ENERGY SURVEY FOR THE UNITED STATES DISCIPLINARY BARRACKS (USDB)

AT

FORT LEAVENWORTH, KANSAS

FINAL SUBMITTAL

ENERGY ENGINEERING ANALYSIS PROGRAM

CONTRACT NUMBER DACA41-89-C-D197

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VOLUME 1

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INTRODUCTION

Fort Leavenworth is a government owned and operated armed forces military base located in Leavenworth, Kansas. Located within the Fort Leavenworth jurisdiction is the United States Disciplinary Barracks (USDB). The USDB is located at the northeast corner of the base. The USDB was originally constructed around 1900, and houses military inmates from all military installations across the United States and in foreign countries. The main structure, called the Castle, contains the majority of the inmates and is located within the walls at the north end of the USDB. Originally the compound included the walls and 10 buildings. Since the original construction, 10 additional buildings have been constructed within the walls of the USDB. Over the years the general use of many of the buildings has changed. Because of these changes, many buildings were remodeled to accommodate their new functions.

Purpose of this Study

The main purpose of this study was to investigate Energy Conserving Opportunities (ECO's) for energy projects. An energy conserving opportunity is any change in the existing physical construction or operating practices of the USDB that can lessen the amount of energy utilized in the form of water, electricity, fuel oil, and natural gas. Any of the individual ECO projects studied can be merged to form a larger project with discrete parts. The main funding group is the Energy Conservation Investment Program (ECIP) for projects with a construction cost exceeding $200,000, a Savings to Investment Ratio (SIR) of greater than one, and a simple payback period of less than 10 years. The second funding group is the Military Construction Army (MCA) for projects with a construction cost exceeding $200,000 and a SIR of greater than one. In addition, to qualify for the MCA funding, all of the discrete parts of the project have to have a SIR greater than one The third funding group is the Non-ECIP for projects that do not meet ECIP criterion but have an overall SIR greater than one.

Scope of this Study

The scope of this study was to survey the buildings of the USDB for energy conservation opportunities. The study was limited to a number of buildings located within the walls of the USDB. The following table displays the buildings studied by number, the approximate square footages, and the general use of each building.

Building Number	Square Footage	General Use of the Building by the USDB
450	9,200	Mental Hygiene Clinic
463	7,700	Command Group, South Gate, Visitors Room
464	6,700	Office, Barber Shop
465	34,500	Inside Barber Shop, Minimum Security
466	22,300	Minimum Security, Carpentry, Masonry
472	19,300	Vocation Printing, Education
473	12,400	Classification
474	7,800	Pope Hall
475	90,981	Rotunda, Control, Laundry Issue
475A	17,900	DOC, Investigations, Chapel
475B	11,100	Dining Facility, Chapel, Library, Band Room
475C	46,800	3-Wing, Housing Unit, Reception, ID
475D	54,400	4-Wing, Housing Unit, 4 Base
475E	91,000	Dining Facility, DLS, Gym, Mail Room, Property
475F	54,400	6-Wing, Housing Unit
475G	46,800	7-Wing, Housing Unit, Officer/Female Housing
475H	11,100	MSA, D & A Board, TDS, DMH

The locations of the various buildings displayed in the previous table are shown in figure 1.1 which is a general map of the USDB.

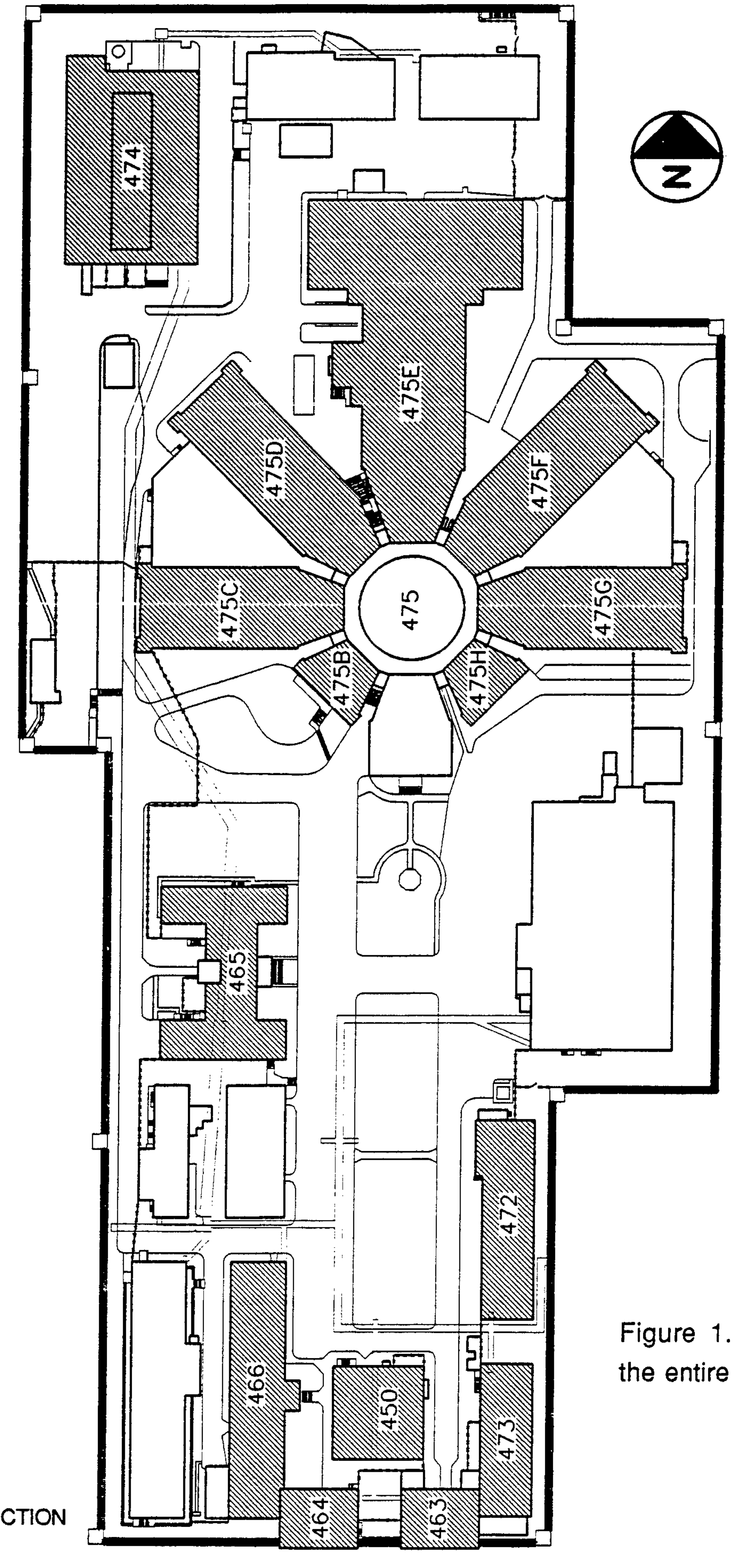

Figure 1.1 Plan view of the entire USDB.

The scope of work for this project as presented by the Corps of Engineers is located in the Appendix.

All of the ECO considered fit into three categories; architectural, mechanical, and electrical. The architectural ECO's considered were projects that changed the construction of the buildings. The mechanical ECO's were projects that changed the space air conditioning equipment and auxiliary equipment or the operation of equipment. The electrical ECO's were projects that changed the lighting or motor equipment or the operation of these systems.

Work Performed

A complete list of feasible ECO's to be studied in this project was compiled using; the list presented in the "General Scope of Work" by the Corps of Engineers, and meetings with the Director of Engineering and Housing (DEH) at Fort Leavenworth. A comprehensive list of the ECO's studied in this report is located in the ECO listing section of this Volume. Any of the ECO's listed in the "General Scope of Work" for this project that were not studied were considered not feasible. These are also shown behind the tab "ECO Listing". The ECO's were numbered relating to the discipline of the ECO, starting with an "A" for architectural, "M" for mechanical type, and "E" for electrical. The numbers of the ECO's are not consecutive because they were numbered from the "General Scope of Work", and some of the ECO's were combined or were not studied. A method for calculating the energy associated with the ECO project was determined next. Some of the energy calculations were completed using a computer simulation model of the buildings. A description of the computer simulations is located in the computer simulations section in this Volume. Other ECO's not evaluated with a computer simulation were studied with energy calculations located in each ECO section in this Volume.

The evaluation of the ECO's started with a number of field trips to the Fort Leavenworth. During each field trip, detailed field sheets were filled out containing the majority of information used to build computer models of each of the buildings to be studied for energy conservation. The field sheets contain information relating the number of people, lights and equipment located in a space and the schedule with which each occurred during a typical day. The field sheets also encompassed the physical construction of the building, the exterior wall construction, the number and types of doors and windows, and the type and structure of the roof. The field sheets are located in Volume 5 of this report. A valuable part of the field trip was conversations with the Officers or maintenance personnel located in or in charge of the operation of the equipment and the building. All the facts about the buildings were collected and used in building the computer models and calculating the energy used for each of the ECO's.

The majority of the building information aided in developing a computer model of each of the buildings. The models were built to run a computer simulation to evaluate the energy used by the building in its existing condition and with the ECO project completed. All of the information used to build the models was taken during a field trip or was determined by an ASHRAE[1] typical average. One instance where the ASHRAE methodology was used, was building 475E, where the building at the present time is vacant waiting to be remodeled. In that case, no information could be obtained by a field trip therefore, a set of plans for the remodel was studied and averages were considered for the models. With the models built, a base load was executed to obtain an existing energy use for each building. After the base energy use for the building was determined to be reasonably accurate, the computer model was changed to reflect the construction of the ECO project.

The computer model was changed to reflect the ECO implementation and was executed to determine the energy use by the building if the ECO project were completed. The base energy use and all of the various energy uses for the ECO projects studied are located in Volumes 2, 3, and 4 of this report. Some of the ECO energy savings were not determined using the computer simulations but formula calculations. These calculations are located with each ECO section.

Existing Building Conditions

Besides a few individual cases as detailed in section ECO-A9 of this report, the buildings were in fair shape architecturally. The majority of the buildings have had insulated glass installed within the past 10 years. Although the window itself in most cases was in good shape the fit of the window in the exterior wall was terrible. Some of the exterior doors to the buildings lacked adequate weatherstripping. Over half of the buildings studied in this report had their roofs replaced recently and good insulation was incorporated.

The general condition of mechanical heating and cooling equipment was poor. The majority of the controls that operate the equipment did not function and the controls that did function were not operating correctly to make the equipment perform. Many of the air handling units were altered to, what looked like, suffice for the present situation. When the season changes outdoors the air handling units are fixed to accommodate the new heating or cooling function required. All of the air handling units and auxiliary heating and cooling equipment should be cleaned to allow them to function better. During several of the field trips, personnel working in the spaces complained about the room uncomfortable conditions.

Electrically, all of the lighting systems functioned and were fluorescent. Only a few incandescent lights exist and their replacement was considered in ECO-E1.

Facility Maintenance

The maintenance personnel for the USDB is not a large work force. The work force is divided into the major types of maintenance to be performed; mechanical, electrical, and plumbing. In a discussion with the maintenance department, it was determined that their number of personnel is only enough to keep up with the repair work to be performed due to a failure. In many cases inmates lacking skills are utilized to work on the equipment. A large amount of energy is lost from the equipment not being maintained. An energy savings could be recovered by repairs of existing equipment, but actually, the energy savings is false because the piece of equipment should have been maintained. For the size of work force available to maintain the entire USDB, many energy saving plans are already in place. The personnel are energy minded and seem to know of many cases where a repair could save energy. A sizeable amount of pipe insulation has been done because bare steam piping was exposed. A regular routine of checking steam traps for bypassed steam is enabled when possible. The number one maintenance item to be considered is the controls for all the equipment. In almost every case the controls were in place but not functioning or calibrated, therefore overheating or cooling. A one time contract with an outside control service to check for repair and calibration is a strong suggestion.

The notable exception, is the boiler plant where full time boiler operators are employed to take care of the equipment.

Previous Studies of the USDB

In 1980 the entire Fort Leavenworth Post was studied for energy savings. An "Integrated Energy Master Plan" was developed. This study is a detailed portion of the original master plan for energy savings and takes into account any additional energy conserving opportunities that have become evident since the submitted master plan. Since the earlier master plan dealt with Fort Leavenworth on a global scale, a detailed analysis was not presented for the part of Fort Leavenworth studied in this report, the USDB.

The ECO's that were developed in the Energy Evaluation Anticipated Program (EEAP) were studied in detail in this report. A complete and comprehensive ECO listing for the USDB as part of this report is located in this Volume under, ECO listing. Some ECO's were presented in the EEAP but are not feasible at this time due to physical construction or operating procedures. The reasons for not considering some of the ECO's established in the EEAP are defined in the same section.

ENERGY TYPES

The present utilities used at the USDB are; natural gas, fuel oil, water, and electricity. The amount of energy used by the boilers for the production of steam is converted to natural gas for the purpose of calculating energy costs in this report. All of the costs in dollars per unit of energy were calculated from information gathered from the DEH located at Fort Leavenworth.

