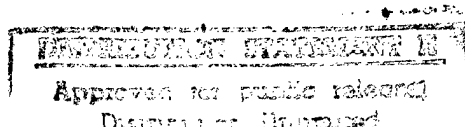


Limited Energy Study of Hangar Facilities at Simmons Army Airfield (SAAF), Fort Bragg, North Carolina

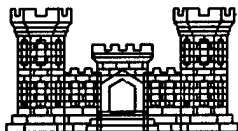
Final Report

Volume 1 of 2
Sections 1-5



CONTRACT #DACA01-94-D-0034
DELIVERY ORDER 0004
SYSTEMS CORP PROJECT #94013.04

April 26, 1995



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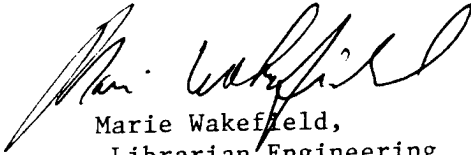


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TABLE OF CONTENTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

VOLUME 1

1.	INTRODUCTION AND REPORT REVIEW FORMS	1-1
1.1	SUMMARY RESULTS	1-3
2.	WORK ACCOMPLISHED TO DATE	
2.1	FIELD SURVEY	2-1
2.2	BUILDING ENERGY CONSUMPTION BASELINE	2-2
2.2.1	Lighting Systems	2-2
2.2.2	HVAC Systems	2-2
2.3	ENERGY CONSERVATION OPPORTUNITIES	2-3
2.3.1	ECO-1: Install High Efficiency Interior/Exterior Lighting Systems	2-4
2.3.2	ECO-2: Install Natural Gas Boilers & Infrared Heaters	2-5
2.3.3	ECO-3: Install Electric Infrared Heaters	2-6
2.3.4	ECO-4 Renovate HVAC Systems	2-7
2.4	FIELD NOTES	2-8
2.4.1	ECO-1: Install High Efficiency Interior/Exterior Lighting Systems	2-8
3.	ANALYSIS METHODS	
3.1	FIELD SURVEY	3-1
3.2	CALCULATIONS	3-2
3.2.1	Baseline Energy Consumption	3-2
3.2.1.1	Baseline Energy Consumption: ECO-1	3-2
3.2.1.2	Baseline Energy Consumption: ECOs 2, 3, & 4	3-2

TABLE OF CONTENTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

3.2.2	ECO Energy Consumption	3-2
3.2.2.1.	ECO Energy Consumption: ECO-1	3-3
3.2.2.2	ECO Energy Consumption: ECO-2	3-3
3.2.2.3	ECO Energy Consumption: ECO-3	3-3
3.2.2.4	ECO Energy Consumption: ECO-4	3-3
3.3	COST ESTIMATES	3-3
3.3.1	Construction Costs	3-3
3.3.2	Project Costs	3-4
3.4	ECO LIFE CYCLE COSTS	3-4
3.4.1	Energy Costs	3-4
3.4.2	Maintenance and Replacement Costs	3-5
4.	PLAN FOR REMAINING WORK	
4.1	REMAINING PHASES	4-1
4.1.1	Response to Prefinal Review Comments	4-1
4.1.2	Preparation of Final Report	4-1
4.2	TASK LIST	4-1
4.3	SCHEDULE FOR THE REMAINING WORK	4-2
5.	NARRATIVE SUMMARY OF WORK AND RESULTS	
5.1	FIELD SURVEY	5-1
5.2	ENERGY BASELINE	5-1
5.3	ENERGY CONSERVATION OPPORTUNITIES	5-2
5.3.1	ECO-1: Install High Efficiency Interior/Exterior Lighting Systems	5-3
5.3.2	ECO-2: Install Natural Gas Boilers & Infrared Heaters	5-5

TABLE OF CONTENTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

5.3.3	ECO-3	Install Electric Infrared Heaters	5-5
5.3.4	ECO-4	HVAC Renovations	5-5
5.4	RECOMMENDED PROJECTS AND ORGANIZATION		5-10

APPENDIX

A.	SCOPE OF WORK	A-1
B.	CORRESPONDENCE	B-1
C.	PROJECT DOCUMENTS	C-1
D.	RESPONSE TO INTERIM REVIEW COMMENTS	D-1
E.	LIGHTING SURVEY FORMS	E-1

VOLUME 2

6.	ECO-1 CALCULATIONS	6-1
7.	ENERGY CALCULATIONS: ECO - 2, 3, 4	7-1
8.	ECO-2 LIFE CYCLE COSTS	8-1
9.	ECO-3 LIFE CYCLE COSTS	9-1
10.	ECO-4 LIFE CYCLE COSTS	10-1

TABLE OF CONTENTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

LIST OF TABLES

Table 2.1.1.1	Buildings Surveyed	2-1
Table 2.2.1.1	Baseline Energy Consumption for ECO-1	2-2
Table 2.2.2.1	Baseline Energy Consumption for ECOs 2, 3, & 4	2-3
Table 2.3.1	ECOs Considered for this Project	2-3, 2-4
Table 2.3.1.1	Buildings Evaluated for ECO-1	2-5
Table 2.3.2.1	Buildings Evaluated for ECO-2	2-6
Table 2.3.3.1	Buildings Evaluated for ECO-3	2-6, 2-7
Table 2.3.4.1	Buildings Evaluated for ECO-4	2-7
Table 3.4.2.1	Lighting Maintenance and Replacement Costs	3-6
Table 3.4.2.2	FY94 HVAC Maintenance Costs by Building	3-6
Table 5.2.1	Energy Baseline for All ECOs	5-2
Table 5.3.1.1	Recommended Lighting Levels	5-4
Table 5.3.2.1	ECO-2A & 2B Investment Costs	5-6
Table 5.3.2.2	ECO-2 Modifications	5-7
Table 5.3.4.1	ECO-4 Modifications	5-9
Table 5.4.1	All ECOs from Highest to Lowest SIR	5-11, 5-12
Table 5.4.2	Recommended ECOs from Highest to Lowest SIR	5-13
Table 5.4.3	Non-Recommended ECOs from Highest to Lowest SIR	5-14
Table 5.4.4	Recommended ECOs Sorted by Building Number	5-15, 5-16
Table 5.4.5	Project Results by ECO	5-16
Table 6.1	Lighting Fixture Replacements and Installations	6-1

LIST OF FIGURES

Figure 1	Gas Distribution Plan	5-5A
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1 INTRODUCTION AND REPORT REVIEW FORMS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

This document has been prepared to provide a final report on the project. It also provides information required to identify projects for programming and preparation of necessary funding documentation. The projects are formed by grouping energy conservation opportunities (ECOs) for the buildings into packages which meet specific funding criteria.

Project Review Comments	Interim ☐ Project: LES of Hangar Facilities at Simmons Army Airfield Pre-Final ☐ Location: Fort Bragg, NC Final ☐ Year: P.N.	Reviewer: _____ Page: <u>1</u> of _____ Name: _____ Date: _____ Organizer: _____
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Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☐ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.

1 INTRODUCTION AND REPORT REVIEW FORMS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

1.1 SUMMARY RESULTS

This analysis involved 14 hangar buildings located at Simmons Army Airfield at Fort Bragg. The buildings range in age from 1950s construction to late 1980s construction. All are currently heated by oil-fired boilers serving unit heaters in high bay areas, and radiators or fan-coils in other areas. Few have centralized cooling systems; most utilize window units for cooling. Most hangars currently utilize mercury vapor or incandescent lighting.

Four specific energy conservation opportunities (ECOs) were analyzed for this report:

- ECO-1: Install High Efficiency Interior/Exterior Lighting Systems
- ECO-2: Install Natural Gas Boilers and Infrared Heaters
- ECO-3: Install Electric Infrared Heaters
- ECO-4: Renovate HVAC Systems

ECO-1 incorporates changing from T-12 fluorescent to T-8 fluorescent fixtures; replacing incandescents with compact fluorescents; replacing mercury vapors with metal halide or high pressure sodium; retrofitting incandescent exit sign lamps with LED lamps and installing skylights with automatic lighting controls in high bay areas.

The analyses for ECO-1 were performed on a building-by-building basis, and all but two (2) buildings resulted in a payback of less than 10 years and an SIR of greater than 1.25. Buildings 2936 and 3007 had an SIR of less than 1.25. These two buildings were then analyzed as high bay and non-high bay areas in an attempt to create individual lighting opportunities. This resulted in a payback for only the sky lighting portion of these buildings. All feasible lighting opportunities were then grouped together for one project. The total project for ECO-1 has an investment cost of \$680,783 with a payback of 4.05 years and an SIR of 2.12.

ECO-2 evaluates replacing oil-fired boilers with natural gas boilers and unit heaters in high bay areas with natural gas infrared heaters. The installation requires a four-mile extension of a natural gas main to the airfield. The ECO was analyzed in two ways:

1. In ECO-2A, North Carolina Natural Gas (NCNG) funds the gas line extension.
2. In ECO-2B, Fort Bragg pays for the gas line construction.

The only difference in the two is the up-front investment cost to the Government, and in either case the project qualifies for funding. However, since it is unlikely (at this time) that NCNG will provide funds for the project, ECO-2B is the one recommended for funding.

1 INTRODUCTION AND REPORT REVIEW FORMS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

ECO-3 is the installation of electric infrared heaters in high bay areas. For this installation, the existing electrical source to each building must be upgraded to accommodate the additional electrical load. In energy simulations, the sum of new electrical demand and energy charges is greater than the current cost of fuel oil heating. Thus, the ECO has a negative payback and savings-to-investment ratio (SIR) and cannot be recommended for further analysis.

ECO-4 is the renovation of existing HVAC systems to install more efficient systems. Where central systems already exist, they were replaced with more efficient variable air volume (VAV) systems. Where no central system exists, new VAV systems were simulated. None of the renovations qualified for funding, due to the relatively small areas within each building which require both heating and cooling, resulting in little attainable energy savings.

2 WORK ACCOMPLISHED TO DATE

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

The work which has been accomplished as of the date of this report is summarized as follows:

1. Field Surveys completed for 14 buildings
2. Baseline Building Energy Computer Models for 14 buildings
3. Evaluation of Energy Conservation Opportunities
4. Calculation and Reporting of Energy Conservation Opportunities
5. Preparation and completion of all Field Notes
6. Completion of Interim Report.
7. Interim Review Conference
8. Completion of Pre-Final Report

This section of the report outlines the details of the work accomplished primarily through the use of a database which contains the information obtained in the field and developed from calculations. The data is presented in tables to provide specific information about each segment of the work accomplished to date.

2.1 FIELD SURVEY

The field survey as required in *Section 2, Scope of Work* (refer to *Appendix A* of this document) has been completed.

Fourteen buildings were surveyed at the Airfield for lighting and HVAC system improvements. The Airfield buildings represent one functional building type. *Table 2.1.1.1* provides a listing of the surveyed buildings.

TABLE 2.1.1.1				
BUILDINGS SURVEYED				
BUILDING TYPE	BUILDING NUMBER	BUILDING AREA (FT ²)	HEATED AREA (FT ²)	COOLED AREA (FT ²)
AIRCRAFT HANGAR	2936	63,800	63,800	17,100
AIRCRAFT HANGAR	3007	55,700	55,700	9,800
AIRCRAFT HANGAR	3262	64,200	64,200	21,700
AIRCRAFT HANGAR	3354	33,865	33,650	11,130
AIRCRAFT HANGAR	3637	20,900	20,900	2,800
AIRCRAFT HANGAR	3642	35,015	34,800	9,120
AIRCRAFT HANGAR	3807	56,700	56,700	22,100
AIRCRAFT HANGAR	3954	35,185	35,185	13,900
AIRCRAFT HANGAR	3962	35,015	34,800	7,600
AIRCRAFT HANGAR	4137	21,200	21,200	5,100
AIRCRAFT HANGAR	4242	8,350	8,350	2,000
AIRCRAFT HANGAR	7397	65,100	65,100	19,000
AIRCRAFT HANGAR	8944	50,700	50,700	3,750
AIRCRAFT HANGAR	9647	57,500	57,500	14,800

2 WORK ACCOMPLISHED TO DATE

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

2.2 BUILDING ENERGY CONSUMPTION BASELINE

The building energy consumption baselines were established using computer calculation techniques as required by the Scope of Work. The calculation methods are discussed in detail under *Section 3.2, Calculations*. An energy baseline was calculated for each ECO for each building.

2.2.1 Lighting Systems

The baseline energy consumption for the lighting systems surveyed at Simmons Army Airfield were calculated using computerized techniques. The building baselines were calculated using Lotus 1-2-3 spreadsheets specifically designed for each energy conservation opportunity and include only lighting energy consumption. The baseline energy consumption for the lighting systems was used for calculating savings associated with ECO-1 only. *Table 2.2.1.1* shows the lighting energy consumption baseline for each building.

TABLE 2.2.1.1		
BASELINE ENERGY CONSUMPTION FOR ECO-1		
ECO NUMBER	BUILDING NUMBER	BASELINE ENERGY CONSUMPTION (MWH)
1	2936	339
1	3007	146
1	3262	706
1	3354	161
1	3637	398
1	3642	304
1	3807	298
1	3954	98
1	3962	268
1	4137	192
1	4242	59
1	7937	447
1	8944	348
1	9647	357

2.2.2 HVAC Systems

The baseline energy consumption for ECOs 2, 3, & 4 were modeled using the Department of Energy's Buildings Energy Performance Program, DOE 2. This building model considers all energy sources within a building and their impact upon each other. Each of the 14 buildings under consideration was modeled separately. The baseline computer model was input so that the model

2 WORK ACCOMPLISHED TO DATE

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

matched the conditions found in each building during the field survey to the extent possible. This baseline was used for calculating savings associated with ECOs 2, 3, and 4 only. The baseline energy consumption figures for these ECOs is shown in *Table 2.2.2.1*.

TABLE 2.2.2.1		
BASELINE ENERGY CONSUMPTION FOR ECOs 2, 3, & 4		
ECO NUMBER	BUILDING NUMBER	BASELINE ENERGY CONSUMPTION (MWH)
2, 3, 4	2936	2,917.2
2, 3, 4	3007	3,012.2
2, 3, 4	3262	4,090.1
2, 3, 4	3354	1,727.8
2, 3, 4	3637	1,320.0
2, 3, 4	3642	1,850.7
2, 3, 4	3807	3,027.8
2, 3, 4	3954	1,421.10
2, 3, 4	3962	1,820.3
2, 3, 4	4137	1,323.2
2, 3, 4	4242	833.5
2, 3, 4	7937	4,380.8
2, 3, 4	8944	3,730.2
2, 3, 4	9647	3,109.0

2.3 ENERGY CONSERVATION OPPORTUNITIES

The energy conservation opportunity calculations were performed using computerized techniques. Spreadsheets were developed on Lotus 1-2-3 for ECO-1. For ECOs 2, 3, and 4, DOE computer simulations were used to compare ECO energy usage to baseline energy usage. *Table 2.3.1* lists all the energy conservation opportunities by number with a description of each.

TABLE 2.3.1		
ECOs CONSIDERED FOR THIS PROJECT		
ECO NUMBER	ECO NAME	ECO DESCRIPTION
1	Install high efficiency interior/exterior lighting systems.	Lighting efficiency improvements include: T8 fluorescent lamps with electronic ballasts, compact fluorescents, LED exit signs, metal halide HID fixtures and conventional sky lights with automatic lighting control.
2	Install natural gas boilers and infrared heaters	New-natural-gas-fired heating boilers and natural gas infrared heaters for high bay areas.

2 WORK ACCOMPLISHED TO DATE

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

TABLE 2.3.1		
ECOs CONSIDERED FOR THIS PROJECT		
ECO NUMBER	ECO NAME	ECO DESCRIPTION
3	Install electric infrared heaters	Electric infrared heaters for high bay areas.
4	Renovate HVAC systems	HVAC system improvements include: Convert/install variable air volume air handlers; install central air handling units; install two-pipe fan coil system; install more efficient chillers.

2.3.1 ECO-1: Install High Efficiency Interior/Exterior Lighting Systems

This energy conservation opportunity was calculated using a Lotus 1-2-3 spreadsheet for each building. Manufacturers' information and field notes were used in formulating the calculations. The systems evaluated include fluorescent lighting, incandescent lighting, mercury vapor lighting, exit signs, and sky lights. The 14 hangars currently use T-12, 34-watt, four-foot lamps with magnetic ballasts. These areas were evaluated for a fixture retrofit to T-8 lamps and electronic ballasts. Existing one- and two-lamp fixtures were replaced with one- and two-lamp fixtures, respectively. Three- and four-lamp fixtures were replaced with two- and three-lamp fixtures, respectively, with reflectors.

Incandescent lamps 100-watts and less were replaced with compact fluorescents. Incandescents over 100-watts were replaced with two T-8, four-foot lamps. Every two incandescents were replaced with one two-lamp, T-8 fixture. Incandescents in the hangar spaces were replaced with metal halide fixtures on a lumen-for-lumen basis.

The exit signs at the Airfield buildings currently utilize incandescent lamps. In evaluating this ECO, these signs are to be equipped with a retrofit kit in which existing lamps are replaced with a light-emitting diode (LED) lamp.

Exterior lighting retrofits were considered only where high efficiency lighting was not currently in use. All hangars except one are already utilizing high pressure sodium fixtures, and all hangar exterior lighting is controlled by photocells. Thus, the calculations apply to only one facility which uses mercury vapor exterior lighting.

Sun-tracking sky lights were originally evaluated for installation in the high bay hangar spaces in order to utilize natural daylighting whenever possible. Due to concerns raised at the Interim Review meeting, conventional sky lights were substituted for the sun-tracking sky lights. Included in the evaluation of conventional sky lights were automatic lighting controls connected to a programmable

2 WORK ACCOMPLISHED TO DATE

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

time delayed photocell. Each skylight is approximately 15 square feet in size and installed every 600 feet. This will reduce the operating hours of the lighting system by 60% during daylight hours. An average of 12 hours per day of daylight was used for the calculations, as determined from the Local Climatological Data for Raleigh, North Carolina.

Table 2.3.1.1 is a list of the buildings assigned to ECO-1. Each has been individually evaluated.

TABLE 2.3.1.1		
BUILDINGS EVALUATED FOR ECO-1		
BUILDING NUMBER	CALCULATED (YES/NO)	JUSTIFICATION FOR NOT CALCULATING
2936	YES	ECO WAS CALCULATED
3007	YES	ECO WAS CALCULATED
3262	YES	ECO WAS CALCULATED
3354	YES	ECO WAS CALCULATED
3637	YES	ECO WAS CALCULATED
3642	YES	ECO WAS CALCULATED
3807	YES	ECO WAS CALCULATED
3954	YES	ECO WAS CALCULATED
3962	YES	ECO WAS CALCULATED
4137	YES	ECO WAS CALCULATED
4242	YES	ECO WAS CALCULATED
7937	YES	ECO WAS CALCULATED
8944	YES	ECO WAS CALCULATED
9647	YES	ECO WAS CALCULATED

2.3.2 ECO-2: Install Natural Gas Boilers and Infrared Heaters

This ECO was the evaluation of natural gas boilers to replace oil-fired heating boilers and natural-gas-fired infrared heaters to replace existing unit heaters in high bay areas of all 14 buildings. Buildings 3354, 3642, 3954, 3962, and 4137 utilize steam from central plant P-4041 for heating. The boilers in the central plant currently are equipped with dual-fuel burners, so no boiler replacement is necessary in P-4041. However, the other buildings under study have self-contained boiler systems which require replacing the boilers with new natural-gas-fired boilers. See Table 2.3.2.1 for a listing of buildings evaluated under ECO-2.

