FINAL REPORT

ENERGY EFFICIENCY STUDY
STEAM, WATER, AND SEWER SYSTEMS

FORT GREELY, ALASKA

Prepared for

U.S. ARMY ENGINEER DISTRICT, ALASKA
ANCHORAGE, ALASKA

Under

U.S. ARMY ENGINEER DISTRICT, MOBILE
INDEFINITE DELIVERY A-E CONTRACT
CONTRACT NO. DACA01-94-D-0033
DELIVERY ORDER NO. 003

EMC ENGINEERS, INC.

DENVER, COLORADO
ATLANTA, GEORGIA

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EMC No. 1406-003

March 1996

By

E M C Engineers, Inc.
2750 S. Wadsworth, Suite C-200
Denver, Colorado 80227
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This report has been prepared at the request of the client, and the observations, conclusions, and recommendations contained herein constitute the opinions of E M C Engineers, Inc. In preparing this report, EMC has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, E M C Engineers, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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LIST OF ABBREVIATIONS

ACH	-	air changes per hour
AHU	-	air handling unit
ASHRAE	-	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
Btu	-	British thermal units
Btuh	-	Btu per hour
ccf	-	one hundred cubic feet
cfm	-	cubic feet per minute
DPW	-	Department of Public Works
ECIP	-	Energy Conservation Investment Program
ECO	-	Energy Conservation Opportunity
EMC	-	E M C Engineers, Inc.
F	-	Fahrenheit
FEMP	-	Federal Energy Management Program
FLA	-	full load amperes
ft	-	foot, feet
ft^2	-	square feet
gpm	-	gallons per minute
hp	-	horsepower
hr	-	hour
HRU	-	heat recovery unit
HVAC	-	heating, ventilating, and air-conditioning
KBtu	-	one thousand British thermal units
Klb	-	one thousand pounds
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hours, one thousand watt-hours
LCCA	-	Life Cycle Cost Analysis
MER	-	Mechanical Equipment Room
rpm	-	revolutions per minute
SF	-	square foot, feet
SIR	-	Savings-to-Investment Ratio

SOW	-	Scope of Work
SPV	-	single present value factor
SZ	-	single zone
temp.	-	temperature
U	-	thermal transmittance
UA	-	thermal transmittance x area
UPV	-	Uniform Present Value factor
yr	-	year(s)

EXECUTIVE SUMMARY

AUTHORITY FOR STUDY

This energy efficiency study of steam, potable water, and sanitary sewer systems was conducted and this report prepared under the Indefinite Delivery Architect-Engineer Contract for Energy Engineering Analysis Program (EEAP) No. DACA01-94-D-0033, Delivery Order No. 3.

PURPOSE OF STUDY

The purpose of the Energy Efficiency Study is to identify modifications necessary to provide the most energy efficient configuration of utilities (steam, water, and sewer) to serve designated active buildings at Fort Greely following implementation of the base realignment plan. Specifically the study is to evaluate central versus distributed utility systems.

UTILITY OPTIONS

The following utility options were analyzed:

- **Baseline.** The baseline reflects the current operating costs of the utilities at existing operational levels.

- **Reduced Central Utilities with Abandoned Buildings Heated to 45°F.** This option assumes continued operation of the central utilities to serve active buildings and to provide heat to utilidors and abandoned buildings to prevent deterioration.

- **Reduced Central Utilities with Abandoned Buildings Not Heated.** This option assumes continued operation of the central utilities to serve active buildings and to provide heat to utilidors to prevent freezing of water and sewer pipes.

- **Reduced Central Utilities Serving Only Active Buildings and Selected Utilidors.** This option assumes continued operation of the central utilities to serve active buildings and to provide heat to only those utilidors serving the active buildings. Steam, water, and sewer pipes in inactive utilidors would be isolated and drained. Fire hydrants served by inactive utilidors would not be operational.

- **Distributed Utilities.** This option would provide individual boilers, wells, and septic systems for each individual active building. All utilidors and existing fire

hydrants would be abandoned. Underground cisterns for fire protection would be provided in selected locations.

- **Mixed Utilities.** This option combined distributed heating and sewer systems with a central water system. Three options for freeze protection of the central water system were evaluated:

    1. **Circulation to Drain.** This option prevents freezing of the water distribution by constantly circulating water to each active building.