The USDB is located in and falls under the jurisdiction of the Fort Leavenworth Military Base and receives it's electricity from the main Post feed. The electricity for the USDB is not metered separately. The Fort Leavenworth Military Base purchases electrical power from Kansas Power and Light (KPL) at a racheted rate depending on the amount of power being used at any one time by the entire base. For the purposes of this report and to simplify the calculations of dollars expended for a unit of electricity, the cost for a unit of electricity will be a set amount. The cost in dollars per KWh paid by the base was calculated to be $0.0425/KWh.

The USDB utilizes high pressure steam boilers to heat the buildings located within the walls and for the laundry located within the walls. The boilers are esentially the only equipment using natural gas. Therefore, instead of calculating a utility cost of natural gas to be used in calculating the energy usage for each building, a cost for a therms per hour (therms/hr) was calculated. A therm/hr of energy is equal to 100,000 pounds of steam/hr. The cost of steam used in this report was calculated to be $0.0534/MBTUh. The calculation for the cost of steam was:

Natural Gas Cost:	$4.00/MCF (1000 ft.^{3})
Energy per ft^3:	1,000 Btu/ft.^{3}
Boiler Efficiency:	80%
Boiler Make-up:	6%

($4.08/MCF)(1 MCF/1000 CF)(1 CF/1000 BTU)(1,000,000 BTU/MBTU)
=$4.08 / MBTU
With a global steam production efficiency of 74%, energy cost is $5.51/MBTU

Fort Leavenworth Military Base has a water treatment plant. None of the ECO's studied in this report consider the reduction in the amount of cold water received from Fort Leavenworth's water treatment system.

The energy consumption for the buildings studied as a total is shown per month in Table 1.1 and graphed in Figures 1.1 and 1.2.

MONTH	STEAM CONSUMPTION (therms)	ELECTRICITY CONSUMPTION (KWh)
January	38,691	184,945
February	35,643	165,192
March	33,399	189,410
April	10,596	168,277
May	87	163,499
June	12	238,151
July	0	268,027
August	0	260,588
September	113	195,114
October	235	155,269
November	19,550	168,693
December	46,196	173,686

Table 1.1

184,522 2,330,651

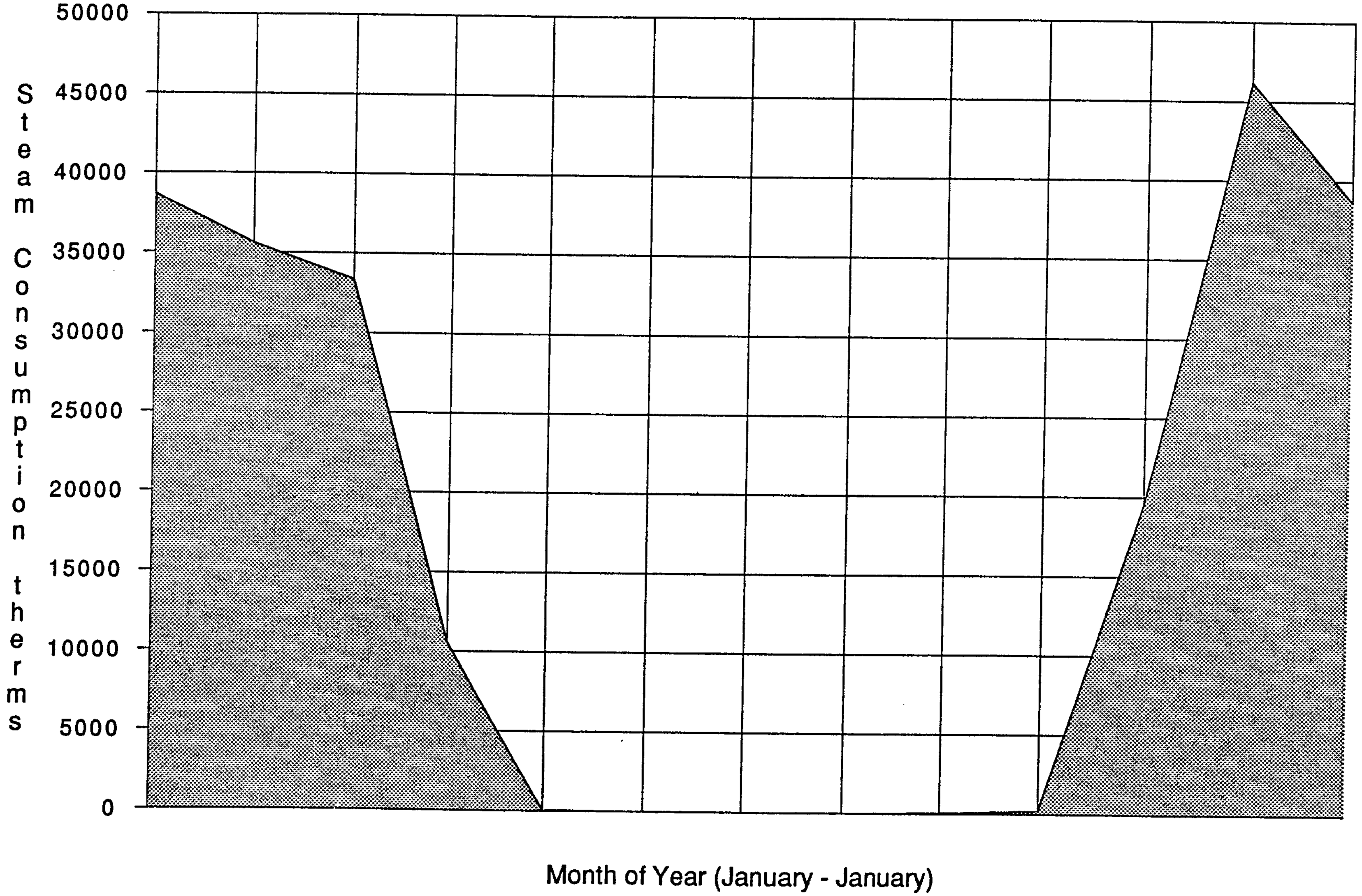
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Steam Consumption therms
Month of Year (January - January)

Figure 1.1

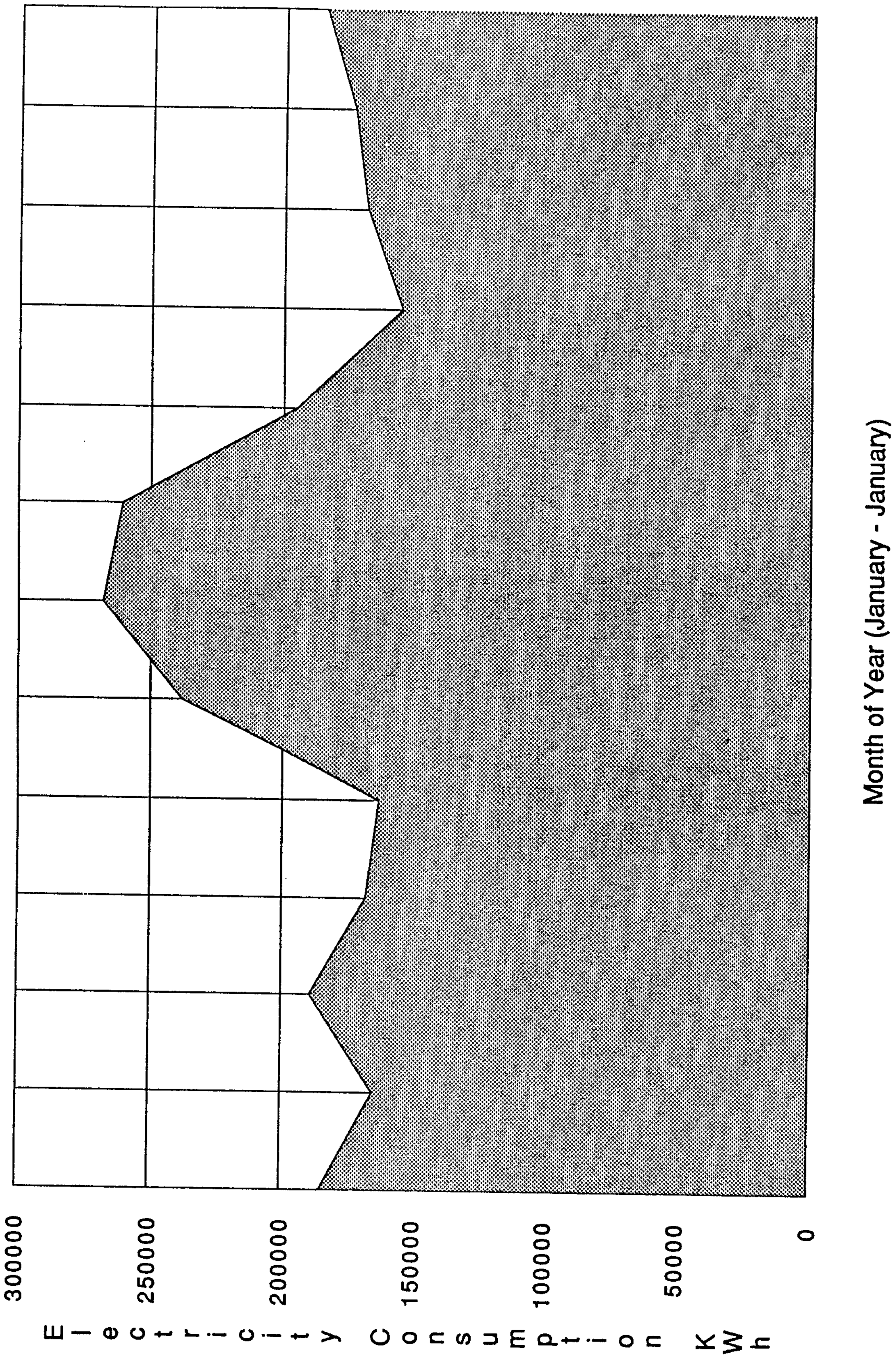
Electricity Consumption KWh
300000
250000
200000
150000
100000
50000
0
Month of Year (January - January)

Figure 1.2

COMPUTER SIMULATIONS

The computer program allows the user to physically model a building by inputting known dimensions and capacities of the building and equipment. The parameters the program uses to calculate the energy usage include; occupant load, equipment load, and weather conditions. Changes in the weather bring about changes to interior space conditions and therefore increase and decrease the energy consumed by the building for heating and cooling the space.

Energy Program

The computer program used for the majority of the energy calculations for this report, was "*Trace Ultra* ". This computer program was developed and is serviced by the Trane Company in LaCrosse, Wisconsin. The program allows the user, to model the building using the through menu driven screen displays. The program has several calculation alternatives available to the user once the model is input. The program allows the user to execute a "load" run, which calculates the largest amount of air conditioning needed to satisfy space conditions within the building. With the largest amount of air conditioning load known, a piece of HVAC equipment can be sized for the spaces. In most cases, the building equipment size was known by site observation, but where a nameplate or records were unavailable, equipment was sized for the model using the "load" calculation part of the program. Another calculation utilized in the program, was the energy simulation which calculated the energy consumed by the HVAC equipment to satisfy the space conditions on an hourly basis for an entire year. The energy simulation takes into account people and equipment moving in and out of a space and the changing conditions of the weather outside.

Program Schedules

The program utilizes schedules to know when equipment and lights are on and off, know when people are in and out of spaces, and know when the conditions of the space need to be satisfied. The schedules utilized for the models executed in this report are located in the Volume 2, Program Schedules.

Wall and Roof Types

The heat transfer to and from the interior spaces of the buildings through the exterior walls and roofs constitutes a major source of energy consumption. The heat transfer coefficient of the wall or roof, known as the "R" or "U" factor, is used to determine the amount of energy transferred through the wall or roof. The "U" factor is the inverse of the "R" factor or, U=1/R. The program accepts the "U" factor as input for the wall and roof coefficients and assigns it units of BTUh/Sq.Ft.•Hr.•°F. The wall and roof coefficients used for the buildings studied in this report were determined using a computer calculation available within the "*Trace Ultra* " program. All of the wall and roof coefficients used are located in Volume 2, Program "U" Values.

Computer Model Input

The computer models representing the buildings studied in the USDB were entered in the computer using a screen menu penetration scheme. The "*Trace Ultra*" program prompts the user for input on a fill in the blank basis. The program prompting the user for all of the input insures that none of the input necessary and relevant to computing the energy consumed by the building was left unentered.

Computer Model Output

The program calculates the energy consumed by the HVAC and auxiliary equipment in the building and creates an output file to be printed on the screen or a line printer. The output file contains many forms of the energy information about the building. The energy consumption for the building can be printed off in several different forms using the same values. One of the outputs allows the user to compare the overall wall, roof, and building "U" values to the ASHRAE 90 guidelines. The table, on the following page, displays the base load of the buildings in their existing condition.

