ENERGY REPORT

ENERGY ENGINEERING ANALYSIS PROGRAM

ENERGY SAVINGS OPPORTUNITY SURVEY

FORT HUACHUCA, ARIZONA 1994

VOLUME I

PREPARED FOR

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

PREPARED BY

KELLER & GANNON
ENGINEERS • ARCHITECTS
1453 MISSION STREET, SAN FRANCISCO, CA 94103

CONTRACT NO. DACA05-C-92-0155

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

REPLY TO
ATTENTION OF: TR-I Library

17 Sep 1997

Based on SOW, these Energy Studies are unclassified/unlimited. Distribution A. Approved for public release.

Marie Wakefield,
Librarian Engineering

Table of Contents

List of Figures

List of Tables

1.0 Executive Summary

1.1 Introduction

This report summarizes all work performed for the Energy Engineering Analysis Program (EEAP) Energy Savings Opportunity Survey (ESOS) at Fort Huachuca, Arizona, authorized under Contract DACA05-92-C-0155 with the U.S. Army Corps of Engineers, Sacramento District, Sacramento, California.

The purpose of this study is to develop projects and actions that will reduce facilities energy consumption and operating costs at Fort Huachuca. Implementation of these projects will contribute to achieving the goal of the Army Facilities Energy Plan of a reduction in energy consumption per square foot of building floor area of 20 percent by FY2000 from FY1985 baseline levels.

The facility survey and evaluation effort was limited to 21 buildings and a specific set of energy conservation opportunities (ECOs) having a high likelihood of proving to be economically feasible. Also included were feasibility evaluations of cogeneration alternatives including (a) cogenerating alternatives serving the existing central heating/cooling plants, (b) a generating facility sized to serve the total electric power requirements of Fort Huachuca and (c) a generating facility sized to serve the total power requirements of both Fort Huachuca and the adjacent city of Sierra Vista. Both turbine generators and reciprocating-engine generators were evaluated for a cogeneration facility serving the two central heating/cooling plants.

Harmonic distortion sampling at four buildings containing significant computer loads or electronic fluorescent ballasts was also included in the study scope.

1.2 Energy Conservation Projects

Successful ECOs were packaged into project groups containing similar trades in order to eliminate the extra charges associated with subcontractor services. A Work Request (EHSC Form 4283-1) was prepared for each project group. Each programming document included complete supporting data: retrofit descriptions, energy and cost savings calculations, construction cost estimates and life cycle cost analysis summaries. Data summaries for each of the project groups appear in Table 1-1.

Each of the following ECOs was found to be cost-effective in at least one of the buildings studied:

- Roof and wall insulation
- Low emissivity roof coating
- Replacing electric motor-driven chiller with gas engine-driven chiller
- Economizer and supply air temperature reset controls
- High-efficiency motor retrofits
- Lighting fixture and control retrofits

1.3 Cogeneration Feasibility

A number of cogeneration alternatives serving either one or both of the central heating/cooling plants and containing either gas turbine or gas-fired reciprocating engine prime movers were evaluated. A summary of life cycle cost analyses for these central heating/cooling plant cogeneration alternatives appears in Table 1-2. The recommended alternative, based on highest savings-to-investment ratio (SIR), is a cogeneration facility serving both central heating/cooling plants and containing ebullient-cooled gas-engine generators with single-stage absorption chilling and steam heat exchangers to provide chilled and hot water for building HVAC use.

A summary of life cycle cost analyses for power generation facilities sized to serve Fort Huachuca and the City of Sierra Vista appears in Table 1-3. Generation facilities of the sizes required to serve Fort Huachuca and Sierra Vista cannot be served from existing gas distribution on post or upstream from Southwest Gas Corporation's Fort Huachuca regulating station. Budget costs for installing gas supply piping from a point 4.5 miles from the potential generating facility site were included in the investment amount. However, an in-depth engineering analysis to determine the need for additional facilities must first be performed by Southwest Gas Corporation before the overall economic feasibility of a power generating plant serving Fort Huachuca and the City of Sierra Vista can be determined.

1.4 Harmonic Distortion Survey

Harmonic distortion monitoring conducted at a representative sample of four buildings revealed that all measured voltage distortion levels were within the 5 percent recommended by ANSI/IEEE Standard 519. Current distortion percentages measured during early May were generally higher than those recommended by Standard 519, but are expected to fall within the guidelines during peak summer electrical demand periods when linear motor loads increase dramatically.