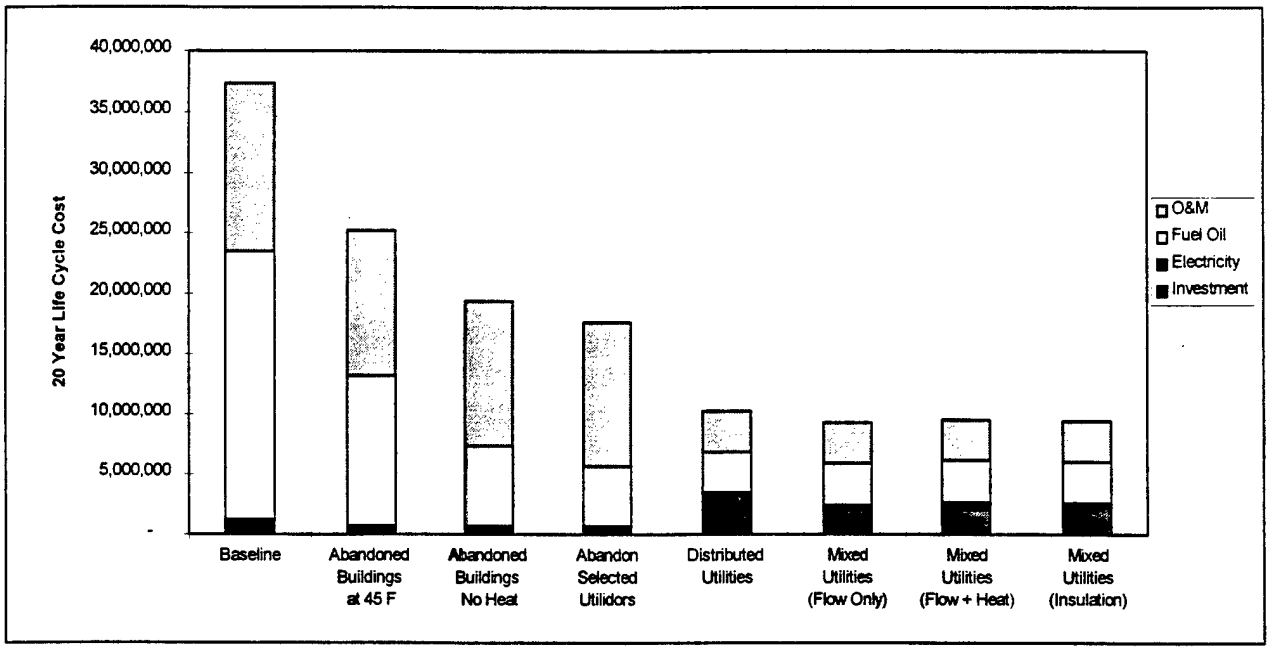
    2. **Heating and Circulation to Drain.** This option heats water circulating through the distribution system to 60°F and maintains water distribution temperatures above 32°F.

    3. **Heating, Circulation to Drain, and Pipe Insulation.** This option combines insulated water pipes with heating circulating water to 60°F and maintains water distribution temperatures above 32°F.

LIFE CYCLE COST ANALYSIS

Figure ES-1 below presents the results of the life cycle analysis.

Figure ES- 1. Graphical LCCA



The Mixed Utilities option with heating, circulation to drain, and pipe insulation for protecting the water distribution system is recommended. The mixed utilities option has

the least life cycle cost and requires the least capital investment of the utility options. The recommended freeze protection option is slightly more expensive than other freeze protection options, but it is considerably more reliable.

DISCUSSION

The study revealed the following about each utility:

- **STEAM HEATING.** The existing central steam heating plant serves over 100 building. The number of active buildings will be reduced to ten buildings. The existing central steam heating plant cannot efficiently serve only ten active buildings. Heat loss from the central steam distribution system exceeds the space heating load of the ten active buildings. Fuel oil consumption of distributed boilers would be about half that of operating the existing central steam heating plant.

  A 16 man utility staff is currently required to operate the existing central utilities with most of the staff dedicated to operating the central steam heating plant. Distributed boilers do not require continuous manning and the existing utility staff could be cut to 4 people saving about $760,000 per year.

- **WASTE WATER.** The existing central contonment area is served by a central sewer system and waste water treatment plant. The central sewer system is located in a utilidor system which must be continuously heated by heat loss from steam piping to prevent freezing of sewer pipes.

  It is not possible to operate the central sewer system unless the central steam distribution system is operated also. The alternative is a dedicated septic system for each remaining active building which also saves the energy and manpower required to operate the waste water treatment plant.

- **POTABLE WATER.** Buildings and fire hydrants in the existing central contonment area are served by a central water system which receives water from wells. There is a 180,000 gallon water storage tank on the system for fire protection. The water distribution system is located in a utilidor system which must be continuously heated by heat loss from steam piping to prevent freezing of water pipes.

  Annual operating cost of the water system is small. The capital costs of providing dedicated water wells at each active building and fire protection cisterns is high. Therefore, the central water system should be retained.

