COMPLETE PROGRAMMING DOCUMENTATION

for

ECIP Expansion of Existing

Energy Monitoring and Control System (EMCS)

Fort Leonard Wood, Missouri

Prepared By:

E M C Engineers, Inc.

Atlanta, Georgia

DTIC QUALITY INSPECTED 2

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for

U.S. Army Corps of Engineers

Kansas City, Missouri

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December 1993



DEPARTMENT OF THE ARMY

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	А.	Functional Requirements Summary
	B.	Documentation Checklist
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PART 1

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PROJECT DEVELOPMENT BROCHURE

installation: Fort Leonard Wood, Missouri	
<pre>project:ECIP Expansion of Existing EMCS ()</pre>	<u>Energy Monitoring Control Syst</u> em)
project number temporary:	program yearFY95
permanent:	category code
point of contact:	
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other (A-E) name	_ date
title	_ phone
	autovon
reviewed by	
installation facility engineer	date
title	_ phone
	autovon
approved by: macom engineer	
name	date
title	phone
	autovon
project develo	pment brochure, PDB-1
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DA FORM 5020-R, Feb 82



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OBJECTIVE

The objective of this project is to reduce energy consumption in 203 buildings by providing a new EMCS (Energy Monitoring Control System) to control and monitor systems.

REQUIREMENTS

Of the 203 buildings on the new EMCS, 45 buildings are currently controlled and monitored by an existing EMCS. The existing hardware in the 45 buildings shall be replaced, but the fiber optic (FO) cable to the hardware should be retained. The new EMCS shall include 158 additional buildings. The new EMCS should consist of new PC-based front-end computers communicating to building Remote Control Units, Auxiliary Control Units, and Unitary Control Units. There are 3,826 EMCS points in the 158 additional buildings. A new data transmission system, consisting of contractorinstalled aerial and underground FO cable shall be provided for all data communication needs to the 158 buildings.

The EMCS configuration shall be based on the Huntsville Division Corps of Engineers current draft guide specifications. These specifications include the following main components:

- PC-based front-end computers, specified to be the fastest available microprocessor at the time (currently an Intel 80486-66 mHz).
- Remote Control Units (RCU), microprocessor-based field panels which coordinate communications and some high level control coordination with ACUs and UCUs. There is typically one RCU per 64 ACUs and UCUs.
- Auxiliary Control Units (ACU), microprocessor-based panels set up to control and monitor single pieces of equipment, or groups of equipment. ACUs are typically used for large systems.
- Unitary Control Units (UCU), microprocessor-based panels set up to control and monitor single pieces of equipment, or groups of equipment. UCUs are typically used for terminal devices (such as variable air volume boxes) and fan coils.
- Central Operator Station (COS), is the site where the front-end computers are located and the system operator technician operates the EMCS.
- Communication Processor and Communication Network Interface, provide the interface and management of the networks. Different networks could exist between COSs, between the COS and RCUs, and between RCUs, ACUs, and UCUs.

The data transmission media (DTM) shall be FO cable. The existing EMCS utilizes fiber optic DTM. The Johnson Controls EMCS which preceded the current EMCS was turned off and removed because the coaxial communication system was prone to lightning strikes. Fort Leonard Wood is in a high lightning area of the United States.

functional requirements summary, PDB-1

REQUIREMENTS (continued)

Sensors and actuators shall be provided to monitor and control the remote points of the EMCS. The sensors should include, but not be limited to the following:

- Temperature sensors with transmitters
- Relative humidity sensors with transmitters
- Pressure sensors
- Pressure switches
- Watt meters
- Amp meters
- Flow meters
- Current transformers
- Status relays
- Start/stop control relays
- Electric/pneumatic transducers
- Pneumatic/electric transmitters.

The EMCS at Fort Leonard Wood is operated and maintained by the EMCS manager and the system operator technician. No major maintenance or calibration work would be done by this staff. The staff, however, should be able to troubleshoot, exchange defective boards on computer-based hardware, and perform similar tasks. Two additional EMCS operators should be provided to operate the EMCS.

Correct and continuing maintenance of EMCS equipment is essential if the maximum benefits of the system are to be realized. Without proper maintenance, the reliability of an EMCS will rapidly deteriorate, thereby reducing its energy conservation capability and benefits.

functional requirements summary, PDB-1

Α.	SPECIAL CONSIDERATIONS	ired or lequired	* mined	nent hed	nent
	ITEM	Requi Not R	To Be Deteri	Сот Attaci	Docur
.1	Cost estimates for each primary and supporting facility	R		V	
.2	Telecommunications system coordination with USACC and authorization for exceptions	NR			
1-3	Coordination with state and local governmental requirements (blind vendors, medical facilities, construction and operating permits, clearinghouse ccoordination, etc.)	NR			
4	Assignment of airspace	NR			
5	Economic analysis of alternatives	R		V	
6	Approval for new starts	NR			
7	International balance of payments (IBOP) coordination with U.S. European command and NATO-overseas cost estimates and comparables (include rate of exchange used in estimates)	NR			
8	Impact on historic places—on site survey by authorized archeologist and coordination with state historic preservation officer and advisory council on historic preservation	NR			
1.9	Exceptions to established criteria	NR			
1.10 International balance of payments (IBOP) coordination with U.S. European command and NATO-overseas cost estimates and comparables (include rate of exchange used in estimates) NR 1.48 Impact on historic places-on site survey by authorized archeologist and coordination with state historic preservation officer and advisory council on historic preservation NR 4.9 Exceptions to established criteria NR A.10 Coordination with various staff agencies (Provost Marshall-physical security, etc.) R A.11 Identification of related or support projects (so projects can be coordinated) R A.12 Required completion date R Other Special Considerations (List and number items) R		V			
1.11	ITEM 1 Cost estimates for each primary and supporting feellity 2 Telecommunications system coordination with USACC and authorization for exceptions 3 MR 4 Assignment of airspace 5 Economic analysis of alternatives 6 Approval for new starts 7 International balance of payments (IBOP) coordination with U.S. Europeen command and NATO-overseas cost estimates and comparables (include rate of exchange used in estimates) 8 Impact on historic places-on site survey by authorized archeologist and coordination with state historic preservation officer and advisory council on historic preservation 9 Exceptions to established orieria 10 Coordination with various staff agencies (Provost Marshall-physical security, etc.) 11 Identification of related or support projects (so projects can be coordinated) 12 Required completion date 0 Other Special Considerations (List and number items)	R	P		
-12	Required completion date	R	A		
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В.	SITE DEVELOPMENT	red or equired	* nined	ent aed	nent
	ITEM	Requi Not R	To Be Deterr	Comm Attach	Docun
B-1	Consultation with the District Office to determine and evaluate flood plain hazards				
		NR			
B-2	Preparation, submission, and/or approval of new				
(A)	General Site Plan	NR			╂
(B)	Annotated General Site Plan	LNR			
(ē)	Sketch Site Plan	NR			
(0)	Facilities Requirements Sketch	NR			
B-3	Preparation of			1	
(A)	Site Survey	NR			
(B)	Subsoil information		1 -		Ť
	Annual by Deserve of Defense Fuelesius Safety Deard (DDESD) for Safety Site Plan			<u> </u>	╂──
5-4	Approval by Department of Defense Explosive Safety Board (DDESD) for Safety Site Fian	NR			
REQUI mur Ente TO BE Ente	RED OR NOT REQUIRED – Not relevant or no information to com- hicate. Enter "R" if item is relevant and is required for this project. ar "NR" if item is irrelevant and is not required for this project. DETERMINED – Information needed but not currently available. ar code for information source. DETERMINED – Significant information summarized or explained	ck and inse		opriate le	tter)

