



## Executive Summary

# ENERGY ENGINEERING ANALYSIS PROGRAM FORT BLISS, TX

U S Army Corps of Engineers  
Fort Worth District  
FORT WORTH, TEXAS

CONTRACT NO. DACA63-79-C-0192

April 1984

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CRS GROUP INC.  
Houston, Texas




DEPARTMENT OF THE ARMY  
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS  
P.O. BOX 9005  
CHAMPAIGN, ILLINOIS 61826-9005

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ENERGY ENGINEERING ANALYSIS PROGRAM  
FORT BLISS, TEXAS

EXECUTIVE SUMMARY

Prepared for

Department of the Army  
Corps of Engineers  
Fort Worth District  
Fort Worth, Texas

Contract No. DACA63-79-C-0192  
Modifications P00001, P00002, P00003, P00006

Prepared by

CRS Group Inc.  
Houston, Texas

April 1984

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Within each volume is a detailed Table of Contents for that volume.

1. INTRODUCTION

The CRS Group Inc. is pleased to submit this report on Increments A, B, C, D, E, F and G of the Energy Engineering Analysis Program (EEAP) for Fort Bliss, Texas. This work was accomplished under Contract No. DACA63-79-C-0192 with four modifications. The associated volumes, general contents, level of completion and contract modification numbers are listed in TABLE ES1.

TABLE ES1  
REPORT SUMMARY

<u>Volume</u>	<u>Contents</u>	<u>Level of Completion</u>	<u>Modification</u>
I	Program Overview	Final Report (Jan. 1983)	P00001
II	Increment A	Final Report (Jan. 1983)	P00001
III	Increment B	Final Report (Jan. 1983)	P00001
IV	Increment E	Final Report (Jan. 1983)	P00001
V	Increment G	Final Report (Sep. 1983)	P00002
VI	Increment C	Final Report (Apr. 1984)	P00003
VII	Increment D	Final Report (Apr. 1984)	P00003
VIII	Increment F	Final Report (Apr. 1984)	P00003
IX	ECIP Update	Final Report (Sep. 1983)	P00006
Appendices	Building Data Base	Final Report (Jan. 1983)	P00001

1.1 Report Format

The work presented in these volumes represents final results on Increments A, B, C, D, E, F and G (and Appendices). This Executive Summary includes a summary of the entire Fort Bliss EEAP results. As this work has been done under varying scopes of work, a copy of the applicable scope of work is included in appropriate volumes (specifically in Volume I for Increments A, B and E; in Volume V for Increment G, in Volume VI for Increments C, D and F and in Volume IX for the ECIP Update).

1.2 ECIP Documentation

Forwarded to FWD and Fort Bliss were copies of the ECIP's (DD Forms 1391 and PDB's) from Increments A, B and G.

1.2.1 TABLE ES2 below summarizes the present completion of the increments of the Fort Bliss EEAP where:

- Phase I: Data gathering and field inspections;
- Phase II: Analysis, project identification, technical feasibility and economic evaluations;
- Phase III: Preparation of DD Forms 1391 and PDB's where applicable and final documentation of results and recommendations.

TABLE ES2

COMPLETION PERCENTAGE OF FORT BLISS EEAP

Increment	Phase	I	II	III
A - Buildings		100%	100%	100%
B - Utilities/EMCS		100%	100%	100%
C - Solar/Renewable Energy		100%	100%	100%
D - TE & SE		100%	100%	100%
E - Central Boiler Plant		100%	100%	100%
F - Facility Engineer's Conservation Measures		100%	100%	100%
G - Maintenance/Repair		100%	100%	100%

1.3 Schedule

All Increments of the Fort Bliss, Texas EEAP are complete.

