

FINAL REPORT

ENERGY SAVINGS OPPORTUNITY SURVEY
FY 85 ENERGY ENGINEERING ANALYSIS PROGRAM
VARIOUS LOCATIONIS, EIGHTH US ARMY, KOREA

Prepared for
DEPARTMENT OF THE ARMY
FAR EAST DIVISION, CORPS OF ENGINEERS
SEOUL, KOREA

Prepared by
KNIGHT KOREA
LESTER B. KNIGHT & ASSOCIATES, INC.
U-IL ARCHITECTS & ENGINEERS

MARCH 1987

DACA81-85-C-0209

19971023 161

DTIC QUALITY INSPECTED 2

DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited



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.

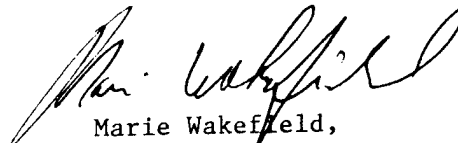

Marie Wakefield,
Librarian Engineering

TABLE OF CONTENTS

EXECUTIVE SUMMARY COMPREHENSIVE REPORT

1.0 INTRODUCTION

1.1 Purpose

1.2 Scope

1.3 Methodology

1.3.1 Pre-Survey Preparation

1.3.2 Building Surveys

1.3.3 Data Base Preparation

1.3.4 ECO Analysis

1.3.5 Facilities Engineering Work Request (FEWR)

1.4 Findings and Recommendations

1.4.1 New Construction ECO Projects

1.4.2 Repair ECO Projects

1.4.3 O & M ECO Projects

1.4.4 Future Energy Use

2.0 STUDY METHODOLOGY

2.1 Building Surveys

2.1.1 Pre-Survey Preparation

2.1.2 FY85 ESOS Entry Briefing

2.1.3 AFE In-Briefings and Building Substitutions

2.1.4 Field Work

2.2 Analysis

2.2.1 Development of a Building Data Base

2.2.2 Determination of Baseline Energy Use

2.2.3 Evaluation of Energy Savings Opportunities

2.3 Funding Considerations

2.3.1 Funding Alternatives

2.3.2 Funding Method Selected

3.0 EVALUATION OF PREVIOUS EEAP

3.1 Status of 1981 Energy Engineering Analysis Program Recommendations

3.2 FY85 ESOS Handling of 1981 EEAP Recommendations

4.0 FY85 AND FUTURE BASELINE ENERGY CONSUMPTION

4.1 FY85 Baseline Energy Use

- 4.1.1 Space Heating Energy Use
- 4.1.2 Space Cooling Energy Use
- 4.1.3 Auxiliary Equipment Energy Use
- 4.1.4 Domestic Hot Water Heating Energy Use
- 4.1.5 Lighting Energy Use
- 4.1.6 Process Energy Use

4.2 Future Baseline Energy Use

- 4.2.1 Space Heating Energy Reductions
- 4.2.2 Space Cooling Energy Reductions
- 4.2.3 Auxiliary Equipment Energy Reductions
- 4.2.4 Domestic Hot Water Heating Energy Reductions
- 4.2.5 lighting Energy Reductions
- 4.2.6 Process Energy Reductions

5.0 ECONOMIC ANALYSIS FACTORS

5.1 Energy Costs

- 5.1.1 Electricity
- 5.1.2 Fuel Oil

5.2 Construction Costs

5.3 Economic Assumptions

6.0 FINDINGS AND RECOMMENDATIONS

6.1 Facilities Included

- 6.1.1 Types of Facilities
- 6.1.2 Condition of FY85 ESOS Buildings

6.2 Operation and Maintenance (O & M) Problems

- 6.2.1 U.S. Personnel Staffing
- 6.2.2 Korean National (KN) Personnel Staffing
- 6.2.3 Korean O & M History
- 6.2.4 Observations During Site Surveys
- 6.2.5 Energy Considerations
- 6.2.6 Recommendations for USFK O & M

6.3 Specific Energy Conservation Recommendations

- 6.3.1 Recommended New Construction Projects
- 6.3.2 Recommended Repair Projects
- 6.3.3 Recommended Operations & Maintenance Procedures
- 6.3.4 Energy Conservation Projects Evaluated Resulting in Savings-to-Investment-Ratios of Less than 1.

