EMC

EXECUTIVE SUMMARY
FINAL REPORT
Of

ENERGY ENGINEERING ANALYSIS (EEA) PROGRAM

For

CORPUS CHRISTI ARMY DEPOT
TEXAS

1981

Prepared for

UNITED STATES ARMY DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

Under

CONTRACT NO. DACA 63-79-C-0177

Prepared by
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EXECUTIVE SUMMARY

ENERGY ENGINEERING ANALYSIS (EEA) PROGRAM
CORPUS CHRISTI ARMY DEPOT
CORPUS CHRISTI, TEXAS

Introduction

The objective of this Energy Engineering Analysis (EEA) for Corpus Christi Army Depot (CCAD) is to develop a systematic plan of projects which will result in the reduction of energy consumption at CCAD in compliance with the objectives set forth in the Army Facilities Energy Plan dated 1 October 78. The long range objective of the Army is to implement a policy under which CCAD will become as energy efficient as the state of the art for energy conservation will allow. In development of the planned projects, an assessment of the entire energy picture at CCAD was completed. This report is a summary of that effort.

CCAD was activated in 1961 as the only depot level facility for the maintenance of aircraft in the U.S. Army. The facility, with 45 structures encompassing 1,936,506 square feet, was acquired from existing facilities at Corpus Christi Naval Air Station, and is considered a permanent tenant of the air station. The depot reached its highest activity level during the Viet Nam conflict (1965 through 1974); since then CCAD has reverted to its current peacetime level of operation in maintaining the aircraft fleet of the Army.

The missions of CCAD are as follows:

- Perform overhaul, repair, modification, retrofit and modernization of aircraft systems.
- Maintain a mobilization and training base to provide capability for mission support during national emergency.
- Perform storage and distribution functions associated with overhaul, repair, modification, retrofit, and modernization of aircraft and related aeronautical items.

Data Base For Analysis

The study began with the collection of all data and information required to determine the distribution and forms of present energy consumption. These data and information include such building characteristics as type and method of environmental and process energy systems now in operation, building population and occupancy schedules, historical energy usage, and building envelope conditions. Such information was then used to develop a detailed energy data base for the entire facility. The energy data base maps the form and quantity of energy consumption from the receiving point, through conversion processes, and on to the point of end use for heating, cooling, lighting, process, and other systems; thus it provides a detailed picture of present energy consumption. The energy data base is used both to identify energy conservation opportunities (ECOs) and to serve as a gauge against which energy savings calculations can be compared.

For CCAD, present energy consumption was defined as the actual total energy consumption recorded for FY1980, the most recent complete year of data when the study began. Thus, the energy data base used is a detailed breakdown of the actual total energy consumption for FY1980. Table ES-1 below shows the composite breakdown for an energy consumption assessment in six categories. A more detailed breakdown on a building-by-building basis may be found in Table 3.6 beginning on page 3-21 in Volume I of the report.

TABLE ES-1

SOURCE ENERGY DATA BASE (FY1980) - CCAD

	Fossil Fuel (%)	Electricity (%)	Total %
Heating	12.1	2.7	14.8
Cooling	19.3	15.0	34.3
Lighting	0.0	9.5	9.5
Process	12.6	20.3	32.9
Domestic Hot Water	0.1	0.1	0.2
Miscellaneous	5.1	3.2	8.3
			100.0

Evaluation of Energy Conservation Opportunities

Potential ECOs were identified in a number of areas during the initial energy analysis. Not only did typical building envelope ECOs exist, but opportunities also were found in process ventilation systems, outside air reductions, steam and condensate return system modifications, lighting systems, and an extension of the centralized Energy Monitoring and Control System (EMCS). All ECOs were evaluated to determine feasibility in accordance with the requirements of the Energy Conservation Investment Program (ECIP) guidelines.

Since many ECOs are interrelated (i.e., the savings of one affect the savings of another), the energy conservation potential of a building with multiple ECOs was analyzed in the following sequence:

1. The building envelope was evaluated first to ensure that it was as weathertight as is economically feasible under ECIP guidelines.

2. Centralized control of energy systems through use of and expansion of the Energy Monitoring and Control System (EMCS) now under design was evaluated.

3. Next, the building envelope ECOs which met ECIP criteria were assumed to be implemented; the heating, ventilating, air conditioning, and exhaust systems were evaluated based upon these assumed implementations. Internal process system ECOs were evaluated concurrently where such ECOs would not detrimentally affect the functional requirements being performed.

4. Internal building steam distribution, compressed air, chilled water, and lighting systems were evaluated.

The results of the detailed analysis of ECOs, including the EMCS expansion, based on ECIP criteria are summarized in Table ES-2 below. Descriptions of the ECOs and identification of buildings to which they apply may be found in Sections 4.0 and 5.0 of this report.