BASE LOAD BUILDING SIMULATIONS

Building Number	Electrical (KWh/yr)	Steam (therms/yr)
450	135,466	3,629
463	80,795	1,481
464	84,234	822
465	228,068	35,995
466	208,461	1,103
472	234,490	15,515
473	148,420	2,407
475	58,399	13,619
475A	146,357	12,773
475B	95,207	8,477
475C	45,478	13,472
475D	53,358	15,188
475E	611,712	21,657
475F	53,357	15,926
475G	45,481	12,853
475H	87,858	8,137
Totals	**2,317,141**	**183,054**

Table 1.1

Both are less than 1% ERROR

The computer simulation printout for the base load, reflected in the proceeding table, and all of the ECO alternate executions are located in Volumes 2, 3,.and 4.

ENERGY CONSERVATION OPPORTUNITIES LISTING

This section lists the Energy Conservation Opportunities (ECO's) that were studied as part of this report and also ECO's that were considered, but not studied because it was considered not to be feasible at this time. Along with the ECO's considered feasible, a brief description of the opportunity for energy savings is included.

Feasible ECO's

Reduce Infiltration (ECO-A1): This opportunity for energy conservation deals with the reduction in the amount of outside air infiltrating into the building. At the present time, most of the windows and doors for the buildings located in the USDB have large cracks that allow outside air to infiltrate into the building. If an excess amount of outside air is infiltrating into the space through windows and doors, an excess amount of energy is consumed.

Window Replacement (ECO-A2): This ECO studied the installation of double glazed windows anywhere single glazed windows exist. The replacement of any window with a window having a smaller "U" value decreases the amount of heat transferred to and from the space. Infiltration into the building is also usually decreased because the new windows seal the opening better.

Attic Insulation (ECO-A3): This ECO studied the addition of insulation to the attic. The additional insulation in the attic increases the "R" value for the attic and roof and decreases the "U" value. The decreased "U" value relates a decreased amount of heat transferred to and from the interior spaces of the building.

Dock Door Replacement (ECO-A4): This opportunity for energy conservation is relevant to a dock door located in building 470. The present overhead dock door needs to be replaced. The energy savings associated with a new door is derived from a reduction in heat transferred to and from interior spaces, and from decreased infiltration.

Vestibules (ECO-A5): This ECO studied the installation of vestibules for the southgate, building 463. At the present time, no vestibules exist at the entrance or exit of this building. Especially during the heating season, the heating equipment runs non stop to try and satisfy the space conditions. Most of the time the temperature conditions are not met. The installation of a revolving door on the south entrance and a vestibule on the north will reduce the amount of outside air infiltrating into the space. The existing vestibule leading into rotunda of the castle is considered for service in ECO-A9.

Solar Window Shading (ECO-A6): This energy conserving opportunity was studied for all the buildings having cooling. The reduction in solar gain to a building from the sun through an unshaded window is beneficial during the cooling season but not during the heating season. The solar shading reflects the sunlight from heating an interior space during the cooling season, but also reduces the solar gain in the winter when it is beneficial.

Exterior Wall Insulation (ECO-A7): This ECO studied the addition of wall insulation to exterior walls. This ECO is difficult to implement in a facility of this nature. The materials necessary for the addition of wall insulation, have a reasonable resistance to damage, and have sizable material and labor costs.

Architectural Repairs (A9): This section is not an ECO, but a study of any architectural repairs for the buildings located within the USDB. Many of the items considered do not have a direct relationship to an energy savings, therefore the items listed in this section are recommended service items for the USDB.

Schedule Air Handling Equipment (ECO-M1): This ECO studied the scheduling of HVAC equipment to shut down or setback any equipment because the space is not being utilized and space temperatures do not need to be met.

Dry-Bulb Economizer Controls (ECO-M2): This ECO studied the service or addition of economizer controls and dampers to air handling units utilizing outside air at the present time. Most of the air handling units studied had or have economizer controls and dampers but do not function properly.

Service Steam Piping and Traps (ECO-M3): This ECO studied the addition of pipe insulation and steam trap replacement. Energy savings are shown in a reduction of steam use if the piping is insulated and failed traps are repaired so they do not pass steam into the condensate piping.

Exhaust Heat Recovery (ECO-M5): This ECO studied the addition of a heat recovery system for the exhausted air from the cell barracks in the castle. The location of the heat recovery system is ideal because the exhaust air is directly adjacent to the intake air to be preheated.

Insulate Ductwork (ECO-M6): This ECO studied the addition of insulation to ductwork located off of air handling units. The heat transferred from inside the ductwork to outside the ductwork is a function of the heat transfer coefficient of the ductwork material. Adding insulation to the ductwork improves the heat transfer resistance and therefore limits the amount of energy lost.

Central Plant Cooling (ECO-M10): This ECO studied the replacement of all the package air cooling equipment to a central plant chiller producing chilled water for cooling coils. In almost all of the cases where a space is being cooled a package direct expansion type of cooling is utilized. The cost per BTUh of cooling by a direct expansion type of machine is greater than the cost per BTUh of chilled water system cooling.

Castle Air System Repair (ECO-M11): This ECO studied the energy savings associated with properly heating and ventilating the cell barracks of the castle. At the present time, the air within the cell barracks is stratified and the amount of heating that is applied does not reach the bottom floors.

Reduce Steam Distribution Pressure (ECO-M12): This energy conserving opportunity deals with reducing the steam pressure needed for the USDB. The needs of the laundry are 120 psi steam, but the rest of the steam is used for heating and can be at a lower pressure. A lower pressure steam costs less to generate.

Service Condensate Return System (ECO-M14): This ECO studied the condensate system. Much of the condensate system needs to be insulated and repaired. By insulating the condensate piping, the condensate returns to the boiler plant at a higher temperature thus requiring the boilers to do less work to produce steam.

Boiler Plant Modifications (ECO-M15): This ECO studied the boiler plant and any modifications that could save energy. The energy lost during a blowdown of a boiler can be recovered and used to preheat the boiler feedwater. Installing a boiler stack economizer is also another possible method of heat recovery off of the boilers. Preheating the combustion air to the boilers will save boiler energy. Oxygen trim control will help improve the operating efficiency of the boilers.

Convert From Steam to Hot Water (ECO-M24): This ECO studied the conversion of the existing steam system to a hot water system. The cost per BTUh for heating using steam is larger than the cost per BTUh for heating with hot water.

Convert From Steam to Cogeneration (ECO-M25): This ECO studied the conversion of the existing steam system to cogeneration. Cogeneration is possible if a large heat energy and cooling energy occur at the same time for a long period of time.

Reduce Hot Water Temperature (ECO-M26): This opportunity studied the energy savings associated with a reduction of the domestic hot water temperature used for restrooms and showers. An energy savings can be realized by lower heat losses from the water lines.

Decentralize Hot Water System (ECO-M29): This ECO studied the breakup of the domestic hot water system. At the present time several buildings are served from a hot water tank located in one building. By decentralizing the hot water system, the heat loss can be decreased.

Domestic Water Pipe Insulation (ECO-M30): This energy conserving opportunity evaluated the installation of pipe insulation on the domestic hot water piping. Energy is saved by reducing the amount of heat loss.

Heat Recovery for Laundry (ECO-M31): This ECO studied the addition of heat recovery units for the laundry wash water, dryers, and steam irons to recover water heat.

Water Heating Heatpumps (ECO-M39): This ECO studied the replacement of the existing heating and cooling equipment with a heatpump. In general heatpumps have a greater efficiency than the types of heating and cooling in the USDB buildings.

Lighting Levels (ECO-E1): This ECO studied the reduction in lighting levels in areas where the existing lighting was considered to be more than necessary.

Energy Efficient Lighting Systems (ECO-E2): This ECO studied the replacement of existing lighting systems with more efficient lighting systems of the same light level. The replacement of lights would reduce the electrical consumption of the lighting system.

Energy Efficient Motors (ECO-E3): This ECO studied the replacement of existing motors that operate fans and pumps with high efficient motors that have a higher KWh per horsepower rating. The increase in motor efficiency will decrease the amount of electrical energy used by the motors.

Non-Feasible ECO's

Prevent Air Stratification: This opportunity for energy savings is only feasible where stratification can occur. The only places that were evident of air stratification was the tall ceilings located in the cell barracks of the castle. The solution to the air stratification was studied in ECO-M11, which looked at repairing the castle's air handling systems.

Install Electrical Capacitors: This opportunity for energy savings is only feasible where a power factor less than 1.0 occurs. Based on a telephone conversation with the electrical utility for the USDB within Fort Leavenworth, no power factor charge has been charged to the USDB.

Install Flow Restrictors: This opportunity for energy savings occurs in a facility where a large amount of water is consumed by faucets in restrooms. The USDB does not have an extreme number of restrooms utilized on a regular basis. The only place where an extreme amount of water could be used, due to the number of people, would be the cell barracks where the cells are already designed for limited use.

Install Automatic Shutoff Valves: This opportunity for energy savings is similar to the flow restriction in that not an exceedingly amount of water is consumed by the restrooms within the USDB.

Laundry Heat Recovery: The opportunity for energy savings for the laundry was studied as one ECO because the laundry facility was relocated, due to a present project, into the boiler plant.

Kitchen Heat Recovery: This opportunity for energy savings was limited because the kitchen was remodeled, due to a present project. Some of the possible energy saving opportunities were considered in other global ECO's. The exhaust air and make-up air systems were retrofitted under the current project. Shutting off appliances when not being utilized is an operational consideration and not something that can be addressed in an energy study.

Reduce Outside Air Intake: This opportunity for energy savings was incorporated into ECO-A1, a reduction in infiltration. The energy savings associated with heating or cooling outside air before it's use is encompassed in reducing the amount of outside air infiltrating through window and door cracks.

Maintain Equipment: The energy associated with maintaining equipment is difficult to show in a calculation for savings of equipment repair. To recover an energy savings due to a maintenance item, the work was encompassed in various ECO's where savings could be shown.

Boiler Plant Efficiencies: The energy conserving opportunities for the boiler plant were all combined into one ECO. Many of the ECO's relied on another ECO to show a savings. For instance, the energy recovered from a boiler blowdown has to be utilized somewhere else to show a savings. Therefore the feedwater preheat was combined with the blowdown recovery.

ECO-A1

REDUCE INFILTRATION

REDUCE INFILTRATION

ENERGY CONSERVATION OPPORTUNITY: ECO-A1

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-A1) analyzes the energy savings associated with reducing the amount of infiltration into the majority of the buildings located in the USDB. The implementation of this project will not change any of the existing window or door arrangements for any of the buildings.

SCOPE:

The ECO simulation (ECO-A1) adds additional weatherstripping and caulking to the existing windows and doors of the buildings to seal the cracks that are letting through outside air. The application of this project was considered for the following buildings:

Building 463
Building 464
Building 465
Building 466
Building 472
Building 473
Building 475
Building 475A
Building 475B
Building 475C
Building 475D
Building 475E
Building 475F
Building 475G
Building 475H

MODELING TECHNIQUES:

The modeling technique used to calculate the present infiltration rate for the windows and doors was determined using an infiltration calculation method as described the ASHRAE load calculation handbook[1]. All of the exterior windows and doors for the buildings being considered are shown in the schedules for each building, Volume 3. The windows and doors were then fit into one of several categories describing the free area to the outside. The categories that the windows fit into were based on the crack width around the windows and the doors. A loose fitting window was considered to have a small or 1/4" crack. A medium fitting window was considered to have a 1/8" crack and a tight fitting window would have a 1/16" crack. With the tightness and the crack length a free area was determined. A differential pressure chart[1], was used to find the driving force, based on a wind speed of 10 mph, for the air to be infiltrated. Using the differential pressure and the free area of the crack, an amount of infiltration was determined. ASHRAE guidelines for general constructed buildings state that the infiltration total for the building is about 1.5 air changes per hour. The infiltration from window and door cracks should be approximately 10% of the total infiltration for the buildings. The amount is infiltration calculated for the buildings considered fell into this guideline. This infiltration amount was entered into the computer simulation models to calculate the energy usage of the building. Using the same electronic spreadsheet, as shown in for each building in Volume 3, a new window and door infiltration value was determined based on the windows and doors having a tight fit, with the addition of new weatherstripping and caulking. The ECO infiltration value was entered into the same computer simulation model and executed for an energy usage. The calculation procedure for this ECO is displayed under ECO-A1, Volume 3. The difference in the energy usage before and after the implementation of the ECO was the energy savings from the ECO.

ECO IMPLEMENTATION:

The method of implementing this ECO is not difficult and could be completed by the maintenance staff with the walls of the USDB. In most cases, each of the window or door frames needs to have a bead of caulk placed between the wall and window or door frame. Almost all of the double hung windows need to have the seal between the sashes replaced with a new thicker seal with new rubber. To install new rubber seal, the upper and lower sash need to be separated and old seal removed from the track that it sits in. With the old seal removed the new seal can be fed into the channel from one of the ends. The cost estimate displays the windows in which of the buildings needs to be weatherstripped.