#### 1.4 Overview

This report consists of nine volumes and a set of appendices in which the EEAP results are presented. All calculational routines for the analyzed Energy Conserving Measures (ECM's) are either explicitly presented or the computer code employed is referenced. The purpose of the presentation is to allow others to follow the procedures in a straight-forward manner. Costs of implementing an ECM are also shown, broken out by labor and material where applicable, referenced and adjusted to the Fort Bliss market. Where appropriate, applicability lists have been prepared identifying where the ECM's are to be implemented. Additionally, ECIP Economic Analysis Summary Sheets, Detailed Cost Estimates and Life Cycle Cost Analysis Summary Sheets are included where appropriate. A brief overview of each volume is presented below.

1.4.1 Volume I (Final), previously submitted, presents general information used throughout the program. The EEAP objectives are reviewed, and the contract and modifications are identified. While a data base of building information was available, there was some question as to its accuracy and adequacy for EEAP application. An extensive verification procedure was carried out including checking of as-built drawings and site visits to buildings. The data base was found adequate for use in calculating potential energy savings once updating and minor corrections were incorporated. (The corrected data base is presented as part of the Appendices volume.)

1.4.1.1 A detailed Baseline Assessment of Fort Bliss was carried out which covered applicable previous work, local climate, energy consumption history, energy costs and end use. Factors which could impact the implementation of an ECM were investigated. Finally, the Scope of Work for this contract and modification, References, Abbreviations and Acronyms are presented. (The References and Abbreviations and Acronyms sections are included in each volume to aid the reader.)



1.4.2 Volume II (Final), previously submitted, contains the methodology used, analysis and summary of the ECM's investigated for Increment A: Buildings including Family Housing. (Applicable ECIP projects have been updated to current ECIP criteria and economic analysis procedures in Volume IX: ECIP Update, previously submitted, as specified in Contract Modification P00006.)

1.4.3 Volume III (Final), previously submitted, contains the Increment B work. Covered in this volume are the methodology, a baseline assessment and analysis of ECM's relevant to the utilities and distribution systems at Fort Bliss. The EMCS methodology, analysis and results are presented, and a section on metering is included. (Applicable ECIP projects have been updated to current ECIP criteria and economic analysis procedures in Volume IX: ECIP Update, previously submitted, as specified in Contract Modification P00006.)

1.4.4 Volume IV (Final), previously submitted, presents the work completed under Increment E and contains an introduction, the methodology, the analysis and a summary of results relating to the Central Boiler Plant study.

1.4.5 Volume V (Final), previously submitted, presents the work completed under Increment G - a detailed analysis of those ECM's developed in Increments A and B which did not qualify under the ECIP criteria. Also included in this volume is an investigation of possible modifications to the William Beaumont Army Medical Center and one additional ECIP: Automatic Setback Thermostats.

1.4.6 Volume VI (Final) covers the work under Increment C: Renewable Energy.

1.4.7 Volume VII (Final) covers the work under Increment D: Total and Selective Energy.

1.4.8 Volume VIII (Final) covers the work under Increment F: Facility Engineer's Conservation Measures.

1.4.9 Volume IX (Final), previously submitted, presents the work completed under Contract Modification P00006. This modification specifies that Increments A and B ECIP's not previously submitted for funding will be updated to the 22 September 1982 General Scope of Work and the 31 December 1982 ECIP Guidance.

1.4.10 The Appendices Volume (Final), previously submitted, contains the Fort Bliss EEAP data base consisting of:

- Appendix I : Building Locator
- Appendix II : Index Building Data
- Appendix III: Duplicate Building List
- Appendix IV : Recent Construction
- Appendix V : Low Energy Use Building List

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2. EXISTING ENERGY CONSUMPTION

Basewide consumption records from the base year, FY75, show that the vast majority of consumed energy at Fort Bliss consists of electricity and natural gas. In FY75, Fort Bliss used 1,485,414 source MBtu (millions of Btu's) or 128,052,919 metered kWh of electricity at a cost of over \$2.2 million. During that same period, 1,594,200 source MBtu of natural gas were purchased for \$1.1 million. Additionally, liquid petroleum products were used at Fort Bliss. The records indicate that significant amounts of the following fuels were consumed during FY75:

- JP-4 (aviation turbine fuel): 19,946 barrels;
- Motor gasoline: 34,494 barrels;
- Diesel fuel: 24,547 barrels.