2 WORK ACCOMPLISHED TO DATE

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

TABLE 2.3.2.1		
BUILDINGS EVALUATED FOR ECO-2		
BUILDING NUMBER	CALCULATED (YES/NO)	JUSTIFICATION FOR NOT CALCULATING
2936	YES	ECO WAS CALCULATED
3007	YES	ECO WAS CALCULATED
3262	YES	ECO WAS CALCULATED
3354	YES	ECO WAS CALCULATED
3637	YES	ECO WAS CALCULATED
3642	YES	ECO WAS CALCULATED
3807	YES	ECO WAS CALCULATED
3954	YES	ECO WAS CALCULATED
3962	YES	ECO WAS CALCULATED
4137	YES	ECO WAS CALCULATED
4242	YES	ECO WAS CALCULATED
7937	YES	ECO WAS CALCULATED
8944	YES	ECO WAS CALCULATED
9647	YES	ECO WAS CALCULATED

2.3.3 ECO-3: Install Electric Infrared Heaters

ECO-3 was the evaluation of electric infrared heaters in the high bay areas of all 14 buildings. The installation involves upgrading the existing electrical service to each building to accommodate the additional capacity required by the heaters. This ECO DOES NOT involve switching the existing fuel-oil-fired boilers as was done in ECO-2. Table 2.3.3.1 lists the buildings evaluated for ECO-3.

TABLE 2.3.3.1		
BUILDINGS EVALUATED FOR ECO-3		
BUILDING NUMBER	CALCULATED (YES/NO)	JUSTIFICATION FOR NOT CALCULATING
2936	YES	ECO WAS CALCULATED
3007	YES	ECO WAS CALCULATED
3262	YES	ECO WAS CALCULATED
3354	YES	ECO WAS CALCULATED
3637	YES	ECO WAS CALCULATED
3642	YES	ECO WAS CALCULATED
3807	YES	ECO WAS CALCULATED
3954	YES	ECO WAS CALCULATED
3962	YES	ECO WAS CALCULATED

2 WORK ACCOMPLISHED TO DATE

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

TABLE 2.3.3.1		
BUILDINGS EVALUATED FOR ECO-3		
BUILDING NUMBER	CALCULATED (YES/NO)	JUSTIFICATION FOR NOT CALCULATING
4137	YES	ECO WAS CALCULATED
4242	YES	ECO WAS CALCULATED
7937	YES	ECO WAS CALCULATED
8944	YES	ECO WAS CALCULATED
9647	YES	ECO WAS CALCULATED

2.3.4 ECO-4: Renovate HVAC Systems

This ECO involved several different options. When centralized HVAC systems were less than five years old and/or performing adequately, no changes were proposed. Refer to *Table 2.3.4.1* for a listing of buildings for which ECO-4 was calculated. *Section 5.3.4* provides details of work accomplished under this ECO.

TABLE 2.3.4.1		
BUILDINGS EVALUATED FOR ECO-4		
BUILDING NUMBER	CALCULATED (YES/NO)	JUSTIFICATION FOR NOT CALCULATING
2936	YES	ECO WAS CALCULATED
3007	NO	HAS NEW HVAC SYSTEM
3262	YES	ECO WAS CALCULATED
3354	YES	ECO WAS CALCULATED
3637	YES	ECO WAS CALCULATED
3642	YES	ECO WAS CALCULATED
3807	NO	HAS NEW HVAC SYSTEM
3954	NO	HAS NEW HVAC SYSTEM
3962	YES	ECO WAS CALCULATED
4137	YES	ECO WAS CALCULATED
4242	YES	ECO WAS CALCULATED
7937	NO	HAS NEW HVAC SYSTEM
8944	NO	HAS NEW HVAC SYSTEM
9647	NO	HAS NEW HVAC SYSTEM

2 WORK ACCOMPLISHED TO DATE

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

2.4 *FIELD NOTES*

The field notes which were taken during the site survey are contained in a separately bound volume of the Interim Report previously distributed except for an update to the lighting survey forms.

2.4.1 *ECO-1: Install High Efficiency Interior/Exterior Lighting Systems*

The field notes for this ECO are arranged in ascending order by building number. The notes include information required for calculations such as existing lamp and fixture type, ballast volts and amps, and operation hours. In addition, the type of replacement fixture was added to the survey forms. These forms can be found in *Appendix E*.

3 ANALYSIS METHODS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

3.1 FIELD SURVEY

The field survey as performed by Systems Corp is designed to provide the data required to complete the Scope of Work for this project. It is also designed to provide residual benefits to the installation by providing an organized and readily available source of information which can be used in future years. The information is transmitted in the form of field notes made on standardized survey forms.

The survey forms were designed to allow notations of all data which could be utilized (not necessarily required) to calculate the energy savings gained by implementing a specific energy conservation opportunity. These forms contain data obtained from as-built drawings and confirmed in the field, as well as data obtained only in the field.

Thorough preparation for the building survey is required to ensure the data required to perform the technical analysis is obtained. The building surveys were performed in a manner which assured the best results. A simple listing of each step of the process best describes our approach to the surveys.

1. The list of ECOs included in the work scope were reviewed in detail.
2. Each ECO was given an identification number which is used consistently throughout this project.
3. An expanded description of each ECO was formulated to outline the possible methods for implementation of the ECO.
4. Survey forms were developed for each ECO to provide space to enter any data which might possibly be used in performing the engineering and economic analysis of the ECO.
5. A list of the types of as-built drawings required for the buildings was prepared based on the information required on the ECO survey forms.
6. A Systems Corp representative assisted during the survey in gathering the necessary as-built drawings.
7. Due to the age of drawings, it was determined that most required information would need to be gathered during the survey at the buildings.
8. The building surveys were then performed, confirming or revising data obtained from the drawings. Additional data was obtained as required.
9. Systems Corp survey teams met with the Post Energy Officer throughout the survey on an as-needed basis.
10. Observations regarding other possible ECOs or code violations were made and reported to the Post Energy Officer.

3 ANALYSIS METHODS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

3.2 CALCULATIONS

Energy calculations were performed using computerized techniques. Due to the large volume of calculations to be performed, standardized procedures were developed for the computer models. This assured consistent results and uniformity of quality in all of the calculations performed.

3.2.1 Baseline Energy Consumption

The following sections describe the method for calculating the baseline energy consumption for each of the ECOs.

3.2.1.1 Baseline Energy Consumption: ECO-1

The baseline energy consumption for this ECO was calculated using a Lotus 1-2-3 spreadsheet. This spreadsheet modeled the energy consumption of the existing lighting systems by utilizing the following:

1. Existing fixture and lamp type (i.e. fluorescent, mercury vapor, etc.)
2. Lamp wattage
3. Ballast wattage
4. Hours of use.

The above information was obtained during the field survey.

See *Section 6* for calculations of ECO-1.

3.2.1.2 Baseline Energy Consumption: ECOs 2, 3, and 4

The baseline energy consumption for these ECOs was calculated using the DOE 2 computer simulation model. The program simulates a building's total energy consumption and different systems' impacts on each other. Each building was modeled as closely as possible to the conditions found during the field survey. See *Sections 7, 8, and 9* for ECO calculations.

3.2.2 ECO Energy Consumption

The following sections describe how the energy consumption (or energy savings) for each of the four ECOs was calculated.

3 ANALYSIS METHODS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

3.2.2.1 ECO Energy Consumption: ECO-1

The energy consumption for this ECO was calculated in the same manner as the baseline for ECO-1 (see *Section 3.2.1.1*). New lamp wattages, number of lamps, and ballast wattages were substituted for the existing lighting systems. For a detailed description of replacement fixtures, please refer to *Section 5.3.1*.

3.2.2.2 ECO Energy Consumption: ECO-2

The energy consumption for this ECO was calculated by modifying the baseline DOE 2 input files for each building. The modifications model the installation of natural gas boilers and infrared heaters as proposed under this ECO.

3.2.2.3 ECO Energy Consumption: ECO-3

The energy consumption of this ECO was calculated by modifying the baseline DOE 2 input files for each building. The modifications model the installation of electric infrared heaters in high bay areas of each building.

3.2.2.4 ECO Energy Consumption: ECO-4

The energy consumption of this ECO was calculated by modifying the baseline DOE 2 input files for each building. The modifications model the HVAC renovations proposed for each building under this ECO.

3.3 COST ESTIMATES

The cost estimates for the ECOs were obtained using a variety of sources. This section explains how each part of the cost estimate was determined.

The initial cost for each ECO is the sum of the construction costs and the project costs. The construction cost includes all costs in materials, labor, and contractor's overhead and profit. The project costs include supervision, inspection and overhead (SIOH), as well as design costs.

3.3.1 Construction Costs

The construction costs for each ECO were estimated using MeansData for Windows Spreadsheets, Version 2.0a, a cost estimating software. Prices not available in the accompanying database were

3 ANALYSIS METHODS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

obtained using a combination of sources. These sources include the following:

Local supplier and vendors
Systems Corp Estimating Data

All pricing has been adjusted where applicable to represent the labor costs in the Fort Bragg labor market. The construction cost estimates have been prepared to include a reasonable level of detail for each ECO calculated.

3.3.2 Project Costs

The project cost for each ECO include the cost of supervision, inspection, and overhead required to complete the project. A value of 5.0% of the construction cost has been used for the SIOH. Also included in the project cost is the cost to design each ECO. The design cost has been included at a fixed value of 5.0% of construction cost. This approach assures consistent values have been used for the project costs, and ECOs can be combined into larger projects without adjusting these values.

3.4 ECO LIFE-CYCLE COSTS

The life-cycle cost analyses evaluate energy, investment, maintenance, and replacement costs over the lifetime of each ECO. Each of these components may or may not be significant factors in determining the life-cycle cost of the project. Each of these cost components have been evaluated for each ECO in order to determine their contribution, if any, to the life-cycle cost of the project.

The life-cycle costs were calculated using the computer program Life-Cycle Costing in Design (LCCID) as required by the Scope of Work.

3.4.1 Energy Costs

FY94 energy and consumption data for each fuel type under study were obtained from the installation and through the Defense Energy Information System (DEIS). Average energy costs per unit of electricity, natural gas and fuel oil were calculated.

The following costs were used in evaluating ECOs:

ELECTRICITY COST	=	\$ 0.03495/kWh(Energy only, not including demand)
ELECTRIC DEMAND COST	=	\$9.25/kW (Average Monthly demand)
FUEL OIL COST	=	\$5.62/MBtu
NATURAL GAS COST	=	\$3.94/MBtu

3 ANALYSIS METHODS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

3.4.2 Maintenance and Replacement Costs

The operational and maintenance (O&M) cost/savings are referred to as non-energy, annual recurring costs in the LCCID program. These values are sometimes distorted to produce the desired results for the project economic analysis. Therefore, we typically assume maintenance and operation activities will continue at the same rate as before the project. However, where there are readily identifiable differences, such as increased lamp life for fluorescent lamps as compared to incandescent lamps, they have been included. The estimated costs were obtained from the Means Facilities Costs Data, 1994. Other sources included local service companies and in-house data. These costs are shown on each life-cycle summary sheet.

The replacement costs (non-energy non-annual recurring cost) for each ECO has been evaluated in the same manner as non-energy annual recurring costs. Some examples of these types of cost items are as follows:

1. lamp replacements
2. ballast replacements

The cost data for these items was obtained from the same sources as mentioned above. Systems Corp's policy is to make conservative estimates regarding subjective cost components.

Table 3.4.2.1 shows the maintenance and replacements costs used in the analysis. FY94 maintenance costs obtained from Fort Bragg DPWE personnel for HVAC systems in each of the 14 buildings is shown in *Table 3.4.2.2*. These costs were used in the analysis of ECOs 2, 3, 4.

3 ANALYSIS METHODS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

TABLE 3.4.2.1		
LIGHTING MAINTENANCE & REPLACEMENT COSTS		
PRODUCT DESCRIPTION	PRODUCT LIFE (HRS)	MATERIAL & LABOR COSTS
INCANDESCENT < 100 WATTS	750	\$3.50
INCANDESCENT 100-300 WATTS	750	\$5.25
INCANDESCENT > 300 WATTS	1,000	\$26.00
4 FOOT FLUORESCENT TUBES	20,000	\$5.00
FLUORESCENT EXIT SIGNS	20,000	\$8.00
COMPACT FLUORESCENT	10,000	\$2.00
MERCURY VAPOR - 250 WATTS	12,000	\$50.00
MERCURY VAPOR - 400 WATTS	16,000	\$50.00
MERCURY VAPOR - 1,000 WATTS	24,000	\$70.00
METAL HALIDE - 250 WATTS	10,000	\$41.00
METAL HALIDE - 400 WATTS	20,000	\$47.00
HIGH PRESSURE SODIUM $\geq$ 150 WATTS	24,000	\$38.00

TABLE 3.4.2.2	
FY94 HVAC MAINTENANCE COSTS BY BUILDING	
BUILDING NUMBER	COST (\$)
2936	\$2,774
3007	\$538
3262	\$2,986
3354	\$5,389
3637	\$500
3642	\$1,243
3807	\$500
3954	\$3,281
3962	\$5,150
4137	\$1,739
4242	\$3,821
7937	\$2,354
8944	\$6,654
9647	\$1,432

4 *PLAN FOR REMAINING WORK*

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

The plan for the remaining work for this project includes the identification of the tasks remaining to be accomplished, assignment of staff and other resources to complete the tasks, and the development of a schedule to complete the work.

4.1 *REMAINING PHASES*

The remaining phases of work to be accomplished include the following:

1. Response to Prefinal Review Comments
2. Preparation of Final Report

The required tasks for each phase have been identified, resources and staff assigned, and a schedule prepared.

4.1.1 *Response to Prefinal Review Comments*

The Prefinal Review Comments will be reviewed at the Prefinal Review Conference. An action code will be assigned to each comment and a response will be prepared where required by the action code. Responses will be prepared by the project manager in consultation with project staff. Where clarifications are required, discussions will be held with the reviewer upon approval of Mr. Rob Callahan. A copy of the comments and responses will be included in the Final Report.

4.1.2 *Preparation of Final Report*

Any revisions or corrections resulting from comments made during the review of the Prefinal Report will be incorporated by page-for-page replacement or page addition to the Prefinal Report. A separately bound Executive Summary will be prepared and distributed to the appropriate personnel.

4.2 *TASK LIST*

1. Prefinal Review Conference Presentation
2. Prefinal Review Conference
3. Prepare responses to the Prefinal Review Comments
4. Perform any necessary corrections
5. Prepare Final Report

4 PLAN FOR REMAINING WORK

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

4.3 SCHEDULE FOR THE REMAINING WORK

- | | |
|----------------------------|----------------|
| 1. Prefinal Review Meeting | March 08, 1995 |
| 2. Final Submittal | March 24, 1995 |

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

This section of the report includes a narrative summary of the work accomplished to date. The project is divided into three major tasks: the field survey, the energy baseline, and the energy conservation opportunities. We have described the performance of these tasks in the following three sections. The last section is an outline of our recommendations and suggestions for implementing the ECOs and combining them into projects.

5.1 FIELD SURVEY

The field survey was performed in two parts. The lighting survey was conducted September 20-23, 1994, while the remaining field data was gathered October 24-28, 1994. All available drawings and data were gathered at these times. Interviews were conducted throughout the week during each survey.

During the interviews, the general results of the field survey were discussed. Each ECO was discussed along with preliminary suggestions about the expected payback of each project. The minutes of these meetings are included in *Appendix B* of this report.

The survey was performed by three survey teams, each with two engineers. The survey was performed between the hours of 7:00 a.m. and 5:00 p.m. with the exception of surveying exterior lighting which was accomplished during non-daylight night hours.

A high level of cooperation and support by DPWE, maintenance personnel and building occupants contributed substantially to the success of the survey.

5.2 ENERGY BASELINE

After completing the field survey, the next task was to establish the baseline energy consumption for each building. The approach taken was to determine the baseline energy consumption for the system analyzed within each building. In ECO-1 baseline calculations, only the lighting energy for a particular system was calculated so that each ECO would stand alone if necessary. For ECOs 2, 3, and 4, each building's baseline was modeled using the DOE 2 Energy Modeling Program so that the baseline calculations include all energy systems within each building.

The baselines were determined using data from many sources. These sources include:

1. Field survey notes
2. As-built drawings
3. Past experience of Systems Corp engineers

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

4. Manufacturers' catalog data
5. Manufacturers' performance data
6. Past years utility consumption data provided by Mr. Sam Musulin, Fort Bragg Energy Coordinator.

Before preparing the energy baseline, each ECO assigned to a building was reviewed with respect to the information now available. A decision was then made on the applicability of each ECO to the particular building. If the ECO was not applicable, the reason for that determination is documented. This procedure was followed for every building and every ECO. These justifications are listed in the tables included in *Section 2.3*.

After completing the energy baseline, the results were reviewed for technical accuracy. When problems were found, the calculations were revised.

The baseline energy consumed by each building is given in *Tables 2.2.1.1* and *2.2.2.1*. The baseline energy consumption totals for each ECO is given in *Table 5.2.1*.

TABLE 5.2.1		
ENERGY BASELINE FOR ALL ECOs		
ECO NUMBER	ECO NAME	BASELINE ENERGY CONSUMPTION (MWH)
1	LIGHTING SYSTEMS	4,121
2	NATURAL GAS BOILERS & INFRARED HEATERS	34,564
3	ELECTRIC INFRARED HEATERS	34,564
4	HVAC SYSTEMS	34,564

5.3 ENERGY CONSERVATION OPPORTUNITIES

The energy consumption for each of the energy conservation opportunities were prepared after the successful run of the baseline calculations. Calculation of the ECOs requires preparing a conceptual design which would allow implementation of the ECO. It is important to note that an ECO may be implemented in several ways. The designer must carefully consider the options to ensure the chosen design is the most likely to result in a savings that can justify the investment. After completing the conceptual design, the energy results were calculated by computer spreadsheets for ECO-1. For ECOs 2, 3, and 4, energy savings were modeled by modifying the baseline DOE 2 input files to simulate the implementation of each of the ECOs. The calculations were then reviewed for accuracy and technical feasibility.

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

After completing the energy calculations for each ECO, the cost estimates and economic analyses were prepared. A standardized bill of materials has been prepared for each building within each ECO. Material sizes, quantities, and prices were estimated to represent specific conditions of the ECO. Annual and non-annual recurring costs are an important part of the life-cycle cost for a given project. Each ECO is evaluated individually to determine the correct difference in these costs between the current condition and the future condition.

The following is a description of the energy-efficient replacement products used in each ECO.

5.3.1 ECO-1: Install High Efficiency Interior/Exterior Lighting Systems

Many options are available in lighting efficiency improvements. The goal of this ECO is to increase the efficiency of the interior and exterior lighting while still being cost effective.