SUMMARY:

The energy savings associated with the implementation of this ECO by building is shown in Table A1.1 in million BTU's per year savings as determined using the computer simulation model located in Volume 2.

The project cost is the construction cost as determined in this section plus 6% SIOH.

Many of the buildings show a poor energy return on the investment of weatherstripping the windows and doors because the buildings are heating only. This ECO does not show a good payback because many of the buildings are heating only building. Another reason for the poor payback is that some of the buildings have at the present time, no means of bringing in outside air for current ventilation standards of 15 CFM per person. The standard 15 CFM per person was used for the computer simulations after the windows and doors are sealed. Building 466 shows as unusually low energy savings due to the fact that the building has a base board radiant heating system and no other energy using systems.

Building Number	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
463	12	$49	$11,254	163.91	0.10
464	9	$42	$5,882	97.68	0.15
465	256	$1058	$65,089	11.22	1.44
466	1	$8	$19,199	4544.0	0.00
472	62	$265	$26,516	72.34	0.22
473	12	$54	$12,985	168.40	0.09
475	15	$59	$8,337	96.26	0.17
475A	93	$399	$10,074	17.83	0.89
475B	16	$65	$10,380	109.2	0.15
475C	42	$171	$33,721	137.01	0.12
475D	48	$195	$40,013	142.94	0.11
475E	53	$146	$44,628	168.33	0.11
475F	89	$365	$40,269	77.80	0.21
475G	41	$169	$34,670	146.53	0.11
475H	20	$85	$8,017	69.00	0.23

Table A1.1

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 463A1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	10617.
B. SIOH	$	637.
C. DESIGN COST	$	584.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	10654.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	10654.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	16.	$ 65.	16.15	1050.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		16.	$ 65.		$ 1050.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 347.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 65.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1050.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.10
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 163.91

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 464A1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	5549.
B. SIOH	$	333.
C. DESIGN COST	$	305.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5568.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5568.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	1.	$	12.	11.16		134.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	11.	$	45.	16.15		727.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			12.	$	57.		$	861.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 284.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 57.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 861.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.15
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 97.68

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 465A1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	61405.
B. SIOH	$	3684.
C. DESIGN COST	$	3377.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	61619.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	61619.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	2.00	0.	$	0.	11.16		0.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	343.24	16.	$	5492.	16.15		88696.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			16.	$	5492.		$	88696.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 29270.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 5492.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 88696.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.44
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 11.22

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 466A1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	18112.
B. SIOH	$	1087.
C. DESIGN COST	$	996.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	18176.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	18176.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	1.	$ 4.	16.15	65.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		1.	$ 4.		$ 65.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 21.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 4.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 65.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.00
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 4544.00

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 472A1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	25015.
B. SIOH	$	1501.
C. DESIGN COST	$	1376.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	25103.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	25103.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	1.	$ 12.	11.16	134.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	82.	$ 335.	16.15	5410.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		83.	$ 347.		$ 5544.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	11.65		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1830.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE))	$	347.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)	$	5544.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.22
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 72.34

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 473A1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	12250.
B. SIOH	$	735.
C. DESIGN COST	$	674.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	12293.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	12293.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	1.	$ 12.	11.16	134.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	15.	$ 61.	16.15	985.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		16.	$ 73.		$ 1119.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 369.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 73.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1119.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.09
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 168.40

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475A1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	7865.
B. SIOH	$	472.
C. DESIGN COST	$	433.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	7893.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	7893.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	20.	$ 82.	16.15	1324.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		20.	$ 82.		$ 1324.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 437.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 82.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1324.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.17
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 96.26

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475AA1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	9504.
B. SIOH	$	570.
C. DESIGN COST	$	523.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	9537.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	9537.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	3.	$	37.	11.16		413.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	122.	$	498.	16.15		8043.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			125.	$	535.		$	8456.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2790.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 535.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 8456.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.89
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 17.83

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475BA1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	9793.
B. SIOH	$	588.
C. DESIGN COST	$	539.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	9828.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	9828.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	0.	$	0.	11.16		0.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	22.	$	90.	16.15		1454.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			22.	$	90.		$	1454.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 480.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 90.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1454.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.15
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 109.20

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475CA1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	31812.
B. SIOH	$	1909.
C. DESIGN COST	$	1750.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	31924.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	31924.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	0.	$	0.	11.16		0.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	57.	$	233.	16.15		3763.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			57.	$	233.		$	3763.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1242.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 233.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3763.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.12
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 137.01

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475DA1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	37748.
B. SIOH	$	2265.
C. DESIGN COST	$	2076.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	37880.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	37880.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	65.	$ 265.	16.15	4280.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		65.	$ 265.		$ 4280.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1412.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 265.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 4280.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.11
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 142.94

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475EA1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	42102.
B. SIOH	$	2526.
C. DESIGN COST	$	2316.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	42250.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	42250.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	-8.	$ -100.	11.16	-1116.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	86.	$ 351.	16.15	5669.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		78.	$ 251.		$ 4553.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1502.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 251.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 4553.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.11
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 168.33

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475FA1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	37990.
B. SIOH	$	2279.
C. DESIGN COST	$	2089.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	38122.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	38122.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	120.	$ 490.	16.15	7914.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		120.	$ 490.		$ 7914.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2612.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 490.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 7914.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.21
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 77.80

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475GA1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	32708.
B. SIOH	$	1962.
C. DESIGN COST	$	1799.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	32822.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	32822.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	55.	$ 224.	16.15	3618.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		55.	$ 224.		$ 3618.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	11.65		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1194.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 224.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3618.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.11
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 146.53

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475HA1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	7563.
B. SIOH	$	454.
C. DESIGN COST	$	416.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	7590.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	7590.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	27.	$ 110.	16.15	1777.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		27.	$ 110.		$ 1777.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 586.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 110.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1777.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.23
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 69.00

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 17

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 463							
REMOVE OLD SEALANT INSTALL NEW SEALANT	830	FT	0.60	498	1.40	1,162	$1,660
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	830	FT	0.60	498	1.40	1,162	$1,660
WEATHERSTRIP WINDOWS	239	FT	1.40	335	2.60	621	$956
REMOVE DOOR/FRAME	2	EA			100.00	200	$200
NEW DOOR/FRAME	2	EA	420.00	840	80.00	160	$1,000
FINISH HARDWARE	2	EA	510.00	1,020	90.00	180	$1,200
PAINT	2	EA	5.00	10	35.00	70	$80
SEALANT/CAULK	34	FT	0.60	20	1.40	48	$68
MOBILIZATION	2	EA			140.00	280	$280
SUBTOTAL				$3,221		$3,883	$7,104
CONTINGENCY 10%			10%	$322	10%	$388	$710
SUBTOTAL				$3,543		$4,271	$7,814
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$124	13.0%	$555	$679
DIRECT COST				$3,667		$4,826	$8,493
OVERHEAD AND PROFIT			25%	$917	25%	$1,207	$2,124
SUBTOTAL				$4,584		$6,033	$10,617
CONSTRUCTION COST							$10,617

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 2 **OF** 17

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A1 REDUCE INFILTRATION	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 464							
REMOVE OLD SEALANT INSTALL NEW SEALANT	697	FT	0.60	418	1.40	976	$1,394
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	697	FT	0.60	418	1.40	976	$1,394
WEATHERSTRIP WINDOWS	220	FT	1.40	308	2.60	572	$880
SUBTOTAL				$1,144		$2,524	$3,668
CONTINGENCY 10%			10%	$114	10%	$252	$366
SUBTOTAL				$1,258		$2,776	$4,034
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$44	13.0%	$361	$405
DIRECT COST				$1,302		$3,137	$4,439
OVERHEAD AND PROFIT			25%	$326	25%	$784	$1,110
SUBTOTAL				$1,628		$3,921	$5,549
CONSTRUCTION COST							$5,549

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 3 **OF** 17

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 465							
REMOVE OLD SEALANT INSTALL NEW SEALANT	5272	FT	0.60	3,163	1.40	7,381	$10,544
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	5272	FT	0.60	3,163	1.40	7,381	$10,544
WEATHERSTRIP WINDOWS	1850	FT	1.40	2,590	2.60	4,810	$7,400
WEATHERSTRIP DOORS	120	FT	1.40	168	2.60	312	$480
INSTALL NEW THRESHOLD AT DOORS (03, 05, 102, 202, AND 302)	6	EA	40.00	240	10.00	60	$300
REPLACE ENTRY (06 AND 104)							
REMOVE DOOR/FRAME	2	EA			150.00	300	$300
NEW DOOR/FRAME	2	EA	600.00	1,200	150.00	300	$1,500
FINISH HARDWARE	2	EA	510.00	1,020	90.00	180	$1,200
PAINT	2	EA	10.00	20	50.00	100	$120
SEALANT/CAULK	80	FT	0.60	48	1.40	112	$160
MOBILIZATION	2	EA			160.00	320	$320
INSTALL NEW HALLOW METAL DOOR AND FRAME (01, 08, 103, AND 301)							
REMOVE DOOR/FRAME	4	EA			100.00	400	$400
NEW DOOR/FRAME	4	EA	420.00	1,680	80.00	320	$2,000
FINISH HARDWARE	4	EA	510.00	2,040	90.00	360	$2,400
PAINT	4	EA	$5	20	35.00	140	$160
SEALANT/CAULK	136	FT	$1	82	1.40	190	$272
MOBILIZATION	4	EA			140.00	560	$560
REPLACE PAIR OF DOORS (04)							
REMOVE DOOR/FRAME	1	EA			150.00	150	$150
NEW DOOR/FRAME	1	EA	$840	840	160.00	160	$1,000
FINISH HARDWARE	1	EA	$680	680	120.00	120	$800
PAINT	1	EA	$20	20	80.00	80	$100

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE	**DATE PREPARED** 4/2/90	**SHEET** 4 **OF** 17

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A** (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. NONE	**ESTIMATOR** DLS	**CHECKED BY** TOL

ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 465 CONTINUED							
SEALANT/CAULK	40	FT	0.60	24	1.40	56	$80
MOBILIZATION	1	EA			160.00	160	$160
SUBTOTAL				$16,998		$23,952	$40,950
CONTINGENCY 10%			10%	$1,700	10%	$2,395	$4,095
SUBTOTAL				$18,698		$26,347	$45,045
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$654	13.0%	$3,425	$4,079
DIRECT COST				$19,352		$29,772	$49,124
OVERHEAD AND PROFIT			25%	$4,838	25%	$7,443	$12,281
SUBTOTAL				$24,190		$37,215	$61,405
CONSTRUCTION COST							$61,405

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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

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PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
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CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 466							
REMOVE OLD SEALANT INSTALL NEW SEALANT	1520	FT	0.60	912	1.40	2,128	$3,040
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	1520	FT	0.60	912	1.40	2,128	$3,040
WEATHERSTRIP WINDOWS	275	FT	1.40	385	2.60	715	$1,100
WEATHERSTRIP DOORS	37	FT	1.40	52	2.60	96	$148
INSTALL THRESHOLD DOOR (102)	1	EA	40.00	40	10.00	10	$50
INSTALL THRESHOLD DOOR (201)	1	EA	80.00	80	20.00	20	$100
REPLACE DOORS (101 AND 105)							
REMOVE DOOR/FRAME	2	EA			150.00	300	$300
NEW DOOR/FRAME	2	EA	550.00	1,100	100.00	200	$1,300
FINISH HARDWARE	2	EA	510.00	1,020	90.00	180	$1,200
PAINT	2	EA	8.00	16	42.00	84	$100
SEALANT/CAULK	72	FT	0.60	43	1.40	101	$144
MOBILIZATION	1	EA			140.00	140	$140
REPLACE OVERHEAD DOOR (103)							
REMOVE DOOR/TRACK	1	EA			150.00	150	$150
NEW INSULATED DOOR/TRACK	1	EA	850.00	850	250.00	250	$1,100
MOBILIZATION	1	EA			200.00	200	$200
SUBTOTAL				$5,410		$6,702	$12,112
CONTINGENCY 10%			10%	$541	10%	$670	$1,211
SUBTOTAL				$5,951		$7,372	$13,323
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$208	13.0%	$958	$1,166
DIRECT COST				$6,159		$8,330	$14,489
OVERHEAD AND PROFIT			25%	$1,540	25%	$2,083	$3,623
SUBTOTAL				$7,699		$10,413	$18,112
CONSTRUCTION COST							$18,112

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PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

DRAWING NO. NONE

BASIS FOR ESTIMATE

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OTHER (SPECIFY)