2.1 Basewide Consumption FY80

In FY80, 1,571,531 source MBtu (135,476,792 metered kWh) of electricity at a cost of over \$5.4 million were used. During that same period, 1,287,913 source MBtu of natural gas were purchased for over \$2.8 million.

2.1.1 The overall use of other liquid petroleum products shows an increase in FY80 due to a large increase in the use of diesel fuel with slight decreases in aviation turbine fuel and motor gasoline. The number of gallons used with the percentage increase or decrease over FY75 use in parentheses was:

- JP-4 (aviation turbine fuel): 17,288 barrels (-13.3%);
- Motor gasoline: 33,626 barrels (- 2.5%);
- Diesel fuel: 42,512 barrels (+85.4%).

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2.2 Basewide Consumption FY83

In a more recent Fiscal Year, FY83, the Fort used 1,707,146 source MBtu (147,167,735 metered kWh) of electricity at a cost of \$9.8 million. During that same period 1,662,107 source MBtu of natural gas were purchased for \$6.7 million.

2.2.1 The use of other liquid petroleum products in FY83 is shown below, again with the percentage increase or decrease over FY75 use in parentheses:

- ° JP-4 (aviation turbine fuel): 13,118 barrels (-34.2%)
- ° Motor gasoline: 31,474 barrels (-8.8%)
- ° Diesel fuel: 48,464 barrels (+97.4%)

None of these fuels were used for heating in FY83.

3. RESULTS

The EEAP at Fort Bliss has identified over 60 projects for energy conservation. These projects are detailed in the volumes of the EEAP submittal. This EEAP was originally contracted under the 5 November 1979 General Scope of Work (GSOW) and associated ECIP Guidance dated 7 November 1977 which required ECM's to be analyzed using energy to cost (E/C) and benefit to cost (B/C) ratios. Recently, Modification P00006 was incorporated into the contract to update those ECIP's not yet forwarded for funding to the 22 September 1982 GSOW and 31 December 1982 ECIP Guidance.

3.1 ECIP Projects

Results of ECIP projects prepared under this EEAP are summarized in TABLE ES3.

TABLE ES3  
ECIP's PREPARED UNDER EEAP

ECIP #T-483 Energy Monitoring and Control System  
Install an EMCS with 396 points in 41 AHU's in 26 buildings.

Implementation	=	FY86
Total Cost	=	\$970,606
SIR	=	2.59
Savings	=	35,497 MBtu/year (source) Electricity 7,204 MBtu/year (source) Natural Gas
Total Savings	=	42,701 MBtu/year (source) Energy
Status	=	ECIP submitted to Fort Bliss.

TABLE ES3 (Continued)  
ECIP's PREPARED UNDER EEAP

ECIP #T-484 Energy Conserving Projects for Family Housing  
Install automatic setback thermostats, flow-restricting showerheads, DHW tank insulation and convert kitchen lighting to fluorescent in 3,582 Family Houses.

Implementation = FY85  
Total Cost = \$1,058,877  
E/C = 71.1  
B/C = 3.6  
Payback = 3.4 years  
Savings = 9,479 MBtu/year (source) Electricity  
65,858 MBtu/year (source) Natural Gas  
Total Savings = 75,337 MBtu/year (source) Energy  
Status = Forwarded for funding.

ECIP #T-485 Barracks Energy Alterations  
Install 2,915 flow-restricting showerheads in 230 buildings and radiator controls in 70 buildings.

Implementation = FY86  
Total Cost = \$761,872  
SIR = 6.24  
Savings = 1,479 MBtu/year (source) Electricity  
83,036 MBtu/year (source) Natural Gas  
Total Savings = 84,515 MBtu/year (source) Energy  
Status = ECIP submitted to Fort Bliss.

ECIP #T-486 Laundry Heat Recovery  
Install laundry waste water heat recovery and dryer exhaust air heat recovery.