LIST OF TABLES

| | |
|-----------|--|
| Table 1-1 | FY 85 ESOS Building List |
| 1-2 | Energy Conservation Project Summary |
| Table 2-1 | FY85 ESOS Building Substitutions |
| 2-2 | Productivity Capital Investment Programs Project Categories, Effective FY83 |
| Table 3-1 | Status of 1981 EEAP Energy Conservation Recommendations |
| Table 4-1 | FY85 Baseline Energy Use |
| 4-2 | Future Baseline Energy Use |
| 4-3 | Heating and Cooling Systems Installed in FY85 ESOS Buildings |
| Table 5-1 | Korean Hourly Labor Rates |
| Table 6-1 | FY85 ESOS Buildings - By Type |
| 6-2 | Condition and Age of FY85 ESOS Buildings |
| 6-3 | FY85 ESOS Energy Saving Projects Ranked by Savings-to- Investment-Ratio |
| 6-4 | FY85 ESOS Energy Saving Projects Listed by Project Type |
| 6-5 | FY85 ESOS Energy Saving Projects - Energy Savings per Building |
| 6-6 | Statement-of-Work Energy Conservation Project List |
| 6-7 | FY85 ESOS Energy Conservation Project Building-by-Building Check List |

LIST OF FIGURES

- Figure 1-1 Installation Location Map, FY85 ESOS, Korea
- 1-2 Future Energy Use and Savings From the FY85 Baseline
- 4-1 Heating, Cooling and Ventilation Seasons, FY85 ESOS, Korea
- 4-2 Monthly Energy Use Profile Representative Office Building
- 4-3 Monthly Energy Use Profile Representative Shop/Ware-house Building
- 4-4 Monthly Energy Use Profile Representative Barracks Building
- 4-5 Monthly Energy Use Profile Representative Dining Facility with Cooling
- 4-6 Monthly Energy Use Profile Representative Dining Facility without Cooling
- 4-7 Monthly Energy Use Profile Representative Open Dining Facility
- 4-8 Monthly Energy Use Profile Representative Community Facility

VOLUME II: APPENDICES

TABLE OF CONTENTS

PART A

| | |
|------------|--|
| Appendix A | Scope of Work, 14 August 1985 |
| Appendix B | Sample Completed Building Survey Forms |
| Appendix C | Minutes of In and Exit Briefings |
| Appendix D | Baseline Heating Energy Use |
| Appendix E | Baseline Energy Consumption Calculations |
| Appendix F | Backup Data: Architectural ECO Analyses |
| Appendix G | Backup Data: Electrical ECO Analyses |

PART B

| | |
|------------|--|
| Appendix H | Backup Data: Mechanical ECO Analyses |
| Appendix I | Cooling Load and Energy Use Calculations |
| Appendix J | Heat Transfer Characteristics |
| Appendix K | Outside Air Flow Rates for Use in Calculating Baseline Heating and Cooling Loads |
| Appendix L | Auxiliary Equipment Electric Energy Use |
| Appendix M | U.S.F.K Energy Regulation 700-1 |
| Appendix N | Baseline Lighting Energy Calculations |

VOLUME III: SURVEY DATA

VOLUME IV: FUNDING DOCUMENTS

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

1. Introduction

This study was prepared as part of the Engineering Energy Analysis Program (EEAP). The EEAP is a Department of Defense (DOD) program which was initiated in the late 1970's in response to a Presidential Order. The program's primary goal is to reduce energy consumption within the DOD thereby curbing dependence on foreign non-renewable energy sources, notably oil. The Energy Engineering Analysis Program (EEAP) is administrated by the U.S. Army Corps of Engineers through the Huntsville Division located in Huntsville, Alabama.

The EEAP program effort in Korea has consisted of two major studies. The first study occurred in 1981 and consisted of basewide energy studies. The scope for these studies included looking at entire camps. The second effort under the EEAP program in Korea is this study. The scope of work for this study includes a total of 63 buildings located at 19 different camps throughout Korea from Taegu to the DMZ (see Figure 1). This study is properly known as an Energy Savings Opportunity Survey (ESOS). Since an ESOS is limited to examining individual buildings, energy savings projects are limited to the scale and complexity of the buildings within the study.

2. Study Methodology

The study was carried out in a three step procedure, beginning with detailed field building surveys. A multi-disciplinary field inspection team surveyed all of the 63 buildings (which include 61 buildings and 2 detached utility buildings). These surveys gathered all of the vital building characteristics which affect each buildings' energy consumption. All of the building thermal envelope properties were noted. Measurements were taken on total building electrical loads, boiler efficiencies, lighting intensity levels, space temperatures, domestic hot water temperatures, air flow quantities, and electrical motor loads. Other building data including building occupancy, and schedules were also noted. Assessments were made on individual building system status and condition. All possible Energy Conservation Opportunities (ECO) were identified at this time.

The second phase of the study included summarizing all of the field data collected and development of a data base. Included in this phase was determining the existing energy consumption of all of the 63 buildings by calculating heating, cooling, process, electrical power and lighting loads and developing an energy baseline for each building. All of the field data obtained during site surveys formed the basic input for the energy baseline data base.

The last phase of the study included analyzing each individual Energy Conservation Opportunity (ECO) to test its economic viability and determine both the implementation cost and the resulting energy and dollar savings. Those projects that provide energy savings and pay back within their economic life are recommended for funding. A number of repair projects were also identified and recommended for funding. Facilities Engineering Work Requests (FEWRs) were prepared for each building including all energy saving recommendations developed under this study.

