for each alternative. The results of the costs estimates were as follows:

Alternative	Chiller Type	Estimated Cost
N1	Electric Centrifugal	$1,040,094
N2	Electric Centrifugal & VFD	$1,080,752
N3	Electric Screw	$1,089,311
N4	Gas Driven Centrifugal	$1,659,208

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on each chiller alternative for this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. By installing the new centrifugal chillers, the installation will save the cost of retrofitting the three R-11 machines for the HCFC-123 refrigerant as mentioned previously. The cost of this retrofit was estimated to be $45,000 and shown as a non-recurring cost associated with this ECO. Moreover, there is a second non-recurring cost associated with the reclaim value of the refrigerant R-11. This cost was estimated at $2.00 per pound of R-11 and 2 pounds per ton resulting in a total cost of $2,628. A summary sheet for each life cycle cost analysis is shown on pages C-274 through C-277. The results of the alternative life cycle cost analysis were as follows:

Alternative	Chiller Type	Payback Years	SIR
N1	Electric Centrifugal	18.9	0.80
N2	Electric Centrifugal & VFD	19.0	0.80
N3	Electric Screw	21.6	0.70
N4	Gas Driven Centrifugal	27.1	0.50

Since the electric centrifugal chiller has the highest SIR and lowest payback period, it is recommended as the most economical choice to replace the existing machine. The data from the life cycle cost analysis for this alternative were included in the summary on page C-242.

REFERENCES

1. Per current EPA regulations on CFC refrigerants.
2. See Appendix H for Area 2200 cooling system load profile.
3. See Appendix H for computer model input assumptions and data, and energy consumption output data.
4. See Appendix G for building field data and existing HVAC system data.
5. See Appendix A for utility cost analysis data, used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-N1, FORT SAM HOUSTON, AREA 2200 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York YT water cooled, centrifugal, 270 tons, R-123a	Area 2200	New	154 KW
Chilled Water Pump	1	Bell and Gossett 540 gpm, 110 ft 40 HP	Area 2200	New	29.80 KW
Condenser Water Pump	1	Bell and Gossett 810 gpm, 70 ft 20 HP	Area 2200	New	14.90 KW
Cooling Tower	1	Evapco AT crossflow, 1 cell 20HP fans	Area 2200	New	14.90 KW
Water Chiller	1	York YT water cooled, centrifugal, 545 tons, R-123a	Area 2200	New	300 KW
Chilled Water Pump	1	Bell and Gossett 1090 gpm, 110 ft 40 HP	Area 2200	New	29.80 KW
Condenser Water Pump	1	Bell and Gossett 1635 gpm, 70 ft 40 HP	Area 2200	New	29.80 KW
Cooling Tower	1	Evapco AT crossflow, 1 cell 25 HP fans	Area 2200	New	18.60 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-N2, FORT SAM HOUSTON, AREA 2200 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York YT, electric, VFD water cooled, centrifugal 270 tons, R-123	Area 2200	New	154 KW
Chilled Water Pump	1	Bell and Gossett 540 gpm, 110 ft 40 HP	Area 2200	New	29.80 KW
Condenser Water Pump	1	Bell and Gossett 810 gpm, 70 ft 20 HP	Area 2200	New	14.90 KW
Cooling Tower	1	Evapco AT crossflow, 1 cell 20HP fans	Area 2200	New	14.90 KW
Water Chiller	1	York YT, electric, VFD water cooled, centrifugal, 545 tons, R-123	Area 2200	New	300 KW
Chilled Water Pump	1	Bell and Gossett 1090 gpm, 110 ft 40 HP	Area 2200	New	29.80 KW
Condenser Water Pump	1	Bell and Gossett 1635 gpm, 70 ft 40 HP	Area 2200	New	29.80 KW
Cooling Tower	1	Evapco AT crossflow, 1 cell 25 HP fans	Area 2200	New	18.60 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-N3, FORT SAM HOUSTON, AREA 2200 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York YS water cooled screw 270 tons	Area 2200	New	167 KW
Chilled Water Pump	1	Bell and Gossett 540 gpm, 110 ft 40 HP	Area 2200	New	29.80 KW
Condenser Water Pump	1	Bell and Gossett 810 gpm, 70 ft 20 HP	Area 2200	New	14.90 KW
Cooling Tower	1	Evapco AT crossflow, 1 cell 20HP fans	Area 2200	New	14.90 KW
Water Chiller	1	York YS water cooled screw 545 tons	Area 2200	New	349 KW
Chilled Water Pump	1	Bell and Gossett 1090 gpm, 110 ft 40 HP	Area 2200	New	29.80 KW
Condenser Water Pump	1	Bell and Gossett 1635 gpm, 70 ft 40 HP	Area 2200	New	29.80 KW
Cooling Tower	1	Evapco AT crossflow, 1 cell 25 HP fans	Area 2200	New	18.60 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-N4, FORT SAM HOUSTON, AREA 2200 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	York, gas engine driven YG water cooled, centrifugal 815 tons, R-134a	Area 2200	New	5,379 MBH
Chilled Water Pump	1	Bell and Gossett 1630 gpm, 110 ft 60 HP	Area 2200	New	44.70 KW
Condenser Water Pump	1	Bell and Gossett 2690 gpm, 70 ft 60 HP	Area 2200	New	44.70 KW
Cooling Tower 2-speed fan	1	Evapco AT crossflow, 1 cell 50 HP fan	Area 2200	New	37.20 KW

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-O, FORT SAM HOUSTON, AREA 2200 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Hot Water Boiler	3	Aerco #KC-2000 GWB natural draft, watertube 1830 MBH output	Area 2200	New	2,000 MBH
Heating Water Pump	3	Bell and Gossett 172 gpm, 150 ft 15 HP	Area 2200	New	11.20 KW

ITEM	ECO N - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller (2263-2266)					538.1	573.9	594.1	600.1	581.7	410.6			908,553	
Cooling Tower (2263-2266)					29.8	29.8	29.8	29.8	29.8	29.8			120,368	
CHW Pump (2263-2266)					74.6	74.6	74.6	74.6	74.6	74.6			329,433	
CW Pump (2263-2266)					37.3	37.3	37.3	37.3	37.3	37.3			164,717	
CHW controls (2263-2266)					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
A/C chiller (2200)	28.3	28.3	36.8	54.5	75.0	78.8	81.6	81.0	75.7	49.6	36.3	28.3	118,315	
CHW controls (2200)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4,866	
CHW Condensing unit (2244)	13.9	13.4	17.0	19.7	24.2	26.9	29.2	29.0	25.8	20.0	165.7	13.6	88,789	
CHW Condenser fans (2244)	0.7	0.6	1.3	1.6	1.9	2.1	2.9	2.9	2.0	1.7	1.3	0.7	6,705	
CHW controls (2244)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	2,485	
CHW Condensing unit (2247)	19.8	19.3	25.5	30.2	34.2	34.7	35.5	35.8	35.0	29.1	25.5	20.3	72,917	
CHW Condenser fans (2247)	0.9	0.8	1.2	1.4	1.5	1.5	1.5	1.5	1.5	1.4	1.2	0.9	2,891	
CHW controls (2247)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	539	
A/C chiller (2248)					60.6	67.0	72.2	71.5	62.5	47.4			122,882	
CHW controls (2248)					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
CHW Condensing unit (2270)					80.7	82.6	83.7	84.5	82.6	45.0			125,222	
CHW Condenser fans (2270)					2.2	2.2	2.2	2.2	2.2	1.1			3,063	
CHW controls (2270)					0.1	0.1	0.1	0.1	0.1	0.1			442	
A/C chiller (2272,73)					35.6	38.9	42.0	41.9	37.9	31.0			73,197	
CHW controls (2272, 73)					1.0	1.0	1.0	1.0	1.0	1.0			4,416	
Totals	65.0	63.8	83.2	108.8	1000.2	1054.8	1091.1	1096.6	1053.1	783.1	231.4	65.2	2,158,632	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	488	479	624	816	7,502	10,548	10,911	10,966	10,531	5,873	1,736	489		

Total Demand	60,961	$/yr	
Total Energy	7,367	MMBTU/yr	(electric)
Total Energy		MMBTU/yr	(gas)

ITEM	ECO-N1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller	25.9	24.6	31.3	41.7	145.9	148.3	152.7	154.6	150.3	130.0	31.1	25.8	187,162	
Cooling Tower Fans			14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9		46,986	
CHW Pump	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	196,173	
CW Pump	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	98,087	
CHW controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	6,583	
Water Chiller				284.6	288.9	297.6	301.2	292.8	261.2				540,670	
Cooling Tower Fans				18.6	18.6	18.6	18.6	18.6	18.6				44,491	
CHW Pump				29.8	29.8	29.8	29.8	29.8	29.8				71,282	
CW Pump				29.8	29.8	29.8	29.8	29.8	29.8				71,282	
CHW controls				1.0	1.0	1.0	1.0	1.0	1.0				2,392	
Total (KW)	71.6	70.3	91.9	466.1	574.6	585.7	593.7	587.2	551.3	190.6	91.7	71.5	1,265,108	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	537	527	689	3,496	4,310	5,857	5,937	5,872	5,513	1,430	688	536		

Total Demand	35,391	$/yr	
Demand Savings	25,570	$/yr	
Energy Savings	3,050	MMBTU/yr	(electric)
Energy Savings		MMBTU/yr	(gas)

ITEM	ECO-N2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller	21.8	20.3	28.6	36.7	154.0	154.0	154.0	154.9	154.0	153.7	28.3	21.8	154,748	
Cooling Tower Fans					10.9	11.8	13.5	14.9	12.6	11.5			5,000	
CHW Pump	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	196,173	
CW Pump	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	98,087	
CHW controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	6,563	
Water Chiller				300.0	300.0	300.0	301.7	300.0	300.0				540,171	
Cooling Tower Fans				13.6	14.7	16.9	18.6	15.7	11.8				25,637	
CHW Pump				29.8	29.8	29.8	29.8	29.8	29.8				71,282	
CW Pump				29.8	29.8	29.8	29.8	29.8	29.8				71,282	
CHW controls				1.0	1.0	1.0	1.0	1.0	1.0				2,392	
Total (KW)	67.5	66.0	74.3	456.6	585.9	589.0	594.1	591.8	584.7	210.9	74.0	67.5	1,171,335	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	506	495	557	3,425	4,394	5,890	5,941	5,918	5,847	1,582	555	506		

Total Demand	35,616	$/yr	
Demand Savings	25,345	$/yr	
Energy Savings	3,370	MMBTU/yr	(electric)
Energy Savings		MMBTU/yr	(gas)

ITEM	ECO-N3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller	31.8	30.8	35.8	41.7	159.0	161.4	165.7	167.0	163.3	143.3	35.9	31.8	177,906	
Cooling Tower Fans			14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9		46,920	
CHW Pump	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	196,173	
CW Pump	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	98,087	
CHW controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	6,583	
Water Chiller				332.6	337.2	346.2	349.0	341.2	308.3				610,843	
Cooling Tower Fans				18.6	18.6	18.6	18.6	18.6	18.6				44,491	
CHW Pump				29.8	29.8	29.8	29.8	29.8	29.8				71,282	
CND Pump				29.8	29.8	29.8	29.8	29.8	29.8				71,282	
CHW controls				1.0	1.0	1.0	1.0	1.0	1.0				2,392	
Total (KW)	77.5	76.5	96.4	514.1	636.0	647.4	654.5	648.0	611.4	203.9	96.5	77.5	1,325,959	
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	581	574	723	3,856	4,770	6,474	6,545	6,480	6,114	1,529	724	581		

Total Demand	38,951	$/yr	
Demand Savings	22,010	$/yr	
Energy Savings	2,842	MMBTU/yr	(electric)
Energy Savings		MMBTU/yr	(gas)

ITEM	ECO-N4: NEW GAS ENGINE CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW)												ANNUAL ENERGY USAGE (KWH)	ANNUAL ENERGY USAGE (MCF)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Water Chiller														8,229
Cooling Tower			37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2		167,687	
CHW Pump	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	285,276	
CW Pump	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	285,276	
CHW controls	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	6,382	
Total (KW)	90.4	90.4	127.6	127.6	127.6	127.6	127.6	127.6	127.6	127.6	127.6	90.4	744,621	8,229
Rate ($/KW)	7.50	7.50	7.50	7.50	7.50	10.00	10.00	10.00	10.00	7.50	7.50	7.50		
Cost ($)	678	678	957	957	957	1,276	1,276	1,276	1,276	957	957	678		

Total Demand	11,923	$/yr	
Demand Savings	49,038	$/yr	
Energy Savings	4,826	MMBTU/yr	(electric)
Energy Savings	-8,229	MMBTU/yr	(gas)

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-0185.6N1

DATE: 9/19/96

ECO NO. N-1 Retrofit Existing Individual Chillers

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL AREA 2200

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	670	TON	1.5	28.91	29,829	25.00	16,750	46,579
RMV CHILLER UP TO 50 TON	100	TON	1.6	28.91	4,655	25.00	2,500	7,155
REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED	2	EA	1.5	22.00	66	50.00	100	166
RMV DIRECT EXPANSION CONDENSER & AHU	2	EA	5.0	28.91	289	50.00	100	389
RMV COOLING TOWER	675	TON	0.3	20.00	4,050	3.00	2,025	6,075
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
10"	100	LF	1.8	28.91	5,204	56.50	5,650	10,854
4"	10	LF	0.8	28.91	217	19.55	196	412
3"	700	LF	0.6	28.91	12,142	15.70	10,990	23,132
2-1/2"	400	LF	0.5	28.91	5,551	13.33	5,332	10,883
SUBTOTAL					62,002		43,643	105,645
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6N1 | **DATE:** 9/19/96

ECO NO. N-1 Retrofit Existing Individual Chillers | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL AREA 2200

ITEM DESCRIPTION SHEET 2	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
SECTIONALIZING VALVE AND BOX	4	EA	2.1	28.91	241	590.00	2,360	2,601
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	200.0	20.00	4,000	3,000.00	3,000	7,000
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	3	LOC	10.7	28.91	924	717.00	2,151	3,075
ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE,								
PIPING ASSEMBLY & ELECTRICAL CONNECTION								
AHU W/ CHW COIL 2-PIPE	2	EA	54.0	28.91	3,122	6,400.00	12,800	15,922
				SUBTOTAL	8,737		21,346	30,083
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6N1	**DATE:** 9/19/96
ECO NO. N-1 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL AREA 2200

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
EXPAND CENTRAL PLANT BASE BUILDING	750	BSF				75.00	56,250	56,250
HISTORICALLY COMPATIBLE								
COOLING TOWER ENCLOSURE	1	SUM	1.0	9,000.00	9,000	12,000.00	12,000	21,000
CENTRAL PLANT ELECTRICAL SYSTEM	750	BSF				34.00	25,500	25,500
CHILLER (YORK YT) WITH PIPING & VESELS	815	TON	3.2	28.91	75,397	371.00	302,365	377,762
PRIMARY PUMPS 40 HP	1	EA	60.0	28.91	1,735	7,500.00	7,500	9,235
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	815	TON	0.6	28.91	14,137	92.00	74,980	89,117
10" PIPING MANIFOLD AND VALVES	1	JOB	170.0	28.91	4,915	5,700.00	5,700	10,615
SUBTOTAL					105,184		484,295	589,479
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6N1	DATE: 9/19/96
ECO NO. N-1 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL AREA 2200

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND NEW CHW PUMPS COST PER LOCATION								
3"	1	LOC	21.2	28.91	613	2,417.00	2,417	3,030
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	100	EA	0.5	28.91	1,446	7.05	705	2,151
1-1/2"	50	EA	0.4	28.91	578	5.05	253	831
1"	50	EA	0.3	28.91	434	4.38	219	653
3/4"	100	EA	0.3	28.91		2.75		
SUBTOTAL					3,070		3,594	6,664
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

HUITT-ZOLLARS, INC.
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512 MAIN STREET, SUITE 1500
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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6N1 | **DATE:** 9/19/96

ECO NO. N-1 Retrofit Existing Individual Chillers | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL AREA 2200

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, CONTROL VALVE AND ELECTRIC CIRCUIT	2	EA	4.8	28.91	275	1,375.00	2,750	3,025
CHANGE 3-WAY CONTROL VALVES TO 2-WAY	71	EA	4.0	28.91	8,210	450.00	31,950	40,160
SUB TOTAL FROM SHEET 1					62,002		43,643	105,645
SUB TOTAL FROM SHEET 2					8,737		21,346	30,083
SUB TOTAL FROM SHEET 3					105,184		484,295	589,479
SUB TOTAL FROM SHEET 4					3,070		3,594	6,664
SUBTOTAL					187,479		587,577	775,056
O & P @ 20%					37,496		117,515	155,011
SUBTOTAL					224,975		705,092	930,067
DESIGN @ 6%								55,804
SUBTOTAL								985,871
SIOH @ 5.5%								54,223
TOTAL								$1,040,094

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6N2	**DATE:** 9/19/96
ECO NO. N-2 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD AREA 2200

ITEM DESCRIPTION SHEET 1	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	670	TON	1.5	28.91	29,829	25.00	16,750	46,579
RMV CHILLER UP TO 50 TON	100	TON	1.6	28.91	4,655	25.00	2,500	7,155
REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED	2	EA	1.5	22.00	66	50.00	100	166
RMV DIRECT EXPANSION CONDENSER & AHU	2	EA	5.0	28.91	289	50.00	100	389
RMV COOLING TOWER	675	TON	0.3	20.00	4,050	3.00	2,025	6,075
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
10"	100	LF	1.8	28.91	5,204	56.50	5,650	10,854
4"	10	LF	0.8	28.91	217	19.55	196	412
3"	700	LF	0.6	28.91	12,142	15.70	10,990	23,132
2-1/2"	400	LF	0.5	28.91	5,551	13.33	5,332	10,883
				SUBTOTAL	62,002		43,643	105,645
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6N2	**DATE:** 9/19/96
ECO NO. N-2 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
AREA 2200

ITEM DESCRIPTION SHEET 2	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SECTIONALIZING VALVE AND BOX	4	EA	2.1	28.91	241	590.00	2,360	2,601
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	200.0	20.00	4,000	3,000.00	3,000	7,000
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	3	LOC	10.7	28.91	924	717.00	2,151	3,075
ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE,								
PIPING ASSEMBLY & ELECTRICAL CONNECTION								
AHU W/ CHW COIL 2-PIPE	2	EA	54.0	28.91	3,122	6,400.00	12,800	15,922
				SUBTOTAL	8,737		21,346	30,083
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6N2 | **DATE:** 9/19/96

ECO NO. N-2 Retrofit Existing Individual Chillers | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD AREA 2200

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
EXPAND CENTRAL PLANT BASE BUILDING	750	BSF				75.00	56,250	56,250
HISTORICALLY COMPATIBLE								
COOLING TOWER ENCLOSURE	1	SUM	1.0	9,000.00	9,000	12,000.00	12,000	21,000
CENTRAL PLANT ELECTRICAL SYSTEM	750	BSF				34.00	25,500	25,500
CHILLER (YORK YT) WITH PIPING & VESELS	815	TON	3.2	28.91	75,397	371.00	302,365	377,762
ADD FOR VFD	175	HP	0.8	28.91	4,047	150.00	26,250	30,297
PRIMARY PUMPS 40 HP	1	EA	60.0	28.91	1,735	7,500.00	7,500	9,235
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	815	TON	0.6	28.91	14,137	92.00	74,980	89,117
10" PIPING MANIFOLD AND VALVES	1	JOB	170.0	28.91	4,915	5,700.00	5,700	10,615
SUBTOTAL					109,231		510,545	619,776
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. N-2 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6N2

BY : KOTHMANN, K

DATE: 9/19/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
AREA 2200

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND NEW CHW PUMPS COST PER LOCATION								
3"	1	LOC	21.2	28.91	613	2,417.00	2,417	3,030
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	100	EA	0.5	28.91	1,446	7.05	705	2,151
1-1/2"	50	EA	0.4	28.91	578	5.05	253	831
1"	50	EA	0.3	28.91	434	4.38	219	653
3/4"	100	EA	0.3	28.91		2.75		
SUBTOTAL					3,070		3,594	6,664
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-185.6N2 **DATE:** 9/19/96

ECO NO. N-2 Retrofit Existing Individual Chillers

BY : KOTHMANN, K **CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD AREA 2200

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY,	2	EA	4.8	28.91	275	1,375.00	2,750	3,025
CONTROL VALVE AND ELECTRIC CIRCUIT								
CHANGE 3-WAY CONTROL VALVES TO 2-WAY	71	EA	4.0	28.91	8,210	450.00	31,950	40,160
SUB TOTAL FROM SHEET 1					62,002		43,643	105,645
SUB TOTAL FROM SHEET 2					8,737		21,346	30,083
SUB TOTAL FROM SHEET 3					109,231		510,545	619,776
SUB TOTAL FROM SHEET 4					3,070		3,594	6,664
SUBTOTAL					191,526		613,827	805,353
O & P @ 20%					38,305		122,765	161,071
SUBTOTAL					229,832		736,592	966,424
DESIGN @ 6%								57,985
SUBTOTAL								1,024,409
SIOH @ 5.5%								56,343
TOTAL								$1,080,752

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6N3	**DATE:** 9/19/96
ECO NO. N-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW
AREA 2200

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	670	TON	1.5	28.91	29,829	25.00	16,750	46,579
RMV CHILLER UP TO 50 TON	100	TON	1.6	28.91	4,655	25.00	2,500	7,155
REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED	2	EA	1.5	22.00	66	50.00	100	166
RMV DIRECT EXPANSION CONDENSER & AHU	2	EA	5.0	28.91	289	50.00	100	389
RMV COOLING TOWER	675	TON	0.3	20.00	4,050	3.00	2,025	6,075
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
10"	100	LF	1.8	28.91	5,204	56.50	5,650	10,854
4"	10	LF	0.8	28.91	217	19.55	196	412
3"	700	LF	0.6	28.91	12,142	15.70	10,990	23,132
2-1/2"	400	LF	0.5	28.91	5,551	13.33	5,332	10,883
				SUBTOTAL	62,002		43,643	105,645
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	PROJECT NO: 03-185.6N3	DATE: 9/19/96
ECO NO. N-3 Retrofit Existing Individual Chillers	BY : KOTHMANN, K	CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW
AREA 2200

ITEM DESCRIPTION SHEET 2	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
SECTIONALIZING VALVE AND BOX	4	EA	2.1	28.91	241	590.00	2,360	2,601
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	200.0	20.00	4,000	3,000.00	3,000	7,000
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	3	LOC	10.7	28.91	924	717.00	2,151	3,075
ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE,								
PIPING ASSEMBLY & ELECTRICAL CONNECTION								
AHU W/ CHW COIL 2-PIPE	2	EA	54.0	28.91	3,122	6,400.00	12,800	15,922
				SUBTOTAL	8,737		21,346	30,083
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6N3	**DATE:** 9/19/96
ECO NO. N-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW
AREA 2200

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
EXPAND CENTRAL PLANT BASE BUILDING	750	BSF				75.00	56,250	56,250
HISTORICALLY COMPATIBLE								
COOLING TOWER ENCLOSURE	1	SUM	1.0	9,000.00	9,000	12,000.00	12,000	21,000
CENTRAL PLANT ELECTRICAL SYSTEM	750	BSF				34.00	25,500	25,500
CHILLER (YORK YS) WITH PIPING & VESELS	815	TON	3.2	28.91	75,397	416.00	339,040	414,437
PRIMARY PUMPS 40 HP	1	EA	60.0	28.91	1,735	7,500.00	7,500	9,235
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	815	TON	0.6	28.91	14,137	92.00	74,980	89,117
10" PIPING MANIFOLD AND VALVES	1	JOB	170.0	28.91	4,915	5,700.00	5,700	10,615
SUBTOTAL					105,184		520,970	626,154
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

HUITT-ZOLLARS, INC.
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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6N3	**DATE:** 9/19/96
ECO NO. N-3 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW AREA 2200

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND NEW CHW PUMPS COST PER LOCATION								
3"	1	LOC	21.2	28.91	613	2,417.00	2,417	3,030
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	100	EA	0.5	28.91	1,446	7.05	705	2,151
1-1/2"	50	EA	0.4	28.91	578	5.05	253	831
1"	50	EA	0.3	28.91	434	4.38	219	653
3/4"	100	EA	0.3	28.91		2.75		
SUBTOTAL					3,070		3,594	6,664
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

HUITT-ZOLLARS, INC.
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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. N-3 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6N3

BY : KOTHMANN, K

DATE: 9/19/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: NEW Central Plant and HVAC Equipment WATER COOLED SCREW
AREA 2200

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, CONTROL VALVE AND ELECTRIC CIRCUIT	2	EA	4.8	28.91	275	1,375.00	2,750	3,025
CHANGE 3-WAY CONTROL VALVES TO 2-WAY	71	EA	4.0	28.91	8,210	450.00	31,950	40,160
SUB TOTAL FROM SHEET 1					62,002		43,643	105,645
SUB TOTAL FROM SHEET 2					8,737		21,346	30,083
SUB TOTAL FROM SHEET 3					105,184		520,970	626,154
SUB TOTAL FROM SHEET 4					3,070		3,594	6,664
SUBTOTAL					187,479		624,252	811,731
O & P @ 20%					37,496		124,850	162,346
SUBTOTAL					224,975		749,102	974,077
DESIGN @ 6%								58,445
SUBTOTAL								1,032,522
SIOH @ 5.5%								56,789
TOTAL								$1,089,310

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-0185.6N4	**DATE:** 9/19/96
ECO NO. N-4 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN AREA 2200

ITEM DESCRIPTION SHEET 1	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
REMOVE THE FOLLOWING EQUIPMENT								
INCLUDEING ELECTRICAL AND ASSOCIATED PIPING								
RMV CHILLER	670	TON	1.5	28.91	29,829	25.00	16,750	46,579
RMV CHILLER UP TO 50 TON	100	TON	1.6	28.91	4,655	25.00	2,500	7,155
REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED	2	EA	1.5	22.00	66	50.00	100	166
RMV DIRECT EXPANSION CONDENSER & AHU	2	EA	5.0	28.91	289	50.00	100	389
RMV COOLING TOWER	675	TON	0.3	20.00	4,050	3.00	2,025	6,075
(NO DISCOUNT FOR SALVAGE)								
PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET								
DIRECT BURY WITH TRENCH AND BACKFILL								
10"	100	LF	1.8	28.91	5,204	56.50	5,650	10,854
4"	10	LF	0.8	28.91	217	19.55	196	412
3"	700	LF	0.6	28.91	12,142	15.70	10,990	23,132
2-1/2"	400	LF	0.5	28.91	5,551	13.33	5,332	10,883
				SUBTOTAL	62,002		43,643	105,645
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6N4		**DATE:** 9/19/96
ECO NO. N-4	**BY :** KOTHMANN, K		**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
AREA 2200

ITEM DESCRIPTION SHEET 2	QUANTITY # of Units	QUANTITY Unit Meas.	LABOR Hrs / Unit	LABOR Rate	LABOR Total	MATERIAL Unit Price	MATERIAL Total	TOTAL COST
SECTIONALIZING VALVE AND BOX	4	EA	2.1	28.91	241	590.00	2,360	2,601
				28.91				
REPAIR HARDSCAPE AND LANDSCAPE	1	JOB	200.0	20.00	4,000	3,000.00	3,000	7,000
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND CONNECT TO EXISTING CHW PUMPS PER LOCATION								
4"	1	LOC	15.6	28.91	451	1,035.00	1,035	1,486
3"	3	LOC	10.7	28.91	924	717.00	2,151	3,075
ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE,								
PIPING ASSEMBLY & ELECTRICAL CONNECTION								
AHU W/ CHW COIL 2-PIPE	2	EA	54.0	28.91	3,122	6,400.00	12,800	15,922
				SUBTOTAL	8,737		21,346	30,083
				O & P @ 20%				
				SUBTOTAL				
				DESIGN @ 6%				
				SUBTOTAL				
				SIOH @ 5.5%				
				TOTAL				

HUITT-ZOLLARS, INC.
ENGINEERS / ARCHITECTS
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FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6N4	**DATE:** 9/19/96
ECO NO. N-4 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
AREA 2200

ITEM DESCRIPTION SHEET 3	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
EXPAND CENTRAL PLANT BASE BUILDING	750	BSF				75.00	56,250	56,250
HISTORICALLY COMPATIBLE								
COOLING TOWER ENCLOSURE	1	SUM	1.0	9,000.00	9,000	12,000.00	12,000	21,000
CENTRAL PLANT ELECTRICAL SYSTEM	750	BSF				34.00	25,500	25,500
CHILLER (YORK YG) WITH PIPING & VESELS	815	TON	4.5	28.91	106,027	896.00	730,240	836,267
PRIMARY PUMPS 60 HP	1	EA	110.0	28.91	3,180	8,900.00	8,900	12,080
COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS	815	TON	0.6	28.91	14,137	92.00	74,980	89,117
10" PIPING MANIFOLD AND VALVES	1	JOB	170.0	28.91	4,915	5,700.00	5,700	10,615
SUBTOTAL					137,259		913,570	1,050,829
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. N-4 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6N4

BY : KOTHMANN, K

DATE: 9/19/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN AREA 2200

ITEM DESCRIPTION SHEET 4	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY								
AND NEW CHW PUMPS COST PER LOCATION								
3"	1	LOC	21.2	28.91	613	2,417.00	2,417	3,030
INTERIOR BUILDING PIPING W/ INSULATION								
SCH 40 BLK T&C W/ FITTINGS & HANGERS								
2"	100	EA	0.5	28.91	1,446	7.05	705	2,151
1-1/2"	50	EA	0.4	28.91	578	5.05	253	831
1"	50	EA	0.3	28.91	434	4.38	219	653
3/4"	100	EA	0.3	28.91		2.75		
SUBTOTAL					3,070		3,594	6,664
O & P @ 20%								
SUBTOTAL								
DESIGN @ 6%								
SUBTOTAL								
SIOH @ 5.5%								
TOTAL								

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ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX	**PROJECT NO:** 03-185.6N4	**DATE:** 9/19/96
ECO NO. N-4 Retrofit Existing Individual Chillers	**BY :** KOTHMANN, K	**CHKD BY:** CARTER, J.

PROJECT DESCRIPTION: NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
AREA 2200

ITEM DESCRIPTION	QUANTITY		LABOR			MATERIAL		TOTAL COST
	# of Units	Unit Meas.	Hrs / Unit	Rate	Total	Unit Price	Total	
FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, CONTROL VALVE AND ELECTRIC CIRCUIT	2	EA	4.8	28.91	275	1,375.00	2,750	3,025
CHANGE 3-WAY CONTROL VALVES TO 2-WAY	71	EA	4.0	28.91	8,210	450.00	31,950	40,160
SUB TOTAL FROM SHEET 1					62,002		43,643	105,645
SUB TOTAL FROM SHEET 2					8,737		21,346	30,083
SUB TOTAL FROM SHEET 3					137,259		913,570	1,050,829
SUB TOTAL FROM SHEET 4					3,070		3,594	6,664
SUBTOTAL					219,555		1,016,852	1,236,407
O & P @ 20%					43,911		203,370	247,281
SUBTOTAL					263,465		1,220,222	1,483,688
DESIGN @ 6%								89,021
SUBTOTAL								1,572,709
SIOH @ 5.5%								86,499
TOTAL								$1,659,208

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Life Cycle Cost Analysis Study: FSH-3.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-N1
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: JOHN CARTER

ECIP Summary Report

1. Investment

A. Construction Cost	$930,067
B. SIOH	$54,223
C. Design Cost	$55,804
D. Total Cost (1A+1B+1C)	$1,040,094
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,040,094

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	3,050	Mbtus	$19,154	15.08	$288,842
Elec. Deman					$25,570	14.88	$380,482
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			3,050	Mbtus	$44,724		$669,324

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$8,005	Annual	14.88	$119,114
ANNUAL TOTAL	$8,005			$119,114
REFRIGERANT RECLA	$2,628	0	1.0	$2,628
CHILLER RETROFIT	$45,000	0	1.0	$45,000
ONE TIME TOTAL	$47,628			$47,628
TOTAL	$55,633			$166,742

4. First Year Dollar Savings	$55,110
5. Simple Payback Period (Years)	18.87
6. Total Net Discounted Savings	$836,066
7. Savings to Investment Ratio	.8
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	1.88%

Life Cycle Cost Analysis Study: FSH-3.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-N2
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: JOHN CARTER

ECIP Summary Report

1. Investment

A. Construction Cost	966424
B. SIOH	56343
C. Design Cost	57985
D. Total Cost (1A+1B+1C)	$1,080,752
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	0
G. Total Investment (1D-1E-1F)	$1,080,752

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	3,370	Mbtus	$21,164	15.08	$319,147
Elec. Deman					$25,345	14.88	$377,134
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			3,370	Mbtus	$46,509		$696,281

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$8,005	Annual	14.88	$119,114
ANNUAL TOTAL	$8,005			$119,114
REFRIGERANT RECLA	$2,628	0	1.0	$2,628
CHILLER RETROFIT	$45,000	0	1.0	$45,000
ONE TIME TOTAL	$47,628			$47,628
TOTAL	$55,633			$166,742

4. First Year Dollar Savings	$56,895
5. Simple Payback Period (Years)	19.0
6. Total Net Discounted Savings	$863,023
7. Savings to Investment Ratio	.8
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	1.85%

Life Cycle Cost Analysis Study: FSH-3.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-N3
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

A. Construction Cost	$974,077
B. SIOH	$56,789
C. Design Cost	$58,445
D. Total Cost (1A+1B+1C)	$1,089,311
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,089,311

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	2,842	Mbtus	$17,848	15.08	$269,144
Elec. Deman					$22,010	14.88	$327,509
Natural Gas	$3.5	/Mbtus	0	Mbtus	$0	18.58	$0
TOTAL			2,842	Mbtus	$39,858		$596,653

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost	
ANNUAL RECURRING	$8,005	Annual	14.88	$119,114	
ANNUAL TOTAL	$8,005			$119,114	
REFRIGERANT RECLA	$2,628	0	1.0	$2,628	
CHILLER RETROFIT	$45,000	0	1.0	$45,000	<
ONE TIME TOTAL	$47,628			$47,628	
TOTAL	$55,633			$166,742	

4. First Year Dollar Savings	$50,244
5. Simple Payback Period (Years)	21.68
6. Total Net Discounted Savings	$763,395
7. Savings to Investment Ratio	.7
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	1.19%

Life Cycle Cost Analysis Study: FSH-3.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-N4
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: JOHN CARTER

ECIP Summary Report

1. Investment

A. Construction Cost	$1,483,688
B. SIOH	$86,499
C. Design Cost	$89,021
D. Total Cost (1A+1B+1C)	$1,659,208
E. Salvage Value of Existing Equip.	$0
F. Public Utility Company Rebate	$0
G. Total Investment (1D-1E-1F)	$1,659,208

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

Fuel	Price	Price Units	Usage Savings	Usage Units	Annual Savings	Discount Factor	Discounted Savings
Electricity	$6.3	/Mbtus	4,826	Mbtus	$30,307	15.08	$457,034
Elec. Deman					$49,038	14.88	$729,685
Natural Gas	$3.5	/Mbtus	-8,229	Mbtus	-$28,472	18.58	-$529,016
TOTAL			-3,403	Mbtus	$50,873		$657,703

3. Non Energy Savings (+) / Costs (-)

Item	Savings/ Cost	Year	Discount Factor	Discounted Savings/Cost
ANNUAL RECURRING	$8,005	Annual	14.88	$119,114
ANNUAL TOTAL	$8,005			$119,114
REFRIGERANT RECLA	$2,628	0	1.0	$2,628
CHILLER RETROFIT	$45,000	0	1.0	$45,000
ONE TIME TOTAL	$47,628			$47,628
TOTAL	$55,633			$166,742

4. First Year Dollar Savings	$61,259
5. Simple Payback Period (Years)	27.08
6. Total Net Discounted Savings	$824,446
7. Savings to Investment Ratio	.5
If < 1, Project does not qualify	
8. Adjusted Internal Rate of Return	-.54%

APPENDIX D
SCOPE OF WORK AND REVIEW COMMENTS

TABLE OF CONTENTS

Detailed scope of work D-1

DETAILED SCOPE OF WORK
CONTRACT NO. DACAC63-94-D-0015
DELIVERY ORDER NO. 0008

1. The Architect-Engineer (A-E) shall furnish all services, material, supplies, plant, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified project for design in accordance with the original basic contract and this Detailed Scope of Work. Appendis "A" of the basic contract shall be followed for performance requirements for A-E services. Where this Detailed Scope of Work conflicts with Appendix "A", this Detailed Scope of Work shall govern.

INSTALLATION	PROJECT TITLE
Fort Sam Houston, TX	Boiler/Chiller Study (EEAP)

2. The work and other related data and sevices required in this Delivery Order shall be accomplished within the time schedule required, in accordance with the subject stated above and scope of work described in paragraph 3 below. The schedule for delivery of data to the Contracting Officer is in calendar days as follows:

	DELIVERY SCHEDULE
a. Interim Submittal and related data for studies (See Annex B for number of copies)	120 calendar days after receipt of Delivery Order
b. Pre-Final Submittal(s) (95% Submittal)	60 calendar days after approval of Interim submittal
c. Final Submittal (original and all data developed under this submittal)	60 calendar days after approval of the pre-final

3. The items of work included in this Delivery Order shall be in accordance with criteria furnished at the Scoping conference held 19 April 1995 at Fort Sam Houston. The services to be provided shall include, but not be limited to, the following Scope of Work.

a. Items of Work:

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

1.2 Perform a limited site survey of specific buildings or areas to collect all data required to evaluate the specific ECOs included in this study.

1.4 Evaluate specific ECOs to determine their energy savings potential and economic feasibility.

1.5 Provide project documentation for recommended ECOs as detailed herein.

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

2. GENERAL

2.1 This study is limited to the evaluation of the specific buildings, systems, or ECOs listed in Annex A, DETAILED SCOPE OF WORK.

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

2.3 For the buildings, systems or ECOs listed in Annex A, all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all energy sources applicable to each building, system, or ECO.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from DAIM-FDF-U, dated 10 Jan 1994 (including current updates) establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified

in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Computer modeling will be used to determine the energy savings of ECOs which would replace or significantly change an existing heating, ventilating, and air-conditioning (HVAC) system. The requirement to use computer modeling applies only to heated and air-conditioned or air-conditioned-only buildings which exceed 8,000 square feet or heated-only buildings in excess of 20,000 square feet. Modeling will be done using a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting and other energy-producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads of the building under study. The program will use established weather data files and may perform calculations on a true, hour-by-hour basis or may condense the weather files and the number of calculations into several "typical" days per month. The Detailed Scope of Work, Annex A, will list programs that are acceptable to the Contracting Officer. If the AE desires to use a different program, it must be submitted for approval with a sample run, an explanation of all input and output data, and a summary of program methodology and energy evaluation capabilities.

2.7 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 FEMP funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

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

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

2.7.3 At some installations Energy Conservation and Management (ECAM) funding will be used instead of ECIP funding. The criteria for each program is the same. The Director of Public Works will indicate which program is used at this installation. This Scope of Work mentions only ECIP, however, ECAM is also meant.

2.8 Metric Reporting Requirements: In this study, the analyses of the ECOs may be performed using English or Metric units as long as they are consistent throughout the report. The final results of energy savings for individual recommended projects and for the overall study will be reported in units of MegaBTU per year and in MegaWatts per year. Paragraph 7.6.2 details requirements for the contents of the final submittal.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for 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. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the installation representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in 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's project manager and the Government's representative 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, will be in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE 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, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this

contract. The records 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 Public Works before starting work at the installation 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 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 site survey.

c. Proposed working hours.

d. Support requirements from the Director of Public Works.

3.7.2 Exit. The exit interview shall be held when the field work is essentially complete; it shall briefly describe the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Public Works.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), labor, supervision, and travel necessary to perform the work and render the data required under this contract are 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 in the report as such:

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 $300,000, a Savings to Investment Ratio (SIR) greater than 1.25 and a simple payback period of less than ten years. The overall project and each discrete part of the project shall have an SIR greater than 1.25. All projects meeting the above criteria shall be arranged as specified in paragraph 2.7.1 and shall be provided with programming documentation. Programming documentation shall consist of a DD Form 1391 and life cycle cost analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented). A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account

the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate, but which have an SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.7.2 and shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA (energy savings calculations and cost estimate), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. Federal Energy Management Program (FEMP) Projects. A FEMP (or O&M Energy) project is one that results in needed maintenance or repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings. The criteria are similar to the criteria for ECIP projects, ie, SIR $\geq$ 1.25, and simple payback period of less than ten years. Projects with a construction cost estimate up to $1,000,000 shall be documented as outlined in par 5.2 above; projects over $1,000,000 shall be documented on 1391s. In the FEMP program, a system may be defined as "failed or failing" if it is inefficient or technically obsolete. However, if this strategy is used to justify a proposed project, the equipment to be replaced must have been in use for at least three years.

b. Low Cost/No Cost Projects. These are projects which the Director of Public Works (DPW) can perform using his resources. Documentation shall be as required by the DPW.

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

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A.

7. WORK TO BE ACCOMPLISHED.

7.3 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study. The AE shall document his site survey on forms developed for the survey, or on standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.4 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog 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.

7.5 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph [7.6.1], the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par [7.6.2].

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 shall be indexed. Tabs and dividers shall clearly and distinctly divide sections,

subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the 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. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the Director of Public Works, 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 the field survey has been completed 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, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a. All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

b. All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. These lists may be subdivided by building or area as appropriate for the study.

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. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the Director of Public Works to 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 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study 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 recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph [7.6.1] shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An 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 B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

ANNEX A

DETAILED SCOPE OF WORK

BOILER/CHILLER STUDY

FORT SAM HOUSTON, TX

1. The General Scope of Work outlines the requirements for the study and the report; and the detailed scope of work describes the specific areas to be studied. If any conflicts arise between the General and the Detailed scopes of work, the Detailed Scope of Work shall govern.

2. A study shall be conducted in five operational areas within Fort Sam Houston. These areas are generally described as 100, 500, 1000, 1300, and 2200 Areas; each including several major and secondary buildings. The study shall focus on establishing the feasibility of modifying or constructing centralized heating and cooling plants to serve each of the five areas. Each of the areas designated, other than the 100 Area, has existing central facilities in place. Each of the areas designated, other than the 500 and 1000 Areas, has been the subject of recent investigation and analysis in a prior boiler/chiller study. This study seeks to expand the recommendations developed in the previous study for areas 100, 1300, and 2200 to include additional existing buildings within those areas which were excluded from the scope of work in the prior study. All recommendations will be reevaluated based on the expanded load profile generated by the increased area served. A study of the specified buildings in Areas 500 and 1000 will be conducted to establish recommendations for centralized heating and cooling facilities in those areas.

3. The work consists of evaluating buildings listed below for each functional area and modeling each building to develop a probable annual thermal load profile. Fort Sam Houston will furnish as-built drawings on the buildings and the Consultant will perform a survey of the buildings to collect information necessary to more accurately develop the annual thermal profile of each. The Consultant will evaluate the feasibility and economic impacts of modifying the existing cooling and heating plants in the areas served. The feasibility study will consider chiller replacement or retrofit and boiler upgrade or replacement. A limited survey of the existing buildings served by each plant will be performed to permit a qualitative verification that the existing plant capacities are adequate. The survey will also reveal constraining requirements such as year-round cooling requirements which may influence the recommendations. Chiller replacement/retrofit recommendations will consider refrigerants 123 or 134a only, gas vs. electrical driven compressors, drive configuration (i.e. open-drive vs. hermetic), operating efficiency (i.e. compressor type: screw vs. centrifugal part load and full load capacities and variable speed drive) and maintainability. The cost effects of the new design criteria from the Uniform Mechanical code which requires a partition be provided between the chiller and boiler shall be investigated. The efficacy of installing DDC control systems for each of the five functionaa areas will be evaluated. Recommendations will be supported by life cycle cost analyses which will include initial purchase and installation costs, energy consumption costs, and maintenance costs extended over the useful life of the equipment.

4. The following buildings will be evaluated during this study:

a. 123, 126, 129, 131, 140, 141, 151, 152, 154, 155, 156, 157, 158, 159, 260, 261, 268; and previously studied buildings 122, 124, 125, 127, 128, 133, 134, 135, 142, 143, 144, 145, 146, 147, 149, 197, 198, 199, and 250.

b. 590, 591, and 592.

c. 1000, 1001, 1029, and 1088.

d. 1384, 1387, 1396, 1398; and previously studied buildings 1350, 1374, 1375, 1377, 1379, 1380, 1382, and 1385.

e. 2200, 2244, 2247, 2248, 2250, 2270, 2272, 2273, 2288; and previously studied buildings 2263, 2264, 2265, and 2266.

5. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The final report for this study shall be due not later Notice to Proceed.

MILESTONE	PERCENT OF CONTRACT AMOUNT AUTHORIZED FOR PAYMENT
Completion of Field Work	25
Receipt of Interim Submittal	75
Completion of Interim Presentation & Review	85
Receipt of Pre-Final Submittal	95
Receipt of Final Report	100

6. Thermal modeling will be accomplished using the Trane Air-Conditioning Economics (TRACE) computer program. Economic analysis will be accomplished using the computer program Life Cycle Costing in Design (LCCID).

7. The following documents will be furnished to the Consultant by the Government:

a. As-built drawings of the buildings specified above.

b. Energy consumption records.

c. Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

d. ETL 1110-3-254, Use of Electric Power for Comfort Space Heating

e. ETL 1110-3-282, Energy Conservation

f. TM 5-785, Engineering Weather Data

g. TM 5-800-2, Cost Estimates, Military Construction

h. AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

i. Architectural and Engineering Instructions, Design Criteria, 18 September 1992

j. The latest MCP Index.

8. Reports and correspondence shall be provided as follows:

Commander ATTN: AFZG-PW-ESB/Mr. Frank Carbonel Department of the Army HQ, Fort Sam Houston Fort Sam Houston, TX 78234	2 copies each report 1 copy of field notes 1 copy of correspondence
Commander U.S. Army Engineer District, Fort Worth ATTN: CESWF-ED-MP/Mr. Richard Champagne 819 Taylor Street/P.O. Box 17300 Fort Worth, TX 76102-0300	2 copies each report 1 copy of field notes 1 copy of correspondence
Commander U.S. Army Engineer District, Fort Worth ATTN: CESAM-EN-DM/Mr. Tony Battaglia P.O. Box 2288 Mobile, AL 36628-0001	1 copy each report 1 copy of correspondence

ANNEX B

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   o Total Annual Energy Used.

   o Source Energy Consumption.

   Electricity - MWH, Dollars, BTU
   Fuel Oil - GALS, Dollars, BTU, MWH
   Natural Gas - THERMS, Dollars, BTU, MWH
   Propane - GALS, Dollars, BTU, MWH
   Other - QTY, Dollars, BTU, MWH

4. Reevaluated Projects Results.

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.

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.

ANNEX C

REQUIRED DD FORM 1391 DATA

To facilitate ECIP project approval, the following supplemental data shall be provided:

a. In title block clearly identify projects as "ECIP."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor ajects.

(11) Latest MCP Index, essential for projecting costs for project documentation.

(12) The following items are important and should be provided to the AE to the extent to which they are available:

(a) As-built drawings of applicable buildings, equipment, or systems

(b) Handbooks or SOPs relating to the operation of applicable equipment or systems.

(c) Applicable records of energy or fuel usage.

(d) Copies of bills for electrical enetration assumptions before and after improvements.