The following is a list and description of the options implemented. All options are not evaluated in all buildings due to applicability.

1. Two-Foot, Four-Foot, and Eight-Foot Fluorescent Fixtures: Existing T-12 fixtures were replaced one-for-one with T-8 lamps and electronic ballasts. Reflectors were used in some fixtures to reduce the required number of lamps. Please refer to *Section 5.0* for a detailed description of reflector use. Reflectors were only used in four-foot fixtures.
2. Incandescent Lighting: Incandescents with wattages less than 100 watts were replaced with compact fluorescents. Incandescents in office areas with wattages greater than 100 watts were replaced with a two-lamp, four-foot, T-8 fixture. Incandescents in high bay hangar areas were replaced with metal halide fixtures.
3. Exit Signs: Existing incandescent exit lamps were replaced with LED lamps. This is accomplished with a retrofit kit that requires minor wiring revisions within the existing fixture. A two-watt, LED lamp then replaces the incandescent lamps within each existing sign.
4. Mercury Vapor Fixtures: Existing mercury vapor fixtures were replaced with metal halide or high pressure sodium fixtures. Metal halide fixtures were used inside all hangar facilities. Exterior mercury vapor fixtures were replaced with high pressure sodium fixtures. This ECO incorporates a one-for-one fixture changeout with no decrease in lumen levels.
5. Conventional Sky Lights: Sky lights were evaluated to incorporate daylighting into the hangar high bay areas. Included in the evaluation were automatic lighting controls

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

connected to a time delayed photocell. The photocell is programmable. A sky light is approximately 15 square feet in size and installed every 600 square feet. This will reduce the operating hours of the lighting system by 60% during daylight hours.

In Option 1 above, the decision to use reflectors and to delamp was based on light level readings taken during the field survey. Most areas at the Airfield had average or higher lighting levels. In these areas, reflectors were used along with a reduction in the number of lamps. *Table 5.3.1.1* lists lighting levels for various areas as recommended by the Illumination Engineering Society of North America (IES). Refer to the attached volume of field notes for actual lighting levels within each facility surveyed.

The sky light installation was evaluated under the assumption that all interior mercury vapor fixtures were already upgraded to metal halide fixtures as described in *Number 4* above. Where necessary, the labor and material needed to relocate light switches and shut-off panels to a more visible location were included in the cost estimate of the lighting upgrade.

NOTE: Sun-tracking sky lights were evaluated for daylighting in the high bay hangar areas. A sky light is installed every 600 square feet and reduces the required operating hours of the lighting systems by 90% during daylight hours. Included in the installation are digital controls for automatically shutting off lights when natural lighting reaches a specified level. These were removed from the project evaluation at the Prefinal stage due to concerns by the installation.

TABLE 5.3.1.1	
RECOMMENDED LIGHTING LEVELS*	
AREA/ACTIVITY	RANGE OF ILLUMINANCE, FOOTCANDLES
CONFERENCE ROOMS	20-30-50
INDUSTRIAL GROUPS	
AIRCRAFT MAINTENANCE	50-75
ELECTRONIC SHOP/MAINTENANCE	50-75
GARAGES - REPAIR SERVICE	50-75
MATERIAL HANDLING	20-30-50
STAIRWELLS, CORRIDORS	5 - 7.5 - 10
TOILETS & WASHROOMS	10-15-20

* From "Illumination Engineering Society of North America (IES) Lighting Handbook," 1987 Application Volume, supplemented by Department of Army publication, "Architect-Engineers Instruction Manual."

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

5.3.2 ECO-2: *Install Natural Gas Boilers and Infrared Heaters*

This ECO involves installing new natural gas boilers to replace oil-fired boilers in nine buildings. The other five buildings are served by boilers located in central plant P-4041, which already are equipped with dual-fuel burners capable of firing on natural gas. The ECO also incorporates the use of natural-gas-fired infrared heaters in the high bay areas of all 14 hangars to replace existing unit heaters. In the calculation of energy savings, the oil-fired boilers were modeled with an efficiency of 77% and the new natural gas boilers were modeled as 83% efficient. The infrared heaters' thermostat set-point was assumed to be 55°F as recommended by manufacturers.

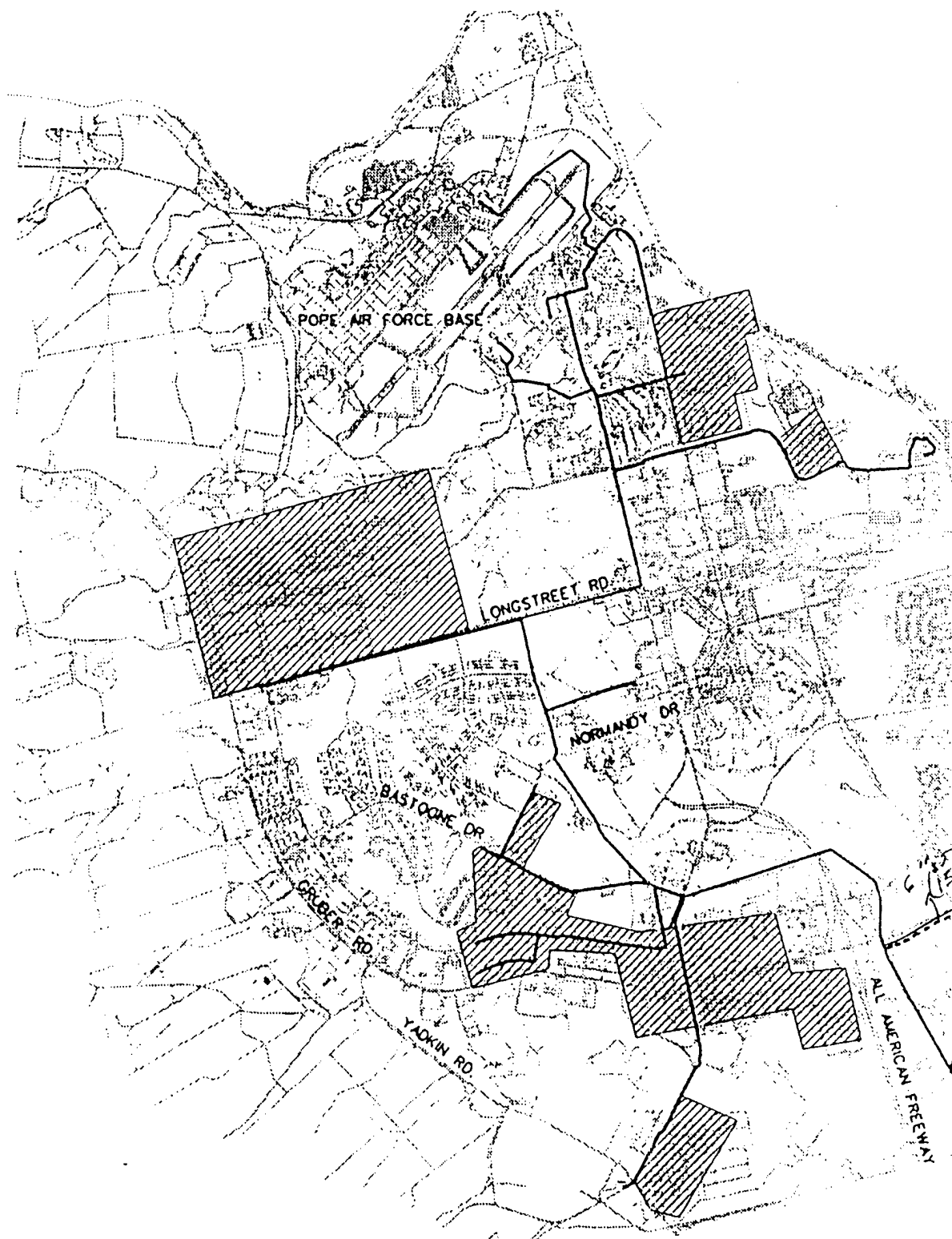
As required by the Scope of Work, this ECO is analyzed in two ways: In the first one, ECO-2A, the cost of providing natural gas lines to the Simmons Airfield area is borne by North Carolina Natural Gas (NCNG), the gas supplier to the Fort. In the second scenario, ECO-2B, the cost of running the four miles of piping is borne by the Government. In discussions with Jim Haywood of the Huntsville District Corps of Engineers (the party responsible for negotiating with NCNG), indications were that NCNG was unwilling to bear the expense of extending the lines. For the life-cycle cost analysis with the Government extending the gas lines, the total cost of the extension was divided equally among the 14 buildings and added to the cost estimate for each. *Figure 1* is a map showing the current and proposed gas distribution system for ECO-2. *Table 5.3.2.1* shows the costs of the two options, by building. Maintenance costs for existing conditions were obtained from DPWE on a building-by-building basis. Maintenance costs for the new boiler and infrared heaters were assumed to be \$500 per year per building. *Table 5.3.2.2* shows the modifications proposed under ECO-2. This ECO stands apart from any modifications made under ECOs 1, 3, and 4.

5.3.3 ECO-3 *Install Electric Infrared Heaters*

ECO-3 is similar to ECO-2 except that electric infrared heaters are used instead of natural gas for the high bay areas. No boilers are changed out in this ECO, so fuel oil boilers remain as the heat sources for areas other than high bays. The existing electrical capacity must be increased to accommodate the electric infrared heaters and this is reflected in the cost estimate for each building. This ECO stands apart from any modifications made under ECOs 1, 2, and 4.

5.3.4 ECO-4: *HVAC Renovations*

This ECO encompassed a number of different modifications to HVAC systems. The evaluation applies only to areas which are both heated and cooled within each building.



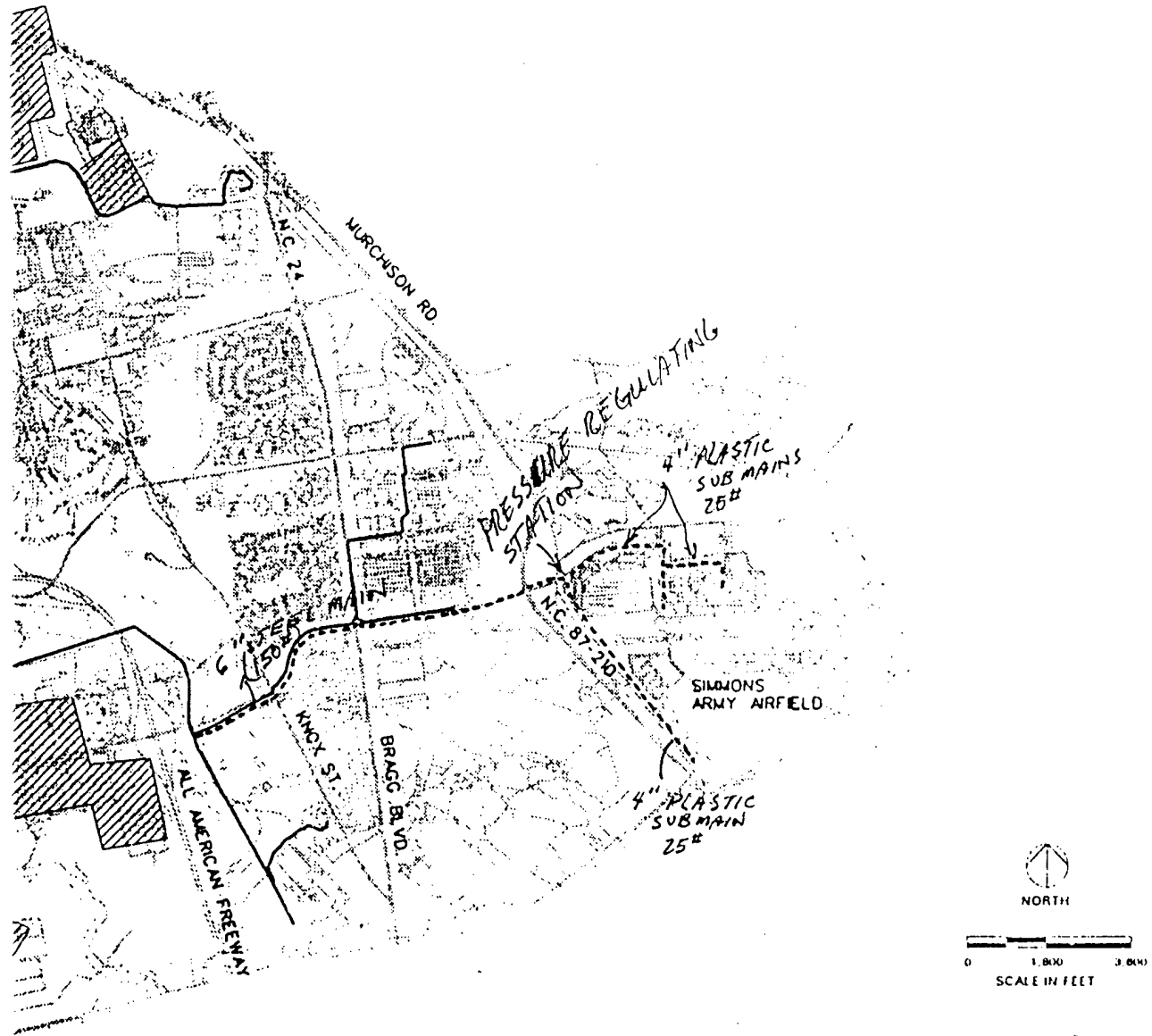
①

LEGEND

— MAIN GAS LINE

 GAS SERVICE AREA

--- PROPOSED
ROUTING SIMMONS AAF
GAS DISTRIBUTION MAINS



0 1,000 3,000
SCALE IN FEET

Figure 1
GAS
DISTRIBUTION PLAN

2

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

TABLE 5.3.2.1

ECO - 2A AND 2B INVESTMENT COSTS

BUILDING NUMBER	ECO-2A INVESTMENT COST WITH NCNG EXTENDING GAS LINE	ECO-2B INVESTMENT COST WITH GOVERNMENT EXTENDING GAS LINE
2936	\$186,838	\$221,085
3007	\$171,792	\$206,039
3262	\$145,961	\$180,208
3354	\$79,087	\$113,336
3637	\$82,716	\$116,965
3642	\$89,267	\$123,514
3807	\$171,766	\$206,013
3954	\$79,087	\$113,336
3962	\$89,267	\$123,514
4137	\$62,506	\$96,755
4242	\$48,326	\$82,573
7937	\$192,072	\$226,319
8944	\$190,425	\$224,672
9647	\$170,718	\$204,967
TOTAL	\$1,759,828	\$2,239,296

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

TABLE 5.3.2.2		
ECO - 2 MODIFICATIONS		
BUILDING	EXISTING HEAT SOURCE	ECO-2 MODIFICATIONS
2936	Oil-fired HW boiler in building	Replace boiler with new natural gas-fired boiler; replace unit heaters with natural gas infrared heaters in high bay areas.
3007	Oil-fired HW boiler in building	Replace boiler with new natural gas-fired boiler; replace unit heaters with natural gas infrared heaters in high bay areas.
3262	Oil-fired HW boiler in building	Replace boiler with new natural gas-fired boiler; replace unit heaters with natural gas infrared heaters in high bay areas.
3354	Steam from central plant	Utilize natural gas in existing central plant boilers; replace unit heaters with natural gas infrared heaters in high bay areas.
3637	Oil-fired HW boiler in building	Replace boiler with new natural gas-fired boiler; replace unit heaters with natural gas infrared heaters in high bay areas.
3642	Steam from central plant	Utilize natural gas in existing central plant boilers; replace unit heaters with natural gas infrared heaters in high bay areas.
3807	Oil-fired HW boiler in building	Replace boiler with new natural gas-fired boiler; replace unit heaters with natural gas infrared heaters in high bay areas.
3954	Steam from central plant	Utilize natural gas in existing central plant boilers; replace unit heaters with natural gas infrared heaters in high bay areas.
3962	Steam from central plant	Utilize natural gas in existing central plant boilers; replace unit heaters with natural gas infrared heaters in high bay areas.
4137	Steam from central plant	Utilize natural gas in existing central plant boilers; replace unit heaters with natural gas infrared heaters in high bay areas.
4242	Oil-fired HW boiler in building	Replace boiler with new natural gas-fired boiler; replace unit heaters with natural gas infrared heaters in high bay areas.
7937	Oil-fired HW boiler in building	Replace boiler with new natural gas-fired boiler; replace unit heaters with natural gas infrared heaters in high bay areas.
8944	Oil-fired HW boiler in building	Replace boiler with new natural gas-fired boiler; replace unit heaters with natural gas infrared heaters in high bay areas.
9647	Oil-fired HW boiler in building	Replace boiler with new Natural gas-fired boiler; replace unit heaters with natural gas infrared heaters in high bay areas.

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

Where existing HVAC systems were chilled water, the renovations incorporate chilled water replacement components. Similarly, if the existing system is a direct-expansion (DX) system, the replacement incorporates DX units. The philosophy behind this approach was to minimize first costs since the amount of cooling energy used in these areas is relatively small and the total amount of attainable energy savings low.

Table 5.3.4.1 shows existing building HVAC systems and the modifications proposed under ECO-4. This ECO stands alone from modifications made under ECOs 1, 2, and 3.

NOT USED
TABLE 5.3.4.1
FEE

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

TABLE 5.3.4.1		
ECO - 4 MODIFICATIONS		
BUILDING	EXISTING HVAC SYSTEM	MODIFICATIONS PROPOSED UNDER ECO-4
2936	5 constant volume air handlers; air cooled chiller, oil HW boiler	Replace air handlers with new VAV air handlers. Replace chiller with more efficient chiller.
3007	2 pipe fan coil units; air cooled chiller, oil HW boiler	None. Existing centralized systems are new and in good work order.
3262	2 Multizone DX AHUs, 2 single zone DX AHUs, window air conditioners, oil HW boiler	Replace existing air handlers with VAV air handlers. Install new centralized VAV system to replace window units.
3354	Window air conditioners, steam radiators	Install new 2 pipe fan coil units, air-cooled chiller and steam-to-HW heat exchanger to replace window units and radiators.
3637	Window air conditioners, steam radiators	Packaged DX variable air volume air handler with hot water heating coil to replace window units and radiators.
3642	Window air conditioners, steam radiators	Install new 2 pipe fan coil units, air-cooled chiller and steam-to-HW heat exchanger to replace window units and radiators.
3807	1 DX Multizone, 2 single zone DX air handlers	None. Existing centralized systems are new and in good working order.
3954	2 pipe fan coils, air cooled chiller and steam-to-HW heat exchanger	None. Existing centralized systems are new and in good working order.
3962	Window air conditioners, steam radiators	Install new 2 pipe fan coil units, air-cooled chiller and steam-to-HW heat exchanger to replace window units and radiators.
4137	Window air conditioners, steam radiators	Packaged DX variable air volume air handler with hot water heating coil to replace window units and radiators.
4242	Window air conditioners, hot water Radiators	Packaged DX Variable air volume air handler with HW heating coil to replace window units and radiators.
7937	3 Multizone air handlers; air cooled chiller	None. Existing centralized systems Are new and in good working order.
8944	4 constant volume DX units	None. Existing centralized systems Are new and in good working order.
9647	1 Multizone AHU and 2 constant volume air handlers; air cooled chiller	None. Existing centralized systems are new and in good working order.