TABLE ES-2
FEASIBLE ECIP ECOS FOR CCAD

ECO Description	Annual Energy Savings: Fossil Fuel (mBtu)	Annual Energy Savings: Electricity (kWh/YR)	Capital Cost* Estimate (FY1984$)	E/C Ratio
Sealant and Weatherstripping	2,064	39,885	$85,937	29.4
Roof Insulation	3,057	108,297	225,024	19.2
Wall Insulation	2,285	13,112	66,540	36.6
Window Insulation and Solar Screen	234	42,390	35,878	20.2
Hangar Door Insulation	1,237	0	58,983	21.0
Outside Air Reduction	22	6,498	1,530	63.6
Supply Air Reduction	0	172,389	61,778	32.4
Chiller Replacement, Building 1808	18,655	(460,550)**	453,620	29.3
Central Chiller Plant Additions	0	131,000	56,370	27.0
Paint Booth Fan Sentry	10.7	5,235	894	79.9
Airless Paint Spray	242.2	385,357	74,963	62.9
Night Air Compressor	0	469,000	132,120	41.2
Tank Covers	1,126	0	2,970	379.1
Tank Insulation	712	0	2,944	241.8
Additional Steam Line Insulation	6,984	11,960	238,707	29.8
Photocell Lighting Control	0	135,651	67,451	23.3
EMCS Proposed Expansion	1,142	120,792	120,289	21.2
TOTALS	37,770.9	1,181,016	$1,685,998	30.5

* Per ECIP escalation criteria (used in initial assessment of ECIP feasibility).

**() Indicates increase in energy consumption.

These ECOs, which meet the ECIP requirement of an E/C ratio of 13 or greater,* represent an energy savings of 9.6% in fossil fuel consumption and 3.4% in electrical energy use when compared to the FY1980 data base. This equals a reduction in total source energy of 6.4%. Based on FY1975 levels of energy consumption, these ECIP ECOs will accrue annual energy consumption reductions of 8.2% for fossil fuel, 3.3% for electricity, and 5.9% for total source energy.

The feasible ECIP ECOs were then grouped into FY1984 ECIP projects for funding. DD Form 1391s and Project Development Brochures (PDBs) were prepared and are submitted with this report. These projects and the ECOs which comprise them are as follows:

Project No.	Project Title	ECOs Included in Project
CC/E-0100	Building Weatherization	Sealant and Weatherstripping Window Insulation and Solar Screens
CC/E-0101	Roof, Wall, and Hangar Door Insulation	Roof Insulation Wall Insulation Hangar Door Insulation
CC/E-0102	EMCS Expansion and Lighting Control	EMCS Expansion Photocell Lighting Control
CC/E-0103	Process and HVAC System Modifications	Outside Air Reduction Supply Air Reduction Airless Paint Spray Night Air Compressor Tank Insulation Tank Covers Paint Booth Fan Sentry System Central Chiller Plant Additions
CC/E-0104	Chiller Replacement	Chiller Replacement, Building 1808
CC/E-0105	Additional Steam and Condensate Line Insulation	Additional Steam and Condensate Line Insulation

Guidance in preparing the programming documents, economic analyses, and DD Form 1391s for each project was received from the Fort Worth District, Corps of Engineers.** Specific instructions were as follows:

- Construction cost escalation factors, provided by AR-415-17 and the latest EIRS Bulletin, should be used to calculate construction cost in Paragraph 1 of the ECIP Economic Analysis Summary, and Items 8 and 9 of DD Form 1391 (Project Cost and Cost Estimates).

- Fuel escalation rates set forth in the ECIP guidance should be used to calculate energy costs in Paragraphs 2 and 3 of the ECIP Economic Analysis Summary.

* DAEN-MPO-U TWX dated 29 December 80.
** 27 February 81

These steps were carried out in preparing each project for FY1984 funding and in adjusting the economic justification to FY1984. Construction costs were escalated to midpoint of construction date (MCD) per AR-415-17 using building construction cost indices as updated by EIRS Bulletin 81-01. Fuel costs were escalated according to ECIP criteria.