3. Conclusions

A. Energy Savings

"Energy savings from recommended new construction, repair and operations and maintenance (O & M) energy conservation opportunity measures will result in overall annual energy savings of 55,063 million Btu's of fuel oil and 1,541 megawatt-hours (MWH) of electric energy. This converts to a total savings of 60,323 million Btu's per year when electric savings are converted using 3,413 Btu's per kilowatt-hour (KWH). Savings are broken down as follows:

| Project | Fuel Oil 10 Btu/Yr | Electricity KWH/Yr | Total 10 Btu/Yr <u>1/</u> |
|---------------------------|-----------------------|-----------------------|------------------------------|
| New Construction | 35,847 | 1,337,128 | 40,411 |
| Repair Projects | 10,946 | 183,742 | 11,573 |
| O & M Projects | 8,271 | 20,152 | 8,339 |
| Subtotal Repair and O & M | 19,216 | 203,894 | 19,912 |
| ===== Total <u>2/</u> | 55,063 | 1,541,022 | 60,323 |

When developing the FY85 aseline it was assumed that certain repairs and O & M procedures had already been implemented. Thus, the difference between the FY85 and Future Baseline energy use shown on Figure 2 may not appear to agree with the above savings claims.

The resulting energy savings between FY 85 and Future Baselines is 27% for these 63 buildings which exceeds the overall Eighth U.S. Army (EUSA) FY 95 energy savings goal of a 10% reduction. It is noted that most of the savings (40%) occurs in the area of Heating, Ventilating and Air Conditioning (HVAC)."

B. Recommended Energy Saving Projects

Table 1 summarizes all of the energy saving opportunities recommended by this study. The projects are classified into three groups; new work, repair, and operations and maintenance. These groups include the FEWR funding allocations of OMA L, K, and M accounts respectively.

From a total investment of \$1,150,243 for all projects, annual savings of \$443,794 are realized. This allows for a payback period of 2.59 years. The total Life Cycle Cost (LCC) Savings for all the projects is \$5,005,550.

C. Operations and Maintenance

Although a detailed study of AFE/DEH operations and maintenance procedures is not required by this energy study, certain generic problems specific to the Korean environment became evident during the detailed building surveys, which are worthy of note.

O & M crews do not understand new systems. As a result of the higher technology involved in the new facilities, the lack of sufficient personnel, and a long term O & M training program, actual maintenance crews lack the skills to enact proper maintenance. During site surveys automatic controls were found to be routinely defeated or bypassed. This condition was the rule and not the exception. Even an item as simple as a three-way automatic control valve was almost always found to be disconnected and manually controlled or bypassed.

The attendant O & M problems in Korea surface significant questions related to energy savings. Most energy saving opportunities require installation of many differing devices which although not "high tech" require a significant understanding of the purpose of the installation and a concurrent understanding of how the hardware components operate.

The approach taken in this study was to recommend energy conservation opportunities that can realistically be expected to be effective within the apparent limitations imposed by the unique aspects of O & M in Korea.