  A different method of freeze protection for the water distribution system will be required since the utilidors will no longer receive heat from the existing central steam heating system. A continuous circulation system is recommended which draws water from the wells, heats and circulates it through insulated water

distribution piping to each active building, where it is recycled to the earth via the septic system.

PROJECT ECONOMICS

Operation of existing central utilities would require little capital investment, but would incur higher than necessary operating costs. The recommended mixed utility option would require a large capital investment, but would operate more efficiently. The ECIP economic evaluation form on the following page evaluates the economics of the recommended mixed utility option relative to the most cost effective central utility option.

The results of the ECIP evaluation are a 3.0 year simple economic payback and a Savings-to-Investment Ratio (SIR) of 4.7.

RECOMMENDATIONS

The mixed utilities option with potable water freeze protection by water heating, circulation to drain, and pipe insulation is recommended. The other mixed utility options offer similar favorable economics and could be implemented with similar simple economic paybacks and SIRs. The only difference in the three mixed utility options are the method of freeze protection for the central water system. The following modifications are required:

- The central steam plant would be abandoned.
- Each remaining active building should be fitted with a steam boiler and fuel oil tank. Existing HVAC and DHW heating equipment in each building should be connected to the new steam source.
- Each remaining active building should be fitted with a septic tank and drain field.
- The portion of the existing central water system serving active buildings should be retained. The existing well and storage tanks within the central steam plant should be retained. Freeze protection should be provided for the central water system in the form of water heating, circulation to drain, and pipe insulation. Water flow for freeze protection would be recycled to the ground through the proposed septic system.

It should be noted that fire hydrants near active buildings will still be functional, but fire hydrants in the vicinity of abandoned buildings will not.

The cost of the above modifications is estimated at $2,227,641. Economic comparison of the recommended option to the most cost effective central plant option indicates a 3.0 year simple economic payback and a Savings-to-Investment Ratio (SIR) of 4.7.

1. COMPONENT	MILITARY CONSTRUCTION PROJECT DATA	2. DATE
ARMY		Dec-95
3. INSTALLATION AND LOCATION		
Ft. Greely, Alaska		
4. PROJECT TITLE	Convert Existing Central Utilities to Distributed Utilities	5. PROJECT NUMBER

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Ft. Greely, Alaska — REGION: 4 — PROJECT NO: 1413-001
PROJECT TITLE: Replace Central Utilities with Distributed Utilities — FISCAL YEAR: 1995
DISCRETE PORTION NAME: TOTAL
ANALYSIS DATE: 03/25/96 — ECONOMIC LIFE 20 — PREPARED BY: D Jones

1. INVESTMENT

A.	CONSTRUCTION COST	=	$1,997,884	
B.	SIOH COST	(5.5% of 1A) =	$109,884	
C.	DESIGN COST	(6.0% of 1A) =	$119,873	
D.	TOTAL COST	(1A +1B +1C) =	$2,227,641	
E.	SALVAGE VALUE OF EXISTING EQUIPMENT =			
F.	PUBLIC UTILITY COMPANY REBATE =			
G.	TOTAL INVESTMENT	(1D -1E -1F) =	------>	$2,227,641

2. ENERGY SAVINGS (+) OR COST (-):

DATE OF NISTR-4942-1 USED FOR DISCOUNT FACTORS: OCT '94

	ENERGY SOURCE	FUEL COST	ENERGY SAVINGS	SAVINGS (MBtu)	ANNUAL $ SAVINGS	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELECTRICITY	$0.0711 ($/kWh)	(418,883) kWh	(1,430)	($29,783)	14.47	($430,954)	
B.	DIST	0.73 ($/gal)	126,078 gal	16,959	$92,037	17.01	$1,565,545	
C.	NAT GAS							
D.	REFUS							
E.	COAL							
F.	OTHER							
G.	ELEC DEMAND	75.00 ($/kW)	34 kW		$2,563	14.47	$37,090	
H.	TOTAL				$64,817		------>	$1,171,680

3. NON-ENERGY SAVINGS (+) OR COST (-)

A.	ANNUAL RECURRING (+/-)		$ 659,714	
	1 DISCOUNT FACTOR	(From Table A) =	13.47	
	2 DISCOUNTED SAVINGS (+) / COST (-)	(3A x 3A1) =		$8,886,343

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE B)	DISCOUNTED SAVINGS/COST (4)
a.				
b.				
c.				
d. TOTAL				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-) (3A2 + 3Bd4) = $8,886,343

4.	FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bd1/Economic Life))	$724,531
5.	SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	3.07
6.	TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$10,058,023
7.	DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	4.52