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

e. Claims for boiler efficiency improvements must identify data to support present properly adjusted boiler operation and future expected efficiency. If full replacement of boilers is indicated, explain rejection of alternatives such as replace burners, nonfunctioning controls, etc. Assessment of the complete existing installation is required to make accurate determinations of required retrofit actions.

f. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

g. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

h. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period.

i. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

j. For each temporary building included in a project, separate documentation is required showing (1) a minimum 10-year continuing need, based on the installation's annual real property utilization survey, for active building retention after retrofit, (2) the specific retrofit action applicable and (3) an economic analysis supporting the specific retrofit.

k. Nonappropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

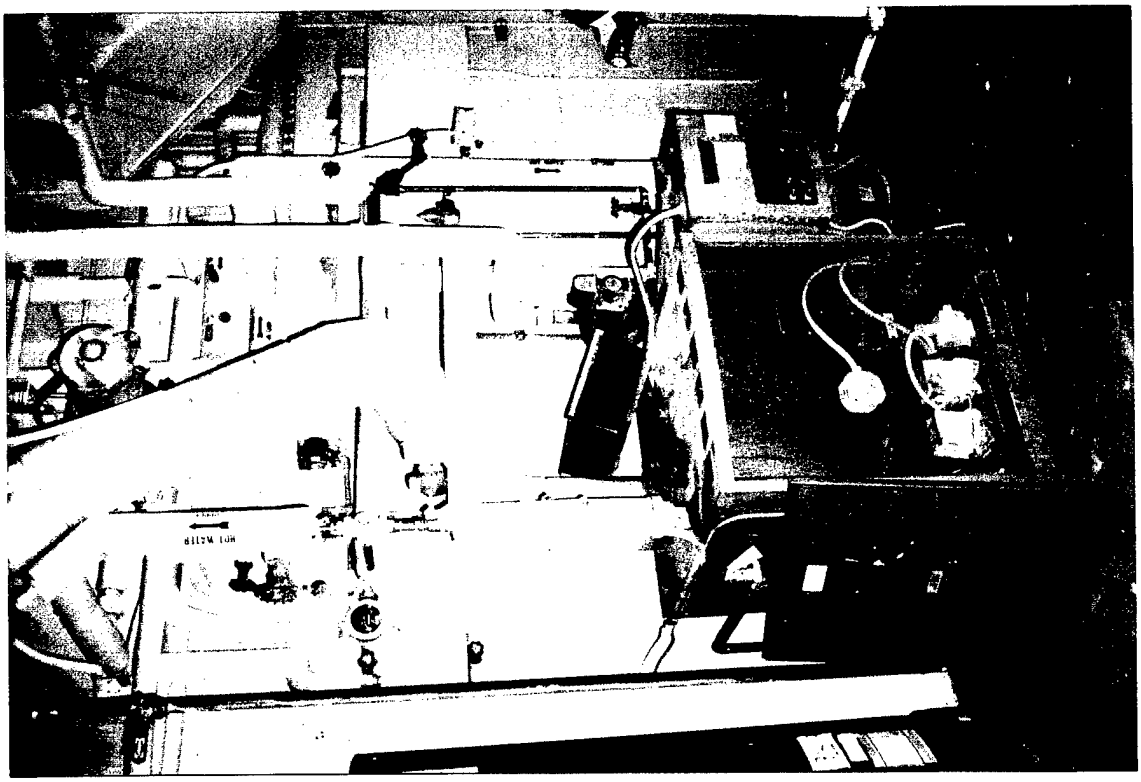
l. Any requirements required by ECIP guidance dated 10 Jan 1994 and any revisions thereto. Note that unescalated costs/savings are to be used in the economic analyses.

m. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

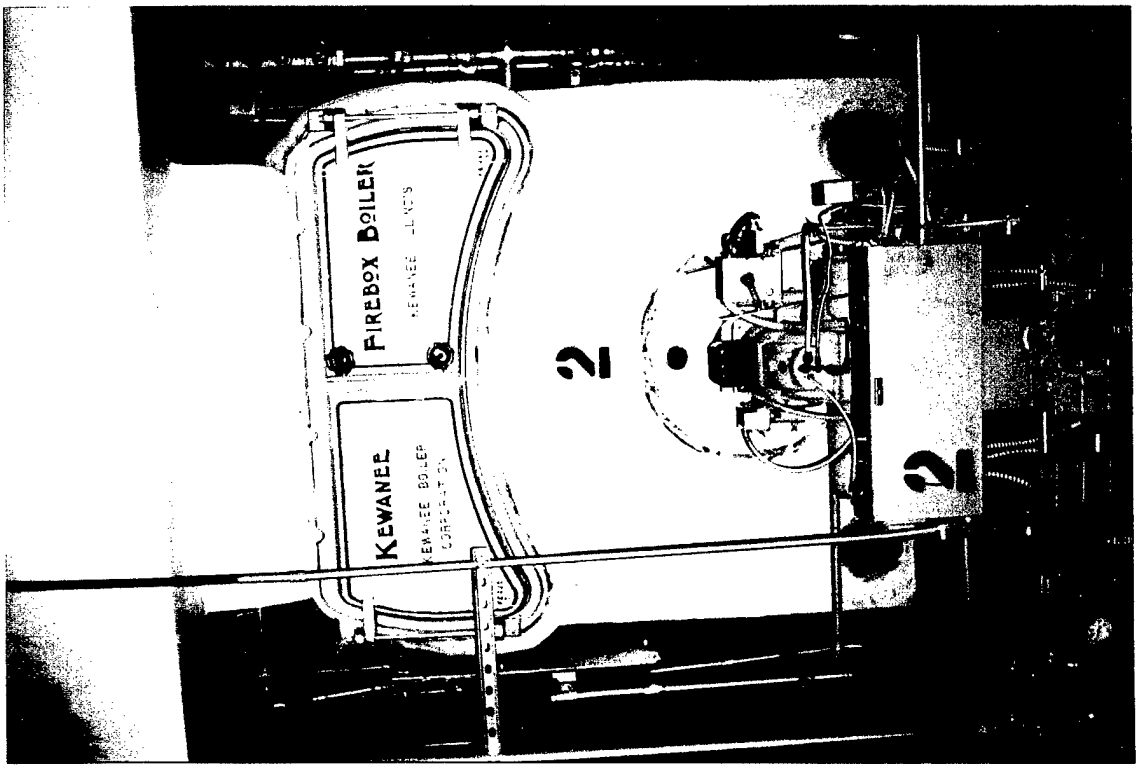
APPENDIX E
PHOTOGRAPHS

TABLE OF CONTENTS

Area 100 ..... E-1
Area 500 ..... E-17
Area 1000 ..... E-21
Area 1300 ..... E-26
Area 2200 ..... E-34



HW boiler serving building 268. Three (3) way actuator has been removed.



Steam boiler serving building 250, typical of two(2).



Air cooled chiller serving building 268. Notice bushes at inlet of condenser.



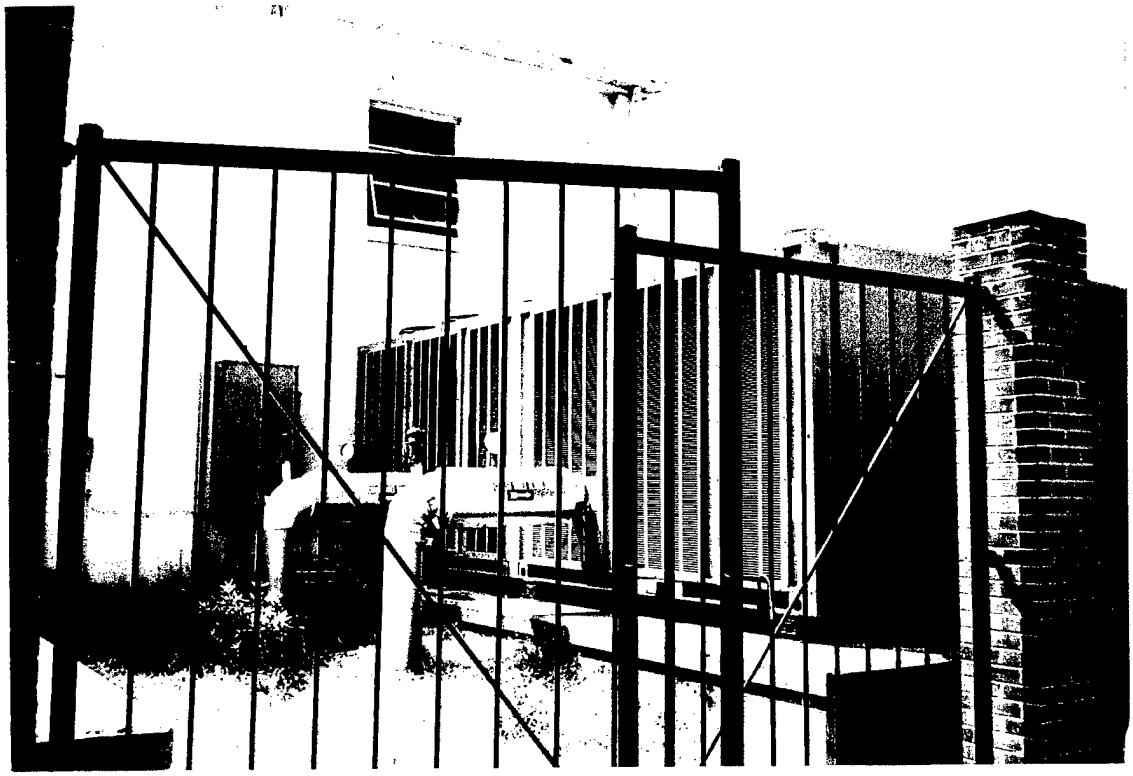
Additional chiller pad (21'-5" x 10'-8") for additional chiller (if needed).



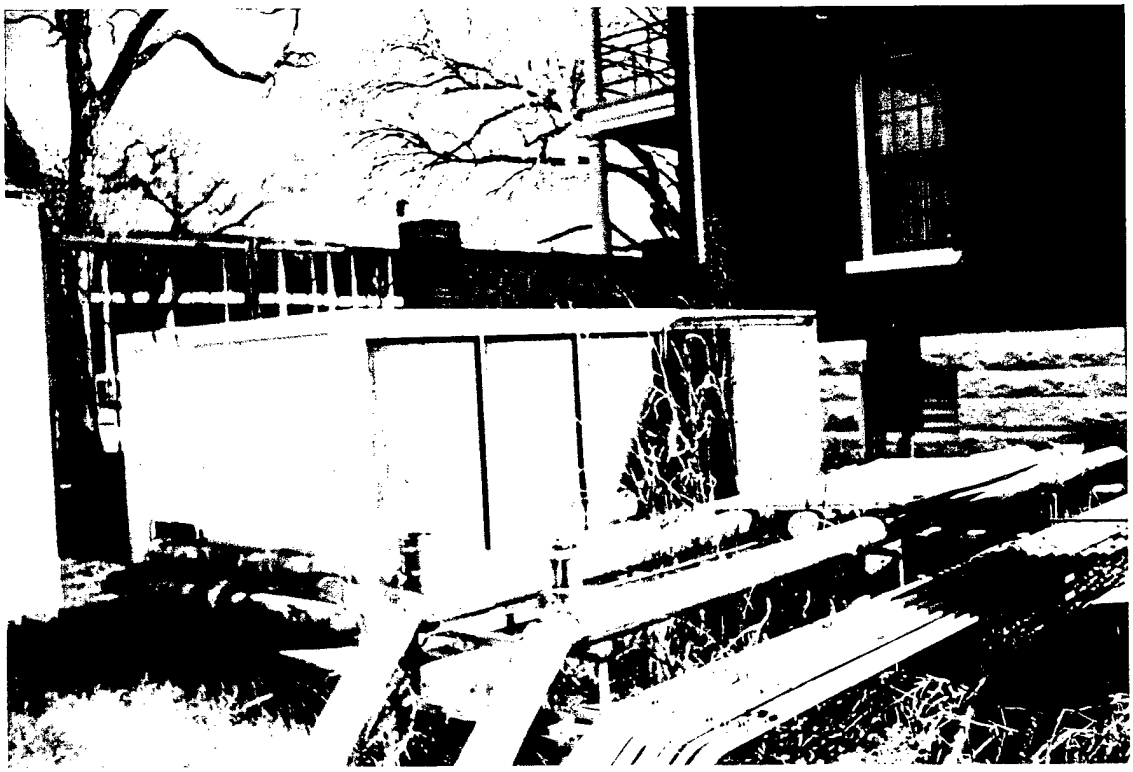
Building 250 existing central boiler plant and air cooled chiller yard.



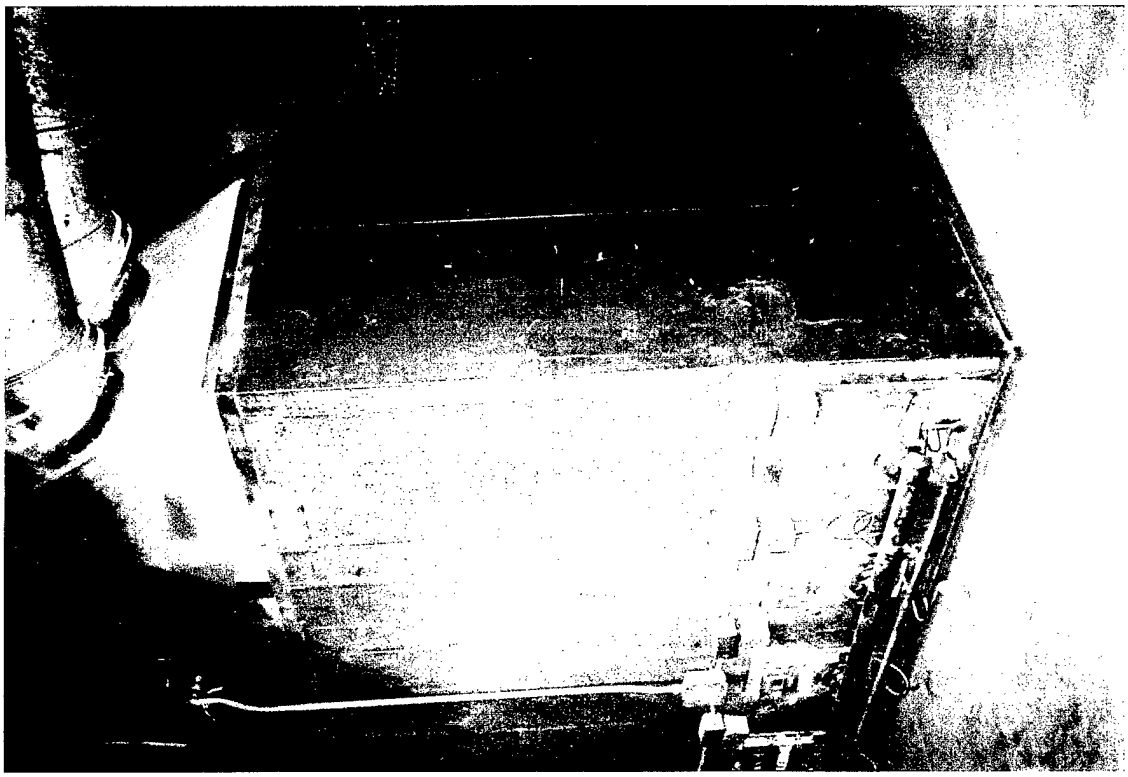
Proposed location for Area 100 central plant addition.



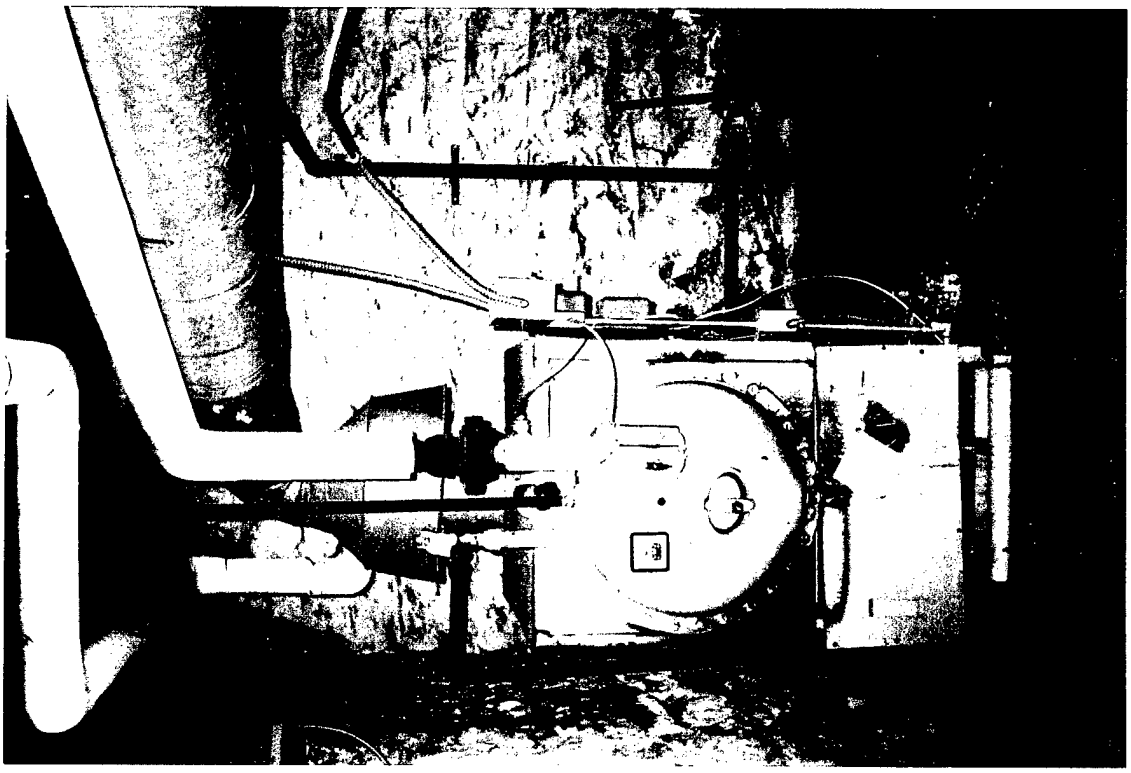
Air cooled chiller serving building 250.



Air cooled chiller serving buildings 147 & 149.



Warn air furnace serving building 145 located in the basement.



HW boiler serving building 149 located in the basement.



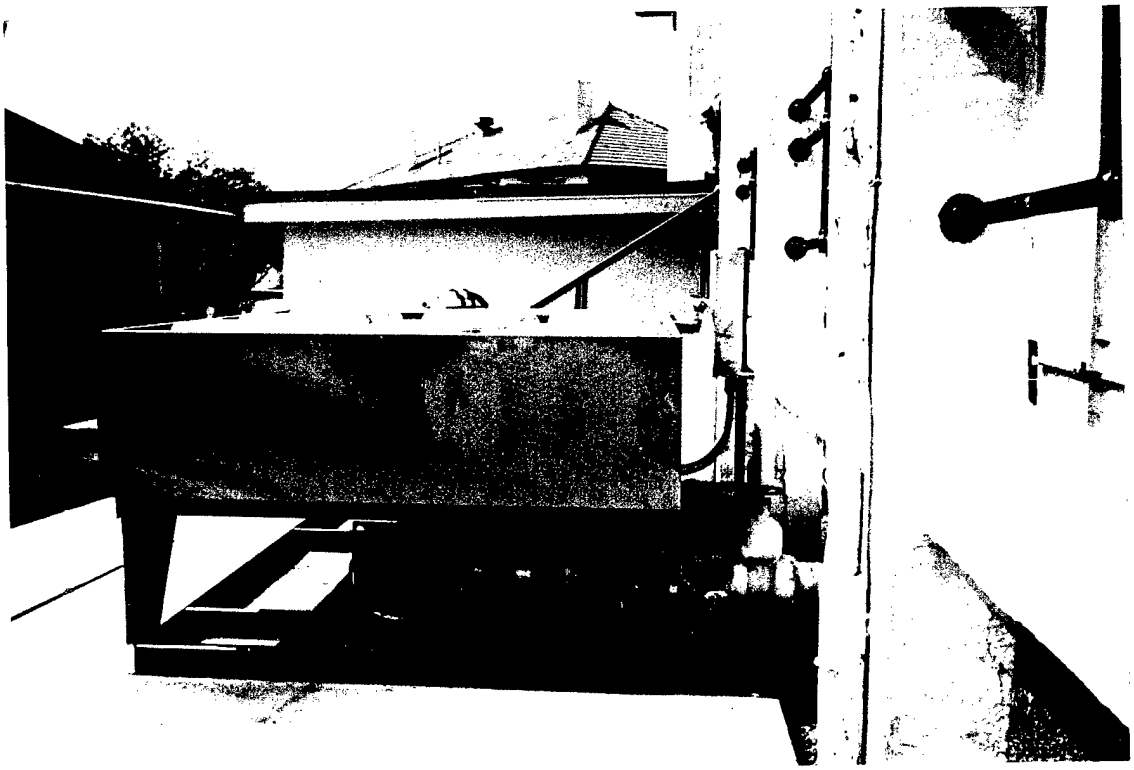
Window units serving building 145.



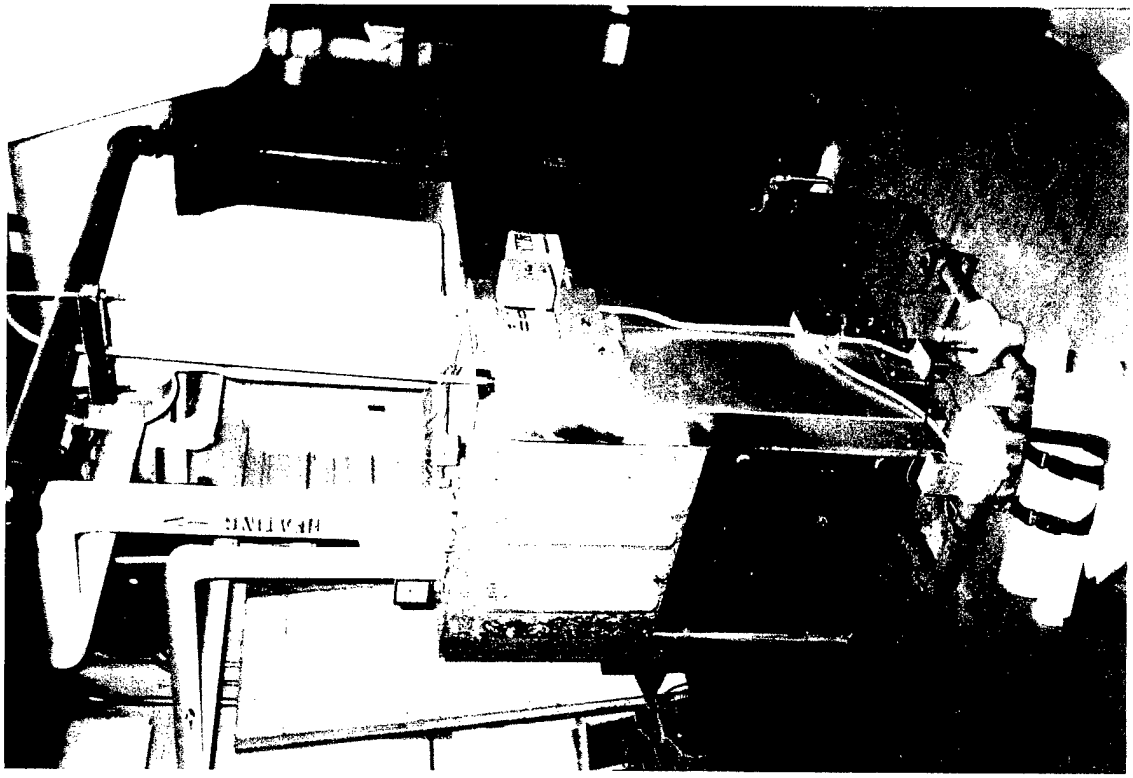
HW boiler and DHW heater serving building 144.



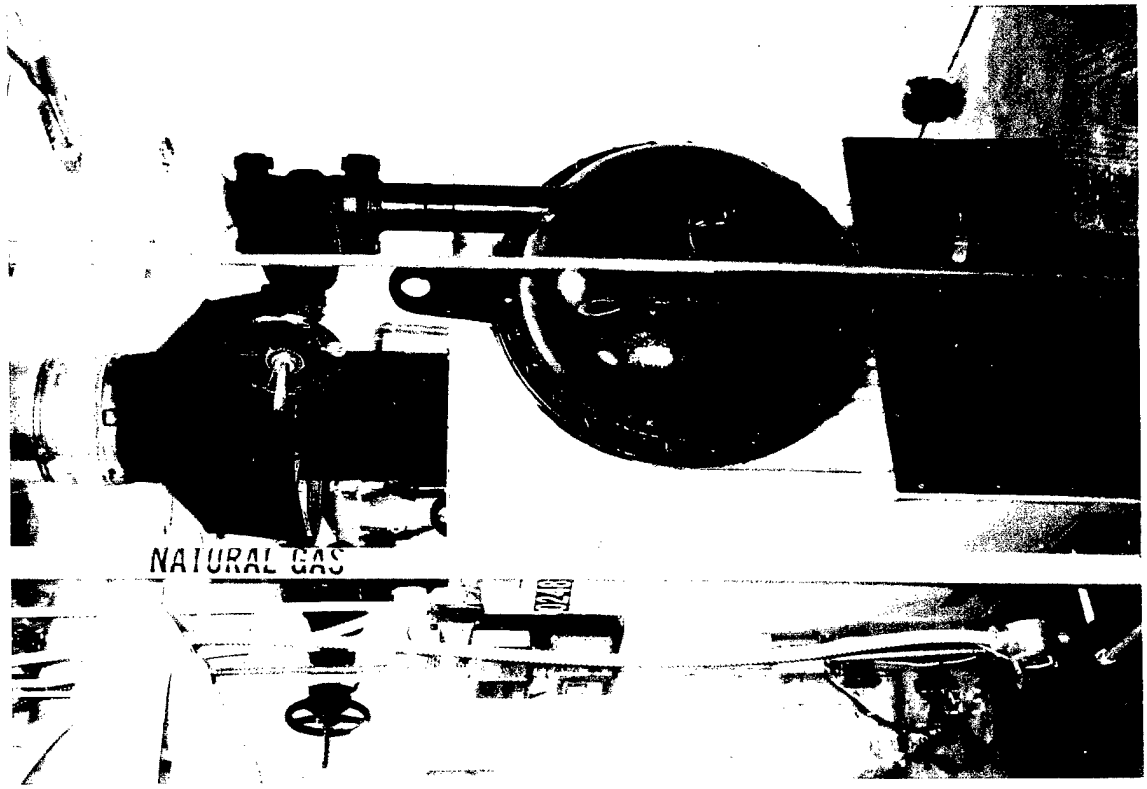
Air cooled chiller serving building 142.



Air cooled chiller serving building 197.



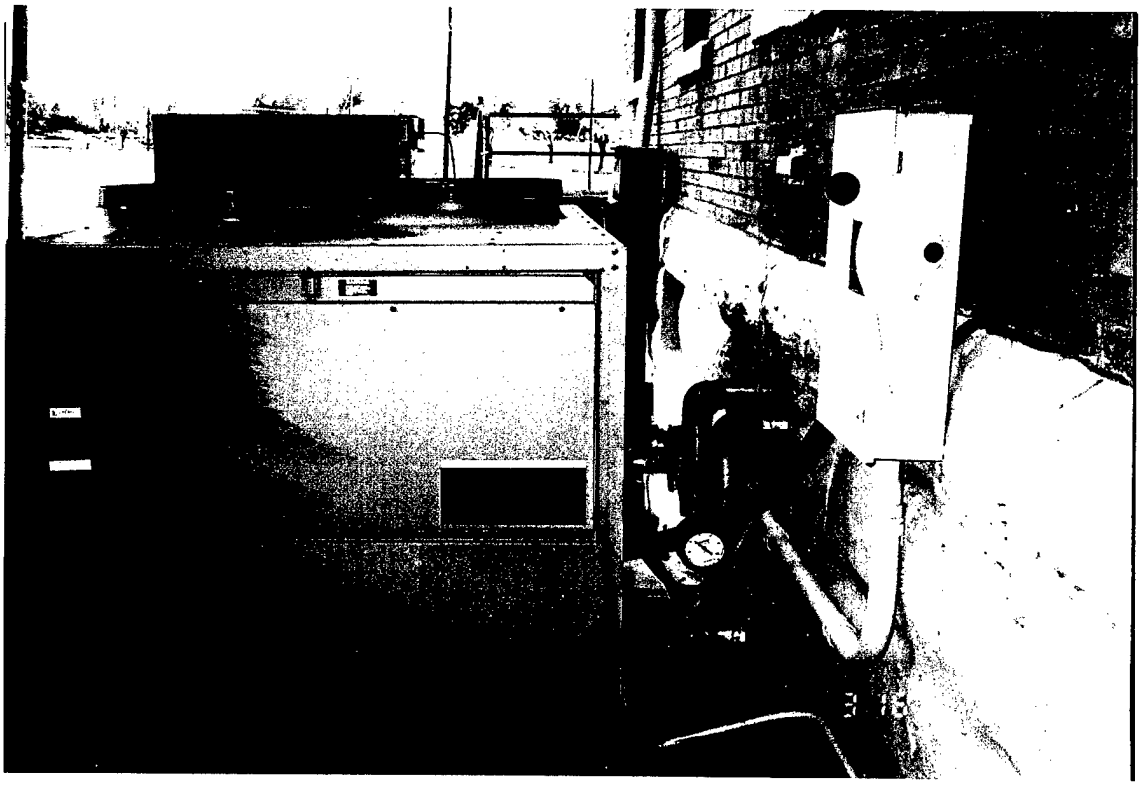
HW boiler serving building 197



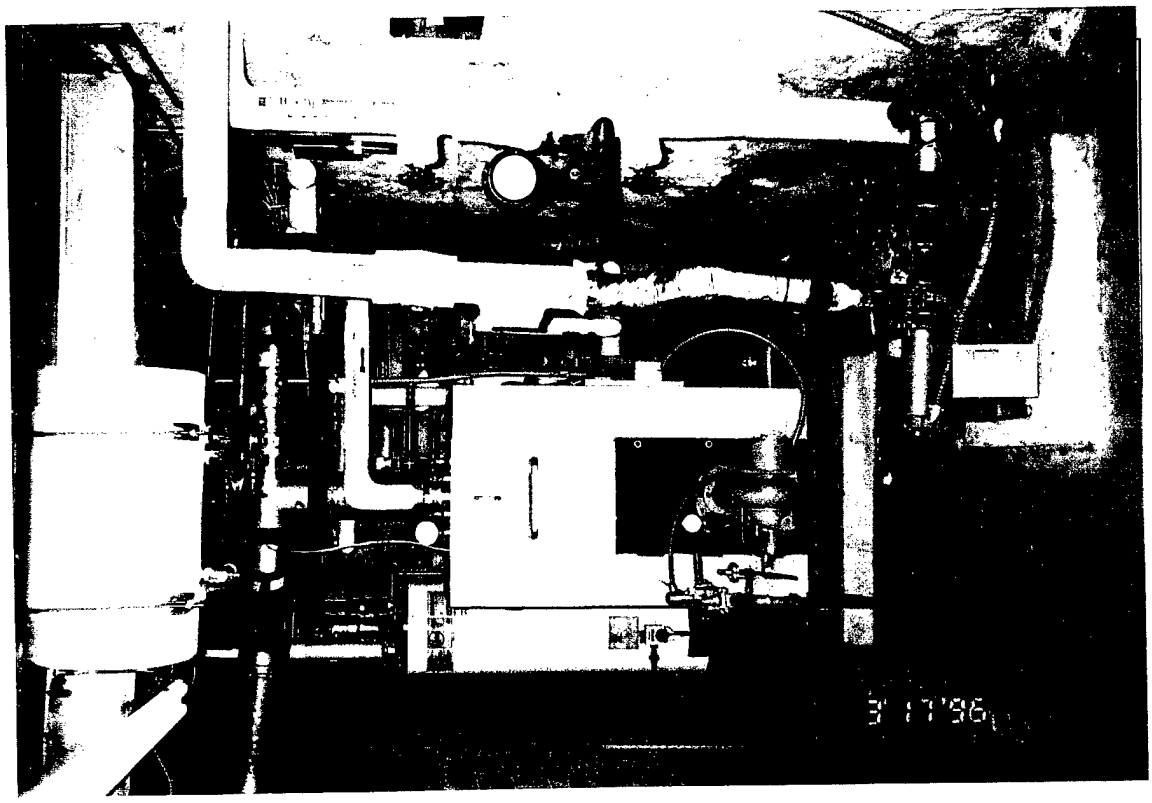
HW boiler serving building 134



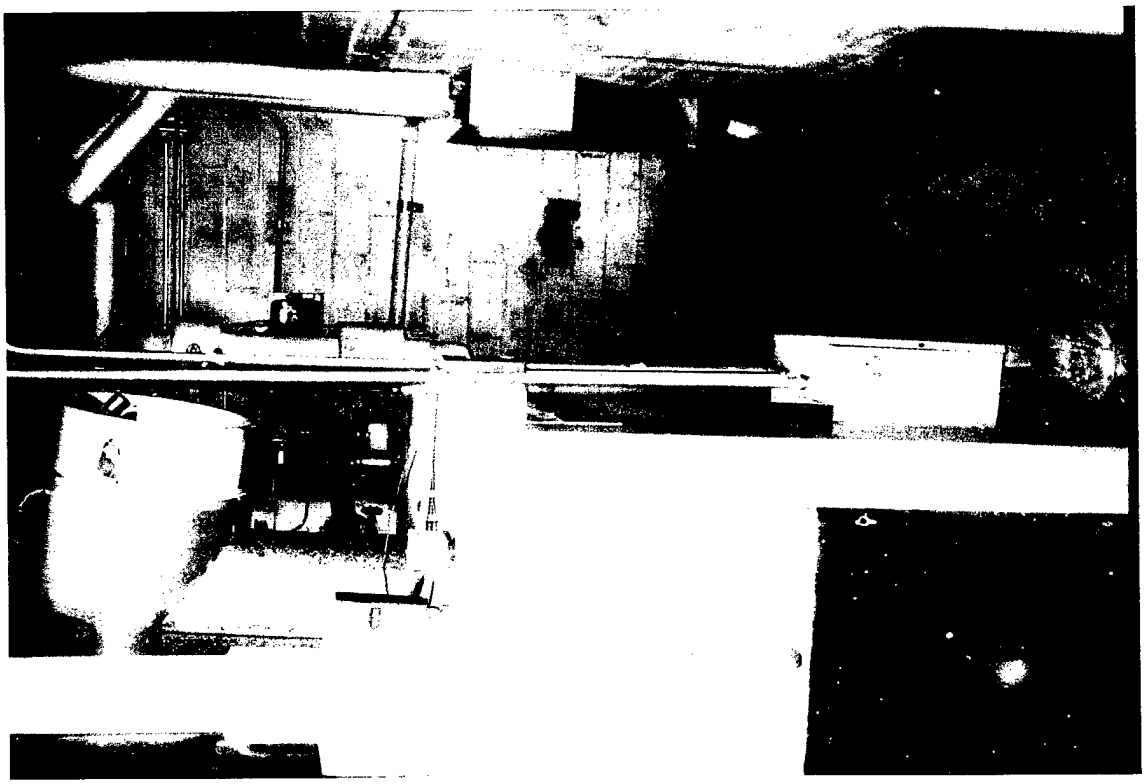
Air cooled chiller serving buildings 134 & 135 (foreground)



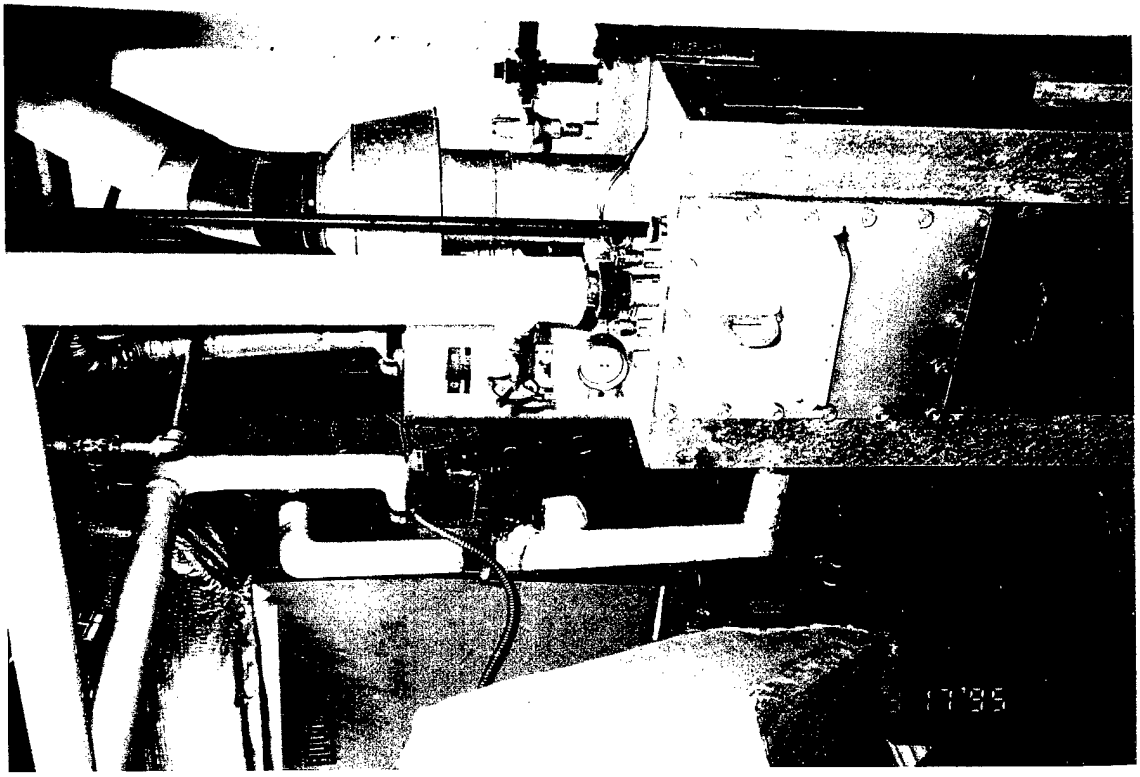
Air cooled chiller serving building 133.



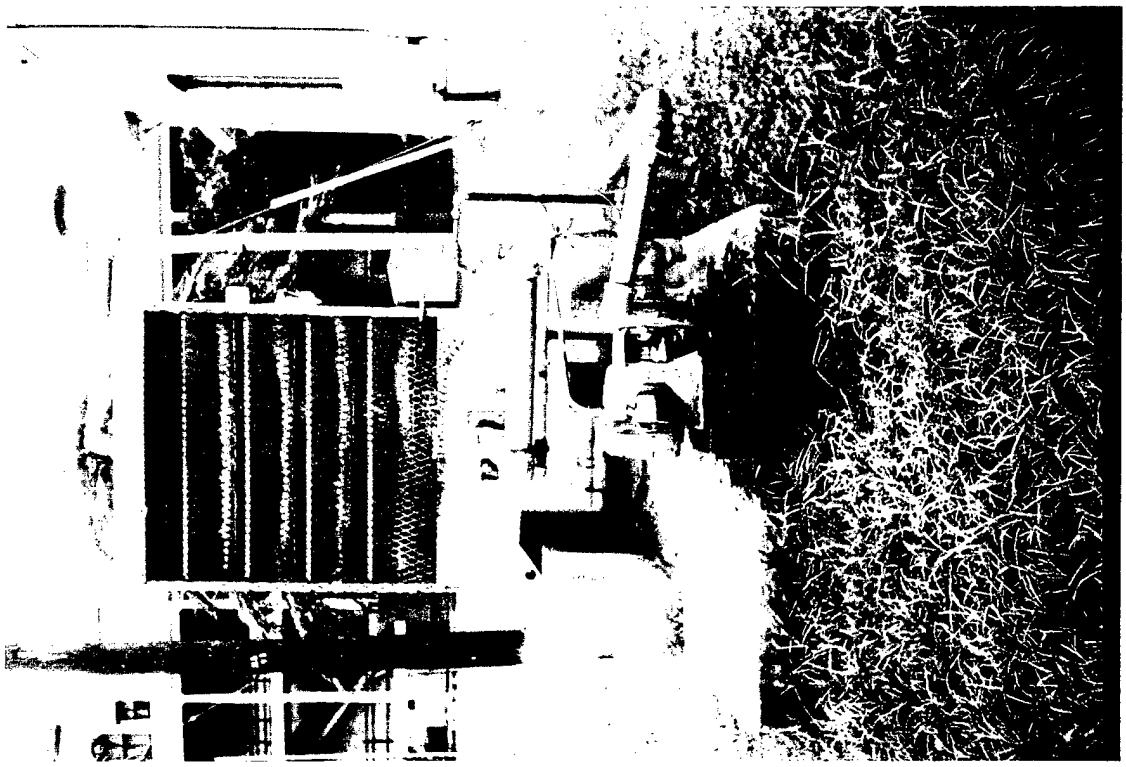
HW boiler serving building 133.



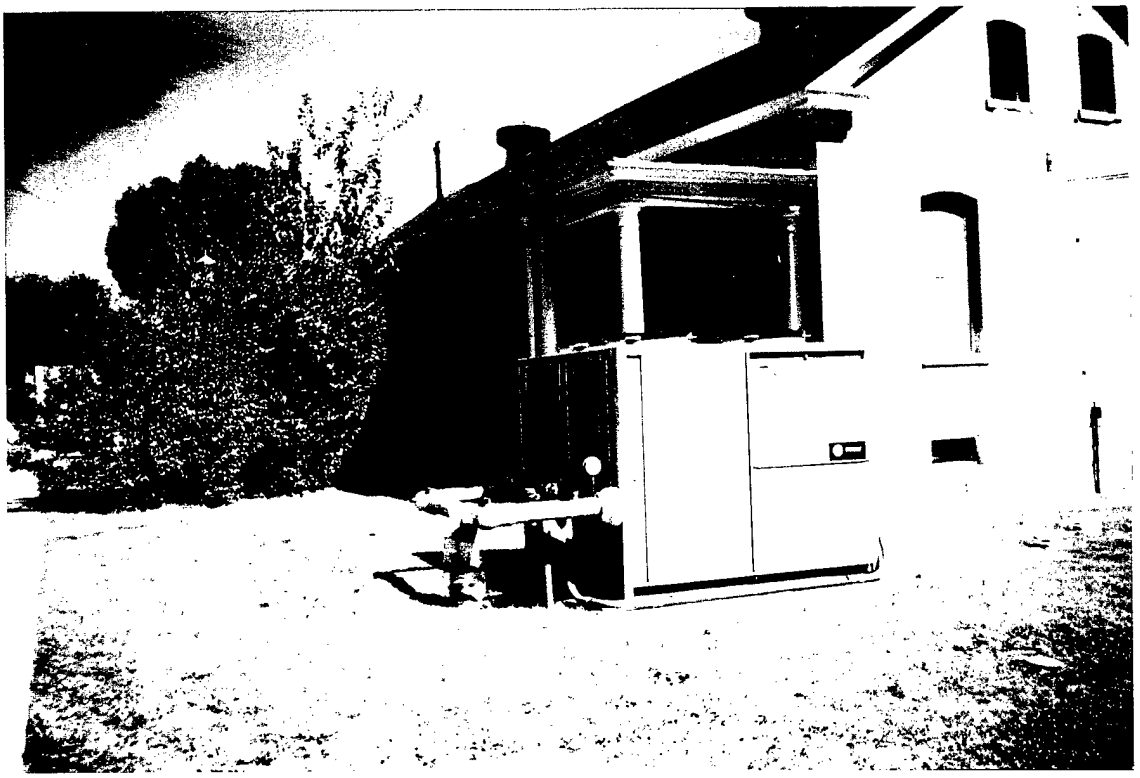
HW boiler serving building 124.



HW boiler serving building 199.



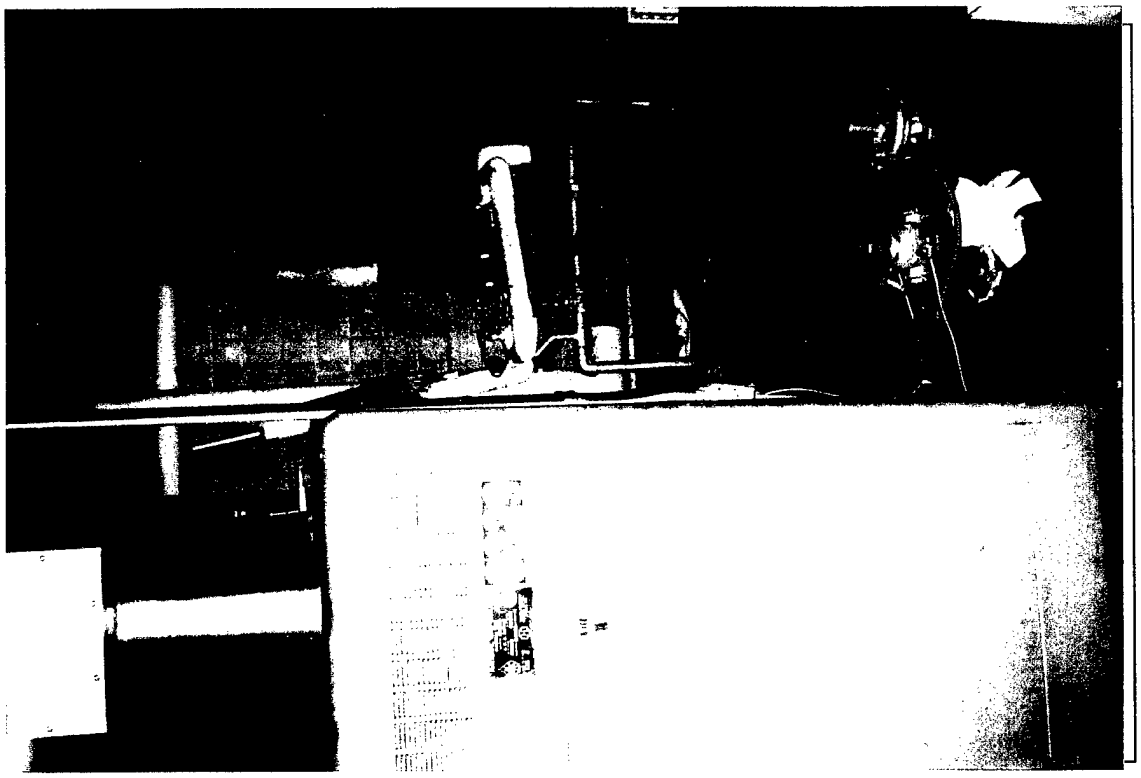
Cooling tower serving building 123.



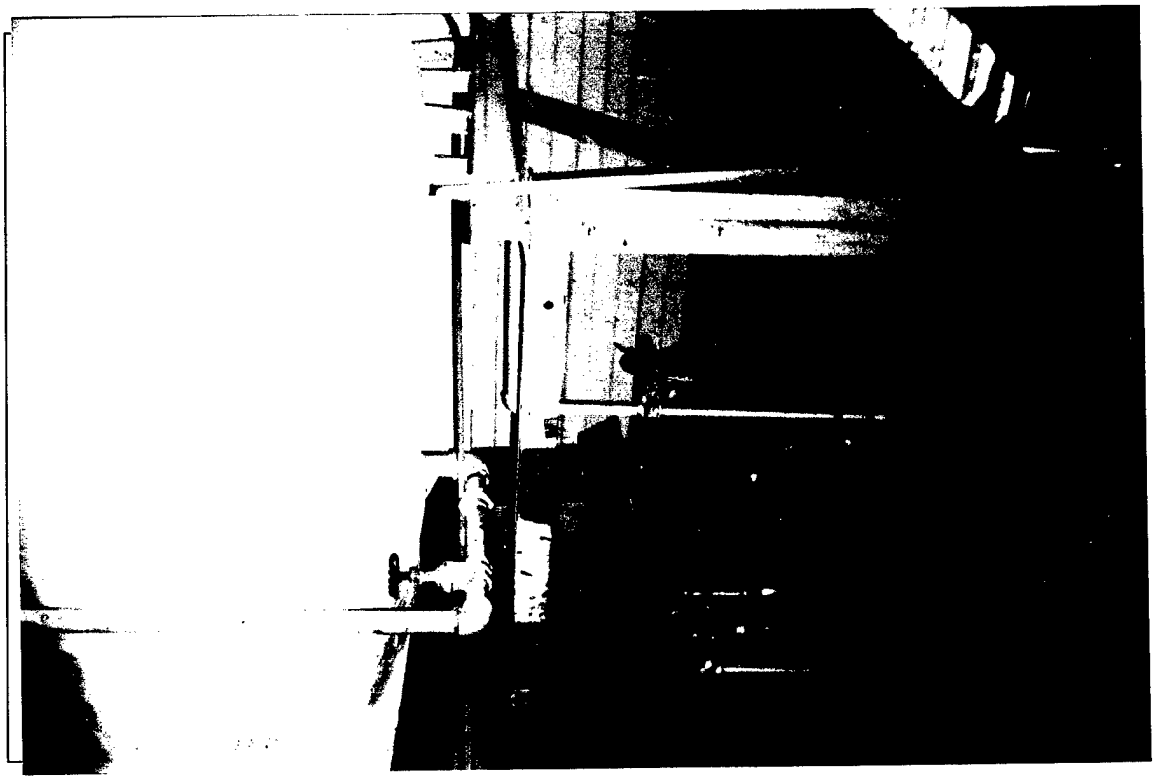
Air cooled chiller serving building 126



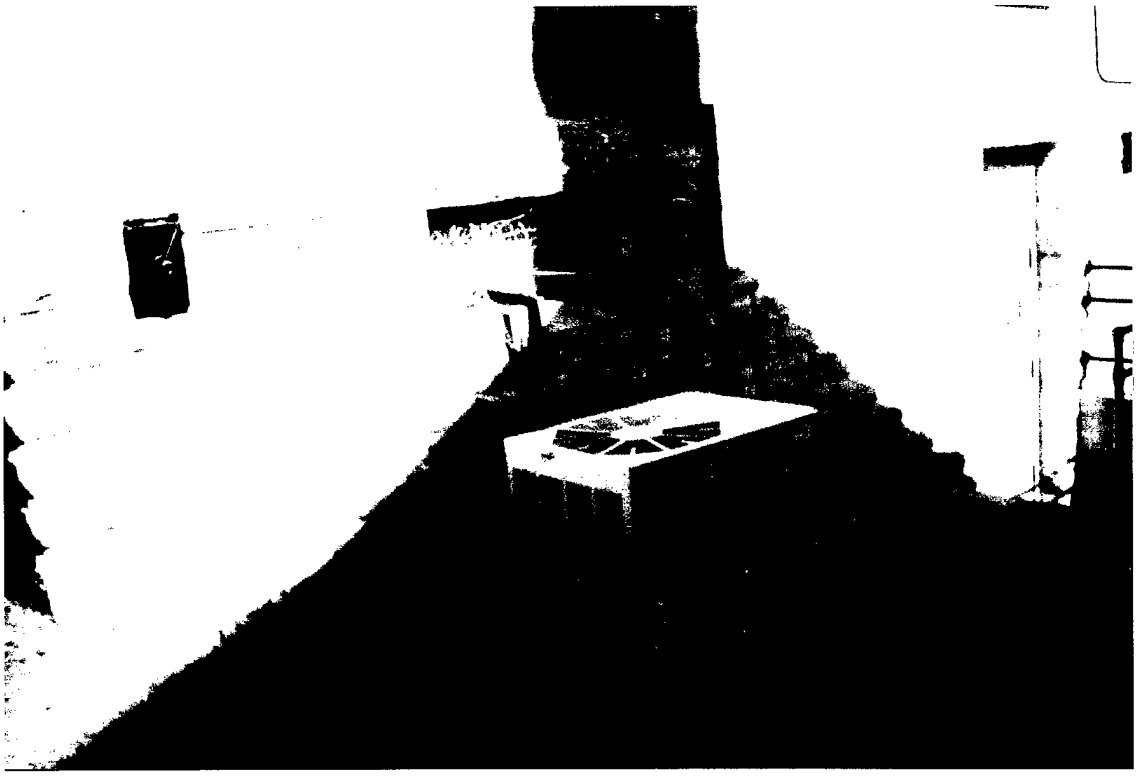
Temporary air cooled chiller serving building 129 while existing chiller is under repairs.