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	ITEM	n n n n n n n n n n n n n n n n n n n	²	ĥ	ÅĈ	Ϋ́ο
C-1	Reconciliation with troop housing programs and requirements	N	R			
$\frac{c}{c \cdot 2}$	Evaluation of existing facilities (including degree of utilization)	F	2		V	
<u> </u>	Approval for removal and relocation of existing useable facilities	1 N	R			
<u><u>c</u>-4</u>	Evaluation of off-post community facilities	N I	R			
C-5	Storage and maintenance facilities (including nuclear weapons)		IR			
C-6	Coordination hospitals, medical and dental facilities with Surgeon General	Γ _λ	JA I			
C.7	Coordination of aviation facilities with FAA		IR			
C-8	Coordination air traffic control and navigational aids with USACC	K	IR			
C-9	Tabulation of types and numbers of aircraft		JR			
C-10	Evaluation of laboratory, research and development, and technical maintenance facilities		IR			
C-11	Coordination chapels with Chief of Chaplains		IR			
C-12	Review food service facilities by USATSA		R			
C.13	Automated data processing system or equipment approvals-cost analysis when ADP and/or		.			
	communication centers not co-located with related facilities		sr]	
C-14	Coordination postal facilities with U.S. Postal Service Regional Director		18		[
C-15	Laundry and dry cleaning facilities coordination with ASD(I&L)		JR			
C-16	Tenant facilities coordination with installation where sited		JR			
C-17	Facilities for or exposed to explosions, toxic chemicals, or ammunition-review by DDESB (See					
	also Item B-4)	K	R			
C-18	Analysis of deficiencies	1	2		V	
C-19	Consideration of alternatives		2		V	
C-20	Determination whether occupants will Include physically handicapped or disabled persons		2		V	
C-21	As-build drawings for alterations or additions		2		_ <u>¥_</u>	
C-22	Availability of Standard Design or site adaptable designs	1	VR			
	Other Architectural & Structural (List and number items)					
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	documentation char	k	jC	241	[
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	D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS		ired or Require	e rmined	ment ched	iment
	ITEM		Requ Not F	To B Detei	Com	Docu
0-1	Fuel considerations and cost comparison analysis		NR			
.2	Energy requirements appraisal (ERA)		R		<u> </u>	
.3	Conformance with DOD Energy Reduction requirements		R		<u> </u>	
)-4	Evaluation of existing and/or proposed utility systems		NR			
	Other Mechanical and Utility Systems (List and number items)				V	
-5	Evaluation of existing and/or proposed EMCS					
				tert appro		
REC TO E COM	DUIRED OR NOT REQUIRED Not relevant or no information to com- nunicate. Enter "R" if item is relevant and is required for this project. Enter "NR" if item is irrelevant and is not required for this project. BE DETERMINED Information needed but not currently available. Enter code for information source. MMENT ATTACHED Significant information summarized or explained and attached.	*BY WHOM (Chec A - DFAE B - Using Serv C - Construct D - Designer E - Other (Ch	ck and ins vice ion Servic eck Comi	ert appr e nents At	opriate la ttached a	atter) Ind
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	E ENVIRONMENTAL CONSIDERATIONS	ſ	<u></u>			\square
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			πz	+0	υ<	<
$\frac{E \cdot 1}{E \cdot 2}$	Environmental impact assessment		NR			·
E-3	Determination of health, environmental or related hazards. Assistance to determine existence of any		- 44			
	health, environmental or related hazard may be requested from Aberdeen Proving Ground, MD 21010, the Office of the Surgeon General, Attn: DASG-HCH (Army Environmental Hygiene Agency)		NR			
E-4	Air/water pollution permit, coordination with agencies and compliance with standards at Federal, state and local level		NR			
E-5	Corrective measures associated with Environmental Impact Statements or assessment—list separately and evaluate.		NR			
	Other environmental considerations (list and number items)					
						1
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REO	UIRED OR NOT REQUIRED Not relevant or no information to com- *BY WHOM (Chee	ck an	id inse	rt appro	priate le	tter)
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DOC	UMENT ATTACHED - Significant information is in an existing docu- explain)					
	documentation char	k	lic	st	1	
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DA.	EODM 5022 E. P. Ech 82					

COMMENTS

DOCUMENTATION CHECKLIST

Item	Comments
A-1	See the cost estimates in Part 3, "Economic Analysis".
A-5	Alternatives to the EMCS in relation to the energy conservation project were considered as a part of the study.
A-10	Scheduling and clearances for access to permanent buildings must be considered.
C-2	Evaluations concerning the thermal characteristics of the subject facilities were completed as an integral part of the energy study.
C-18	Deficiencies in efficient energy consumption have been identified and corrections have been proposed.
C-19	Alternatives to the EMCS with respect to the energy study were considered.
C-20	The scope of work will not affect accessibility of the handicapped.
C-21	As-built drawings for project facilities are available for check-out and reproduction from DEH.
D-2	The Energy Requirements Appraisal was completed and included in Part 3.
D-3	Implementation of this project will result in reduced energy consumption.
D-5	Evaluations concerning the existing EMCS and a proposed EMCS were completed as an integral part of the energy study.