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

5.4 RECOMMENDED PROJECTS AND ORGANIZATION

A considerable amount of data has been generated as a result of this study, to date. There is a wide variety of ways to present the data. Systems Corp has presented the data in five tables to provide the installation with different viewpoints. The first table (*Table 5.4.1*) simply lists all of the ECOs in order from highest to lowest savings-to-investment ratio (SIR), in accordance with the Scope of Work. In addition, four other listings have been presented which should give the installation a clearer choice of project groupings.

The second listing is *Table 5.4.2*. Only those ECOs recommended for consideration are listed. Projects can be recommended only if the SIR is greater than 1.25 and the simple payback is ten years or less.

The third listing is *Table 5.4.3*. Only those ECOs not recommended for implementation are listed. If the simple payback is greater than ten years or the SIR is less than 1.25, the ECO is not recommended.

The fourth listing is *Table 5.4.4*, which lists the recommended ECOs by building. This presentation indicates the work required in each building if all ECOs are implemented. The listing also totals the investment cost and the first year savings. We have purposely provided only relevant information in these tables, omitting other data which is available in many locations throughout this report.

The fifth listing is *Table 5.4.5*, which presents the total SIR and simple payback if all ECOs evaluated are implemented. A grand total SIR and simple payback was computed totaling all buildings and ECOs.

ECOs 2A and 2B are mutually exclusive. At this time, negotiations with NCNG to fund the gas line extension are not promising; therefore ECO 2B is the option recommended for funding. At the request of Fort Bragg personnel who will continue to negotiate with NCNG, *Tables 5.4.2* and *5.4.4* show ECO 2A as an alternative.

ECO-3 and -4 are clearly not recommended due to the extremely long paybacks and low SIRs.

The logical grouping for projects is to combine all the recommended lighting projects (ECO-1) into one project and the natural gas improvements (ECO-2B) into another project grouping. The necessary information for funding documentation of these projects is found in Appendix C.

TABLE 5.4.1

ALL ECOs FROM HIGHEST TO LOWEST SIR

ECO NUMBER	BUILDING NUMBER	TOTAL INVESTMENT	1st YEAR SAVINGS	SIMPLE PAYBACK	SIR	AIRR
2A	8944	\$190,425	\$46,633	4.08	4.39	10.91%
2A	4242	\$48,326	\$12,100	3.99	4.34	10.85%
2A	4137	\$62,506	\$14,655	4.27	4.22	10.69%
2A	3354	\$79,087	\$18,457	4.29	4.15	10.59%
2A	3262	\$145,961	\$31,726	4.60	3.95	10.32%
2A	7937	\$192,072	\$40,966	4.69	3.90	10.26%
2A	3962	\$89,267	\$19,664	4.54	3.88	10.23%
2B	8944	\$224,672	\$46,633	4.82	3.72	10.00%
1	3962	\$52,595	\$22,028	2.39	3.60	17.19%
2A	3954	\$79,087	\$15,358	5.15	3.45	9.58%
1	3637	\$41,771	\$16,545	2.52	3.43	16.62%
2B	7937	\$226,319	\$40,966	5.52	3.31	9.36%
2A	3642	\$89,267	\$15,654	5.70	3.21	9.19%
2B	3262	\$180,208	\$31,726	5.68	3.20	9.17%
1	3642	\$66,699	\$24,039	2.77	3.10	15.43%
2A	9647	\$170,718	\$28,526	5.98	3.07	8.93%
2A	3637	\$82,716	\$13,375	6.18	2.96	8.74%
2A	3007	\$171,792	\$27,540	6.24	2.96	8.74%
2A	3807	\$171,766	\$27,484	6.25	2.95	8.73%
2B	3354	\$113,336	\$18,457	6.14	2.89	8.62%
2B	3962	\$123,514	\$19,664	6.28	2.81	8.45%
2A	2936	\$186,838	\$28,937	6.46	2.80	8.45%
2B	4137	\$96,755	\$14,655	6.60	2.73	8.30%
2B	9647	\$204,967	\$28,526	7.19	2.55	7.94%
2B	4242	\$82,573	\$12,100	6.82	2.54	7.92%
1	4137	\$41,016	\$12,098	3.39	2.54	13.17%
2B	3007	\$206,039	\$27,540	7.48	2.47	7.76%
2B	3807	\$206,013	\$27,484	7.50	2.43	7.75%
1	3262	\$94,048	\$26,347	3.57	2.42	12.64%
2B	3954	\$113,336	\$15,358	7.38	2.41	7.62%
2B	2936	\$221,085	\$28,937	7.64	2.37	7.54%
2B	3642	\$123,514	\$15,654	7.89	2.32	7.43%
1	4242	\$21,694	\$5,340	4.06	2.11	11.09%
2B	3637	\$116,965	\$13,375	8.75	2.09	6.87%
1.1	2936 High Bay	\$27,647	\$5,626	4.91	1.75	9.06%
4	3962	\$104,879	\$10,295	10.19	1.71	5.80%
1	3354	\$42,429	\$8,043	5.28	1.63	8.26%

TABLE 5.4.1

ALL ECOs FROM HIGHEST TO LOWEST SIR

ECO NUMBER	BUILDING NUMBER	TOTAL INVESTMENT	1st YEAR SAVINGS	SIMPLE PAYBACK	SIR	AIRR
1	7937	\$62,380	\$11,606	5.37	1.60	8.09%
3	4242	\$64,550	\$3,767	17.14	1.48	
1.1	3007 High Bay	\$29,473	\$5,031	5.86	1.47	7.12%
1	8944	\$51,337	\$8,695	5.90	1.46	7.07%
1	3954	\$32,165	\$4,877	6.59	1.30	5.87%
1	3807	\$58,764	\$8,823	6.66	1.29	5.80%
1	9647	\$58,764	\$8,823	6.66	1.29	5.80%
1	2936	\$104,436	\$14,844	7.04	1.22	5.19%
1	3007	\$58,091	\$7,526	7.72	1.11	4.21%
1.2	2636 Non-high Bay	\$76,789	\$9,218	8.33	1.03	3.41%
4	4242	\$16,232	\$845	19.21	0.91	
4	3262	\$254,620	\$12,435	20.48	0.89	2.42%
4	3354	\$104,879	\$6,297	16.66	0.85	
1.2	3007 Non-high Bay	\$28,618	\$2,495	11.47	0.75	0.18%
4	2936	\$123,005	\$5,982	20.56	0.73	
3	8944	\$211,132	(\$5,186)	-40.71	0.55	
4	4137	\$84,677	\$2,319	36.52	0.51	
4	3637	\$84,677	\$994	85.22	0.28	-3.41%
4	3642	\$104,879	\$1,930	54.34	0.23	
3	3637	\$100,729	(\$6,429)	-15.67	-0.34	
3	7937	\$217,710	(\$17,343)	-12.55	-0.35	
3	4137	\$100,729	(\$6,691)	-15.05	-0.42	
3	3954	\$116,142	(\$8,638)	-13.45	-0.57	
3	3354	\$116,142	(\$8,446)	-13.75	-0.59	
3	3007	\$236,236	(\$19,518)	-12.10	-0.65	
3	3807	\$236,236	(\$19,922)	-11.86	-0.68	
3	9647	\$236,236	(\$20,571)	-11.48	-0.74	
3	3962	\$158,431	(\$12,453)	-12.72	-0.75	
3	3642	\$158,431	(\$16,199)	9.78	-1.07	
3	2936	\$245,426	(\$29,379)	-8.35	-1.21	
3	3262	\$181,143	(\$30,288)	-5.98	-1.73	

TABLE 5.4.2

RECOMMENDED ECOs FROM HIGHEST TO LOWEST SIR

ECO NUMBER	BUILDING NUMBER	TOTAL INVESTMENT	1st YEAR SAVINGS	SIMPLE PAYBACK	SIR	AIRR
2A	8944	\$190,425	\$46,633	4.08	4.39	10.91%
2A	4242	\$48,326	\$12,100	3.99	4.34	10.85%
2A	4137	\$62,505	\$14,655	4.27	4.22	10.69%
2A	3354	\$79,087	\$18,457	4.29	4.15	10.59%
2A	3262	\$145,961	\$31,726	4.60	3.95	10.32%
2A	7937	\$192,072	\$40,966	4.69	3.90	10.26%
2A	3962	\$89,267	\$19,664	4.54	3.88	10.23%
2B	8944	\$224,672	\$46,633	4.82	3.72	10.00%
1	3962	\$52,595	\$22,028	2.39	3.60	17.19%
2A	3954	\$79,087	\$15,358	5.15	3.45	9.58%
1	3637	\$41,771	\$16,545	2.52	3.43	16.62%
2B	7937	\$226,319	\$40,966	5.52	3.31	9.36%
2A	3642	\$89,267	\$15,654	5.70	3.21	9.19%
2B	3262	\$180,208	\$31,726	5.68	3.20	9.17%
1	3642	\$66,699	\$24,039	2.77	3.10	15.43%
2A	9647	\$170,718	\$28,526	5.98	3.07	8.93%
2A	3007	\$171,792	\$27,540	6.24	2.96	8.74%
2A	3637	\$82,716	\$13,375	6.18	2.96	8.74%
2A	3807	\$171,766	\$27,484	6.25	2.95	8.73%
2B	3354	\$113,336	\$18,457	6.14	2.89	8.62%
2B	3962	\$123,514	\$19,665	6.28	2.81	8.45%
2A	2936	\$186,838	\$28,937	6.46	2.80	8.45%
2B	4137	\$96,755	\$14,655	6.60	2.73	8.30%
2B	9647	\$204,967	\$28,526	7.19	2.55	7.94%
1	4137	\$41,016	\$12,098	3.39	2.54	13.17%
2B	4242	\$82,573	\$12,100	6.82	2.54	7.92%
2B	3007	\$206,039	\$27,540	7.48	2.47	7.76%
2B	3807	\$206,013	\$27,484	7.50	2.43	7.75%
1	3262	\$94,048	\$26,347	3.57	2.42	12.64%
2B	3954	\$113,336	\$15,358	7.38	2.41	7.62%
2B	2936	\$221,085	\$28,937	7.64	2.37	7.54%
2B	3642	\$123,514	\$15,654	7.89	2.32	7.43%
1	4242	\$21,694	\$5,340	4.06	2.11	11.09%
2B	3637	\$116,965	\$13,375	8.75	2.09	6.87%
1.1	2936 High Bay	\$27,647	\$5,626	4.94	1.75	9.06%
1.1	3007 High Bay	\$29,473	\$5,031	5.86	1.47	7.12%

2936, 3007, 3807, 3954, 3962, 4137, 4242, 7937, 8944, 9647

TABLE 5.4.3

NON-RECOMMENDED ECOs FROM HIGHEST TO LOWEST SIR

ECO NUMBER	BUILDING NUMBER	TOTAL INVESTMENT	1st YEAR SAVINGS	SIMPLE PAYBACK	SIR	AIRR
4	3962	\$104,879	\$10,295	10.19	1.71	5.80%
3	4242	\$64,550	\$3,767	17.14	1.48	
1.2	2936 High Bay	\$76,789	\$9,218	8.33	1.03	3.41%
4	4242	\$16,232	\$845	19.21	0.91	
4	3262	\$254,620	\$12,435	20.48	0.89	2.42%
4	3354	\$104,879	\$6,297	16.66	0.85	
1.2	3007 High Bay	\$28,618	\$2,495	11.47	0.75	0.18%
4	2936	\$123,005	\$5,982	20.56	0.73	
3	8944	\$211,132	(\$5,186)	-40.71	0.55	
4	4137	\$84,677	\$2,319	36.52	0.51	
4	3637	\$84,677	\$994	85.22	0.28	-3.41%
4	3642	\$104,879	\$1,930	54.34	0.23	
3	3637	\$100,729	(\$6,429)	-15.67	-0.34	
3	7937	\$217,710	(\$17,343)	-12.55	-0.35	
3	4137	\$100,729	(\$6,691)	-15.05	-0.42	
3	3954	\$116,142	(\$8,638)	-13.45	-0.57	
3	3354	\$116,142	(\$8,446)	-13.75	-0.59	
3	3007	\$236,236	(\$19,518)	-12.10	-0.65	
3	3807	\$236,236	(\$19,922)	-11.86	-0.68	
3	9647	\$236,236	\$(20,571)	-11.86	-0.74	
3	3962	\$158,431	(\$12,453)	-12.72	-0.75	
3	3642	\$158,431	(\$16,199)	-9.78	-1.07	
3	2936	\$245,426	(\$29,379)	-8.35	-1.21	
3	3262	\$181,143	(\$30,288)	-5.98	-1.73	

TABLE 5.4.4

RECOMMENDED ECOs SORTED BY BUILDING NUMBER

ECO NUMBER	BUILDING NUMBER	TOTAL INVESTMENT	1st YEAR SAVINGS	SIMPLE PAYBACK	SIR	AIRR
1.1	2936 High Bay	\$27,647	\$5,626	4.91	1.75	9.06%
2A	2936	\$186,838	\$28,937	6.46	2.80	8.45%
2B	2936	\$221,085	\$28,937	7.64	2.37	7.54%
1.1	3007 High Bay	\$29,473	\$5,031	5.86	1.47	7.12%
2A	3007	\$171,792	\$27,540	6.24	2.96	8.74%
2B	3007	\$206,039	\$27,540	7.48	2.47	7.76%
2B	3262	\$180,208	\$31,726	5.68	3.20	9.17%
2A	3262	\$145,961	\$31,726	4.60	3.95	10.32%
1	3262	\$94,048	\$26,347	3.57	2.42	12.64%
1	3354	\$42,429	\$8,043	5.28	1.63	8.26%
2A	3354	\$79,087	\$18,457	4.29	4.15	10.59%
2B	3354	\$113,336	\$18,457	6.14	2.89	8.62%
2A	3637	\$82,716	\$13,375	6.18	2.96	8.74%
1	3637	\$41,771	\$16,545	2.52	3.43	16.62%
2B	3637	\$116,965	\$13,375	8.75	2.09	6.87%
2B	3642	\$123,514	\$15,654	7.89	2.32	7.43%
1	3642	\$66,699	\$24,039	2.77	3.10	15.43%
2A	3642	\$89,267	\$15,654	5.70	3.21	9.19%
2B	3807	\$206,013	\$27,484	7.50	2.43	7.75%
1	3807	\$58,764	\$8,823	6.66	1.29	5.80%
2A	3807	\$171,766	\$27,484	6.25	2.95	8.73%
2B	3954	\$113,336	\$15,358	7.38	2.41	7.62%
2A	3954	\$79,087	\$15,358	5.15	3.45	9.58%
1	3954	\$32,165	\$4,877	6.59	1.30	5.87%
2B	3962	\$123,514	\$19,664	6.28	2.81	8.45%
1	3962	\$52,595	\$22,028	2.39	3.60	17.19%
2A	3962	\$89,267	\$19,664	4.54	3.88	10.23%
2B	4137	\$96,755	\$14,655	6.60	2.73	8.30%
1	4137	\$41,016	\$12,098	3.39	2.54	13.17%
2A	4137	\$62,506	\$14,655	4.27	4.22	10.69%
1	4242	\$21,694	\$5,340	4.06	2.11	11.09%
2B	4242	\$82,573	\$12,100	6.82	2.54	7.92%
2A	4242	\$48,326	\$12,100	3.99	4.34	10.85%

5 NARRATIVE SUMMARY OF WORK AND RESULTS

LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY AIRFIELD, FT. BRAGG, NC

TABLE 5.4.4

RECOMMENDED ECOs SORTED BY BUILDING NUMBER

ECO NUMBER	BUILDING NUMBER	TOTAL INVESTMENT	1st YEAR SAVINGS	SIMPLE PAYBACK	SIR	AIRR
2A	7937	\$192,072	\$40,966	4.69	3.90	10.26%
1	7937	\$62,380	\$11,606	5.37	1.60	8.09%
2B	7937	\$226,319	\$40,966	5.52	3.31	9.36%
1	8944	\$51,337	\$8,695	5.90	1.46	7.07%
2A	8944	\$190,425	\$46,633	4.08	4.39	10.91%
2B	8944	\$224,672	\$46,633	4.82	3.72	10.00%
2B	9647	\$204,967	\$28,526	7.19	2.55	7.94%
1	9647	\$58,764	\$8,823	6.66	1.39	5.80%
2A	9647	\$170,718	\$28,526	5.98	3.07	8.93%

TABLE 5.4.5

PROJECT RESULTS BY ECO

ECO NUMBER	TOTAL INVESTMENT	1st YEAR SAVINGS	SIMPLE PAYBACK	SIR	AIRR
ECO - 1	\$680,783	\$167,921	4.05	2.12	11.17%
ECO - 2A	\$1,759,820	\$341,074	5.16	3.51	9.67%
ECO - 2B	\$3,026,833	\$341,074	8.87	2.04	6.74%
ECO - 3	\$2,380,274	(\$197,291)	-12.06	-0.61	N/A
ECO - 4	\$877,848	\$41,095	21.36	0.88	N/A

Appendix A

SCOPE OF WORK



DEPARTMENT OF THE ARMY

SAVANNAH DISTRICT, CORPS OF ENGINEERS

P.O. BOX 888

SAVANNAH, GEORGIA 31402-0888

REPLY TO
ATTENTION OF:

CESAS-PM-MP-2

AUG 19 1994

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Delivery Order No. 4 under Contract No. DACA01-94-D-0034, Indefinite Delivery Contract for A-E Services for the Energy Engineering Analysis Program (EEAP) for the Midsouth Region Including Kentucky, NC, TN, VA, and WV

I am enclosing the minutes of the Prenegotiation Conference for the subject project held at Fort Bragg on 11 Aug 94. Please advise the Project Manager, Mr. Rob Callahan, of any additions, deletions, or corrections to these minutes.

FOR THE COMMANDER:

Encl

Ed Watford

EDWARD R. WATFORD
Acting Chief, Military Programs
and Project Management Branch

DISTRIBUTION:

CDR, XVIII Airborne Corps and Fort Bragg, ATTN: AFZA-PW-M
(Mr. Musulin), Fort Bragg, NC 28307-5000
CDR, XVIII Airborne Corps and Fort Bragg, ATTN: AFZA-DPT-S
(Mr. Brown), Fort Bragg, NC 28307-5000
CDR, U.S. Forces Command, ATTN: AFPI-ENO (Mr. Kapur),
Fort McPherson, GA 30330
CDR, U.S. Army Engineer Division, South Atlantic, ATTN:
CESAD-EN-TE (Mr. Baggette), 77 Forsyth Street, SW, Atlanta,
GA 30335-6801
CDR, U.S. Army Engineer District, Mobile, ATTN: CESAM-EN-DM
(Mr. Battaglia), P.O. Box 2288, Mobile, AL 36628-0001

CF:

→ Systems Corp, ATTN: Mr. Keith Derrington, Cherokee Place,
Suite 306, 2200 Sutherland Avenue, Knoxville, TN 37919

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31 994
CORP

13 Aug 1994

MEMORANDUM FOR RECORD

SUBJECT: Prenegotiation Conference for Delivery Order No. 4 under Contract No.DACA01-94-D-0034, Indefinite Delivery Contract for Architect-Engineer Services for the Energy Engineering Analysis Program (EEAP) for the Midsouth Region Including Kentucky, North Carolina, Tennessee, Virginia, West Virginia

1. The undersigned called the subject meeting to order on August 11, 1994, at 8:00 a.m. in the Fort Bragg DPWE Design Branch conference room. The team members in attendance are shown at encl 1.