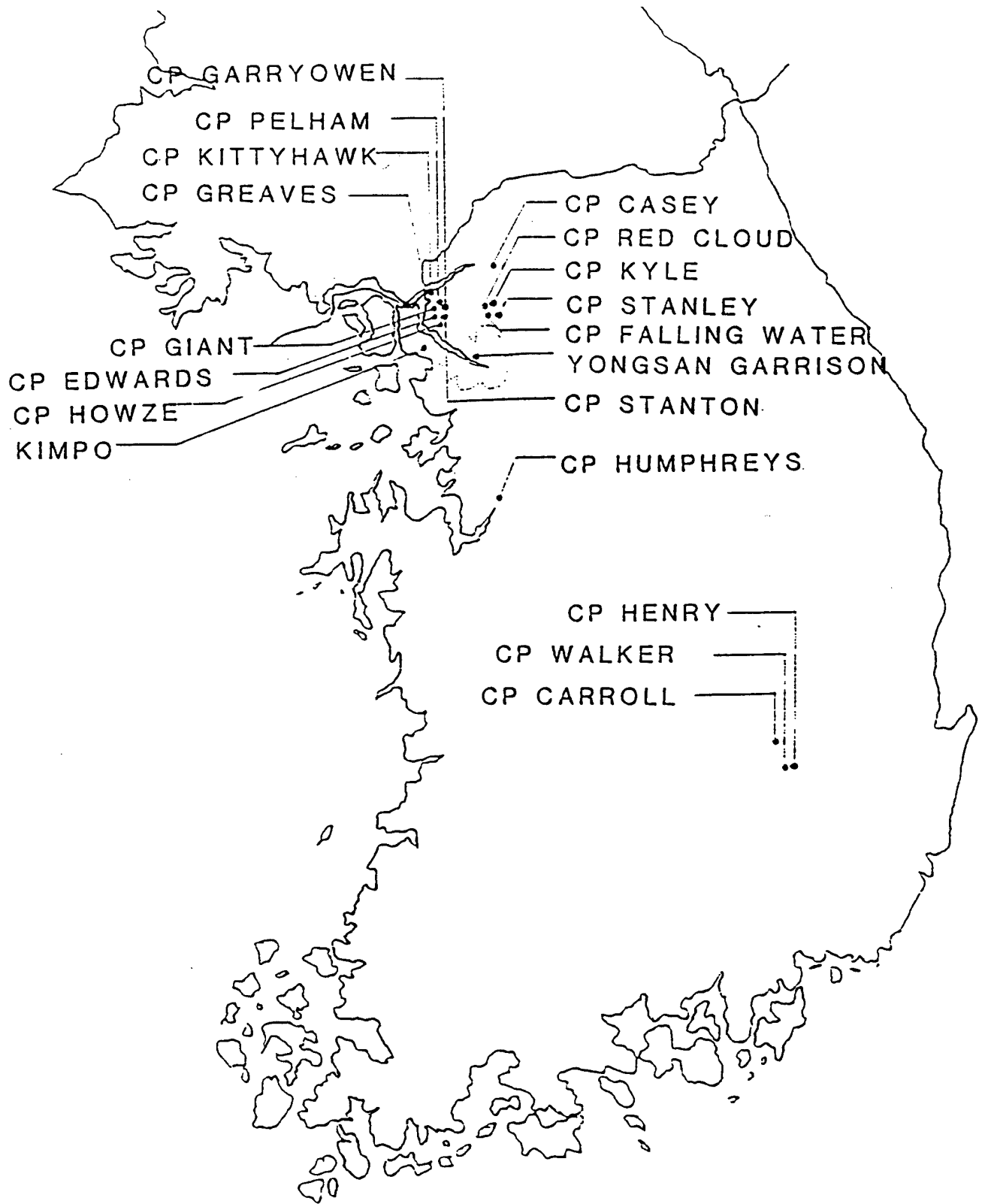
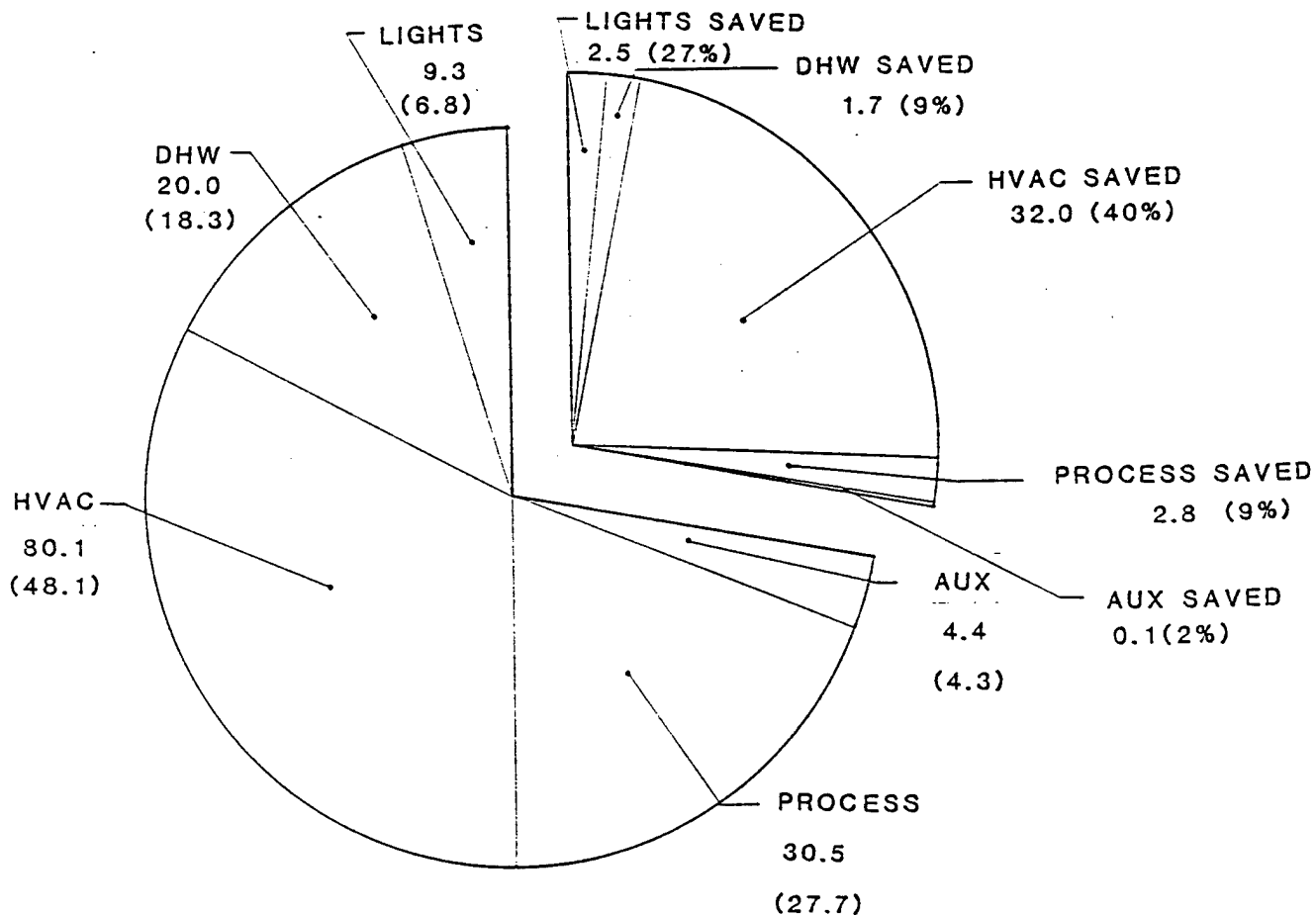


