Limited Energy Study
Energy Engineering Analysis Program (EEAP)
Rock Island Arsenal

Executive Summary

CONTRACT # DACA27-93-C-0096
SYSTEMS/CORP PROJECT # 93006.02
NOVEMBER 5, 1993

SYSTEMScorp

SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION

US Army Corps of Engineers

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Executive Summary

1 Executive Summary

1.1 PURPOSE

The purpose of this limited energy survey is to evaluate Energy Conservation Opportunities (ECOs) at three locations at Rock Island Asenal. The three ECOs evaluated are:

1. Lighting efficiency improvements in Building 220.
2. Lighting efficiency improvements in Building 350.
3. Cogeneration/Peak-Shaving Installation at Buildings 160 and 168.

Table 1.1.1 shows the buildings surveyed, building types, and their square footages.

TABLE 1.1.1

BUILDINGS SURVEYED

BUILDING TYPE	BUILDING NUMBER	BUILDING AREA
Administrative	350	453,600
TOTAL AREA THIS TYPE		453,600
Machine Shop	220	536,970
TOTAL AREA THIS TYPE		536,970
Hydro Electric Plant	160	30,894
TOTAL AREA THIS TYPE		30,894
Old Steam Plant	168	8,349
TOTAL AREA THIS TYPE		8,349

1.2 PRESENT ENERGY CONSUMPTION

Using computerized techniques, the present energy consumption for each ECO was evaluated using data gathered during the field survey (September 7-10, 1993). The present energy consumption totals for each ECO are presented in *Table 1.2.1.*

TABLE 1.2.1

ENERGY BASELINE FOR ALL ECOs

ECO NUMBER	ECO NAME	BASELINE ENERGY CONSUMPTION (SOURCE-MBTU)
1A	FLUORESCENT FIXTURE REPLACEMENTS - BUILDING 220	35,616 (ELEC)
1B	FLUORESCENT FIXTURE RETROFIT - BUILDING 220	35,616 (ELEC)
1C	MERCURY VAPOR FIXTURE REPLACEMENTS - BUILDING 220	6,980 (ELEC)
1D	EXIT SIGN RETROFIT - BUILDING 220	176 (ELEC)
2A	FLUORESCENT FIXTURE REPLACEMENTS - BUILDING 350	6,650 (ELEC)
2B	OCCUPANCY SENSOR INSTALLATION - BUILDING 350	2,218 (ELEC)
2C	FLUORESCENT FIXTURE REPLACEMENTS - BUILDING 350	59,580 (ELEC)
2D	INCANDESCENT FIXTURE REPLACEMENTS - BUILDING 350	1,354 (ELEC)
2E	EXIT SIGN RETROFITS - BUILDING 350	315 (ELEC)
3A	INSTALL 1 MW PEAK-SHAVING GENERATOR - BUILDING 160	2,396,700 (ELEC)
3B	INSTALL 6 MW PEAK-SHAVING GENERATOR - BUILDING 160	2,753,400 (ELEC)
3C	INSTALL 24 MW BASELOADED GENERATOR - BUILDING 168	2,397,000 (ELEC) & 1,121,200 (COAL)

1.3 ECOs INVESTIGATED

The three ECOs were further subdivided into 12 separate ECOs as follows:

ECO - 1A: Fluorescent Fixture Replacements in Building 220.
ECO - 1B: Fluorescent Fixture Retrofits in Building 220.
ECO - 1C: Mercury Vapor Fixture Replacements in Building 220.
ECO - 1D: Exit Sign Retrofits in Building 220.