2. Following introductions, we began our review of the project Appendix A. In addition to comments that resulted in making minor changes to Appendix A, the final revised version of which is attached at encl 2, the following points were made by various team members:

a. Sam informed us that North Carolina Natural Gas Company is the local supplier of natural gas and that Huntsville Division of the Corps of Engineers (P.O.C. Jim Haywood) has made contact with them on Fort Bragg's behalf to initiate discussion and a possible project to construct a gas main to Simmons Army Airfield (SAAF). The Contractor will need to coordinate with Jim Haywood when he begins his analysis of heating options for SAAF to determine how, if in any way, Mr. Haywood's work can be incorporated into the Contractor's work.

b. Based on a previous comment by Naresh Kapur of FORSCOM, I brought up the issue of gas-fired infrared heating being a possible explosive safety concern in aircraft maintenance facilities. Both the Contractor and Tommie Brown had seen many

applications of this technology in hangars during their careers. So, while it appears that this should not be a problem, the Contractor is nonetheless cautioned to insure if he recommends this as the preferred option that he is certain there is no possibility of explosion or fire.

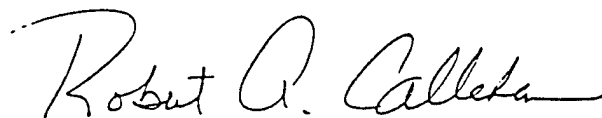
c. Tommie brought up the subject of building 3262 having a problem with one of the existing boilers. The Contractor will need to determine the extent of the problem and factor this into his analysis for this one facility.

d. Tommie stated that while there is some classified equipment on site, it is generally locked away in secure vaults. When I raised the question of the Contractor needing access to all areas of the facilities, Tommie assured us that with coordination through himself or his Logistics Officer, Bill Gibson, access can be granted. This will require some advance notification so that Tommie can coordinate with the units to insure that they take the proper alternate security measures.

e. While we were discussing the alternative of skylights, the Contractor made the statement that he would need to know more about planned roof replacement cycles on the facilities. Tommie stated that buildings 2936 and 3262 had the worst roofs.

f. Sam volunteered to assist in setting up the Contractor's representative with the record drawing vault attendant for the purpose of pulling as-builts during the first phase of the field work once the Contractor begins.

3. Sam, Kieth, and I signed our Partnering Agreement (encl 3). I adjourned the meeting at 10:00. At about 11:00 we drove out to SAAF and walked through one facility and drove around the whole complex to give the Contractor a better idea of the project.



Robert A. Callahan
Project Manager

CONFERENCE PARTICIPANTS

PROJECT: EEAP Projects DATE: 11 Aug 94
 BASE: Ft. Bragg TIME: 0800
 FISCAL YEAR: 94 LOCAL:

LINE ITEM

TYPE CONFERENCE
Pre-negotiation

Name	Position	Organization	Office Symbol	Telephone
1. Rob Callahan	Project Manager	Grps of Engineers Savannah District	CESAS-PM-MP	(912) 652-52
2. Sam Musulin	Energy Coord.	DPWE	AFZA-PW-M	910 396 27
3. GREG LOFLIN	PROJ. MGR.	SYSTEMS CORP		615 521 65
4. KENH DERRINGTON	PROJ. MGR	SYSTEMS CORP		615 521 65
5. MIMIE BIRCHALL	Post Ann	DPT	AFZA-DPT-S	910-396/6605/12
6.				
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APPENDIX A
for Delivery Order No. 4,
A LIMITED ENERGY STUDY OF HANGAR FACILITIES AT SIMMONS ARMY
AIRFIELD (SAAF), FORT BRAGG, NC

1. BRIEF DESCRIPTION OF WORK:

The Architect-Engineer (A-E) shall:

1.1 Site Survey. Perform a limited site survey and investigation of specific facilities to collect all data required to determine the baseline energy consumption of the heating, cooling, and lighting systems and lighting levels and to evaluate various heating, cooling and lighting system alternatives in and around the aircraft hangar facilities located at SAAF. This will include survey of all interior spaces and lighting attached to the buliding exteriors.

1.2 Other Savings Opportunities. Within the general area of the site survey, defined as the interior of the hangars, the surrounding exterior to the limit of the area lighting and the perimeter road lighting, identify any other energy or water savings opportunities that, in the A-E's judgment, would be worthy of further study and analysis.

1.3 Alternatives to be Studied. Evaluate the heating, cooling, and lighting systems alternatives identified by the Fort Bragg Energy Coordinator (FBEC) and any alternatives suggested by other team members (to include the A-E's staff), subject to the approval of the FBEC, to determine their energy savings potential, economic feasibility, and technical applicability based on present conditions at SAAF and current technical criteria and Army policy.

1.4 Project Identification and Documentation. There are three possible types of projects that may result from this study, as described below in paragraph 2.4. The projects that result from the survey of the general area have abbreviated documentation requirements. For the other two types, however, after technical and economic evaluation, the A-E is instructed to provide complete project documentation for the solution(s) considered to be most cost-effective in improving heating, cooling, and lighting in the hangar facilities.

1.5 Study Report. Prepare a comprehensive report to document all work performed, the results and conclusions, and all recommendations. The specifics of this report are more fully described in paragraph 6.

2. SPECIFIC INSTRUCTIONS:

2.1 Site Survey. The primary purpose of this study is to evaluate heating, cooling and lighting systems in the fourteen (14) hangar buildings at SAAF listed below:

<u>Building Number</u>	<u>Type</u>	<u>Approximate Square Footage</u>
2936	Perm	64,680
3007	Perm	55,736
3262	Perm	63,651
3354	Perm	34,474
3637	Perm	21,151
3642	Perm	35,590
3807	Perm	58,019
3954	Perm	35,642
3962	Perm	33,476
4137	Perm	21,151
4242	Perm	8,788
7937	Perm	65,664
8944	Perm	49,943
9647	Perm	58,019

The site survey will include verification of facility gross square footage, heated square footage, and cooled square footage; inventory of heating, cooling, and lighting systems components (e.g., number of air handlers in each building, cooling unit types and sizes serving the facilities, types of lighting fixtures, and other component information pertinent to the energy analysis); and metering of existing lighting levels. The A-E shall document his site survey on forms developed for the survey or on standard forms and shall submit these completed forms as part of the report. If any code violations related to these systems are detected during inspection, they will be documented and the FBEC will be notified immediately.

2.2 Other Savings Opportunities. Because the FBEC has limited resources at his disposal to identify possible future energy or water conserving studies that might qualify for funding under the Army Energy Engineering Analysis Program (EEAP), the A-E is instructed to have his field crew make notes of other potential savings opportunities. Analysis of each potential project so identified will be limited to "back of the envelope" calculations. A list of possible energy conservation opportunities is included in reference 9.7. This list is not necessarily all-inclusive, nor does it address any water conserving opportunities.

2.3 Alternatives to be Studied.

2.3.1 Heating system alternatives that have been identified for study and evaluation include:

- Natural gas boilers or furnaces, under the assumption that the local gas company will incur the cost of installing, operating, and maintaining a gas main to serve the area
- Natural gas boilers or furnaces with the government incurring the cost of installing, operating, and maintaining the main
- Natural gas-fired infrared heaters, with and without the government incurring the cost of the main
- Electric infrared heaters

2.3.2 Lighting system alternatives that have been identified for study and evaluation include:

- Replacement of ballasts in existing lighting fixtures with more energy efficient type(s)
- Replacement of existing incandescent lamps with compact fluorescent with or without the use of high grade reflectors
- Replacement of existing fluorescent lamps with more energy efficient fluorescent lamps
- Replacement of existing luminaires with most cost-effective type
- Installation of skylights
- Installation of occupancy sensors in all appropriate areas
- Lowered light fixtures
- Altered light switching arrangements
- Improved reflection and dispersion with light colored ceilings and walls
- Delamping
- Reducing wattage while maintaining proper lighting levels

2.3.3 No cooling alternatives have been identified, other than consideration of consolidating multiple units, if such exist at each individual hangar, or the replacement of an existing heat pump with an air conditioning unit, in the event one of the natural gas heating alternatives proves to be most cost effective and results in the installation of a natural gas main. In any event, however, the cost of studying alternative means of providing cooling will not be greater than the cost of providing the proposed improvements.

2.3.4 The A-E is strongly encouraged to suggest for study other reasonable and practical alternatives or combinations of alternatives that, in his judgment, could possibly provide the most economical means of heating, cooling, or lighting these facilities. The A-E is instructed to recommend other changes, e.g., to maintenance practices, operational procedures, or controls in these facilities, that will reduce energy consumption at SAAF. Other team members may suggest other heating, cooling, or lighting alternatives for evaluation during the progress of this study.

2.4 Project Identification and Documentation. There will be three possible types of projects to be identified as a result of this study. Descriptions and documentation requirements for each type are presented below.

2.4.1 Identification of the first type of project will result from the survey of the general area of the hangars and perimeter road around SAAF. Documentation requirements will consist of a brief description of the character and extent of the energy conservation opportunity (ECO) with sketches, photographs, or map extracts included, if necessary, to better indicate the buildings or areas involved in each. A short description of the recommended improvement and calculations to support each will be provided but will be limited to show only the logic to the improvement recommendation and to demonstrate that a simple payback could occur in 10 years or less and the improvement would have a Savings to Investment Ratio (SIR) greater than 1.25. These will be included in the study report described in paragraph 6 behind a separate tab.

2.4.2 Identification of the second type of project, which will require further guidance from the FBEC and the FORSCOM P.O.C. on packaging for funding purposes, will concern the actual heating, cooling, and lighting systems improvement projects. Every attempt will be made to keep all projects within the Installation Commander's funding approval authorities applicable to the Operations and Maintenance, Army (OMA) account. These limitations are generally \$300,000 for a project classified as construction and \$1,000,000 for projects classified as maintenance or repair, as defined in reference 9.2 as modified by reference 9.10. To be classified as an OMA Energy maintenance or repair project, the project must result in needed maintenance or repair to an existing facility or replace a failed or failing system or component and result in energy savings. If the project would replace a system or component that is considered failed or failing due solely to obsolete technology or inefficiency, the system or component to be replaced must have been in use for at least three years and the simple payback period must be ten years or less. So long as the work can be logically separated and identified, projects can be combined in one undertaking. There is a special source of OMA funding called the Federal Energy Management Program (FEMP) that can generally provide funding for energy savings type projects, the cost of which is estimated to fall below these limitations, on a one year cycle or less, if a project is properly justified. Any recommended project must have, as a minimum, an SIR of 1.25 and a simple payback period of 10 years or less. The documentation required for each project is the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA (i.e., energy and non-energy savings calculations and cost estimate), the SIR, and the simple payback period. The documentation of these projects will be a part of the study report described below in paragraph 6. See paragraph 3.4 for further guidance.

2.4.3 The last, and most intensive, type of project documentation is required for any project that exceeds the funding authorities shown above in paragraph 2.4.2. These are by definition Energy Conservation Investment Program (ECIP) projects. To qualify as an ECIP project, the cost estimate associated with the energy improvement must be at least \$300,000. In addition to the documentation requirements shown above in paragraph 2.4.2, this will include a DD Form 1391 for each project. AR 415-15 provides specific guidance for preparing a DD Form 1391. The other documentation guidance is shown in references 9.4 and 9.8.

3. GENERAL

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

3.2 For the buildings listed above and their installed heating, cooling, and lighting systems 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 heating, cooling, and lighting system alternatives, or other changes, that are considered during the study will be documented in the report, including those that are rejected because they are considered infeasible with reasons given for elimination. If, under another set of assumptions, an infeasible project will become feasible, then so state. For example, if using in-house labor to perform work would be less costly than using contract labor, and this change would result in meeting the SIR and payback criteria, then document this.

3.3 The study shall consider the use of all energy sources applicable to each building or system and shall examine the possibility of combinations of heating, cooling, or lighting improvements if, for example, some buildings are more suited for certain types of heating because of site layout, condition, or floor plan.

3.4 The "Energy Conservation Investment Program (ECIP) Guidance," described in a letter from DAIM-FDF-U, dated 10 Jan 1994, and any subsequent revisions establish criteria for ECIP projects and shall be used for performing the economic analyses associated with these projects. The software 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. The LCCID program is available from the BLAST Support Office at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana,

Illinois 61901 for a nominal fee. The telephone number is (217) 333-3977 or (800) 842-5278.

3.5 Computer modeling will be used to determine the energy savings of alternatives which would replace or significantly change an existing heating or cooling system. Modeling will be done using professionally recognized and proven software program(s) that integrate architectural features with heating and cooling systems. This(ese) program(s) will be capable of simulating the features, systems, and thermal loads of the buildings under study. The program(s) will use established weather data files and may perform calculations on a true hour-by-hour basis or may condense the weather files and number of calculations into several "typical" days per month. The program(s) to be used by the A-E will 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, unless it is one of the following: Building Loads and System Thermodynamics (BLAST), DOE 2.1E, Carrier E20 or Hourly Analysis Program (HAP), Trane Air-Conditioning Economics (TRACE).

3.6 The A-E shall take great care to insure that the FBEC is kept apprised of the ongoing work, is regularly consulted from beginning to end, and has every opportunity to input his thoughts and guidance into the study process. The alternatives that become the final recommended projects will be acceptable to the FBEC and will be both technically and economically feasible.

3.7 Public Disclosures. The A-E shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.8 Meetings. Meetings will be scheduled whenever requested by the A-E or the government's representative acting for the installation project manager for the resolution of questions or problems encountered in the performance of the work. These meetings, if necessary, will be in addition to the scheduled review meetings and presentations.

3.9 Site Visits, Inspections, and Investigations. The Contractor shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work. Visits will be coordinated with the FBEC at least a week in advance. The Contractor will determine whether any special security clearances are required with the assistance of the FBEC.

3.10 All invoices or payment estimates (ENG Form 93) will be sent to the Savannah District project manager, who is identified below in paragraph 5.4, for review and approval.

3.11 Records

3.11.1 The A-E shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with government personnel relative to this project in which the A-E has participated. These records shall be dated and shall identify the contract number, participating personnel, subject discussed and conclusions reached. The A-E shall forward by letter to the list of P.O.C.'s in paragraph 5 within ten calendar days a reproducible copy of the records. These will also be included in the study report as an appendix.

3.11.2 The A-E 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 D.O. The records shall be dated and shall identify the contract number. The A-E shall forward to the Savannah District project manager within ten calendar days a reproducible copy of the record of request or receipt of material.

3.12 Interviews. The A-E and Savannah District project manager shall conduct entry and exit interviews with the Director of Public Works and Environment (DPWE), or his designated representative, before starting work at the installation and after completion of the field investigation phase.

3.12.1 Entry. The entry interview shall describe the purpose of the study, the intended procedures for the survey, schedule, names of personnel performing the field investigation and the A-E's project manager, support required by the A-E of the DPWE staff, a description of the final products, and any other information the A-E wishes to communicate and shall be conducted prior to commencing work at the installation.

3.12.2 Exit. The exit interview shall briefly describe the items surveyed, an initial assessment of the condition of existing systems, and the most likely alternatives that will be further analyzed.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor (including that required to research installation records or databases to obtain all information needed to perform a thorough study), supervision, and travel necessary to complete the work and render the data required under this delivery order (D.O.) are to be included in the lump sum price.

5. PROJECT MANAGEMENT

5.1 The A-E shall designate a project manager to serve as the point of contact and liaison for work required under this (D.O.). Upon award of this D.O., the individual shall be immediately designated in writing. The A-E'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 D.O. The A-E's project manager shall submit monthly progress reports, typically in conjunction with pay requests, and shall telephonically update the Savannah District project manager on project events about every two weeks between pay requests. Immediately upon award of the D.O., the A-E's project manager will submit a project schedule substituting dates for calendar days, with an assumed 30 day government review period after each submittal.

5.2 The Fort Bragg Energy Coordinator and project manager for this effort is Sam Musulin, telephone number (910) 396-2772, FAX number (910) 396-1725. He will assist the A-E in obtaining information and establishing contacts necessary to accomplish the work required under this contract.

5.3 The Forces Command program manager is Naresh Kapur, telephone number (404) 669-5327, FAX number (404) 669-7751.

5.4 The Corps of Engineers, Savannah District, project manager is Rob Callahan, telephone number (912) 652-5246, FAX number (912) 652-5442.

5.5 The Corps of Engineers, Savannah District, Contracting Officers Representative is Ira D. Hefner, telephone number (912) 652-5364, FAX number (912) 652-5442.

5.6 The Corps of Engineers, Mobile District, is the Army's designated Technical Center of Expertise for the EEAP. Mobile District's program manager is Tony Battaglia, telephone number (205) 690-2618, FAX number (205) 690-2424.

6. SUBMITTALS, PRESENTATIONS, AND REVIEWS.

6.1 General. The work accomplished shall be fully documented by a comprehensive report. While the cost of report production is certainly a consideration, the report submittals must be well organized and lend themselves to quick and easy review. The interim submittal may be copied and bound in the most convenient and least expensive manner, so long as it meets the two criteria above. The pre-final report will be organized, tabbed, copied and bound in the exact manner which the Contractor proposes to produce the final report. Review of this submittal will include comments on the report's organization and flow of thought. The final report will incorporate all earlier comments and, if the pre-final report is produced properly, will be produced by page for page replacement or page addition in the pre-final report. A high quality 3-ring binder will be used to package the pre-final report. For easy reading line length on the printed page is a consideration. It may be advisable to use a two column format to accomplish this. The pages of the original copy will be laser printed. Xeroxed copies on high quality copy paper is acceptable so long as there is essentially no discernible difference between them and the original. A title

page will be inserted in a sleeve on the front cover and will contain a photograph descriptive of the report contents. The inside title page will also incorporate logos and credits to the A-E and the offices who have played a role in development of the study and report. This will be followed by a table of contents. Each section, subsection, and appendix shall be separated by a thick paper divider tabbed with the section name and number. Each page will be numbered with a section number followed by a dash and a page number. A separately bound Executive Summary of the study, giving a brief overview of the conclusions and recommendations using graphs, tables, and charts as much as possible, will be prepared. For clarity, color will be used in these graphic elements or any others that appear in the report. The body of the report itself, that portion where the technical analysis, conclusions, and recommendations are developed, shall be organized in a logical manner, written simply enough for a person not an expert in the field to follow the line of reasoning for each project. All project documentation will be presented in this portion of the report. Appendices will include as a minimum the Scope of Work, meeting minutes, survey forms, code violations found, and recommended projects for further study. Any other appendices that the A-E thinks will assist in making the report better and more organized are also encouraged. There will be a list of acronyms used with definitions.