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A. SPECIAL CONSIDERATIONS	ired or tequired	mined *	nent hed	ment
ITEM	Requi Not R	To Be Deter	Comn Attac	Docu
Factors of risk, restriction or unusual circumstance expected to increase costs beyond applicable area averages	NR			
Construction phasing requirements	R	A		.
Functional support equipment (mechanical, electrical, structural, and security) to be built in	NR			
Equipment in place and justification	NR		[·	
Other equipment and furniture (O&MA, OPA) and costs	NR	.		
Special studies and tests (hazards analyses, compatibility testing, new technology testing, etc.)	NR		<u> </u>	
Type of construction (permanent, temporary, semi-permanent)	NR	.		.
Government furnished equipment (quantities, procurement time, availability and special handling and storage requirements). Funds used for procurement.	NR			
NUIRED OR NOT REQUIRED – Not relevant or no information to com-	bck and int	ert appr	opriate la	otte
Inter "NR" if item is irrelevant and is not required for this project. A - DFAE BE DETERMINED - Information needed but not currently available. B - Using Se Construct C - Construct MMENT ATTACHED - Significant information is in an existing docu- C - Other (C	rvice tion Servic heck Com	e nents At	ttached a	nd

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В.	SITE DEVELOPMENT) [ired or Required	e • mined	nent :hed	ment thed
	ITEM		Requ Not F	To Be Deter	Comr Attac	Docu Attac
B-1 (A)	Construction restrictions or guidelines pertaining to site access and preferred construction routes		NR			
(B)	Airfield clearance, explosive storage, working hours, safety, etc.		NR			
(c)	Facilities and/or functions or adjoining areas (structures, materials, impact)		NR			
B-2	Real estate actions (acquisition, disposal, lease, right-of-way)		NR			
B-3	Demolition/relocation required (data)				ł	
(A)	Special considerations due to explosives/radioactivity/ chemical contamination/asbestos emissions/toxic gases		NR			
(8)	Restrictions on disposal of demolished/relocated material including hazardous waste		NR			
B-4	Pavement types and requirements (including traffic surveys and MTMC coordination)		NR			
8-5	Landscape considerations					
(A)	Protection of existing vegetation		NR			
(B)	Stockpile topsoil		NR			ļ
	Other Site Development (List and number items)					
REQUIR mun Ente TO BE Ente COMME and DOCUM	RED OR NOT REQUIRED – Not relevant or no information to com- icate. Enter "R" if item is relevant and is required for this project. r "NR" if item is irrelevant and is not required for this project. DETERMINED – Information needed but not currently available. r code for information source. INT ATTACHED – Significant information summarized or explained attached. IENT ATTACHED – Significant information is in an existing docu- t which is attached.	eck rvice tior	and inse e n Service k Comm	ert appro ents At	opriate le	stter) Ind
	technical data chec	;}	li	st		

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c	. ARCHITECTURAL & STRUCTURAL	ſ	ed or quired	* ined	ž p	a t
	ITEM		Require Not Re	To Be Determ	Comme	Docum
C-1	Vibration-producing equipment requiring isolation		NR			
C-2	Seismic zone and other design load criteria (typhoon, hurricane, earthquake loads, high or low loss potential)		NR			
C-3	Protective shelter evaluation and resistant design criteria (conventional/nuclear blast and radia- tion, chemical/biological)		NR			
C-4	Unusual foundation requirements (pier, pile, caisson, deep foundations, mat, special treatment, permafrost areas, soil bearing)		NR			
C-5	Designation and strength of units to be accommodated		NR			
C-6	Requirements and data for special design projects		NR			
C.7	Unusual floor and roof loads (safes, equipment)		NR			
<u>C.8</u>	Security features (arms rooms, vaults, interior secure areas)	-	NR			
REQU M Ea TO E E COM ar DOC	UIRED OR NOT REQUIRED - Not relevant or no information to com- unicate. Enter "R" if item is relevant and is required for this project. Inter "NR" if item is irrelevant and is not required for this project. BE DETERMINED - Information needed but not currently available. Inter code for information source. MENT ATTACHED - Significant information summarized or explained attached. UMENT ATTACHED - Significant information is in an existing docu- tent which is attached.	ice on S eck	nd inser Service Comme	nt appro	priate le ached ar	tter) od
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Required or Not Required D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS To Be * Determined Comment Attached Document Attached ITEM Special mechanical requirements or considerations (elevator, crane, hoist, etc.) NR D-1 Special peak usage periods and peak leveling techniques D R D-2 Maintenance considerations (accessibility of equipment, compatibility with existing equipment) D R D-3 Plumbing-availability, general system type and characteristics (proposed and/or existing, incl. D-4 compressed air and gas) NR Heating-availability, general system type and characteristics (proposed and/or existing) NR D-5 Ventilating, air condition/refrigeration-availability, general system type and characteristics (pro-D-6 posed and/or existing) NR Electrical-availability, general system type and characteristics incl. airfield lighting, communica-D-7 tion, etc. (proposed and/or existing) NR Water supply/waste treatment-availability, general system type and characteristics (proposed D-8 and/or existing) NR Energy requirements/fuel conversion (sources, availability, loads, types of fuel, etc.) NR D-9 NR D-10 Solar energy evaluation Other Mechanical & Utility Systems (List and number items) R D D-11 EMCS - availability, general systems type and characteristics (proposed and/or existing) REQUIRED OR NOT REQUIRED - Not relevant or no information to com-*BY WHOM (Check and insert appropriate letter) municate. Enter "R" if item is relevant and is required for this project. A - DFAE Enter "NR" if item is irrelevant and is not required for this project. B - Using Service TO BE DETERMINED - Information needed but not currently available. C - Construction Service Enter code for information source. D - Designer COMMENT ATTACHED - Significant information summarized or explained and attached. E - Other (Check Comments Attached and DOCUMENT ATTACHED - Significant information is in an existing docuexplain) ment which is attached. technical data checklist

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E	E. ENVIRONMENTAL CONSIDERATIONS		iired or Required	e * rmined	ment ched	ment thed
	ITEM		Requ	To B Dete	Com Atta	Docu
E·1	Weste water treatment, air quality, and solid waste disposal criteria		NR			
	Other Environmental Considerations (List and humber items)					
REQU MI En TO B En	JIRED OR NOT REQUIRED - Not relevant or no information to com- unicate. Enter "R" if item is relevant and is required for this project. Inter "NR" if item is irrelevant and is not required for this project. In DETERMINED - Information needed but not currently available. Inter code for information source.	* BY WHOM (Check A - DFAE B - Using Servic C - Construction D - Designer	and inser e n Service	7 rt approj	priate let	tter)
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	technical data	check	dic	•	\square	