ECO - 2A: Fluorescent Fixture Replacements in Building 350 - Perimeter Office Area
ECO - 2B: Occupancy Sensor Installation in Building 350 - Perimeter Office Area
ECO - 2C: Fluorescent Fixture Replacements in Building 350 - Core Area
ECO - 2D: Incandescent Fixture Replacements in Building 350
ECO - 2E: Exit Sign Retrofits in Building 350

ECO - 3A: 1 MW Peak-Shaving Gas Engine at Building 160
ECO - 3B: 6 MW Peak-Shaving Gas Turbine at Building 160
ECO - 3C: 24 MW Cogneration Plant at Building 168

Table 1.3.1 lists the results of each of these 12 ECOs evaluated, ranking each by savings-to-investment ratios (SIRs). *Table 1.3.2* lists only the ECOs that can be recommended. *Table 1.3.3* shows the non-recommended ECOs and the justification for not recommending each. *Table 1.3.4* groups the recommended ECOs by building, which is the method of grouping used in preparing the ECIP programming documents.

TABLE 1.3.1 ALL ECOs RANKED BY SIR			
ECO NUMBER	BUILDING NUMBER	ENERGY SAVINGS (MBTU-SOURCE)	S I R
1D	220	164	8.0
2E	350	291	8.0
IC	220	3424	2.5
2D	350	1062	2.3
2C	350	51225	2.1
1B	220	20054	1.6
2B	350	1109	1.5
1A	220	21724	1.4
2A	350	4432	1.3
3C	168	1275566	1.0
3A	160	-2349	0.5
3B	160	71550	0.1

TABLE 1.3.2

RECOMMENDED ECOs RANKED BY SIR

ECO NUMBER	BUILDING NUMBER	ENERGY SAVINGS (MBTU) (SOURCE)**	S I R
1D	220	164	8.0
2E	350	291	8.0
1C	220	3424	2.5
2D	350	1062	2.3
2C	350	51225	2.1
1B	220	20054	1.6
2B	350	1109	1.5
1A	220	21724	1.4
2A	350	4432	1.3
3C	168	1275566	1.0
	TOTALS*	1,379,051 MBTU	1.3 OVERALL SIR

*TOTAL EXCLUDES ECO-1B SINCE ECO-1A WAS THE PREFERRED ALTERNATIVE.

**SOURCE ELECTRICITY = SITE ELECTRICITY * 11,400/3,413

TABLE 1.3.3

NON-RECOMMENDED ECOs RANKED BY SIR

ECO NUMBER	BUILDING NUMBER	REASON FOR NOT RECOMMENDING	S I R
3A	160	SIR IS LESS THAN 1.0	0.5
3B	160	SIR IS LESS THAN 1.0	0.1

TABLE 1.3.4

RECOMMENDED ECOs BY BUILDING

BUILDING NUMBER	ECO NUMBER	INVESTMENT COST ($)	ANNUAL SAVINGS ($)	SIMPLE PAYBACK YEARS
168	3C	16,199,000	2,844,423	5.7
TOTAL BUILDING 168	**3C**	**16,199,000**	**2,844,423**	**5.7**
220	1A	1,003,000	177,222	5.7
220	1B	739,000	147,001	5.0
220	1C	59,000	21,723	2.7
220	1D	4,000	2,473	1.6
TOTAL BUILDING 220*	**1A, 1C, 1D**	**1,066,000**	**201,418**	**5.3**
350	2A	313,000	51,508	6.1
350	2B	27,000	3,366	8.0
350	2C	975,000	249,963	3.9
350	2D	43,000	8,312	5.2
350	2E	6,400	4,431	1.4
TOTAL BUILDING 350	**2A - 2E**	**1,364,000**	**317,580**	**4.3**
TOTAL*	**1A, 1C, 1D 2A - 2E, 3C**	**18,629,000**	**3,363,421**	**5.5**

* TOTAL EXCLUDES ECO-1B SINCE ECO-1A WAS THE PREFERRED ALTERNATIVE.

The following is a description of each of the twelve ECOs evaluated.