Implementation = FY86  
Total Cost = \$279,630  
SIR = 1.08  
Savings = - 339 MBtu/year (source) Electricity  
6,359 MBtu/year (source) Natural Gas  
Total Savings = 6,020 MBtu/year (source) Energy  
Status = ECIP submitted to Fort Bliss.

TABLE ES3 (Continued)  
ECIP's PREPARED UNDER EEAP

ECIP #T-487 Automatic Setback Thermostats

Install 1,956 automatic setback thermostats in 579 buildings.

Implementation = FY87  
Total Cost = \$359,030  
SIR = 4.81  
Savings = 29,520 MBtu/year (source) Natural Gas  
Status = ECIP submitted to Fort Bliss.

→ ECIP #T-488 Boiler Alterations

Install turbulators in 120 boilers in 79 buildings and flue-gas analyzers with feedback trim in six boilers in two buildings.

Implementation = FY86  
Total Cost = \$280,808  
SIR = 2.52  
Savings = 13,071 MBtu/year (source) Natural Gas  
          3,876 MBtu/year (source) Fuel Oil  
Total Savings = 16,947 MBtu/year (source) Energy  
Status = ECIP submitted to Fort Bliss.

ECIP #T-489 AFH Evap. Cooler FM Controls

Install FM controls on 3,643 evaporative coolers in 2,419 Army Family Houses (AFH).

Implementation = FY86  
Total Cost = \$628,895  
SIR = 1.77  
Savings = 16,866 MBtu/year (source) Electricity  
Status = ECIP submitted to Fort Bliss.

TABLE ES3 (Continued)  
ECIP's PREPARED UNDER EEAP

ECIP #T-490 Evap. Cooler FM Controls

Install FM controls on 844 evaporative coolers in 203 offices, shops and barracks.

Implementation = FY86  
Total Cost = \$215,750  
SIR = 2.77  
Savings = 13,407 MBtu/year (source) Electricity  
Status = ECIP submitted to Fort Bliss.

3.1.1 TABLE ES4 lists the ECIP projects as ranked by SIR or E/C where appropriate.

3.2 Other ECM's

TABLE ES5 lists all other ECM's investigated which did not meet ECIP criteria broken out by Increment. These projects were not part of the modification to update projects to the 31 December 1982 ECIP Guidance (SIR). Increment F results are discussed separately following TABLE ES5.



TABLE ES4  
RANKED ECIP's

<u>Project No.</u>	<u>Title</u>	<u>E/C or SIR</u>
T-484	Energy Conserving Project for Family Housing	71.1 E/C
T-485	Barracks Energy Alterations	6.24 SIR
T-487	Automatic Setback Thermostats	4.81 SIR
T-490	Evap. Cooler FM Controls	2.77 SIR
T-483	Energy Monitoring and Control System	2.59 SIR
T-488	Boiler Alterations	2.52 SIR
T-489	AFH Evap. Cooler FM Controls	1.77 SIR
T-486	Laundry Heat Recovery	1.08 SIR

Additionally, detailed investigation of a solar swimming pool heating application for Building 5035 (Replica Pool) shows an SIR of 1.52. However, this ECM has a project cost less than the \$200,000 minimum for ECIP project funding. It is recommended for inclusion with another project.

TABLE ES5  
ECM's NOT MEETING ECIP CRITERIA

INCREMENT A: Buildings - Final Report Results

<u>Title</u>	<u>E/C</u>	<u>Notes</u>
Electronic Furnace Ignition	27.1	Pilot lights turned off in summer already. Replacement units are ordered with electronic ignition.
AFH Storm Windows	9.1	Highest Value
AFH Wall Insulation	7.6	
AFH Perimeter Floor Insulation	6.6	
Wall Insulation	3.9	Highest Value
Roof Insulation	N/A	No additional buildings beyond Post ECIP submission met ECIP criteria.