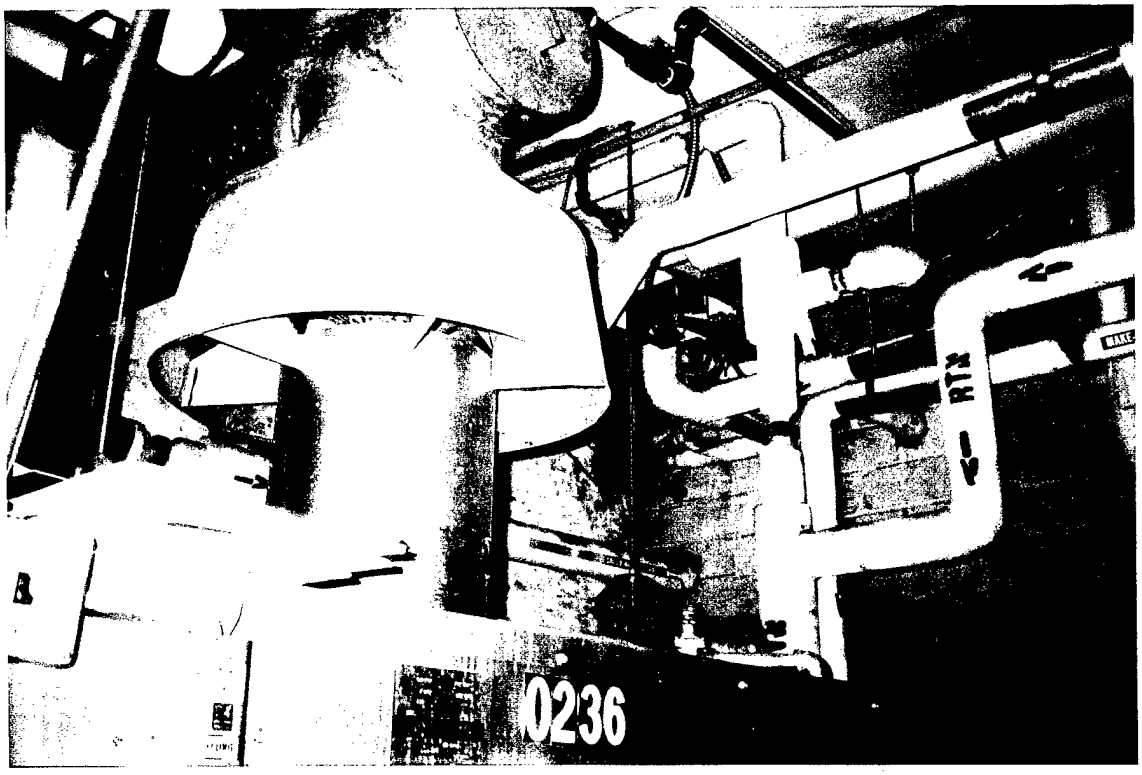
HW boiler serving building 126



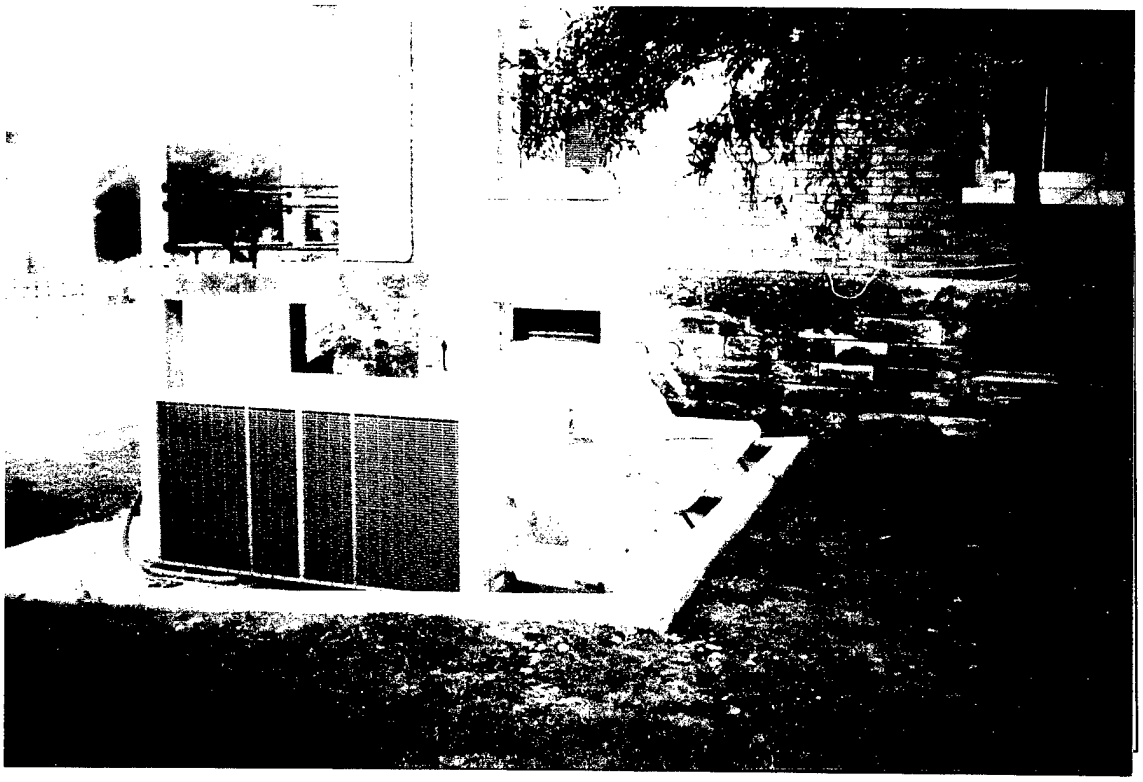
Abandoned steam boiler and heat exchanger (DHW generator) serving building 156.



Split system condensing unit serving partial basement of building 129.



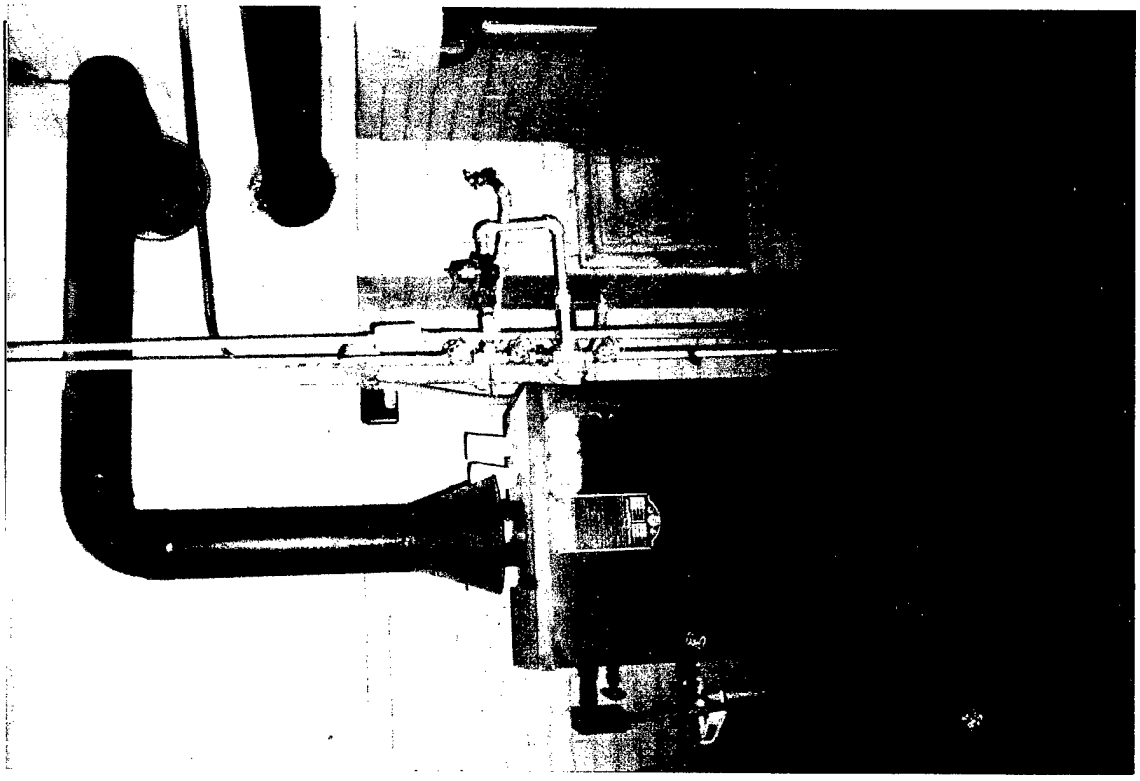
Four (4) pipe to two (2) pipe manual change-over arrangement for building 129 (typical).



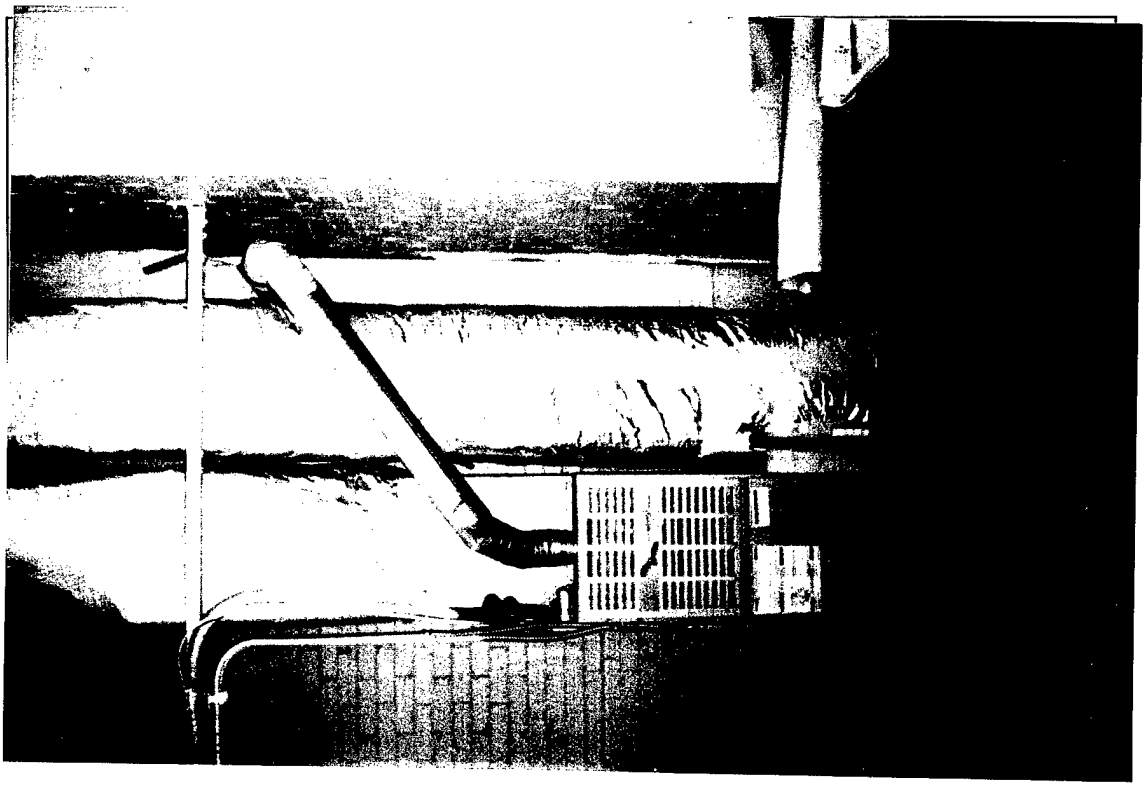
New air cooled chiller serving building 131.



Air cooled chiller serving building 126.



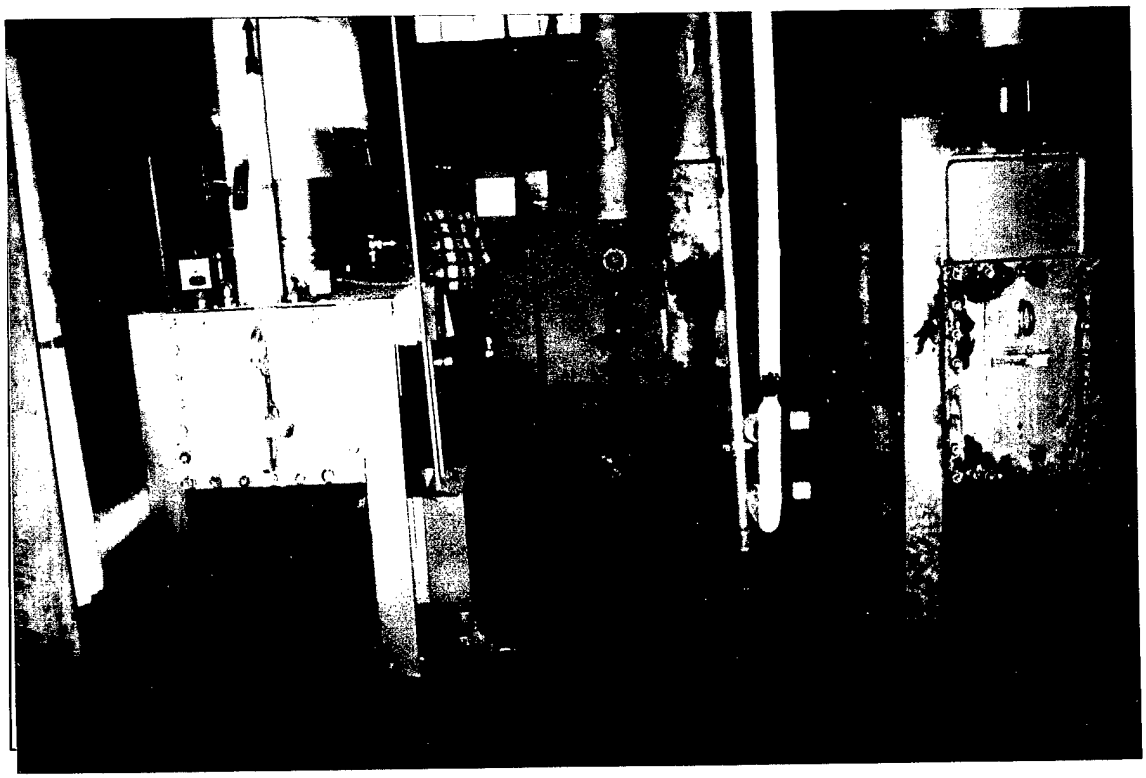
HW boiler serving building 156 (HW pump operates 24 hours/day, year round).



Residential type furnace unit serving building 159.



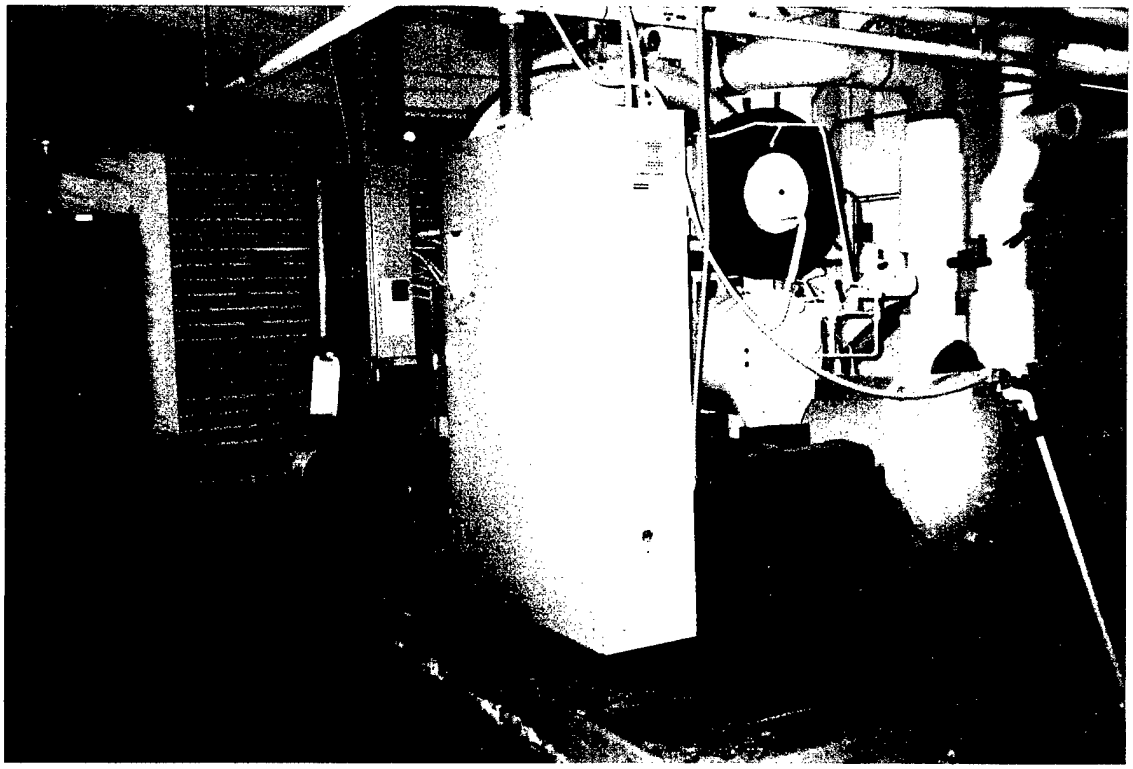
Air cooled chiller serving building 590



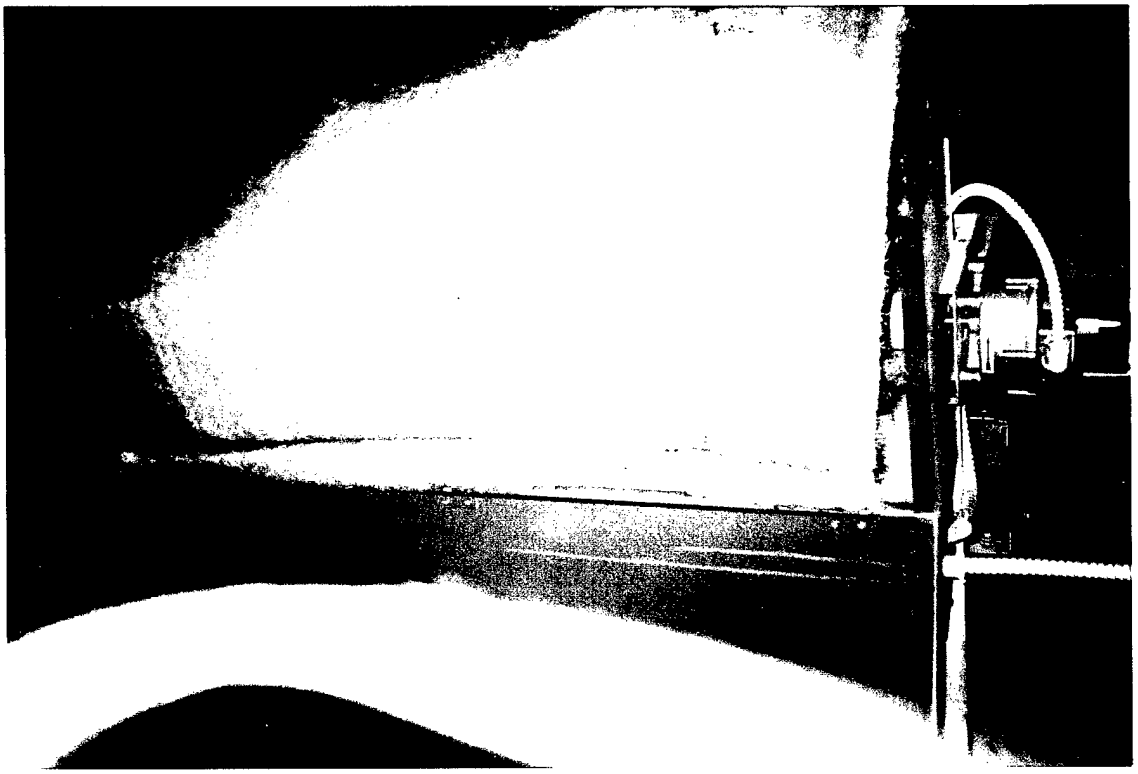
HW boiler (left) and DHW steam boiler (right) serving building 590 located in the basement.



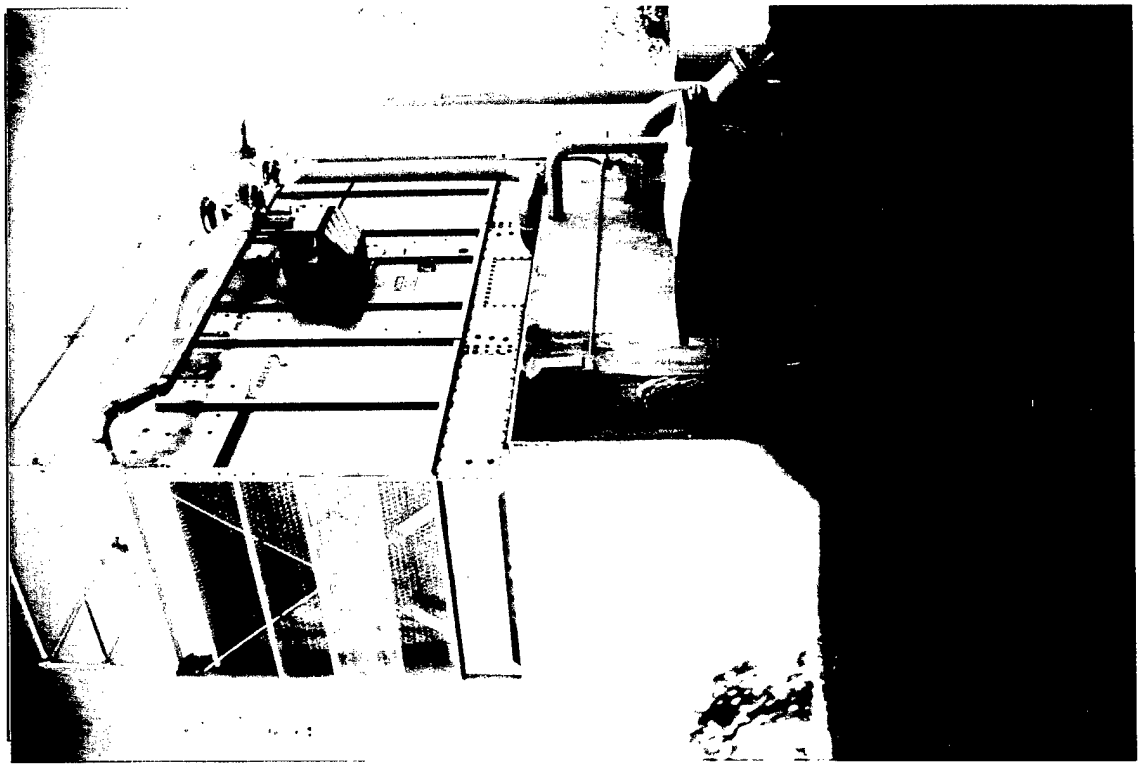
Air cooled chiller serving building 590.



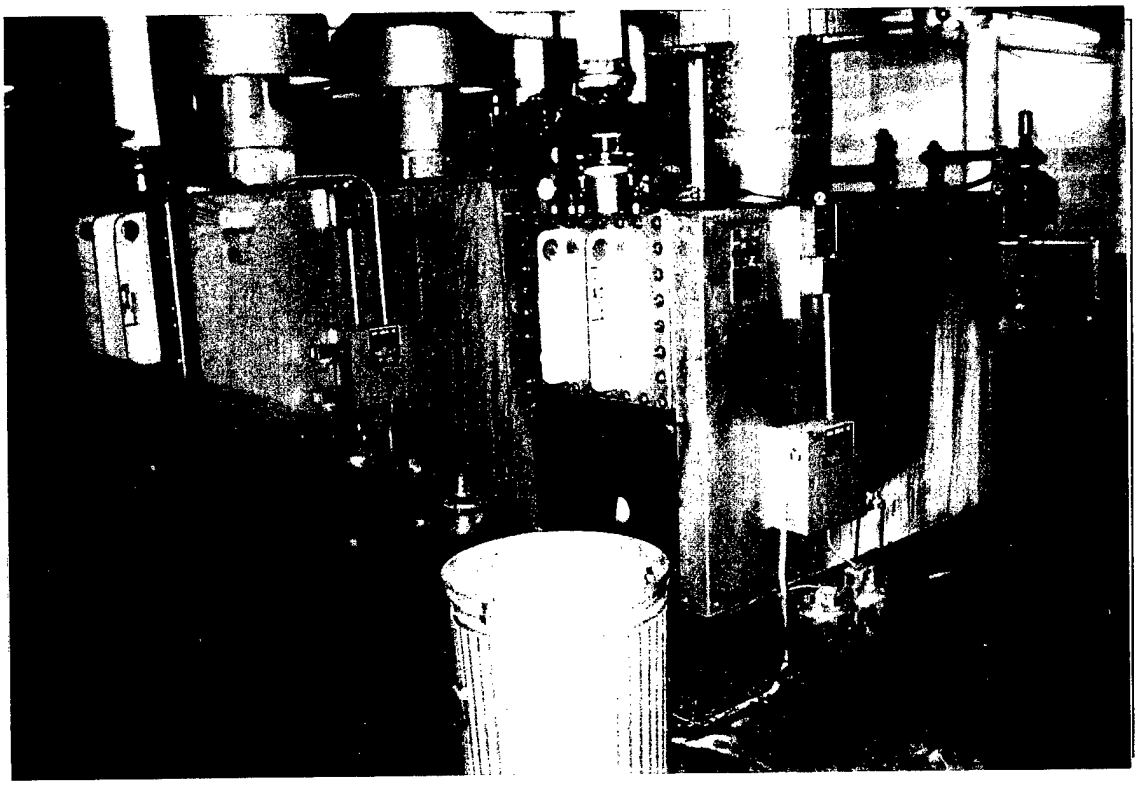
New water cooled centrifugal chiller with economizer section serving building 592.



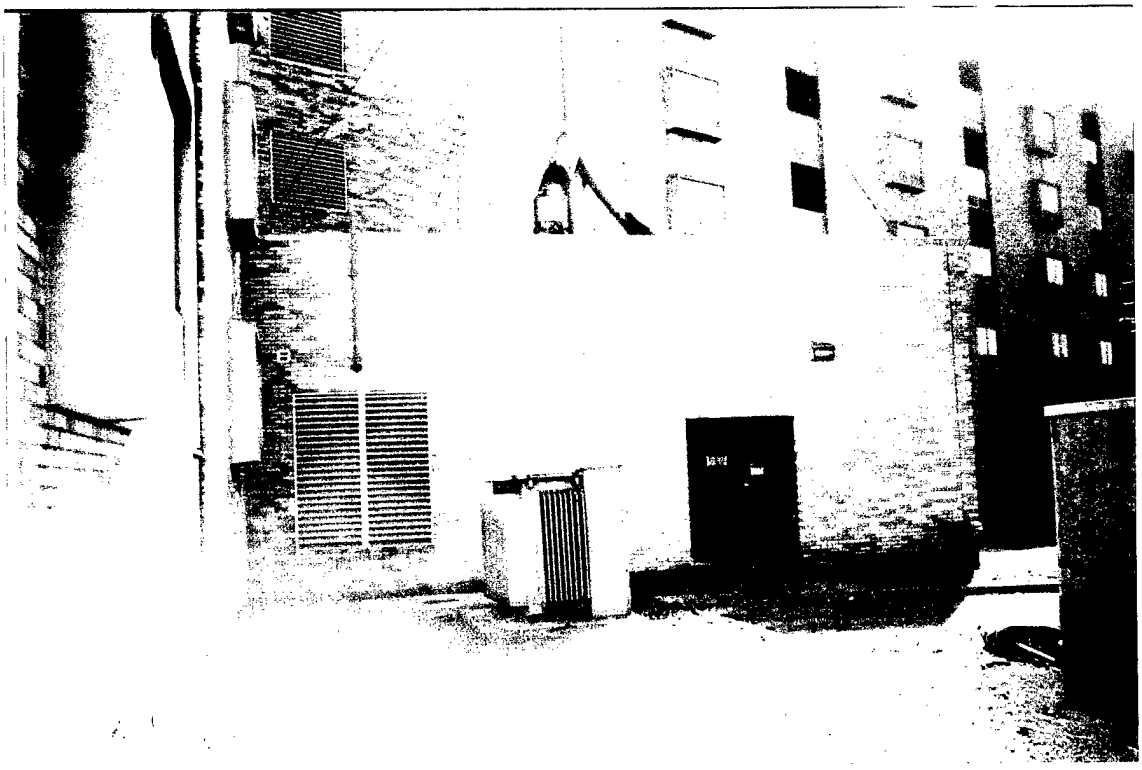
Roll filter in AHU , second floor - building 592, installed backwards.



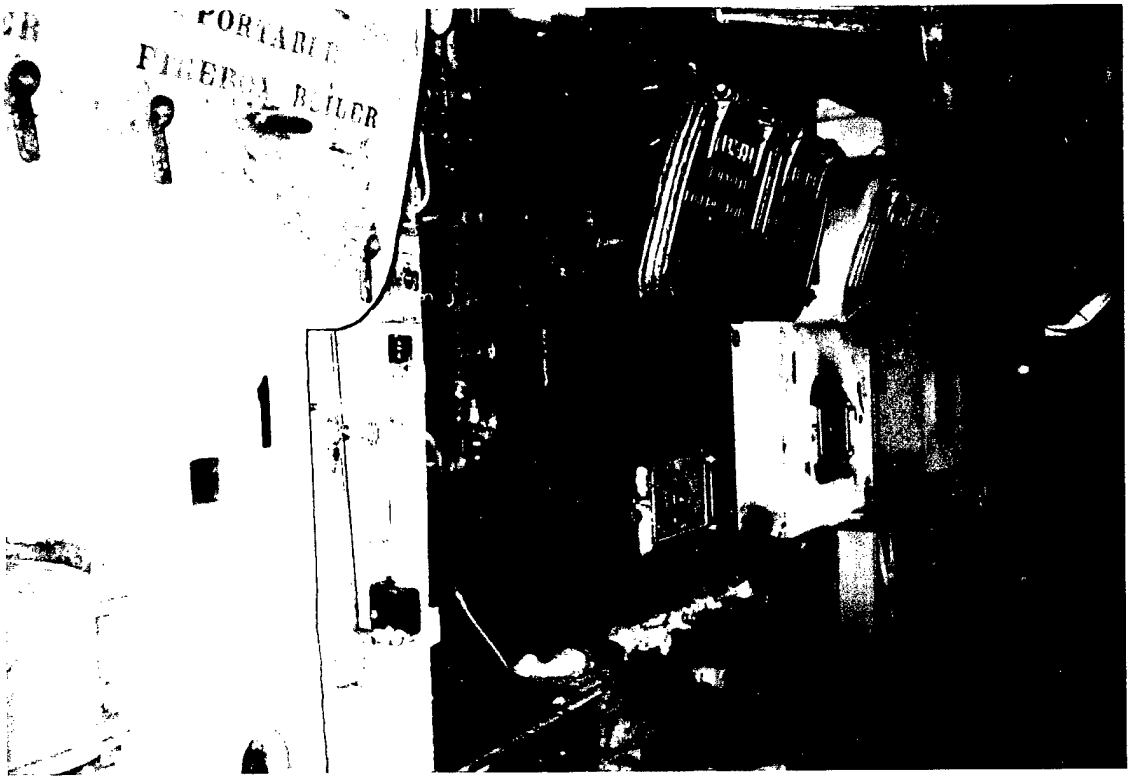
Cooling tower serving building 592 chiller.



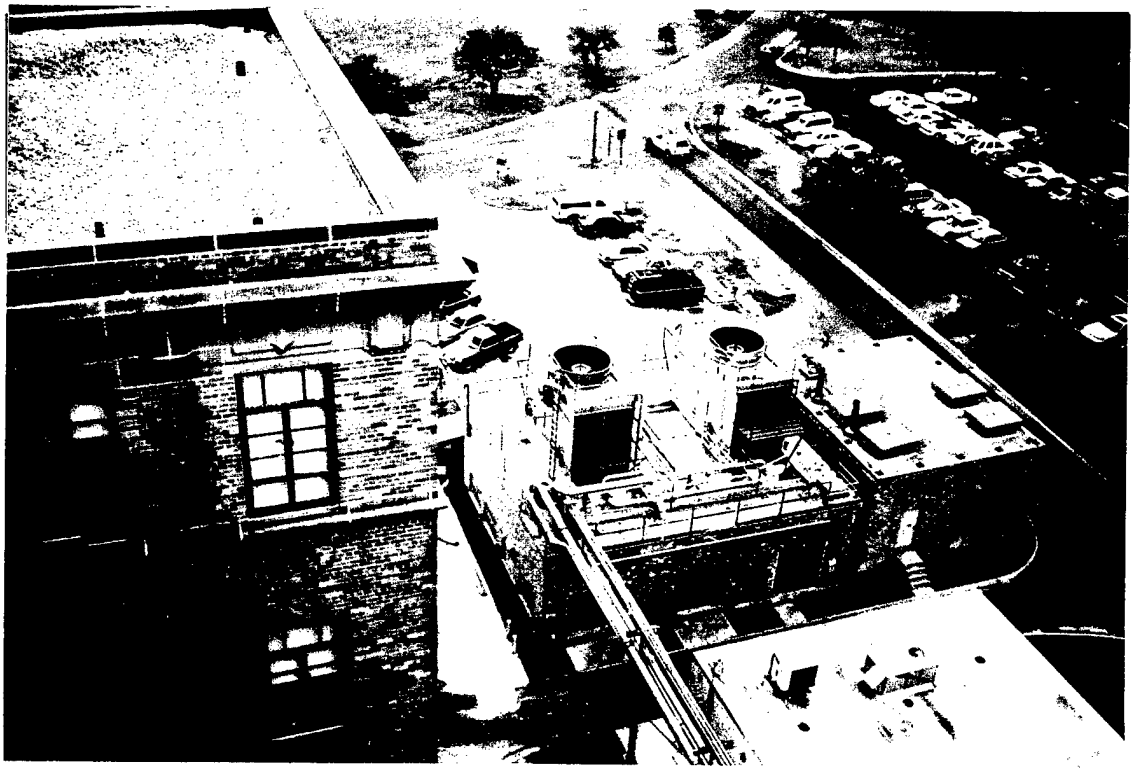
HW boiler (right) and DHW boiler (left) serving building 592.



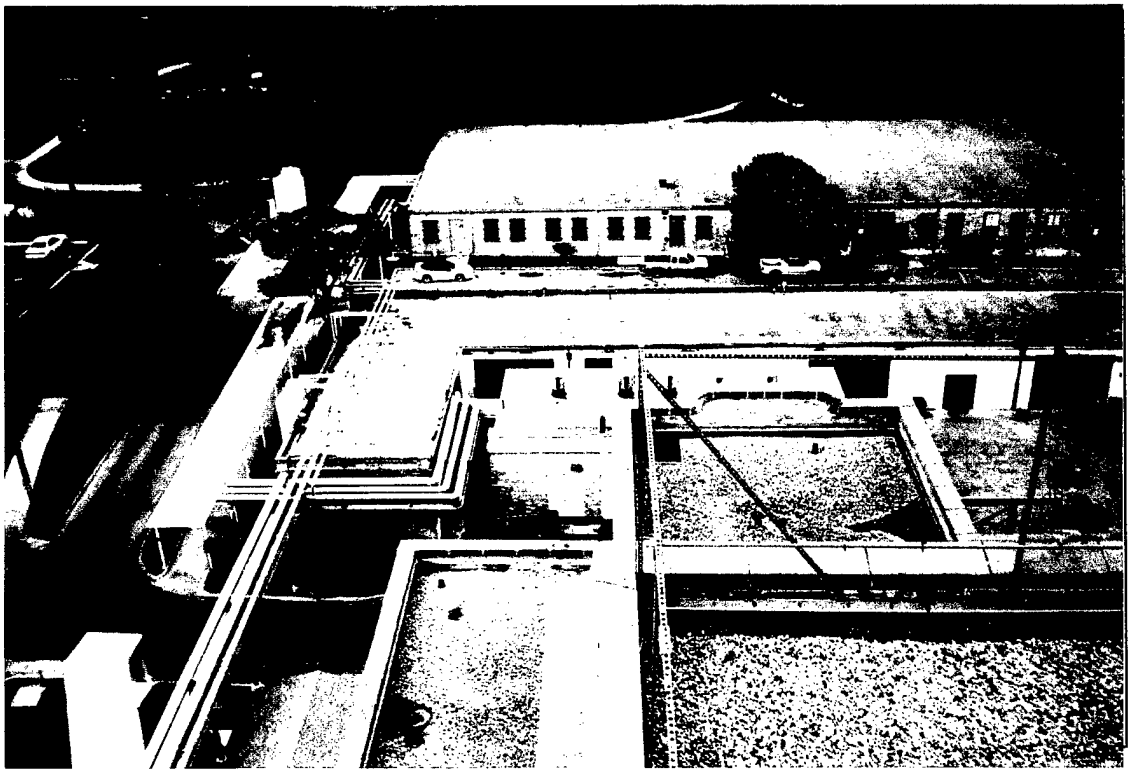
Building 592 central plant and proposed location of central plant addition.



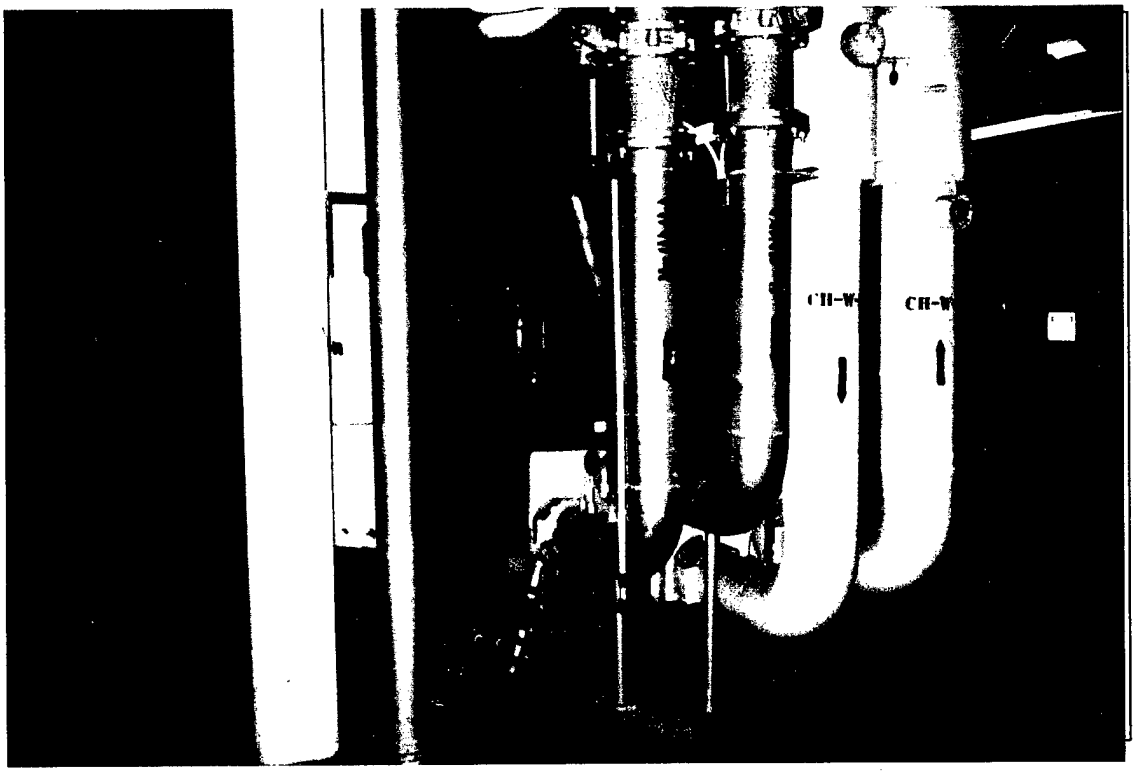
Two (2) condemned HPS boilers, and three (3) LPS boilers which serve convectors in bldg. 1000.



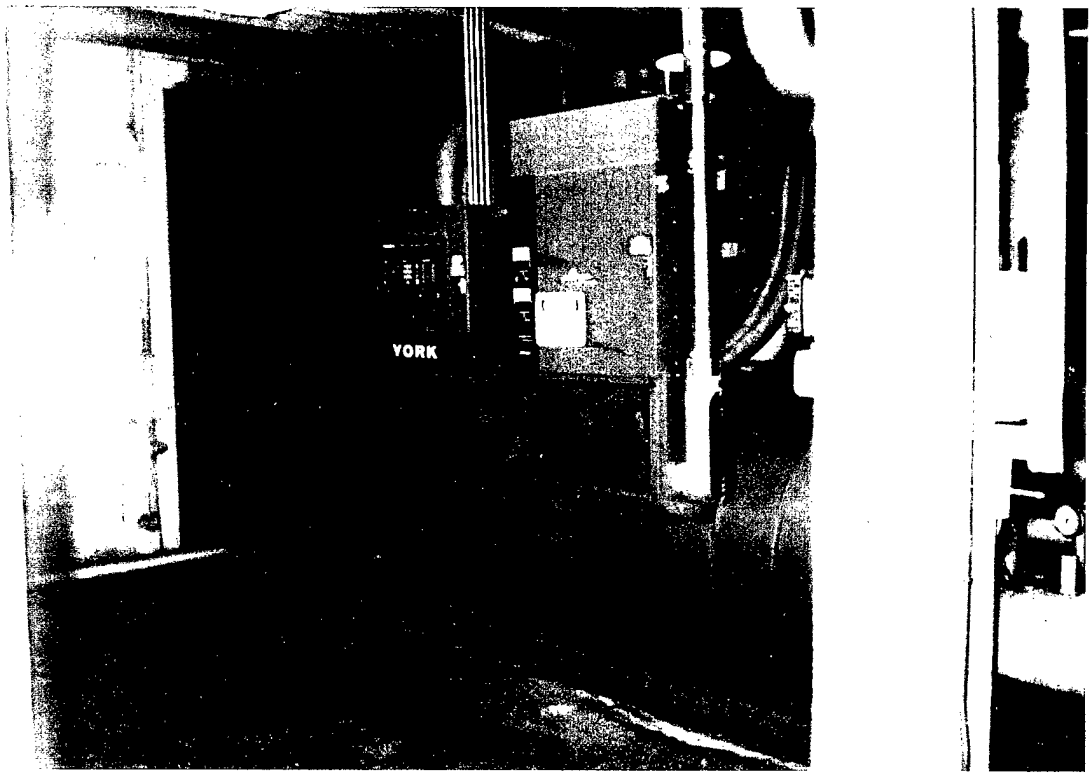
Cooling towers serving building 1000 located on the top of building 1088.



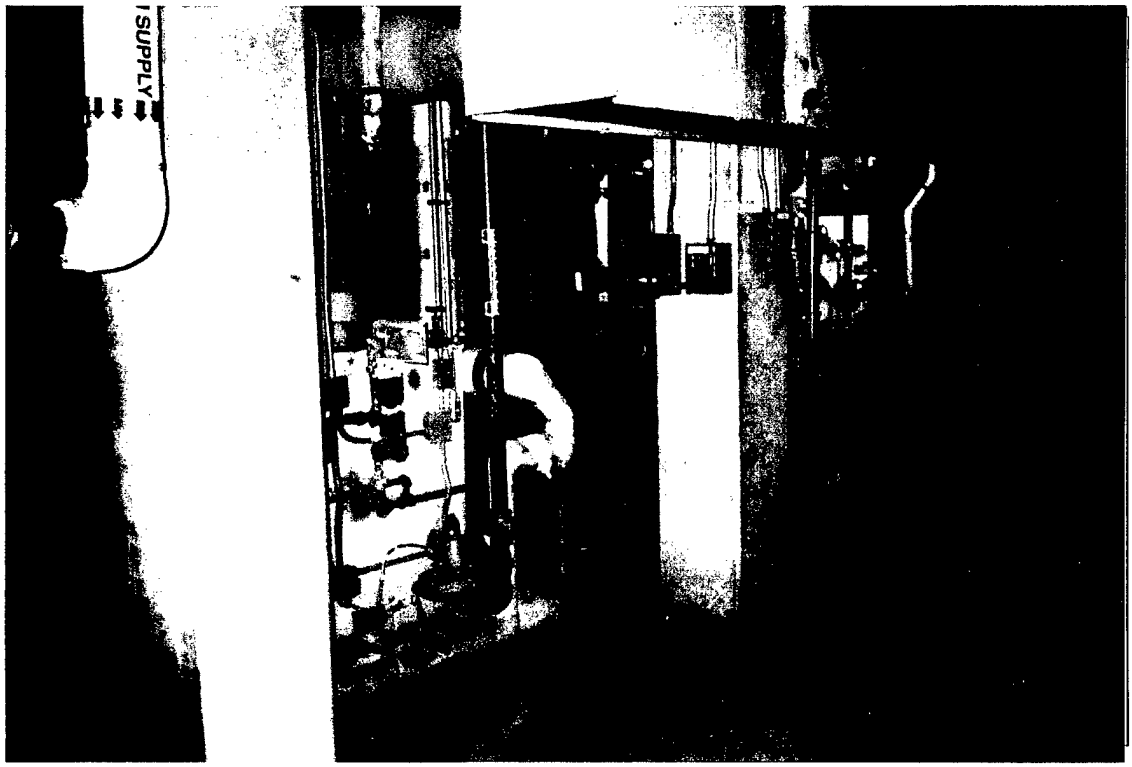
Boiler plant serving building 1000 located on the North side.



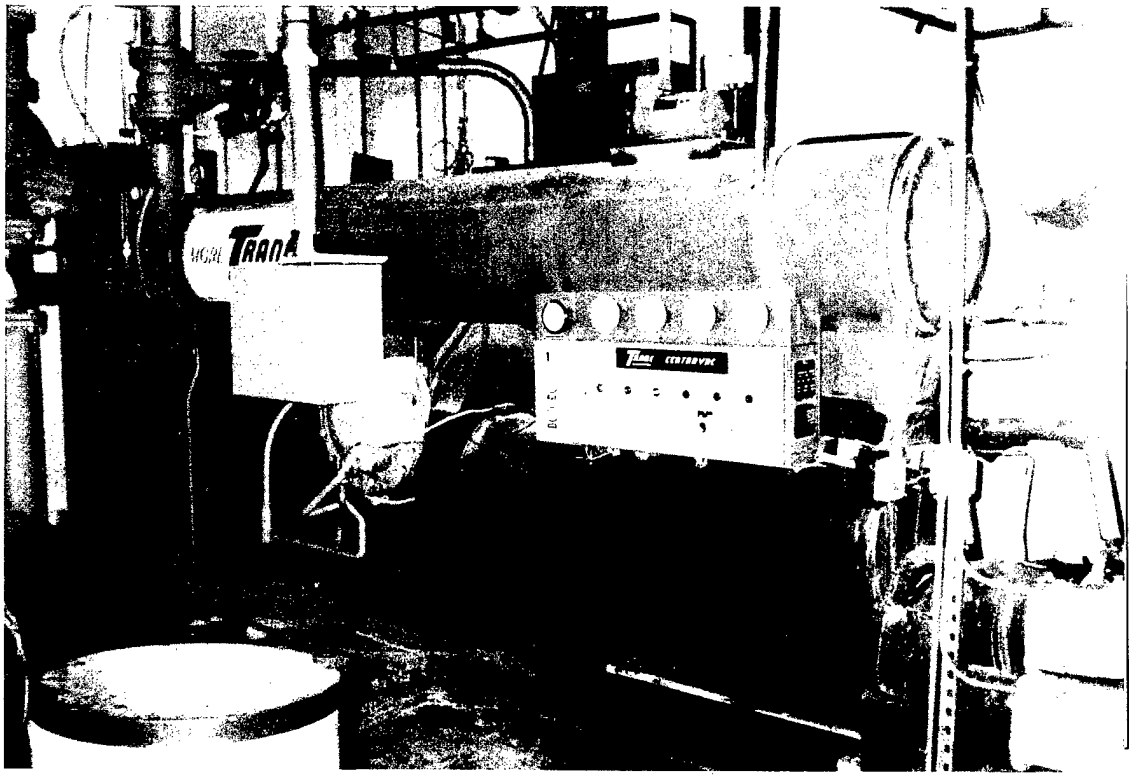
Water cooled centrifugal chiller (CH-1) serving building 1000 located in building 1088.



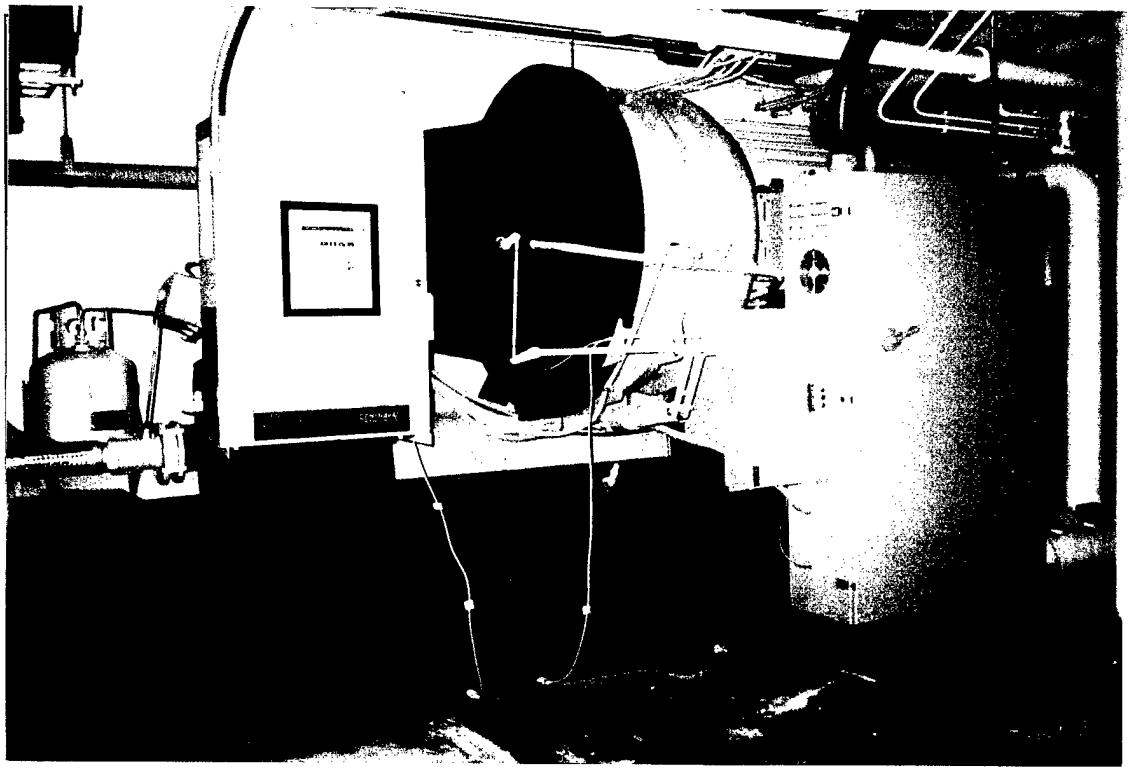
Water cooled centrifugal chiller (CH-2) serving building 1000 located in building 1088.