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	ITEM		Red Not	To Det	Con Att	Doc Att
F-1	Special fire protection systems or features (detection and suppression equipment	t, hazards, etc.)	NR			
REQ m E TO 1 E COM e DOC	UIRED OR NOT REQUIRED - Not relevant or no information to com- bunicate. Enter "R" if item is relevant and is required for this project. Inter "NR" if item is irrelevant and is not required for this project. BE DETERMINED - Information needed but not currently available. Inter code for information source. IMENT ATTACHED - Significant information summarized or explained and attached. CUMENT ATTACHED - Significant information is in an existing docu- nent which is attached.	BY WHOM (Check A – DFAE B – Using Servic C – Constructio D – Designer E – Other (Che explain)	and inse ce on Service ck Comm	ert appro	priate le tached a	nd

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DD FORM 1391

1. COMPONENT ARMY	FY 1995 MILITARY CO	ONSTRU		ECT DATA	2. DATE 27 DEC 93
3. INSTALLATION AND L Fort Leonard Wood, N	OCATION Iissouri		4. PROJECT ECIP Expan (Energy Mo System)	TITLE sion of Existin nitoring Cont	ng EMCS rol
5. PROGRAM ELEMENT	6. CATEGORY CODE 80000	7. PRO	JECT NO.	8. PROJECT (\$000)	COST
			_	3,4	10
	9. COST ES	STIMATES	3 		0007
רו	EM	U/M	QUANTITY	UNIT COST	COST (\$000)
Primary Facility: Expand the ex 158 additional based front-en Operator Static Processor and Remote Control Control Units, sensors, and a hardware in 45 existing EMCS (FO) cable to t Provide FO ca additional build	isting EMCS to include buildings. Provide PC- d computers, Central on, Communication Network Interface, of Units, Auxiliary Unitary Control Units, actuators. Replace field 5 buildings on the and retain fiber optic hese buildings. ble to the 158 dings.	LS			2,77
Supporting Facilities: Design Cost (6 Estimated Contract C	S%) ost	LS			_ <u>16</u> 2,93
Contingency (10%)		LS			29
Subtotal					3,23
Supervision, Inspection (5.5%)	on and Overhead	LS			17
TOTAL REQUEST					3,41
10. DESCRIPTION OF F The proposed constru- monitor systems in 18 buildings on the exist computers communic Unitary Control Units, and 1,133 are existing installed aerial and ur needs to the 158 new shall be retained and	PROPOSED CONSTRUCTIO uction includes a new EN 58 new buildings and rep ing EMCS. The new EM sating to building Remote to control and monitor 4 g points. A new data tran derground FO cable sha v buildings. The FO cabl used for the replacemen	N ACS at F blace field CS shou COntrol 9,959 poi nsmissio all be pro le to the nt field ha	ort Leonard V d hardware in Ild consist of Units, Auxilia nts, of which n system, cor bvided for all o 45 buildings ardware.	Vood to contr the original PC-based fro ry Control Ur 3,826 are ne nsisting of co data commur on the existin	rol and 45 int-end hits, and w points ntractor- hication ng EMCS
DD FORM 1391 1 DEC 76	PREVIOUS EDITIONS MA UNTIL EXI FOR OFFICIA	Y BE USEI HAUSTED L USE			PAGE N

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1.	COMPONENT
	ARMY

3. INSTALLATION AND LOCATION Fort Leonard Wood, Missouri

4. PROJECT TITLE ECIP Expansion of Existing EMCS (Energy Monitoring Control System) 5. PROJECT NUMBER

11. REQUIREMENT

PROJECT:

Expand the existing EMCS to include 158 additional buildings. Provide PC-based front-end computers, Central Operator Station, Communication Processor and Network Interface, Remote Control Units, Auxiliary Control Units, Unitary Control Units, sensors, and actuators. Replace field hardware in 45 buildings on the existing EMCS and retain fiber optic (FO) cable to these buildings. Provide FO cable to the 158 additional buildings. Provide two additional EMCS operators for the EMCS.

REQUIREMENT:

This project is required to reduce the fuel oil consumption, LPG consumption, electrical consumption, and electrical demand of HVAC equipment, boilers, chillers, and electric domestic hot water heaters through EMCS control technology.

CURRENT SITUATION:

Fort Leonard Wood has an existing EMCS in 45 buildings. The final construction and acceptance of this EMCS was completed in the summer of 1991. The EMCS configuration includes dual Digital Equipment Corporation (DEC) MicroVax 3100 minicomputers, three DEC VaxStation 3100's with 19^e color monitors, plus peripherals and a failover controller. Six FO data transmission cables facilitate the communications from the master control room to the buildings.

Discussions with the EMCS operators at Fort Leonard Wood regarding the existing EMCS indicated the system was operational and was providing them significant utility savings (especially through electrical demand limiting). The discussions also revealed some problems and defects associated with the existing EMCS.

DD FORM 1391c 1 DEC 76 PREVIOUS EDITIONS MAY BE USED INTERNALLY UNTIL EXHAUSTED FOR OFFICIAL USE ONLY (WHEN DATA IS ENTERED)

PAGE NO. 2

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJE	CT DATA	2. DATE 27 DEC 93
3. INSTALLATION AND LO Fort Leonard Wood, Mis	CATION souri		
4. PROJECT TITLE ECIP Expansion o System)	f Existing EMCS (Energy Monitoring Control	5. PROJECT	NUMBER
IMPACT IF NOT PROVID	DED:	- A	
If this project is not funct of fuel oil, LPG, natural of to energy reduction goa	led, a reduction of 195,777 MBtu/yr cannot be ac gas and electricity will continue to be used, and t is established for U.S. Army facilities by Army He	chieved. Exce there will be n adquarters.	essive amounts to contribution
ADDITIONAL:			
This project complies wi Program (ECIP) Guidan payback of 3.2 years. T 195,777 MBtu and an ar	th the scope and design criteria of the "Energy C ce". The project has a Savings to Investment Ra he implementation of this project will provide an nnual total dollar savings of \$1,037,666.	Conservation I tio (SIR) of 3.0 annual energ	nvestment) and a simple y savings of
Project validation will be consumption basewide.	through the use of electric and gas meters on the	he existing uti	lities to record

(WHEN DATA IS ENTERED)

PART 3

SUPPORTING DATA

Date: December 1993 Project Number: Project Title: ECIP Expansion of Existing EMCS (Energy Monitoring Control System)

PROGRAMMING DOCUMENTATION Supporting Data

Method of Analysis:

A series of computer programs and analysis techniques were used to select the buildings, systems, and functions which would provide an optimum EMCS configuration for Fort Leonard Wood. This main analysis program, written by EMC Engineers, Inc., calculates the energy savings which result when a particular EMCS function is applied to a specific mechanical system type. Savings are calculated on a function-by-function basis for each system. Typical system configurations were developed for a range of AHUs, pumps, boilers, and chillers. The calculations follow the basic guidelines described in "CR82.030, <u>Standardized EMCS Energy Savings Calculations</u>, Naval Civil Engineering Laboratory".