1.3.1 ECO-1A: Fluorescent Fixture Replacements in Building 220

This ECO evaluated the feasibility of changing out all the existing 4- and 8-foot T-12 fluorescent fixtures in Building 220 and replacing them with new 4-foot T-8 fluorescent fixtures utilizing high efficiency lamps, ballasts, and reflectors. The new system provides the same light output as the existing system in all areas, and in many cases provides more light than currently provided. This ECO provides a one-for-one fixture replacement, however the number of lamps has been reduced due to reflector usage. The existing 8- foot fixtures are replaced by two 4-foot fixtures. The existing 8-foot fixtures were a conglomeration of standard wattage (60 watt), high output (110 watt), and very high output (215 watts) lamps, all using standard efficiency ballasts. The existing 4-foot fixtures were mainly economy watt (32 watt) bulbs with some very high output (115 watts) bulbs, both employing standard efficiency ballasts.

1.3.2 ECO-1B: Fluorescent Fixture Retrofit in Building 220

This ECO utilizes the same technology as ECO-1A, however this ECO would reduce initial costs by utilizing the existing fixtures as much as possible. The use of a retrofit kit to convert existing T-12 fixtures to T-8 fixtures includes electronic ballasts, T-8 lamps, and reflectors applied to the existing fixtures. Again, the existing 8-foot fixtures are replaced by two 4-foot fixtures due to the unreliable nature of the 8-foot T-8 ballasts currently available on the market.

1.3.3 ECO-1C: Mercury Vapor Fixture Replacement in Building 220

This ECO evaluated the change out of the existing mercury vapor fixtures in high bay areas of Building 220. The existing fixtures provide light in the areas known as "the Craneway" and "Honing and NC Lathe Shop". In the Craneway the 1000 watt mercury vapor fixtures are replaced on a two-for-one basis by 1000 watt metal halide fixtures, providing more light than existing conditions. In the Lathe Shop, existing 400 watt mercury vapors are replaced two-for-one with 400 watt metal halides, also providing more light output than existing conditions. Eight existing 750 watt mercury vapors located underneath the movable crane in the Lathe Shop are replaced one-for-one by 450 watt metal halide fixtures.

1.3.4 ECO-1D: Exit Sign Retrofits in Building 220

This ECO proposes to use a retrofit kit to convert existing 40 watt incandescent exit signs to 3 watt light-emitting diode (L. E. D.) fixtures. The retrofit kit provides for hard-wiring the L.E.D. fixtures in place so that a return to incandescent lamp usage is not possible. The L.E.D. has a minimum life expectancy of 25 years without maintenance.

1.3.5 ECO-2A: Fluorescent Fixture Replacements in Building 350 - Office Area

This ECO evaluated the feasibility of changing out all the existing 4-foot T-12 Fluorescent fixtures in Building 350 and replacing them with new 4-foot T-8 fluorescent fixtures utilizing high efficiency lamps, ballasts, and reflectors. The new system provides the same light output as the existing system in all areas, and in many cases provides more light than currently provided. This ECO provides a one-for-one fixture replacement, however the number of lamps has been reduced due to reflector usage. Unlike Building 220, the existing 4-foot fixtures in Building 350 were found to be mainly standard wattage lamps (40 watts each), thus the calculations for this ECO reflect a higher existing wattage per fixture than that of ECO-1A and ECO-1B.

1.3.6 ECO-2B: Installation of Occupancy Sensors in Building 350 - Office Area

ECO-2B was the installation of 250 occupancy sensors in the perimeter office areas of Building 350. The field survey revealed that approximately half of the office areas had lights left on by occupants after hours. Also, during working hours approximately one-half of the offices were unoccupied at any one time. Thus the on-time of lights in this area were assumed to be one-half of the baseline for the calculation of the ECO.

This ECO does not provide occupancy sensors in the core area offices. Due to the large number of sensors that would be required in these modular-style offices, the application was deemed infeasible.

1.3.7 ECO-2C: Fluorescent Fixture Replacements in Building 350 - Core Area

This ECO evaluated the feasibility of changing out all the existing 4- and 8-foot T-12 fluorescent fixtures in the core area of Building 350 and replacing them with new 4-foot T-8 fluorescent fixtures utilizing high efficiency lamps, ballasts, and reflectors. The new system provides the same light output as the existing system in all areas, and in many cases provides more light than existing fixtures. This ECO provides a one-for-one fixture replacement, however the number of lamps has been reduced due to reflector usage. The existing 8-foot fixtures are replaced by two 4-foot fixtures. As in ECO-2A, 40 watt lamps were observed in use, and were used in the baseline calculations.