FIGURE 1
 INSTALLATION LOCATION MAP
 FY 85 EEAP, KOREA

FIGURE 2
 FUTURE ENERGY USE
 AND
 SAVINGS FROM THE FY85 BASELINE



LEGEND

FY85 BASELINE ENERGY USE

ENERGY USAGE CATEGORY
 BILLION BTU'S PER YEAR
 (FUTURE BASELINE)

ENERGY SAVED-FY85 ESOS

ENERGY USAGE CATEGORY
 BILLION BTU'S PER YEAR
 (% FY85 BASELINE SAVED)

ELECTRICITY CONVERTED TO BTU'S USING 3,412 BTU PER KWH

TABLE 1
SUMMARY OF FY85 ESOS RECOMMENDATIONS

| ECD NO. | DESCRIPTION | PROJECT TYPE | ENERGY SAVINGS (MIL BTU/Y) | S&D (\$/Y) | O&M COST S&D (\$/Y) | TOTAL S&D (\$/Y) | TOTAL LCC SAVED (\$) | INVESTMENT NEW (\$) | INVESTMENT REPAIR (\$) | SIR (RATIO) | PAYBACK (YEARS) |
|--|--|------------------|----------------------------|------------|---------------------|------------------|----------------------|---------------------|------------------------|-------------|-----------------|
| NEW CONSTRUCTION PROJECTS (FUNDING REQUESTED FROM OMA-L ACCOUNT) | | | | | | | | | | | |
| ML-11C | INSULATE COND. RECEIVERS & STEAM PRESSES | NEW CONSTRUCTION | 446 | \$2,735 | \$0 | \$2,735 | \$30,607 | \$427 | \$0 | 71.66 | 0.16 |
| MC-20A | SET-BACK THERM CONTROLS | NEW CONSTRUCTION | 14,849 | \$92,934 | \$0 | \$92,934 | \$1,033,970 | \$37,626 | \$0 | 27.48 | 0.40 |
| E-32 | DISCONNECT LIGHTING FIXTURES | NEW CONSTRUCTION | 13 | \$223 | \$0 | \$223 | \$2,660 | \$180 | \$0 | 14.78 | 0.81 |
| E-54 | PROVIDE MORE LIGHT SWITCHING ZONES | NEW CONSTRUCTION | 73 | \$1,253 | \$0 | \$1,253 | \$14,940 | \$1,404 | \$0 | 10.64 | 1.12 |
| E-61 | INSTALL PENDANT FIXTURES | NEW CONSTRUCTION | 38 | \$657 | \$27 | \$684 | \$8,152 | \$1,063 | \$0 | 7.67 | 1.55 |
| MC-12 | FLUE DAMPERS ON BOILERS & WARM AIR FURNACES | NEW CONSTRUCTION | 2,224 | \$13,632 | (\$1,800) | \$11,832 | \$136,141 | \$21,773 | \$0 | 6.25 | 1.84 |
| MC-20C | ADD HVAC ZONES | NEW CONSTRUCTION | 8,367 | \$52,437 | (\$604) | \$51,833 | \$577,688 | \$98,297 | \$0 | 5.88 | 1.98 |
| E-37 | REPLACE INCAND. FIXTURES WITH ENERGY SAVING FLUOR. LAMPS & BALLASTS FIXTURES | NEW CONSTRUCTION | 1,235 | \$21,355 | \$30,546 | \$51,900 | \$610,487 | \$100,627 | \$0 | 5.62 | 2.09 |
| E-30 | TIMER SWITCHES FOR LIGHTING | NEW CONSTRUCTION | 219 | \$3,782 | \$0 | \$3,782 | \$26,591 | \$4,856 | \$0 | 5.48 | 1.28 |
| E-50 | REPLACE EXIT SIGNS WITH MORE EFFICIENT FIXTURES | NEW CONSTRUCTION | 335 | \$5,788 | \$3,532 | \$9,320 | \$85,248 | \$16,646 | \$0 | 5.12 | 1.79 |