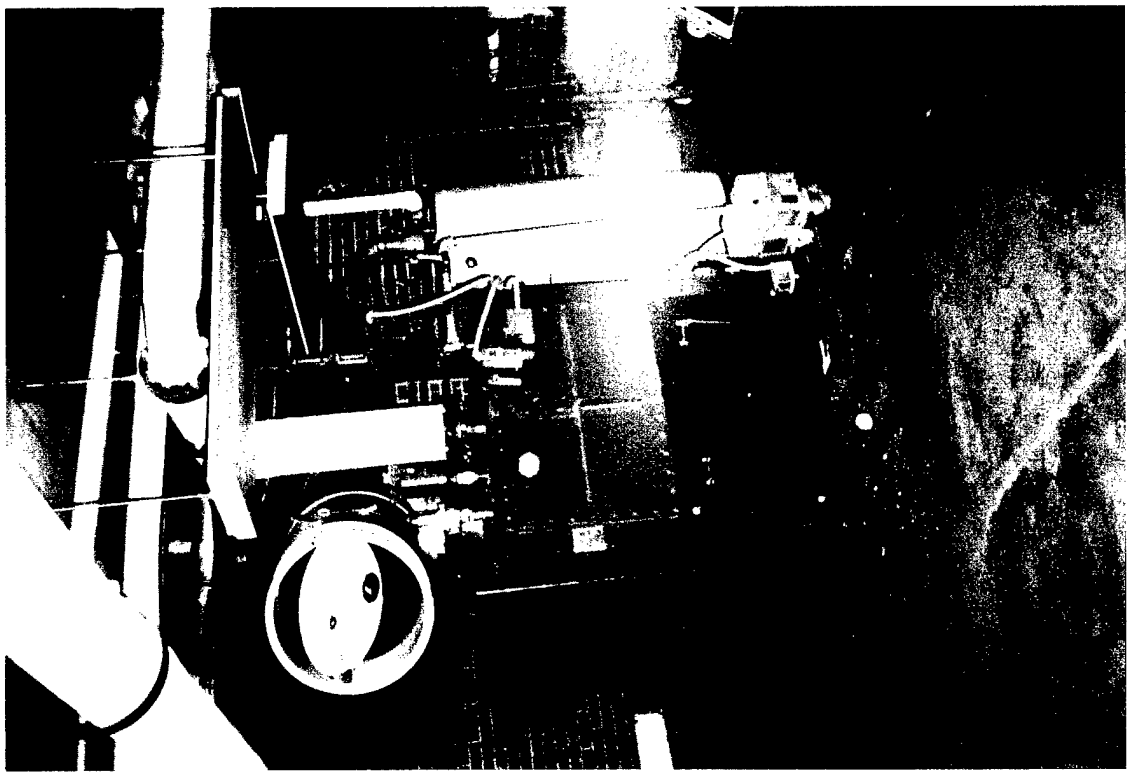
Two (2) abandoned and one (1), far right, operational steam boiler in basement of building 1001.



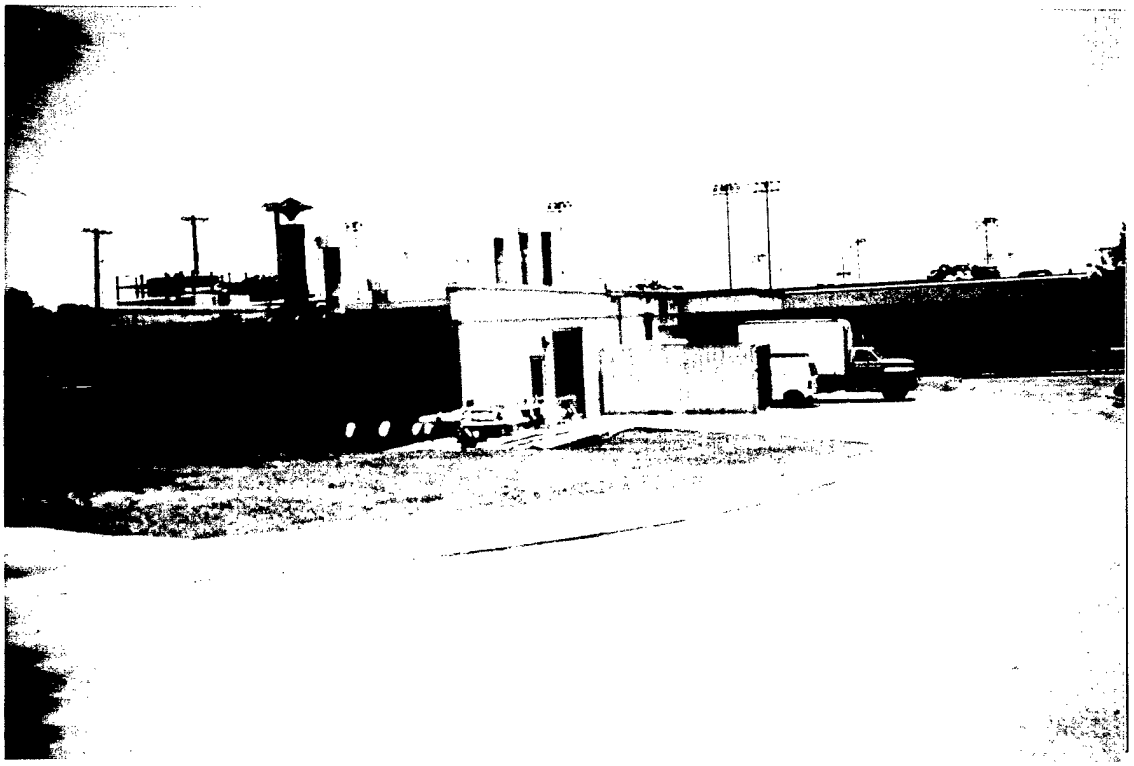
Water cooled centrifugal chiller serving building 1001 and located in building 1002.



New water cooled centrifugal chiller serving building 1029 located in basement of building.



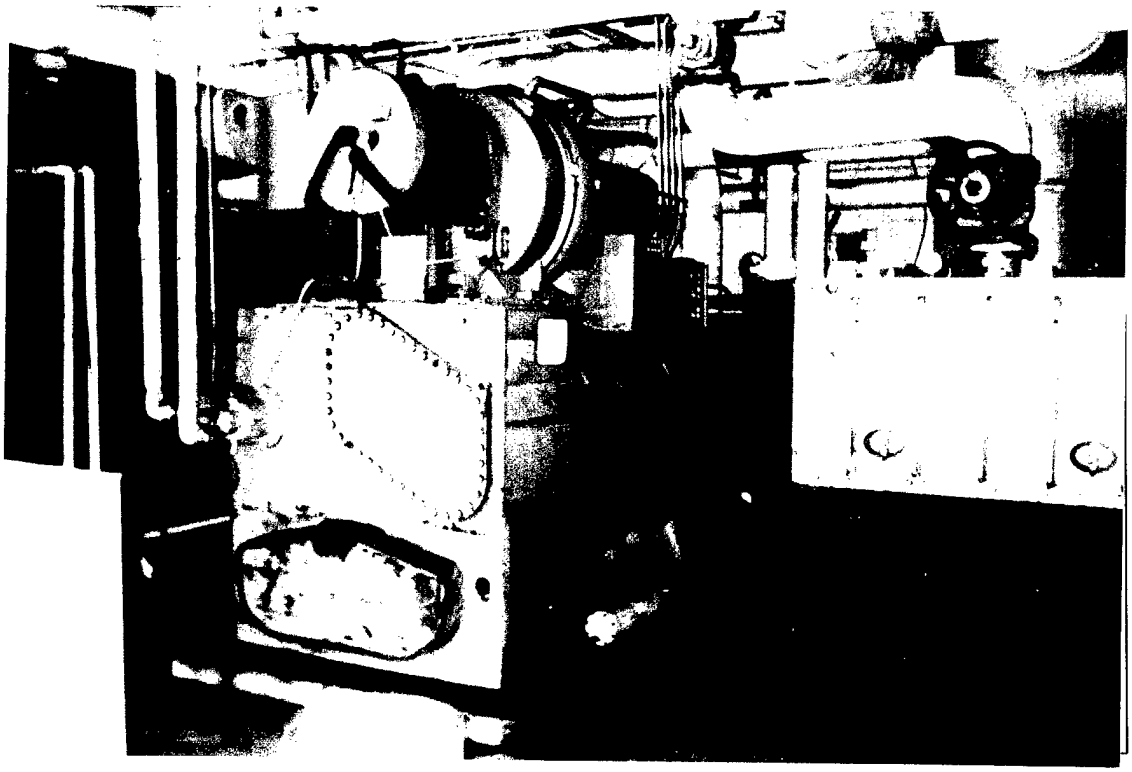
HW boiler and DHW heater serving building 1029 located in basement.



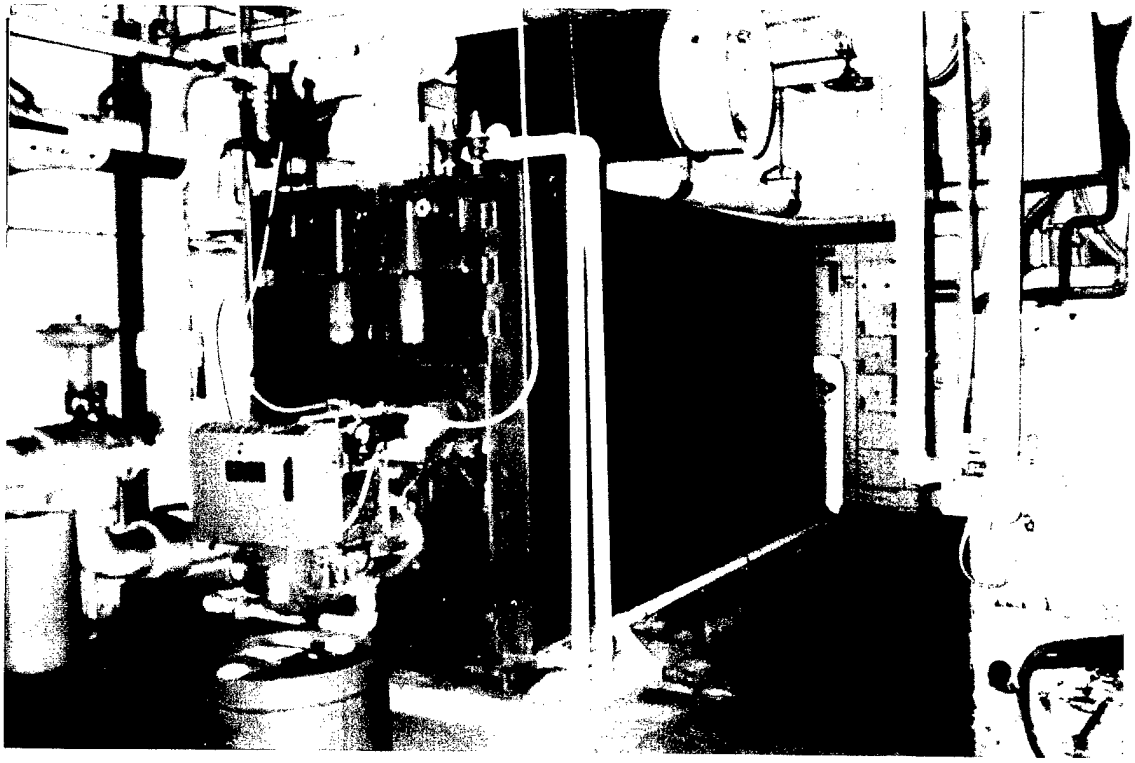
Bldgs.1350, 1374, 1375,1377, 1379, & 1380 central plant located adjacent to bldg. 1377.



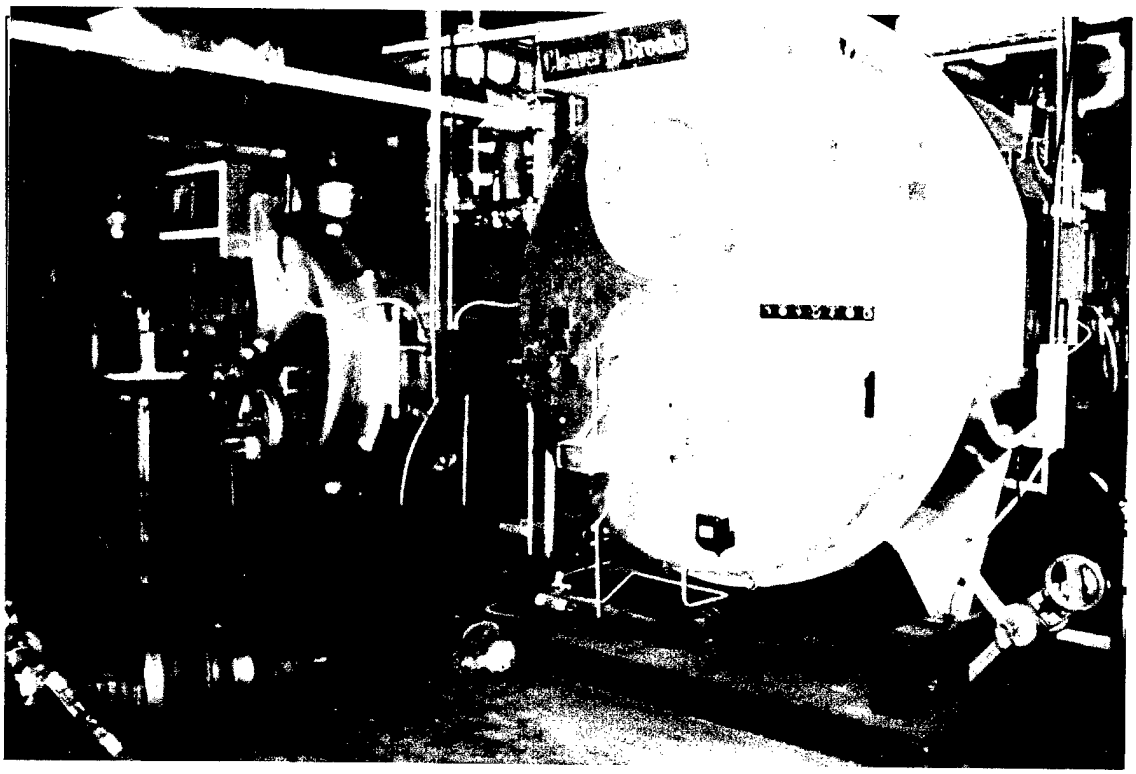
Bldgs.1350, 1374, 1375,1377, 1379, & 1380 cooling towers.



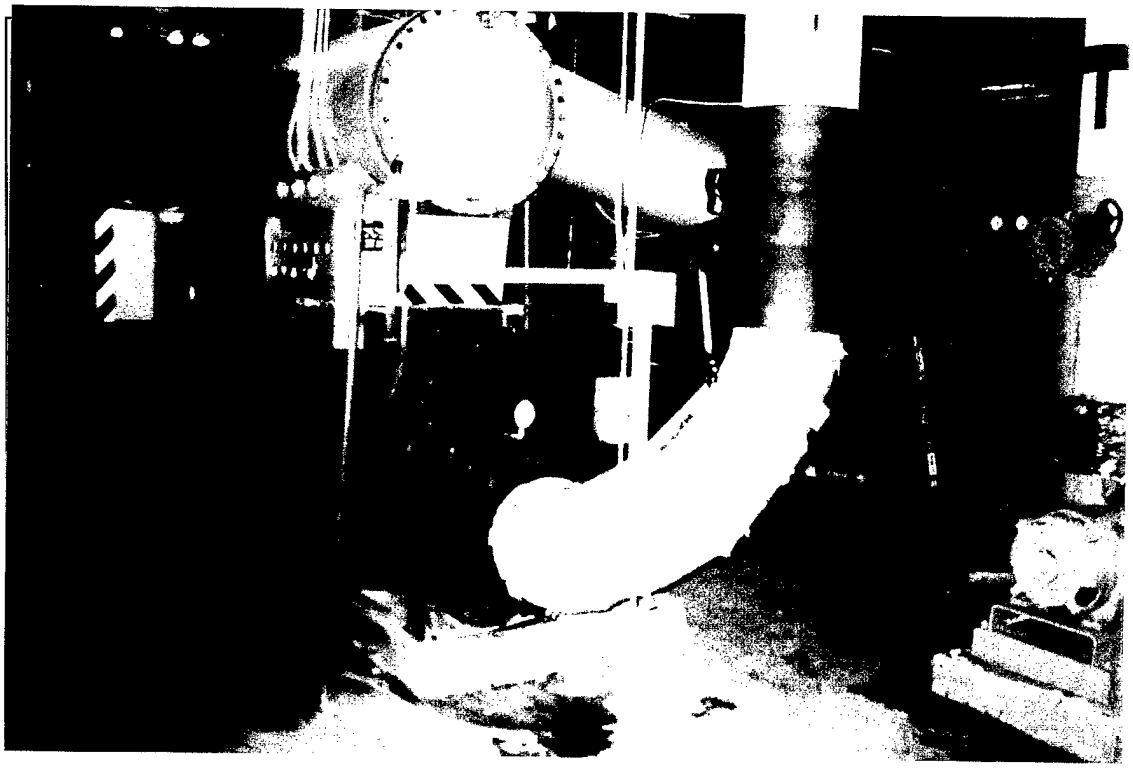
Building 1350 water cooled centrifugal chiller and the second of two (2) HW boilers.



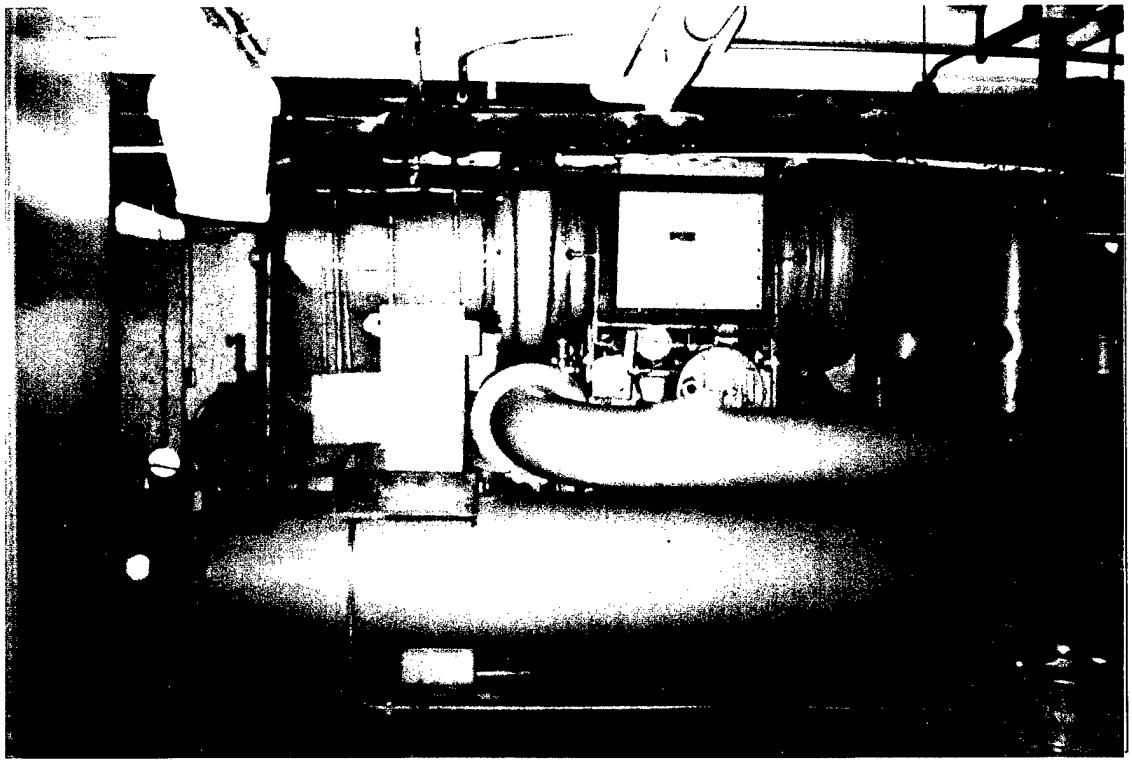
The first of two (2) HW boilers serving building 1350.



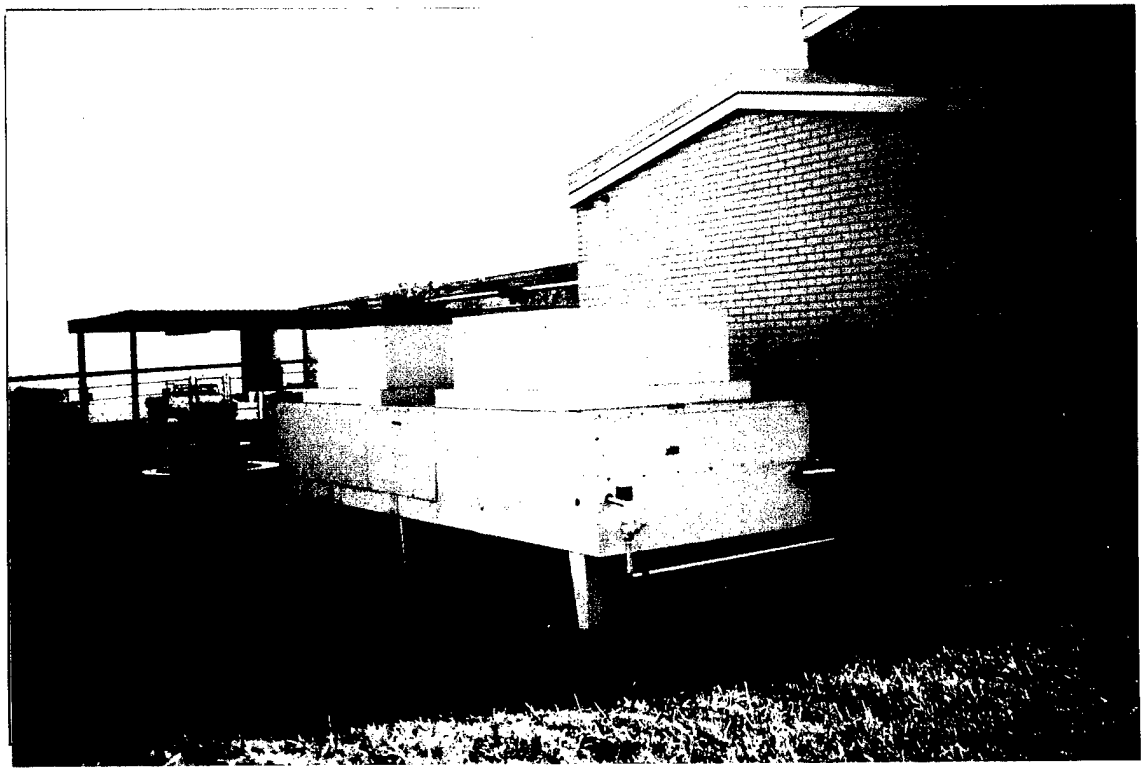
Two (2) HW boilers and one (1) steam boiler serving bldgs. 1374, 1375, 1377, 1379, & 1380



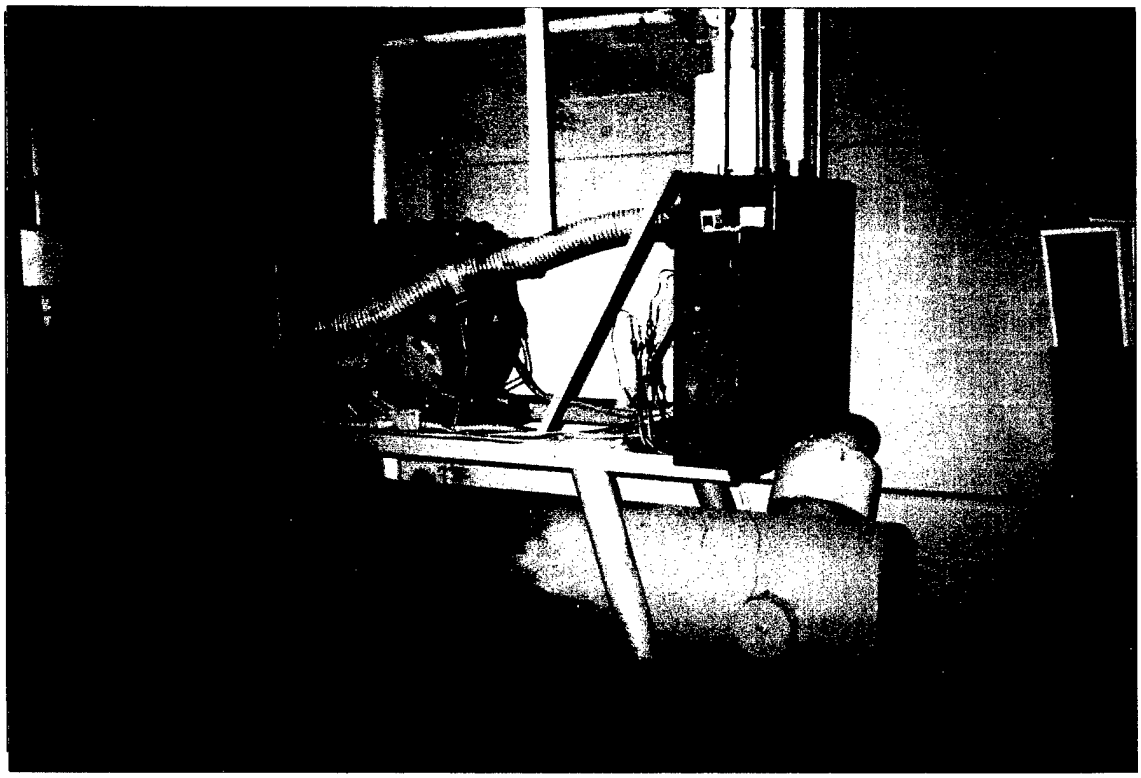
First of two (2) water cooled centrifugal chillers serving bldgs. 1374, 1375, 1377, 1379, & 1380.



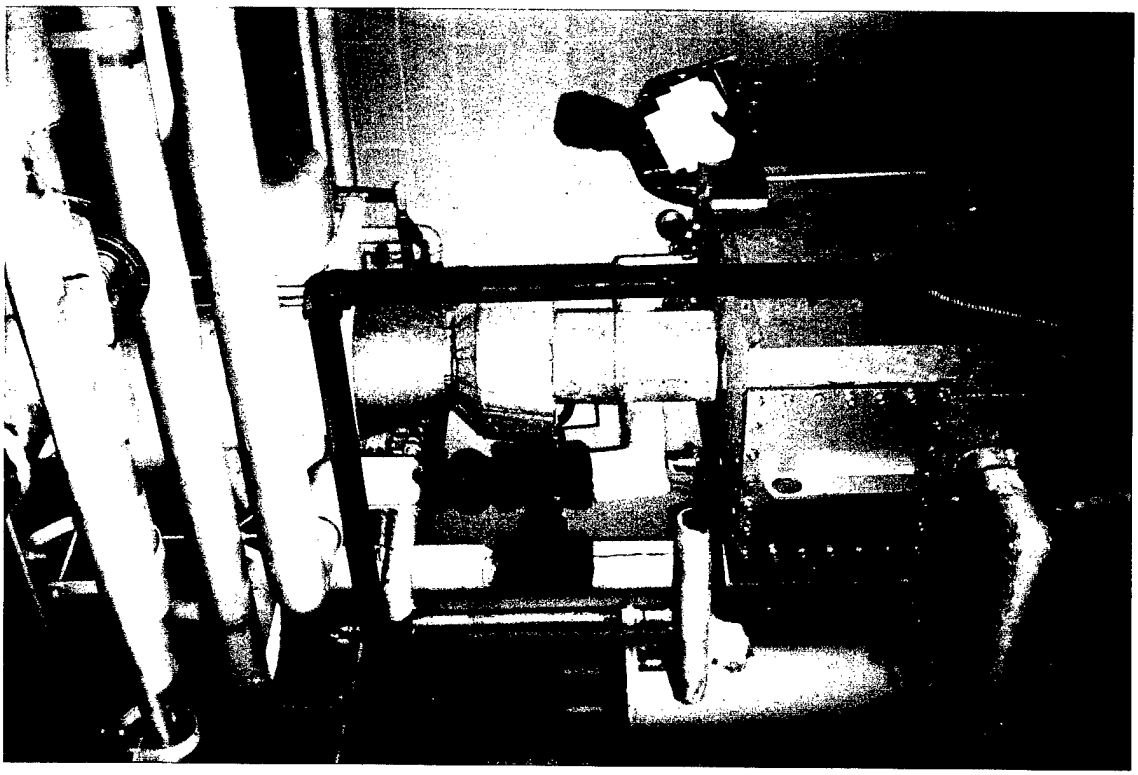
Second of two (2) water cooled centrifugal chillers serving bldgs. 1374, 1375, 1377, 1379, & 1380



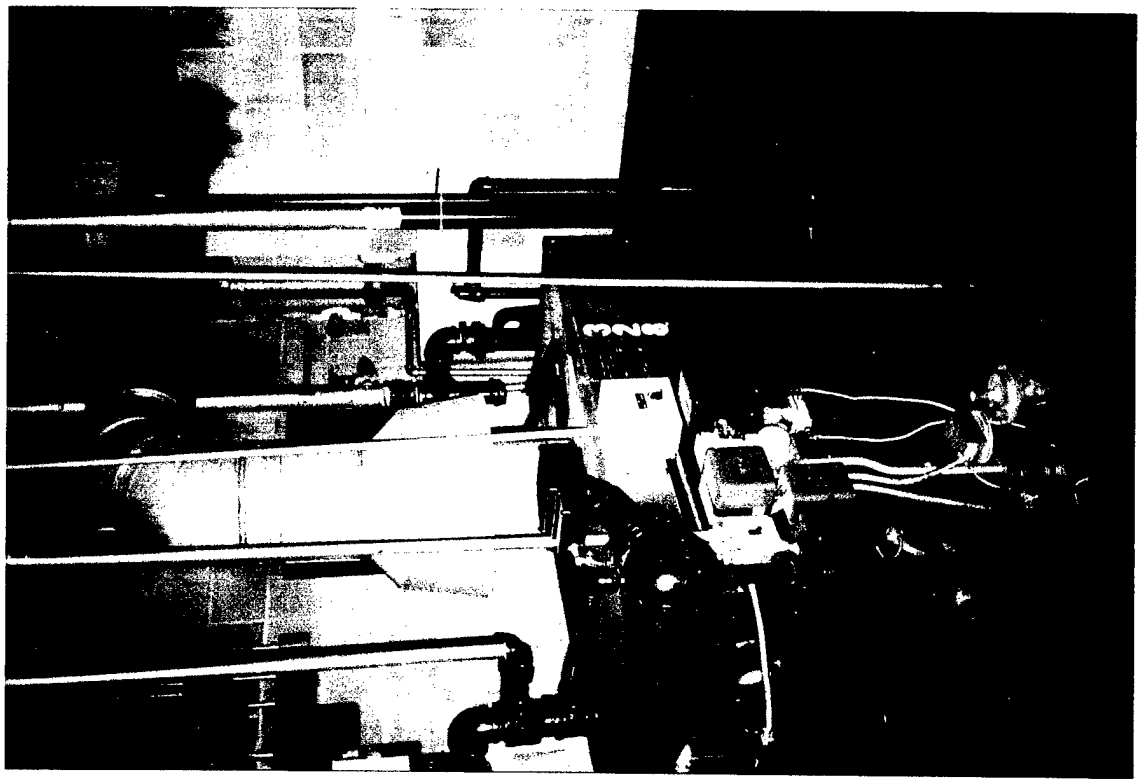
Air cooled condenser serving building 1398.



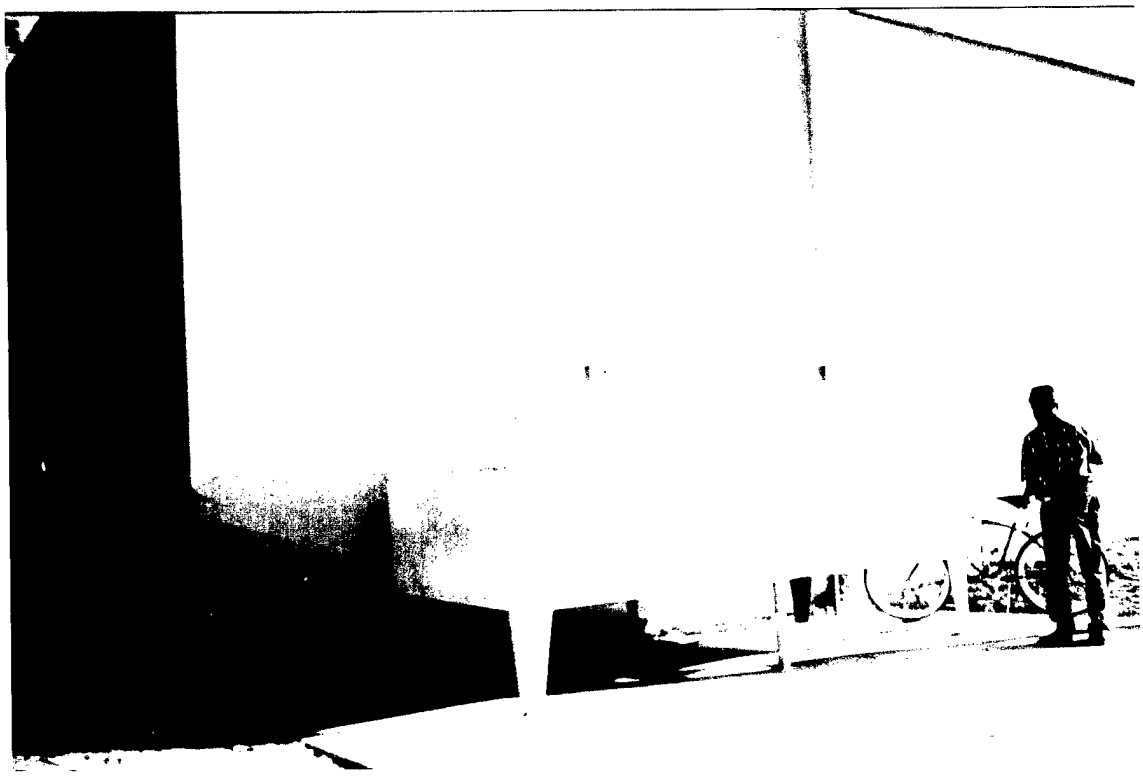
Hermetic chiller serving building 1398



HW boiler serving building 1398.



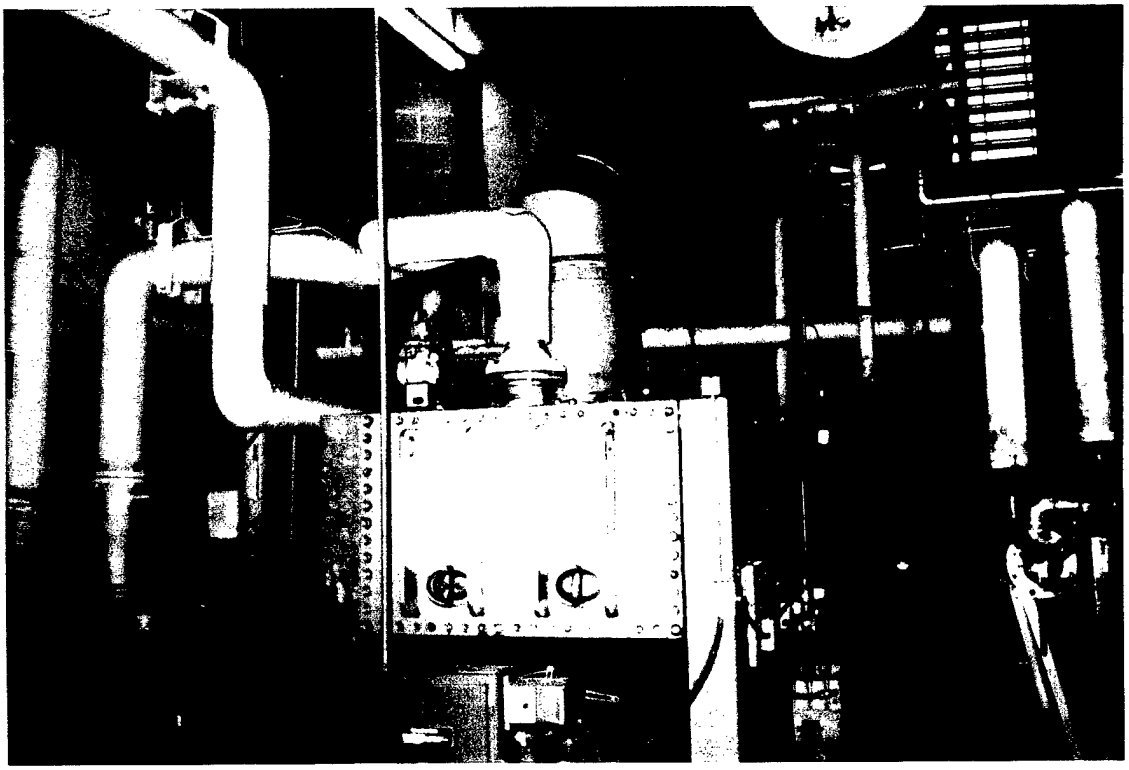
HW boiler serving building 1396.



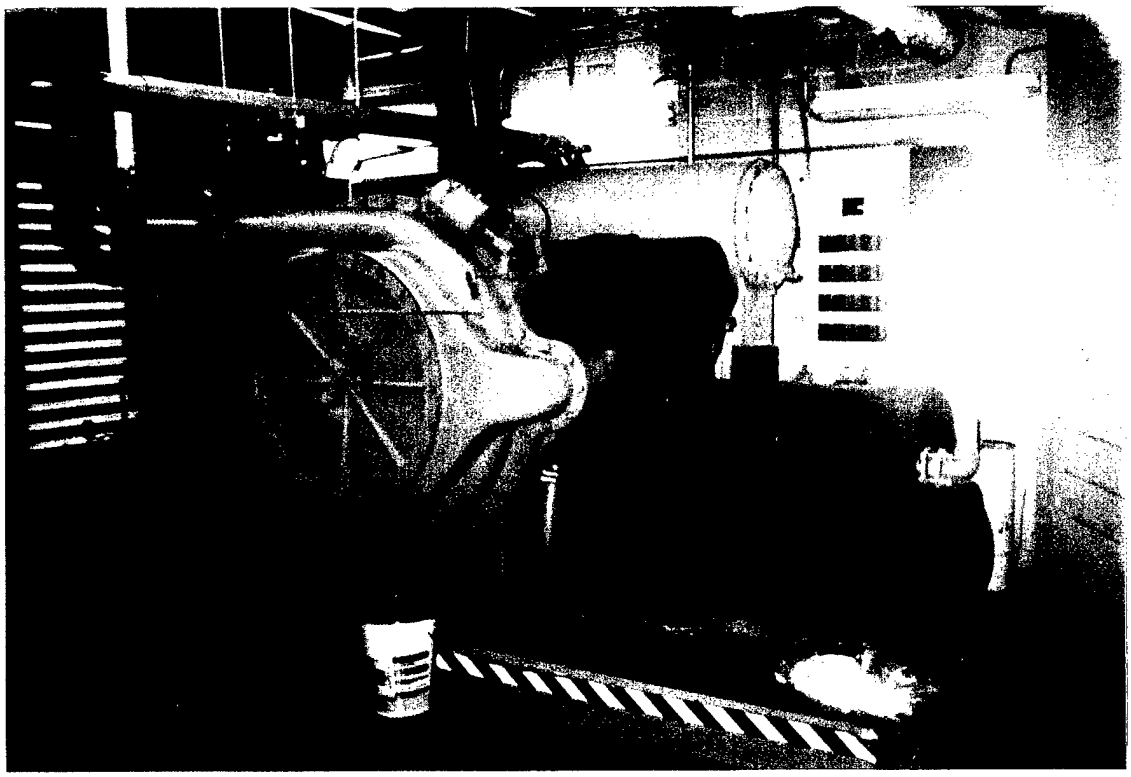
Air cooled condenser serving building 1396.



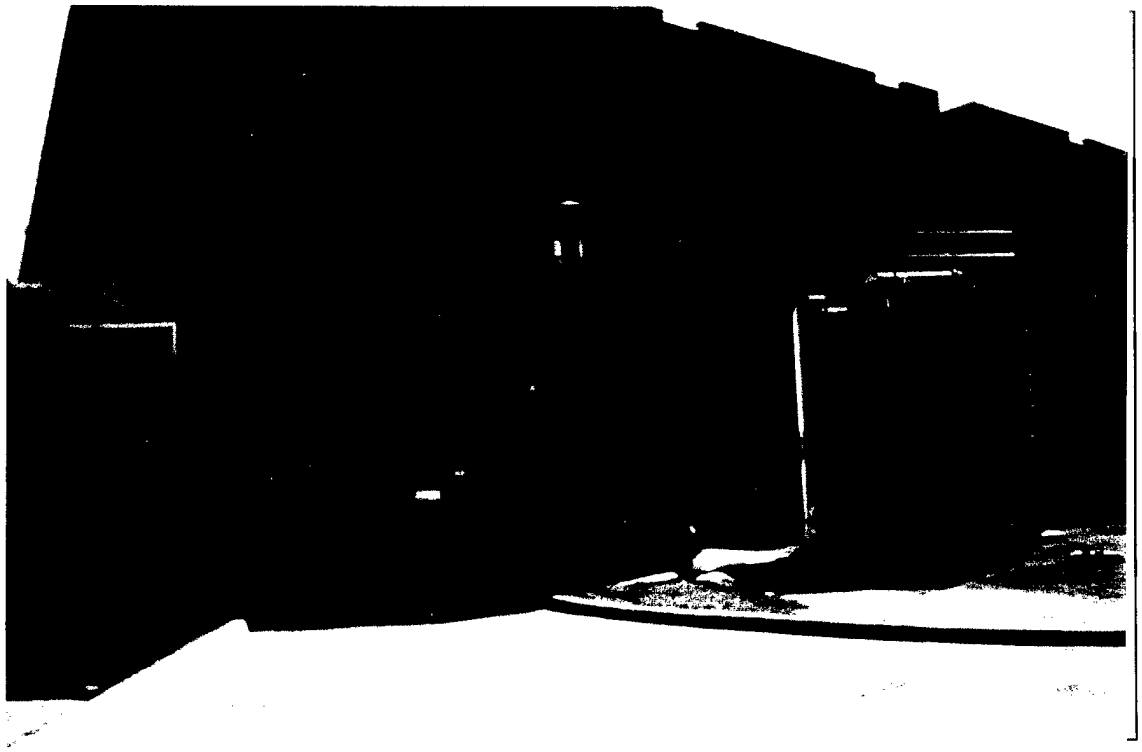
Cooling tower serving chiller for building 1384.



HW boiler serving building 1384.



Water cooled centrifugal chiller serving building 1384.



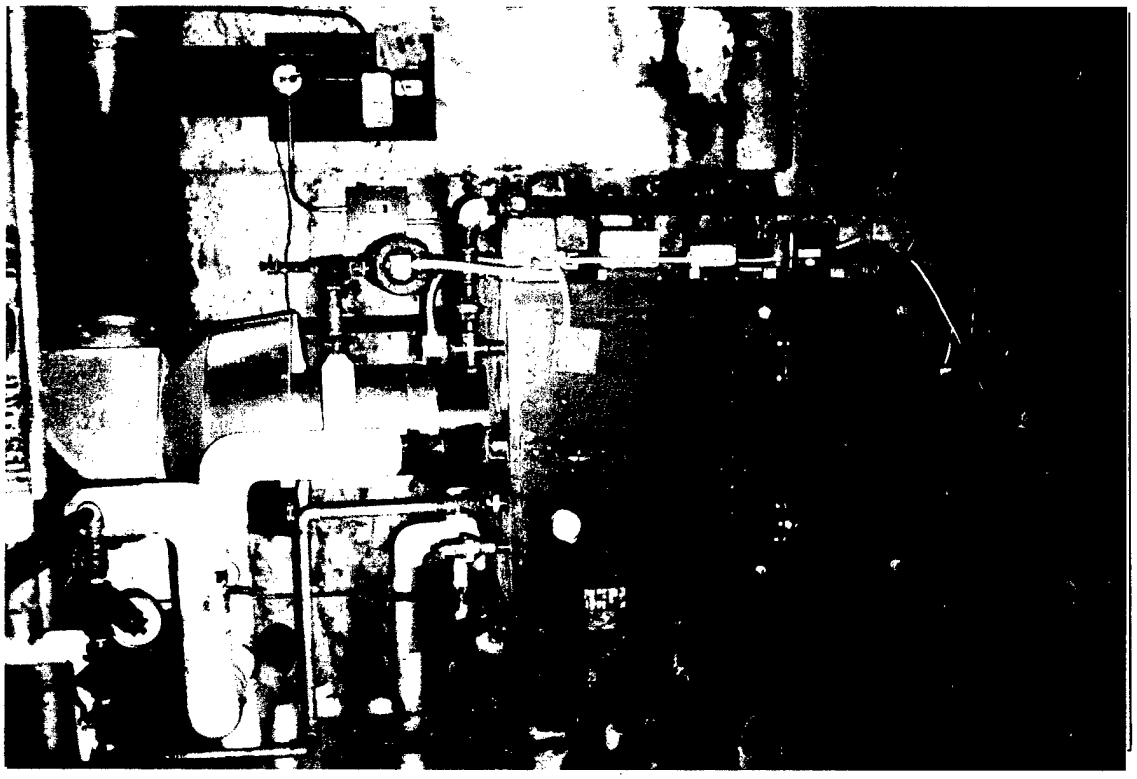
Central plant for building 1384.



Open drive DX compressor and evaporator barrel serving building 2247.



HW boiler serving building 2247. Flooding occurs in this basement.



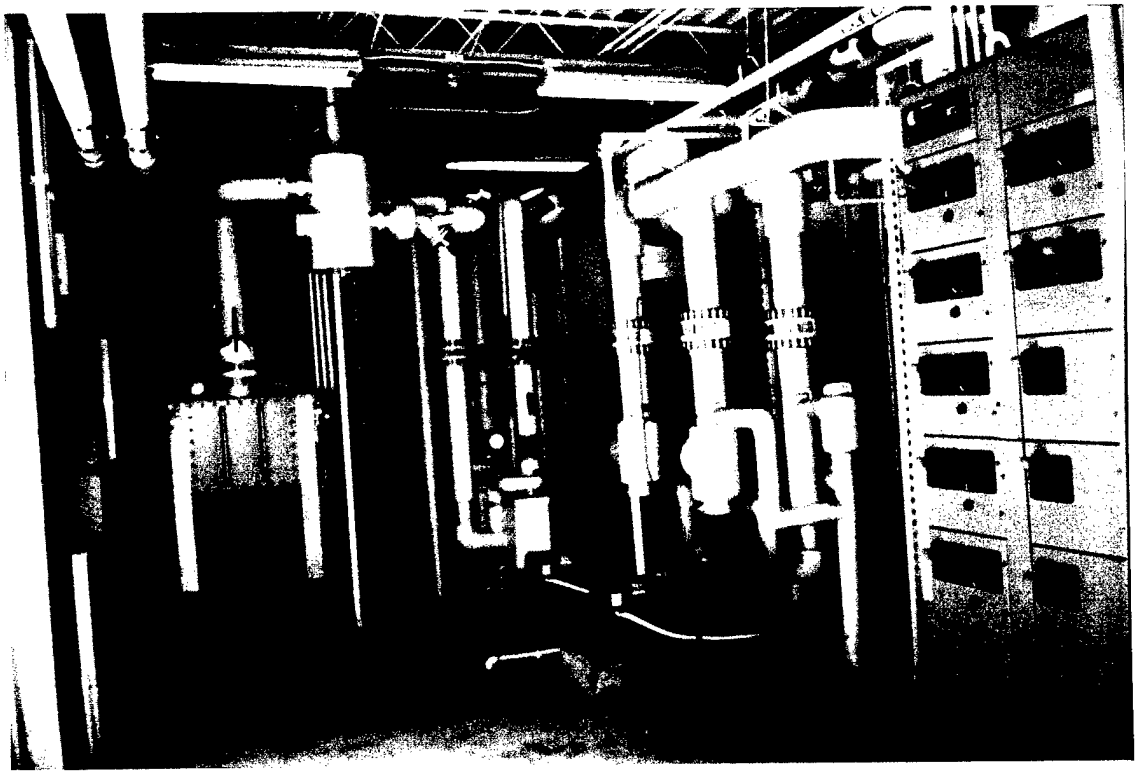
HW boiler serving buildings 2248 & 2250.



Air cooled chiller serving buildings 2248 & 2250.



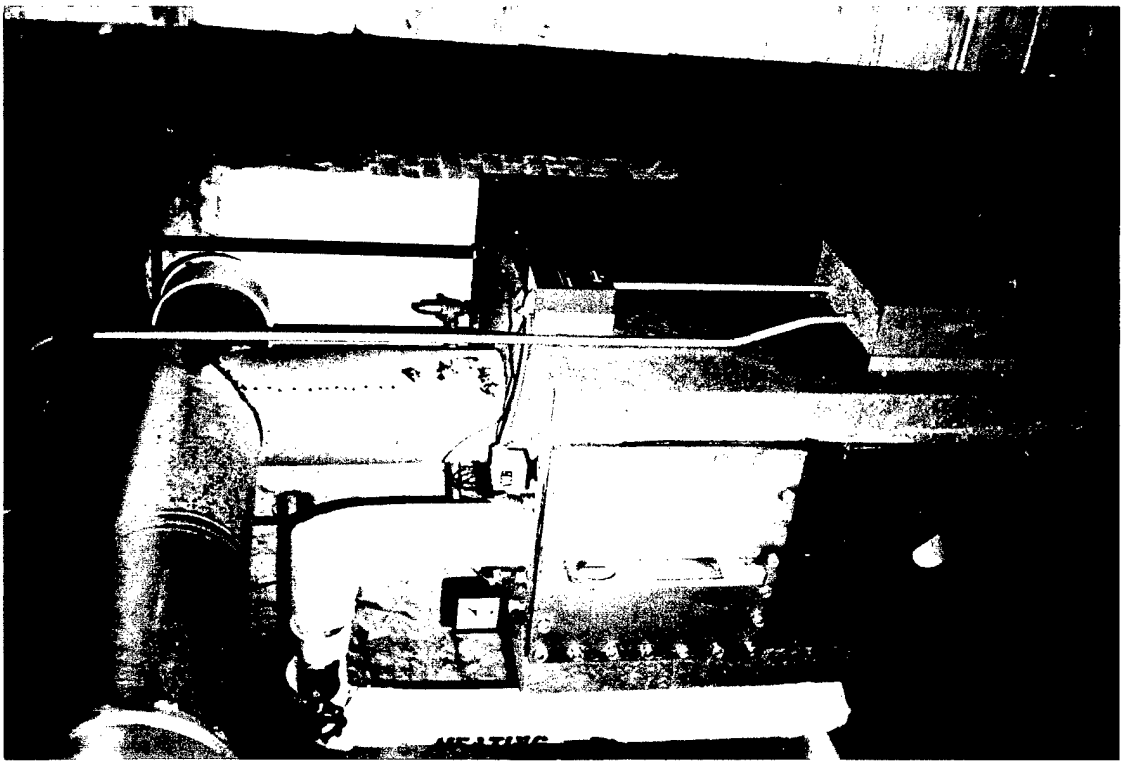
Air cooled chiller and boiler plant (behind) serving building 2200.



