(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
	AREA 1000									
H	Retrofit Existing Individual Chillers With Central Chillers	1,016	3,865	0	1,016	27,480	37,885	480,090	12.7	1.18
	AREA 1300									
K	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
	AREA 100									
B	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
	AREA 1000									
I	Retrofit Existing Individual Boilers With Central Boilers	-28	-158	80	52	10,380	10,323	186,539	18.1	0.83
	AREA 2200									
N	Replace Existing Chillers With Central Chillers	3,050	25,570	0	3,050	8,005	55,110	1,040,094	18.9	0.80
	AREA 1300									
L	Retrofit Existing Individual Boilers With Central Boilers	342	1,256	1,064	1,406	15,180	22,265	484,544	21.8	0.71
	AREA 500									
F	Retrofit Existing Individual Boilers With Central Boilers	-109	-329	79	-30	7,980	7,240	164,799	22.8	0.66
	AREA 500									
D	Install Energy Management (EMS) for HVAC System	1,957	-401	39	1,996	0	12,024	278,393	23.2	0.65
	AREA 100									
A	Install Energy Management (EMS) for HVAC System	5,928	-2,523	691	3,876	0	37,738	928,408	24.6	0.62
	AREA 2200									
M	Install Energy Management (EMS) for HVAC System	5,002	-1,740	124	5,126	0	30,102	889,460	29.6	0.51
	AREA 500									
E	Retrofit Existing Individual Chillers With Central Chillers	705	3,743	0	705	9,080	17,250	516,826	30.0	0.50
	AREA 1300									
J	Install Energy Management (EMS) for HVAC System	3,105	-471	915	4,020	0	22,194	970,739	43.7	0.36
	AREA 1000									
G	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	