Energy savings were calculated using energy constants derived by computer energy simulations of representative buildings and weather conditions at Fort Leonard Wood. The TRACE and BEACON computer programs were used to execute the computer energy simulations. Both programs perform hourly energy calculations and can predict the energy consumption which would result from various heating and cooling systems and operational settings. The energy savings for the buildings not simulated were extrapolated using the energy constants derived for the representative buildings.

The functions provided in the analysis program include:

- Scheduled start/stop
- Optimum start/stop
- Duty cycling
- Demand start/stop of motors
- Demand start/stop of chillers
- Economizer
- Direct digital control
- Unoccupied setback
- Hot water outside air reset
- Chilled water temperature reset
- Ventilation/recirculation damper control.

The analysis computer program also developed the I/O summary table for the proposed functions for each system, estimated the cost for the hardware to implement the functions, and split the cost between function groups. Savings and costs computed by the analysis program were then entered into the spreadsheet program to calculate the economics for various functions.

The spreadsheet program has special features which allow calculations, selection of items, sorting, and prioritization of items. This system was used for the following purposes:

- To perform economic analyses on EMCS functions, systems, and buildings.
- To sort data on the benefits provided by the EMCS to obtain the optimum system.

Based on the final selection of functions, systems, and buildings, the total savings and costs were developed into an EMCS project.

Date: December 1993 Project Number: Project Title: ECIP Expansion of Existing EMCS (Energy Monitoring Control System)

PROGRAMMING DOCUMENTATION Supporting Data

Assumptions:

Electric cost = \$0.025/kWh

Electric demand cost = \$6.185/kW/month

No. 2 fuel oil cost = \$5.4398/MBtu

No. 6 fuel oil cost = 4.4312/MBtu

Liquified petroleum gas cost = \$5.6305/MBtu

Calculations:

Annual Recurring Cost =	Annual Maintenance Manhours Savings + Annual Electrical Demand Savings + (Annual Staff Cost) + (Annual Maintenance Cost)
=	\$58,644 + \$38,118 + (\$66,000) + (\$114,533)
=	(\$83,771)

Economic Analysis:

TABLE 3-1ECONOMIC SUMMARY

Project	Annual Energy Savings (MBtu/yr)	Total Annual Cost Savings (\$/yr)	Simple Payback (yrs)	SIR
ECIP Expansion of Existing EMCS (Energy Monitoring Control System)	195,777	1,037,666	3.2	3.0

The Life Cycle Cost Analysis (LCCA) for the ECIP project is presented on page 3-3. The economic summary for the 158 additional buildings on the EMCS is presented in Table 3-2 beginning on page 3-4.

LIFE CYCLE COST ANALYSIS SUMMARY ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) INSTALLATION & LOCATION: FT. LEONARD WOREGION NOS. 7 CENSUS: 2 PROJECT NO. & TITLE: 3204-000 EMCS FEASIBILITY STUDY FISCAL YEAR 1993 DISCRETE PORTION NAME: EXPANSION AN EXISTING EMCS ANALYSIS DATE: 12-27-93 ECONOMIC LIFE 10 YEARS PREPARED BY: KC

1.	INVESTMENT		
	A. CONSTRUCTION COST	\$	2772023.
	B. SIOH	\$	152462.
	C. DESIGN COST	\$	166322.
	D. SALVAGE VALUE COST	-\$	0.
	E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	3090807.

2. ENERGY SAVINGS (+) / COST (-) ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

3.

U FUEL \$	JNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT B. DIST C. RESID D. NAT G E. COAL	7.32 5.44 4.43 5.63 .00	16701. 98345. 61870. 18861. 0.	\$ 122334. \$ 534977. \$ 274158. \$ 106197. \$ 0.	8.08 9.44 10.90 9.35 8.51	988456. 5050184. 2988326. 992941. 0.
F. TOTAL		195777.	\$ 1037666.		\$ 10019910.
NON ENERGY	SAVINGS(+)	/ COST(-)			
A. ANNUAL F	RECURRING (+	+/-)			\$ -83771.

A. ANNUAL RECURRING (+/-)		\$ -83771.
(1) DISCOUNT FACTOR (TABLE A)	7.87	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		\$ -659278.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)\$ -659278.

D. PROJECT NON ENERGY QUALIFICATION TEST
 (1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 3306570.
 A IF 3D1 IS = OR > 3C GO TO ITEM 4
 B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)_____
 C IF 3D1B IS = > 1 GO TO ITEM 4
 D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY</pre>

4.	FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3	BB1D/(YRS ECONOMIC	LIFE))\$	953895.
5.	TOTAL NET DISCOUNTED SAVINGS (2F5+3	BC)	\$	9360629.
6.	DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALIFY)	(SIR)=(5 / 1E)=	3.03	
7.	SIMPLE PAYBACK PERIOD (ESTIMATED)	SPB=1E/4	3.24	