HW boiler serving building 2200 located in boiler plant.



Condensing unit serving DX AHU in mechanical room of building 2244.



HW boiler serving buildings 2272 & 2273.

APPENDIX F
MAINTENANCE PROGRAM AND SAMPLE PRODUCTS

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EQUIPMENT CODE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER (PAGE 1 OF 6)

AGREEMENT NO _____ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION _____ BUILDING NAME _____ BUILDING CODE __

	F	TASK	X	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CONDENSER															
INSPECT TUBES	A	002													
BRUSH TUBES	*A	003													
~~ACID CLEAN TUBES~~	~~*A~~	~~004~~													
LUBRICATION SYSTEM															
CHANGE OIL	*A	010													
CHANGE OIL FILTER	*A	011													
CHECK IMMERSION OIL HEATER	A	012													
ADJUST IMMERSION HEATER	*A	013													
TEST OPERATION OF OIL PUMP	A	014													
PURGE - DEHYDRATOR															
CHECK CAPACITY	A	020													

N/A

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

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly;

M=Monthly; X - Indicates extra tasks to be printed on monthly task lists

* - Extras on CPM III

(c) The Linc Corporation 1980

(Updated 10-29-92)

EQUIPMEN. ODE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER (PAGE 2 OF 6)

AGREEMENT NO _____ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION _____ BUILDING NAME _____ BUILDING CODE __

	F	TASK	X	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PURGE - DEHYDRATOR TEST OPERATING AND SAFETY CONTROLS	A	021													
OVERHAUL AS REQUIRED	*A	022													
CHANGE FILTER DRYER	*Q	023													
MOTOR TEST MOTOR WINDING INSULATION RESISTANCE	A	030													
STARTER TIGHTEN ALL ELECTRICAL CONNECTIONS	*A	040													
CHECK OIL LEVEL IN OVERLOAD DASH POTS	A	041													
CHECK STARTER CONTACTORS	A	042													

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

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly; M=Monthly; X - Indicates extra tasks to be printed on monthly task lists

* - Extras on CPM III

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(Updated 10-29-92)

EQUIPMENT CODE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER (PAGE 3 OF 6)

AGREEMENT NO _____ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION _____ BUILDING NAME _____ BUILDING CODE __

	F	TASK	X	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
STARTER CLEAN STARTER CONTACTORS	*A	043													
CHECK FOR PROPER SEQUENCE OF OPERATION OF STARTER MOUNTED CONTROLS	A	044													
VERIFY PROPER OVERLOAD PROTECTION	U	045													
CONTROL PANEL TIGHTEN ALL ELECTRICAL CONNECTIONS	*A	050													
VERIFY PROPER OPERATION AND SETTINGS OF ALL OPERATING AND SAFETY DEVICES	A	051													
TEST ALL TEMPERATURE AND PRESSURE INDICATORS	A	052													

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

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly;

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EQUIPMENT CODE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER (PAGE 4 OF 6)

AGREEMENT NO _____ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION _____ BUILDING NAME _____ BUILDING CODE __

	F	TASK	X	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CONTROL PANEL ADJUST ALL TEMPERATURE AND PRESSURE INDICATORS	*A	053													
TEST ALL INDICATOR LIGHTS	A	054													
OPERATIONAL INSPECTION REVIEW CUSTOMER DIFFICULTIES AND QUESTIONS	Q	070													
LOG ALL OPERATING TEMPERATURES AND PRESSURES	Q	071													
CHECK AND ADJUST CRITICAL OPERATING AND SAFETY CONTROLS	*Q	072													

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

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly; M=Monthly; X - Indicates extra tasks to be printed on monthly task lists

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EQUIPMENT JDE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER (PAGE 5 OF 6)

AGREEMENT NO _____ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION _____ BUILDING NAME _____ BUILDING CODE __

	F	TASK	X	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
OPERATIONAL INSPECTION PERFORM VIBRATION ANALYSIS ON APPLICABLE BEARINGS, DRIVES, MOTORS AND COMPRESSORS. RECORD AND COMPARE RESULTS TO PREVIOUS READINGS. REPORT SIGNIFICANT VARIANCES.	*A	073													
OBTAIN OIL SAMPLE	*A	074													
GENERAL MAINTENANCE CHANGE REFRIGERANT FILTERS	*A	100													
REFRIGERANT LEAK TEST	A	101													
REPLENISH REFRIGERANT LEVEL	*A	102													
CLEAN, SCRAPE, AND PAINT RUST SPOTS AS REQUIRED	*A	103													

N/A

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

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly; M=Monthly; X - Indicates extra tasks to be printed on monthly task lists

* - Extras on CPM III

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(Updated 10-29-92)

DAILY C... R C

UNIT MODEL	TRANE																													
LOCATION	1029																													
SYSTEM NUMBER																														
RECORDED BY	CW	CW	CW	CW	CW	EV	CW	CW	CW	BH	CW	CW	BK	CW	CW	CW	CW	BK	CW	CW	BK	CW								
MONTH / DATE	8/1	8/6	8/7	8/8	8/13	8/15	8/27	9/28	10/3	10/4	10/5	10/6	10/12	10/11	10/12	10/13	10/16	10/18	10/19	10/20	10/23	10/24								
MOTOR AMPS	54 / 49 / 57	52 / 46 / 56	57 / 49 / 60	59 / 48 / 63	55 / 46 / 55	52 / 46 / 55	53 / 47 / 57	61 / 50 / 65	54 / 45 / 50	59 / 48 / 55	54 / 44 / 49	52 / 43 / 48	53 / 44 / 55	52 / 43 / 52	58 / 48 / 63	54 / 45 / 51	50 / 41 / 48	54 / 45 / 53	58 / 48 / 55	50 / 41 / 49	54 / 45 / 55	54 / 45 / 53								
OIL LEVEL	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK								
OIL PRESSURE	12/140	12/144	12/143	12/144	11/141	11/144	12/146	12/145	10/142	10/142	11/144	11/144	10/144	10/144	10/145	11/144	10/140	10/143	10/140	10/144	10/144	10/140								
EVAPORATOR PRESSURE	-8.3	-8.1	-8.3	-8.1	8.2	-8.2	8.1	-8.2	8.2	8.3	8.0	8.1	-8.2	-8.1	-8.3	-8.1	-8.1	8.1	8.2	-8.0	8.2	7.8								
REFRIGERANT TEMPERATURE	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK								
ENTERING CHILL WATER	49	47	48	48	48	47	47	47	46	44	44	45	46	46	48	46	45	45	47	46	46	46								
LEAVING CHILL WATER	44	44	44	44	45	44	44	44	44	43	43	44	43	43	43	43	44	44	44	44	44	43								
REFRIGERANT LEVEL	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK								
CONDENDER PRESSURE	.8	.7	1.3	2.3	.3	.5	1.9	.1	.6	.3	.7	.4	.2	.1	.6	.7	1.3	.9	.4	.2	.2	.2								
REFRIGERANT TEMPERATURE	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/										
CONDENSER WATER INLET TEMPERATURE	81	82	82	86	81	82	86	80	78	80	80	84	84	83	82	80	76	79	80	81	80	76								
CONDENSER WATER OUTLET TEMPERATURE	85	86	86	90	84	85	88	83	80	82	83	83	82	81	87	82	78	81	82	82	82	77								
CONDENSER PUMP DISCHARGE PRESSURE	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/								
CHILL WATER DISCHARGE PUMP	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/								
A TEMP	75	76	77	72	75	74	75	74	70	70	64	66	74	60	65	68	60	55	72	50	82	62								
APPROCH Temp EVAP																2.0	1.3	1.7	2.1	1.2	2.3	1.4								
COND																1.3	.5	1.0	1.2	.7	.2	.0								

NOTE: ALL REFRIGERANT TEMPERATURES FROM TEMPERATURE PRESSURE CHART

SERVICES PROVIDED BY CALGON CORPORATION

COOLING TOWERS, CONDENSERS, BOILERS AND CLOSED LOOPS

1. Calgon will supply one full time account Manager in San Antonio with 24 years of water treatment experience and fifteen years of experience on Ft. Sam Houston.

2. Calgon will supply one full time Service Technician dedicated to Ft. Sam Houston for fulfilling the water treatment contract obligations. The technician has over seven years of experience on Ft. Sam Houston equipment.

3. Calgon will supply the Service Technician with a pickup truck, fitted with a lift gate, for transporting water treatment chemicals to each of the locations specified.

4. Calgon will have available two other Service Technicians, located in the San Antonio area, that are designated as back-up if assistance is required.

5. Calgon will visit each individual cooling and boiler system one time a week or as many time as needed to accomplish the task.

6. A complete water analysis; condenser, cooling tower and boiler report on each system weekly to include;

COOLING WATER ANALYSIS REPORT

A. Chloride test in ppm
B. Alkalinity test in ppm
C. Conductivity test in micromhos
D. TDS in ppm
E. pH
F. Product residual
G. Cycles of concentration

CONDENSER REPORT

A. Condenser pressure
B. Condenser water temperatures
C. Delta T
D. Delta P (actual and design)
E. Amperage reading

COOLING TOWER REPORT

A. Inspect fill
B. Inspect sump
C. Inspect distribution decks
D. Inspect float valve
E. Fan and by-pass operation
F. Water level
G. Water meter reading
H. Any other condition that may effect the operation of the cooling tower and condenser and closed loop system.

BOILER WATER ANALYSIS REPORT

A. Neutralized Conductivity
B. Total Dissolved Solids
C. Hydroxide Alkalinity
D. Sulfite
E. Phosphate
F. pH

CONDENSATE

A. pH
B. Total Dissolved Solids

MAKE UP

A. Hardness
B. Total Dissolved Solids
C. Water Meter Reading

7. Monitor, calibrate and adjust all control equipment for the water treatment program.
   A. Conductivity meter
   B. Chemical feed pumps
   C. Sample lines
   D. Blowdown valves

8. Replacement of the cooling tower float valves when necessary. (labor only)

9. Adjustment of the balancing valves on the distribution decks of the cooling towers when necessary.

10. Keep the distribution decks and nozzles clean of mud, silt and foreign debris.

11. Delivery of all water treatment chemicals to each of the individual locations as needed.

12. Maintain an on going inventory of chemicals at each location where water treatment is required.

13. Disposal of all empty or used containers used in the water treatment program.

14. Chemical cleaning of condensers and cooling towers if it is a direct result of water treatment problems.

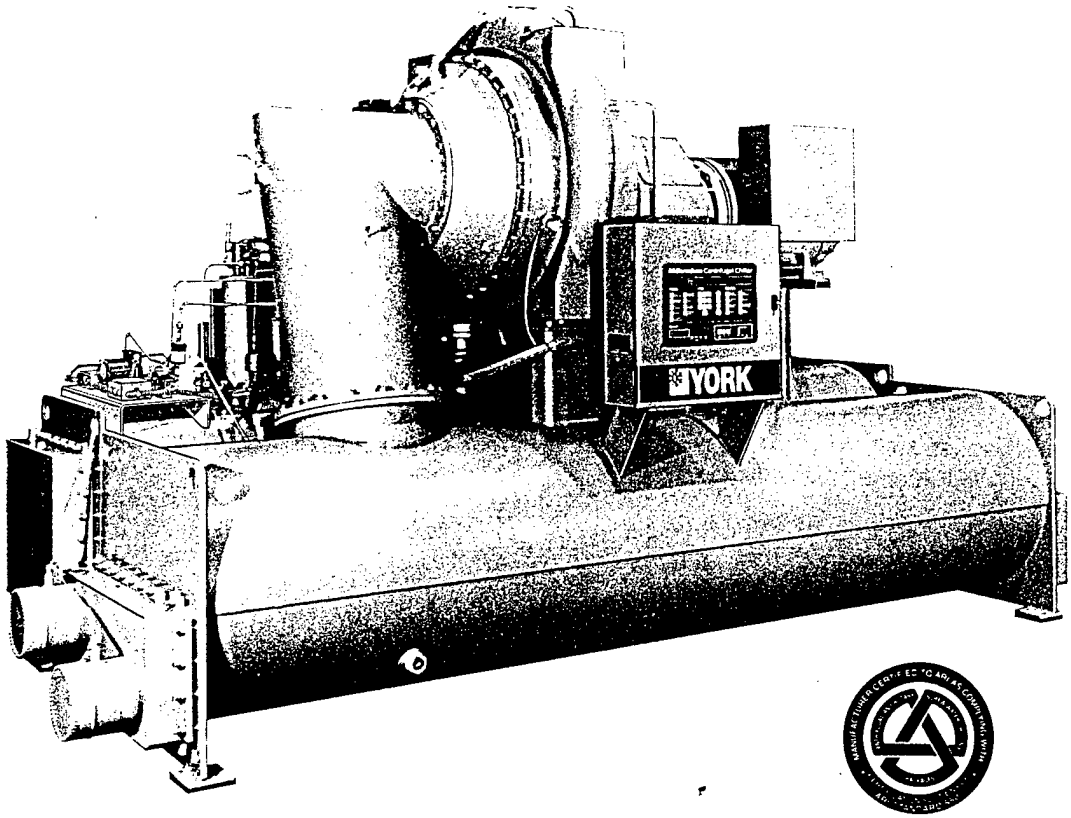
15. Complete analytical lab for detailed water analysis if necessary, Ie. closed loop system contaminates.

16. The weekly cooling system water analysis will be done locally so that there can be an immediate response to systems that may be out of adjustment.

FORM 160.48-EG1 (196)

YORK®

MILLENNIUM ™
Centrifugal Liquid Chillers



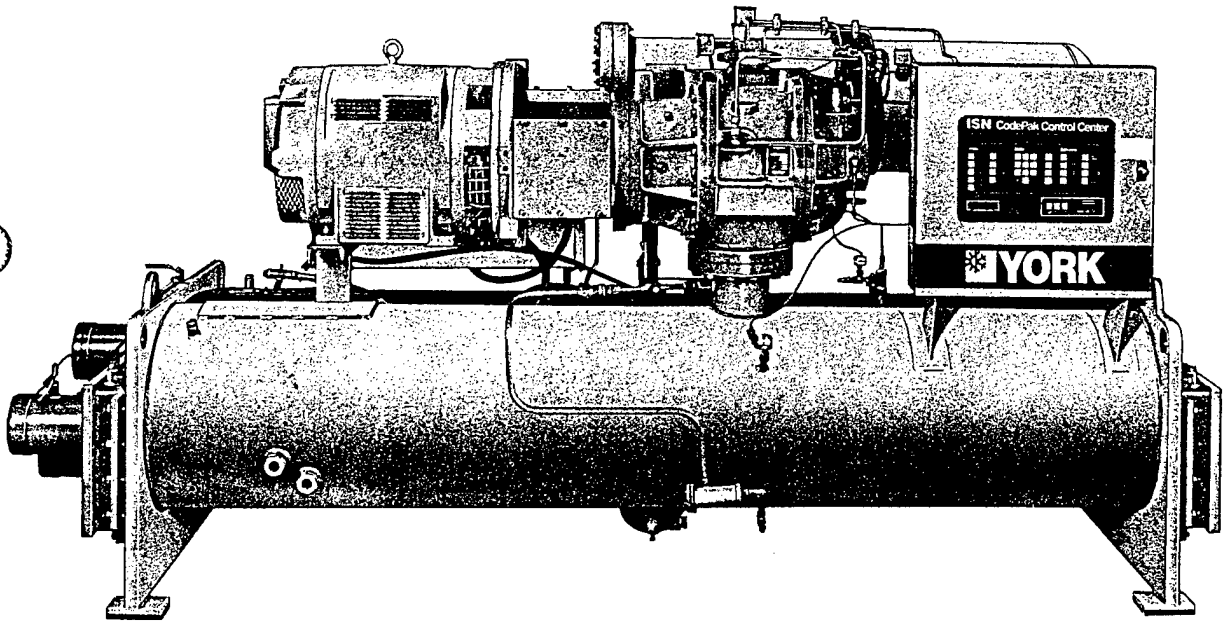
Rated In Accordance with
ARI Standard 550-92

MODEL YT
150 THROUGH 850 TONS
HCFC - 123

YORK®

CodePak™

Rotary Screw Liquid Chillers

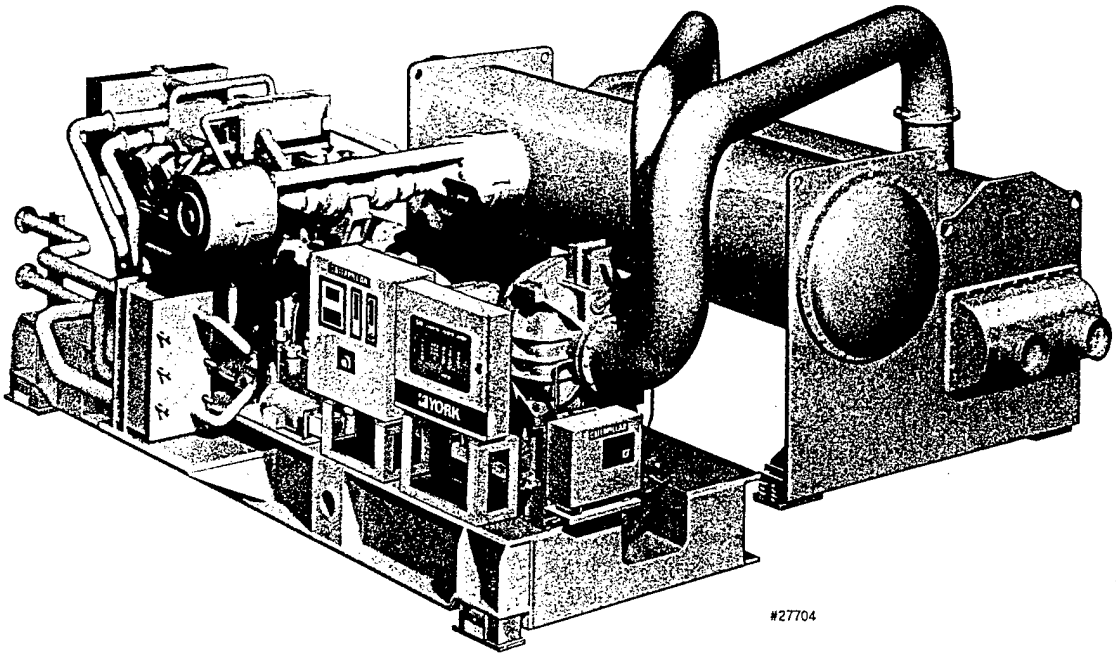


125 through 675 tons

FORM 160.60-EG1 (1295)

YORK®

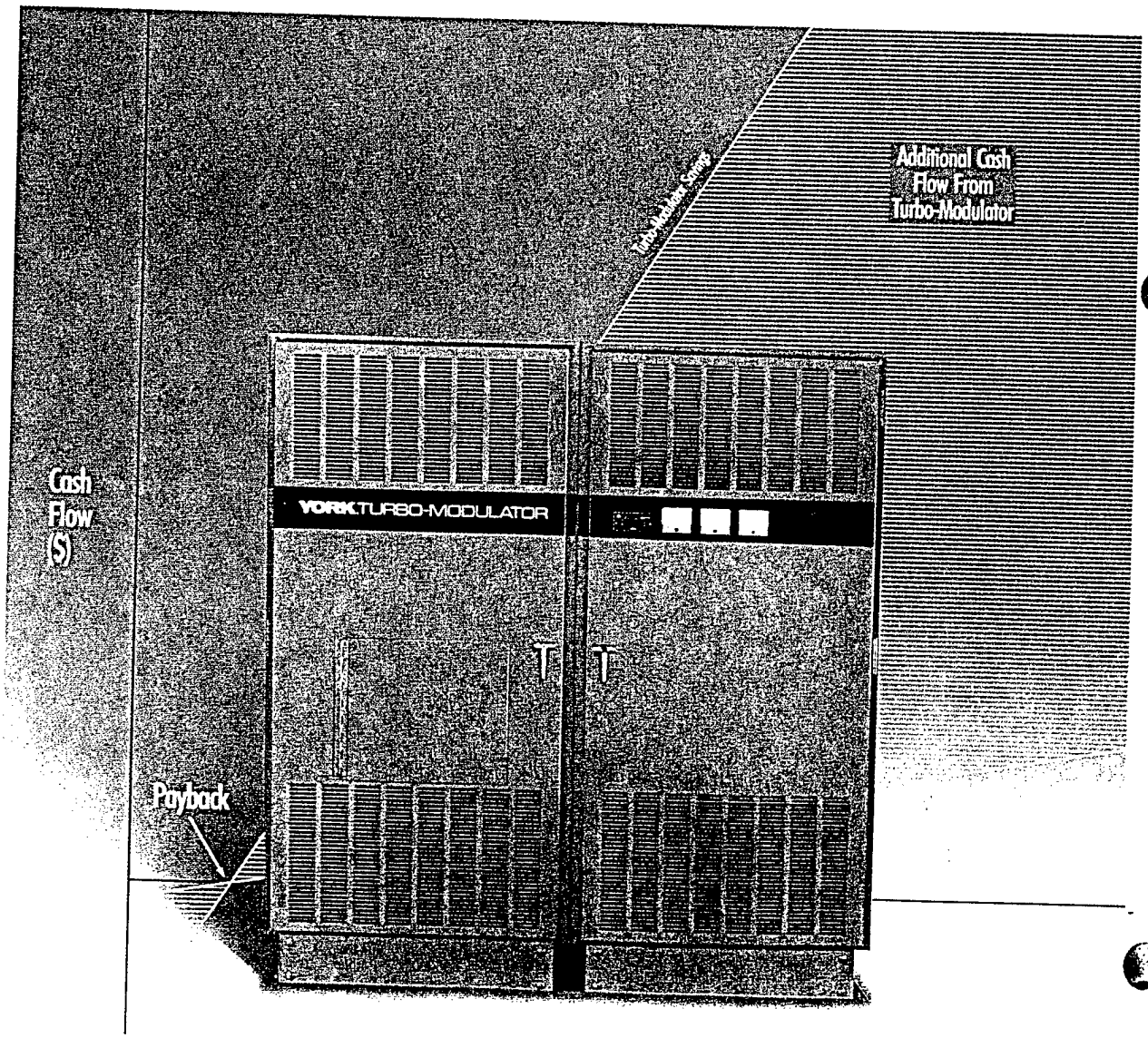
MILLENNIUM ™
GAS-ENGINE-DRIVE CHILLERS
Design Level "A"



#27704

400 Through 2100 Tons
Utilizing HFC-134a

Greater payback potential—at a lower first cost.

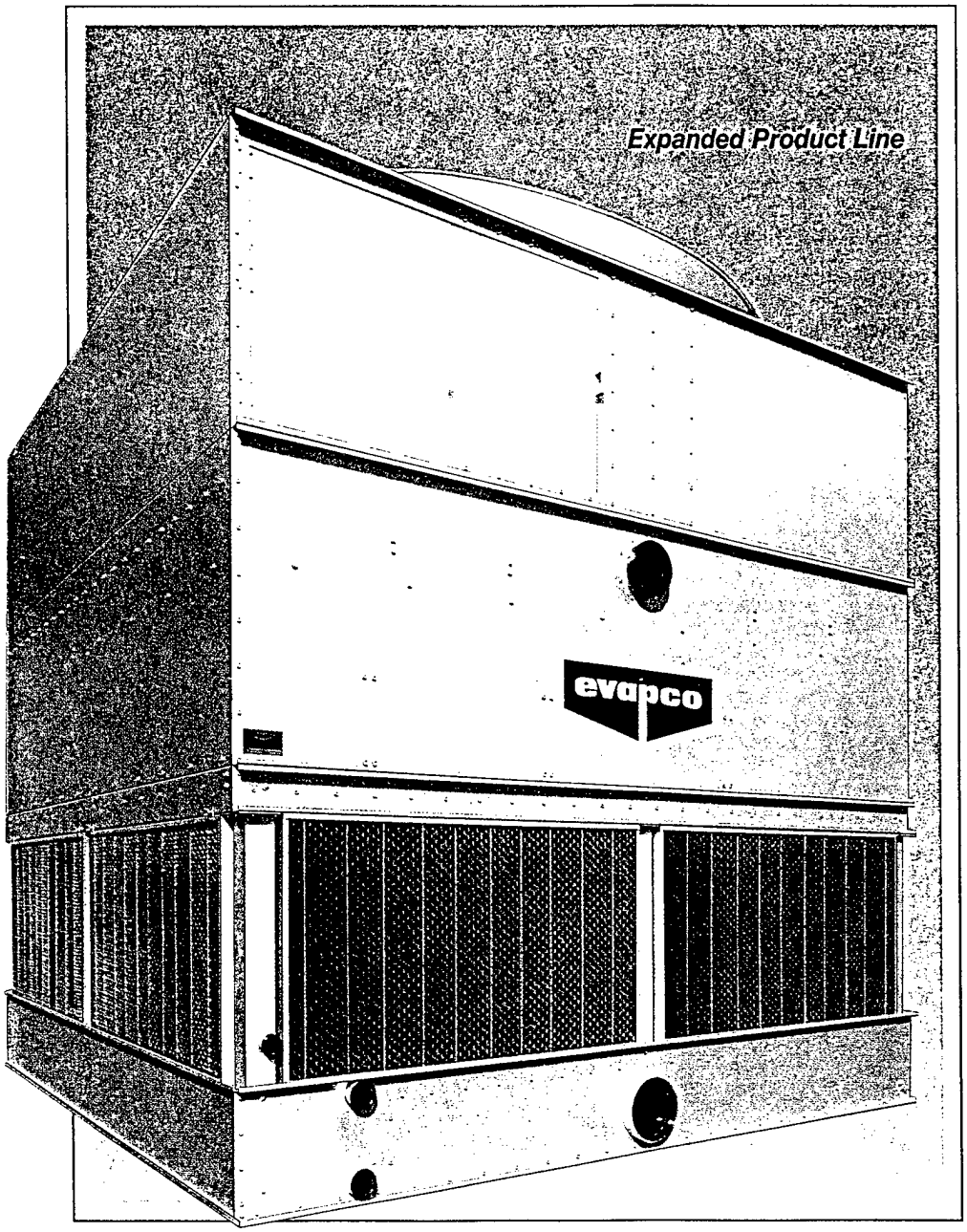


AT-Line Cooling Towers

Advanced Features In
Induced Draft, Counterflow Towers

Member A.R.I.
Air Conditioning and Refrigeration Institute

Member C.T.I.
Cooling Tower Institute



AERCO KC Gas Fired Hot Water Boiler System

The AERCO KC Water Boiler is a true industry advance that meets the needs of today's energy and environmental concerns. Designed for application in any closed loop hydronic system, it relates energy input directly to fluctuating system load, yielding ***seasonal efficiencies as high as 95%.*** The boiler can be used singly or in ***modular arrangements for inherent standby with minimum space requirements.*** Venting flexibility permits installation without normal restrictions.



The advanced electronics of each boiler module offer selectable modes of operation. The options available include:

Constant Temperature Internal Setpoint
Indoor/Outdoor Reset
4-20ma Linear Signal Response
AERCO Boiler Management System Integration
AERCO Combination Domestic Water/Boiler Plant

Regardless of the mode of operation, the load tracking capability of every unit delivers the ultimate in energy control through energy input modulation with a 14:1 ratio while meeting all load demands.

With condensing capability, the KC Boiler is ideally suited for modern low temperature as well as conventional heating systems. Because of the compact design with direct or conventional venting, the KC Boiler system is applicable to either new construction or retrofit application with the same excellent results. Efficiently, reliability, and longevity make the KC Boiler System a true step forward in heating system design.

KC1000 FEATURES

- Natural Gas or Propane
- 14:1 Turndown Ratio
- Direct Vent or Conventional Vent Capabilities
- ASME 150 PSIG Working Pressure Certified
- UL, ULC Listed, FM Approved, ASME Coded
- UL, ULC Listed for Alcove Installation on Combustible Flooring
- Quiet Operation throughout Firing Range
- Internal Low Water Cutoff and Dual Over Temperature Protection
- Compact Space Efficient Design
- Precise Temperature Control +/– 2F
- Optional Sealed Combustion

KC-1000 Specifications

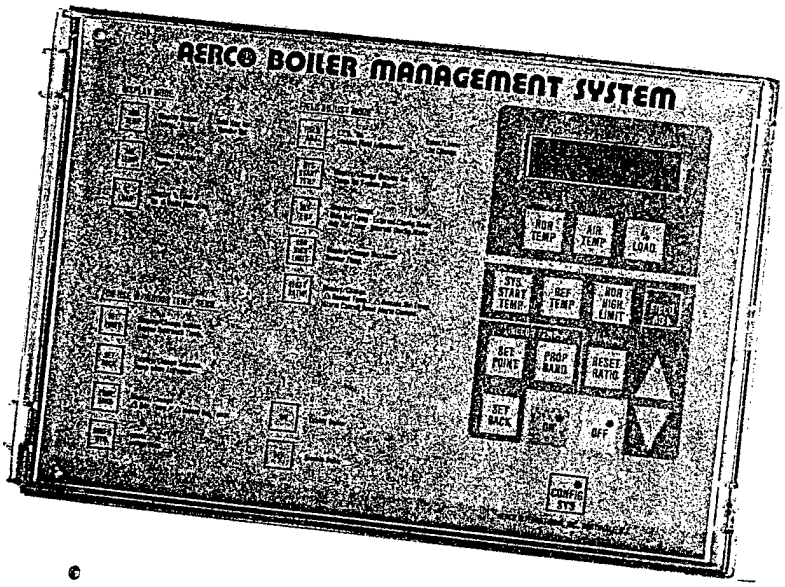
BTU Input	1,000,000 BTU/Hr†
Net Output @ full input	860,000–915,000 BTU/Hp*
ASME Working Pressure	150 PSIG
Electrical Requirement	120/1/60 20 Amp
Gas Requirements	8.5" W.C. Minimum @Full Load 14" W.C. Maximum
Vent Size	6" Diameter
Water Connections	4" Flanged 150 lb. ANSI
Gas Connection	1-1/4" NPT
Minimum Water Flow	25 GPM
Maximum Water Flow	150 GPM
Water Pressure Drop	0.23 Ft. 100 GPM
Water Volume	23 Gallons
Control Range	50F to 220F
Standard Listings & Approvals	UL, ULC, FM, ASME
Optional Approval	IRI
Weight, Installed	1200 lbs.

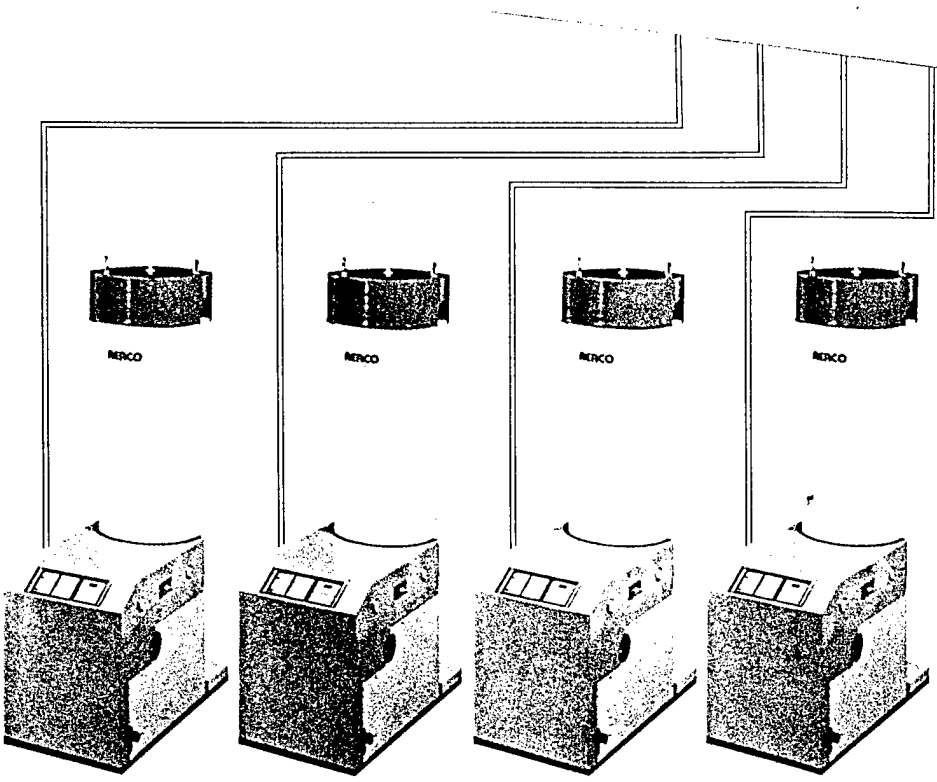
*Output is dependent upon return water temp. and firing rate—see efficiency curves on reverse.

†Up to 2000 Altitude.

AERCO Boiler Management System

- Powerful Main Mode Selections
- Powerful Internal Programmable Software
- Completely Operator Controlled & Responsive
- Full Information LCD Display
- Controls up to Eight KC Series Boilers

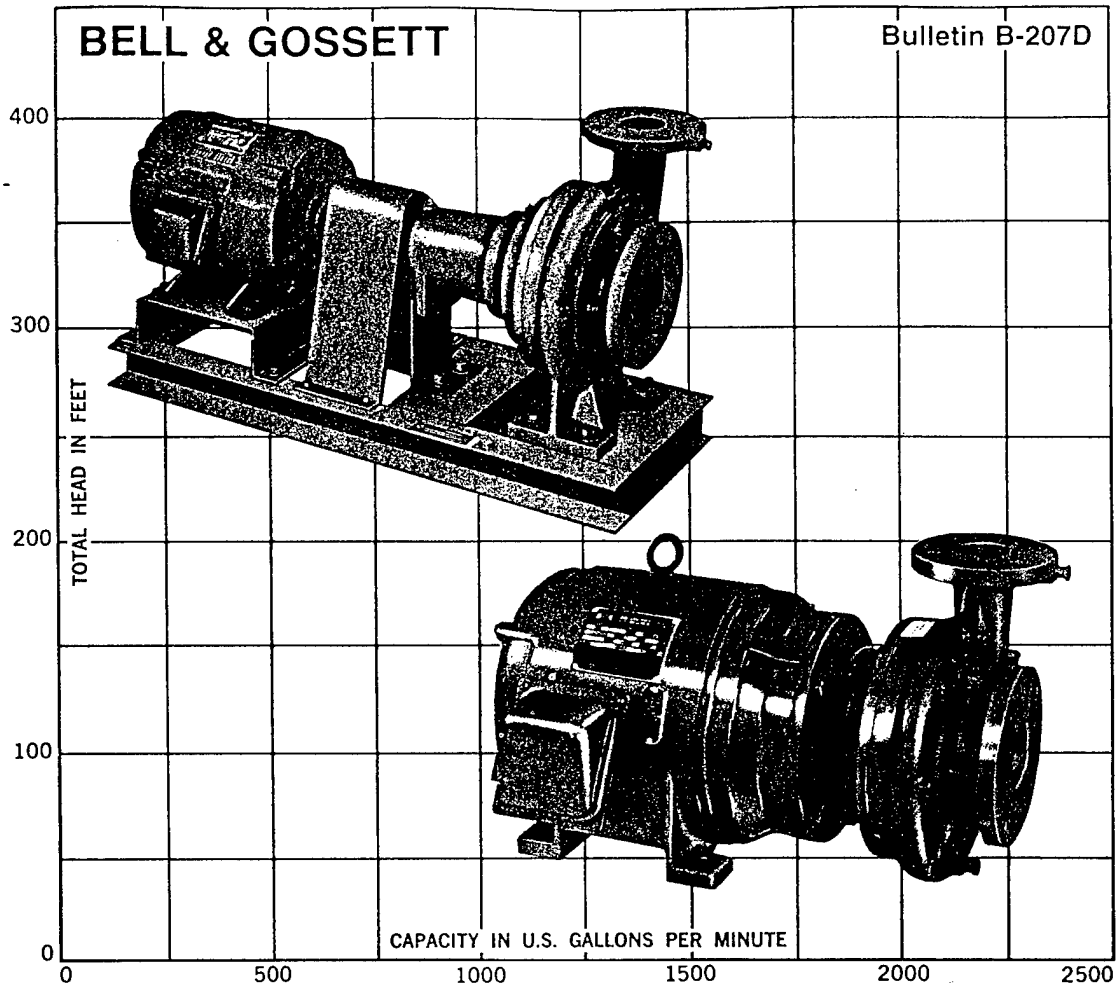




- "Bumpless" Energy Transfer
- Maximizes Efficiency of KC Boile Modules
- Easy Installation & Automatic Operation
- Complete Control of Auxiliary Equipment

BELL & GOSSETT

Bulletin B-207D



Centrifugal Pumps

Applications

- Hydronic Heating & Cooling Systems
- Industrial
- Pressure Boosting
- General Pumping Requirements

Advantages

- High Efficiency Low Operating Costs
- Modern Designs
- Easy Maintenance
- Several Seal Options
- Broad Range of Application

Part of the ESP Equipment Selection Program

ITT Bell & Gossett
ITT Fluid Technology Corporation

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SERIES 1510/1531

1750 RPM PUMP CURVES

PERFORMANCE CHARACTERISTIC CURVE

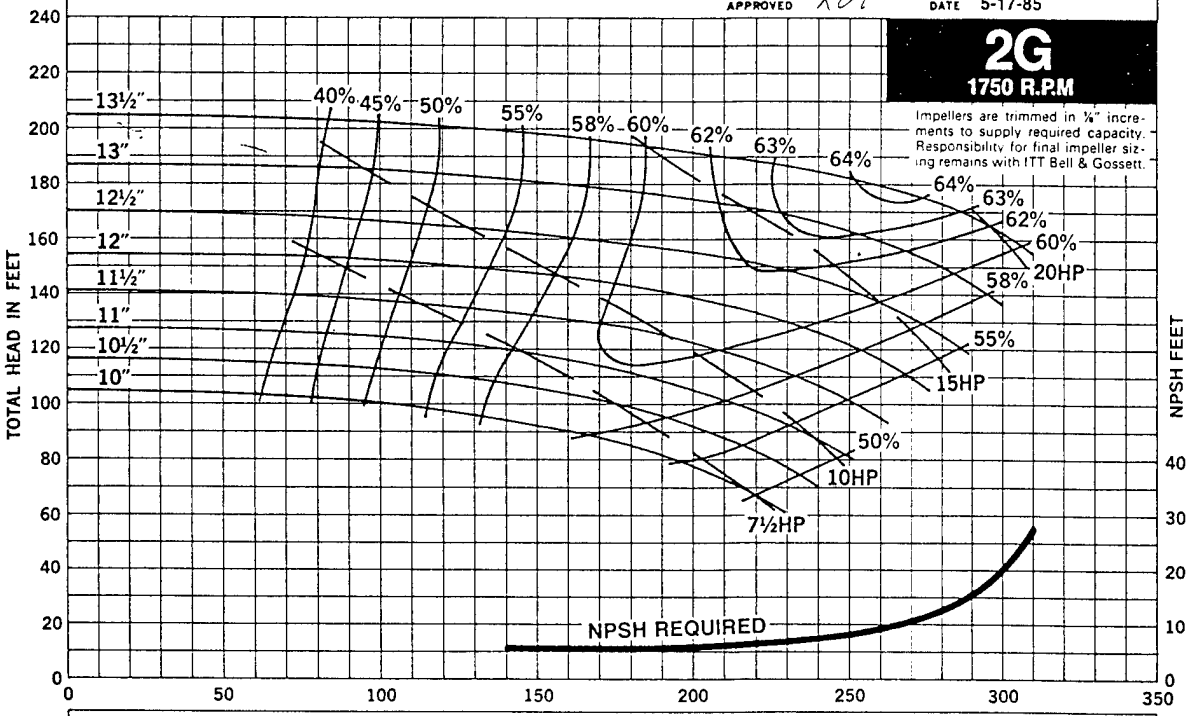
FOR 2G CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED DATE 5-17-85

2G
1750 R.P.M

Impellers are trimmed in ⅛" increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.



PERFORMANCE CHARACTERISTIC CURVE

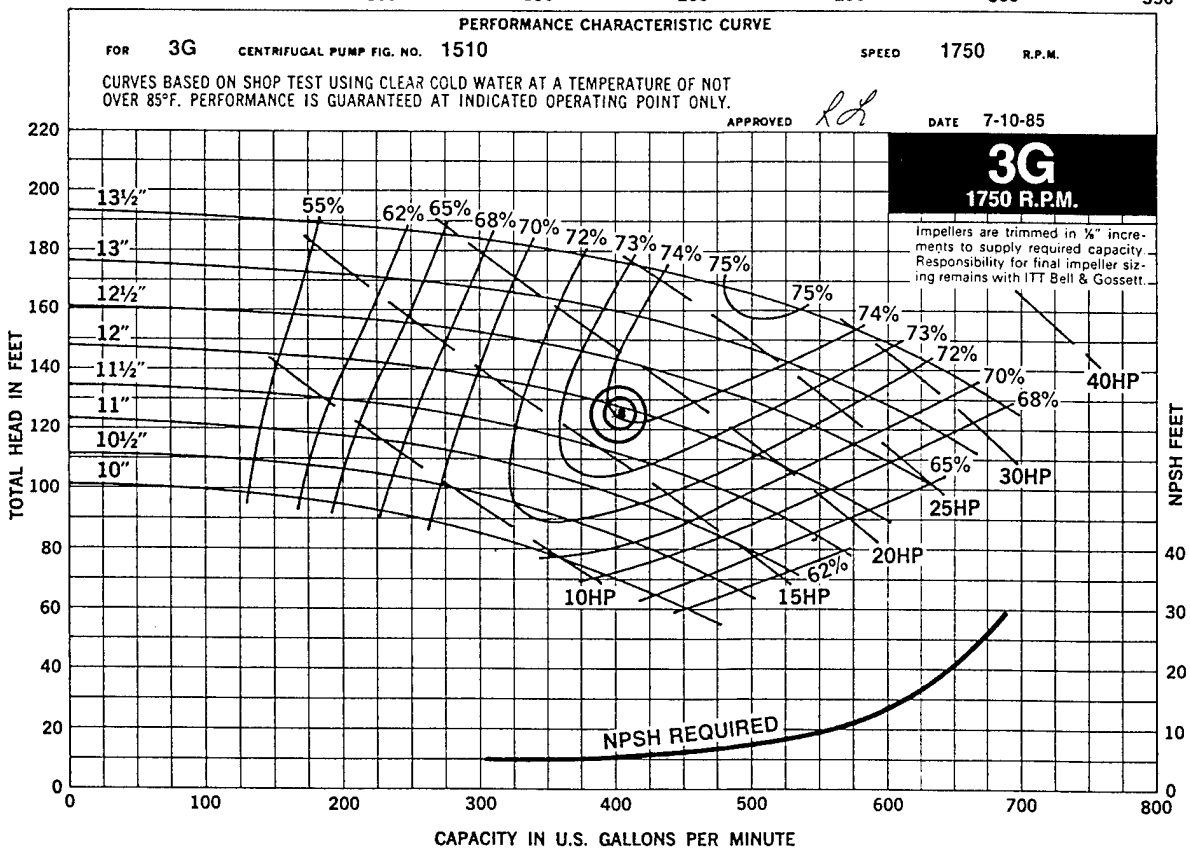
FOR 3G CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED DATE 7-10-85

3G
1750 R.P.M.

Impellers are trimmed in ⅛" increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.