6.2 Interim Report Submittal. An interim report containing all the sections described above, except the Executive Summary, shall be submitted for review after the field survey has been completed and the heating, cooling, and lighting systems analyses have been performed. 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 for the work remaining to complete the study. All alternatives that have been identified for study shall be included. For those that are recommended for elimination from further study reasons for their elimination shall be given. The A-E shall make a presentation of the report at a review conference. Visual aids or other methods of presentation will be at the A-E's discretion to make understanding by those present easier. One copy each shall be submitted for review to the FORSCOM and Mobile District P.O.C.'s. Two copies each of the report, and one copy of a separately bound notebook of survey forms only, shall be submitted to the Fort Bragg and Savannah District P.O.C.'s. Review comments at this stage of report development will include those pertinent to packaging of projects for funding purposes.

6.3 Prefinal Report Submittal. The A-E shall prepare and submit the pre-final report when all work under this contract is essentially complete. The report will be formatted and bound exactly as the A-E proposes to format the final report. All project documentation shall be completed and included in the report. All comments resulting from review of the interim submittal or from the presentation shall have been addressed in compiling this report, and review action comments related to the

interim report shall be included in a separate appendix keyed to sections of the pre-final report where the appropriate changes have been made. The same number of copies shall be sent to the same offices as specified above for the interim report.

6.4 Final Report. Any revisions or corrections resulting from comments made during the review of the pre-final report will be able to be incorporated by page for page replacement or page addition in the pre-final report, if it has been produced in accordance with these instructions. All instructions on organization and formatting shall be strictly followed. A separately bound Executive Summary will be prepared, as described above in paragraph 6.1. One copy of the final submittal shall be sent to the FORSCOM and Mobile District P.O.C.'s; two copies shall be sent to the Savannah District P.O.C.; and three copies, along with the original, shall be sent to the Fort Bragg P.O.C. In addition one copy each of only the Executive Summary shall be sent to the Corps of Engineers, South Atlantic Division, P.O.C., the U.S. Army Logistics Evaluation Agency P.O.C., and to the HQUSACE P.O.C. listed below in paragraph 8.

7. PROJECT SCHEDULE

Milestone

Date

Entry interview and begin
field work

NLT 15 days
after changeover
to heat occurs

A-E calls in code violations (if any)

As soon as they
are discovered

A-E submits interim report

NLT 90 days
after entry
interview

Interim submittal review meeting
and presentation

NLT 30 days
after submittal
of interim
report

A-E submits pre-final report

NLT 60 days
after receipt
of government
review comments
on interim

A-E submits final report inserts

NLT 30 days
after receipt
of government
review comments
on pre-final

8. ADDRESSES:

Commander
XVII Airborne Corps and Fort Bragg
ATTN: AFZA-PW-M (Mr. Sam Musulin)
Fort Bragg, NC 28307-5000

2 RPT 1 FN

Commander
U.S. Army Forces Command
ATTN: AFPI-ENO (Mr. Naresh Kapur)
Fort McPherson, GA 30330

1 RPT

Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
100 W. Oglethorpe Avenue
P.O. Box 889
Savannah, GA 31402-0889

2 RPT 1 FN

Mobile District, Corps of Engineers
ATTN: CESAM-EN-CM (Mr. Tony Battaglia)
P.O. Box 2288
Mobile, AL 36628-0001

1 RPT

Commander
U.S. Army Engineer Division, South Atlantic
ATTN: CESAD-EN-TE (Mr. Baggette)
77 Forsyth Street, SW
Atlanta, GA 30335-6801

Commander
U.S. Army Corps of Engineers
ATTN: CEMP-ET (Mr. Gentil)
20 Massachusetts Avenue, NW
Washington, DC 20314-1000

Commander
U.S. Army Logistics Evaluation Agency
ATTN: LOEA-PL (Mr. Keath)
New Cumberland Army Depot
New Cumberland, PA 17070-5007

9. REFERENCES:

- 9.1 Architect and Engineer Instructions, 9 Dec 91
- 9.2 AR 420-10, Management of Installation Directorates of Engineering and Housing, 2 Jul 87
- 9.3 AR 415-15 (DRAFT), Army Military Construction Program Development and Execution
- 9.4 Energy Conservation Investment Program (ECIP) Guidance, 10 Jan 94

- 9.5 TM 5-785, Engineering Weather Data
- 9.6 TM 5-800-4, Programming Cost Estimates for Military Construction, Feb 94
- 9.7 General Energy Conservation Opportunities
- 9.8 Required DD Form 1391 Data
- 9.9 AR 11-27, Army Energy Program, 14 July 89
- 9.10 TWX dated 111600Z Jul 94 from DAIM-FDF-B, subject:
Future Change to AR 420-10

encl 3-18

Appendix B
CORRESPONDENCE

October 12, 1994

Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
100 West Oglethorpe Avenue
P. O. Box 889
Savannah, GA 31402-0889

Dear Mr. Callahan:

RE: Clarification to Lighting Field Survey Meeting Minutes
Limited Energy Study of Facilities in the Historic, Red Brick
Main Post Area and Hangars at Simmons Army Airfield at Fort
Bragg, NC
Contract No. DACA01-94-0034

The minutes from the Lighting Field Survey was distributed on 28 September 1994. The following are clarifications to the Lighting Field Survey Meeting Minutes:

- Sam Musulin, of Fort Bragg DPW, will assist in the collection of facility drawings.
- The basement of the Headquarter's Building, bldg , will be evaluated for the lighting ECOS. The entire building will be evaluated for all other ECOS.
- The hangars at Simmons Army Airfield will be evaluated for the installation of skylights. It is the decision of the installation the applicability of energy conservation opportunities. Systems Corp was only communicating the concerns of the building occupants.
- The light meters used by Systems Corp are rated to be within .5% of the actual footcandles.
- The Defense General Supply Center's (DGSC) February 1994 High Efficiency Lighting Catalog includes the sky lighting product suggested by Naresh Kapur of Forces Command.

Rob Callahan
Page 2
October 12, 1994

- Systems Corp determines the approximate amount of daylight and artificial light by taking light level readings during the day with the lights on and off. This is only to get a general idea of the benefits of additional lighting controls and/or sky lights. The amount of hours a facility can benefit from daylighting controls or skylights is determined through historical weather data. The historical weather data is then used to calculate the proposed savings for each facility.

If you have any questions or comments regarding this material, please do not hesitate to contact me at (708) 462-9150 or Greg Loflin at (615) 521-6536.

Sincerely,

SYSTEMS CORP

Julie Hollensbe, E.I.T.

cc: Sam Musulin, AFZA-PW-M
Naresh Kapur, AFPI-ENO
Tony Battaglia, CESAM-EN-CM
Greg Loflin, Systems Corp (Knoxville)

SYSTEMS_{corp}

SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION

November 2, 1994

Savannah District, Corps of Engineers
Attention: CESAS-PM-MP (Mr. Rob Callahan)
100 West Oglethorpe Avenue
P.O. Box 889
Savannah, GA 31402-0889

Dear Mr. Callahan:

RE: HVAC Field Survey Exit Interview
Limited Energy Study of Facilities in the Historic, Red Brick Main Post Area and
Hangars at Simmons Army Airfield at Fort Bragg, NC
Contract No. DACA01-94-0034

The HVAC, envelope and water field survey at Fort Bragg was conducted from 24 October through 28 October 1994. The following is a description of the topics discussed and decisions reached during the field survey:

Thursday October 27, 1994

Persons Present:

Sam Musulin	Fort Bragg DPW Energy Officer
Tommy Brown	Fort Bragg Airfield Commander
Greg Loflin	Systems Corp Project Manager
M. Wallace Green	Systems Corp Representative
Jonathan Driskill	Systems Corp Representative
Bruce Yates	Systems Corp Representative

- Accurate drawings or manufacturer's data for existing HVAC systems are not available for many of the buildings under consideration, particularly in the Red Brick area. Some assumptions will be made based on the information gathered during the site survey.
- Boiler systems were not operating in most facilities during the survey. However, visual inspection and manufacturer's data will provide information as to operating efficiencies.
- Systems Corp representatives will make a return trip to Fort Bragg in mid-November to gather more information as necessary.

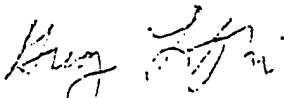
Mr. Rob Callahan
Page 2
November 2, 1994

- Sam Musulin will provide operational and maintenance cost data for each of the buildings under study as quickly as possible.
- The distance from Simmons Army Airfield to the nearest natural gas line which could provide service to the area is over three miles.
- Code violations reported:
 - (1) Storage of cleaning chemicals in mechanical rooms used as plenum returns in three mechanical rooms of the Headquarters Building (1-1326).
 - (2) Few, if any, of the HVAC Systems in the Red Brick Area meet ASHRAE ventilation requirements for minimum outdoor air flow rates based on occupancy.
 - (3) Several mechanical rooms have no working light fixtures.

If you have any questions or comments regarding this material, please do not hesitate to contact me at (615) 521-6536.

Sincerely,

SYSTEMS CORP



Gregory B. Loflin
Project Manager

GBL:jal

cc: Sam Musulin, AFZA-PW-M
Naresh Kapur, AFPI-ENO
Tony Battaglia, CESAM-EN-CM

November 16, 1994

Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
100 West Oglethorpe Avenue
P. O. Box 889
Savannah, GA 31402-0889

Dear Mr. Callahan:

RE: Progress Report
Limited Energy Study of Facilities in the Hangars at Simmons
Army Airfield at Fort Bragg, NC
Contract No. DACA01-94-0034

The calculations, cost estimates and life cycle cost analyses have been completed for the lighting energy conservation opportunities at the hangars located at the Simmons Army Air Field. The lighting products evaluated for installation were compact fluorescents, T8 fluorescent lamps with electronic ballasts, LED exit sign retrofit kits, metal halide fixtures, high pressure sodium fixtures and sky lights. High pressure sodium fixtures were only considered for exterior use. The sky lights evaluated are sun tracking sky lights with lighting controls.

Enclosed is a table summarizing the life cycle cost analysis results. The buildings requiring a high bay lighting upgrade result in the quicker paybacks.

The Interim Report for the hangar buildings will be completed by December 16, 1994. If you have any questions or comments regarding this material, please do not hesitate to contact me at (708) 462-9150.

Sincerely,

SYSTEMS CORP

Julie Hollensbe, E.I.T.

Enclosure

cc: Sam Musulin, AFZA-PW-M
Greg Loflin, Systems Corp (Knoxville)

September 28, 1994

Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
100 West Oglethorpe Avenue
P. O. Box 889
Savannah, GA 31402-0889

Dear Mr. Callahan:

RE: Lighting Field Survey Meeting Minutes
Limited Energy Study of Facilities in the Historic, Red Brick
Main Post Area and Hangars at Simmons Army Airfield at Fort
Bragg, NC
Contract No. DACA01-94-0034

The lighting field survey at Fort Bragg was conducted from 20
September through 23 September 1994. The following is a
description of the topics discussed and decisions reached during
the field survey:

Tuesday, September 20, 1994

Persons Present:

Rob Callahan	Savannah District COE
Naresh Kapur	Forces Command Representative
Sam Musulin	Fort Bragg DPW Energy Officer
Tommy Brown	Fort Bragg Airfield Commander
Julie Hollensbe	Systems Corp Project Manager
M. Wallace Green	Systems Corp Representative

- Julie Hollensbe passed out a detailed schedule of the projects to be performed on the Red Brick area and the Airfield.
- Tommy Brown will escort Systems Corp through all the Airfield buildings included in the scope of work.
- Sam Musulin will provide Systems Corp with an access letter, 12 months of electric bills and the drawings available on the buildings included in the scope of work.
- Naresh Kapur passed out a brochure on a sky light product he would like evaluated on the hangars.
- The airfield personnel are concerned with the risk of adding sky lights to the hangars and damaging the roofs due to the expensive equipment and material stored in the hangars.

Rob Callahan

Page 2

September 28, 1994

- Systems Corp will look for addition future energy projects while surveying.
- The basement of the installation headquarter's building will be the only floor surveyed in this building (Bldg 1326) due to the controlled access.
- The exit interview will follow the second field survey trip in October when all field survey work is completed.

Friday, September 23, 1994

Persons Present:

Sam Musulin	Ft. Bragg Energy Officer
Mr. Walker	Ft. Bragg High Voltage Crew
Julie Hollensbe	Systems Corp Project Manager
M. Wallace Green	Systems Corp Representative

- High pressure sodium lamps in the hangars are 250 watt.
- Metal halide lamps in the hangars are 400 watts.
- Mercury vapor lamps in the hangars are 1000 watts.
- Incandescent lamps in the high bay hangars are 750 and 1000 watts.
- The exterior lamps on the buildings are 400 watt mercury vapor and 250 watt high pressure sodium.
- The street lamps along the perimeter of the airfield are a mixture of 250 and 400 watt high pressure sodium.
- Sam Musulin wants Systems Corp to evaluate replacing the mercury vapor and incandescent fixtures at the hangars with metal halide and not high pressure sodium.

Rob Callahan

Page 3

September 28, 1994

If you have any questions or comments regarding this material,
please do not hesitate to contact me at (708) 462-9150.

Sincerely,

SYSTEMS CORP

Julie Hollensbe, E.I.T.

cc: Sam Musulin, AFZA-PW-M
Naresh Kapur, AFPI-ENO
Tony Battaglia, CESAM-EN-CM
Greg Loflin, Systems Corp (Knoxville)

Appendix C

PROJECT DOCUMENTS

LIFE CYCLE COST ANALYSIS SUMMARY FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

DISCRETE PORTION NAME:	Fort Bragg, NC
PROJECT NAME:	Lighting Upgrade and Conventional Sky Lights with Automatic Lighting Controls
TOTAL INVESTMENT:	\$680,783
MBTU/YR SAVED:	74,780
DISCOUNTED ENERGY SAVINGS:	\$655,823
DISCOUNTED DEMAND SAVINGS:	\$595,523
TOTAL ENERGY SAVINGS:	\$1,251,345
TOTAL NON ENERGY SAVINGS:	\$195,245
FIRST YEAR DOLLAR SAVINGS:	\$167,921
SIMPLE PAYBACK IN YEARS:	4.05
TOTAL NET SAVINGS:	\$1,446,590
SAVINGS TO INVESTMENT RATIO:	2.12

REQUIREMENT:

This project is required to replace/retrofit the inefficient fluorescent, incandescent and mercury vapor lighting systems currently in use and install conventional sky lights with automatic lighting controls in 14 hangars at Fort Bragg. The lighting project will replace the existing T12 fluorescent lamps with T8 lamps, the magnetic ballasts with electronic ballasts, incandescent exit signs with LED exit signs, incandescent lamps with compact fluorescent lamps and mercury vapor fixtures with metal halide fixtures. The sky lights will be installed every 600 square feet in high bay hangar areas. The completion of this project will save Fort Bragg 2,140 MWH of energy and \$167,921 annually to help meet the requirements of the Energy Policy Act of 1992 (PL 102-486). This act states Fort Bragg must achieve a 30 percent reduction in it's energy consumption over the next 10 years, ending in FY 2005 using 1985 as a baseline.

DESCRIPTION OF PROPOSED CONSTRUCTION:

This project consists of replacing /retrofitting inefficient lighting systems with more energy efficient T8 fluorescent lamps, electronic ballasts, LED exit signs, compact fluorescent lamps and metal halide fixtures and installing conventional sky lights with automatic lighting controls.

CURRENT CONDITION:

The energy lost due to the current usage of inefficient lighting systems is in excess of 2,140 MWH per year at a cost of \$167,921 per year. At this rate a more energy efficient lighting system would pay for itself in approximately 4.05 years.

IMPACT IF NOT PROVIDED:

If this project is not funded, Fort Bragg will continue to spend in additional utility and operating costs over the next 4.05 years enough to purchase the more efficient and lower maintenance lighting systems. Also if this project is not funded, Fort Bragg will have more difficulty meeting the mandates of the Energy Policy Act of 1992 (PL 102-486).

LIFE CYCLE COST ANALYSIS SUMMARY FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

DISCRETE PORTION NAME:	Fort Bragg, NC
PROJECT NAME:	REPLACE OIL-FIRED HEATING SYSTEMS WITH NATURAL GAS
TOTAL INVESTMENT:	\$3,026,833.00
MWH/YR SAVED:	10,791.00
DISCOUNTED ENERGY SAVINGS:	\$5,690,136.00
DISCOUNTED DEMAND SAVINGS:	\$0.00
TOTAL ENERGY SAVINGS:	\$5,690,136.00
TOTAL NON ENERGY DISCOUNTED SAVINGS	\$487,484.00
FIRST YEAR DOLLAR SAVINGS:	\$341,074.00
SIMPLE PAYBACK IN YEARS:	8.87
TOTAL NET DISCOUNTED SAVINGS:	\$6,177,619.00
SAVINGS TO INVESTMENT RATIO:	2.04

REQUIREMENT:

This project is required to replace the inefficient heating systems and install natural gas infrared heaters in 14 hangars at Fort Bragg. The completion of this project will save Fort Bragg 10,791 MWH of energy and \$341,074 annually to help meet the requirements of the Energy Policy Act of 1992 (PL 102-486). This act states Fort Bragg must achieve a 30 percent reduction in it's energy consumption over the next 10 years, ending in FY 2005 using 1985 as a baseline.

DESCRIPTION OF PROPOSED CONSTRUCTION:

This project consists of replacing inefficient heating systems with more energy efficient natural gas infrared heating systems in 14 hangars.

CURRENT CONDITION:

The energy lost due to the current usage of inefficient heating systems is in excess of 10,791 MWH per year at a cost of \$341,074 per year. At this rate a more energy efficient heating system would pay for itself in approximately 6.57 years.

IMPACT IF NOT PROVIDED:

If this project is not funded, Fort Bragg will continue to spend in additional utility and operating costs over the next 6.57 years enough to purchase the more efficient and lower maintenance heating systems. Also if this project is not funded, Fort Bragg will have more difficulty meeting the mandates of the Energy Policy Act of 1992 (PL 102-486).

Appendix D

*RESPONSE TO
REVIEW COMMENTS*

*RESPONSE TO
INTERIM REVIEW COMMENTS*

Project Review Comments	Interim ☐ Project: Limited Energy Study of Hangar Facilities at Simmons Army Airfield Pre-Final ☒ Location: Fort Bragg, NC Final ☐ Year: P.N.	Reviewer: USACE-SAVANNAH (EN-DE) Name: C. FULTON Organizer:	Page: 1 of 1 Date: 1/13/95
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Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☐ Mech. ☒ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1	--	--	--	The study is well done. The relighting is particularly attractive with short pay-back times. Would recommend that the electric infrared heating be dropped and not be developed further. I do not think the sun tracking sky lighting is practical.	A	The electric infrared heating (ECO-3) will not be developed further. Suntracking skylights have been dropped in favor of conventional skylights.	