Based on ECIP criteria and project costs for the programming year, a summary of the project results is presented in Table ES-3 following:

TABLE ES-3
ECIP PROJECTS - CCAD
(FY 1984)

Project Number and Title	Annual Source Energy Savings (mBtu/yr)	Project Cost ($1000)	E/C Ratio	B/C Ratio	Simple Payback Period (yrs)
CC/E-0100 Weatherization Weatherstripping	2,526.7	$ 89.2	28.3	2.93	3.46
Window Insulation and Solar Screen	725.7	37.2	19.5	2.84	6.31
CC/E-0101 Roof, Wall and Hangar Door Insulation	7,987.0	363.9	21.9	4.22	4.45
CC/E-0102 EMCS Expansion and Lighting Control					
EMCS Expansion	2,543.2	124.8	20.4	2.03	6.49
Photocell Lighting Control	1,573.6	70.0	22.5	1.77	6.56
CC/E-0103 Process and HVAC System Modifications	15,678.8	346.2	45.3	3.93	3.00
CC/E-0104 Chiller Replacement	13,313.0	470.9	28.3	4.51	2.79
CC/E-0105 Additional Steam & Condensate Line Insulation	7,122.2	247.8	28.7	5.94	3.19
Total	51,470.2	1,750.0	29.4		

The projects evaluated in Increments A and B, listed in Table ES-3 above, represent logical groupings of ECOs according to application or means of implementation. Projects are listed in order of the recommended sequence of implementation. Weatherization and roof, wall, and hangar door insulation should be implemented first, followed by EMCS expansion. Reduction in heating and cooling loads should be accomplished before implementing process and HVAC modifications. The remaining projects should be implemented in order of decreasing E/C ratio; this sequence of implementation will provide the greatest annual energy savings per dollar of capital investment.

Increment G Projects

Other ECOs were evaluated in the process of determining feasible ECIP projects. Those which did not meet ECIP criteria were considered further as possible Increment G projects. In addition, a number of ECOs were identified as "maintenance and repair" ECOs. Some of the maintenance and repair ECOs were grouped separately; these are replacement ECOs which can be performed as needed on a "unit basis."

The three groups of ECOs were evaluated for Increment G under ECIP criteria for common baseline comparison to Increments A and B projects. Energy savings, energy savings-to-cost (E/C) ratios, benefit-to-cost (B/C) ratios, man-hours to accomplish the work, and current working estimates (CWE) were developed using ECIP guidelines. The economic summaries of the evaluations for non-qualifying ECIP ECOs, maintenance and repair ECOs, and "unit basis" ECOs are presented respectively in Tables ES-4, ES-5, and ES-6 on the following pages.

Because none of these projects has a capital cost over $100,000, no 1391s and PDBs were prepared; funding can be obtained for implementation from other sources such as Operations and Maintenance (O&M) or Minor Military Construction Appropriations (MMCA) budgets.

TABLE ES-4
CCAD
NON-QUALIFYING ECIP ECOs

Description	Annual Energy Savings (mBtu)	Man-Hours Required	Capital Cost (CWE) ($FY84)	E/C Ratio	B/C Ratio
Precool-Reheat Run-Around Heat Recovery System	915	479	$ 77,000	11.9	2.95
Additional Steam Line Insulation	890	954	84,499	10.5	2.32
Wall Insulation	536	570	57,044	9.4	1.62
Total	2,341	2,003	$218,543	10.7	

TABLE ES-5
CCAD
MAINTENANCE AND REPAIR ECOs

Description	Annual Energy Savings (mBtu)	Man-Hours Required	Capital Cost (CWE) ($FY82)	E/C Ratio	B/C Ratio
Upgrade HVAC Controls	2,741	301	$24,657	111	3.24
Maintenance of Filters, Fan Belts, and Cooling Coils	1,735	460	12,521	139	2.22
Maintenance of Condenser Coils	217	125	3,278	66.2	1.64
Maintenance and Repair of Fan Coil Units in Bldg 1727	149	320	11,682	12.7	1.54
Total	4,842	1,206	$52,138	92.8	

TABLE ES-6a
CCAD
"UNIT BASIS" ECOs*

Description	Annual Energy Savings Per Unit(mBtu)	Man-Hours Per Unit Required	Unit Cost (CWE) ($FY82)	E/C Ratio	B/C Ratio
Flange, Valve, and Elbow Insulation					
12"Ø	71.43	1.5	$115.00	621.0	105.0
6"Ø	31.66	1.0	70.00	452.0	76.6
2"Ø	10.13	0.5	38.00	267.0	45.2
Maintenance of Pressure Regulating Valves					
Repair	17.6	2.5	58.20	302.0	12.2
Replacement	17.6	3.0	613.00	28.7	4.86
Repair Air Leaks	37.7	1.25	89.52	422.0	10.5
Maintenance of Steam Traps					
Repair	24	1.0	146.00	164.0	6.63
Maintenance of Steam Valves					
Repair	6	1.0	58.20	103.0	4.14
Replace	6	2.0	308.00	19.5	3.29
Replace Standard Fluorescent lamps with Reduced Wattage Lamps - "Cool-White"	0.241	0**	0.61	395.0	12.9
"Lite-White"	0.241	0**	0.84	287.0	9.36
Incandescent Conversion to Fluorescent Lighting	1.47	0**	20.75	70.8	7.68
Replace Standard Fluorescent Lamps and Ballasts with Reduced Wattage Lamps and Ballasts	0.338	0**	4.33	78.1	6.16
Replace Standard Fluorescent Ballasts with Reduced Wattage Ballasts	0.194	0**	2.78	69.8	4.92