CAPACITY IN U.S. GALLONS PER MINUTE

22

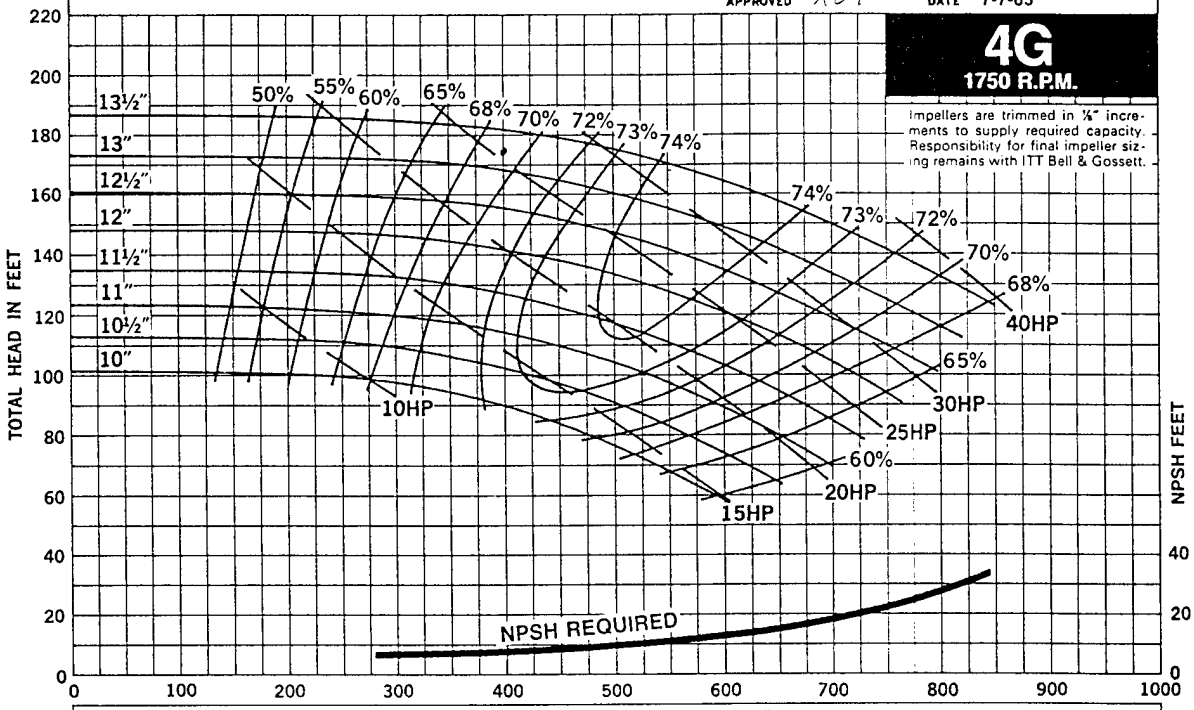
1750 RPM PUMP CURVES

PERFORMANCE CHARACTERISTIC CURVE

FOR 4G CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED RL DATE 7-7-85

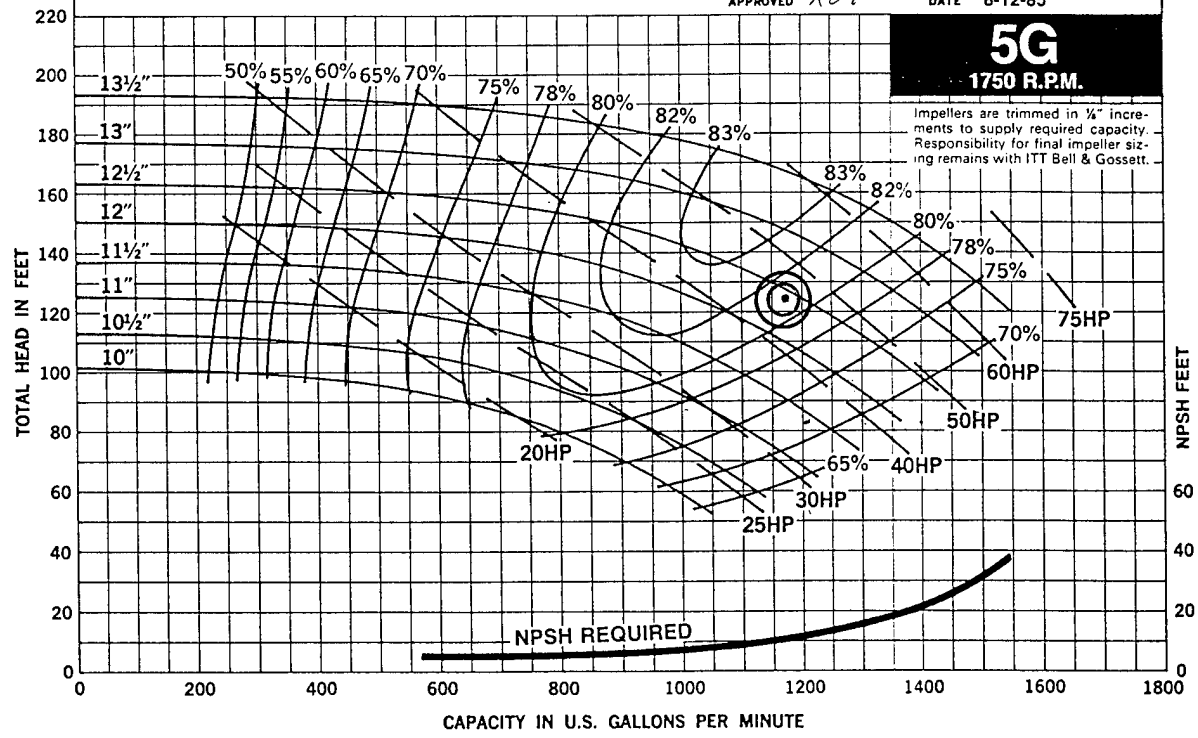


PERFORMANCE CHARACTERISTIC CURVE

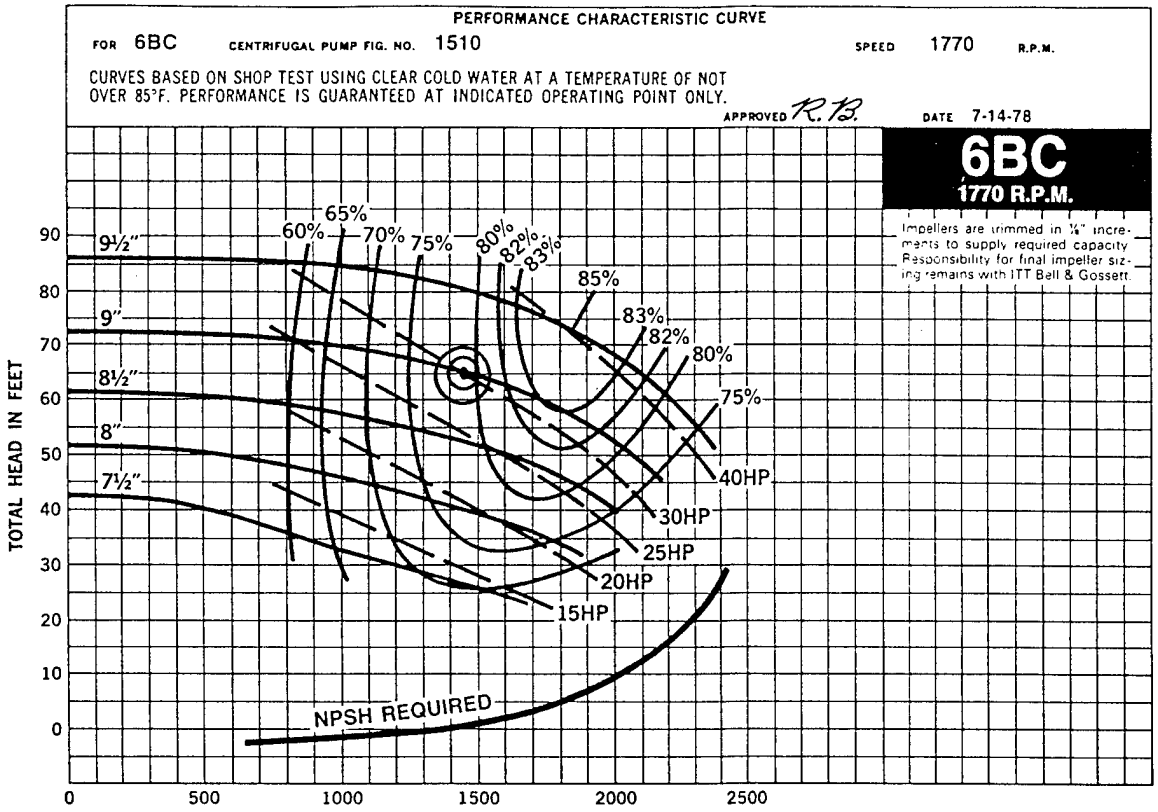
FOR 5G CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

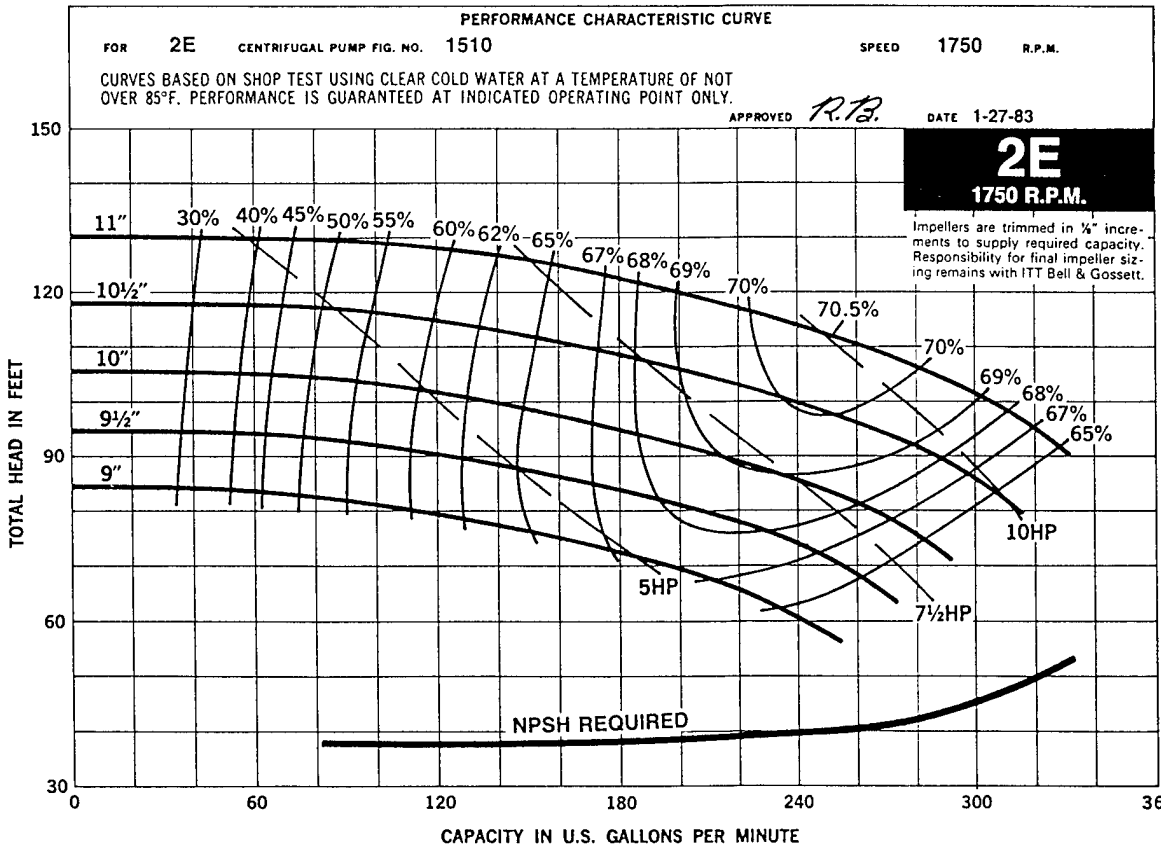
CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED RL DATE 8-12-85



1750 RPM PUMP CURVES





1750 RPM PUMP CURVES

PERFORMANCE CHARACTERISTIC CURVE

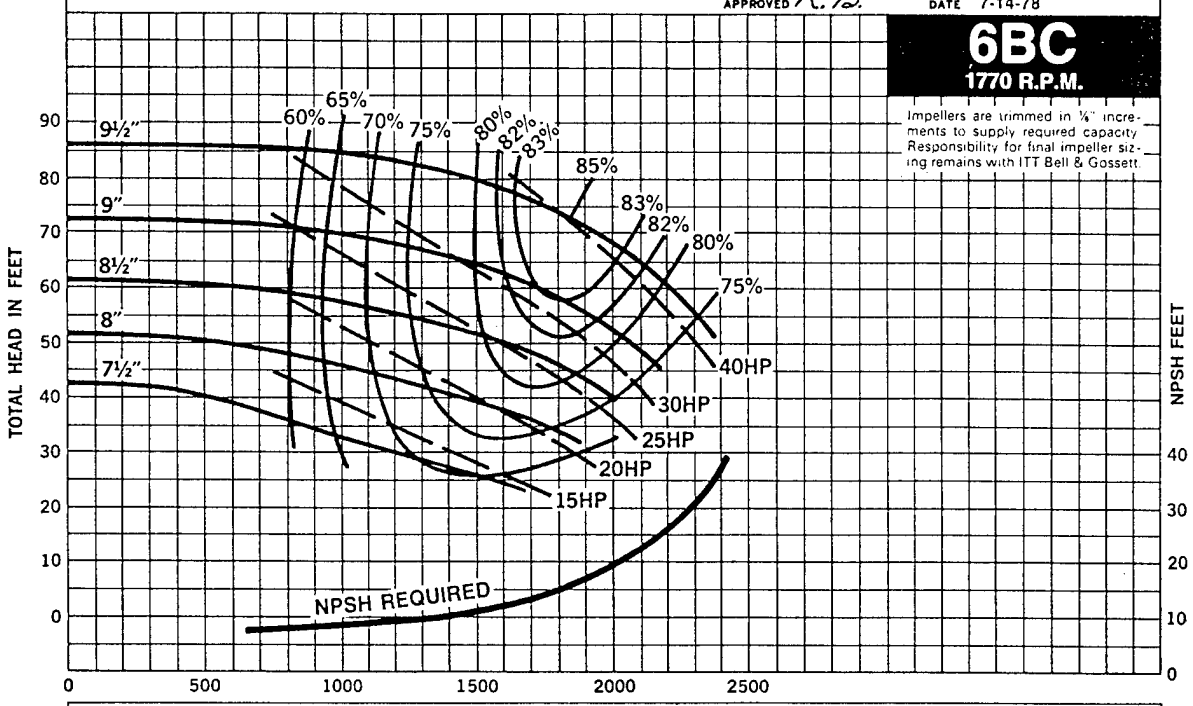
FOR 6BC CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1770 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED R.B. DATE 7-14-78

6BC
1770 R.P.M.

Impellers are trimmed in ⅛" increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.



PERFORMANCE CHARACTERISTIC CURVE

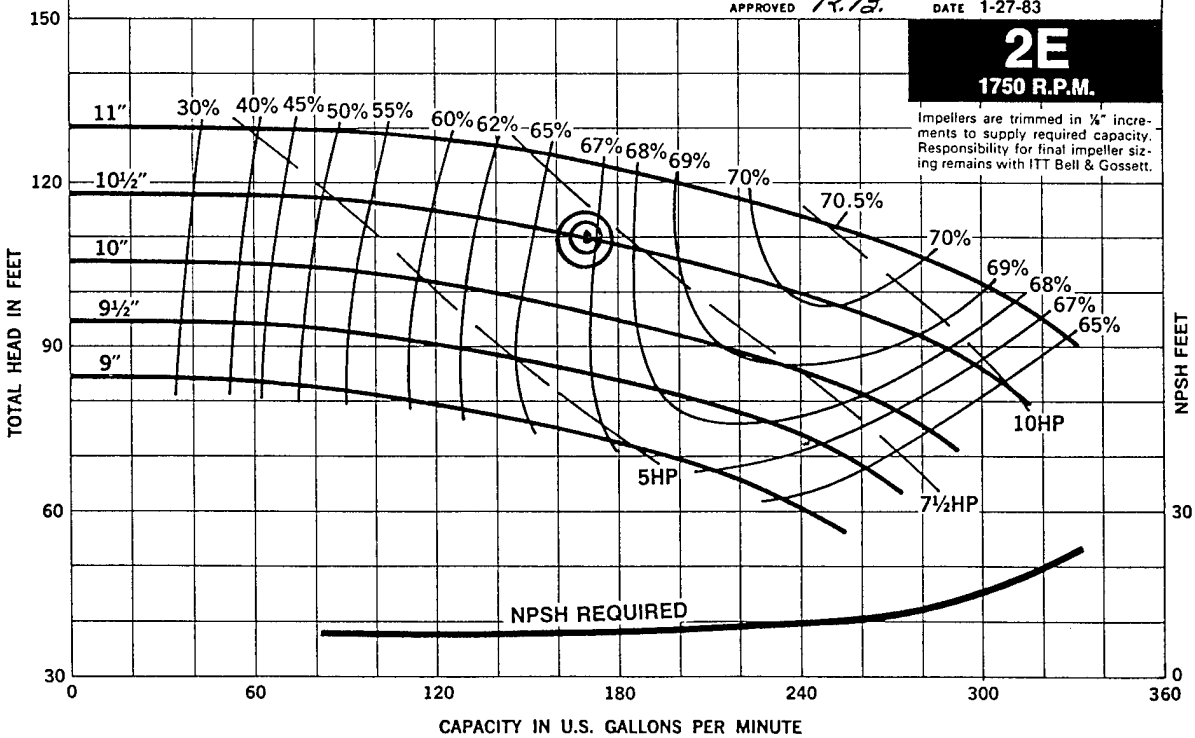
FOR 2E CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED R.B. DATE 1-27-83

2E
1750 R.P.M.

Impellers are trimmed in ⅛" increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.



1750 RPM PUMP CURVES

PERFORMANCE CHARACTERISTIC CURVE

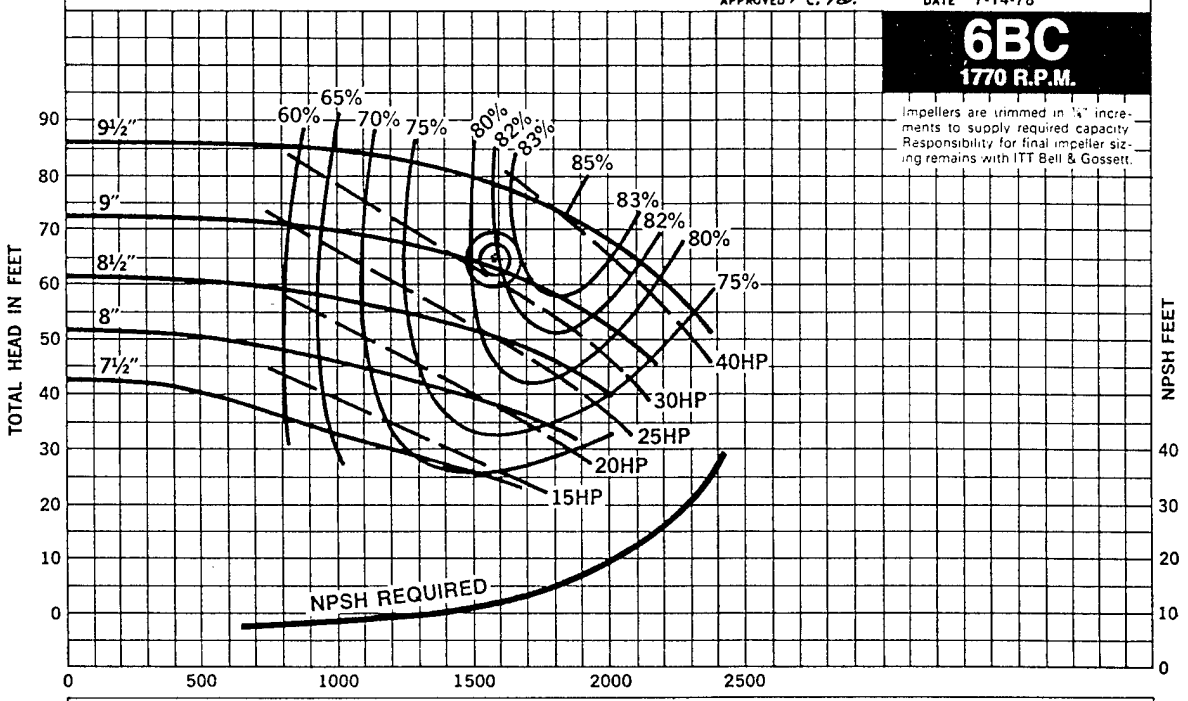
FOR 6BC CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1770 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED R.B. DATE 7-14-78

6BC
1770 R.P.M.

Impellers are trimmed in ¼" increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.



PERFORMANCE CHARACTERISTIC CURVE

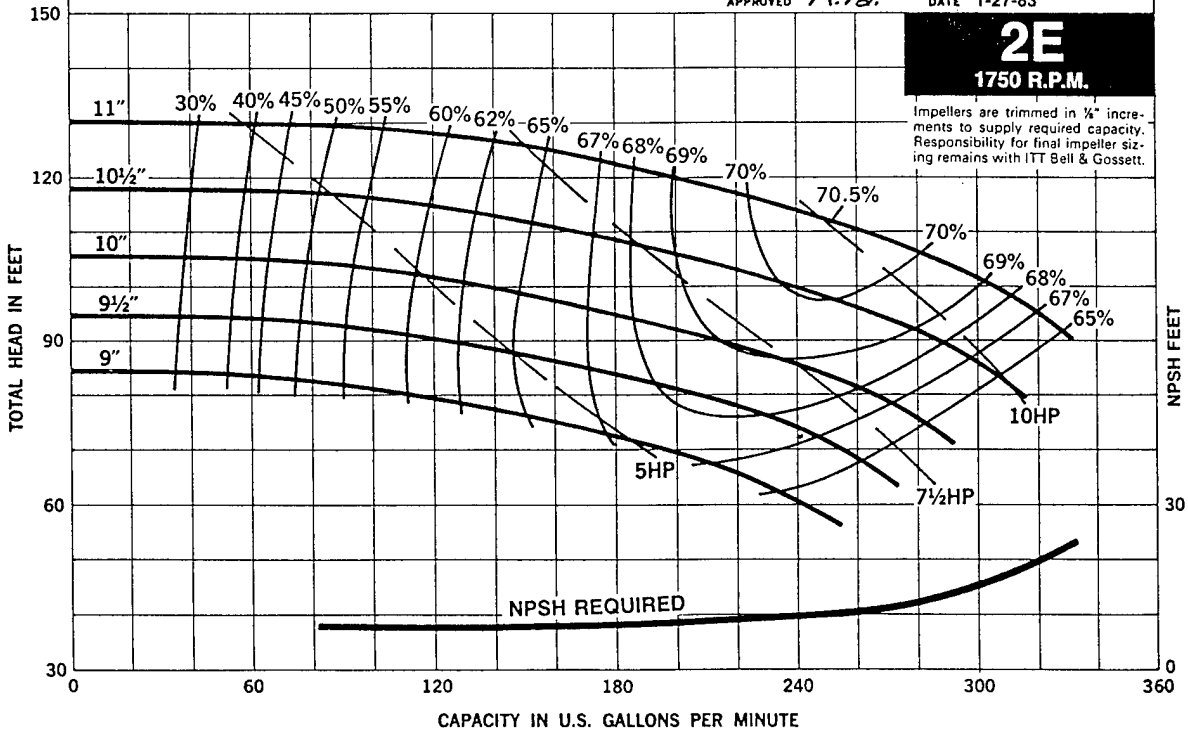
FOR 2E CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED R.B. DATE 1-27-83

2E
1750 R.P.M.

Impellers are trimmed in ⅛" increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.

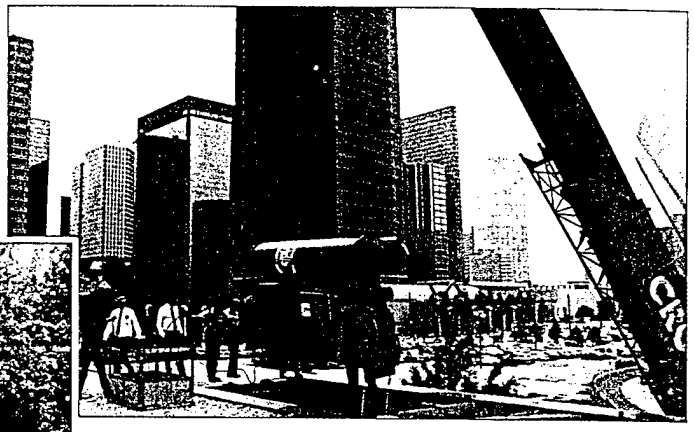


19

entech
SALES & SERVICE, INC.

CHILLERS
COOLING SOLUTIONS

SALES





SERVICE



RENTALS



TRAINING

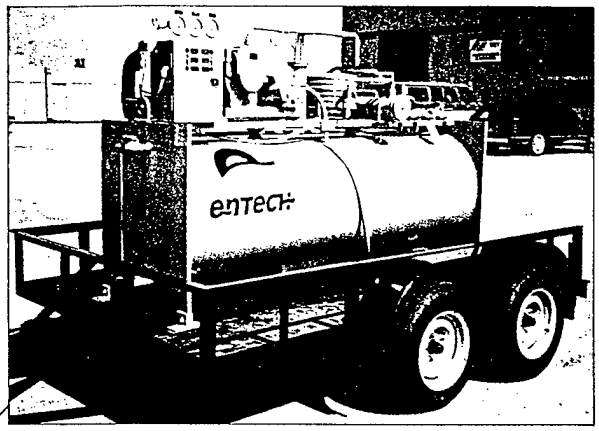
LARGE INVENTORY

- Water Cooled Chillers
- Air Cooled Chillers
- Cooling Towers

WE BUY EQUIPMENT

REBUILT CHILLERS FOR SALE

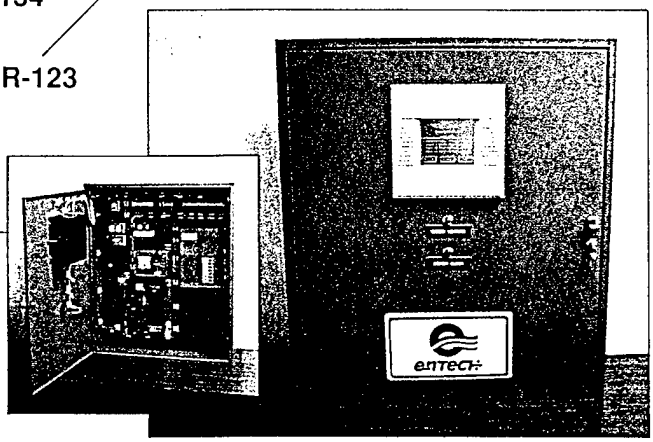
- Over 10,000 tons of Water Cooled Chillers. Sizes range from 15 tons to over 500 tons
- Air Cooled Chillers from 20 tons to 320 tons
- Cooling Towers from 100 tons to 600 tons

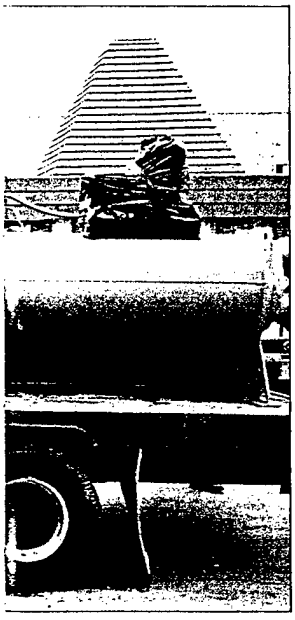


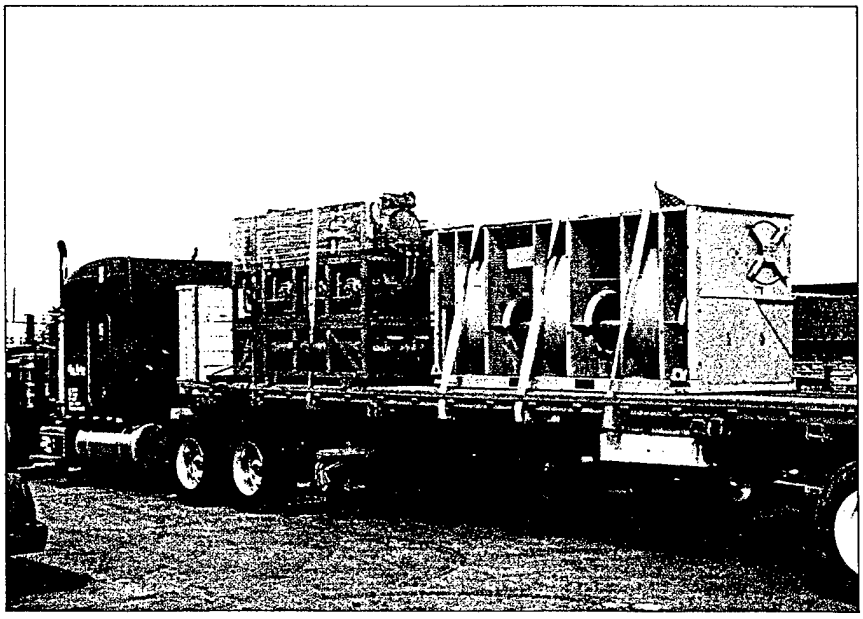
Entech Will Convert Chillers For The New Acceptable Refrigerants – R-123 and R-134

Refrigerant Recovery Units for R-11 and R-123 Refrigerants

Chiller Plant Monitors For Monitoring Refrigerant Loss.

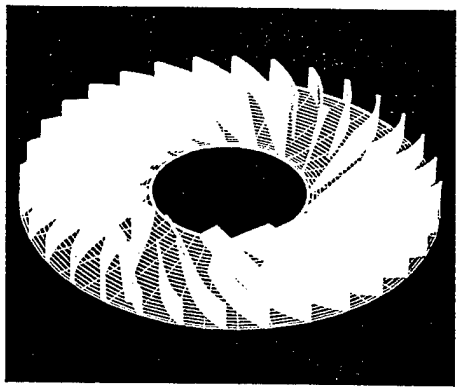




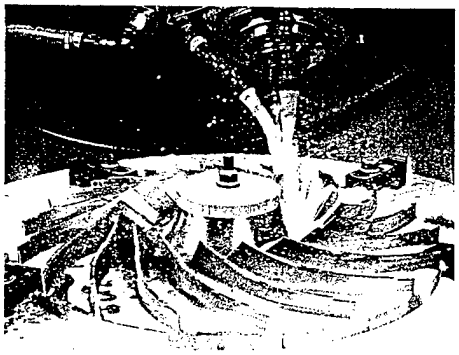


Centrifugal Chiller Conversions

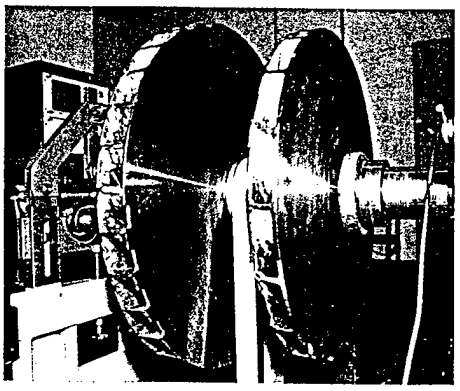
NREC uses high-performance impellers to convert centrifugal chillers from CFCs to environmentally safer refrigerants with no loss in cooling capacity.



- Replace CFC refrigerants
- Maintain cooling capacity
- Improve power consumption
- Avoid new equipment costs
- Minimize installation costs
- Reduce impact on operations



Companies using CFC refrigerants in centrifugal chiller systems must face the phase out and elimination of CFCs. Simply substituting a new refrigerant in an existing unit will typically result in a 5% to 30% loss in cooling capacity and up to a 20% increase in power consumption. The only practical solutions to this problem are to modify or replace these chiller units. For most installations, modifying a chiller to use alternative refrigerants is far less expensive than replacing the machine.



NORTHERN RESEARCH
AND ENGINEERING CORPORATION

NREC

39 Olympia Avenue · Woburn, MA 01801-2073 USA
Telephone: (617) 935-9050 · Telefax: (617) 935-9052
Telex: 466928 NOR RES WOB UD

June 16, 1995

Mr. John Carter
Huitt-Zollars
512 Main Street, Suite 1500
Forth Worth, TX 76102

Dear Mr. Carter:

We are pleased to provide our Preliminary and Budgetary Quotation No. 950-2361 describing the design and manufacture of replacement impellers for returning original capacity to various chillers described in your fax of June 14, 1995.

Based on our past experience, we believe that any capacity loss resulting from the conversion from CFC-11 refrigerant to HCFC-123 can be rectified by changing the impellers. This option will retain original operating conditions, including driving speed, and will avoid the need to change other system components such as the condenser. This presumes that the evaporator and condenser are adequately sized for the added HCFC-123 flow rates.

NREC proposes to design and supply new compressor impellers which will provide the pressure ratios and flow rates required by the use of the new refrigerant. NREC predicts that the present capacity of the systems using CFC-11 can be achieved using our high performance impellers with negligible increases in power consumption. However, we reserve the possibility of up to a 5 percent increase in power consumption.

This proposal assumes that we will work with a contractor of Huitt-Zollars's choice to perform the entire conversion of the machines for the customer. NREC will be responsible for:

- measuring compressor internals,
- designing and fabricating new impellers,
- balancing the impellers,
- supporting the contractor during the installation, conversion, completion, and operational testing of the converted system.

The selected contractor would be responsible for:

- removing and reinstalling the impeller,
- providing all other on-site support and conversion tasks.

NREC will retain overall responsibility for the satisfaction of the performance requirements. The impellers will be designed and manufactured to operate within the

specified original equipment. The impellers will be individually balanced, spin-tested, and assembled to the original rotor shaft.

Listed below are the preliminary and budgetary prices for the chillers you outlined in your request:

Area:	900	2200	1300	1350
Manufacturer:	York	Chrysler	Trane	Carrier
Make:	TurboPak HT	Airtemp	Centravac	
Model:	YTC3D3C1CJC	C2MN7792	PCV5FC1D1	19DK7894CP
Quantity:	One (1)	One (1)	Two (2)	One (1)
Budget Price:	$175,000	$250,000	$275,000	$35,000

Since NREC have not yet designed impellers for the specific York, Chrysler, and Trane compressors above, a significant non-recurring engineering and tooling effort is included in the budget price. NREC is currently evaluating market potentials and, within six months, may develop a design and production plan for the York TurboPak and Trane Centravac chillers. This new position could possibly reduce the costs for the replacement TurboPak and Centravac impellers.

This proposal is subject to the standard "Products Sales" Terms and Conditions of our parent company, Ingersoll-Rand. A copy of these Terms and Conditions is attached. If you have any questions about the quotation, please feel free to contact me at (617) 937-4668 or Mel Mittnick, Senior Applications Engineer, at (617) 937-4655.

Sincerely,

NORTHERN RESEARCH AND ENGINEERING CORPORATION

C. Jimmy Tang

Chi-Wu (Jimmy) Tang
Sales Engineer

CJT/ph
Enclosure

2361HUIT.DOC

TERMS AND CONDITIONS
Products

1. GENERAL

The Terms and Conditions of Sale outlined herein shall apply to the sale by Ingersoll-Rand Company (hereinafter referred to as Company) of products, equipment and parts relating thereto (hereinafter referred to as Equipment). Unless prior written agreement is reached, it shall be understood that the Company's proceeding with any work shall be in accordance with the terms and conditions outlined herein.

The Company will comply with applicable laws and regulations in effect on the date of the Company's proposal as they may apply to the manufacture of the Equipment. Compliance with any local government laws or regulations relating to the location, use, or operation of the Equipment, or its use in conjunction with other equipment, shall be the sole responsibility of the Purchaser.

2. TITLE AND RISK OF LOSS

Title and risk of loss or damage to the Equipment shall pass to the Purchaser upon tender of delivery F.O.B. manufacturing facility unless otherwise agreed upon by the parties, except that a security interest in the Equipment shall remain in the Company, regardless of mode of attachment to realty or other property, until full payment has been made therefore. Purchaser agrees upon request to do all things and acts necessary to perfect and maintain said security interest and shall protect Company's interest by adequately insuring the Equipment against loss or damage from any cause wherein the Company shall be named as an additional insured.

3. ASSIGNMENT

Neither party shall assign or transfer this contract without the prior written consent of the other party. The Company however shall be permitted to assign or transfer, without the prior written consent of the Purchaser, the Company's right to receive all or any portion of the payment due from the Purchaser under this contract.

4. DELIVERY AND DELAYS

Delivery dates shall be interpreted as estimated and in no event shall dates be construed as falling within the meaning of "time is of the essence".

The Company shall not be liable for any loss or delay due to war, riots, fire, flood, strikes or other labor difficulty, acts of civil or military authority including governmental laws, order, priorities or regulations, acts of the Purchaser, embargo, car shortage, damage or delay in transportation, inability to obtain necessary labor or materials from usual sources, faulty forgings or castings, or other causes beyond the reasonable control of the Company. In the event of delay in performance due to any such cause, the date of delivery or time for completion will be adjusted to reflect the actual length of time lost by reason of such delay. The Purchaser's receipt of Equipment shall constitute a waiver of any claims for delay.

5. TAXES

The price does not include any present or future Federal, State, or local property, license, privilege, sales, use excise, gross receipts or other like taxes or assessments which may be applicable to, measured by, imposed upon or result from this transaction or any services performed in connection therewith. Such taxes will be itemized separately to Purchaser, who shall make prompt payment to the Company. The Company will accept a valid exemption certificate from Purchaser, if applicable. If such exemption certificate is not recognized by the governmental taxing authority involved, Purchaser agrees to promptly reimburse the Company for any taxes covered by such exemption certificate which the Company is required to pay.

6. SET OFFS

Neither Purchaser nor any affiliated company or assignee shall have the right to claim compensation or to set off against any amounts which become payable to the Company under this contract or otherwise.

7. PATENTS

The Company shall defend any suit or proceeding brought against the Purchaser and shall pay any adverse judgment entered therein so far as such suit or proceeding is based upon a claim that the use of the Equipment manufactured by the Company, and furnished under this contract constitutes infringement of any patent of the United States of America, providing the Company is promptly notified in writing and given authority, information and assistance for defense of same; and the Company shall, at its option, procure for the Purchaser the right to continue to use said Equipment, or to modify it so that it becomes non-infringing, or to replace the same with non-infringing equipment, or to remove said Equipment and to refund the purchase price. The foregoing shall not be construed to include any agreement by the Company to accept any liability whatsoever in respect to patents for inventions including more than the Equipment furnished hereunder, or in respect of patents for methods and processes to be carried out with the aid of said Equipment. The foregoing states the entire liability of the Company with regard to patent infringement.

8. WARRANTY

The Company warrants that the Equipment manufactured by it and delivered hereunder will be free of defects in material and workmanship for a period of twelve months from the date of placing the Equipment in operation or eighteen months from the date of shipment, whichever shall first occur. The Purchaser shall be obligated to promptly report any failure to conform to this warranty, in writing to the Company within said period, whereupon the Company shall, at its option, correct such nonconformity by suitable repair to such Equipment or, furnish a replacement part F.O.B. point of shipment, provided the Purchaser has stored, installed, maintained and operated such Equipment in accordance with good industry practices and has complied with specific recommendations of the Company. Accessories or equipment furnished by the Company, but manufactured by others, shall carry whatever warranty the manufacturers have conveyed to the Company and which can be passed on to the Purchaser. The Company shall not be liable for any repairs, replacements, or adjustments to the Equipment or any costs of labor performed by the Purchaser or others without the Company's prior written approval.

The effects of corrosion, erosion and normal wear and tear are specifically excluded. Performance warranties are limited to those specifically stated within the Company's proposal. Unless responsibility for meeting such performance warranties are limited to specified shop or field tests, the Company's obligation shall be to correct in the manner and for the period of time provided above.

THE COMPANY MAKES NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

Correction by the Company of nonconformities whether patent or latent, in the manner and for the period of time provided above, shall constitute fulfillment of all liabilities of the Company for such nonconformities, whether based on contract, warranty, negligence, indemnity, strict liability or otherwise with respect to or arising out of such Equipment.

The Purchaser shall not operate Equipment which is considered to be defective, without first notifying the Company in writing of its intention to do so. Any such use of Equipment will be at the Purchaser's sole risk and liability.

9. LIMITATION OF LIABILITY

THE REMEDIES OF THE PURCHASER SET FORTH HEREIN ARE EXCLUSIVE, AND THE TOTAL LIABILITY OF THE COMPANY WITH RESPECT TO THIS CONTRACT OR THE EQUIPMENT AND SERVICES FURNISHED HEREUNDER, IN CONNECTION WITH THE PERFORMANCE OR BREACH THEREOF, OR FROM THE MANUFACTURE, SALE, DELIVERY, INSTALLATION, REPAIR OR TECHNICAL DIRECTION COVERED BY OR FURNISHED UNDER THIS CONTRACT, WHETHER BASED ON CONTRACT, WARRANTY, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE, SHALL NOT EXCEED THE PURCHASE PRICE OF THE UNIT OR EQUIPMENT UPON WHICH SUCH LIABILITY IS BASED.

THE COMPANY AND ITS SUPPLIERS SHALL IN NO EVENT BE LIABLE TO THE PURCHASER, ANY SUCCESSORS IN INTEREST OR ANY BENEFICIARY OR ASSIGNEE OF THIS CONTRACT FOR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES ARISING OUT OF THIS CONTRACT OR ANY BREACH THEREOF, OR ANY DEFECT IN, OR FAILURE OF, OR MALFUNCTION OF THE EQUIPMENT HEREUNDER, WHETHER BASED UPON LOSS OR USE, LOST PROFITS OR REVENUE, INTEREST, LOST GOODWILL, WORK STOPPAGE, IMPAIRMENT OR OTHER GOODS, LOSS BY REASON OF SHUTDOWN OR NON-OPERATION, INCREASED EXPENSES OF OPERATION, COST OF PURCHASE OR REPLACEMENT POWER OR CLAIMS OF PURCHASER OR CUSTOMERS OF PURCHASER FOR SERVICE INTERRUPTION WHETHER OR NOT SUCH LOSS OR DAMAGE IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE.

10. NUCLEAR LIABILITY

In the event that the Equipment sold hereunder is to be used in a nuclear facility, the Purchaser shall, prior to such use, arrange for insurance or governmental indemnity protecting the Company against liability and hereby releases and agrees to indemnify the Company and its suppliers for any nuclear damage, including loss of use, in any manner arising out of a nuclear incident, whether alleged to be due, in whole or in part to the negligence or otherwise of the Company or its suppliers.

11. GOVERNING LAW

The rights and obligations of the parties shall be governed by the laws of the State of New Jersey excluding any conflicts of law provisions. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this agreement.

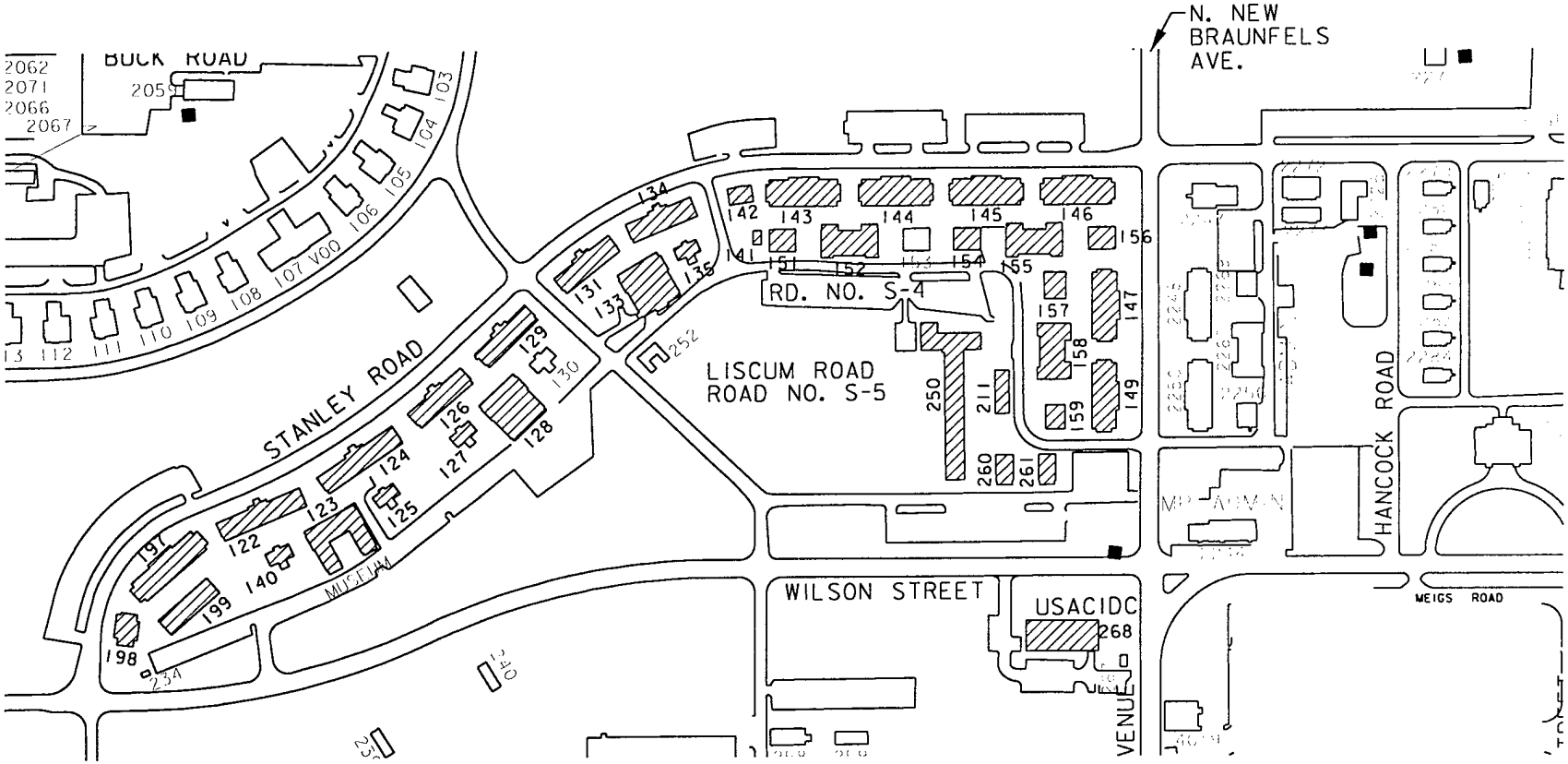
12. EXECUTION

The Company shall not be bound by any contract or any modification thereto until approved in writing by an officer of the Company. The contract, when so approved shall supersede all previous communications, either oral or written.

APPENDIX G
MAPS, BUILDING, AND EQUIPMENT DATA FORMS

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N. NEW BRAUNFELS AVE.
BUCK ROAD
2062
2071
2066
2067
205
103
104
105
106
107
VOO
108
109
110
111
112
13
STANLEY ROAD
134
131
133
135
129
130
126
127
128
124
123
125
122
140
191
199
198
234
252
RD. NO. S-4
LISCUM ROAD
ROAD NO. S-5
142
143
144
145
146
156
151
152
154
155
157
158
159
147
149
250
211
260
261
HANCOCK ROAD
WILSON STREET
USACIDC
268
VENUE
MEIGS ROAD
N

AREA 100

BUILDING DESCRIPTION

NAME: Building 123

USE: Fort Sam Houston Museum. Continuous occupancy from Wednesday through Sunday, between 10:00 A.M. and 4:00 P.M. Four full-time staff and 20,000 visitors per year.

GROSS AREA (SQ.FT.): 10,389 STORIES: 1 DATE OF SURVEY: 10/17/95

DATE OF CONSTRUCTION: 1941

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete finish, carpet, and vinyl coated tile

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Five (5) ½ HP, one (1) 3/4 HP water cooled packaged FCU's serve the entire museum. These units are controlled manually by unit mounted switches. Also, fourteen (14) 1/6 HP floor mounted dehumidifiers condition the air and provide spot dehumidification. The six packaged air handlers reject the heat of the space to a condenser water loop that is served by a cooling tower with a 2 HP fan located on the West side of the building. See HVAC Equipment Lists for details.

HEATING EQUIP: Four (4) ceiling mounted, gas fired, unit heaters heat the museum. See HVAC Equipment Lists for details.

LIGHTING: Suspended 2'/4', 2-lamp, fluorescent lay-in fixtures on the first floor and incandescent fixtures in the basement.

DOMESTIC WATER HEATING: One (1) 100 gallon gas fired domestic water heater, and one (1) 50 gallon gas fired domestic water heater in basement were not currently operating.

OTHER: One (1) condenser water pump located with the cooling tower, and one (1) restroom exhaust fan interlocked with the lights. See HVAC Equipment Lists for details.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. The cooling tower fan does not cycle with temperature but runs continuously. One (1) of the packaged air handlers is never operated, and another is operated with the fan only and no cooling. Fiberglass batt insulation is above the 10' clear ceiling space.

BUILDING DESCRIPTION

NAME: Buildings 122 & 124

USE: Administrative offices - Dir. of Resource Management. Continuous occupancy of approximately 30 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 12,782 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Two (2) 3 HP and one (1) 5 HP four-pipe, multi-zone AHU's with three-way controlled CHW and HW coils serve each building. Units served by ACR located outside each bldg. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. Heating water is provided by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: CHW pump and HW pump for each bldg. See HVAC Equipment Lists for details.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Poor temperature control, very hot inside during the field visit. Building 124 was being renovated at the time of the site visit. All HVAC equipment appeared to be in fair to poor condition, however most controls were not functioning properly.

BUILDING DESCRIPTION

NAME: Buildings 126, 129, 131

USE: Administrative offices - Dir. Of Patient admin. Services & Biostat Activities (PASBA), BAMC Info. Mgt. Div. & Visual Info. Med. Informatics, and H.Q. 41st Combat Support Hospital. Continuous occupancy during weekdays, between 7:00 A.M. and 5:00.

GROSS AREA (SQ.FT.): 12,087 STORIES: 2 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete finish in basement, carpet on other floors

CEILINGS: Acoustical tile and plasterboard

WINDOWS: single pane, clear glass

COOLING EQUIP: Bldg. 126 is served by one (1) cooling-only, single zone, 5 HP AHU with three-way controlled chilled water coil, and one (1) ACR chiller outside. The first and second floors of Bldg. 129 are served by two 7.5 HP (2) two-pipe FCU's, and one (1), 2-pipe, multi-zone (2 zones) 3 HP AHU with three-way controlled HW/CHW coil, and face and bypass dampers. The AHU is served by one (1) ACR chiller outside on the South side of the bldg. The occupied portion of the basement is served by one (1) single zone DX AHU with condensing unit outside on the West side of bldg. Bldg. 131 is served by two (2), four-pipe multi-zone 7.5 HP AHU's with three-way controlled HW and CHW coils, and one ACR chiller on the East side of the building. See HVAC Equipment Lists for details.

HEATING EQUIP: Heating for Bldg. 126 is provided by individual radiators in the building served by HW boiler in the basement. See above for bldg. 129 air-side heating which is served by HW boiler in basement. Bldg. 131 is served by the above air-side system and one (1) high efficiency HW boiler (with one stand-by boiler), with hot water reset control, located in the basement. The entrance vestibule for bldg. 131 is served by a heating only FCU. See HVAC Equipment Lists for details.

LIGHTING: Surface mounted, 2-lamp fluorescent fixtures serve bldgs. 126 & 129 with 129 also lit by recessed, 4-lamp fluorescent fixtures. Bldg. 131 has 2'/4' 3-lamp fluorescent fixtures with electronic ballast.

DOMESTIC WATER HEATING: Bldgs. 126 & 129 have no domestic water heater. However,

bldg. 131 is served by a 100 gal gas fired DHW heater.

OTHER: Bldg. 126 - one (1) HW pump and one (1) CHW pump. Bldg. 129 - split system computer room unit serves computer room on first floor. Also, one HW/CHW pump and basement convertors. Bldg. 131 - two HW pumps (1 stand-by), one CHW pump, and exhaust fan for restrooms which operates continuously, and ventilation fan for mechanical room which is controlled by outside t-stat. See HVAC Equipment Lists for details.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Bldg. 129 boiler was designed to be controlled by an outside t-stat; however, it was currently not operating as such. Also, bldg. 129 has a 4-pipe to 2-pipe manual changeover arrangement, and a minimum outside air duct. Bldg. 131 had recently been renovated (but currently unoccupied) so that all the mechanical equipment was new and the controls operating properly.

BUILDING DESCRIPTION

NAME: Buildings 125, 127, & 135

USE: Administrative offices - Community Operations Div., J. A. office, U.S.M.A. Admin. Field office. Continuous occupancy of approximately 5 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 1,593 STORIES: 1 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: Single pane clear glass

COOLING EQUIP: Building 125 is the only one of these buildings that has fan coils. Building 135 has a single zone 3 HP AHU, while building 127 has a residential type furnace unit with evaporator coil. Bldgs. 125 and 135 are both served by air cooled chillers that also serve adjacent building 124 and 134. Building 127 is served by a 4.5 ton outdoor condensing unit. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. Heating water for bldg. 125 and 135 is provided by a boiler in the basement of buildings 124 and 134. the furnace in Bldg. 127 is served by gas. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

OTHER: One (1) CHW pump and HW pump in bldg. 125.

DOMESTIC WATER HEATING: Electric hot water heater in building.

REMARKS: Poor temperature control, very hot inside during the field visit. All HVAC equipment appeared to be in fair to poor condition, however most controls were not functioning properly.

BUILDING DESCRIPTION

NAME: Building 128

USE: Boys & Girls Scouts Offices.

GROSS AREA (SQ.FT.): 14,224 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Frame

EXTERIOR WALLS: Brick , stone, and siding

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Air handling units, fan coil units, and several window units serve all conditioned areas of the building. Units served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Electric hot water heater in building.

OTHER: One (1) CHW pump and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: This building was unavailable to be entered during site visit. Chiller appeared to be in fair condition.

BUILDING DESCRIPTION

NAME: Building 133

USE: Administrative offices - Medical/Pharmaceutical operations. Continuous occupancy of approximately 50 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 13,232 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and siding

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: One (1) 4-pipe, multi-zone 10 HP AHU (five zones) serves the first floor, and one (1) 4-pipe fan coil units serves the basement of the building. Units served air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above cooling equipment is served by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: 40 gallon, gas fired DHW heater.

OTHER: One (1) CHW pump, and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Temperature control in good condition. Comfortable inside during the field visit. All HVAC equipment appeared to be in fair condition.

BUILDING DESCRIPTION

NAME: Building 134

USE: Legal offices. Continuous occupancy of approximately 40 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 10,434 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Two (2) 5 HP and, one (1) 1 HP multi-zone AHU's with three-way controlled CHW and HW coils serving all conditioned areas of the building. Units served air cooled reciprocating chiller which also serves bldg. 135. See HVAC Equipment Lists for details.

HEATING EQUIP: Above cooling equipment is served by HW boiler in basement. See HVAC Equipment Lists for details..

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: One (1) CHW and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control, very hot inside during the field visit especially on second floor near window covered vestibule. All HVAC equipment appeared to be in fair to poor condition, however most controls were not functioning properly.

BUILDING DESCRIPTION

NAME: Building 140

USE: Equal Employment Opportunity Office. Continuous occupancy of six (6) people weekdays between 8:00 A.M. and 5:00 P.M.

GROSS AREA (SQ.FT.): 1,593 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: One (1) 1 HP, single zone AHU that has three (3) VAV terminal boxes, and a three way controlled CHW coil and two-way controlled HW coil. This AHU is served by Bldg. 122 ACR chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment served by boiler in bldg. 122. See HVAC Equipment Lists for details.

LIGHTING: 2'/2', u-tube fluorescent fixtures

DOMESTIC WATER HEATING: One (1) 30 gallon gas fired domestic water heater in mechanical room has been disconnected.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Outside air is not available for this unit, and there is poor temperature control. VAV boxes apparently no longer operate, and the CHW actuator has been manually stuck open.

BUILDING DESCRIPTION

NAME: Building 141

USE: National Association of Federal Employees. Continuous occupancy of five (5) people weekdays between 7:00 A.M. and 5:00 P.M.

GROSS AREA (SQ.FT.): 1,008 STORIES: 2 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1913

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Plaster

WINDOWS: single pane clear glass

COOLING EQUIP: Two (2) window unit heat pumps provide both heating and cooling. One is located upstairs and the other is located downstairs. See HVAC Equipment Lists for details.