Table 1-1. Project Group Summaries for Recommended ECOs

Building or ECO Number	Retrofit Description		Energy Savings Electric (kW)	Energy Savings Electric (kWH/Year)	Gas (Million BTU/Yr)	Energy Cost Savings Electric ($/Year)	Energy Cost Savings Gas ($/Year)	Energy Cost Savings LCC Savings ($)	O&M Savings ($/Year)	Utility Rebate ($)	Investment ($)	Payback (Years)	SIR
Building Envelope Modifications													
15544	Wall & Roof Insul + Low E Roof Coat		0.0	27,827	442	$1,750	$1,556	$43,080	$0	$0	$24,210	7.32	1.78
20200	Retrofit Roof Insulation	3,130 SF	0.0	4,029	64	$253	$226	$6,245	$0	$0	$4,147	8.65	1.51
43083	Roof: Insulation & Low E	29,982 SF	0.0	124,909	1,228	$7,857	$4,318	$155,623	$0	$0	$58,567	4.81	2.66
51005	Apply Low E Roof Coating	78,400 SF	0.0	(14,401)	928	($906)	$3,264	$35,364	$0	$0	$16,822	7.13	2.10
56301	Apply Low E Roof Coating	30,000 SF	0.0	149,852	567	$9,426	$1,994	$141,556	$0	$0	$6,437	0.56	21.99
91114	Apply Low E Roof Coating	6,979 SF	0.0	5,460	(16)	$343	($57)	$3,321	$0	$0	$1,498	5.23	2.22
Subtotal, Building Envelope Modifications			**0.0**	**297,676**	**3,214**	**$18,724**	**$11,301**	**$385,191**	**$0**	**$0**	**$111,681**	**3.72**	**3.45**
Gas Engine-Driven Chiller Retrofit													
56301	Gas Engine-Driven Chiller - 72 Tons		67.0	267,690	(1,823)	$21,508	($8,218)	$142,078	($1,032)	$0	$122,512	9.99	1.06
Building HVAC Control Modifications and High Efficiency Motor Retrofits													
56301	Economizer Control & SA Reset @ OA Temp		0.0	382,501	28,726	$1,577	$1,443	$39,403	$0	$0	$16,548	5.48	2.38
15544	SA Fan HVAC Unit	20 HP TEFC	1.2	10,783	0	$679	$0	$10,235	$0	$80	$1,356	2.00	7.55
43083	SA Fan AHU No. 1	7.5 HP ODP	0.2	2,068	0	$130	$0	$1,963	$0	$46	$476	3.66	4.12
43083	SA Fan AHU No. 2	7.5 HP ODP	0.2	2,068	0	$130	$0	$1,963	$0	$46	$476	3.66	4.12
56301	SA Fan, North HVAC Unit	10 HP ODP	0.3	2,246	0	$141	$0	$2,132	$0	$56	$578	4.09	3.69
56301	SA Fan, Central HVAC Unit	10 HP ODP	0.3	2,246	0	$141	$0	$2,132	$0	$56	$578	4.09	3.69
56301	SA Fan, South HVAC Unit	10 HP ODP	0.3	2,246	0	$141	$0	$2,132	$0	$56	$578	4.09	3.69
56301	CHW Circ. Pump 1	5 HP ODP	0.3	1,168	0	$73	$0	$1,108	$0	$17	$421	5.73	2.63
56301	CHW Circ. Pump 2	5 HP ODP	0.2	727	0	$46	$0	$691	$0	$17	$421	9.20	1.64
56301	Condenser Fan 1	7.5 HP ODP	0.2	661	0	$46	$0	$694	$0	$46	$476	10.35	1.46
56301	Condenser Fan 2	7.5 HP ODP	0.2	661	0	$46	$0	$694	$0	$46	$476	10.35	1.46
57305	CHW Circ. Pump 2	25 HP TEFC	0.5	2,368	0	$149	$0	$2,248	$0	$88	$1,623	10.89	1.38
61701	Pool Circ. Pump	20 HP ODP	0.4	3,472	0	$219	$0	$3,296	$0	$75	$947	4.33	3.48
62704	SA Fan	25 HP ODP	0.6	4,974	0	$313	$0	$4,721	$0	$87	$1,091	3.48	4.33
62704	RA Fan	10 HP ODP	0.3	2,246	0	$141	$0	$2,132	$0	$56	$578	4.09	3.69
67601	AHU 1 SA Fan	15 HP ODP	0.5	887	0	$95	$0	$1,438	$0	$58	$766	8.03	1.88
67601	AHU 2 SA Fan	15 HP ODP	0.5	887	0	$95	$0	$1,438	$0	$58	$766	8.03	1.88
67601	AHU 3 SA Fan	15 HP ODP	0.5	887	0	$95	$0	$1,438	$0	$58	$766	8.03	1.88
67601	AHU 4 SA Fan	15 HP ODP	0.5	887	0	$95	$0	$1,438	$0	$58	$766	8.03	1.88
67601	AHU 5 SA Fan	15 HP ODP	0.5	887	0	$95	$0	$1,438	$0	$58	$766	8.03	1.88
67601	AHU 7 SA Fan	15 HP ODP	0.5	887	0	$95	$0	$1,438	$0	$58	$766	8.03	1.88
80505	SA Fan East	30 HP ODP	0.9	7,536	0	$474	$0	$7,154	$0	$85	$1,266	2.67	5.65
80505	SA Fan West	30 HP ODP	0.9	7,536	0	$474	$0	$7,154	$0	$85	$1,266	2.67	5.65