INCREMENT B: Utilities/EMCS - Final Report Results

<u>Title</u>	<u>E/C</u>	<u>Notes</u>
Replace Transformers	9.5	Highest Value
Replace Overhead Conductors	Low	
Basewide Capacitance Correction	Low	
High Efficiency Pump Motors		
Water Pumps	Less than 6.0	
Sewer Pumps	Less than 6.0	
Drainage Pumps	Less than 6.0	
Improved Pump Motor Power Factor	Low	

TABLE ES5 (Continued)  
ECM's NOT MEETING ECIP CRITERIA

INCREMENT C: Renewable Energy - Final Report Results

Renewable Energy Systems

<u>Title</u>	<u>DeltaLCC*</u>
Wind Energy	-\$45,905
Geothermal Energy	-\$50,997,016
Nuclear Energy	Not Recommended

\* A negative DeltaLCC here implies it costs more than it saves.

Solar Projects

<u>Title</u>	<u>ECIP SIR</u>	<u>Solar Project SIR</u>	<u>Solar Demonstration Project SIR</u>
Solar Heat - Replica Pool	1.52	--	--
40 Barracks (DHW)	0.36	0.54	0.87
400 Family Houses (DHW)	0.23	0.36	0.70
Solar Gel Pond	0.18	0.29	0.65
3 Barracks (DHW)	0.16	0.27	0.62
400 Family Houses (DHW & SH)	0.15	0.24	0.60
40 Barracks (DHW & SH)	0.12	0.20	0.56
3 Barracks (DHW & SH)	0.10	0.18	0.54
1 Barracks (DHW & SH)	0.05	0.11	0.48
Salt Gradient Solar Pond	0.01	0.05	0.43
8 Family Houses (DHW)*	-0.003	0.04	0.42
1 Barracks (DHW)*	-0.03	-0.003	0.38
3 Family Houses (DHW & SH)*	-0.06	-0.04	0.34
8 Family Houses (DHW & SH)*	-0.08	-0.07	0.32
1 Family House (DHW)*	-0.15	-0.17	0.23
3 Family Houses (DHW)*	-0.16	-0.18	0.22
1 Family House (DHW & SH)*	-0.17	-0.20	0.20

Note: DHW = Domestic Hot Water Heating  
SH = Space Heating

\* Results indicate that these projects would cost more to maintain than they would save in reduced energy costs.

TABLE ES5 (Continued)  
ECM's NOT MEETING ECIP CRITERIA

INCREMENT D: TE & SE - Final Report Results

<u>Title</u>	<u>Net Life Cycle Cost*</u>
Basewide Total Energy	\$91,204,840
Basewide Total Energy plus Refuse Derived Fuel	\$90,298,556
WBAMC Selective Energy	\$ 7,492,349
WBAMC Selective Energy plus Refuse Derived Fuel	\$ 6,586,065
WBAMC Selective Energy at Full Electrical Output	\$ 3,767,526
WBAMC Selective Energy at Full Electrical Output plus Refuse Derived Fuel	\$ 2,861,242

\*If Net Life Cycle Cost is positive, the concept costs more than it saves.

INCREMENT E: Central Boiler Plants - Final Report Results

<u>Title</u>	<u>E/C</u>	<u>B/C</u>
Main Post	0	0.50
WBAMC	0	0.48
Logan Heights	0	0.64
Biggs Army Air Field	0	0.57

TABLE ES5 (Continued)  
ECM's NOT MEETING ECIP CRITERIA

INCREMENT G: Non-ECIP Projects - Final Report Results

<u>Title</u>	<u>E/C</u>	<u>Note</u>
WBAMC		
Solar Film*	N/A	SIR = 2.05
Power Factor Correction	317.5	Low cost project
Winter Cooling Modifications	5.2	
Replacement of Heating Coils	0	To improve comfort-no energy savings
High-Efficiency Air Washer Evaporators in Barracks	14.6	B/C = 0.93
Insulating Uninsulated Floors	6.2	
Caulk and Weatherstrip Family Housing	4.5	Total Project E/C
Door Weatherstripping	11.2	
Window Caulking	5.4	
Door Caulking	5.4	
Window Weatherstripping	1.9	
Powered Attic Ventilation in AFH	Negative	Consumes more energy than it saves
Wind Driven Attic Ventilation in AFH	2.4	

\* The Post requested a revised economic analysis based on a local contractor bid received by the Post. The result of this analysis is an SIR of 2.05.