*Each ECO was evaluated on a unit repair basis; for each item repaired, the annual savings and the cost of the repair are identified. Each of the items identified does exist at CCAD; however, the extent to which it exists will vary continuously depending on when the survey is performed. Most of these energy saving repairs should be implemented on a continuing basis as part of the maintenance program at CCAD.

**Indicates no additional incremental increase in man-hours to replace item at the time normal replacement is required.

TABLE ES-6b
ELECTRIC MOTOR REPLACEMENT
ECONOMIC SUMMARY

Motor HP	kW Saved	Price Premium (FY1982$)	*Operational Hours Per Year to Achieve B/C of 1.0	Operational Hours Per Year Per HP to Achieve B/C of 1.0
1	0.063	$ 60	1,770	1,770
2	0.041	54	2,447	1,224
3	0.123	69	1,042	347
5	0.117	82	1,315	263
7.5	0.195	85	810	108
10	0.150	105	1,301	130
15	0.451	136	560	37.3
20	0.441	154	649	32.5
25	0.470	171	676	27.0
30	0.475	189	739	24.6
40	0.821	255	577	14.4
50	0.810	301	690	13.8
60	0.826	440	990	16.5
75	0.845	558	1,227	16.4
100	1.301	661	944	9.44
125	1.351	835	1,148	9.18
150	1.636	1,035	1,175	7.83

*Computed with the following equation:

$$\text{Hrs} = \frac{\text{Price Premium}}{(\text{kW saved})(0.0617/\text{kWh}(8.737)}$$

Average kWh cost with demand = $0.0617
Uniform present worth factor, assuming differential escalation rate @ 7% for 10 year life = 8.737

Energy Conservation Plan-Energy Savings Summary

The Army Facilities Energy Plan has set a goal of 25% net reduction in energy consumption by FY1985 compared to historic FY1975 energy consumption levels. A review of FY1980 energy consumption shows a significant energy reduction (73,084 mBtu/yr or 8.3%) has already been achieved through energy conservation projects and improved operation and maintenance procedures. Assuming implementation by FY1985 of all the recommended ECIP projects, including EMCS system expansion and the Increment G non-qualifying ECIP and maintenance and repair ECOs, Corpus Christi Army Depot would achieve net annual energy savings of 215,519 mBtu/yr, or a 24.6% reduction in comparison to FY1975 energy consumption levels. An itemized summary of these projected energy savings is presented in Table ES-7 below.

TABLE ES-7

CCAD ENERGY PROFILE: FY1975-FY1985

Item	Annual Energy Use		Annual Energy Savings			%
	Fossil Fuel (mBtu)	Electric (kWh)	Fossil Fuel (mBtu)	Electricity (kWh)	Source (mBtu)	Savings *
FY1975 Energy Use	461,632	35,675,220	-	-	-	-
FY1980 Use; Annual Savings Since FY1975	394,757	35,139,961	66,875	535,259	73,084	8.3
After Installation of EMCS Under Design**	364,559	30,520,795	30,198	4,619,166	83,780	9.6
After ECIP Projects Implemented	326,788	29,339,779	37,771	1,181,016	51,471	5.9
After Increment G ECOs Implemented	323,674	28,988,950	3,114	350,829	7,183	0.9
Total			137,958	6,686,270	215,519	24.6

*Based on FY1975 level of source energy use.

Recommendations

With a 24.6% reduction in energy consumption from 1975 levels, CCAD will be very close to Army energy conservation goals and DOD energy conservation goals for existing facilities as required by Executive Order 12003.

It is recommended that all six ECIP projects, all non-qualifying ECIP ECOs, and maintenance and repair ECOs be implemented as soon as funding will permit.

A further reduction in energy can be achieved by the on-going implementation of "unit basis" maintenance ECOs. The establishment of such a program is highly recommended.

**Herman Blum Consulting Engineers, Inc., "Energy Monitoring and Central System for Corpus Christy Army Depot; Phase II, 100% Design Submittal, 12 June 1982. Contract No N62467-79.C-0430.