3-3

TABLE 3-2 BUILDING ECONOMIC SUMMARY

ſ

	SIR	76 50.2	74 34.2	22 28.2	62 21.8	62 21.8	62 21.8	62 21.8	62 21.8	21 17.9	21 17.9	21 17.9	21 17.9	21 17.9	21 17.9	21 17.9	21 17.9	21 17.9	6.71 12	87 14.8	28 14.8	43 11.7	28 10.1	44	44 8.7	44 8.7	44	44	2.9 7 0 7 0	1 0.0	71 0.0	71 85	71 8.5	71 8.5	71 8.5	71 8.5	71 8.5	71 8.5	46 8.0	07 7.5	7 7.3	95 6.7	78 6.4	20 6.4	20 6.4	35 6.2	35 6.2	15 R 2
	SAVING	3,427,9	400,1	538,5	148,9	148,9	148,9	148,9	148,9	152,9	152,9	152,9	152,9	152,9	152,9	152,9	152,9	152,9	152,9	170,6	200,1	123,4	210,0	21,1	21,1	21,1	21,12	1,12	9,02 7,72	2,4	36	20.6	20,6	20,6	20,6	20,6	20,6	20,6	58,8	36,2	58,7	18,5	65,8	79,2	79,2	63,7	63,7	637
\$ FELD IARDWARE	COST	68,229	11,707	19,097	6,844	6,844	6,844	6,844	6,844	8,521	8,521	8,521	8,521	8,521	8,521	8,521	8,521	8,521	8,521	11,497	19,2/3	10,583	20,858	2,440	2,440	2,440	2,440	2,440	2,440	2,440	2 440	2.440	2,440	2,440	2,440	2,440	2,440	2,440	7,311	4,813	7,400	2,780	10,214	12,437	12,437	10,214	10,214	1001
• 3	COST	14,652	2,664	3,996	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	2,664	3,996	2,664	3,996	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1 330	1 332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1.332	2,664	2,664	2,664	2,664	2,664	
\$ CONST	COST	53,577	9,043	15,101	5,512	5,512	5,512	5,512	5,512	7,189	7,189	7,189	7,189	7,189	7,189	7,189	7,189	7,189	7,189	8,833	15,277	7,919	16,862	801,1	1,108	1,108	1,108	1,108	1,108	90L'L		- 10	1.108	1,108	1,108	1,108	1,108	1,108	5,979	3,481	6,068	1,448	7,550	9,773	9,773	7,550	7,550	
TOTAL BLDG	PNI	5 218	1 36	8 66	6 18	6 18	6 18	6 18	6 18	8 23	8	8	8	8 23	8 23	8	8	8 23	8 23	6 42	202	36	100	8	8	8	8	8	00 00 00 00	8 0		v c	2 8	2 8	2	2	2 8	2 8	13	5 13	9 24	2 6	13 32	19 44	19 44	13 32	13 32	
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2	ING 1	52 47	5	15 20	4	4	4	4	4 4	5	2	5	5	2	5 2	5	5	2	2	5	∓ ∓	9	17	-	_												_		3	2	S	2	5	5	5	2	S	
Š		34	S	13	4	4	4	4	4	ۍ	5	5	5	5	5	5	5	5	5	ი	16	5	9	6	e	0	6	ر	с і	0		<u>ה</u> כ) (°.	0 0	e	9	9	3	3	3	4	2	9	0	σ	9	9	
SOST SVCS	ER YR PI	365,175	43,166	58,505	13,709	13,709	13,709	13,709	13,709	14,205	14,205	14,205	14,205	14,205	14,205	14,205	14,205	14,205	14,205	18,498	30,836	13,908	22,706	2,293	2,293	2,293	2,293	2,293	2,223	2,223	2,223	2,223	5 223	2 223	2.223	2,223	2,223	2,223	6,529	3,905	5,992	2,074	7,446	8,162	8,162	6,670	6,670	
LABOR HOURS EVEs	PER YR P	106	19	38	9	9	9	9	9	15	15	15	15	15	15	15	15	15	15	8	R	8	19					-											÷	9	10		19	28	28	19	19	
LPG LPG CVCcc	PER YR			9,191																		1,541		366	366	366	366	366														257						
MMBhu F. Olt.#6	PER YR				2,992	2,992	2,992	2,992	2,992	2,987	2,987	2,987	2,987	2,987	2,987	2,987	2,987	2,987	2,987																						419			1,038	1,038	769	769	
F.OIL #2	SVGS. PER YR	64.515	6,945														-			2,863	4,993		3,589						366	366 366	366	366	005 335	000	998	366	366	366	823	629			769					
3	SVGS PER YR	75	8	321	55	55	55	55	5	33	55	55	55	55	55	55	55	55	55	179	40	198	30	3	3	3	3	3	3	3	3	3	<u>, , , , , , , , , , , , , , , , , , , </u>	0 0		2 6	3	3	14	6	8	3 6	20	1	1	9 50	9 50	
W N	SVGS. PFH YR	471 757	195,947	162,580						13,922	13,922	13,922	13,922	13,922	13.922	13.922	13,922	13,922	13,922	56,541	108,910	143,870	105,973	8,593	8,593	8,593	8,593	8,593	8,590	8,590	8,590	8,59	8,09	0,03	04.0	505 8	8.59	8.59	70.619	12.63	145,68	23.48	104 02	109.35	109.35	104,02	104.02	
2	BLDG	IOC	Administration	VCO Club	Barracks, w/o a/c	Barracks. w/o.a/c	Barracks. w/o a/c	Parracks, w/o a/c	Parmicks, w/o.a/c	Barracks, w/o a/c	Parracks, w/o.a/c	Barracks, w/o a/c	Barracks, w/o a/c	Barracks, w/o a/c	Reserve Center	Officers Club	Mess Hall	Mess Hall	Motor Pool	Motor Pool	Motor Pool	Motor Pool	Motor Pool	Motor Pool	Motor Pool	Motor Dool	Motor Dool	Motor Pool	Motor Pool	TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT	Administration/Sunnly	Mass Hall	Davroom	Maee Hall	Maaa Hall	Mags Hall	Mess Hall	Mass Hall										
	SUDS M	5265	1750	7391	730	731	736	737	738	815	816	817	818	819	827	828	829	830	831	1350	4109	2105	1740	680	8	991	866	6 66	672	673	681	772	773	8	0/0	0/2		8	1711	1025	8.37	3210	1007	735	739	630	653	-