This area was separated from the office area of Building 350 due to the different utilization times of the lights in the core and office areas. The lights in the core area were observed during the field survey to stay on 24 hours a day. The reason given for this was for security purposes. Therefore, in this ECO, the addition of 18 compact fluorescent fixtures in the core area was incorporated so that the existing lights could be shut off during unoccupied hours. The compact fluorescent fixtures will provide sufficient security lighting during off-hours.

1.3.8 ECO-2D: Incandescent Fixture Replacements in Building 350

ECO-2D involves replacing 277 incandescent fixtures with fluorescent fixtures throughout Building 350. A total of 193 lower-wattage fixtures will be replaced with compact fluorescent fixtures and eighty-four 200 and 300 watt fixtures are to be replaced by 4-foot T-8 fixtures. The bulk of the smaller-wattage fixtures are located in restrooms and stairwells, with a few located in recessed spotlight fixtures in conference rooms and offices. The 200 and 300 watt fixtures are all located in mechanical rooms where about half of the total were found to be on all day, and the other half, off all day.

1.3.9 ECO-2E: Exit Sign Retrofits in Building 350

This ECO proposes to use a retrofit kit to convert existing 40 watt incandescent exit signs to 3 watt light-emitting diode (L. E. D.) fixtures. The retrofit kit provides for hard-wiring the L.E.D. fixtures in place so that a return to incandescent lamp usage is not possible. The L.E.D. has a minimum life expectancy of 25 years without maintenance.

1.3.10 ECO-3A: Install 1 MW Peak-Shaving Plant at Building 160

ECO-3A evaluates the installation of a 1 MW natural gas/diesel engine-generator set to provide electrical demand peak-shaving capabilities for the Arsenal. The run time of the engine was determined from historical electrical demand profiles provided by the installation. The low amount of run time associated with the generator installation (about four hours per day, five days per week) provides for limited opportunities of heat recovery and utilization, and was deemed infeasible for this ECO. The annual maintenance cost used in the analysis was $0.01 per kilowatthour of engine run time.

1.3.11 ECO-3B: Install 6 MW Peak-Shaving Plant at Building 160

ECO-3B was evaluated similarly to ECO-3A, however in this size generating equipment a natural gas/diesel turbine is more practical than a gas engine. The increased run time (about ten hours per day, five days per week) with this ECO allowed the consideration of heat recovery from the turbine. A heat recovery steam boiler package was chosen so that about 35,000 lbs/hr of 135 psig steam could be generated for injection into the Arsenal's central steam system. This requires making steam line tie-ins, water treatment, and handling of the condensate from the system, which was all included in the cost estimate.

1.3.12 ECO-3C: Install 24 MW Base Loaded Generating Plant at Building 160

This ECO was evaluated in the same manner as ECO-3B with the only difference being that ECO-3C provides for generating all the power that is currently purchased by the Arsenal by means of four 6 MW natural gas/diesel turbine-generators. The heat recovered from the turbine set is used to generate 110,000 lb/hr of 135 psig steam for use by the installation at the peak electrical demand of 24 MW.

Due to the size of the installation with four turbines, an alternative site to Building 160 was chosen. Building 168 (the old heating plant) was chosen since it is an open area building of 8,349 ft^2. This site will provide some investment savings for the project as some of the steam lines are still in place. As an alternative to this site, a new facility could be built next to the present heating plant.

In preparing the life cycle cost analysis for this ECO, a much cheaper gas rate was used. If this ECO was implemented, the Arsenal would most likely buy gas from a direct supplier due to the large quantities of gas invloved. Thus a rate of $3.00/MBTU was used in the analysis.