Project Review Comments	Interim ☐	Project:	Limited Energy Study of Hangar Facilities at Simmons Army Airfield		Reviewer: USACE-MOBILE (EN-DM)	Page: <u>1</u> of <u>2</u>
	Pre-Final ☒	Location:	Fort Bragg, NC		Name: HAI K. LE	Date: <u>1/17/95</u>
	Final ☐	Year:	P.N.		Organizer:	

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☒ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1	1	--	--	Provide a brief explanation of ECO-1, 2, 3, and 4 in the first part of Section 2 of the report. As is, the ECO's are not described until page 2-6, Table 2.3.1. There is no reference to this Table until page 2-4, thus making it difficult to understand the first few pages.	N	The first few pages of Section 2 are general items, not specifics. The general consensus of the customers present at the Interim Review was to leave the report as is in regard to the organization. However, Summary Section 1.1 has been added which accomplishes the desired result.	
2	1	5	5-1	Calculations of energy baselines and ECO energy consumptions should include the data input used to acquire the output values. On page 5-1, paragraph 5.2 indicates that six sources were used to determine the energy baselines. However, only item 6, Past Years Utility Consumption Data, was included in the report. Item 3 is past experience of Systems Corp engineers. What is this experience? Item 4 and 5 are manufacturer's data. Which manufacturer was this and what type of equipment was selected?	N	The DOE 2 data input to acquire output values is voluminous and indecipherable to anyone not familiar with the program. The pertinent data and assumptions made are available in the field notes and "ECO Calculations" sections of the Report. Systems Corp has extensive engineering and design experience which is documented in our bid package prior to being given this contract. Manufacturers' data is used to obtain general characteristics of products such as price, energy consumption, dimensions, etc. No single manufacturer was (nor should be) selected during the study phase.	
3	1	5	5-5	Maintenance cost was assumed to be \$500 per year per building. This seems to be a poor assumption since the largest building is almost 8 times the size of the smallest building. Furthermore, there is no justification or reason why \$500 is assumed.	N	Maintenance savings (not cost) for installing new boilers was assumed to be \$500 per year. Routine boiler maintenance cost does not generally depend on size. All boilers have certain items such as tube and burner cleaning which must be performed annually. The size and range of boilers under study does not vary enough to warrant different maintenance costs.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/VEP Attached

W - Withdrawn

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☒ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
4	1	5	5-5	The cost of laying the gas pipeline was divided equally among the buildings. Since the gas consumption varies from building to building, consider dividing the cost based on gas consumption rates.	A	This was considered. However, since the project pays back by all individual buildings, or by one grouping of all buildings, the method really does not matter.	
5	1	5	5-7	The net difference in investment costs for 2A and 2B is \$479,469, the cost of extending the gas line. This conflicts with the cost for the main gas line shown on p. 8-8 of \$435,889.	N	The cost estimate, shown on page 8-8, is for construction costs only. Table 5.3.2.1 shows total ECO investment costs used in the Life Cycle Cost Analysis, which includes design and SIOH costs	
6	2	8	13	On page 8-13, and other similar pages, there are notes "(See Attached Estimates for details)." There are no estimates attached. Provide page or section references for such attachments.	A	The detailed estimates for the infrared heating systems are complete as shown. The phrase "See attached estimate for details" should not appear and has been removed.	
7	2	--	--	Provide a brief discussion in the Calculations, Section 7, explaining the result printouts. State which output values were used and not used.	A	See beginning of Sections 7, 8, 9, and 10. Report has been modified accordingly.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/VEP Attached

W - Withdrawn

Project Review Comments	Interim ☐	Project:	Limited Energy Study of Hangar Facilities at Simmons Army Airfield		Reviewer: HQ FORSCOM (AFPI-END)	Page: <u>1</u> of <u>3</u>
	Pre-Final ☒	Location:	Fort Bragg, NC		Name: NARESH KAPUR	Date: <u>12/30/94</u>
	Final ☐	Year:	P.N.		Organizer:	

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☒ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1	--	--	--	Systems Corp has prepared a well organized interim submittal. Congratulations.			
2	1	2.3.1	2-4	We suggest more detailed description of ECO-1. Several opportunities could be for bay areas; e.g., fixture, replacement with or without multiple switching; skylights using non-recurring savings associated with less frequent change of lights. In non-bay areas, describe what retrofit is used in which areas. Also, let us not lump all lighting opportunities together. It should not be all or nothing. Present the LCC data in such a way that cost effective ECOs under lighting can be readily salvaged.	A	ECO-1 includes the maintenance and material savings for light fixtures less frequently used due to the installation of skylights. the field survey notes will be updated to reflect the replacement fixture. Buildings with a payback greater than 10 years or an SIR less than 1.25, will be updated to break down the LCCID to high bay and non-bay areas.	
3	1	5.3.2	5-5	It would be safer to assume that cost of new gas lines will be borne by the government. Let us not use 2A for the ECO listing. We should indicate how LCC figures compare with ECO 2B.	A	As decided at the Interim Review Conference, 2A will be left in the tables for further use by Fort Bragg personnel in negotiations with NCNG. Section 5.4 has been modified to show that 2B is the recommended option.	
4	1	5.3.3	5-5	Consider discarding ECO-3 because its SIR/PB are much less favorable than ECO-2. Of course, a brief discussion will be in order.	A	ECO-3 is not included in recommended ECO tables. Section 5.4 has been modified to make clear that ECO-3 is not recommended.	
5	1	5.3.4	5-9	After brief discussion, we could discard this ECO from the listing.	A	ECO-4 is not listed as a recommended ECO. Section 5.4 has been modified to make clear that ECO-4 is not recommended.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/VEP Attached

W - Withdrawn

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☒ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
6	1	5.4	5-11	Do the savings include non-energy savings? If so, identify non-recurring, non-energy savings.	A	Yes. First year savings include energy savings and recurring non-energy savings. They do not include non-recurring non-energy savings.	
7	1	5.4	5-14	For non-competing ECOs, we like to see an overall investment, L.C. Annual saving, SIR and PB.	A	Table 5.4.2 is for recommended ECOs. Information requested for non-recommended ECOs is shown in Table 5.4.3, page 5-15.	
8	1	5	5-19	Delite 2A. 2B will be a safe bet.	A	As decided at the Interim review Conference, 2A will be left in the tables for further use by Fort Bragg personnel in negotiations with NCSG. Section 5.4 has been modified to show that 2B is the recommended option.	
9	1	5.4	5-20	Let us try sub-ECOs for lighting and pick up the valid ones from those. As a minimum, we suggest using lighting ECOs for bay and non-bay areas separately.	A	Analysis has been modified accordingly.	
10	2	6	6-1	Expand third paragraph. A single LCC analysis for each building for lighting ECOs may not provide optimum results.	A	Analysis has been modified accordingly.	
11	2	6	6-1	Table 6-1 needs to clarify intents in more detail. In some cases, delamp and replacement of 2-lamp fixtures by 1-lamp fixtures could be valid option.	N	It is not the belief of Systems Corp to replace a 2 lamp fixture with a 1 lamp fixture when existing light levels are below IES standards.	
12	2	6	6-2	Let us expand this index to explain what is what.	A	Index has been expanded.	
13	2	6	6-11	Separate man-hours are used for demolition and installation of replacement fixture. In case of a 2x4 fixture, the labor component for both will be 2 hours. Can we use more reasonable values and also use economy of scale. This applies to other similar items elsewhere. Please discuss possibilities so we can get better LCC analysis.	A	Cost estimates include a total of 1.5 through 2.0 hours per fixture for demolition and installation. It is the belief of Systems Corp that those figures are reasonable amounts of time. Economy of scale does not apply.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/VEP Attached

W - Withdrawn

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☒ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
14	2	6	6-15	For building 2936 and other buildings. If we use sky lights, bay area lights will be replaced less frequently. If so, we can claim the savings under 3B. Try this one.	A	Concur. Maintenance and material savings are already included in the analysis. It appears under 3A based on the yearly average.	
15	2	6	6-20	What does this LCC analysis represent?	A	Index has been modified to explain each LCCID in Section 6.	
16	2	7	7-1	List assumptions made in each of the simulations.	A	Assumptions are stated in discussion of ECO calculations, Section 5.3.2, 5.3.3, and 5.3.4.	
17	2	8	--	List all assumptions made in this LCC analysis. We would like to see sample calculations for items in 2 and 3 of a LCC in this section.	A	Assumptions are stated in discussion of ECO Calculations, Section 5.3.2. As agreed upon at the Interim Review Conference, sample DOE inputs are not included in the report.	
18	2	9	--	Same as above.	A	Assumptions are stated in discussion of ECO Calculations, Section 5.3.3.	
19	2	10	--	Same as above.	A	Assumptions are stated in discussion of ECO Calculations, Section 5.3.4.	
20	--	--	--	ECO-2 has a good bit of new work. As such, it may be a prime candidate for consideration. Let us discuss.	A	ECO-2 programming documents have been prepared for ECIP funding.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/VEP Attached

W - Withdrawn

**Project Review
Comments**

Interim ☐ Project: **Limited Energy Study of Hangar
Facilities at Simmons Army Airfield**
Pre-Final ☒ Location: **Fort Bragg, NC**
Final ☐ Year: **P.N.**

Reviewer: **USACE - SAVANNAH
(EN-DM)** Page: 1 of 1
Name: **LYNCH** Date: 1/16/95
Organizer:

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☐ Mech. ☒ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1	1	5	5-5	Paragraph 5.3.2 states the cost of the gas line extension was divided equally among the 14 buildings. From Table 5.3.2.1, it was determined that the cost of the gas line extension was \$479,458 dollars. This figure is not consistent with the cost estimate in Volume II, page 8-8, which states the gas line extension would cost \$435,889 dollars. Coordinate these figures.	A	The cost estimate is for construction costs only. Table 5.3.2.1 shows total ECO investment costs which include construction costs plus SIOH and design costs.	
2	1	5	5-5	Paragraph 5.3.2, this paragraph implies that the gas company would not pay for the gas line extension. Based on this, deleting ECO 2A from Tables 5.4.1.2, 3, and 4 should be considered.	A	At the request of Fort Bragg personnel, the Tables are left as is for further negotiations with NCNG.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/VEP Attached

W - Withdrawn

Project Review Comments	Interim ☐ Project: Limited Energy Study of Hangar Facilities at Simmons Army Airfield Fort Bragg, NC Pre-Final ☒ Location: P.N. Final ☐ Year:	Reviewer: USACE-MOBILE Page: <u>1</u> of <u>1</u> Name: LARRY T. MINIARD Date: <u>1/17/95</u> Organizer:
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Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☐ Mech. ☒ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1	1	2.3.1	2-7	Paragraph 2.3.1 indicates 100 Watt incandescent lamps are the cut off for replacement but the remainder of the study shows 200 Watt. Examples, paragraph 5.3.1, Table 6.1. Please clarify.	A	Has been corrected in referenced sections.	
2	1	2.3.1	2-7	Paragraph 2.3.1, page 2-7. The use of 12 hours of average daylight appears to be overly optimistic. I would think it would be lower. Please justify value.	N	The 12 hours of daylight per day were based on the yearly average of daylight hours for Raleigh, North Carolina.	
3	1	3.3.2	3-4	Paragraph 3.3.2. A 5.0% SIOH and 5% design cost appears low. Historically, on small projects, these values are much higher. Please check and justify.	N	These values are in line with values used in similar studies. Based on customer comments at Interim Review, these values will be used.	
4	1	5.2.1	5-3	Table 5.2.1. Nitpickey I know, but baseline of 4,123 MWH does not total from Table 2.2.1.1.	A	Table 5.2.1 has been corrected.	
5	1	5.3.1	5-2	Paragraph 5.3.1. See comment 1 above.	A	Has been corrected in referenced sections.	
6	1	5.3.1	5-2	Paragraph 5.3.1 and Table 5.3.1.1. Use attached AEI for lighting levels.	A	Table has been modified to incorporate information provided.	
7	2	6	6-1	Table 6.1. See comment 1 above.	A	Has been corrected in referenced sections.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/NEP Attached

W - Withdrawn

Project Review Comments	Interim ☐	Project:	Limited Energy Study of Hangar Facilities at Simmons Army Airfield Fort Bragg, NC		Reviewer: FORT BRAGG DPWE	Page: <u>1</u> of <u>1</u>
	Pre-Final ☒	Location:	Fort Bragg, NC		Name: SAM MUSULIN	Date: <u>1/18/95</u>
	Final ☐	Year:	P.N.		Organizer:	

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☐ Mech. ☒ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1	--	--	--	I don't think the electronic skylighting system is a wise choice from a maintenance point of view. A maintenance free skylighting system would be more appropriate at Simmons Army Airfield.	A	Suntracking skylight system has been dropped from the analysis in favor of conventional skylight systems.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/VEP Attached

W - Withdrawn

*RESPONSE TO
PRE-FINAL
REVIEW COMMENTS*

Project Review Comments	Interim ☐ Project: Limited Energy Study of Hangar Facilities at Simmons Army Airfield Pre-Final ☒ Location: Fort Bragg, NC Final ☐ Year: P.N.	Reviewer: Corps of Engineers Page 1 of <u>1</u> Savannah District Name: FULTON Date: 3/13/95 Organizer:
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Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☐ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1	2	6	--	The labor rate looks to be high. Electricians in the Ft. Bragg area usually run about \$10/hr plus 20 to 25% labor burden. The \$27.50/hr seems high. This will affect the savings (increasing them).	N	The labor rates are from the Corps-wide accepted Means Cost Estimating Database and has been adjusted to reflect the cost of labor in the Fort Bragg area. This rate includes the overhead and profit of a subcontractor.	
2	2	6	--	The .13 man hour for the 18-watt compact fluorescent fixtures is too low.	N	This is not too low in our opinion and in the opinion of the contractors and suppliers contacted in regard to this project.	
3	--	--	--	Suggest that you check Davis-Bacon labor rates for the Fayetteville area.	N	The labor rates are from the Corps-wide accepted Means Cost Estimating Database and has been adjusted to reflect the cost of labor in the Fort Bragg area. This rate includes the overhead and profit of a subcontractor.	
4	--	--	--	The report is well done.		No Action Necessary.	

ACTION CODES: D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

A - Accepted/Concur

Project Review Comments	Interim ☐ Project: Limited Energy Study of Hangar Facilities at Simmons Army Airfield Fort Bragg, NC Pre-Final ☒ Location: P.N. Final ☐ Year:	Reviewer: Fort Bragg DPWE Page 1 of 1 Name: SAM MUSULIN Date: 3/10/95 Organizer:
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Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☐ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1	2	8	4	Costs for pressure testing, overhead, bond, and subcontracting need to be added to cost estimate.	A	Costs have been added to cost estimates.	
2	2	8	4	Sixty psi, 4" line is stated. The gas company states that high pressure (150 psi), steel 6" line should be used to transport that distance.	A	Cost estimates have been revised to incorporate recommended changes by NCNG.	
3	--	--	--	A map showing the proposed gas line routing and distribution is needed.	A	Map has been included in Final submittal. See Section 5.3.2.	

ACTION CODES: D - Action Deferred N - Non-concur VE - VE Potential/VEP Attached W - Withdrawn

A - Accepted/Concur

Project Review Comments	Interim ☐	Project:	Limited Energy Study of Hangar Facilities at Simmons	Reviewer: HQ FORSCOM	Page 1 of 2
	Pre-Final ☒	Location:	Army Airfield Fort Bragg, NC	Name: NARESH K. KAPUR, P.E.	Date: 3/24/95
	Final ☐	Year:	P.N.	Organizer:	

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☐ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
1	--	--	--	General. Please refer to our 30 December 1994 comments for Interim Submittal when a comment number is mentioned.	A	Concur.	
2	1	App. D	D-4	Refer to Comment 2 and your response in Appendix D. Response and follow up actions are incomplete. For example, multiple switching is not adequately discussed. In non-bay areas, discuss what retrofit is used in what functional area (corridors, rest rooms, administrative areas). There may be some common features in most of the buildings and special situations in individual buildings.	N	See Appendix E for modified lighting survey forms which discuss in detail replacement fixtures for all areas. Multiple switching is not applicable to most areas under survey and was only considered where applicable.	
3	1	5.3.3	5-5	Need to mention that this ECO is not favorable and will not be recommended.	A	See Section 5.4, "Recommended Projects and Organization" p. 5-10.	
4	1	5.3.4	5-5	Explain what modifications are considered. Also, need to mention that this ECO is not recommended.	A	See Table 5.3.4.1 for building-by-building explanation of proposed HVAC modifications.	
5	1	App. C	C-2	Provide project name and check if discounted demand savings are indeed \$0.00.	A	Project name has been corrected. There are no demand savings associated with this project.	
6	1	App. D	D-5	Please respond to Comment 7. We like to see a tabulation of non-competing recommended ECOs which are most likely to be successful.	A	All information on non-recommended ECOs is shown in Table 5.4.3.	
7	1	App. D	D-5	Response to Comment 13. Need to be discussed. Economy of scale on large lighting project is expected to apply. Please elaborate your response. Did Systems Corp verify their overall estimate from other independent source?	A	The Total Cost for installation and demolition is for 1.5 to 2.0 hours, not 1.5 to 2.0 hours for demolition plus 1.5 to 2.0 hours for installation. This has been verified by several different vendors and contractors. For this reason, no further reduction in man hours is taken as economy of scope is already taken into account.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/VEP Attached

W - Withdrawn

Project Review Comments	Interim ☐	Project: Limited Energy Study of Hangar Facilities at Simmons Army Airfield Fort Bragg, NC	Reviewer: HQ FORSCOM	Page 2 of 2
	Pre-Final ☒ Final ☐	Location: P.N. Year:	Name: NARESH K. KAPUR, P.E. Date: 3/24/95	Organizer:

Comment No.	Vol.	Sec.	Page	COMMENTS ☐ Struc. ☐ Arch. ☐ Civ. ☐ Mech. ☐ Elec. ☐ San. ☐ Env. ☐ Fire ☐ Other	Action Code	RESOLUTIONS (include location of documents)	Ref.
8	1	3.4.2	3-6	For compact fluorescent lamp, material and labor cost is shown as \$2.00. Check this out.	A	This price has been verified with the General Supply agency's Energy Efficient Lighting Supply House.	