| MC-1 | IR SPACE HEATING RETROFIT | NEW CONSTRUCTION | 1,143 | \$7,007 | (\$14) | \$6,993 | \$78,276 | \$15,422 | \$0 | 5.08 | 2.21 |
| ML-68 | IMPROVE REACH-IN REFRIGERATOR PERFORMANCE | NEW CONSTRUCTION | 51 | \$878 | (\$16) | \$862 | \$7,986 | \$1,762 | \$0 | 4.49 | 2.04 |
| E-49 | REPLACE LIGHTING WITH HPS LIGHTS | NEW CONSTRUCTION | 423 | \$7,322 | \$830 | \$8,152 | \$96,947 | \$24,323 | \$0 | 3.98 | 2.99 |
| A-23 | INSTALL INSULATION ON ROOFS OR IN CEILINGS | NEW CONSTRUCTION | 3,041 | \$26,467 | \$0 | \$26,467 | \$379,466 | \$110,085 | \$0 | 3.45 | 4.16 |
| E-38 | SWITCH EXHAUST FANS WITH LIGHTS IN LATRINES & SHOWERS | NEW CONSTRUCTION | 52 | \$895 | \$0 | \$895 | \$10,667 | \$3,609 | \$0 | 2.96 | 4.03 |
| A-22 | INSTALL INSULATION FOR EXTERIOR WALLS | NEW CONSTRUCTION | 2,777 | \$20,779 | \$0 | \$20,779 | \$314,412 | \$106,638 | \$0 | 2.95 | 5.13 |
| MC-64 | INSULATE MECH ROOM WALLS | NEW CONSTRUCTION | 153 | \$937 | \$0 | \$937 | \$15,345 | \$6,266 | \$0 | 2.45 | 6.69 |
| E-47 | REPLACE ENTRANCE LIGHTS WITH MORE EFF. FIXTURES ON PHOTOCELL CNTRL | NEW CONSTRUCTION | 187 | \$1,846 | \$397 | \$2,243 | \$26,625 | \$12,093 | \$0 | 2.20 | 5.39 |
| ML-39 | INSULATE RA DUCTWORK IN MECH. ROOMS | NEW CONSTRUCTION | 20 | \$122 | \$0 | \$122 | \$1,366 | \$638 | \$0 | 2.14 | 5.22 |
| MC-63 | DISHWASHER DRN HT RECOVERY | NEW CONSTRUCTION | 898 | \$5,503 | (\$728) | \$4,775 | \$54,945 | \$26,622 | \$0 | 2.06 | 5.58 |
| E-62 | INSTALL HALLWAY TIMER SWITCHES | NEW CONSTRUCTION | 197 | \$3,412 | \$0 | \$3,412 | \$31,287 | \$17,028 | \$0 | 1.84 | 4.99 |
| ML-23 | HEATING HOT WATER TEMPERATURE RESET CONTROLS | NEW CONSTRUCTION | 62 | \$382 | (\$48) | \$334 | \$3,833 | \$2,286 | \$0 | 1.68 | 6.85 |
| ML-33 | INSULATE REFRIGERANT PPG | NEW CONSTRUCTION | 8 | \$7 | \$0 | \$7 | \$67 | \$41 | \$0 | 1.65 | 5.57 |
| MC-62 | HEAT RECOVERY FOR DMH FROM COOLING REFRIGERATION | NEW CONSTRUCTION | 397 | \$2,435 | (\$18) | \$2,417 | \$27,082 | \$16,575 | \$0 | 1.63 | 6.86 |
| A-15-N | REPLACE WINDOWS WITH THERMAL WINDOWS | NEW CONSTRUCTION | 106 | \$1,166 | \$0 | \$1,166 | \$15,529 | \$9,854 | \$0 | 1.58 | 8.45 |
| E-42 | TIME CLOCKS FOR WATER COOLERS & VENDING MACHINES | NEW CONSTRUCTION | 49 | \$848 | \$0 | \$848 | \$5,958 | \$3,845 | \$0 | 1.55 | 4.54 |