Table 1-1. Project Group Summaries for Recommended ECOs

Building or ECO Number	Retrofit Description			Energy Savings Electric (kW)	Energy Savings Electric (kWH/Year)	Energy Savings Gas (Million BTU/Yr)	Energy Cost Savings Electric ($/Year)	Energy Cost Savings Gas ($/Year)	Energy Cost Savings LCC Savings ($)	O&M Savings ($/Year)	Utility Rebate ($)	Investment ($)	Payback (Years)	SIR
80505	RA Fan East	10	HP ODP	0.4	3,226	0	$203	$0	$3,062	$0	$56	$578	2.85	5.30
80505	RA Fan West	10	HP ODP	0.4	3,226	0	$203	$0	$3,062	$0	$56	$578	2.85	5.30
80505	Fan Coil Unit, Rm 213	5	HP TEFC	0.2	1,789	0	$113	$0	$1,698	$0	$35	$520	4.62	3.26
80505	HWP-1	7.5	HP ODP	0.3	1,459	0	$92	$0	$1,385	$0	$46	$476	5.19	2.91
80505	Fan Coil Unit, Rm 249	7.5	HP TEFC	0.2	1,935	0	$122	$0	$1,836	$0	$46	$708	5.82	2.59
80505	CHWP-1	15	HP ODP	0.4	1,959	0	$123	$0	$1,859	$0	$58	$766	6.21	2.43
80505	CHWP-2	15	HP ODP	0.4	1,959	0	$123	$0	$1,859	$0	$58	$766	6.21	2.43
80505	VAVH2 West, Roof FCU	15	HP ODP	0.2	1,676	0	$105	$0	$1,591	$0	$58	$766	7.26	2.08
80505	VAVH2, Roof FCU	15	HP ODP	0.2	1,676	0	$105	$0	$1,591	$0	$58	$766	7.26	2.08
91114	HW Circ. Pump	5	HP ODP	0.3	1,439	0	$91	$0	$1,366	$0	$17	$421	4.65	3.24
Subtotal, Building HVAC Control Modifications and High Efficiency Motor Retrofits				**13.2**	**461,172**	**28,726**	**$6,775**	**$1,443**	**$117,789**	**$0**	**$1,778**	**$40,098**	**4.88**	**2.94**
Lighting Fixture and Control Retrofits														
Lights A	LED Exit Fixtures	108	EA	2.0	17,171	0	$1,082	$0	$13,000	($165)	$972	$5,438	5.94	2.03
Lights B2	Ballasts/T8s 2xF30T12	124	EA	3.7	8,124	0	$868	$0	$10,438	$104	$1,240	$5,502	5.66	2.12
Lights D1	Ballasts/T8, 1xF40T12	120	EA	1.7	9,066	0	$658	$0	$7,912	($136)	$1,080	$5,217	9.99	1.20
Lights D2	Ballasts/T8, 2xF40T12	1,401	EA	30.0	107,700	0	$9,046	$0	$108,733	($48)	$14,010	$67,229	7.47	1.61
Lights D5	Delamp 4 to 3 T8s, Ballasts	671	EA	49.3	144,543	0	$13,296	$0	$159,823	$497	$12,749	$43,531	3.16	3.81
Lights E1	Ballasts 2 xF48T12HO	48	EA	1.6	5,491	0	$468	$0	$5,625	$0	$192	$2,107	4.50	2.67
Lights F1	Ballasts/T8, 2xF96T12	20	EA	0.8	1,872	0	$193	$0	$2,317	($32)	$200	$1,822	11.35	1.06
Lights F2	Ballasts/T8, 4xF96T12	1	EA	0.1	166	0	$18	$0	$220	($3)	$20	$182	11.73	1.03
Lights G1	DTT 13W CF-Downlights	2	EA	0.1	139	0	$18	$0	$218	$7	$10	$37	1.44	8.36
Lights G2	TRI 20W Compact Flour.	24	EA	2.4	4,547	0	$523	$0	$6,284	$278	$35	$62	0.08	153.60
Lights G3	TT 7W Compact Fluor.	71	EA	2.4	4,488	0	$519	$0	$6,239	$246	$225	$1,166	1.52	7.87
Lights G4	DTT 13W CF-Ceiling	45	EA	2.1	3,786	0	$446	$0	$5,360	$147	$230	$876	1.48	8.12
Lights G5	TRI 23W Compact Fluor.	28	EA	2.3	4,965	0	$535	$0	$6,435	($88)	$150	$894	2.00	6.02
Lights H1	17W CF Table Lamps	249	EA	10.7	23,384	0	$2,499	$0	$30,043	$994	$1,245	$4,876	1.40	8.60
Lights J1	150W HPS & Ballast	33	EA	3.2	5,448	0	$673	$0	$8,085	$54	$320	$6,568	9.05	1.33
Lights J2	200W HPS & Ballast	54	EA	11.3	23,475	0	$2,578	$0	$30,985	$159	$1,129	$8,387	3.06	3.92
Lights K1	Ceiling PIR Controls	239	EA	0.0	162,912	0	$7,877	$0	$94,679	$1,676	$1,784	$79,611	8.33	1.44
Lights K3	Wall Switch PIR Controls	162	EA	0.0	35,138	0	$1,699	$0	$20,421	$416	$768	$17,829	8.43	1.42
Subtotal, Lighting Fixture and Control Retrofits				**123.6**	**562,417**	**0**	**$42,996**	**$0**	**$516,817**	**$4,105**	**$36,359**	**$251,336**	**5.34**	**2.25**
Totals for Successful ECOs (SIR's > 1.0)				**203.8**	**1,588,955**	**30,117**	**$90,003**	**$4,526**	**$1,161,876**	**$3,073**	**$38,137**	**$525,627**	**5.39**	**2.28**