HEATING EQUIP: See above. See HVAC Equipment Lists for details.

LIGHTING: suspended fluorescent 2'/4', 2-lamp fixtures

DOMESTIC WATER HEATING: One (1) 30 gallon gas fired domestic water heater in mechanical room which does not operate.

REMARKS: These two units maintain good temperature control throughout year.

BUILDING DESCRIPTION

NAME: Buildings 142

USE: Administrative offices - Reg. H.Q. and deferred maintenance.

GROSS AREA (SQ.FT.): 4,735 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and CMU

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: Single pane clear glass

COOLING EQUIP: This building is served by an air cooled chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: HW boiler in the basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Electric hot water heater in building.

REMARKS: This building was unavailable to be entered during site visit. Chiller appeared to be in fair condition. This building has it's own electrical meter.

BUILDING DESCRIPTION

NAME: Buildings 143, 144, 145,146

USE: Administrative offices. Continuous occupancy of approximately 50 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 13,483 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry with frame add-on

EXTERIOR WALLS: Brick, stone and wood shingles

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass and tempered glass for enclosed porch

COOLING EQUIP: Bldgs. 143, 144, and 146 are served by 4-pipe, multi-zone and single-zone air handling units with three way controlled CHW and HW coils, and bldg 145 contains packaged window units for cooling. The air handlers in bldg 143, 144, & 146 are served by air cooled reciprocating chillers. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. The air handlers in bldgs. 143, 144, & 146 are served by HW boilers in the basements. Warm air furnace provides heating for bldg. 145. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heaters in buildings.

OTHER: One HW pump and CHW pump in each building. Building 144 also has a 4 ton condensing unit that serves computer room. See HVAC Equipment Lists for details.

REMARKS: Building 143 was empty and awaiting renovation at the time of the site visit. Window units are in poor condition and thus create maintenance problems. All other HVAC equipment appeared to be in fair to poor condition and most controls were not functioning properly.

BUILDING DESCRIPTION

NAME: Buildings 147 & 149

USE: Billeting for Reserves, Family Residence. Continuous occupancy of approximately 50 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 11,522 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1939

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: One (1) 10 HP multi-zone air handling unit serves each of these buildings. ACR chiller serves both bldg. 147 & 149. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler in each bldgs. basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures and scattered incandescent fixtures.

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: One (1) CHW pump, and two (2) HW pumps. See HVAC Equipment Lists for details.

REMARKS: All HVAC equipment appeared to be in fair to poor condition. Piping between buildings appears to be deteriorating.

BUILDING DESCRIPTION

NAME: Building 151, 154, 156, 157, 159

USE: Military Honor's Platoon, Ninety Fourth Medical Detachment, Fifth Army Band, M.P. Company Orderly Room and Command Office. Bldgs. 154 & 156 are continuously occupied between approximately 7:00 A.M. and 4:00 P.M. Bldg. 151 was currently unoccupied, and bldg. 157 is occupied only half a day for three days out of the week. Bldg. 159 is a twenty-four hour operation with four people during the daytime hours and one (1) person during the night.

GROSS AREA (SQ.FT.): 1,860 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945 & 1946

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles or clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet in all buildings except 157 which has vinyl coated tile

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Window unit heat pumps serve every bldg. except 159 which is served by a residential type fan and coil system with a split system heat pump outside. See HVAC Equipment Lists for details.

HEATING EQUIP: In bldgs. 151 & 154, the heat pumps utilize electric resistance heat. However, in bldg. 156; heating is provided by one (1) boiler that serves HW radiators in bldg. Bldg. 157 is served by gas fired unit heaters in the space, and a residential gas furnace serves bldg. 159. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' recessed 2-lamp and 4-lamp fluorescent fixtures in all the bldgs.

DOMESTIC WATER HEATING: Bldg. 154 does have 10 gallon DHW electric heater which is not operating, and bldg. 156 has abandoned steam boiler and heat exchanger. The rest of the buildings do not have DHW generating capabilities.

OTHER: One (1) restroom fan serves bldg. 154, and bldg. 156 has a HW pump. Two (2) dehumidifiers condition the air for the vault in bldg. 159.

REMARKS: Domestic water for the building is not available due to a base wide policy. Bldg. 151 was abandoned at the time of the site visit. Bldg. 154 has steam radiators that are no longer used. Bldg. 156 has an abandoned steam boiler and domestic hot water storage tank, the HW pump for his same bldg. operates continuously. Bldg. 157 is occupied on an as needed basis.

BUILDING DESCRIPTION

NAME: Building 152

USE: Civilian Training Office - administration and classroom space. Continuously occupied by 8 people between approximately 7:00 A.M. and 4:00 P.M. Classes are occupied an average of once per week with 40 people per classroom (2 classrooms).

GROSS AREA (SQ.FT.): 8,457 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945 & 1946

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Eight (8) cooling only window units serve the bldg. See HVAC Equipment Lists for details.

HEATING EQUIP: Ten (10) gas fired space heaters located on the floor heat the space. See HVAC Equipment Lists for details.

LIGHTING: 8' suspended fluorescent fixtures and 2'/4' recessed fluorescent fixtures

DOMESTIC WATER HEATING: N/A

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water.

BUILDING DESCRIPTION

NAME: Building 155

USE: Research Management Division, Plans and Ops., Directorate Planning, Security and Mobilization, Training, Emergency Operation Center (EOC), Visual Eq. of Base. Continuously occupied by 15 people between approximately 7:00 A.M. and 4:00 P.M.

GROSS AREA (SQ.FT.): 7,374 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Vinyl coated tile and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: The secured EOC area in the basement is served by a 1/4 HP four-pipe, three-way controlled CHW and HW vertical FCU. The other occupied area of the basement is served by a ½ HP four-pipe, three-way controlled CHW and HW single zone AHU. These units are served by two (2) split system condensing units located outside on the East side of the building that are piped to a heat exchanger in the basement mechanical room that exchanged heat between the chilled water and the refrigerant. The rest of the building is served by eight (8) packaged window units. See HVAC Equipment Lists for details.

HEATING EQUIP: See above for air-side equipment. The basement units are served by HW boiler located in the basement mechanical room, and the window units all have electric resistance heat. The restrooms have space heaters that do not operate. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' 2-lamp pendant mounted fluorescent fixtures on the first floor and 2'/4' 4-lamp surface mounted fluorescent fixtures in the basement.

DOMESTIC WATER HEATING: None

OTHER: Small restroom exhaust fan which is interlocked with the lights

REMARKS: Domestic water for the building is not available due to a policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water.

BUILDING DESCRIPTION

NAME: Building 158

USE: Company A Support and Training which includes supply, conference, training and office areas. Continuous occupancy by 12 people between 6:00 A.M. and 6:00 P.M.

GROSS AREA (SQ.FT.): 6,429 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Vinyl coated tile

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Eight (8) packaged window units. See HVAC Equipment Lists for details.

HEATING EQUIP: In the Supply area, the window units have electric resistance heat. In all other areas, eight (8) gas fired unit heaters provide the heat. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' recessed, 4-lamp fluorescent fixtures in the supply and office areas, and suspended, 2'/4' 2-lamp fluorescent fixtures in the conference room.

DOMESTIC WATER HEATING: Gas fired DHW heater in basement serves restrooms but is not operating.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Window units run continuously to maintain building setpoints. Room furnaces throughout building are no longer used.

BUILDING DESCRIPTION

NAME: Buildings 197

USE: Headquarter of Fifth Army Band, future 323rd Medical Battalion Supply. Continuous occupancy of approximately 35 people during weekdays, between approximately 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 13,819 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Frame

EXTERIOR WALLS: Stucco

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile, Plaster

WINDOWS: Single pane clear glass

COOLING EQUIP: Three 3 HP, 4- Pipe, single-zone fan and coil units serve all conditioned areas of the building, and the space thermostats modulate the CHW and HW control valves. Units do have economizer control capabilities but it has been de-activated. Units served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in and surface mounted fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: One (1) CHW pump and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control, very hot inside during the field visit. Very old ductwork with dust mold and mildew. Control problems create moisture pockets on furniture and causes moisture problems with computers. All HVAC equipment appeared to be in poor condition, and most controls were not functioning properly.

BUILDING DESCRIPTION

NAME: Building 198

USE: Physical/Medical Evaluation Board. Continuous occupancy of approximately 20 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 5,468 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Frame

EXTERIOR WALLS: Stucco

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile, Plaster

WINDOWS: single pane clear glass

COOLING EQUIP: Two (2) single-zone fan and coil units serving all conditioned areas of the building. HW valves and CHW valves are modulated to maintain return air temperature. Units served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Surface mounted incandescent fixtures and fluorescent fixtures

DOMESTIC WATER HEATING: Electric water heater in building.

OTHER: One (1) CHW pump and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control. Air-side equipment is maintenance intensive. All HVAC equipment appeared to be in poor condition.

BUILDING DESCRIPTION

NAME: Building 199

USE: Band Rehearsal Hall. Intermittent occupancy of approximately 60 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 6,415 STORIES: 1 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION 1940

EXTERIOR WALLS: Stucco

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Plaster

WINDOWS: single pane clear glass

COOLING EQUIP: One multi-zone air handling unit serves all conditioned areas of the building. Unit is served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Recessed and surface mounted fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: One (1) CHW pump and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control. Area is critical to humidity control because instruments are susceptible to humidity. All HVAC equipment appeared to be in fair condition, however most controls were not functioning properly.

BUILDING DESCRIPTION

NAME: Building 250

USE: NCO Academy, barracks, and future chef training school. Continuous occupancy of approximately 250 people between 5:00 pm and 7:00 a.m.

GROSS AREA (SQ.FT.): 42,955 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Stucco

ROOF: Flat built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete, tile and carpet

CEILINGS: Acoustical tile, gypsum wallboard, plaster

WINDOWS: single pane clear glass

COOLING EQUIP: Six (6), 7.5 HP, multi-zone air handling units with three-way controlled CHW coil , and two-way controlled steam coil serve the barracks portion of building and one multi-zone air handling unit with the same controls serves the future chef school. Hot and cold deck temperature setpoints are maintained by modulating CHW and steam valves, and space thermostats control zone dampers. Units do have economizer capabilities but they have been de-activated. All units are served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. All heating coils in the air handlers are steam. Steam is provided by steam boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures in future chef school, admin, and barracks; surface mounted incandescent and fluorescent fixtures in barracks.

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: CHW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control, very hot inside during the field visit. The air cooled chiller appeared to be in good condition and all other HVAC equipment appeared to be in fair condition.

BUILDING DESCRIPTION

NAME: Building 260 & 261

USE: Bldg. 260 is currently unoccupied but Dispute Resolution Department will move into the building. Bldg. 261 is the Post Inspector General's Office with a continuous occupancy of 6 people between 7:30 A.M. and 4:30 P.M.

GROSS AREA (SQ.FT.): 1,756 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Wood and carpet

CEILINGS: Plaster in bldg. 260 and acoustical tile in bldg. 261

WINDOWS: Single pane, clear glass

COOLING EQUIP: Five (5), 1/6 HP, three speed, two-pipe FCU's with wild coils located along the walls of each building are served by one (1) ACR chiller located between the buildings. One (1) wall mounted thermostat in each building appears to cycle on a compressor in the chiller according to the CHW supply temperature. See HVAC Equipment Lists for details.

HEATING EQUIP: HW boiler serves the above air-side equipment in both buildings and is located in the mechanical room of bldg. 260. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' 4-lamp, surface mounted fluorescent fixtures and 2'/4' suspended 2-lamp fluorescent fixtures in bldg. 260. 2'/4' recessed fluorescent fixtures in office space, and incandescent in copy room of bldg. 261.

DOMESTIC WATER HEATING: Gas fired 30 gallon DHW heater in mechanical room serves restrooms in bldg. 260 but is not operating, and none in bldg. 261.

OTHER: One (1) CHW/HW pump for two-pipe application in each building mechanical room.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Manual changeover valves for boilers were not closed during the site visit which results in the chilled water flow running through the boiler and creates a greater head on the pump. Bldg. 261 has recently been renovated.

BUILDING DESCRIPTION

NAME: Building 268

USE: FSH Resident Agency Sixth Region U.S. Army Criminal Investigation Command. Continuous occupancy of 25 people between 7:30 A.M. and 4:30 P.M.

GROSS AREA (SQ.FT.): 8,800 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1982

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with slates

FLOOR CONSTRUCTION: Slab on grade

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: Single pane, clear glass

COOLING EQUIP: Three (3), 1/3 HP, 4-pipe, three-way controlled FCU's are located in the building above the ceiling. A fourth, 7.5 HP, 4-pipe, three-way controlled AHU ("Texas Multi-zone Unit") is located in the main mechanical room and has six zones with duct mounted heating coils in each zone. All units are served by ACR chiller outside on the East side of the building. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler and is located in the main mechanical room of this building. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' 2-lamp, recessed fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired 100 gallon DHW heater and tank and is operating.

OTHER: One (1) base mounted CHW pump, one (1) in-line HW pump, and one (1) DHW pump. One (1) exhaust fan serves restroom, one (1) floor mounted dehumidifier in space, and small ventilation fan for mechanical room.

REMARKS: Three-way control valve for boilers has been dismantled. Also, some three-way control valved for the water systems are inoperative because the actuators have been installed upside down which floods the element in the actuator. The chilled water system for this building operates year round.

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Hot Water Boiler	1	Rite #HD-85 natural draft, watertube 618 MBH output	Bldg. 122 & 140	1985	850 MBH
Heating Water Pump	2	B&G model 1.5 x 7B 83/4 BF 32 gpm, 50 ft 1.5 HP	Bldg. 122 & 140	1985	1.12 KW
Water Chiller	1	Trane #CGABC401AF01FK, 40 tons Comp-1, 460 V, 3 ph, 31.3 RLA Fan-4, 460 V, 3 ph, 31.3 RLA	Bldg. 122 & 140	1985	70 KW
Chilled Water Pump	2	N/A 3 HP	Bldg. 122 & 140	1985	2.24 KW
Cooling Tower	1	Halstead & Mitchell cross flow # CP-40 2 HP Fan, 35 tons cooling	Bldg. 123	1985	1.49 KW
Cond. Pump	1	No name plate 3 HP	Bldg. 123	1985	2.24 KW
Water Cooled Pack. FCU	4	Fedders, # GAWO65088 Comp 1, 208 V, 14.5 FLA, Blower 1/2 HP	Bldg. 123	1980	23.29 KW
Water Cooled Pack. FCU	1	Chrysler # 106-00R Comp 1, 208 V, 23 FLA, Blower 1/2 HP	Bldg. 123	1980	9.24 KW
Water Cooled Pack. FCU	1	Weather King # SW 90 3A Comp 2, 208 V, 18.2 FLA, Fan 0.75HP	Bldg. 123	1980	7.31 KW
Space Heaters	5	Gas, over head Name and capacity unknown 140 MBH design heating	Bldg. 123	1980	195.4 MBH
Dehumidifier	14	Model # D-1600 1/6 HP, 115 V, total 3.4 A per unit refrigerant - 500	Bldg. 123	1985	6.04 KW
Hot Water Boiler	1	Ajax, inclined natural draft, watertube, 200 F 618 MBH output	Bldgs. 124, 125	1985	850 MBH
Heating Water Pumps	2	Amtrol 23 GPM, 50 ft 1.5 HP	Bldgs. 124, 125	1985	1.12 KW

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	TSI #30-AOCD65, 50 tons Comp-1, 460 V, 56 RLA, Comp-1, 48 RLA Fan-4, 460 V, 31.3 RLA	Bldgs. 124, 125	1985	88 KW
Chilled Water Pumps	2	Mueller 53 gpm, 71 ft 3 HP	Bldgs. 124, 125	1985	2.24 KW
Air Cooled Chiller	1	Trane, # CGABC403AE00F 2 Comp. 62.8 RLA, 230 V. 4 Cond. fans 1 HP ea., 40 tons	Bldg. 126	1985	58.45 KW
Chilled Water Pump	1	Armstrong 2 HP	Bldg. 126	1985	1.49 KW
HW Water Pump	1	1 HP No name plate	Bldg. 126	1985	0.746 KW
HW Boiler	1	National 587 MBH output	Bldg. 126	1985	810 MBH
Split System Furnace	1	RUUD 33 MBH output	Bldg 127	1985	45 MBH
Condensing Unit	1	RUUD #UACC-056JAS 4.5 ton, 7 EER	Bldg 127	1985	7.71 KW
Hot Water Boiler	1	N/A 109 MBH output	Bldg. 128	1985	150 MBH
Heating Water Pump	1	N/A 1/2 HP	Bldg. 128	1985	0.37 KW
Air Cooled Chiller	1	Trane #CGABC403AE00F, 40 tons Comp-2, 230 V, 62.8 RLA Fan-4, 230 V, 3.6 RLA	Bldg. 128	1985	58.50 KW
Chilled Water Pump	1	N/A 1.5 HP	Bldg. 128	1985	1.12 KW
Air Cooled Chiller	1	York, # YCAZ33JD346, 54.4 GPM 2 Comp. 25.3 RLA, 460 V 2 Cond. fans 1.5 HP ea., 25 tons	Bldg.129	1988	46 KW

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Air Cooled Cond.	2	Larkin, # FCA 26 3 fans/ unit, 2.0 FLA/ fan, 10 tons for comp. rm. units and not modeled	Bldg.129	1990	2.29 KW
Air Cooled Cond.	1	Rudd # UACC048JAS 208 V, 28.2 AMP 3 tons	Bldg.129	1992	6.1 KW
HW / CHW Water Pump	1	Armstrong 3 HP, 2 pipe system	Bldg.129	1988	2.38 KW
HW Boiler	1	AJAX # G 24783 108.8 MBH output	Bldg.129	1971	154.7 MBH
HW Circulator	1	TACO # 8-91 3/4 HP	Bldg.129	1991	0.56 KW
Air Cooled Chiller	1	McQuay # ALR030C, 29 tons Comp. 1ea. 35 HP, 56 RLA Fan 2 ea. 2 FLA & 1 ea. 5.6 FLA	Bldg.131	1994	37.8 KW
Chilled Water Pmp	1	Taco 92.5 GPM, 55 ft head, 3 HP	Bldg.131	1994	2.24 KW
HW boiler	1	Teledyne # HH0250CN12KBAX 201.0 MBH output non-modulating	Bldg.131	1995	250 MBH
HW Pumps	2	Taco inline (1-standby) # 1651C3N2 5.75 3/4 HP	Bldg.131	1995	0.56 KW
Hot Water Boiler	1	Ajax #WGHD-150 forced draft, 5 HP blower 109 MBH output	Bldg. 133	1985	150 MBH 3.73 KW
Heating Water Pump	1	N/A 1/2 HP	Bldg. 133	1985	0.37 KW
Water Chiller	1	Trane #CGABC256AF01FK, 25 tons Comp. 1ea. 200 V, 3 ph, 56 RLA Fan 3 ea. 200 V, 3 ph, 4.1 FLA tot	Bldg. 133	1985	44 KW
Chilled Water Pump	1	Aurora 40 gpm, 70 ft 1.5 HP	Bldg. 133	1985	1.12 KW

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100
MARCH 1, 1996

ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Hot Water Boiler	1	Thermopak #GWE 825 watertube 596 MBH output	Bldgs 134, 135	1985	820 MBH
Heating Water Pump	1	Armstrong, close coupled 1/2 HP	Bldgs 134, 135	1985	0.37 KW
Water Chiller	1	Trane #CGACC306KANDD303EG, 30 ton Comp. 1ea. 200 V, 3 ph, 103.2 RLA Fan 3 ea. 200 V, 3 ph, 2.1 FLA tot	Bldgs 134, 135	1985	53 KW
Chilled Water Pump	1	Armstrong, close coupled 63 ft, 1/2 HP	Bldgs 134, 135	1985	0.37 KW
Window Units	2	Friedrich # EL19H35B 19,000 BTUH clg. & 17,300 BTUH htg. 10 EER	Bldg.141	1993	3.7 KW
Hot Water Boiler	1	N/A 327 MBH output	Bldg. 142	1985	450 MBH
Heating Water Pump	1	N/A 1/2 HP	Bldg. 142	1985	0.37 KW
Water Chiller	1	Carrier #30GT-020-500 air cooler, recip. 10 tons	Bldg. 142	1985	18 KW
Chilled Water Pump	1	N/A 1 HP	Bldg. 142	1985	0.75 KW
Water Chiller	1	N/A air cooled, recip. 45 tons	Bldg. 143	1985	70 KW
Chilled Water Pump	1	N/A 3 HP	Bldg. 143	1985	2.24 KW
Hot Water Boiler	1	N/A 596 MBH output	Bldg. 143	1985	820 MBH
Heating Water Pump	1	N/A 1/2 HP	Bldg. 143	1985	0.37 KW

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100
MARCH 1, 1996

ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	TSI #CA2CD 45 Comp-2, 230 V, 3 ph, 1 ea 71.4 A, 1 ea 88.5 A 45 tons	Bldg. 144	1985	70 KW
Chilled Water Pump	1	Aurora 58 gpm, 86 ft 3 HP	Bldg. 144	1985	2.24 KW
Hot Water Boiler	1	Bryan 596 MBH output	Bldg. 144	1985	820 MBH
Heating Water Pump	1	B&G 1 HP	Bldg. 144	1985	0.75 KW
Terminal Cooling Unit	1	Data Temp #DTA-0532-01 Russell #TD6.5 condenser 4 ton, 9 EER	Bldg. 144	1985	5.81 KW
Window A/C Units	23	Fredrich #MDD YL 24H3513 2 ton clg, 22.4 MBH htg. 9 EER	Bldg. 145	1985	61.33 KW
Hot Water Boiler	1	Teledyne Laars 596 MBH	Bldg. 146	1985	820 MBH
Heating Water Pump	1	N/A 1 HP	Bldg. 146	1985	0.75 KW
Water Chiller	1	Trane #CGABC404AF00F1K, 40 tons Comp-2, 460 V, 3 ph, 31.3 RLA ea Fan-4, 460 V, 3 ph, 1 HP ea.	Bldg. 146	1985	58 KW
Chilled Water Pump	1	Taco 83 gpm, 1.5 HP	Bldg. 146	1985	1.12 KW
Hot Water Boiler	1	Ajax #WG-750-5 155 F HWS 596 MBH output	Bldg. 147	1985	820 MBH
Heating Water Pump	1	Taco 1 HP	Bldg. 147	1985	0.75 KW
Water Chiller	1	McQuay #ALR 040AD, 50 tons Comp-2, 208 V, 3 ph, 64 A & 76 A Fan-4, 208 V, 3 ph, 10.6 A tot	Bldgs 147, 149	1985	59.80 KW

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100
MARCH 1, 1996

ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Chilled Water Pump	1	Paco 5 HP	Bldgs 147, 149	1985	3.73 KW
Hot Water Boiler	1	Thermopak #GWE 825 220 F HWS 596 MBH output	Bldg. 149	1985	820 MBH
Heating Water Pump	1	Paco 40 gpm, 40 ft 1 HP	Bldg. 149	1985	0.75 KW
Window Units	2	1.5 tons ea.(clg. and htg.) 19,000 BTUH clg. & 17,300 BTUH htg. 9 EER	Bldg.151	1985	4.4 KW
Window Units	8	Friedrich 19,000 BTUH clg. & 17,300 BTUH htg. 10 EER	Bldg.152	1993	14.91 KW
Gas Fired Rm. Heaters	10	Dearborn No name plate 115 MBH design heating load	Bldg.152	1985	157.3 MBH
Window Units	4	Friedrich 19,000 BTUH clg. & 17,300 BTUH htg. 9 EER	Bldg.154	1985	8.89 KW
Air Cooled Cond.	2	Trane # TTB748A100A0 208 V, 24 RLA 5 ton	Bldg.155	1988	10.8 KW
HW boiler	1	Hydrotherm 47.17 MBH output	Bldg.155	1985	65 MBH
HW Pump	1	Taco inline # 1612C2N10 5.75 3/4 HP	Bldg.155	1985	0.56 KW
CHW Pump	1	Taco inline # 1612C2N20 6.35 3/4 HP	Bldg.155	1988	0.56 KW
Window Units	8	19,000 BTUH clg. & 17,300 BTUH htg. 9 EER	Bldg.155	1985	17.79 KW
Window Units	7	19,000 BTUH clg. 9 EER	Bldg.156	1985	16.29 KW

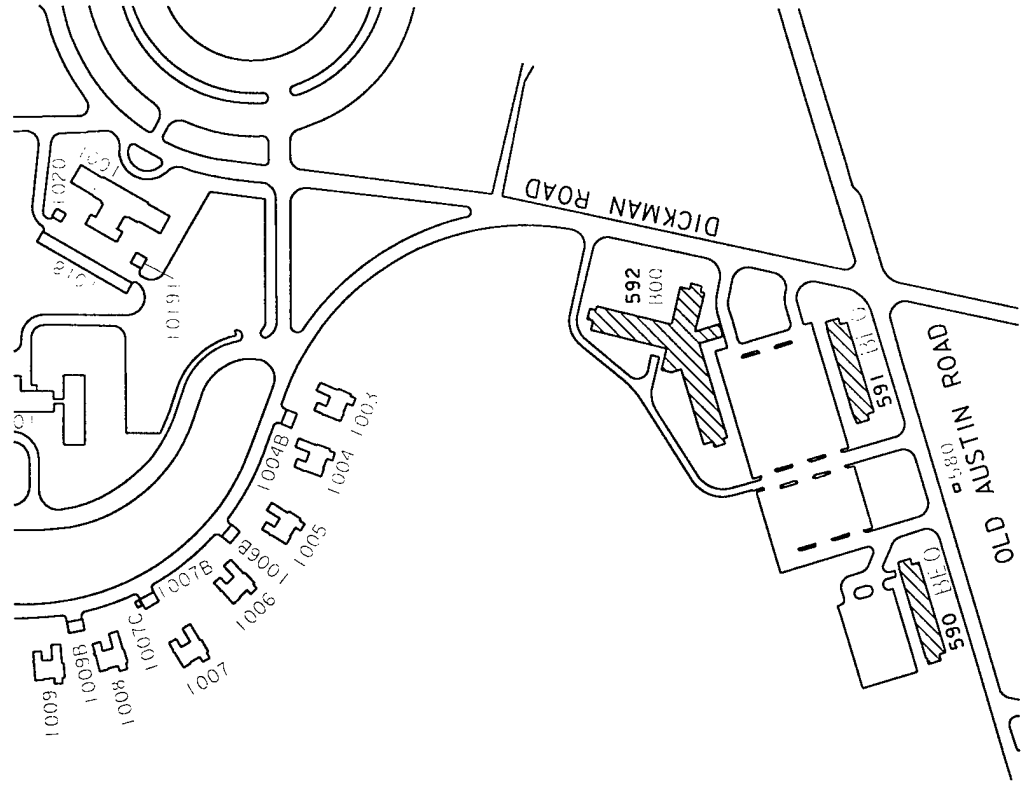
HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100
MARCH 1, 1996

ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
HW boiler	1	Richmond, Type 26SC 125.1 MBH output	Bldg.156	1980	174.4 MBH
HW Pump	1	Bell & Gosset inline circulator 1/4 HP	Bldg.156	1985	0.19 KW
Window Units	2	Friedrich - 1.5 tons Fedder - 1.0 ton 9 EER	Bldg.157	1985	3.68 KW
Gas Space Heaters	2	No name plate 16.74 MBH design heating	Bldg.157	1980	35 MBH
Window Units	8	Friedrich, 1.0 ton ea. No heat Signature model 2000, 9 EER	Bldg.158	1985	11.76 KW
Gas Floor Furnaces	8	26 MBH in each 18.65 MBH out each	Bldg.158	1980	208 MBH
Gas Furnaces	1	No name plate 16.74 MBH design heating	Bldg.159	1980	35 MBH
Split System	1	Bryant # 593CP036-B 208 V, 10 RLA 3 ton	Bldg.159	1990	3.81 KW
Hot Water Boiler	1	Ajax #WG-1750 1400 MBH output	Bldg. 197	1985	1,750 MBH
Heating Water Pump	1	B&G 1 HP	Bldg. 197	1985	0.75 KW
Water Chiller	1	York #LCHA 50-17A, 50 tons Comp-2, 200 V, 3 ph, 81 & 117 RLA Fan-7, 200 V, 3 ph, 8.4 RLA tot	Bldg. 197	1985	78.8 KW
Chilled Water Pump	1	Peerless 2 HP	Bldg. 197	1985	1.49 KW
Hot Water Boiler	1	National #209-7 natural draft 327 MBH output	Bldg. 198	1985	450 MBH

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100
MARCH 1, 1996

ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Heating Water Pump	1	Taco 3/4 HP	Bldg. 198	1985	0.56 KW
Water Chiller	1	Trane #MAUG-C156-B, 10 tons Comp-2, 230 V, 3 ph, 27.1 RLA ea Fan-3, 230 V, 3 ph, 5.0 RLA tot	Bldg. 198	1985	14 KW
Chilled Water Pump	1	N/A 1.5 HP	Bldg. 198	1985	1.12 KW
Hot Water Boiler	1	Ajax #WG-200-S natural draft 145 MBH output	Bldg. 199	1985	200 MBH
Heating Water Pump	1	N/A 1.5 HP	Bldg. 199	1985	1.12 KW
Water Chiller	1	RUUD #RAWC 150 CAS, 15 tons Comp-1, 208 V, 3 ph, 59.6 RLA Fan-2, 208 V, 3 ph, 4.4 RLA tot	Bldg. 199	1985	26 KW
Chilled Water Pump	1	N/A 2 HP	Bldg. 199	1985	1.49 KW
Steam Boiler	2	Kewanee #581, series 3X 726 MBH output each	Bldg. 250	1985	1,000 MBH
Water Chiller	1	Trane #CGACD111, 100 tons Comp-2, 460 V, 3 ph, 98.0 & 78.0 RLA Fan-12, 460 V, 3 ph, 1.8 RLA ea	Bldg. 250	1985	173.6 KW
Chilled Water Pump	1	Paco 7.5 HP	Bldg. 250	1985	5.60 KW
Air Cooled Chiller	1	Trane, # CGAA0153HF53CC5C4A311CK 2 Comp. 208 V, 33 RLA ea. Cond. Fan 3 ea. 0.33 HP ea., 15 tons	Bldg.260 & 261	1985	27 KW
CHW / HW Pump	1	Pace pump # BACH 100 1/2 HP,	Bldg.260 & 261	1985	0.37 KW
HW Boiler	1	Name plate painted over 47.4 MBH design heating	Bldg.260 & 261	1980	66 MBH

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Chilled Water Pump	1	B & G, size 3525, 1/2 HP	Bldg.261	1985	0.37 KW
Air Cooled Chiller	1	Trane # CGACC203KBNB200 Comp. 1 ea. 62.8 RLA, 230 V. Cond. fan 2 ea. 1 HP. ea., 20 tons	Bldg.268	1993	27.3 KW
HW boiler	1	Peerless Boilers # G - 661 125.1 MBH out	Bldg.268	1993	160 MBH
HW pump	1	Taco # 163GN2 5.65 3/4 HP	Bldg.268	1993	0.56 KW
CHW pump	1	Taco # FM 1207 5.75 B2A1A1I2 40 GPM, 30 ft head 3/4 HP	Bldg.268	1993	0.56 KW


N
AREA 500
DICKMAN ROAD
OLD AUSTIN ROAD
592
591
590
1020
1019
1010
1009
1009B
1008
1007C
1007B
1007
1006
1005
1004B
1004
1003

BUILDING DESCRIPTION

NAME: Building 590 & 591

USE: Advanced Non-Commissioned Officers Quarters - barracks. One (1) person per room with 57 rooms per building. Approximately 80% current occupancy.

GROSS AREA (SQ.FT.): 21,940 STORIES: 3 DATE OF SURVEY: 10/19/95

DATE OF CONSTRUCTION: 1956

STRUCTURE: Masonry

EXTERIOR WALLS: Stucco on CMU

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: Single pane, double hung, clear glass

COOLING EQUIP: Three (3), 5 HP, four pipe, multi-zone (three zones) AHU with wild CHW and HW coils and face and bypass control. AHU's in each bldg. are served by ACR chiller located on the East side of each bldg. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW, water tube boiler that has no modulation in basement of each building. Boiler has three-way control on primary side and hot water reset capabilities. See HVAC Equipment Lists for details.

LIGHTING: Surface mounted, 4-lamp fixtures in rooms (along with incandescent bulbs), and surface mounted 1-lamp fixtures in corridors.

DOMESTIC WATER HEATING: One (1) water tube steam boiler with duplex condensate return unit serves a steam-to-DHW heat exchanger & tank (generator) in basement of each building which is then pumped to building.

OTHER: One (1) base mounted CHW pump & HW pump in each bldg. basement, and one (1) in-line DHW pump. Mechanical room propeller vent fan.

REMARKS: Min/max OA damper actuator for all three AHU's on exterior mechanical room wall have been disconnected. Return air is through corridor, and the mechanical room is used as a plenum space. First floor AHU's are larger to handle the lounge area and the extra wings.

BUILDING DESCRIPTION

NAME: Building 592

USE: Unaccompanied Personnel Housing - barracks. Two (2) person per room with 192 rooms per building. Approximately 80% current occupancy.

GROSS AREA (SQ.FT.): 127,537 STORIES: 5 DATE OF SURVEY: 10/19/95

DATE OF CONSTRUCTION: 1975

STRUCTURE: Masonry

EXTERIOR WALLS: Brick, stucco, and precast concrete panels

ROOF: Flat, built-up roof with pitched clay tile on penthouse

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Plaster in quarters, and 2'/2' & 2'/4' acoustical tile in corridors and office areas

WINDOWS: Single pane, operable, double hung, clear glass

COOLING EQUIP: Five, 15 HP, 4-pipe, multi-zone AHU's with wild CHW coils, three-way controlled HW coils, and face and bypass control. First floor AHU's have five zones while all other floors have six zones. Coil control valves are controlled by leaving coil temperature setpoints, and the space temperature controls the zone dampers. Economizer cycle has been de-activated. All of these AHU's is served by a R-123 centrifugal chiller which has no bypass control located in the central plant adjacent to the first floor mechanical room. The three-way controlled cooling tower is located outside the central plant. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by watertube, HW boiler in central plant. Boiler has hot water reset schedule that has been de-activated. See HVAC Equipment Lists for details.

LIGHTING: Recessed, 4-lamp fixtures in rooms (along with incandescent bulbs) and corridors. Surface mounted fluorescents in the laundries.

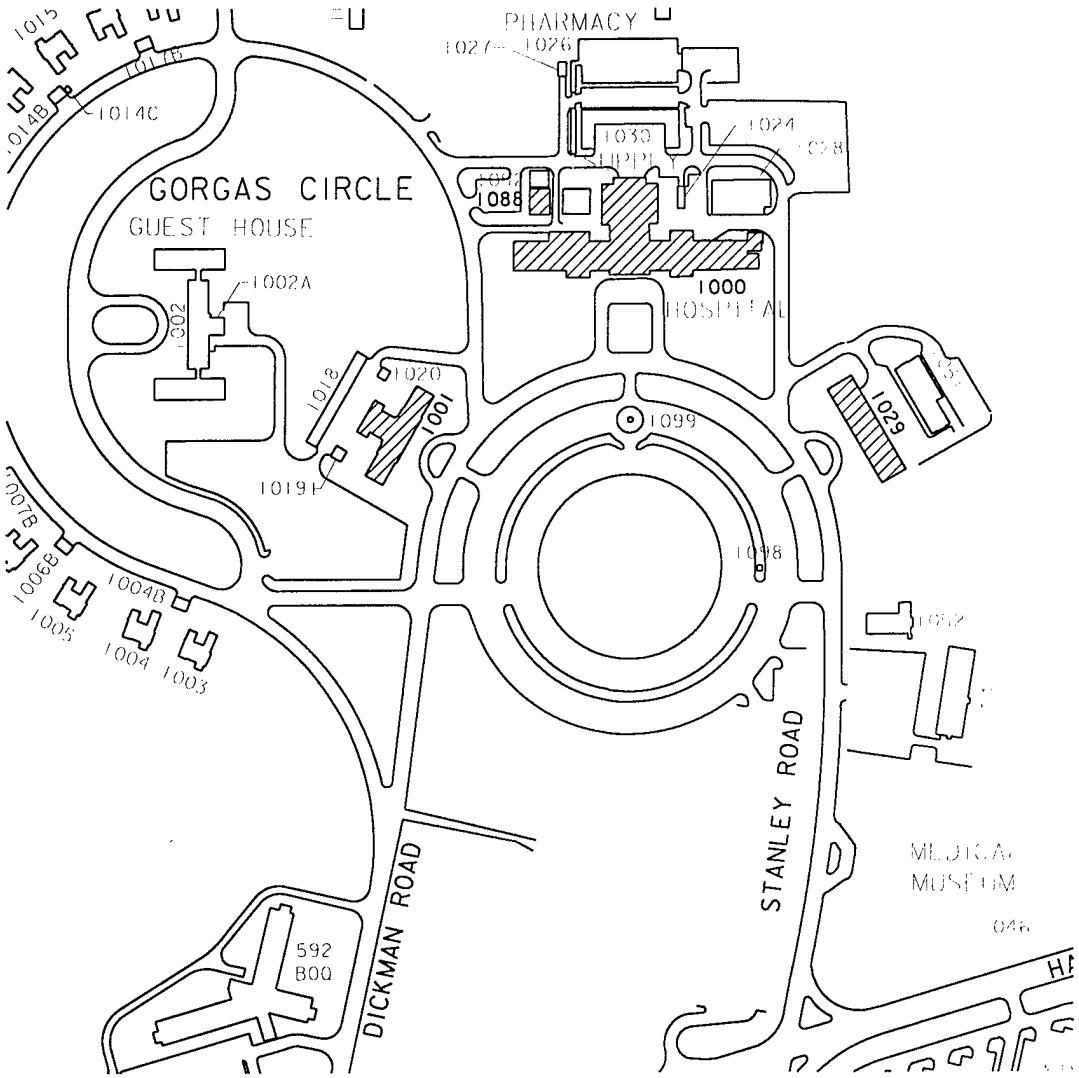
DOMESTIC WATER HEATING: One (1) 1250 MBH, water tube DHW boiler provides DHW to a 1340 gallon storage tank.

OTHER: One (1) central exhaust fan in central plant for building exhaust. One (1) base mounted CHW pump & HW pump in each bldg. basement, and one (1) in-line DHW pump, and DCW primer pump.

REMARKS: Min/max OA damper actuators for all AHU's on exterior mechanical room wall have been disconnected. Return air is through plenum space above corridor ceiling, and the mechanical room is used as a plenum space. Roll filters are used in all AHU's. Chiller, at the time

of the site visit, is six months old. The temperature of the DHW storage tank is maintained at 138°F. Controllers have recently been upgraded from pneumatics to electronics. Building has had a recent lighting renovation where electronic ballasts with T-8 lamps and occupancy sensors have been installed. However, lighting levels appear to be extremely high in many areas. Ventilation fan in elevator room is not operational. Central exhaust was not working at time of site visit. Dryer vent exhaust duct is in mechanical room plenum space, and in a couple of instances; the vent covers were of and adding both heat and lint into the plenum space. Mixing valve for boiler was removed when boiler was replaced.

PROPOSED HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 500 JANUARY 29, 1995										
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD	OPER. TIMES			ANNUAL USE	
						HRS	DAYS	WKS	KWH	MCF
Air Cooled Chiller	1	Dunham Bush, # ACDRO70A, 460 V 2 Comp. 63.5 RLA, 6 Cond. fans 1.5 HP ea., 66.5 tons	Bldg. 590	1986	91.86 KW	24	7	26		
Chilled Water Pump	1	Aurora # D 6466, 5 HP 135 GPM, 42 ft head 5 HP	Bldg. 590	1986	3.73 KW	24	7	26		
HW Water Pump	1	Aurora # D 6466-2A 52 GPM, 32 ft head 3 HP	Bldg. 590	1986	2.24 KW	24	7	26		
HW Boiler	1	AJAX # WG 525-S 381.8 MBH out	Bldg. 590	1986	525 MBH	24	7	26		
Air Cooled Chiller	1	Dunham Bush, # ACDRO70A, 460 V 2 Comp. 63.5 RLA, 6 Cond. fans 1.5 HP ea., 66.5 tons	Bldg. 591	1986	91.86 KW	24	7	26		
Chilled Water Pump	1	Aurora # D 6466 135 GPM, 42 ft head 5 HP	Bldg. 591	1986	3.73 KW	24	7	26		
HW Water Pump	1	Aurora # D 6466-2A 55 GPM, 32 ft head 3 HP	Bldg. 591	1987	2.24 KW	24	7	26		
HW Boiler	1	AJAX # WG 850-S 623.9 MBH out	Bldg. 591	1987	850 MBH	24	7	26		
Chiller	1	Trane Centravac, # CVHE 250 centrifugal, 460 V, 145 AMPS 170 tons	Bldg. 592	1995	105 KW	24	7	26		
Chilled Water Pump	1	Taco 15 HP	Bldg. 592	1987	11.19 KW	24	7	26		
HW Water Pump	1	Aurora # 855 100 94 200 GPM, 60 ft head 5 HP	Bldg. 592	1987	3.73 KW	24	7	26		
HW Boiler	1	AJAX # WGB 2750-S 2,037 MBH out	Bldg. 592	1987	2750 MBH	24	7	26		
Cooling Tower	1	Marley single speed, Approx. 20 HP motor	Bldg. 592	1988	14.91 KW	24	7	26		
Condenser Pump	1	Taco, # FE4008E2H1F2 600 GPM, 65 ft head 15 HP	Bldg. 592	1987	11.19 KW	24	7	26		


PHARMACY
1027
1026
1030
SUPPLY
1024
1028
1088
GORGAS CIRCLE
GUEST HOUSE
1002A
1002
1000
HOSPITAL
1018
1020
1001
1029
1099
1019P
1007B
1006B
1004B
1005
1004
1003
1098
1052
STANLEY ROAD
DICKMAN ROAD
592
BOQ
MUSEUM
046
N

AREA 1000

BUILDING DESCRIPTION

NAME: Building 1000 & 1088

USE: Brooke Army Medical Center - hospital (emergency care, general surgery, radiology, labor & delivery/neonatal, chapel, administration, and kitchen/dining). Continuous occupancy twenty four (24) hours a day and seven (7) days a week.

GROSS AREA (SQ.FT.): 227,302 STORIES: 7 DATE OF SURVEY: 10/25/95

DATE OF CONSTRUCTION: 1930's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Flat, built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet and vinyl coated tile

CEILINGS: 2'/4' acoustical tile

WINDOWS: Operable, single pane, single hung, clear glass

COOLING EQUIP: Four-pipe, multi-zone and single-zone AHU's and two-pipe and four-pipe FCU's are distributed throughout the building. Three (3) primary fresh air units provide 100% outside air to 492 FCU's (original convertors are three-speed with replacement convertors single speed) scattered throughout the building. Air-side equipment is served by two (2) centrifugal chillers in bldg. 1088 that are piped in parallel and operate year round. Each of the chillers are controlled locally to maintain CHW supply setpoint. However, the chillers are not currently sequenced together but are manually shut on and off. The two chillers are served by two (2), single speed cooling towers with manual 3-way bypass. See HVAC Equipment Lists for details.

HEATING EQUIP: All of the AHU's and FCU's that have heating are supplied by three (3) HW boilers (one stand-by) located in the boiler plant behind the hospital. Each boiler has a low fire/ high fire according to the HW return temperature setpoint of 150°F. Also, these boilers operate year round, and have a dedicated HW pump. Three (3) low pressure steam boilers (LPS), 1 stand-by, are located in the hospital subbasement and provide heating for the radiators located throughout the building. These low pressure steam boilers are operated seasonally and are manually shut down. See HVAC Equipment Lists for details.

LIGHTING: Recessed, 2 & 4-lamp fixtures throughout hospital with incandescent fixtures in mechanical rooms.

DOMESTIC WATER HEATING: Two high pressure steam boilers (HPS-60 lb.) with only one firing rate provide steam for DHW generators. These boilers operate year round and provide

steam for sterilization, kitchen equipment, and humidification. DHW generators are located in the subbasement of the hospital.

OTHER: Two (2) primary CHW pumps in chiller plant. Nine (9) secondary CHW pumps not operating. Three (3) HW pumps in boiler plant. Ventilation fans are located in the subbasement and the chiller plant.

REMARKS: Chillers were installed in 1991 and appear in good condition. Both chillers were operating at part load. Each chiller is equipped with dedicated CHW and CND pumps. Some of the CHW piping throughout building was replaced in 1979, the rest is original. Chillers are maintained by base DPW, while boilers are maintained by hospital DPW. Nine (9) secondary CHW pumps located in the subbasement of the hospital were not operating even though several of the pumps were still in the loop. It appears that the primary pumps are capable of handling the distribution head. Two HW boilers operate according to hospital procedure, but one appears to handle the load. HPS and LPS piping is original with many leaks and has asbestos insulation.

BUILDING DESCRIPTION

NAME: Building 1001

USE: Medical Library, Patient Transport Services, Endocrinology Clinic, Environmental Health, Occupational Health Clinic, Community Health Nursing, Social Work Service, Adolescent Med. Service, Dept. of Ministry/Pastoral Care. Continuous Occupancy between 7:30 A.M. and 5:00 P.M. with the exception of the library which is available 24 hours a day if needed.

GROSS AREA (SQ.FT.): 38,202 STORIES: 4 DATE OF SURVEY: 10/19/95

DATE OF CONSTRUCTION: 1936

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet and original Parquet wood

CEILINGS: Acoustical tile

WINDOWS: Single pane, operable, clear glass

COOLING EQUIP: Four-pipe, 10, 7.5, and 5 HP multi-zone (four zones) AHU's with wild CHW coils and two-way controlled steam coils serve first through third floors respectively. Fourth floor is served by 5 HP, four-pipe, single zone, AHU with face and bypass control, wild CHW coil, and a two-way steam coil which is located in the attic. The occupied areas in the basement are served by window units. These AHU's are served by centrifugal chiller and CHW pump located in the basement of bldg. 1002. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by one (1) low pressure steam boiler in the basement. This boiler has one firing rate and also serves restroom and entry vestibule radiators. See HVAC Equipment Lists for details.

LIGHTING: 10', 2-lamp, surface mounted and 2'/4' 2-lamp recessed fluorescent fixtures in most rooms; 4', 1-lamp fluorescent fixtures in corridors.

DOMESTIC WATER HEATING: One (1) 91 gallon, gas fired DHW heater is piped into storage tank located in basement.

OTHER: One (1) condensate return unit. One (1) ventilation fan in mechanical room.

REMARKS: Return air for building is from plenum space above ceilings into the mechanical rooms which serve as plenum. Two other steam boilers are located in basement but they are not used. All mechanical rooms have min/max outside air dampers and pneumatic controls. First floor AHU blower appears to be undersized to condition the air for the entire floor. No DHW pump.

BUILDING DESCRIPTION

NAME: Building 1029

USE: Brooke Army Medical Center Headquarters - Admin, optical lab, mailroom. Continuous occupancy of approximately 100 people between 7:00 A.M. and 5:00 P.M.

GROSS AREA (SQ.FT.): 51,236 STORIES: 4 DATE OF SURVEY: 10/25/95

DATE OF CONSTRUCTION: 1936

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet and vinyl coated tile

CEILINGS: 2'/2' and 2'/4' acoustical tile

WINDOWS: Single pane, single hung, operable, clear glass

COOLING EQUIP: Basement through the third floor is served by four-pipe, 5 HP, single zone, AHU with three-way controlled CHW and HW coils and a face and bypass section. Fourth floor is served by a similar type of unit but has a 3 HP motor, and does not have face and bypass control. A temperature controller modulates the CHW and HW control valves and the face and bypass dampers to maintain space temperature. AHU's do have economizer control but has been de-activated. Optical lab located in basement has DX coil, packaged, AHU's. Centrifugal chiller is located in basement mechanical room and the 2-speed cooling tower, with no bypass, is located on the roof. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by one (1) water tube HW boiler in boiler room. This boiler has no primary bypass loop and has two firing rates. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' 2-lamp recessed fluorescent fixtures in most rooms; 2'/2' u-tube fluorescents in the newly renovated first floor..

DOMESTIC WATER HEATING: One (1) 75 gallon, gas fired DHW heater located in boiler rm.

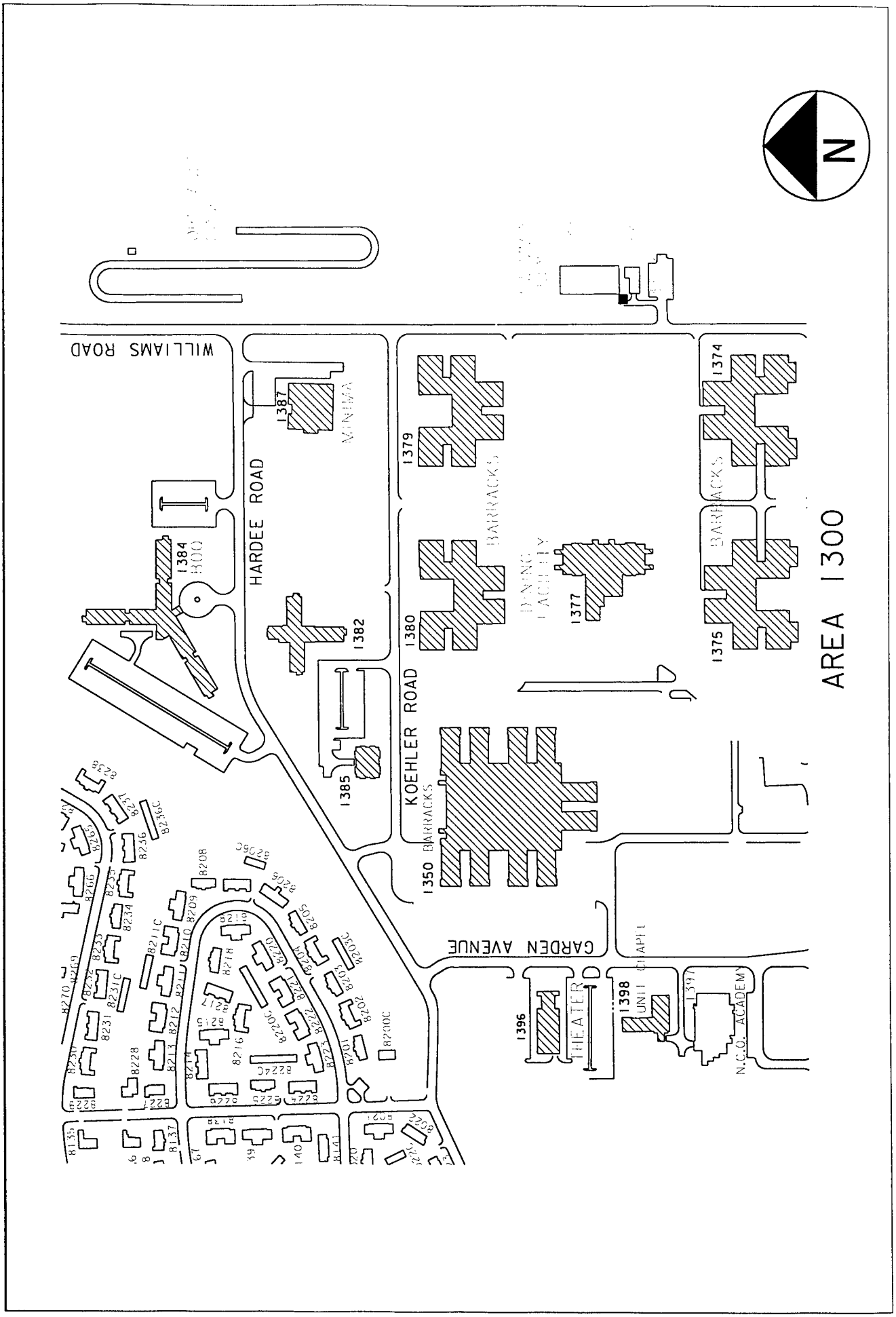
OTHER: One (1) CHW pump, CND pump, and HW pump. One (1) exhaust fan serves restrooms. Two (2) ventilation fans in chiller room.