As mentioned previously, a maintenance savings of at least $200,000 is anticipated by the Arsenal engineering staff due to the shutdown of the existing steam plant for three to four months during the summer. The heat recovered from the 24 MW cogeneration facility will provide more than enough steam to meet the Arsenal's needs during the summer.

Additionally, an investment savings of $4 million is taken for this ECO since the proposed 24 MW facility will serve to provide backup power to Building 350. A detailed estimate for providing an emergency generator installation for Building 350 has been performed by DEH which indicated the cost to be over $4 million for the required project. Thus, if the cogeneration facility is built, Building 350 has prime power supplied by the on-site turbine generators and emergency power provided by the existing Iowa and Illinois Electric Utility tie-in. Therefore, the investment cost used in the life cycle cost analysis for ECO-3C reflects a $4 million credit in the first year.

It should be mentioned that the initial cost of ECO-3C (and ECO's 3A and 3B) could be significantly reduced even further by the use of surplus or reconditioned generators sets. However, this method of purchase is limited by the availability of the equipment (i.e.-a set of four 6 MW dual-fuel turbines may not be available on the surplus market at the time of construction).

1.4 ECIP PROJECTS DEVELOPED

As a result of the analysis, three Energy Conservation Investment Program (ECIP) Projects were developed. The three ECIP projects correspond to the three general ECO divisions:

ECIP - 1: Lighting Improvements in Building 220
ECIP - 2: Lighting Improvements in Building 350
ECIP - 3: Cogeneration Installation at Building 168

Table 1.4.1 lists the pertinent data for each of the three ECIP Projects. ECIP-1 does not include ECO-1B even though it qualifies for ECIP funding because ECO-1A and ECO-1B accomplish the same work by different methods, and ECO-1A is the preferred alternative.
ECIP-3 was developed from ECO-3C: 24 MW Cogeneration System at Building 168.

No non-ECIP projects were developed from this study. No operational or policy changes are recommended as a result of this study.

Table 1.4.3 summarizes the energy savings for each ECIP project.

TABLE 1.4.1

ECIP PROJECTS DEVELOPED

BUILDING NUMBER	ECO NUMBER	INVESTMENT COST ($)	ANNUAL SAVINGS ($)	SIMPLE PAYBACK YEARS	SIR
220	1A	1,003,000	177,222	5.7	1.7
220	1C	59,000	21,723	2.7	2.5
220	1D	4,000	2,473	1.6	8.0
TOTAL ECIP - 1*	**1A, 1C, 1D**	**1,066,000**	**201,418**	**5.3**	**2.1**
350	2A	313,000	51,508	6.1	1.5
350	2B	27,000	3,366	8.0	1.7
350	2C	975,000	249,963	3.9	2.3
350	2D	43,000	8,312	5.2	2.5
350	2E	6,400	4,431	1.4	8.0
TOTAL ECIP - 2	**2A - 2E**	**1,364,000**	**317,580**	**4.3**	**2.6**
160	3C	16,199,000	2,844,423	5.7	1.0
TOTAL ECIP - 3	**3C**	**16,199,000**	**2,844,423**	**5.7**	**1.0**
TOTAL*	**1A, 1C, 1D 2A - 2E, 3C**	**18,629,000**	**3,363,241**	**5.5**	**1.2**

* TOTAL EXCLUDES ECO-1B SINCE ECO-1A WAS THE PREFERRED ALTERNATIVE.

TABLE 1.4.2

ROCK ISLAND ARSENAL
LIMITED ENERGY STUDY

SUMMARY OF ENERGY SAVINGS

ECIP No.	BUILDING No.	CURRENT ENERGY (MBTU)	PROPOSED ENERGY (MBTU)	TOTAL ENERGY SAVINGS (MBTU)	% ENERGY REDUCTION
1	220	12,800 (ELEC.)	5240 (ELEC.)	7560	59.1
2	350	21,000 (ELEC.)	3600 (ELEC.)	17,400	82.9
3	168	1,839,000 (COAL & ELEC.)	2,242,000 (N.G.)	-403,000	-21.9

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

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