ESTIMATOR DLS

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ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 472							
REMOVE OLD SEALANT INSTALL NEW SEALANT	2745	FT	0.60	1,647	1.40	3,843	$5,490
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	2745	FT	0.60	1,647	1.40	3,843	$5,490
WEATHERSTRIP WINDOWS	833	FT	1.40	1,166	2.60	2,166	$3,332
REPLACE PAIR DOORS (105)							
REMOVE DOOR/FRAME	1	EA			150.00	150	$150
NEW DOOR/FRAME	1	EA	840.00	840	160.00	160	$1,000
FINISH HARDWARE	1	EA	680.00	680	120.00	120	$800
PAINT	1	EA	20.00	20	80.00	80	$100
SEALANT/CAULK	42	FT	0.60	25	1.40	59	$84
MOBILIZATION	1	EA			160.00	160	$160
SUBTOTAL				$6,025		$10,581	$16,606
CONTINGENCY 10%			10%	$603	10%	$1,058	$1,661
SUBTOTAL				$6,628		$11,639	$18,267
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$232	13.0%	$1,513	$1,745
DIRECT COST				$6,860		$13,152	$20,012
OVERHEAD AND PROFIT			25%	$1,715	25%	$3,288	$5,003
SUBTOTAL				$8,575		$16,440	$25,015
CONSTRUCTION COST							$25,015

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LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

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DRAWING NO. NONE

ESTIMATOR DLS

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ECO-A1 REDUCE INFILTRATION	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 473							
REMOVE OLD SEALANT INSTALL NEW SEALANT	975	FT	0.60	585	1.40	1,365	$1,950
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	975	FT	0.60	585	1.40	1,365	$1,950
WEATHERSTRIP WINDOWS	347	FT	1.40	486	2.60	902	$1,388
INSTALL NEW HOLLOW METAL DOOR AND FRAME DOORS (104 AND 105)							
REMOVE DOOR/FRAME	2	EA			100.00	200	$200
NEW DOOR/FRAME	2	EA	420.00	840	80.00	160	$1,000
FINISH HARDWARE	2	EA	510.00	1,020	90.00	180	$1,200
PAINT	2	EA	5.00	10	35.00	70	$80
SEALANT/CAULK	68	FT	0.60	41	1.40	95	$136
MOBILIZATION	2	EA			140.00	280	$280
SUBTOTAL				$3,567		$4,617	$8,184
CONTINGENCY 10%			10%	$357	10%	$462	$819
SUBTOTAL				$3,924		$5,079	$9,003
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$137	13.0%	$660	$797
DIRECT COST				$4,061		$5,739	$9,800
OVERHEAD AND PROFIT			25%	$1,015	25%	$1,435	$2,450
SUBTOTAL				$5,076		$7,174	$12,250
CONSTRUCTION COST							$12,250

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LOCATION FORT LEAVENWORTH, KS

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DRAWING NO. NONE

ESTIMATOR DLS

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ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475							
REMOVE OLD SEALANT INSTALL NEW SEALANT	850	FT	0.60	510	1.40	1,190	$1,700
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	850	FT	0.60	510	1.40	1,190	$1,700
WEATHERSTRIP WINDOWS	450	FT	1.40	630	2.60	1,170	$1,800
SUBTOTAL				$1,650		$3,550	$5,200
CONTINGENCY 10%			10%	$165	10%	$355	$520
SUBTOTAL				$1,815		$3,905	$5,720
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$64	13.0%	$508	$572
DIRECT COST				$1,879		$4,413	$6,292
OVERHEAD AND PROFIT			25%	$470	25%	$1,103	$1,573
SUBTOTAL				$2,349		$5,516	$7,865
CONSTRUCTION COST							$7,865

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LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

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DRAWING NO. NONE

ESTIMATOR DLS

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ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475A							
REMOVE OLD SEALANT INSTALL NEW SEALANT	883	FT	0.60	530	1.40	1,236	$1,766
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	883	FT	0.60	530	1.40	1,236	$1,766
WEATHERSTRIP WINDOWS	674	FT	1.40	944	2.60	1,752	$2,696
ASTRAGAL DOOR (30A)	7	FT	6.80	48	1.92	13	$61
SUBTOTAL				$2,051		$4,238	$6,289
CONTINGENCY 10%			10%	$205	10%	$424	$629
SUBTOTAL				$2,256		$4,662	$6,918
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$79	13.0%	$606	$685
DIRECT COST				$2,335		$5,268	$7,603
OVERHEAD AND PROFIT			25%	$584	25%	$1,317	$1,901
SUBTOTAL				$2,919		$6,585	$9,504
CONSTRUCTION COST							$9,504

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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	**DATE PREPARED** 4/2/90	**SHEET** 10 **OF** 17

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

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DRAWING NO. NONE

ESTIMATOR DLS

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ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475B							
REMOVE OLD SEALANT INSTALL NEW SEALANT	686	FT	0.60	412	1.40	960	$1,372
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	686	FT	0.60	412	1.40	960	$1,372
WEATHERSTRIP WINDOWS	310	FT	1.40	434	2.60	806	$1,240
INSTALL NEW DOOR (101)							
REMOVE DOOR/FRAME	1	EA			100.00	100	$100
NEW DOOR/FRAME	1	EA	420.00	420	80.00	80	$500
FINISH HARDWARE	1	EA	510.00	510	90.00	90	$600
PAINT	1	EA	5.00	5	35.00	35	$40
SEALANT/CAULK	34	FT	0.60	20	1.40	48	$68
MOBILIZATION	1	EA			140.00	140	$140
INSTALL NEW DOOR (201)							
REMOVE DOOR/FRAME	1	EA			100.00	100	$100
NEW DOOR/FRAME	1	EA	336.00	336	64.00	64	$400
FINISH HARDWARE	1	EA	340.00	340	60.00	60	$400
PAINT	1	EA	5.00	5	35.00	35	$40
SEALANT/CAULK	28	FT	0.60	17	1.40	39	$56
MOBILIZATION	1	EA			120.00	120	$120
SUBTOTAL				$2,910		$3,638	$6,548
CONTINGENCY 10%			10%	$291	10%	$364	$655
SUBTOTAL				$3,201		$4,002	$7,203
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$112	13.0%	$520	$632
DIRECT COST				$3,313		$4,522	$7,835
OVERHEAD AND PROFIT			25%	$828	25%	$1,130	$1,958
SUBTOTAL				$4,141		$5,652	$9,793
CONSTRUCTION COST							$9,793

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CONSTRUCTION COST ESTIMATE

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LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

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OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

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ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475C							
REMOVE OLD SEALANT INSTALL NEW SEALANT	2244	FT	0.60	1,346	1.40	3,142	$4,488
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	2244	FT	0.60	1,346	1.40	3,142	$4,488
WEATHERSTRIP WINDOWS	3020	FT	1.40	4,228	2.60	7,852	$12,080
SUBTOTAL				$6,921		$14,135	$21,056
CONTINGENCY 10%			10%	$692	10%	$1,414	$2,106
SUBTOTAL				$7,613		$15,549	$23,162
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$266	13.0%	$2,021	$2,287
DIRECT COST				$7,879		$17,570	$25,449
OVERHEAD AND PROFIT			25%	$1,970	25%	$4,393	$6,363
SUBTOTAL				$9,849		$21,963	$31,812
CONSTRUCTION COST							$31,812

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CONSTRUCTION COST ESTIMATE

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LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

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OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

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ECO-A1 REDUCE INFILTRATION	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475D							
REMOVE OLD SEALANT INSTALL NEW SEALANT	2547	FT	0.60	1,528	1.40	3,566	$5,094
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	2547	FT	0.60	1,528	1.40	3,566	$5,094
WEATHERSTRIP WINDOWS	3700	FT	1.40	5,180	2.60	9,620	$14,800
SUBTOTAL				$8,236		$16,752	$24,988
CONTINGENCY 10%			10%	$824	10%	$1,675	$2,499
SUBTOTAL				$9,060		$18,427	$27,487
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$317	13.0%	$2,395	$2,712
DIRECT COST				$9,377		$20,822	$30,199
OVERHEAD AND PROFIT			25%	$2,344	25%	$5,205	$7,549
SUBTOTAL				$11,721		$26,027	$37,748
CONSTRUCTION COST							$37,748

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CONSTRUCTION COST ESTIMATE

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PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

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OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

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ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475E							
REMOVE OLD SEALANT INSTALL NEW SEALANT	2800	FT	0.60	1,680	1.40	3,920	$5,600
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	2800	FT	0.60	1,680	1.40	3,920	$5,600
WEATHERSTRIP WINDOWS	2407	FT	1.40	3,370	2.60	6,258	$9,628
REPLACE PAIR DOORS (40A)							
REMOVE DOOR/FRAME	1	EA			150.00	150	$150
NEW DOOR/FRAME	1	EA	840.00	840	160.00	160	$1,000
FINISH HARDWARE	1	EA	680.00	680	120.00	120	$800
PAINT	1	EA	20.00	20	80.00	80	$100
SEALANT/CAULK	42	FT	0.60	25	1.40	59	$84
MOBILIZATION	1	EA			160.00	160	$160
REPLACE PAIR DOORS (40A)							
REMOVE DOOR/FRAME	1	EA			150.00	150	$150
NEW DOOR/FRAME	1	EA	935.00	935	165.00	165	$1,100
FINISH HARDWARE	1	EA	680.00	680	120.00	120	$800
PAINT	1	EA	25.00	25	95.00	95	$120
SEALANT/CAULK	44	FT	0.60	26	1.40	62	$88
MOBILIZATION	1	EA			160.00	160	$160
REPLACE PAIR DOORS (40A)							
REMOVE DOOR/FRAME	1	EA			150.00	150	$150
NEW DOOR/FRAME	1	EA	1020.00	1,020	180.00	180	$1,200
FINISH HARDWARE	1	EA	680.00	680	120.00	120	$800
PAINT	1	EA	30.00	30	110.00	110	$140
SEALANT/CAULK	46	FT	0.60	28	1.40	64	$92
MOBILIZATION	1	EA			160.00	160	$160

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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	**DATE PREPARED** 4/2/90	**SHEET** 14 **OF** 17

PROJECT
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LOCATION
FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
X **CODE A (NO DESIGN COMPLETED)**
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OTHER (SPECIFY)

DRAWING NO.	**ESTIMATOR**	**CHECKED BY**
NONE	DLS	TOL

ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475E CONTINUED							
SUBTOTAL				$11,719		$16,363	$28,082
CONTINGENCY 10%			10%	$1,172	10%	$1,636	$2,808
SUBTOTAL				$12,891		$17,999	$30,890
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$451	13.0%	$2,340	$2,791
DIRECT COST				$13,342		$20,339	$33,681
OVERHEAD AND PROFIT			25%	$3,336	25%	$5,085	$8,421
SUBTOTAL				$16,678		$25,424	$42,102
CONSTRUCTION COST							$42,102

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CONSTRUCTION COST ESTIMATE

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PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

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OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475F							
REMOVE OLD SEALANT INSTALL NEW SEALANT	2587	FT	0.60	1,552	1.40	3,622	$5,174
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	2587	FT	0.60	1,552	1.40	3,622	$5,174
WEATHERSTRIP WINDOWS	3700	FT	1.40	5,180	2.60	9,620	$14,800
SUBTOTAL				$8,284		$16,864	$25,148
CONTINGENCY 10%			10%	$828	10%	$1,686	$2,514
SUBTOTAL				$9,112		$18,550	$27,662
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$319	13.0%	$2,411	$2,730
DIRECT COST				$9,431		$20,961	$30,392
OVERHEAD AND PROFIT			25%	$2,358	25%	$5,240	$7,598
SUBTOTAL				$11,789		$26,201	$37,990
CONSTRUCTION COST							$37,990

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LOCATION FORT LEAVENWORTH, KS

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ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475G							
REMOVE OLD SEALANT INSTALL NEW SEALANT	2392	FT	0.60	1,435	1.40	3,349	$4,784
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	2392	FT	0.60	1,435	1.40	3,349	$4,784
WEATHERSTRIP WINDOWS	3020	FT	1.40	4,228	2.60	7,852	$12,080
SUBTOTAL				$7,098		$14,550	$21,648
CONTINGENCY 10%			10%	$710	10%	$1,455	$2,165
SUBTOTAL				$7,808		$16,005	$23,813
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$273	13.0%	$2,081	$2,354
DIRECT COST				$8,081		$18,086	$26,167
OVERHEAD AND PROFIT			25%	$2,020	25%	$4,521	$6,541
SUBTOTAL				$10,101		$22,607	$32,708
CONSTRUCTION COST							$32,708

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 17 **OF** 17

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A1 **REDUCE INFILTRATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475H							
REMOVE OLD SEALANT INSTALL NEW SEALANT	900	FT	0.60	540	1.40	1,260	$1,800
REMOVE OLD CAULKING/ INSTALL NEW CAULKING	900	FT	0.60	540	1.40	1,260	$1,800
WEATHERSTRIP WINDOWS	350	FT	1.40	490	2.60	910	$1,400
SUBTOTAL				$1,570		$3,430	$5,000
CONTINGENCY 10%			10%	$157	10%	$343	$500
SUBTOTAL				$1,727		$3,773	$5,500
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$60	13.0%	$490	$550
DIRECT COST				$1,787		$4,263	$6,050
OVERHEAD AND PROFIT			25%	$447	25%	$1,066	$1,513
SUBTOTAL				$2,234		$5,329	$7,563
CONSTRUCTION COST							$7,563

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-A2

WINDOW REPLACEMENT

DOUBLE GLAZED WINDOWS

ENERGY CONSERVATION OPPORTUNITY: ECO-A2

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-A2) analyzed the energy savings associated with reducing the amount of heat transfer to and from the buildings by conduction through the glass or plastic in the windows. The implementation of this ECO will not change the number or location of any of the windows.