ACTION CODES:
A - Accepted/Concur

D - Action Deferred

N - Non-concur

VE - VE Potential/VEP Attached

W - Withdrawn

Appendix E

LIGHTING SURVEY FORMS

INTERIOR/EXTERIOR LIGHTING SURVEY FORM

FACILITY INFORMATION:

BUILDING NUMBER & TYPE: 2936 - HANGAR HOURS OF OPERATION: 12 PAGE ____ OF ____
 AREA DESCRIPTION: Hangars at the Simmons Army Air Field BUILDING VOLTAGE: 277

EXISTING LIGHTING INFORMATION:

ROOM NAME/TYPE	FIXTURE TYPE (*)	LAMP TYPE (**)	LAMPS/ FIXTURE	WATTS/ LAMP	NO. OF FIXTURES	BALLAST AMP/MULT.	ON/OFF PEAK	LIGHTING LEVEL (fc)	REPLACEMENT FIXTURE	COMMENTS: OPERATING HOURS, DAYLIGHT
HANGAR		MH	1	400	110		ON	SEE SKETCH		
1ST FLR OFFICE	1X4 S	F	2	34	10	0.33	ON	35-45	2 Lamp T8	
1ST FLR OFFICE	2X4 R	F	2	34	10	0.33	ON	35-45	2 Lamp T8	
2ND FLR OFFICE	2X4 R	F	2	34	11	0.33	ON	35-45	2 Lamp T8	
2ND FLR OFFICE	2X4 R	F	4	34	157	0.33	ON	35-55	3 Lamp T8	
CORRIDOR	1X4 R	F	2	34	39	0.33	ON	5-30	2 Lamp T8	
LATRINE	1X4 R	F	2	34	6	0.33	ON		2 Lamp T8	
LATRINE	2X4 R	F	4	34	6	0.33	ON		3 Lamp T8	
SHOP	1X8 P	F	2	60	127	0.52	ON	15-35	2 Lamp T8	SHOP TYPE, CONTINUOUS ROWS
CORRIDOR	1X4 S	F	2	34	3	0.33	ON	5-25	2 Lamp T8	
CORRIDOR	6"X4 W	F	2	34	3	0.33	ON	5-25	2 Lamp T8	
STAIRWELL	6"X4 P	F	2	34	12	0.33	ON	5-20	2 Lamp T8	OPEN SHOP TYPE
EXIT SIGNS		INC	2	20	11		ON		LED Kit	OPERATING HOURS - 24 HR/DY
EXTERIOR LIGHTS		MV	1	400	2		OFF		250W - HPS	PHOTOCELL CONTROL

GENERAL INFORMATION:

PROJECT NAME: Fort Bragg - Limited Energy Study SURVEY DATE: 21 SEPT 94
 PROJECT NO.: 94013.04 SURVEY TEAM: JAH/MWG
 NOTES:

* R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE
 ** F=FLUORESCENT, INC=INCANDESCENT, MV=MERCURY VAPOR, MH=METAL HALIDE & HPS=HIGH PRESSURE SODIUM

INTERIOR/EXTERIOR LIGHTING SURVEY FORM

FACILITY INFORMATION:

BUILDING NUMBER & TYPE: 3007 - HANGAR HOURS OF OPERATION: 12 PAGE ____ OF ____
 AREA DESCRIPTION: Hangars at the Simmons Army Air Field BUILDING VOLTAGE: 277

EXISTING LIGHTING INFORMATION:

ROOM NAME/TYPE	FIXTURE TYPE (*)	LAMP TYPE (**)	LAMPS/ FIXTURE	WATTS/ LAMP	NO. OF FIXTURES	BALLAST AMP/MULT.	ON/OFF PEAK	LIGHTING LEVEL (fc)	EPLACEMENT FIXTURE	COMMENTS: OPERATING HOURS, DAYLIGHT OPERATING HOURS - 18 HR/DY
HANGAR		HPS	1	250	90		ON	SEE SKETCH		OPERATING HOURS - 18 HR/DY
OFFICES	2X4 R	F	4	34	2	0.33	ON	55	3 Lamp T8	
OFFICES	2X4 R	F	3	34	39	0.33	ON	45-55	2 Lamp T8	
OFFICES	2X4 R	F	2	34	91	0.33	ON	45-55	2 Lamp T8	
OFFICES	6"X4 S	F	1	34	2	0.16	ON	45-55	1 Lamp T8	
LATRINES	6"X4 S	F	2	34	15	0.33	ON		2 Lamp T8	
LATRINES	6"X4 W	F	2	34	6	0.33	ON		2 Lamp T8	
SHOP		HPS	1	250	27		ON	35-45		LOW BAY AREA
SHOP	1X4 P	F	2	34	12	0.33	ON	35-45	2 Lamp T8	
STAIRWELL	6"X4 W	F	2	34	6	0.33	ON	5-15	2 Lamp T8	
CORRIDOR	2X4 R	F	2	34	13	0.33	ON	5-20	2 Lamp T8	
EXIT SIGNS		INC	2	20	17		ON		LED Kit	OPERATING HOURS - 24 HR/DY

GENERAL INFORMATION:

PROJECT NAME: Fort Bragg - Limited Energy Study SURVEY DATE: 21 SEPT 94
 PROJECT NO.: 94013.04 SURVEY TEAM: JAH/MWG
 NOTES:

* R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE
 ** F=FLUORESCENT, INC=INCANDESCENT, MV=MERCURY VAPOR, MH=METAL HALIDE & HPS=HIGH PRESSURE SODIUM

INTERIOR/EXTERIOR LIGHTING SURVEY FORM

FACILITY INFORMATION:

BUILDING NUMBER & TYPE: 3262 - HANGAR HOURS OF OPERATION: 18 OF _____
 AREA DESCRIPTION: Hangars at the Simmons Army Air Field BUILDING VOLTAGE: 277

PAGE _____ OF _____

EXISTING LIGHTING INFORMATION:

ROOM NAME/TYPE	FIXTURE TYPE (*)	LAMP TYPE (**)	LAMPS/ FIXTURE	WATTS/ LAMP	NO. OF FIXTURES	BALLAST AMP/MULT.	ON/OFF PEAK	LIGHTING LEVEL (fc)	REPLACEMENT FIXTURE	COMMENTS: OPERATING HOURS - 24 HR/DY
HANGAR		MV	1	1000	72		ON	SEE SKETCH	400W MH	OPERATING HOURS - 24 HR/DY
SHOP	1X8 P	F	2	60	86	0.52	ON	35-50	2 Lamp T8	
OFFICE	2X4 R	F	2	34	4	0.33	ON	30-50	2 Lamp T8	
LATRINE	1X4 R	F	2	34	9	0.33	ON		2 Lamp T8	
LATRINE	2X4 R	F	3	34	2	0.33/0.16	ON		2 Lamp T8	
2ND FLR LOUNGE	2X4 R	F	4	34	10	0.33	ON	35-55	3 Lamp T8	
2ND FLR CORRIDOR	G	INC	2	60	12		ON		13W CF	
LATRINE	G	INC	2	60	2		ON		13W CF	
OFFICE	1X4 R	F	2	34	81	0.33	ON	35-50	2 Lamp T8	
2ND FLR CORRIDOR	1X4 R	F	2	34	9	0.33	ON	5-20	2 Lamp T8	
OFFICES	1X4 R	F	2	34	2	0.33	ON		2 Lamp T8	
STAIRWELL	1X4 W	F	2	34	6	0.33	ON	5-15	2 Lamp T8	
2ND FLR OFFICE	2X4 R	F	4	34	20	0.33	ON		3 Lamp T8	
STAIRWELL		INC	1	60	4		ON		13W CF	
SLEEP ROOM	2X4 R	F	4	34	4	0.33	ON		3 Lamp T8	
EXIT SIGNS		INC	2	20	4		ON		LED Kit	OPERATING HOURS - 24 HR/DY

GENERAL INFORMATION:

PROJECT NAME: Fort Bragg - Limited Energy Study SURVEY DATE: 21 SEPT 94
 PROJECT NO.: 94013.04 SURVEY TEAM: JAH/MWG
 NOTES: EXTERIOR LIGHTS - 6 HPS FIXTURES ON PHOTOCELLS - 250 WATT

* R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE
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INTERIOR/EXTERIOR LIGHTING SURVEY FORM

FACILITY INFORMATION:

BUILDING NUMBER & TYPE: 3354 - HANGAR HOURS OF OPERATION: 10 PAGE ____ OF ____
 AREA DESCRIPTION: Hangars at the Simmons Army Air Field BUILDING VOLTAGE: 277

EXISTING LIGHTING INFORMATION:

ROOM NAME/TYPE	FIXTURE TYPE (*)	LAMP TYPE (**)	LAMPS/ FIXTURE	WATTS/ LAMP	NO. OF FIXTURES	BALLAST AMP/MULT.	ON/OFF PEAK	LIGHTING LEVEL (fc)	REPLACEMENT FIXTURE	COMMENTS: OPERATING HOURS, DAYLIGHT
HANGAR		MH	1	400	41		ON	SEE SKETCH		
HANGAR		HPS	1	250	41		ON	SEE SKETCH		
1ST FLR OFFICE	1X4 P	F	2	34	6	0.33	ON	35-45	2 Lamp T8	
1ST FLR OFFICE	1X8 P	F	2	60	18	0.52	ON	60	2 Lamp T8	
SHOP	1X4 P	F	2	34	54	0.33	ON	20-50	2 Lamp T8	SHOP TYPE
PAINT SHOP	G/P	INC	1	75	28		ON	3-7	2 Lamp T8	EXPLOSION PROOF
2ND FLR OFFICE	1X4 P	F	2	34	28	0.33	ON	30-45	2 Lamp T8	
2ND FLR OFFICE	1X4 P	F	2	34	28	0.33	ON	30-45	2 Lamp T8	SHOP TYPE
CORRIDOR	G/P	INC	1	75	3		ON	5-15	18W CF	
LATRINE	G/P	INC	1	75	4		ON		18W CF	
INSTRUMENT SHOP	1X8 P	F	2	60	6	0.52	ON	80-90	2 Lamp T8	CONTINUOUS ROWS
INSTRUMENT SHOP	1X4 P	F	2	34	15	0.33	ON	80-90	2 Lamp T8	
2ND FLR OFFICE	1X8 P	F	2	60	1	0.52	ON	30-45	2 Lamp T8	
STAIRWELL	G/P	INC	1	75	8		ON		18W CF	

GENERAL INFORMATION:

PROJECT NAME: Fort Bragg - Limited Energy Study SURVEY DATE: 21 SEPT 94
 PROJECT NO.: 94013.04 SURVEY TEAM: JAH/MWG

NOTES:

* R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE
 ** F=FLUORESCENT, INC=INCANDESCENT, MV=MERCURY VAPOR, MH=METAL HALIDE & HPS=HIGH PRESSURE SODIUM

INTERIOR/EXTERIOR LIGHTING SURVEY FORM

FACILITY INFORMATION:		PAGE	OF
FACILITY INFORMATION:			

PAGE _____ OF _____

BUILDING VOLTAGE: 277

EXISTING LIGHTING INFORMATION:

[illegible]

GENERAL INFORMATION:

SURVEY DATE: 20 SEPT 94

SURVEY DATE: 20 OCT 1974

SURVEY TEAM: JAH/MWG

NOTES:

* R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE
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INTERIOR/EXTERIOR LIGHTING SURVEY FORM

FACILITY INFORMATION:

BUILDING NUMBER & TYPE: 3642 - HANGAR HOURS OF OPERATION: 12 OF
 AREA DESCRIPTION: Hangars at the Simmons Army Air Field BUILDING VOLTAGE: 277

EXISTING LIGHTING INFORMATION:

ROOM NAME/TYPE	FIXTURE TYPE (*)	LAMP TYPE (**)	LAMPS/ FIXTURE	WATTS/ LAMP	NO. OF FIXTURES	BALLAST AMP/MULT.	ON/OFF PEAK	LIGHTING LEVEL (fc)	REPLACEMENT FIXTURE	COMMENTS: OPERATING HOURS, DAYLIGHT
HANGAR		MV	1	1000	41		ON	SEE SKETCH	250 W HPS	
HANGAR		INC	1	750	41		ON	SEE SKETCH	400W MH	
SHOP		INC	1	200	56		ON	5-20	2 Lamp T8	
SHOP	6"X8 P	F	2	60	7	0.52	ON	15-30	2 Lamp T8	
STAIRWELL		INC	1	60	10		ON	5-15	13W CF	
2ND FLR OFFICE		INC	1	60	21		ON	10-20	13W CF	
2ND FLR OFFICE	1X8 P	F	2	60	20	0.52	ON	35-60	2 Lamp T8	
2ND FLR OFFICE	1X4 P	F	2	34	2	0.33	ON	35-60	2 Lamp T8	
1ST FLR OFFICE		INC	1	75	15		ON	10-20	18W CF	
1ST FLR OFFICE	1X8 P	F	2	60	2	0.52	ON	25-55	2 Lamp T8	
CORRIDOR		INC	1	60	4		ON		13W CF	
LATRINE		INC	1	60	4		ON		13W CF	
2ND FLR OFFICE		INC	1	200	18		ON	15-25	2 Lamp T8	
EXTERIOR LIGHTS		HPS	1	250	6		OFF			PHOTOCELL CONTROL

GENERAL INFORMATION:

PROJECT NAME: Fort Bragg - Limited Energy Study SURVEY DATE: 20 SEPT 94
 PROJECT NO.: 94013.04 SURVEY TEAM: JAH/MWG
 NOTES:

* R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE
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PAGE _____ OF _____

BUILDING NUMBER & TYPE: 3807 - HANGAR

NG NUMBER & TYPE:	3807 - HANGAR
AREA DESCRIPTION:	Hangers at the Simmons Army Air Field

HOURS OF OPERATION:
BUILDING VOLTAGE:

$$\frac{18}{277}$$
[illegible]

PROJECT NAME: Fort Bragg - Limited Energy Study

PROJECT NO.: 94013.04

NOTES:

SURVEY DATE: 20 SEPT 94

SURVEY TEAM: JAH/MWG

**** R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE**
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INTERIOR/EXTERIOR LIGHTING SURVEY FORM

FACILITY INFORMATION:

BUILDING NUMBER & TYPE: 3962 - HANGAR HOURS OF OPERATION: 12 PAGE ____ OF ____
 AREA DESCRIPTION: Hangars at the Simmons Army Air Field BUILDING VOLTAGE: 277

EXISTING LIGHTING INFORMATION:

ROOM NAME/TYPE	FIXTURE TYPE (*)	LAMP TYPE (**)	LAMPS/ FIXTURE	WATTS/ LAMP	NO. OF FIXTURES	BALLAST AMP/MULT.	ON/OFF PEAK	LIGHTING LEVEL (fc)	REPLACEMENT FIXTURE	COMMENTS: OPERATING HOURS - 18 HR/DY
HANGAR		MH	1	400	42		ON	SEE SKETCH		OPERATING HOURS - 18 HR/DY
HANGAR		INC	1	750	42		ON	SEE SKETCH	250W HPS	OPERATING HOURS - 18 HR/DY
SHOP	1X4 P	F	2	34	35	0.33	ON	30	2 Lamp T8	
SHOP	1X8 P	F	2	60	3	0.52	ON	30	2 Lamp T8	
1ST FLR OFFICE	2X4 S	F	4	34	10	0.33	ON	25-45	2 Lamp T8	
SHOP	1X4 P	F	4	34	23	0.33	ON	50	3 Lamp T8	
OFFICE	1X4 P	F	2	34	6	0.33	ON	25-45	2 Lamp T8	
2ND FLR OFFICE	1X4 P	F	4	34	35	0.33	ON	50-65	3 Lamp T8	
2ND FLR SHOP	1X4 P	F	2	34	12	0.33	ON	25-35	2 Lamp T8	
SHOP		INC	1	75	8		ON		18W CF	
2ND FLR OFFICE		INC	1	75	4		ON	15-25	18W CF	
2ND FLR OFFICE	1X4 P	F	2	34	5	0.33	ON	15-25	2 Lamp T8	
STAIRWELL		INC	1	60	8		ON		18W CF	

GENERAL INFORMATION:

PROJECT NAME: Fort Bragg - Limited Energy Study SURVEY DATE: 20 SEPT 94
 PROJECT NO.: 94013.04 SURVEY TEAM: JAH/MWG
 NOTES:

* R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE
 ** F=FLUORESCENT, INC=INCANDESCENT, MV=MERCURY VAPOR, MH=METAL HALIDE & HPS=HIGH PRESSURE SODIUM

FACILITY INFORMATION:

BUILDING NUMBER & TYPE:	4137 - HANGAR	HOURS OF OPERATION:	12
AREA DESCRIPTION:	Hangars at the Simmons Army Air Field	BUILDING VOLTAGE:	277

EXISTING LIGHTING INFORMATION:

[illegible]

GENERAL INFORMATION:

PROJECT NAME: Fort Bragg - Limited Energy Study
PROJECT NO.: 94013.04
SURVEY DATE: 20 SEPT 94
SURVEY TEAM: JAH/MWG
NOTES:

NOTES:

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PAGE OF

BUILDING NUMBER & TYPE: 4242 - HANGAR

4242 - HANGAR
Hangars at the Simmons Army Air Field

HOURS OF OPERATION:
BUILDING VOLTAGE:

$$\frac{10}{277}$$

PAGE OF

EXISTING LIGHTING INFORMATION:

[illegible]

PROJECT NAME: Fort Bragg - Limited Energy Study

PROJECT NO.: 94013.04

NOTES:

SURVEY DATE: 20 SEPT 94

SURVEY TEAM: JAH/MWG

*** F=FLUORESCENT, INC=INCANDESCENT, MV=MERCURY VAPOR, MH=METAL HALIDE & HPS=HIGH PRESSURE SODIUM

INTERIOR/EXTERIOR LIGHTING SURVEY FORM

FACILITY INFORMATION:
 BUILDING NUMBER & TYPE: 7937 - HANGAR HOURS OF OPERATION: 18
 AREA DESCRIPTION: Hangars at the Simmons Army Air Field BUILDING VOLTAGE: 277
 PAGE ____ OF ____

EXISTING LIGHTING INFORMATION:

ROOM NAME/TYPE	FIXTURE TYPE (*)	LAMP TYPE (**)	LAMPS/ FIXTURE	WATTS/ LAMP	NO. OF FIXTURES	BALLAST AMP/MULT.	ON/OFF PEAK	LIGHTING LEVEL (fc)	REPLACEMENT FIXTURE	COMMENTS: OPERATING HOURS - 24 HR/DY
HANGAR		HPS	1	250	124		ON	SEE SKETCH		
1ST FLR OFFICE	2X4 R	F	3	34	62	0.27	ON	30-50	2 Lamp T8	
1ST FLR CORRIDOR	1X4 S	F	2	34	9	0.27	ON	10-15	2 Lamp T8	
LATRINE	1X4 W	F	2	34	4	0.27	ON		2 Lamp T8	
2ND FLR OFFICE	2X4 R	F	2	34	26	0.27	ON	30	2 Lamp T8	
LATRINE	1X4 R	F	2	34	4	0.27	ON		2 Lamp T8	
LATRINE	1X4 S	F	2	34	2	0.27	ON		2 Lamp T8	
SHOPS		MH	1	400	43		ON	25-50		
CORRIDOR	1X4 S	F	1	34	34	0.16	ON	15		
2ND FLR OFFICE	2X4 R	F	2	34	20	0.27	ON	30-40	2 Lamp T8	
STAIRWELL	1X4 S	F	1	34	4	0.16	ON			
LATRINE	1X4 W	F	2	34	2	0.27	ON		2 Lamp T8	
LATRINE	2X4 R	F	2	34	2	0.27	ON		2 Lamp T8	
EXIT SIGNS		INC	2	20	14		ON		LED Kit	

GENERAL INFORMATION:

PROJECT NAME: Fort Bragg - Limited Energy Study SURVEY DATE: 20 SEPT 94
 PROJECT NO.: 94013.04 SURVEY TEAM: JAH/MWG
 NOTES: HANGAR LIGHTS OPERATING 24 HR/DY DUE TO POOR LOCATION OF SWITCHING

* R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE
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INTERIOR/EXTERIOR LIGHTING SURVEY FORM

FACILITY INFORMATION: _____ PAGE _____ OF _____

PAGE OF

BUILDING VOLTAGE: 277

EXISTING LIGHTING INFORMATION:

[illegible]

GENERAL INFORMATION:

SURVEY DATE: 20 SEPT 94

SURVEY TEAM: JAH/MWG

NOTES:

* R = RECESSED, S=SURFACE, P=PENDANT, ST= SHOP TYPE, W=WALL MOUNTED & G=GLOBE
 ** F=FLUORESCENT, INC=INCANDESCENT, MV=MERCURY VAPOR, MH=METAL HALIDE & HPS=HIGH PRESSURE SODIUM