5,423 + 30,119 MBTU → 35,542 MBTU/yr $97,602/yr

Table 1-2. Summary of Life Cycle Cost Analyses for Central Heating / Cooling Plant Cogeneration Alternatives

	Description of Cogeneration Alternative	Power kW	Investment	Annual Cost Savings Energy $/Year	Annual Cost Savings Non-Energy $/Year	SIR	Payback Years
Alternative 1A1 $2,923 / Kw	Gas Turbine-Generator Cogeneration Facility serving Fort Huachuca's South Central Heating/Cooling Plant.	3,312	$9,682,629	$961,462	($29,459)	1.16	10.39
Alternative 1A2 $2,873 / Kw	Gas Turbine-Generator Cogeneration Facility serving Fort Huachuca's North Central Heating/Cooling Plant.	3,312	$9,517,018	$935,657	($29,059)	1.13	10.50
Alternative 1B $2,924 / kW	Gas Turbine-Generator Cogeneration Facility serving both South & North Central Heating/Cooling Plants.	4,727	$13,821,209	$1,610,329	$1,396	1.51	8.58
Alternative 1C1 $1,568 / kW	Gas Engine-Generator Cogeneration Facility serving both Central Heating/Cooling Plants: Ebullient Cooled, Single-Stage Absorption Chilling.	6,600	$10,346,129	$1,384,319	($29,531)	1.74	7.64
Alternative 1C2 $1,654 / kW	Gas Engine-Generator Cogeneration Facility serving both Central Heating/Cooling Plants: Two-Stage Absorption Chilling.	8,800	$14,559,263	$1,915,853	($141,775)	1.55	8.21
Alternative 1C3 $1,829 / kW	Gas Engine-Generator Cogeneration Facility serving both Central Heating/Cooling Plants: Ebullient Cooled, Single & Two-Stage Absorption Chilling.	5,500	$10,059,783	$1,186,046	$4,348	1.60	8.45

Table 1-3. Summary of Life Cycle Cost Analyses for Power Generation Alternatives Serving Fort Huachuca and Sierra Vista

	Description of Cogeneration Alternative	Power kW	Investment	Annual Cost Savings Energy $/Year	Annual Cost Savings Non-Energy $/Year	SIR	Payback Years
Alternative 2 $1,084 / kW	Gas Turbine Combined Cycle Cogeneration Facility serving **Fort Huachuca and Sierra Vista.** Power generated to **match electric demand.**	52,248	$56,615,344	$17,407,722	($1,237,129)	1.98	6.24
Alternative 3 $1,718 / kW	Gas Turbine Combined Cycle Cogeneration Facility serving **Fort Huachuca only.** Power generation to **match electric demand.**	22,248	$38,215,478	$7,349,328	($481,712)	1.39	9.19
Alternative 2 Max $1,084 / kW	Gas Turbine Combined Cycle Cogeneration Facility serving **Fort Huachuca and Sierra Vista.** Power generated at plant capacity with **excess power sales** through the grid.	52,248	$56,615,344	$22,514,378	($1,799,860)	1.89	5.88
Alternative 3 Max $1,718 / kW	Gas TurbineCombined Cycle Cogeneration Facility serving **Fort Huachuca only.** Power generated at plant capacity with **excess power sales** through the grid.	22,248	$38,215,478	$9,911,580	($766,408)	1.54	7.83