SCOPE:

The ECO simulation (ECO-A2) changed the windows in some of the buildings from a single paned plastic or glass to double glazed. The application of this project was considered for the following buildings:

Building 450
Building 465
Building 475
Building 475C

Building 475D
Building 475E
Building 475F
Building 475G

MODELING TECHNIQUES:

The amount of heat loss or gain through the existing windows was simulated using the *"Trace Ultra"* computer program. All of the exterior windows considered for replacement are shown in the window schedules for each building, Volume 5. The windows to be replaced have a coefficient of heat transfer (U-value) associated with the heat conduction through the window material. This U-value was entered into the computer program and used to calculate the amount of energy used by the building. The new double glazed windows have a new U-value that was used in the computer program to calculate the amount of energy used if the windows were replaced. Table A2.1 displays the U-values used for the existing single glazed windows. All of the windows being replaced will be replaced with double glazed windows with the U-values shown in the Table A2.1. If the windows were replaced the tightness of the window would increase, thus a reduction in infiltration would occur. The reduction in infiltration due to weatherstripping and caulking as calculated in ECO-A1 of this report would be valid for this ECO also. The new infiltration as calculated in ECO-A1 will be entered into the computer model for the ECO-A2 execution. The difference in the energy usage before and after the implementation of the ECO was the energy savings from the ECO.

Building Number	Existing Window Type	Existing U-value	New U-value
450	Single Plastic	0.81	0.52
465	Single Plastic	0.81	0.52
475	Single Pane Glass	0.81	0.52
475C	Single Pane Glass	0.81	0.52
475D	Single Pane Glass	0.81	0.52
475F	Single Pane Glass	0.81	0.52
475G	Single Pane Glass	0.81	0.52

Table A2.1

ECO IMPLEMENTATION:

The implementation of this ECO would not change the physical appearance of any of the buildings being considered for the window replacement. The windows that would be replaced are listed in the cost estimate in this section of the report. To remove the existing window in most cases a skilled carpenter can remove the majority of the windows from outside the building with a ladder. The entire window would be removed and a new double glazed window of the same size would be installed and weatherstripped around the casing on the inside and outside. The new double glazed windows would be the same in size, function, and operation. This ECO would need to be implemented during seasonally adequate times, possibly in the spring or fall. The replacement of the windows in the castle cell barracks would have to be scheduled so as not to have the building unsecured for any long periods of time.

SUMMARY:

The energy savings associated with the implementation of this ECO by building is shown below in Table A2.2 in million BTU's per year as determined using the computer simulation model.

The project cost is the construction cost as determined in the following pages plus 6% SIOH is shown in Table A2.2.

The only buildings considered for this energy saving opportunity were buildings where the windows have not already been replaced with insulated windows. Buildings 450 and 465 are cooling buildings but have a tremendous amount of windows. The rest of the buildings considered were heating only buildings and a payback is not feasible.

Building Number	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
450	104	$455	$36,091	74.60	0.21
465	217	$892	$391,395	414.93	0.04
475	78	$317	$111,196	331.03	0.05
475C	161	$658	$640,908	318.52	0.05
475D	237	$967	$755,356	254.16	0.06
475F	186	$761	$755,356	323.81	0.05
475G	164	$671	$640,908	312.81	0.05

Table A2.2

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 450A2
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	34048.
B. SIOH	$	2043.
C. DESIGN COST	$	1873.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	34168.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	34168.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	4.	$ 50.	11.16	558.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	100.	$ 408.	16.15	6589.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		104.	$ 458.		$ 7147.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2359.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 458.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 7147.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.21
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 74.60

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 465A2
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	369241.
B. SIOH	$	22154.
C. DESIGN COST	$	20308.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	370533.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	370533.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	1.	$	12.	11.16		134.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	216.	$	881.	16.15		14228.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			217.	$	893.		$	14362.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 4739.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 893.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 14362.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.04
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 414.93

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475A2
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT		
A. CONSTRUCTION COST	$	104902.
B. SIOH	$	6294.
C. DESIGN COST	$	5770.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	105269.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	105269.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	78.	$ 318.	16.15	5136.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		78.	$ 318.		$ 5136.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	11.65		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1695.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 318.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 5136.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.05
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 331.03

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475CA2
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	208538.
B. SIOH	$	12512.
C. DESIGN COST	$	11470.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	209268.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	209268.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00.	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	161.	$ 657.	16.15	10611.
E. COAL	$ .00	0.	$ 0.	13:92	0.
F. TOTAL		161.	$ 657.		$ 10611.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	11.65		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3502.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 657.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 10611.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.05
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 318.52

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475DA2
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	244911.
B. SIOH	$	14695.
C. DESIGN COST	$	13470.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	245768.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	245768.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	237.	$ 967.	16.15	15617.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		237.	$ 967.		$ 15617.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5154.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 967.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 15617.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.06
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 254.16

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475FA2
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	244911.
B. SIOH	$	14695.
C. DESIGN COST	$	13470.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	245768.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	245768.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	186.	$ 759.	16.15	12258.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		186.	$ 759.		$ 12258.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 4045.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 759.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 12258.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.05
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 323.81

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475GA2
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT		
A. CONSTRUCTION COST	$	208538.
B. SIOH	$	12512.
C. DESIGN COST	$	11470.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	209268.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	209268.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	164.	$ 669.	16.15	10804.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		164.	$ 669.		$ 10804.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3565.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 669.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 10804.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.05
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 312.81

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 7

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A2 **WINDOW REPLACEMENT**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 450							
INSTALL ALUMINUM DOUBLE PANE INSULATED PROJECTION/FIXED WINDOWS	555	SQ FT	37.20	20,646	4.41	2,448	$23,094
MOBILIZATION	555	SQ FT			1.00	555	$555
SUBTOTAL				$20,646		$3,003	$23,649
CONTINGENCY 10%			10%	$2,065	10%	$300	$2,365
SUBTOTAL				$22,711		$3,303	$26,014
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$795	13.0%	$429	$1,224
DIRECT COST				$23,506		$3,732	$27,238
OVERHEAD AND PROFIT			25%	$5,877	25%	$933	$6,810
SUBTOTAL				$29,383		$4,665	$34,048
CONSTRUCTION COST							$34,048

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	DATE PREPARED 4/2/90	SHEET 2 OF 7

PROJECT
USDB ENERGY STUDY

LOCATION
FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE	ESTIMATOR DLS	CHECKED BY TOL

ECO-A2 WINDOW REPLACEMENT	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 465							
INSTALL ALUMINUM DOUBLE PANE INSULATED PROJECTION/FIXED WINDOWS	6019	SQ FT	37.20	223,907	4.41	26,544	$250,451
MOBILIZATION	6019	SQ FT			1.00	6,019	$6,019
SUBTOTAL				$223,907		$32,563	$256,470
CONTINGENCY 10%			10%	$22,391	10%	$3,256	$25,647
SUBTOTAL				$246,298		$35,819	$282,117
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$8,620	13.0%	$4,656	$13,276
DIRECT COST				$254,918		$40,475	$295,393
OVERHEAD AND PROFIT			25%	$63,729	25%	$10,119	$73,848
SUBTOTAL				$318,647		$50,594	$369,241
CONSTRUCTION COST							$369,241

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 3 **OF** 7

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A2 **WINDOW REPLACEMENT**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475							
INSTALL ALUMINUM DOUBLE PANE INSULATED PROJECTION/FIXED WINDOWS	1710	SQ FT	37.20	63,612	4.41	7,541	$71,153
MOBILIZATION	1710	SQ FT			1.00	1,710	$1,710
SUBTOTAL				$63,612		$9,251	$72,863
CONTINGENCY 10%			10%	$6,361	10%	$925	$7,286
SUBTOTAL				$69,973		$10,176	$80,149
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$2,449	13.0%	$1,323	$3,772
DIRECT COST				$72,422		$11,499	$83,921
OVERHEAD AND PROFIT			25%	$18,106	25%	$2,875	$20,981
SUBTOTAL				$90,528		$14,374	$104,902
CONSTRUCTION COST							$104,902

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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	**DATE PREPARED** 4/2/90	**SHEET** 4 **OF** 7

PROJECT USDB ENERGY STUDY	**BASIS FOR ESTIMATE**
LOCATION FORT LEAVENWORTH, KS	X CODE A (NO DESIGN COMPLETED) CODE B (PRELIMINARY DESIGN) CODE C (FINAL DESIGN) OTHER (SPECIFY)
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP	

DRAWING NO. NONE	**ESTIMATOR** DLS	**CHECKED BY** TOL

ECO-A2 **WINDOW REPLACEMENT**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475C							
INSTALL ALUMINUM DOUBLE PANE INSULATED PROJECTION/FIXED WINDOWS	4323	SQ FT	27.99	121,001	4.41	19,064	$140,065
MOBILIZATION	4323	SQ FT			1.00	4,323	$4,323
SUBTOTAL				$121,001		$23,387	$144,388
CONTINGENCY 10%			10%	$12,100	10%	$2,339	$14,439
SUBTOTAL				$133,101		$25,726	$158,827
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$4,659	13.0%	$3,344	$8,003
DIRECT COST				$137,760		$29,070	$166,830
OVERHEAD AND PROFIT			25%	$34,440	25%	$7,268	$41,708
SUBTOTAL				$172,200		$36,338	$208,538
CONSTRUCTION COST							$208,538

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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 5 **OF** 7

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A2 **WINDOW REPLACEMENT**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475D							
INSTALL ALUMINUM DOUBLE PANE INSULATED PROJECTION/FIXED WINDOWS	5077	SQ FT	27.99	142,105	4.41	22,390	$164,495
MOBILIZATION	5077	SQ FT			1.00	5,077	$5,077
SUBTOTAL				$142,105		$27,467	$169,572
CONTINGENCY 10%			10%	$14,211	10%	$2,747	$16,958
SUBTOTAL				$156,316		$30,214	$186,530
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$5,471	13.0%	$3,928	$9,399
DIRECT COST				$161,787		$34,142	$195,929
OVERHEAD AND PROFIT			25%	$40,447	25%	$8,535	$48,982
SUBTOTAL				$202,234		$42,677	$244,911
CONSTRUCTION COST							$244,911

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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 6 **OF** 7

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A2 WINDOW REPLACEMENT	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475F							
INSTALL ALUMINUM DOUBLE PANE INSULATED PROJECTION/FIXED WINDOWS	5077	SQ FT	27.99	142,105	4.41	22,390	$164,495
MOBILIZATION	5077	SQ FT			1.00	5,077	$5,077
SUBTOTAL				$142,105		$27,467	$169,572
CONTINGENCY 10%			10%	$14,211	10%	$2,747	$16,958
SUBTOTAL				$156,316		$30,214	$186,530
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$5,471	13.0%	$3,928	$9,399
DIRECT COST				$161,787		$34,142	$195,929
OVERHEAD AND PROFIT			25%	$40,447	25%	$8,535	$48,982
SUBTOTAL				$202,234		$42,677	$244,911
CONSTRUCTION COST							$244,911

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CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 7 **OF** 7

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A2 **WINDOW REPLACEMENT**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475G							
INSTALL ALUMINUM DOUBLE PANE INSULATED PROJECTION/FIXED WINDOWS	4323	SQ FT	27.99	121,001	4.41	19,064	$140,065
MOBILIZATION	4323	SQ FT			1.00	4,323	$4,323
SUBTOTAL				$121,001		$23,387	$144,388
CONTINGENCY 10%			10%	$12,100	10%	$2,339	$14,439
SUBTOTAL				$133,101		$25,726	$158,827
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$4,659	13.0%	$3,344	$8,003
DIRECT COST				$137,760		$29,070	$166,830
OVERHEAD AND PROFIT			25%	$34,440	25%	$7,268	$41,708
SUBTOTAL				$172,200		$36,338	$208,538
CONSTRUCTION COST							$208,538

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1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-A3 ECONOMIC ANALYSIS

BUILDING NUMBER	STEAM CONSUMPTION			ELECTRIC CONSUMPTION			TOTAL SAVINGS ($)
	BASE ENERGY (THERMS)	ECO-A3 LOAD (THERMS)	ENERGY SAVINGS (MBTU)	BASE LOAD (KW)	ECO-A3 LOAD (KW)	ENERGY SAVINGS (MBTU)	
463	1,577	1,379	20	83,903	82,814	4	$127
464	2,195	1,311	88	91,802	86,441	18	$588
472	15,515	15,241	27	234,490	232,543	7	$194
475	13,619	12,203	142	58,399	58,386	0	$578
475E	21,657	21,253	40	611,712	611,617	0	$169
							$1,657

ECO-A3

ATTIC INSULATION

ATTIC INSULATION

ENERGY CONSERVATION OPPORTUNITY: ECO-A3

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-A3) analyzes the energy savings associated with reducing the amount of heat transferred through the attic and roof of a building. The implementation of this ECO will not change the appearance of any of the buildings being considered.