TABLE 3-2 BUILDING ECONOMIC SUMMARY

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TOTAL * DISC: SAVING	62.379	154,680	17,483	35,651	27,791	33,979	21,600	55,801	46,371	20,131	18,678	25,993	20,982	70,159	17,351	17,351	34,607	18,804	33,638	33,638	33,638	33,638	30,895	75,981	33,859	13,088	13,088	13,088	13,088	13,088	13,088	13,000	13,000	13 088	13.088	13,088	17.528	44,143	13,893	13,422	13,422	35,111	26,368	33,067	49,328	9,430	9,430
FIELD HARDWARE COST	10.214	27,215	3,194	2,009	5,558	6,826	4,363	11,338	9,771	4,249	4,249	6,100	5,037	17,061	4,249	4,249	8,618	4,729	8,618	8,618	8,618	8,618	8,618	21,571	10,518	4,072	4,072	4,072	4,072	4,072	4,0/2	4,0/2	4,072	4 072	4 072	4.072	5.551	14.367	4.737	4,737	4.737	12,412	9,393	11,894	18,054	3,504	3,504
* 13 15	2 664	6,660	1,332	1,332	1,332	1,332	1,332	2,664	2,664	1,332	1,332	1,332	1,332	3,996	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	5,328	2,664	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1 332	1 339	1 332	1.332	1.332	2.664	1.332	1.332	1.332	2,664	2,664	2,664	2,664	1,332	1,332
¢ CONST.	7 550	20,555	1,862	5,677	4,226	5,494	3,031	8,674	7,107	2,917	2,917	4,768	3,705	13,065	2,917	2,917	7,286	3,397	7,286	7,286	7,286	7,286	7,286	16,243	7,854	2,740	2,740	2,740	2,740	2,740	2,740	2,740	2,/40	04/2	0 740	2.740	4 219	11 703	3.405	3.405	3.405	9,748	6,729	9,230	15,390	2,172	2,172
TOTAL BLDG. DWT	30	8	12	8	24	25	21	38	33	8	8	24	20	51	8	8	27	19	27	27	27	27	27	6/	8	6	6	6	თ	6	6	o 0	5	n C		5	2	5	4	14	14	37	8	45	49	6	5
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COST SVGS	PEH YH	18 197	1.994	4,094	3,409	3,528	2,333	5,925	5,120	2,160	2,005	2,743	2,070	7,655	1,863	1,863	3,962	2,075	3,61	3,61	3,61	3,61	3,50	8,82	3,83	1,23	1,23	1,23	1,23	1,23	1,23	1,23	1,23	52	2	3	3 2		0,6	- - - -	3 2	3 70	3.26	3.87	2.29	1,09	1,09
LABOR HOURS SVGS	PEH YH	2 19	5	13	16	4		9	18	9	3	14	15	8	3	3	÷	14	11	=	=	=	5	41	14	3	3	3	3	3	3	3	е -			<u> </u>	2	-				°∓		2 2 2	3 8		
LPG LPG SVGS	RERVIE	1 053	190		8		385			374	346				321	321								643																					6	, æ	æ
MMBhu F. OIL #6 SVGS	PER YR	60/				427		621				299	333						348	348	348	348				246	246	246	246	246	246	246	246	246	246	246	240				601	102	30				
MMBhu F.OIL #2 SVGS.	PER YR			344					674	5			-	1.121			348	274					348	2	387	2				-								132	203	RO				120	3		
KW SVGS	PER YR	2	404 75	22	430	3	3	25	37	5		65		32	}		78	6	78	78	2.82	78	2 &	210	22	3 6	σ	0	6	6	6	6	6	6	6	б (5	ន	45	R 8	€ 8	R 8	3 5	3	Ð	ţ	2 6
kwh Svgs.	PERYR	104,029	333,272	60.671	13 138	43 199	6.593	116.378	35,525	00,000		30.284	12,626	39.675			55 286	8.251	55 286	55 286	55 286	55,286	55 286	125.747	52 172	1.174	1 174	1.174	1.174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	34,286	67,952	13,245	13,245	13,245	60,433	104,023	44,130	19 703	19 703
BLDG	DESCRIPTION	Mess Hall	Heception Center	Day Vare Admin /Courtroom	Control Dhat	CUINE FRIN	Artho Craft Shon	Chanel	Decents Motor Pool		VOO	bX	Gvm	Admin /Maintenance	BED BED		Battelion HO	Entomology	Rettalion HO	Bettation HO	Dattalion HO	Battalion HO	Bettelion HO	Old Commission	Battalion HO	Administration/Supply	Administration/Sundv	Administration/Supply	Vet Clinic	Battalion HQ	Medical Clinic	Clinic	Clinic	Battalion HQ	Mess Hall	Kaneli Hali	AIMBIG FIRE FIQUSE										
 Dependencial de la contrata de Contrata de la contrata de Contrata de la contrata d		-		-+	+	-1-	+-	-+-	+		J m	10	5 6		2 5	2 2	18	1 2	2 2	3 8	y ç	2 2	2 5	g	2 2	t g	2 2	2 5	5	2 2	1	5	N	ŝ	7	Ş	Ŧ	8	ន	8	89	2	N	88	8	5 7	
BLDG	NO	836	2100	1705	2015	02120	1282	200	5001		410		38	615	ĮĘ		÷ 2	00	j ŭ			۲ ۵					5	5 2	5		~ ~	12	ž	80	80	¢	8	33	7	위	9	80	۱ ه	••		5 8	88

TABLE 3-2 BUILDING ECONOMIC SUMMARY

(Continued)