3.2.1 Increment F site surveys have shown that, in general, operations and maintenance (O&M) procedures are adequate to maintain equipment, but there is a shortage of personnel available to implement preventive maintenance procedures. Also, buildings are, for the most part, operated with energy conservation in mind. The largest discrepancy from this attitude occurs in Army Family Housing.

3.2.1.1 Recurring problems in many of the 30 buildings surveyed were:

- Door and window weatherstripping/caulking has deteriorated;
- Radiator valves are inoperable;
- Filters for furnaces and air handling units are dirty or missing;
- Water faucets are leaking;
- Building occupancy is less than design capacity;
- Hot and cold pipes/ducts are not insulated; and
- Building HVAC and domestic hot water systems are operating when the building is unoccupied.

3.2.1.2 Increment F work concentrated on the identification of specific recommendations for O&M opportunities for energy conservation.

4. ENERGY PLAN

The totals for the implementation of the eight ECIP's are summarized below:

Energy Savings	:	76,389 MBtu/yr (source) Electric
		205,048 MBtu/yr (source) Gas
		<u>3,876 MBtu/yr (source) Fuel Oil</u>
Total Energy Savings	:	285,313 MBtu/yr (source) Energy
Total Construction Cost*	:	\$4,556,000 (rounded)
Annual \$ Savings	:	\$1,162,180
SIR	:	3.51

4.1 The savings from these eight ECIP's are shown in TABLE ES6 where a comparison to FY75 energy use is made.

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\* Note that the Family Housing ECIP was prepared for FY84 implementation, and the project has been funded. All other ECIP's were calculated for FY86 implementation except T-487: Automatic Setback Thermostats which was calculated for FY87 implementation.

TABLE ES6  
ECIP ENERGY SAVINGS AND COMPARISON TO FY75 AND FY83 USE

<u>Energy</u>	<u>ECIP Savings in Source MBtu</u>	<u>FY75 Use in Source MBtu</u>	<u>FY83 Use in Source MBtu</u>
Electricity (% Reduction)	76,389	1,485,414 (5.14%)	1,707,146 (4.47%)
Gas/Fuel Oil (% Reduction)	208,924	1,594,200 (13.11%)	1,662,107 (12.57%)
TOTALS (% Reduction)	285,313	3,079,614 (9.26%)	3,369,253 (8.47%)

Percent reduction is calculated as:

Electricity: 
$$100\% \times \frac{\text{ECIP Savings}}{\text{FY75 Electricity Use}} = 5.14\%$$

Gas & Fuel Oil: 
$$100\% \times \frac{\text{ECIP Savings}}{\text{FY75 Gas/Fuel Oil Use}} = 13.11\%$$

TOTAL: 
$$100\% \times \frac{\text{ECIP Savings}}{\text{FY75 Energy Use}} = 9.26\%$$



5. RECOMMENDATIONS

It is recommended that all eight ECIP's from Increments A, B and G be funded. (The Family Housing ECIP already has been.)

5.1 ECIP Implementation

Implementation of these ECIP's will reduce by 9.26 percent (FY75 base year) energy consumption at Fort Bliss - an Army facility which has implemented energy conserving modifications successfully in the past (e.g., delamping, lowering thermostat setpoints, turning off Family Housing heater pilot lights in the summer, insulation of buildings and replacement of hot water heaters, etc.).

5.2 Increment C

Results from Increment C are positive for the Replica Swimming Pool application, and a realistic aggressive plan for solar application should be pursued.

5.3 Increment D

Results from Increment D indicate that a Total Energy concept has a savings to investment ratio (SIR) of less than 1.0 and therefore does not meet the Army's goals. Selective Energy applications are not economically justified either with or without refuse derived fuels.

5.4 Increment F

Results from Increment F indicate that there is room for improvement in operations and maintenance. Specific O&M changes for energy conservation at Fort Bliss, Texas have been recommended.