SCOPE:

The ECO simulation (ECO-A3) adds additional attic insulation to decrease the heat transfer rate into or out of the building. The increased insulation can be added in the attics of the buildings be considered. The application of this project was considered for the buildings listed in Table A3.1.

Building Number	Insulated Section
463	Entire Attic
464	Entire Attic
472	North End of Attic
475	Entire Attic
475E	Stage Area Attic

Table A3.1

MODELING TECHNIQUES:

The heat transfer rate through the attic were simulated using the *"Trace Ultra"* computer program. The coefficient of heat transfer (U-value) for the existing roof was determined using the ASHRAE load calculation handbook[1]. The U-value for the entire roof is the sum of the U-values for each of the materials that make up the attic and roof construction. The calculation of each U-value is located in the appendix with the base load run for each building. Next, the U-value for the attic with additional insulation was determined and entered into the computer model of the building. The existing and new U-values calculated in the appendix are summarized in Table A3.2 along with a description of the method of insulation. The difference in the energy usage before and after the implementation of the ECO was the energy savings from the ECO.

Building Number	Existing U-Value	New U-Value	Insulation Description
463	0.104	0.025	Addition of 10" batt insulation in the attic between the joist.
464	0.342	0.030	Addition of 10" batt insulation in the attic between the joist.
472	0.134	0.027	Addition of 10" batt insulation in the attic between the joist.
475	0.240	0.029	Addition of 10" batt insulation in the attic under plywood between the joist.
475E	0.488	0.030	Addition of 10" batt insulation in new furring channels in the attic.

Table A3.2

ECO IMPLEMENTATION:

The implementation of this ECO in all but one of the buildings is not difficult and can be completed by the maintenance staff within the walls of the USDB. In all of the cases for the different buildings, the addition of insulation is in the attic of the buildings between the joists or roof rafters. The batt insulation, is delivered in plastic wrapped rolls. The insulation is moved to the attic unwrapped and stapled between the joists or roof rafters with a standard staple gun using 1/2" staples.

SUMMARY:

The energy savings associated with the implementation of this ECO by building is shown below in Table A3.3 in million BTU's per year savings as determined using the computer simulation model.

The project cost is the construction cost as determined in this section plus 6% SIOH.

Building 475E does not show as well a payback as the other buildings because of the areas adjacent to the newly insulated section are heating only and the installation cost is relatively high.

Building Number	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
463	51	$462	$3484	7.05	1.71
464	80	$267	$3143	12.18	1.48
472	34	$194	$886	0.09	178.57
475	142	$578	$4868	7.96	2.03
475E	40	$169	$32316	187.69	0.09

Table A3.3

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 463A3
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	3287.
B. SIOH	$	197.
C. DESIGN COST	$	181.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	3299.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	3299.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	31.	$ 386.	11.16	4308.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	20.	$ 82.	16.15	1324.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		51.	$ 468.		$ 5632.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1859.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 468.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 5632.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.71
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 7.05

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 464A3
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	3143.
B. SIOH	$	189.
C. DESIGN COST	$	173.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	3155.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	3155.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	18 ~~-8.~~	$ 228 ~~-100.~~	11.16	2540 ~~-1116.~~
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	88.	$ 359.	16.15	5798.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		80.	$ ~~259.~~ 587		$ 8338 ~~4682.~~

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2752 ~~1545.~~
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 587 ~~259.~~

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 8338 ~~4682.~~

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 2.64 ~~1.48~~
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 ~~12.18~~ 5.4

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 472A3
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	836.
B. SIOH	$	50.
C. DESIGN COST	$	46.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	839.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	839.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44 ~~2.00~~	7.	$ 87.08 ~~14.~~	11.16	~~156.~~ 971.81
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ ~~343.24~~	27.	$ ~~9267.~~ 110.16	16.15	~~149662.~~ 1779.08
E. COAL	$ 4.08 .00	0.	$ 0.	13.92	0.
F. TOTAL		34.	$ ~~9281.~~ 197.24		$ ~~149818.~~ 2750.89

WRONG!

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ ~~49440.~~ 908
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ ~~9281.~~ 197.24

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ ~~149818.~~ 2750.89

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= ~~178.57~~ 3.28
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 ~~.09~~ 4.25

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475A3
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	4592.
B. SIOH	$	276.
C. DESIGN COST	$	253.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4609.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4609.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	0.	$	0.	11.16		0.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	142.	$	579.	16.15		9351.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			142.	$	579.		$	9351.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3086.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 579.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 9351.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 2.03
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 7.96

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475EA3
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	30487.
B. SIOH	$	1829.
C. DESIGN COST	$	1677.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	30594.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	30594.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	40.	$ 163.	16.15	2632.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		40.	$ 163.		$ 2632.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 869.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 163.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2632.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.09
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 187.69

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 5

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A3 **ATTIC INSULATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 463							
10" BATT INSULATION	2375	SQ FT	0.70	1,663	0.15	356	$2,019
MOBILIZATION	2375	SQ FT			0.10	238	$238
SUBTOTAL				$1,663		$594	$2,256
CONTINGENCY 10%			10%	$166	10%	$59	$225
SUBTOTAL				$1,829		$653	$2,481
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$64	13.0%	$85	$149
DIRECT COST				$1,893		$738	$2,630
OVERHEAD AND PROFIT			25%	$473	25%	$184	$657
SUBTOTAL				$2,366		$922	$3,287
CONSTRUCTION COST							$3,287

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE
DATE PREPARED 4/2/90
SHEET 2 **OF** 5
PROJECT USDB ENERGY STUDY
LOCATION FORT LEAVENWORTH, KS
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP
BASIS FOR ESTIMATE
X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)
DRAWING NO. NONE
ESTIMATOR DLS
CHECKED BY TOL

ECO-A3 **ATTIC INSULATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 464							
10" BATT INSULATION	2271	SQ FT	0.70	1,590	0.15	341	$1,930
MOBILIZATION	2271	SQ FT			0.10	227	$227
SUBTOTAL				$1,590		$568	$2,157
CONTINGENCY 10%			10%	$159	10%	$57	$216
SUBTOTAL				$1,749		$625	$2,373
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$61	13.0%	$81	$142
DIRECT COST				$1,810		$706	$2,515
OVERHEAD AND PROFIT			25%	$452	25%	$176	$628
SUBTOTAL				$2,262		$882	$3,143
CONSTRUCTION COST							$3,143

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1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 3 **OF** 5

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A3 **ATTIC INSULATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 472							
10" BATT INSULATION	604	SQ FT	0.70	423	0.15	91	$513
MOBILIZATION	604	SQ FT			0.10	60	$60
SUBTOTAL				$423		$151	$574
CONTINGENCY 10%			10%	$42	10%	$15	$57
SUBTOTAL				$465		$166	$631
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$16	13.0%	$22	$38
DIRECT COST				$481		$188	$669
OVERHEAD AND PROFIT			25%	$120	25%	$47	$167
SUBTOTAL				$601		$235	$836
CONSTRUCTION COST							$836

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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 4 **OF** 5

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A3 **ATTIC INSULATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475							
10" BATT INSULATION	3316	SQ FT	0.70	2,321	0.15	497	$2,819
MOBILIZATION	3316	SQ FT			0.10	332	$332
SUBTOTAL				$2,321		$829	$3,150
CONTINGENCY 10%			10%	$232	10%	$83	$315
SUBTOTAL				$2,553		$912	$3,465
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$89	13.0%	$119	$208
DIRECT COST				$2,642		$1,031	$3,673
OVERHEAD AND PROFIT			25%	$661	25%	$258	$919
SUBTOTAL				$3,303		$1,289	$4,592
CONSTRUCTION COST							$4,592

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1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 5 **OF** 5

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A3 **ATTIC INSULATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475E							
7/8" FURRING CHANNEL	4575	SQ FT	0.20	915	0.65	2,974	$3,889
10" BATT INSULATION	4575	SQ FT	0.70	3,203	0.20	915	$4,118
5/8" FIRECODE GYP. BD.	4575	SQ FT	0.50	2,288	0.85	3,889	$6,176
PAINT	4575	SQ FT	0.25	1,144	0.65	2,974	$4,118
6 MIL. VAPOR BARRIER	4575	SQ FT	0.03	137	0.10	458	$595
MOBILIZATION	4575	SQ FT			0.30	1,373	$1,373
SUBTOTAL				$7,686		$12,581	$20,267
CONTINGENCY 10%			10%	$769	10%	$1,258	$2,027
SUBTOTAL				$8,455		$13,839	$22,294
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$296	13.0%	$1,799	$2,095
DIRECT COST				$8,751		$15,638	$24,389
OVERHEAD AND PROFIT			25%	$2,188	25%	$3,910	$6,098
SUBTOTAL				$10,939		$19,548	$30,487
CONSTRUCTION COST							$30,487

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1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-A4

DOCK DOOR REPLACEMENT

DOCK DOOR REPLACEMENT

ENERGY CONSERVATION OPPORTUNITY: ECO-A4

PURPOSE:

This Energy Conservation Opportunity (ECO-A4) analyzes the energy savings associated with reducing the amount of heat transferred from within building 470 to the outdoors during the winter months alone. The implementation of this project will not change the size or shape of the existing door but will not change the general appearance of the existing door to a new door.

Don't make sense

SCOPE:

The ECO simulation (ECO-A4) replaces the load dock door on the south end of the building. The replacement of the door will reduce infiltration into the building and thus reduce the amount of energy used to heat and cool the building. The method of construction for this ECO is not difficult and amounts to replacement of an overhead door.

MODELING TECHNIQUES:

The modeling technique used to calculate the heat transfer and infiltration rates for the door was determined using the U-value for the door and an infiltration calculation method as described the ASHRAE load calculation handbook[1]. The U-value of the existing door was determined from a field survey to be approximately 1.28 Btu/hr/ft^2/°F. A new rolling overhead door for the opening would have a U-value equal to 0.17 Btu/hr/ft^2/°F.

seems to good? not best fact.

The heat loss calculation due to infiltration around the casement of the door is calculated using a method described in the ASHRAE Load Calculation Manual[1]. The door was fit into one of several categories describing there amount of crack area open to the outside. The category that the door fit into was based on crack width around the door. The door was fit into the loose category with an average crack width of 1/2" and the crack factor equal to 4.46. The door is 8' by 8' in size with 4 panels, which calculates out to a crack length of 56'. The ASHRAE[1] differential pressure chart, was used to find the driving force, based on a wind speed of 10 mph, for the air to be infiltrated. Using the differential pressure and the crack free area an infiltration value for the door was determined. With the amount of unconditioned air entering the building, the infiltration can be determined. The infiltration was calculated by:

Crack Length = 56'
Differential Pressure = 0.045"
Existing Crack Width Factor = 4.46
New Crack Width Factor = 0.67

Infiltration = Q = (Crack Length)*(Differential Pressure)$^{0.5}$*(Crack Factor)
Existing Infiltration = 52.98 CFM
New Infiltration = 7.96 CFM

CRACK LENGTH STAYED THE SAME FOR THE ROLLING? DOOR.

With the U-values and infiltration calculated, the total heat transfer for a year was calculated using an electronic spreadsheet and the bin method of energy analysis as shown in Table A4.2.

NOT ALLOWED

ECO IMPLEMENTATION:

To implement this ECO, the existing overhead door would have to be removed and the new overhead door, of the same size, installed in the same place. The new door would be opened with a new chain hoist on one end. The new door would be an insulated metal door with no windows.

SUMMARY:

The energy savings associated with the implementation of this ECO is shown in million BTU's in Table A4.1 as determined from the calculations as previously outlined .

The project cost is the construction cost as determined in the following pages plus 6% SIOH.

The new door as considered in the ECO section was not part of the original study but was looked at because the existing overhead door is in poor shape and could be replaced with a considerable energy savings. The USDB carpentry shop could install a new overhead door. If an outside contractor were hire for this installation, the energy savings would not pay for the door.