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TOTAL * DISC: SAVING	9,430	9,430	6,047 42 705	37 032	a 100	0,130	10,020	10,173	10,119	6//01	5.338	6,122	14,794	14,794	14,794	7,387	7,387	7,387	7,387	7,387	7,387	13,535	24,924	43,195	7.977	8,565	8,565	8,565	8,565	0,000 8 565	4.893	44.157	5,193	5,664	7,032	11,092	10,361	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384
S HELD MARDWARE COST COST	3,504	3,504	2,203	14 000	2 474	0,1/4	4,221		1.4/1	1,4/1	9,249 2,108	2.562	6.410	6,410	6,410	3,294	3,294	3,294	3,294	3,294	3,294	6,141	11,709	21,072	3,930	4,249	4,249	4,249	4,249	4,249	2,589	26.373	3,129	3,436	4,360	7,524	7,152	15,095	15,095	15,095	15,095	15,095	15,095	15,095	15,095	15,095
ACU *	1,332	1,332	1,332	0.850	1001	1,002	200'1	1,000	1,332	1, 255	1,332	1332	1.332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	3,996	3,996	1,332	1,332	1,332	1,332	1,332	1,332	1 332	5.328	1,332	1,332	1,332	1,332	1,332	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664
\$ CONST. COST	2,172	2,172	931	12,130	000 1	1,842	CRQ'Z	0,143	6,145	6,145	71912	1 230	5.078	5.078	5,078	1,962	1,962	1,962	1,962	1,962	1,962	4,809	7,713	17,076	2,598	2,917	2,917	2,917	2,917	2,917	1.257	21.045	1,797	2,104	3,028	6,192	5,820	12,431	12,431	12,431	12,431	12,431	12,431	12,431	12,431	12,431
IOTAL BLDG. PNF	6	6	9	8 5	4	י ק	2 6	3	ន	ន	80 4		8	26	8	6	6	6	6	6	6	20	50	64	18	80	80	80	80	80 0	0 0	202	12	14	12	25	8	41	41	41	41	41	41	41	41	41
2 IN	3	e	~	3	2	N	4	F	Ŧ	÷	4 (- 1	÷	Ŧ	Ξ	2	2	~	2	~	2	:	15	31	9	4	4	4	4	4 .	4	30	4	4	5	12	8	17	17	17	17	17	17	17	17	17
K Li			~	x 9	2	ر	· ۲	4	4	4	N C	v -	- -		-	e	e	e	9	3	3	5	17	σ	9	2	2	~	~	~ (N 4	2 4		20		2	5	æ	8	80	8	8	8	8	8	8
Q III	9	9		1 0	-	~	-	4	4	4	~	Ŧ	- -		-	2	2	2	2	2	2		2	17		~	~	2	2	~	N	8	3	ļ	~	с С	4	9	₽	9	₽	9	2	우	₽	9
81	9	9	2	80 (0	~	0	4	4	4	1	N C	7		-	~	2	2	2	2	~	4	16	~	9						ſ	~	* 4		2	3	3	e	9	9	9	9	9	9	9	9
COST SVGS PER YR	1,091	1,091	723	4,866	4,000	947	1,215	1,984	1,984	1,984	1,120	1/0	901	1 700	1 709	839	839	839	839	839	839	1,521	2,727	4.966	846	915	915	915	915	915	915	000	4,000	679	778	1,323	1,173	2,156	2,156	2,156	2,156	2,156	2,156	2,156	2,156	2,156
LABOR HOURS SVGS PER YR			9	55	÷	80	9	Ŧ	=	=	e		2 ¢	2 9	2 4	2 60	0	0	60	8	8	=	8	23		9	3	9	3	3		2	2 4		9 9	1	=	8	8	8	3	8	8	8	22	8
MMBhu LPG SVGS PER YR	86	86				74					189	32										173	403										Jä	ă ĉ	<u>פ</u>	- -										
MMBhu F. OIL #6 SVGS PER YR					367		78	214	214	214																							209				89	505	508				506	308	306	309
MMBtu F.OIL #2 SVGS. PER YR			26	466									60	132	132	2 1	5 6	5 6	5 4	5 G	5	5		212	155	158	158	158	158	158	158					2	-									
kw Svgs	¢	19	52	20	83	50	63	62	62	62			24	12	2 9	2	2	2 C	י י י	2	2 6	2	± ¥	2 2	3							41	8.	4	S	75	2 8	5 2	5 2	5 2	5 2	5 2	52	5 20	5 25	54
kwh Svgs Per yr	10 703	19,703	5,936	69,738	66,281	10,149	14,823	13,694	13,694	13,694		1,773	6,987	23,383	23,383	23,383	162'6	8,291	87.6	9,291	9,291	167'S	10,110	0,200	137	2							71,797	2,446	9,6/4	4,346		10,334		1,01		1,011	1,011	1811	1.811	1.811
BLD6			Administration	Gym	Battalion HQ	Air Force Ops	Bricede HQ	Battalion HQ	Battalion HQ	Battalion HQ	BEQ	Reserve Maintenance	Barracks	Administration/Supply	Administration/Supply	Administration/Supply	Dayroom	Dayroom	Dayroom	Dayroom	Dayroom	Layroom	Uispatch	Hanger	Chapel	Slorage	000		BOO	BOQ	BOQ	Wallace Pool	Brigade HQ	MP Kennel	Airline Terminal			Battalion HU	Baftacks, with a/u	B Barracks, with a/c	Barracks, with a/c	Barracks, with a/c	berracks, with a/c	Darracks, with a/c	Defnacros, willt a/c	Parracks with a/c
BLDG	2700	2018	4052	1714	750	5004	741	625	658	825	4104	1391	1769	1701	1706	1707	1721	1727	1736	1760	1120	1//2	5267	1000	1/12		4110	4111	4112	4114	4115	604	844	2240	5002	0622	404	838	120	920	ŝ	38	3	00	979 929	559

TABLE 3-2 BUILDING ECONOMIC SUMMARY (Concluded)

 Contraction (Contraction) Contr	NOH	SVGS	SVGS	SAGS.	SVGS.	SVGS.	SVGS. DEB VB	SVGS.	DO AO	NO LA	2 14	BLDG.	CONST	R R R	COST	SAVING	SIR
660 Barracks, with 199 Sewage Plan 183 Sewage Plan				LENTH			3	2 156	6 1(8 0	17	41	12,431	2,664	15,095	21,384	1.4
199 Sewage Plant 183 Sewage Plant	ha/c	1,811	\$		500		11	202		0		•	397	1.332	1.729	2.410	1.4
183 Sewage Plan	-						0,4	162		1 9			418	1.332	1.750	2.410	1.4
	ţ							167	-	u v		1	2 104	1 332	3 436	4 624	13
000 Front Gate		986	5			44	מ	200		> 	+ •	7	1 703	1 332	5 035	6 737	
013 Barracks				96			12	(4)	4	+ 7	2	<u>±</u> :	3	300'1	100 1	2010	
				y		_	12	745	4	3	3	14	3,703	1,332	CEU,C	6,/3/	<u>.</u>
014 Derracks				8 8			10	745	4	3 4	3	14	3,703	1,332	5,035	6,737	<u> </u>
015 Barracks				8			ļ	746		4	٣	14	3 703	1.332	5.035	6.737	1.3
016 Barracks				ő			2	2	r •		0		202 6	1 333	5 035	6 737	-
28 Barracks				8			2	C4/	4	+ •	2	± ;	202.0	1 333	5,035	6 737 6 737	
29 Barracks				96			12	(4/	4	2 I	, i	± 8	200	1 200	0,000	7007	
320 Administratio	Ĕ	6,017	15	69	_		₽	805	0	4	4	8,	0,920	200'1	0,2,0	120,1	2
725 Barracks		3,549	13	25			3	359	2		- 2	0 0	1,230	2000'1	700.2	202.07	
702 Administratic	on/Supply	117,625	24	946			88	8,945	11 8	\ -	5	3	4/4/CC	1 332	46/00	13,300	-
187 Sewage Plan	Ŧ						32	46C		2	2	2	5,304	200'1	003'1	202	