| ECO NO. | DESCRIPTION | PROJECT TYPE | ENERGY SAVINGS (MIL BTU/Y) | SVD (\$/Y) | D&M COST SVD (\$/Y) | TOTAL SVD (\$/Y) | TOTAL LCC SAVED (\$) | INVESTMENT NEW (\$) | INVESTMENT REPAIR (\$) | SIR (RATIO) | PAYBACK (YEARS) |
|------------------------------------|--|------------------|----------------------------|------------|---------------------|------------------|----------------------|---------------------|------------------------|-------------|-----------------|
| MC-61B | VAV RETROFIT IN S-292 CAMP RED CLOUD | NEW CONSTRUCTION | 367 | \$2,833 | (\$156) | \$2,677 | \$27,387 | \$19,892 | | 1.43 | 7.10 |
| MC-1B | CMRCL DRYER HEAT RECOVERY | NEW CONSTRUCTION | 722 | \$4,359 | (\$312) | \$4,047 | \$46,147 | \$32,459 | \$0 | 1.42 | 8.02 |
| E-66 | INSTALL ENERGY EFFICIENT MOTORS | NEW CONSTRUCTION | 46 | \$799 | \$0 | \$799 | \$9,523 | \$6,732 | \$0 | 1.41 | 8.43 |
| E-36 | REPLACE STANDARD FLUOR. LAMPS & BALLASTS | NEW CONSTRUCTION | 221 | \$3,813 | (\$619) | \$3,194 | \$38,234 | \$28,264 | \$0 | 1.35 | 8.85 |
| MC-60A-N | CLNG SYS ECONOMIZER RETROFITS | NEW CONSTRUCTION | 37 | \$636 | (\$32) | \$604 | \$5,539 | \$4,425 | \$0 | 1.25 | 7.33 |
| ML-57 | REPLACE ELEC DHW HTR WITH FO FIRED HTR | NEW CONSTRUCTION | (8) | \$463 | \$0 | \$463 | \$4,844 | \$3,378 | | 1.28 | 7.28 |
| MC-38 | LNDRY DRAIN HEAT RECOVERY | NEW CONSTRUCTION | 1,811 | \$18,952 | (\$278) | \$18,674 | \$177,177 | \$163,988 | \$0 | 1.88 | 15.36 |
| E-46 | RELOCATE LIGHTING FXTRS | DD WITH E-36&37 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SUBTOTAL NEW CONSTRUCTION PROJECTS | | | 48,411 | \$298,658 | \$38,786 | \$329,364 | \$3,984,887 | \$986,235 | \$0 | 4.31 | 2.75 |

OPERATION AND MAINTENANCE PROJECTS (FUNDING REQUESTED FROM OMA-M ACCOUNT) (3)

| | | | | | | | | | | | |
|---|---|-------|-------|----------|------------|----------|---------|-----|-----------|----|------|
| ML- 2 | (1) REMOVE UNAUTHORIZED ICE MACHINE | O & M | 8 | \$138 | \$0 | \$138 | \$1,191 | | (\$1,852) | NA | NA |
| ML- 3 | (2) RESET DHW TEMPERATURES | O & M | 4,261 | \$26,788 | (\$986) | \$25,802 | \$0 | \$0 | \$0 | NA | 8.84 |
| ML- 6 | (1) REMOVE UNAUTHORIZED DHW FROM SLOP SINKS | O & M | 41 | \$263 | \$0 | \$263 | NA | \$0 | \$72 | NA | 8.27 |
| ML-29 | (2) RETUNE BOILER COMBUSTION CONTROLS | O & M | 3,988 | \$24,488 | (\$18,286) | \$14,194 | NA | NA | NA | NA | 8.42 |
| ML-45 | (2) CVR WINDOW ACCU'S IN WNTR | O & M | 58 | \$388 | (\$173) | \$135 | NA | \$0 | \$0 | NA | 8.56 |
| SUBTOTAL OPERATION AND MAINTENANCE PROJECTS | | | 8,339 | \$51,889 | (\$11,365) | \$48,524 | \$1,191 | \$0 | \$72 | NA | 8.22 |

REPAIR PROJECTS (FUNDING REQUESTED FROM OMA-K ACCOUNT)

| | | | | | | | | | | | |
|--------|--|--------|-------|----------|-----|----------|-----------|-----|---------|--------|------|
| ML-27 | (1) REMOVE HEAT FROM VESTBLS, STRWLLS & STRG AREAS | REPAIR | 1,835 | \$6,345 | \$0 | \$6,345 | \$183,924 | \$0 | \$398 | 261.37 | 8.86 |
| ML-14 | REPLACE STEAM TRAPS | REPAIR | 5,648 | \$34,573 | \$0 | \$34,573 | \$566,389 | \$0 | \$9,566 | 59.28 | 8.28 |
| ML-11B | INSULATE HHW PIPING | REPAIR | 335 | \$2,856 | \$0 | \$2,856 | \$23,889 | \$0 | \$416 | 55.26 | 8.28 |
| ML-11A | INSULATE DHW PIPING | REPAIR | 186 | \$648 | \$0 | \$648 | \$7,246 | \$0 | \$217 | 33.42 | 8.33 |
| ML-36 | INSTALL ASPIRATORS ON LAVDRATORY FAUCETS | REPAIR | 181 | \$637 | \$0 | \$637 | \$7,875 | \$0 | \$684 | 11.72 | 8.95 |
| ML- 7 | REPLACE LEAKING PRV'S | REPAIR | 51 | \$313 | \$0 | \$313 | \$5,131 | \$0 | \$684 | 8.49 | 1.93 |
| MC-28B | HVAC SYSTEM REPAIRS | REPAIR | 558 | \$3,446 | \$0 | \$3,446 | \$38,479 | \$0 | \$9,351 | 4.11 | 2.71 |
| A- 4 | REPLACE FAILING DAMPERS | REPAIR | 43 | \$365 | \$0 | \$365 | \$5,291 | \$0 | \$1,455 | 3.64 | 3.99 |
| MC-61A | DEDICATED COOLING SYSTEM IN S-292 CAMP RED CLOUD | REPAIR | 194 | \$3,351 | \$0 | \$3,351 | \$38,728 | \$0 | \$9,689 | 3.28 | 2.87 |
| ML-46 | INSTALL FIREPLACE DAMPERS | REPAIR | 8 | \$49 | \$0 | \$49 | \$549 | \$0 | \$178 | 3.88 | 3.63 |