REMARKS: Chiller, CHW pump, CND pump in basement are six months old. Controls on the units are in poor condition. Economizer control on AHU's is not working. Elevator room adjacent to classroom on top floor has no ventilation except through louver in door separating the two rooms.

PROPOSED HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Chiller # 1	1	York (centrifugal) # YTG3H3E1CND, R-11 FLA-316, Volts-460, 400 tons	Bldg. 1000	1993	252 KW
Chilled Water Pump	1	TACO, 50 HP 960 GPM, 100 ft head	Bldg. 1000	1993	37.29 KW
Cond. Water Pump	1	TACO, 40 HP 1132 GPM, 66 ft head	Bldg. 1000	1993	29.83 KW
Cooling Tower	1	Marley, 25 HP single speed motor	Bldg. 1000	1993	18.64 KW
Chiller # 2	1	York (centrifugal) # YTG3H3E1CND, R-11 FLA-316, Volts-460, 400 tons	Bldg. 1000	1993	277 KW
Chilled Water Pump	1	TACO, 50 HP 960 GPM, 100 ft head	Bldg. 1000	1993	37.29 KW
Cond. Water Pump	1	TACO, 40 HP 1132 GPM, 66 ft head	Bldg. 1000	1993	29.83 KW
Cooling Tower	1	Marley, 25 HP single speed motor	Bldg. 1000	1993	18.64 KW
HW Boiler	1	Bryan, # K550WGT, high/low fire rate 5000/2500 MBH, 120 HP, flex tube 20 f, delta t, 4230 MBH out	Bldg. 1000	1992	5,500 MBH
HW Pump	1	TACO # 1030 4x5x12, 25 HP 400 GPM, head unknown (90ft. approx.)	Bldg. 1000	1992	18.64 KW
HW Boiler	1	Bryan, # K550WGT, high/low fire rate 5000/2500 MBH, 120 HP, flex tube 20 f, delta t, 4230 MBH out	Bldg. 1000	1992	5,500 MBH
HW Pump	1	TACO # 1030 4x5x12, 25 HP 400 GPM, head unknown (90ft. approx.)	Bldg. 1000	1992	18.64 KW
HW Boiler (Stand-by)	1	Bryan, # K550WGT, high/low fire rate 5000/2500 MBH, 120 HP, flex tube 20 f, delta t, 4230 MBH out	Bldg. 1000	1992	5,500 MBH

PROPOSED HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
HW Pump (Stand-by)	1	TACO # 1030 4x5x12, 25 HP 400 GPM, head unknown (90ft. approx.)	Bldg. 1000	1992	18.64 KW
Low Pressure Boiler	1	Kewanee # 5139 Fire tube, 15 psig. 3072 MBH out	Radiator heaters Bldg. 1000	1950	5,223 MBH
Condensate Ret. Pump	1	0.5 HP. 2 each	Bldg. 1000	1988	0.37 KW
Low Pressure Boiler	1	Kewanee # 5139 Fire tube, 15 psig. 3072 MBH out	Radiator heaters Bldg. 1000	1950	5,223 MBH
Condensate Ret. Pump	1	1.5 HP. 2 each	Bldg. 1000	1988	1.12 KW
Low Pressure Boiler	1	Kewanee # 5139 Fire tube, 15 psig. 3072 MBH out	Radiator heaters Bldg. 1000	1950	5,223 MBH
Condensate Ret. Pump	1	2 HP. 2 each	Bldg. 1000	1988	1.49 KW
Sec. Chilled Water Pumps	9	Various sizes, 1 HP to 7.5 HP *these pumps are not operated, but CHW is supplied through them.*	Bldg. 1000	1980	N/A
Steam Boiller	1	Richmond Heatomat, BO3, 15 psig *not operating* 894 MBH out	Bldg. 1001	1975	1,260 MBh
Steam Boiller	1	Richmond Heatomat, BO2, 15 psig *not operating* 521.5 MBH out	Bldg. 1001	1975	735 MBH
Steam Boiller	1	AJAX, SGX-1050-S, BO1 15 psig. 761.9 MBH out	Bldg. 1001	1975	1,050 MBH
Condensate Ret. Pump	1	Dunham - Bush 1 HP	Bldg. 1001	1994	0.75 KW
Window Units	4	19,000 BTUH clg. & 17,300 BTUH htg. 9 EER	Bldg.1001 Basement	1985	8.4 KW

PROPOSED HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1000 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Chiller	1	Trane, # PVC-2001D2, R-11 460 V, 257 FLA 219 tons	Bldg. 1001 & 1002	1974	209.1 KW
Cooling Tower	1	Marley, # NC2021GM044049-001 15 HP	Bldg. 1001 & 1002	1974	11.19 KW
CHW Pump	1	Aurora 520 GPM, 75 ft. head, 15 HP	Bldg. 1001 & 1002	1974	11.19 KW
Cond. Pump	1	Aurora 640 GPM, 65 ft. head, 15 HP	Bldg. 1001 & 1002	1974	11.19 KW
Chiller	1	Trane, Centravac, # CVHE250 460 V, 137 RLA, R-123 160 tons	Bldg. 1029	1995	100 KW
Cond. Pump	1	TACO 860 GPM, 96 ft. head 25 HP	Bldg. 1029	1995	18.64 KW
CHW Pump	1	TACO # FE3013E2MIGLOA 25 HP	Bldg. 1029	1995	18.64 KW
Cooling Tower	1	Marley 2 speed fan 10/2.5 HP	Bldg. 1029	1995	7.46 KW 4.36 KW
HW Boiler	1	Rite Heating Boilers # 250, No OA temp. reset, or 3-way valve 1887 MBH out	Bldg. 1029	1990	2,500 MBH
HW Pump	1	Bell & Gosset 200 GPM, 37 ft head 3 HP	Bldg. 1029	1990	2.24 KW
Air Cooled Cond.	1	Rudd, # UAWB-100CA5 208 V, 42.3 RLA, cond fans 2 ea. 2.0 FLA *not included in model*	Optical lab Bldg. 1029	N/A	N/A
Air Cooled Cond.	1	Mc Quay # ST010A1S11 208 V, 42 RLA, cond. fans 2 ea. 0.5 HP *not included in model*	Optical lab Bldg. 1029	N/A	N/A


N
AREA 1300
WILLIAMS ROAD
HARDEE ROAD
KOEHLER ROAD
GARDEN AVENUE
1384 BOQ
1387
1382
1385
1350 BARRACKS
1380
1379 BARRACKS
1377
1375
1374 BARRACKS
1396 THEATER
1398
1397 N.C.O. ACADEMY

BUILDING DESCRIPTION

NAME: Building 1350

USE: Barracks, administrative offices, dining and classrooms for single enlisted personnel. Maximum occupancy of 800 persons with current occupancy of 1550 personnel.

GROSS AREA (SQ.FT.): 261,406 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1983

STRUCTURE: Masonry

EXTERIOR WALLS: Both brick and precast panel.

ROOF: Flat built-up roof.

FLOOR CONSTRUCTION: Slab on grade

FLOOR FINISH: Concrete topping, tile, and carpet

CEILINGS: Lay in acoustical tile, plaster, and stucco

WINDOWS: Single pane with glazed, insulating glass.

COOLING EQUIP: Seven central multi-zone, variable volume air handling units with three-way controlled CHW and HW coils serve most of the building. Four of the AHU's have 30 HP motor's, with three other's having a 15, 20, and 25 HP motor each. Temperature controller modulates control valves on HW and CHW coils to maintain leaving air temperature. Space thermostats control zone dampers, and economizer cycle for AHU's has been de-activated. Approximately 20 two-pipe fan coil units serving cadre rooms. All units are served by central chillers in building 1377.

HEATING EQUIP: See cooling equipment above. Multiple heating/ventilating units serving scrub rooms, toilets and kitchen areas along with heating water convection units serving multiple areas throughout building. All units are served by central boilers in building 1377.

LIGHTING: Lay-in fluorescent fixtures in barracks, admin, classrooms, and dining areas. Surface mounted fluorescent fixtures in kitchen and scattered incandescent fixtures.

DOMESTIC WATER HEATING: Gas fired hot water heaters in building to serve restrooms.

OTHER: 7 ½, ½, ½ HP heating water pumps in building. Steam boilers in building serve kitchen equipment.

REMARKS: Poor temperature control, extremely hot during field survey. Piping leaks are a problem. All other HVAC systems appeared to be in fair condition.

BUILDING DESCRIPTION

NAME: Buildings 1374, 1375, 1379, 1380

USE: Barracks for single enlisted personnel, classrooms and administrative offices. Maximum occupancy of approximately 475 people.

GROSS AREA (SQ.FT.): 111,448 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1971

STRUCTURE: Partially exposed structural steel frame

EXTERIOR WALLS: Brick and stucco veneer

ROOF: built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: concrete topping and carpet

CEILINGS: Lay-in acoustical tile in building with stucco over exposed areas

WINDOWS: single pane clear and tempered glass

COOLING EQUIP: Approximately six, 7.5 HP multi-zone, constant volume central AHU's with three-way controlled HW coil and a wild CHW coil serve barracks and office areas of the buildings. Temperature controller modulated HW control valve to maintain leaving coil air temperature setpoint, and space thermostat controls zone dampers. Unit also has economizer control but it has been de-activated. Approximately four cabinet type fan coil units serving classrooms in the buildings. All units served by central chillers in building 1377.

HEATING EQUIP: See cooling equipment above. All units served by central boilers in building 1377.

LIGHTING: Surface mounted incandescent fixtures in exposed areas. Lay-in fluorescent fixtures in admin and barracks areas.

DOMESTIC WATER HEATING: Gas fired hot water boilers in building to serve restrooms.

OTHER: Secondary 7 ½ and 5 HP chilled/heating water pumps in building.

REMARKS: Poor temperature control, extremely hot during field survey. Renovations to building has caused restricted return air flow back to air handling units. All other HVAC systems appeared to be in fair condition.

BUILDING DESCRIPTION

NAME: Building 1377

USE: Kitchen and dining hall in building. Other areas serve as central chiller and boiler plant for buildings in 1300 area. Maximum occupancy of 800 persons on weekdays between 4 am and 9 pm.

GROSS AREA (SQ.FT.): 30,350 STORIES: 1 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1971

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Sloped built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile, gypsum wallboard, and plaster

WINDOWS: single pane clear glass

COOLING EQUIP: Dining areas served by two, 5 HP, single zone air handlers with three-way controlled HW and CHW coils, and face and bypass dampers. Return air temperature is controlled by modulating CHW and HW control valves along with face and bypass dampers to maintain setpoint. Mixed air temperature is maintained at setpoint by modulating return and outside air dampers when outside air dry bulb temperature falls below 68°F. Air handler cooling coils served by central chiller in building 1377. Kitchen served by two, 3 HP evaporative coolers which are controlled manually by three position switch located in kitchen (vent, cool, heat).

HEATING EQUIP: See cooling equipment above. Air handler heating coil served by central boiler in building 1377. Evaporative coolers serving kitchen have steam htg.. coil which is supplied by steam boiler in building 1377.

LIGHTING: Surface mounted fluorescent fixtures

DOMESTIC WATER HEATING: Electric hot water heater in building to serve restrooms.

OTHER: Central chiller and boiler equipment, see HVAC Equipment List for descriptions along with steam boiler to serve bldg. 1377 kitchen equipment.

REMARKS: Poor temperature control, extremely hot during field survey. All mechanical systems appeared to be in a deteriorated state, particularly the HVAC controls and piping insulation. Exhaust fans appeared to operate while central AHUs were off. Return air grilles appeared to be excessively dirty.

BUILDING DESCRIPTION

NAME: Building 1382

USE: Barracks for single enlisted personnel, administrative offices. Continuous occupancy of approximately 240 persons.

GROSS AREA (SQ.FT.): 29,390 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1971

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Flat Built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Gypsum wallboard and acoustical tile

WINDOWS: Single pane clear glass

COOLING EQUIP: Building served by two (2) central, 4-pipe, 5 HP, multi-zone AHU's with three-way controlled CHW and HW coils. Air handler cooling coils served by central chillers in building 1377.

HEATING EQUIP: See cooling equipment above. Air handler heating coils served by central boilers in building 1377.

LIGHTING: Surface and suspended mounted fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heaters in building to serve restrooms.

OTHER: Secondary 3/4 HP chilled water and ½ HP heating water pumps in building.

REMARKS: Poor temperature control, extremely hot during field survey. All other HVAC systems appeared to be in fair condition. Outside air intake louvers have been blanked off with sheet metal, reducing HVAC loads but also reducing indoor air quality. Building may not meet ASHRAE standards for ventilation.

BUILDING DESCRIPTION

NAME: Building 1384

USE: Unlisted Personnel Housing (UPH) - Transient Lodging Facility. Current occupancy of 300 people with one person per room.

GROSS AREA (SQ.FT.): 145,420 STORIES: 5 DATE OF SURVEY: 10/18/95

DATE OF CONSTRUCTION: N/A

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and precast concrete

ROOF: Flat built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: Operable, single pane clear glass

COOLING EQUIP: Five, 20 HP, multi-zone (seven zones on first floor and six zones on 2-5 floors) AHU's with wild CHW coil and three-way controlled HW coil are located on each floor. Controller modulates HW valve to maintain leaving coil temperature setpoint, and space thermostats control zone dampers. AHU's also have economizer control but it has been de-activated. AHU's served by an R-11 centrifugal chiller and one cell, single speed cooling tower in central plant.

HEATING EQUIP: AHU's served by water tube HW boiler in central plant that does have hot water reset control. HW boiler has three way control on primary side.

LIGHTING: Recessed 4-lamp fluorescent fixtures with electronic ballast and T-8 lamps.

DOMESTIC WATER HEATING: 1,650 MBH DHW boiler provides 170°F water to heat exchanger. Primary pump is controlled by setpoint of leaving shell water temperature setpoint of 128°F. As secondary loop circulated DHW from the heat exchanger to a DHW storage tank. A third building loop circulated the water from the tank out through the building.

OTHER: DHW primary, secondary, and building pumps, CHW and HW pumps, bldg. exhaust fan. Secondary 1/4 HP chilled water and 1/8 HP heating water pumps in building.

REMARKS: AHU's do have economizer capabilities but outside air dampers have been de-activated. AHU's have vertical roll filters. 112.5 KVA transformer located in mechanical room plenum space on each floor except the first. HW boiler has dual fire capabilities with diesel being the second fuel. DHW boiler has a tremendous amount of heat loss to the mechanical room space. A new CHW pump was to replace the existing. DHW boiler has draft inducer fan. Kitchen in

lounge has no make-up air for exhaust fans. Controllers have recently been upgraded from pneumatics to electronics. Mechanically, this building is almost identical to Building 592 with the exception of the size and age of the equipment.

BUILDING DESCRIPTION

NAME: Building 1385

USE: Administrative services for 232nd Medical Battalion troops. Continuous occupancy of approximately 22 persons.

GROSS AREA (SQ.FT.): 5,072 STORIES: 1 DATE OF SURVEY: 11/30 to 12/2/94

DATE OF CONSTRUCTION: 1971

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Flat built-up roof

FLOOR CONSTRUCTION: Slab on grade

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile and gypsum wallboard

WINDOWS: Single pane clear glass

COOLING EQUIP: Building served by one (1) 4-pipe, 3 HP, multi-zone AHU with three-way controlled HW and CHW coils. Air handler cooling coil served by central chiller in building 1377.

HEATING EQUIP: See cooling equipment above. Air handler heating coil served by central boiler in building 1377.

LIGHTING: Recessed and surface mounted fluorescent fixtures in office areas and surface mounted incandescent fixtures in other areas

DOMESTIC WATER HEATING: Electric, 66 gallon DHW heater in building to serve restrooms.

OTHER: Secondary 1/4 HP chilled water and 1/8 HP heating water pumps in building.

REMARKS: Poor temperature control, extremely hot during field survey. All other HVAC systems appeared to be in fair condition. Outside air intake louvers have been blanked off with sheet metal, reducing HVAC loads but also reducing indoor air quality. Building may not meet ASHRAE standards for ventilation.

BUILDING DESCRIPTION

NAME: Building 1387

USE: Minimall - grocery, laundry, retail, snack bar, and salon. Continuous occupancy of approximately 20 full-time staff and 200 students between 11:00 A.M. and 8:00 P.M.

GROSS AREA (SQ.FT.): 15,080 STORIES: 1 DATE OF SURVEY: 10/18/95

DATE OF CONSTRUCTION: 1988

STRUCTURE: Masonry facade

EXTERIOR WALLS: Brick

ROOF: Sloped single-ply roof on metal deck

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: vinyl coated tile

CEILINGS: Acoustical tile

WINDOWS: Single pane insulated glass

COOLING EQUIP: Five split system, DX, heat pumps with horizontal and floor mounted AHU's. The AHU motors vary from 15 HP down to 1-1/2 HP. All AHU's except AHU-5 have economizer cycles.

HEATING EQUIP: See cooling equipment above. AHU's have supplemental resistance heat.

LIGHTING: Recessed fluorescent fixtures in snack bars, grocery, salon, and jewelry. Downlights in lobby area.

DOMESTIC WATER HEATING: 50 gallon domestic hot water heater serving kitchen area.

OTHER:

REMARKS: There is limited occupancy until 5 P.M. Poor temperature control. This building is maintained and operated by AAFES instead of DPW. Fire control is integrated into the building mechanical systems.

BUILDING DESCRIPTION

NAME: Building 1396

USE: Evan's Theater - used for shows and classroom. Maximum occupancy of 490 people with 50% capacity year round between the hours of 8:00 A.M. and 12:00 P.M.

GROSS AREA (SQ.FT.): 11,805 STORIES: 1 DATE OF SURVEY: 10/18/95

DATE OF CONSTRUCTION: 1971

STRUCTURE: Masonry facade

EXTERIOR WALLS: Brick and precast concrete

ROOF: Flat built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Tile, wood, and terrazzo

CEILINGS: Acoustical tile, plaster, and stucco

WINDOWS: single pane clear glass

COOLING EQUIP: One (1) packaged, reciprocating, 7.5 HP, single zone, DX unit serves the auditorium and is located in mechanical room. This unit rejects it heat to a condenser water loop from an air cooled condenser located outside. A second 5 HP, DX air handling unit located in mechanical room adjacent to the lobby serves the lobby/office area and is served by a split system condensing unit located on the roof of the first floor lobby. See HVAC Equipment Lists for details.

HEATING EQUIP: Water tube HW boiler (160°F supply temperature) provides HW for two (2) duct mounted heating coils, one for each unit.

LIGHTING: Twenty-six 400 W metal halide fixtures in auditorium, and incandescents in office.

DOMESTIC WATER HEATING: 75 gallon , gas fired, DHW heater without pump in main mechanical room.

OTHER: Three HW pumps (one stand-by) serve two duct mounted coils. Thermostat cycles HW pumps on and off. Exhaust fan for restrooms located on the roof.

REMARKS: None of the HW piping in the mechanical room is insulated. Building is mostly used for classroom space.

BUILDING DESCRIPTION

NAME: Building 1398

USE: AMEDDC Chapel - administration offices and chapel. Maximum occupancy of 350 people with two (2) services on Sunday approximately 75% full. Three miscellaneous services during the week with an average of 50 people. Continuous occupancy of five (5) people in the administration wing between 7:30 A.M. and 5:00 P.M. on the weekdays.

GROSS AREA (SQ.FT.): 8,006 STORIES: 1 DATE OF SURVEY: 10/18/95

DATE OF CONSTRUCTION: 1972

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Sloped built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: operable, single pane clear glass

COOLING EQUIP: Twenty-one (21) 2-pipe, 1/8 HP FCU's with pneumatic mixing valves and thermostats are served by hermetic reciprocating chiller in mechanical room and air cooled condenser outside. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by water tube HW boiler with hot water reset capabilities but de-activated.

LIGHTING: Incandescent downlights in chapel. Surface mounted fluorescent fixtures in administration wing.

DOMESTIC WATER HEATING: 30 gallon, gas fired, DHW heater without pump in main mechanical room.

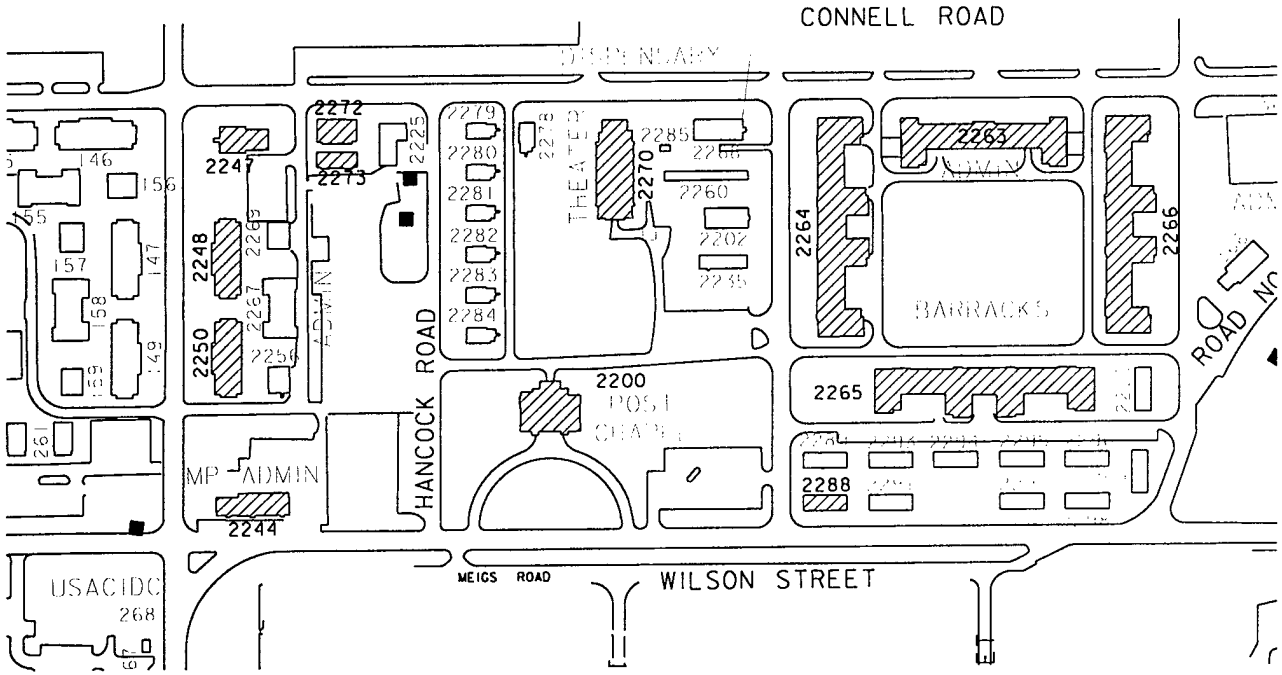
OTHER: Mechanical room ventilation fan

REMARKS: Manual changeover valves are in mechanical room. Filters were installed backwards. One chiller serves the chapel and the administration. Therefore, it is running at low load much of the time which is very inefficient. 2-pipe switch-over is manual but the original intent of the design was for it to be automatic.

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1300 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Water Chiller	1	Trane #PCV-5F-C1D1 water cooled, centrifugal, 544 tons, R-11	Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385	1972	517 KW
Water Chiller	1	Trane #PCV-5F-C1D1 water cooled, centrifugal, 442 tons, R-11	Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385	1972	517 KW
Water Chiller	1	Carrier #19DK 78942P water cooled, centrifugal, 438 tons, R-11	Bldg. 1350	1983	334.5 KW
Chilled Water Pump	2	Aurora 870 gpm, 79 ft 25 HP	Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385	1972	18.65 KW
Chilled Water Pump	1	Allis Chalmers 775 gpm, 114 ft 40 HP	Bldg. 1350	1983	29.84 KW
Condenser Water Pump	2	Aurora 1440 gpm, 70 ft 40 HP	Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385	1972	29.84 KW
Condenser Water Pump	1	Allis Chalmers 1314 gpm, 30 ft 30 HP	Bldg. 1350	1983	22.38 KW
Cooling Tower	1	Marley #324T induced draft, 2-35 HP fans	Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385	1972	52.22 KW
Cooling Tower	1	Marley induced draft, 20 HP fan	Bldg. 1350	1983	14.92 KW
Hot Water Boiler	2	C.B. #CB700X-200 10 HP forced draft, 5912 MBH output	Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385	1972	8,369 MBH 7.46 KW
Hot Water Boiler	1	Rite #A750WG natural draft, watertube 5317 MBH output	Bldg. 1350	1983	7,500 MBH
Hot Water Boiler	1	Ajax #WGB 9500 natural draft, watertube 4336 MBH output	Bldg. 1350	1983	5,800 MBH
Heating Water Pump	2	Aurora 443 gpm, 76 ft 15 HP	Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385	1972	11.19 KW

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1300 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Heating Water Pump	1	Allis Chalmers 134 ft 40 HP	Bldg. 1350	1983	29.84 KW
Chiller	1	Trane, Centravac, # PCV2HC2D2 460 V, 311 RLA, R-11 273 tons	Bldg. 1384	1973	251 KW
Chilled Water Pump	1	Aurora # 723-10408, 15 HP 665 GPM, 65 ft head	Bldg. 1384	1995	11.19 KW
Cond. Water Pump	1	Aurora # 93E-15820, 20 HP 819 GPM, 50 ft head	Bldg. 1384	1973	14.9 KW
Cooling Tower	1	Marley, 20 HP, #05196-00-93 single speed motor Model # NC3021GM	Bldg. 1384	1993	14.9 KW
HW Boiler	1	AJAX # WGOFD-5000 3636 MBH out	Bldg. 1384	1986	5000 MBH
HW Pump	1	Aurora, # 93E16061 265 GPM, 60 ft. head 7.5 HP	Bldg. 1384	1986	5.59 KW
Condensing Unit	2	Carrier heat pump # 38AQ-016-5W, 208V, 63.6 RLA Cond fans 2 ea. 1 ph. 4.0 AMP/fan	Bldg. 1387	1988	55.73 KW
Condensing Unit	1	Carrier heat pump # 38QH024300, 208V, 14.5 RLA Cond fans 1 ea. 1/8 HP	Bldg. 1387	1988	5.74 KW
Condensing Unit	2	Carrier heat pump # 38AQ-012-510, 208V, 43.6 RLA Cond fans 2 ea. 1 ph. 4.0 AMP/fan	Bldg. 1387	1988	37.04 KW
Condensing Unit	2	Carrier heat pump # 38AQ-024-----, 208V, 63.6 RLA Cond fans 3 ea. 1 ph. 4.5 AMP/fan	Bldg. 1387	1988	54.75 KW
DX Packaged AHU	1	Trane, # 5A403C 208 V , 140 RLA 7.5 HP fan, 50 tons	Bldg. 1396	1975	63.17 KW
HW Pump For RH Coils	2	TACO 1/4 HP one stand-by, other serves pack. AHU	Bldg. 1396	1975	0.19 KW

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1300 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
HW Boiler	1	Thermopak # GAW-602 427.1 MBH out	Bldg. 1396	1986	602 MBH
HW Pump For RH Coils	1	TACO 1/4 HP serves split system AHU	Bldg. 1396	1975	0.19 KW
Air Cooled Condenser	1	Trane, # CA 4008 5 HP	Bldg. 1396	1980	3.73 KW
Air Cooled Condensing unit	1	Rudd, # UAWC075AS 230 V, 24.8 RLA, Cond fan 1/3 HP 7.5 ton	Bldg. 1396	1988	10.94 KW
Air Cooled Cond.	1	Trane, # CA 6008 7.5 HP	Bldg. 1398	1980	5.59 KW
CHW/HW Pump	1	Aurora 104 GPM, 80 ft. head, 5 HP	Bldg. 1398	1975	3.73 KW
Chiller	1	Trane, # CG50D 230 V, 91.3 RLA 43.6 tons	Bldg. 1398	1975	55.1 KW
HW Boiler	1	AJAX WG525-S 381.8 MBH out	Bldg. 1398	1986	525 MBH


CONNELL ROAD
2272
2273
2247
2248
2250
2225
2279
2280
2281
2282
2283
2284
2285
2270
2260
2202
2235
2263
2264
2266
BARRACKS
2265
2200
2288
HANCOCK ROAD
MP ADMIN
2244
USACIDC
268
MEIGS ROAD
WILSON STREET
N

AREA 2200

BUILDING DESCRIPTION

NAME: Building 2200

USE: Post Chapel. Maximum occupancy of 550 people in the main sanctuary which is occupied at 80% occupancy once a week on Sundays. The side wings are occupied on an average of once a week.

GROSS AREA (SQ.FT.): 21,536 STORIES: 1 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1940's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and precast concrete

ROOF: flat built-up and cooper roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: N/A

WINDOWS: Single pane clear glass.

COOLING EQUIP: Four single zone AHU's with three-way controlled CHW and HW coils. Two (2) are located in the mezzanine and serve the chapel and the other two (2) are located in the basement and serve the music room and the basement conference room. Ten (10), 4-pipe FCU's serve the side sanctuary areas and the offices. This air-side equipment is served by an ACR chiller located adjacent to the central plant behind the Chapel.

HEATING EQUIP: Above air-side equipment is served by water tube boiler in central plant.

LIGHTING: 2-lamp fluorescent fixtures in offices and incandescents, fluorescents in auditorium.

DOMESTIC WATER HEATING: One (1) 30 gallon DHW heater in basement.

OTHER: CHW, HW pumps in central plant, ventilation fan in mechanical room.

REMARKS: This building has recently been renovated with new mechanical equipment. Air-side equipment in basement is difficult to access for maintenance.

BUILDING DESCRIPTION

NAME: Building 2244

USE: Military Police Station. Continuous Occupancy of twelve (12) people between the hours of 7:00 A.M. and 6:00 P.M. and four (4) people between 6:00 P.M. and 7:00 A.M.

GROSS AREA (SQ.FT.): 4,672 STORIES: 1 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1940's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: 2'/2' Acoustical lay-in tile

WINDOWS: Single pane clear glass.

COOLING EQUIP: One (1) 3 HP, DX AHU with three-way controlled HW coil is located in mechanical room. Space thermostat modulates solenoid valve on DX coil or HW coil. AHU is served by one (1) condensing unit located on North side of building.

HEATING EQUIP: Above air-side equipment is served by one (1) gas fired boiler in mechanical room. Boiler is operated on (100%) and off by outside thermostat setpoint.

LIGHTING: Recessed 2-lamp fluorescent fixtures.

DOMESTIC WATER HEATING: One (1) 30 gallon DHW heater in mechanical room.

OTHER: One (1) in-line cartridge type HW pump in mechanical room.

REMARKS: This building operates the chiller water system year-round. Computer room in building is served by central AHU. Return air is through the corridors.

BUILDING DESCRIPTION

NAME: Building 2247

USE: ARMY Learning Center - classroom, library, study. Continuous occupancy of eight (8) people between 7 A.M. and 7 P.M. and an additional 30 people for 3 hours/week for classes.

GROSS AREA (SQ.FT.): 8,872 STORIES: 1 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1936

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Lay-in acoustical tile

WINDOWS: single pane clear glass.

COOLING EQUIP: One (1) cooling only DX AHU with face and bypass control above restroom ceiling space is served by one open drive, DX, R-12 chiller and one (1) condenser outside.

HEATING EQUIP: Wall radiators located in library heat the entire building with the exception of the converted front porch area which is heated gas fired wall units. Radiators are served by steam boiler in basement.

LIGHTING: 2-lamp fluorescent fixtures in library without covers and recessed fluorescents scattered through building.

DOMESTIC WATER HEATING: Abandoned 30 gallon DHW heater in basement.

OTHER: CND pump in basement.

REMARKS: Boiler room occasionally floods from storm drain back-up. When boiler is operating, this can be a life safety problem which also damages the equipment including the boiler. Chiller constantly leaks refrigerant and there is no ventilation in room which is a code violation, not to mention life safety problem. AHU location is very difficult to access.

BUILDING DESCRIPTION

NAME: Building 2248 & 2250

USE: Education Center, Provost Marshall, M.P. Investigations, AWOL Section, and Physical Security. Continuous occupancy of 35 people in both buildings between 8:00 A.M. and 5:00 P.M.

GROSS AREA (SQ.FT.): 13,716 STORIES: 2 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1936

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Lay-in acoustical tile and plaster

WINDOWS: Operable, single pane, clear glass.

COOLING EQUIP: Two (2) 4-pipe, 3 HP, single zone AHU's with face and bypass control, wild CHW and HW coils are located in each building. Space temperature setpoint is maintained by modulating face and bypass dampers. One AHU is located in basement and the other is located in the attic. Also, six, 1/16 HP FCU's (HW and CHW) serve the perimeter of the building. Both of these buildings are served by one ACR chiller located between the two buildings.

HEATING EQUIP: Above air-side equipment is served by one (1) water tube HW boiler that is located in the basement of bldg. 2248. This boiler has three-way control on the primary side to maintain HW supply temperature and it operates at 100% fire whenever on.

LIGHTING: Recessed 2-lamp fixtures, and suspended 2-lamp and 4-lamp fluorescent fixtures.

DOMESTIC WATER HEATING: 30 gallon DWH and tank in both buildings but they are not operating.

OTHER: Three CHW pumps with one (1) serving bldg 2250, and two serving bldg. 2248. Three HW pumps with one (1) serving Bldg. 2250, and the other two serving bldg. 2248.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Building 2248 appears to have balancing problem, and the second floor of bldg. 2250 has a temperature control problem.

BUILDING DESCRIPTION

NAME: Building 2263

USE: Administrative offices for post fiscal activities. Maximum occupancy of 250 persons from 6:30 am until 5:15 pm on weekdays.

GROSS AREA (SQ.FT.): 81,065 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1970

STRUCTURE: Masonry

EXTERIOR WALLS: Stucco on CMU

ROOF: Pitched shingle roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Lay-in acoustical tile

WINDOWS: single and double pane clear glass in most of building and insulating glass in corridors.

COOLING EQUIP: Eight, 4-pipe, 5 HP, single zone central air handlers serving the general office area with three-way controlled CHW and HW coil, and face and bypass control. Fourteen, four-pipe fan coil units serving corridors, stairwells and first floor office areas on the east and west ends. All units are served by the central chiller in building 2265.

HEATING EQUIP: See cooling equipment above. All units are served by the central boilers in building 2265.

LIGHTING: Recessed fluorescent fixtures and scattered incandescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heaters in building to serve restrooms.

OTHER: Packaged computer room units with outdoor fluid cooler serve the computer room in building. Some rooms in basement served by window units.

REMARKS: Poor temperature control. Extremely hot inside during field visit in mid March. Some inside areas were above 100 degrees F. All HVAC systems appeared to be in good condition with the exception of the temperature controls.

BUILDING DESCRIPTION

NAME: Buildings 2264, 2266

USE: Mainly barracks for single enlisted personnel, with administrative offices and classrooms. Also houses the Academy Museum and band area. Maximum occupancy of 255 persons per building on a continuous basis.

GROSS AREA (SQ.FT.): 98,190 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1970

STRUCTURE: Masonry

EXTERIOR WALLS: Plaster on stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Lay-in acoustical tile

WINDOWS: Single pane clear glass

COOLING EQUIP: Ten, 4-pipe multi-zone (three to six zones) air handlers with three-way controlled CHW and HW coils. Temperature controller modulates CHW and HW valves to maintain leaving coil temperature setpoint while space temperature controls zone dampers. AHU's have economizer control but it has been de-activated. All units are served by the central chiller in building 2265.

HEATING EQUIP: See cooling equipment above. All units are served by the central boilers in building 2265.

LIGHTING: Recessed fluorescent fixtures with incandescent fixtures scattered throughout building.

DOMESTIC WATER HEATING: Gas fired hot water heaters in building to serve restrooms.

REMARKS: Poor temperature control. Extremely hot inside during field visit in mid March. All HVAC systems appeared to be in poor condition, especially the temperature controls.

BUILDING DESCRIPTION

NAME: Building 2265

USE: Mainly barracks for single enlisted personnel, with administrative offices and classrooms. Also houses the mess hall and central boiler and chiller plants. Maximum occupancy of 600 persons at meal time, with approximately 200 persons on a continuous basis.

GROSS AREA (SQ.FT.): 105,564 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1970

STRUCTURE: Masonry

EXTERIOR WALLS: Plaster on stone wall

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile and gypsum wallboard

WINDOWS: single pane clear glass

COOLING EQUIP: Ten, four-pipe multi-zone (two to six zones) air handlers with three-way controlled DHW and HW coils. A temperature controller modulates the CHW and HW control valves to maintain leaving coil temperature setpoints while space thermostats modulate the zone dampers. All AHU's have economizer control, but it has been de-activated. All units are served by the central chiller in building.

HEATING EQUIP: See cooling equipment above. All units are served by the central boilers in a building to the South of this building. All three boilers have three-way valves on primary side which is used to mix supply and return HW to maintain supply HW temperature setpoint.

LIGHTING: Recessed fluorescent fixtures with incandescent scattered in building.

DOMESTIC WATER HEATING: Large gas fired boiler located in basement for domestic hot water heating in the building.

OTHER: Central chiller plant equipment in building and central boiler plant equipment in building behind. See HVAC Equipment Lists for descriptions. Steam boilers in basement serve kitchen equipment.

REMARKS: Poor temperature control. Extremely hot inside during field visit in mid March. All HVAC systems appeared to be in poor condition, especially the temperature controls. Boiler (heating water) plant appears in good condition, while chiller plant is aged.

BUILDING DESCRIPTION

NAME: Building 2270

USE: Post Theater. Occupied on an average of once a month for a period of 4 hours. Maximum occupancy is 950 people.

GROSS AREA (SQ.FT.): 14,692 STORIES: 2 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1935

STRUCTURE: Masonry

EXTERIOR WALLS: Stucco

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Wood, tile, and concrete floor pad

CEILINGS: Plaster

WINDOWS: Single pane clear glass.

COOLING EQUIP: One (1) built-up, approximately 20 HP, DX, single zone AHU with face and bypass dampers supplies the building from a mechanical room on the second floor balcony. Single thermostat controls solenoid valve for cooling and HW valve. AHU is served by three R-12 compressors on the first floor (1- inoperable) and a closed circuit fluid cooler located in the penthouse.

HEATING EQUIP: Above air-side equipment has HW coil and is supplied by two (2) water tube HW boilers located on the first floor.

LIGHTING: Incandescent fixtures

DOMESTIC WATER HEATING: N/A.

OTHER: One (1) HW and one (1) CND pump in first floor mechanical room.

REMARKS: Supply air is distributed in this building through combination diffuser/light fixtures. Chilled water system operates year round.

BUILDING DESCRIPTION

NAME: Building 2272

USE: H.Q. Command Staff, S1, S2, S3 - office space. Continuous occupancy of thirty-five (35) people between 7 A.M. and 5 P.M. on the weekdays.

GROSS AREA (SQ.FT.): 9,016 STORIES: 2 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1930's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: 2'/2' lay-in acoustical tile

WINDOWS: Single pane clear glass.

COOLING EQUIP: 2-pipe wall mounted FCU's with wild coils served by ACR chiller that serves both 2272 and 2273. FCU's have no thermostatic control.

HEATING EQUIP: Above air-side equipment is supplied by water tube HW boiler located in the basement of bldg. 2273.

LIGHTING: 2-lamp suspended fluorescent fixtures

DOMESTIC WATER HEATING: 30 gallon DHW heater in basement not used.

OTHER: One (1) CHW/HW pump in basement of bldg. 2273.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Manual changeover valves are located in the basement of bldg. 2273.

BUILDING DESCRIPTION

NAME: Building 2273

USE: H.Q. Command, S1, S2, S3 - office space. Continuous occupancy of three (3) people between 7 A.M. and 5 P.M. on the weekdays.

GROSS AREA (SQ.FT.): 2,854 STORIES: 1 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1930's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Lay-in acoustical tile

WINDOWS: Single pane clear glass.

COOLING EQUIP: One (1) 3/4 HP, 2-pipe, single zone AHU with three-way controlled HW/CHW coil, and face and bypass dampers is served by ACR chiller that supplies both 2272 and 2273. Space temperature is maintained by modulating face and bypass dampers in conjunction with CHW or HW control valves. Unit is started and stopped by manual switch in occupied space.

HEATING EQUIP: Above air-side equipment is supplied by water tube HW boiler located in the basement of bldg. 2273.

LIGHTING: 2-lamp surface mounted fluorescent fixtures/troffers

DOMESTIC WATER HEATING: 30 gallon DHW heater in basement not used.

OTHER: One (1) CHW/HW pump in basement of bldg. 2273.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Manual changeover valves are located in the basement of bldg. 2273. Supply air is distributed in this building through light fixture troffers.

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 2200 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
HW Boiler	1	AJAX, # WGB-1050 831.7 MBH out	Bldg.2200	1995	1050 MBH
HW Pump	2	Weinman 2 HP 34 GPM, 64 ft. head	Bldg.2200	1995	1.49 KW
CHW Pump	2	Weinman 3 HP 72 GPM, 60 ft. head	Bldg.2200	1995	2.24 KW
Air Cooled Chiller	1	Trane, # CGADC604AEAOEGTR 460 V, 4 comp. 23.5 RLA ea. cond. fans 6 ea. 1 HP ea., 60 tons	Bldg.2200	1995	80.16 KW
HW Boiler	1	Pennco, Model 1506 112.2 MBH out	Bldg.2244	1989	150 MBH
HW Circulator	1	TACO, Cartridge type, 1/16 hp	Bldg.2244	1989	0.05 KW
Air Cooled Condenser	1	York, HICA240A25A comp. 1 ea. 230V, 80 RLA 3 cond. fans 4.3 FLA, 20 ton	Bldg.2244	1989	39.6 KW
Steam Boiler	1	American Boilers No name plate 79.85 MBH design heating	Bldg.2247	1965	197.2 MBH
Water Cooled Chiller	1	Trane, R-12, Open drive, 208V, 20 HP very old chiller 20 tons	Bldg.2247	1960	28.95 KW
Condenser Pump	1	ACE, model ALC-200 2 HP, capacity data not available	Bldg.2247	1975	1.49 KW
Cooling Tower	1	Marley, cross flow #4822 belt driven, 2 HP	Bldg.2247	1990	1.49 KW
Window Units	2	1.5 tons cooling only 9.0 EER	Bldg.2247	1990	4.24 KW
Chilled Water Pump	1	Paco, # 10-20953, 809 IMP GPM & HD N/A 2 HP	Bldg.2250	1993	1.49 KW

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 2200 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Chilled Water Pump	2	TEEL, 1.5 HP GPM & HD N/A	Bldg.2248	1993	2.98 KW
HW Pump	2	TACO 1/8 HP one pump for AHU, the other for FCUs	Bldg.2248	1993	0.19 KW
Air Cooled Chiller	1	Technical Systems # CA2CD75 460 V, 2 comp. 70 RLA ea. cond. fans 6 ea. 2.3 FLA ea., 57.5 tons	Bldg.2248 & 2250	1990	79.5 KW
HW Boiler	1	Rite, Model 5430 56 #90 679 MBH out	Bldg.2248 & 2250	1990	900 MBH
HW Pump	1	Thrush 1/3 HP	Bldg.2250	1993	0.25 KW
Water Chiller	1	Chrysler #C2MN779-2 water cooled, centrifugal, 657 tons, R-11	2263, 2264, 2265, 2266	1973	598 KW
Chilled Water Pump	1	Paco 1526 gpm, 166 ft 100 HP	2263, 2264, 2265, 2266	1973	74.60 KW
Condenser Water Pump	1	Paco 1971 gpm, 63 ft 50 HP	2263, 2264, 2265, 2266	1973	37.30 KW
Cooling Tower	1	Built-up crossflow, 2 cell 2-20HP fans	2263, 2264, 2265, 2266	1973	29.84 KW
Hot Water Boiler	3	Ajax #WGB 4750 natural draft, watertube 2240 MBH output	2263, 2264, 2265, 2266	1988	3,000 MBH
Heating Water Pump	3	Armstrong 207 gpm, 110 ft 15 HP	2263, 2264, 2265, 2266	1988	11.19 KW
Boiler Circulation Pump	3	Armstrong 3/4 HP	Hot Water Boiler 2263, 2264, 2265, 2266	1988	0.56 KW
Condenser Pump	1	HP, capacity data not available assume 5 HP	Bldg.2270	1970	3.73 KW

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 2200 MARCH 1, 1996					
ITEM	QTY.	DESCRIPTION	AREA SERVED	YEAR INSTALLED	FULL LOAD
Cooling Tower	1	Water sprayed over the ref. coils HP, capacity data not available assume 3 HP	Bldg.2270	1970	2.24 KW
Ref. Compressor	3	Total original 100 ton capecity *33.3 ton per compr. (2 operate)*	Bldg.2270	1970	68.4 KW
HW Boiler	1	AJAX # WG-750-S SR # 87-39964 & # 87-39965 550 MBH out	Bldg.2270	1987	750 MBH
HW Pump	2	HP, capacity data not available assume 3 HP	Bldg.2270	1970	2.24 KW
HW Boiler	1	AJAX # WG-750-S SR # 87-39964 & # 87-39965 550 MBH out	Bldg.2270	1987	750 MBH
CHW / HW Pump	1	No name plate 120 GPM, 100 ft 5 HP	Bldg.2272 & 2273	1988	3.73 KW
Air Cooled Chiller	1	Technical systems # 30AOCD 40 2 comp. 57.7 RLA 4 ea. cond fans 1HP ea., 40 tons	Bldg.2272 & 2273	1988	52.87 KW
HW Boiler	1	AJAX # WG-525-S 388 MBH out	Bldg.2272 & 2273	1988	525 MBH

AREA: 100	HARDWARE																											
	OUTPUT								INPUT																			
	DIGITAL					ANALOG			DIGITAL									ANALOG									
ECO A: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	DIFFERENTIAL PRESSURE	GAGE PRESSURE		POSITION		
OCCUPANCY TIME: VARIES																										
GRAPHIC DISPLAY ●																										
POINT DESCRIPTION																										
A/C CHILLERS ●																										
CHILLER					19																					
CHW PUMP	23														23											
CHW SUPPLY HEADER																		19								
CHW RETURN HEADER																		19								
COOLING TOWER																										
TWR. FAN	1														1											
CW PUMP	1														1											
HW BOILERS ●																										
BOILER					21							21														
HW PUMP	25														25											
HW SUPPLY HEADER																		21								
HW RETURN HEADER																		21								
STEAM BOILERS ●																										
BOILER					2							2														
STEAM SUPPLY HEADER																							2			
STEAM RETURN HEADER																							2			
AHU-SZ ●																										
SUPPLY FAN	10														10											
CHW COIL VALVE						10												10								
HW COIL VALVE						10												10								
RETURN AIR																										
FILTER										10																
ZONE TEMPERATURE																		10								
OUTSIDE AIR																										
												1														
AHU-CLG ONLY SZ ●																										
SUPPLY FAN	1														1											
COLD DECK TEMP.						1												1								
RETURN AIR																										
ZONE TEMPERATURE																										
FILTER										1																
OUTSIDE AIR																										

| | | |

RUN TIME	KW	KWH	CFM			REMARKS
X						
X						
X						
X						
						all valves, dampers, thermostats, and
X						actuators are existing.
X						

AREA: 100	HARDWARE																							
	OUTPUT								INPUT															
	DIGITAL					ANALOG			DIGITAL											ANALC				
ECO A: INSTALL EMS FOR HVAC EQUIPMENT	START / STOP	OPEN / CLOSED			ENABLE / DISABLE	CONTROL VALVE	CONTROL DAMPER	4-20 MA OUTPUT	PRESSURE SWITCH	DIFFERENTIAL PRESS. SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE METER	END SWITCH	CURRENT SENSING RELAY		LEVEL	TEMPERATURE F	RELATIVE HUMIDITY %	VOLTS	AMPS	DIFFERENITAL PRESSURE		
OCCUPANCY TIME: VARIES																								
GRAPHIC DISPLAY ●																								
POINT DESCRIPTION																								
AHU (MZ) ●																								
SUPPLY FAN	28														28									
COLD DECK TEMP.						28												28						
HOT DECK TEMP.						28												28						
RETURN AIR																		28						
ZONE DAMPERS							56																	
ZONE TEMPERATURE																		56						
FILTER										28														
FAN COIL UNIT ●																								
ZONE TEMPERATURE																		20						
PACKAGED AHU ●																								
ZONE TEMPERATURE																		6						
PACKAGED WINDOW UNIT ●																								
ZONE TEMPERATURE																		56						
OUTSIDE AIR ●																		1	1					

TOTAL AO POINTS =	131
TOTAL DO POINTS =	133
TOTAL AI POINTS =	151
TOTAL DI POINTS =	339
GRAND TOTAL POINTS =	754

| | SOFTWARE | | |

RUN TIME	KW	KWH	CFM			REMARKS
X						all valves, dampers, thermostats, and
						actuators are existing.