| ECD NO. | DESCRIPTION | PROJECT TYPE | ENERGY SAVINGS (MIL BTU/Y) | SVD (\$/Y) | O&M COST SVD (\$/Y) | TOTAL SVD (\$/Y) | TOTAL LCC SAVED (\$) | INVESTMENT NEW (\$) | INVESTMENT REPAIR (\$) | SIR (RATIO) | PAYBACK (YEARS) |
|--|---|--------------|----------------------------|------------|---------------------|------------------|----------------------|---------------------|------------------------|-------------|-----------------|
| MC-55 | REPLACE BLRS & WAF's | REPAIR | 454 | \$2,783 | \$2,880 | \$4,863 | \$69,818 | \$0 | \$26,215 | 2.66 | 5.39 |
| A- 1 | REALIGN AND WEATHERSTRIP PERSONNEL DOORS | REPAIR | 413 | \$2,531 | \$0 | \$2,531 | \$41,461 | \$0 | \$20,462 | 2.83 | 8.08 |
| A-15-R | REPLACE WINDOWS WITH THERMAL WINDOWS | REPAIR | 418 | \$3,795 | \$0 | \$3,795 | \$53,329 | \$0 | \$38,579 | 1.38 | 10.17 |
| ML-15 | REPLACE EVAPRTR DEFROSTERS | REPAIR | 94 | \$1,619 | \$0 | \$1,619 | \$14,846 | \$0 | \$18,764 | 1.38 | 6.65 |
| A- 2 | REPLACE FAILING PERSONNEL DOORS | REPAIR | 668 | \$5,715 | \$0 | \$5,715 | \$82,485 | \$0 | \$67,117 | 1.23 | 11.74 |
| MC-17 | ADD WATER TREATMENT TO PREVENT TUBE SCALING | REPAIR | 1,396 | \$8,557 | (\$6,120) | \$2,437 | \$48,882 | \$0 | \$37,664 | 1.86 | 15.45 |
| MC-60A-R | CLNG SYS ECONOMIZER REPAIRS | REPAIR | 67 | \$1,164 | \$0 | \$1,164 | \$18,669 | \$0 | \$18,737 | 0.99 | 9.23 |
| SUBTOTAL REPAIR PROJECTS | | | 11,573 | \$77,946 | (\$4,840) | \$73,906 | \$1,188,272 | \$0 | \$243,936 | 4.51 | 3.38 |
| GRAND TOTAL FOR ALL PROJECTS RECOMMENDED FOR FUNDING | | | 68,323 | \$428,493 | \$15,381 | \$443,794 | \$5,885,558 | \$986,235 | \$244,888 | 4.35 | 2.59 |

GENERAL: REPAIRS ALREADY COMPLETED AS A RESULT OF THE INTERIM SUBMITTAL ARE NOT INCLUDED IN THE ABOVE TOTALS.
ELECTRIC ENERGY SAVING ARE CONVERTED TO BTU'S USING 3413 BTU'S PER KWH.

- (1) THIS PROJECT REMOVES AN EXISTING SERVICE. THERE IS NO EQUIPMENT EXPENSE TO AMORTIZE OVER A LIFE CYCLE, THUS NO LIFE CYCLE COST ANALYSIS IS PROVIDED.
- (2) THIS PROJECT REQUIRES THE ADDITION OF OPERATION AND MAINTENANCE AS A RECURRING COST WITHOUT A ONE-TIME INVESTMENT IN EQUIPMENT THAT MUST BE AMORTIZED. THUS, A LIFE CYCLE COST ANALYSIS IS NOT PROVIDED.
- (3) FUNDS ARE REQUESTED ON FACILITIES ENGINEERING WORK REQUESTS FOR THE FIRST YEAR'S ADDITIONAL OPERATION AND MAINTENANCE COSTS AND FOR ANY REQUIRED INVESTMENT FOR THESE PROJECTS.