Building Number	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
470	16	$67	$870	9.70	1.67

Table A4.1

ENERGY ANALYSIS WORKSHEET USING ASHRAE MODIFIED BIN METHOD

BIN TEMP	AVG. DB TEMP	BIN TEMP BELOW 68°F	BIN HOURS PER YEAR	EXIST Q1 U=1.28 A=64	NEW Q2 U=0.17 A=64	EXIST Q3 INFILT. CFM= 52.98	NEW Q4 INFILT. CFM= 7.96	EXIST (Q1+Q3) * (BIN HRS)	NEW Q2+Q4 * (BIN HRS)
100/104	102		3						
95/99	97		41						
90/94	92		197						
85/89	87		436						
80/84	82		638						
75/79	77		788						
70/74	72		710						
65/69	67	1	717	81.92	10.88	57.48	8.64	99952	13993
60/64	62	6	681	491.52	65.28	344.90	51.82	569602	79745
55/59	57	11	587	901.12	119.68	632.32	95.00	900127	126019
50/54	52	16	584	1310.72	174.08	919.73	138.19	1302584	182363
45/49	47	21	539	1720.32	228.48	1207.15	181.37	1577906	220908
40/44	42	26	580	2129.92	282.88	1494.57	224.55	2102202	294310
35/39	37	31	678	2539.52	337.28	1781.98	267.73	2929979	410200
30/34	32	36	589	2949.12	391.68	2069.40	310.92	2955908	413830
25/29	27	41	347	3358.72	446.08	2356.82	354.10	1983291	277663
20/24	22	46	296	3768.32	500.48	2644.23	397.28	1898115	265738
15/19	17	51	153	4177.92	554.88	2931.65	440.47	1087764	152288
10/14	12	56	77	4587.52	609.28	3219.06	483.65	601107	84156
5/9	7	61	67	4997.12	663.68	3506.48	526.83	569741	79764
0/4	2	66	47	5406.72	718.08	3793.90	570.02	432429	60540

TOTAL EXISTING YEARLY LOAD IN BTU'S 19,010,707

TOTAL NEW YEARLY LOAD IN BTU'S 2,661,518

TOTAL YEARLY LOAD DIFFERENCE IN BTU'S 16,349,189

Table A4.1

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 470A4
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	870.
B. SIOH	$	52.
C. DESIGN COST	$	48.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	873.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	873.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	0.	$	0.	11.16		0.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	22.	$	90.	16.15		1454.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			22.	$	90.		$	1454.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 480.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 90.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1454.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.67
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 9.70

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 1

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A4 **DOCK DOOR REPLACEMENT**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 470							
DEMOLITION	1	EA			50.00	50	$50
ROLLING DOOR/HARDWARE	1	EA	745.00	745	75.00	75	$820
CONSTRUCTION COST							$870

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-A5 ECONOMIC ANALYSIS

	STEAM CONSUMPTION			ELECTRIC CONSUMPTION			
BUILDING NUMBER	BASE ENERGY (THERMS)	ECO-A5 LOAD (THERMS)	ENERGY SAVINGS (MBTU)	BASE LOAD (KW)	ECO-A5 LOAD (KW)	ENERGY SAVINGS (MBTU)	TOTAL SAVINGS ($)
463	1,577	1,453	12	83,903	83,775	0	$56
							$56

ECO-A5

VESTIBULES

VESTIBULES

ENERGY CONSERVATION OPPORTUNITY: ECO-A5

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-A5) analyzes the energy savings associated with installation of vestibules on the high traffic entrances and exits of the buildings located in the USDB. The implementation of this project will change the exterior appearance of buildings being considered for vestibules.

SCOPE:

The ECO simulation (ECO-A5) adds and repairs the vestibules on the entrances and exits of building 463 (the south gate) and the castle. At the present time building 463 does not have any type of vestibules on the north or south doorways. This building acts as a entrance and exit for the majority of the personnel that operate the facility. Approximately 1,200 people work in the USDB everyday and pass through building 463 for entering and leaving. A new vestibules for the north entrance and new doors for the south entrance were considered as part of this ECO. The castle has vestibules at the present time on the two highly trafficked doors. Improvements to the function and construction of the existing castle vestibules were considered in ECO-A9.

MODELING TECHNIQUES:

The energy savings for this ECO gained by reducing the large amount of infiltration being induced into the building by the large cracks in the existing doors and the opening and closing the doors to allow people to enter and exit. The addition of a vestibule contains the outside air in a finite space reducing the amount allowed into the building. The addition of a vestibule also prevents the wind from penetrating into the interior spaces. The ASHRAE load calculation handbook[1] covers in detail how to determine the amount of outside air entering through doors with a known amount of traffic. The following data was used in calculating the existing and new infiltration rates:

Differential Pressure = 0.045"
Average Number of People Through Door per Hour = 200
Existing CFM per Door = 1100 CFM
New CFM per Door = 200 CFM
Reduction in Infiltration = 900 CFM

The base load computer run contains a large amount of infiltration and the ECO run for the buildings contains the reduced amount of infiltration.

ECO IMPLEMENTATION:

To implement this ECO the complete south door opening will be removed and a revolving door with standard door will be installed. The new doors and glass for the south opening will have bullet proof glass to be resistant of a .38 cal. fire at close range. The north door for the south gate will have a vestibule added on to the outside of the building. The addition of the vestibule will not be permanently attached to the existing building and could possibly be removed if necessary. Neither the addition of the revolving door on the south or the vestibule on the north will change the visibility or operation of the southgate. Figures A5.1 thru A5.3 show a revolving door and vestibule for this building.

SUMMARY:

Although the addition of the revolving door and vestibule may not be feasible to consider from a payback stand point due to the fact that the comfort levels of the southgate area are not being met with the existing heating cooling equipment. If the heating and cooling equipment were sized adequately for the existing load on the southgate, a return on investment due to energy savings would appear more feasible.

The energy savings associated with the implementation of this ECO is shown in Table A5.1 in million BTU's per year savings as determined using the computer simulation model.

The project cost is the construction cost as determined in the appendix plus 6% SIOH.

Building Number	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
463	39	$391	$88,238	341.88	0.04

Table A5.2

Building 463 South Gate

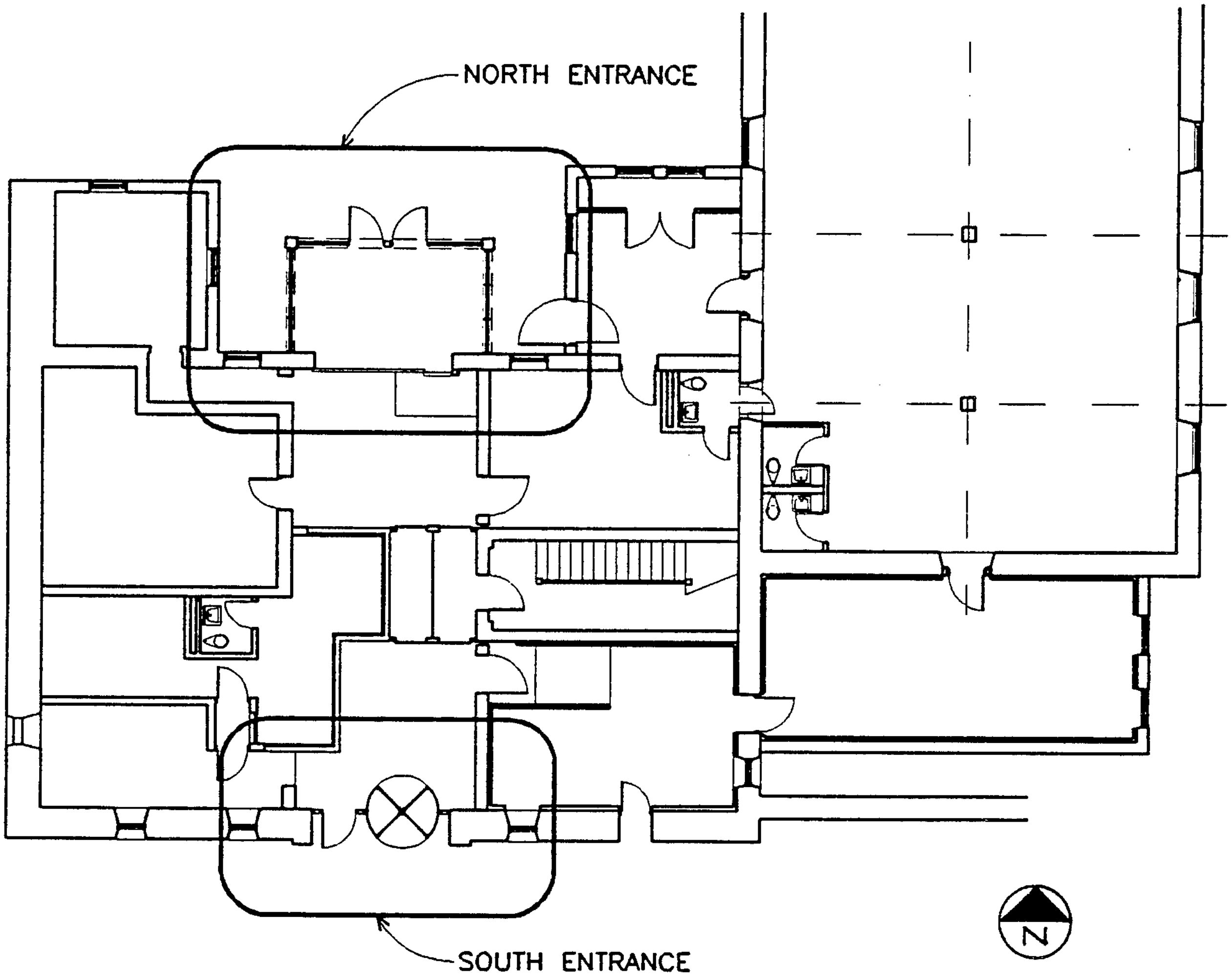
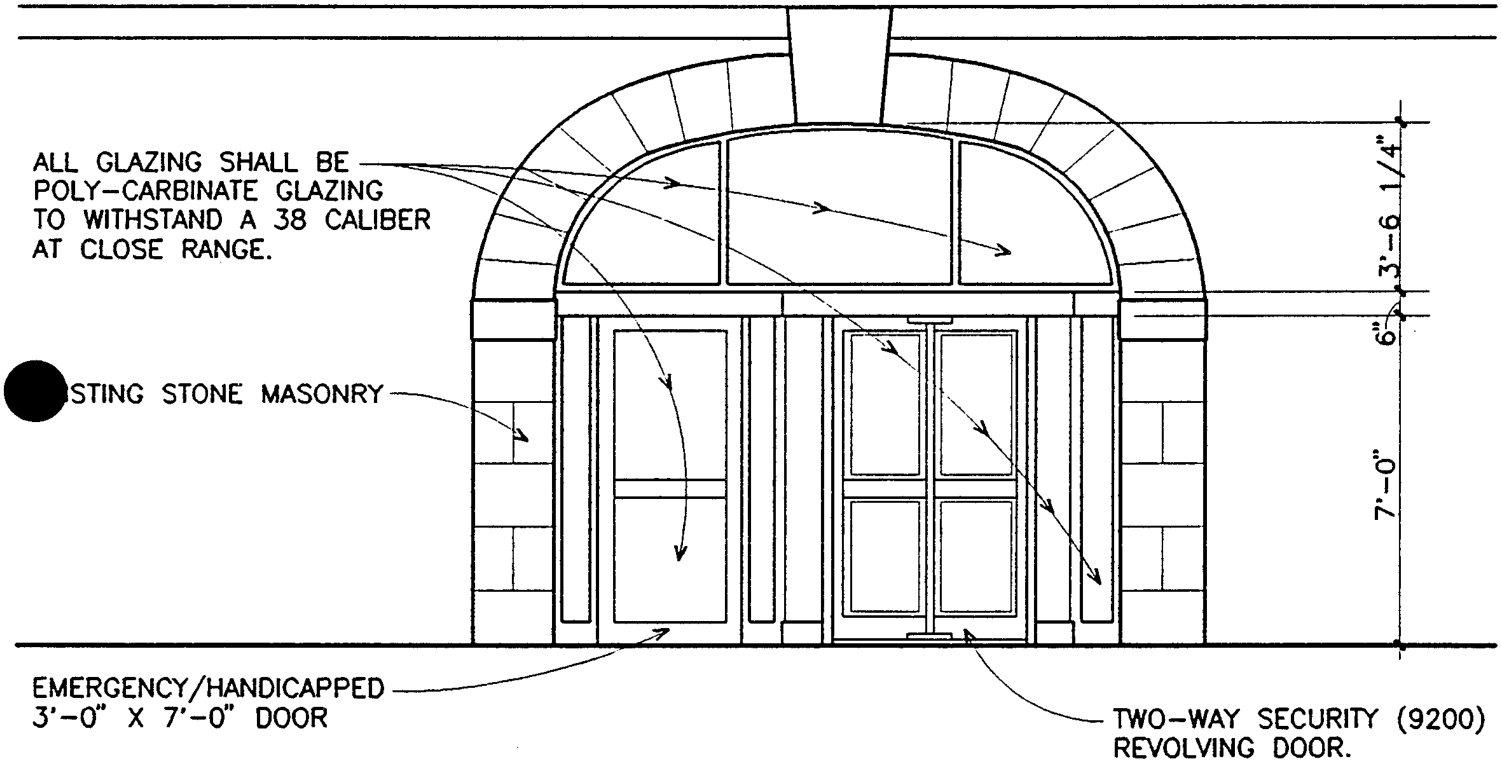


Figure A5.1

Building 463 South Gate

South Elevation



ALL GLAZING SHALL BE POLY-CARBINATE GLAZING TO WITHSTAND A 38 CALIBER AT CLOSE RANGE.

STING STONE MASONRY

EMERGENCY/HANDICAPPED 3'-0" X 7'-0" DOOR

TWO-WAY SECURITY (9200) REVOLVING DOOR.

Figure A5.2

Building 463 South Gate

North Elevation

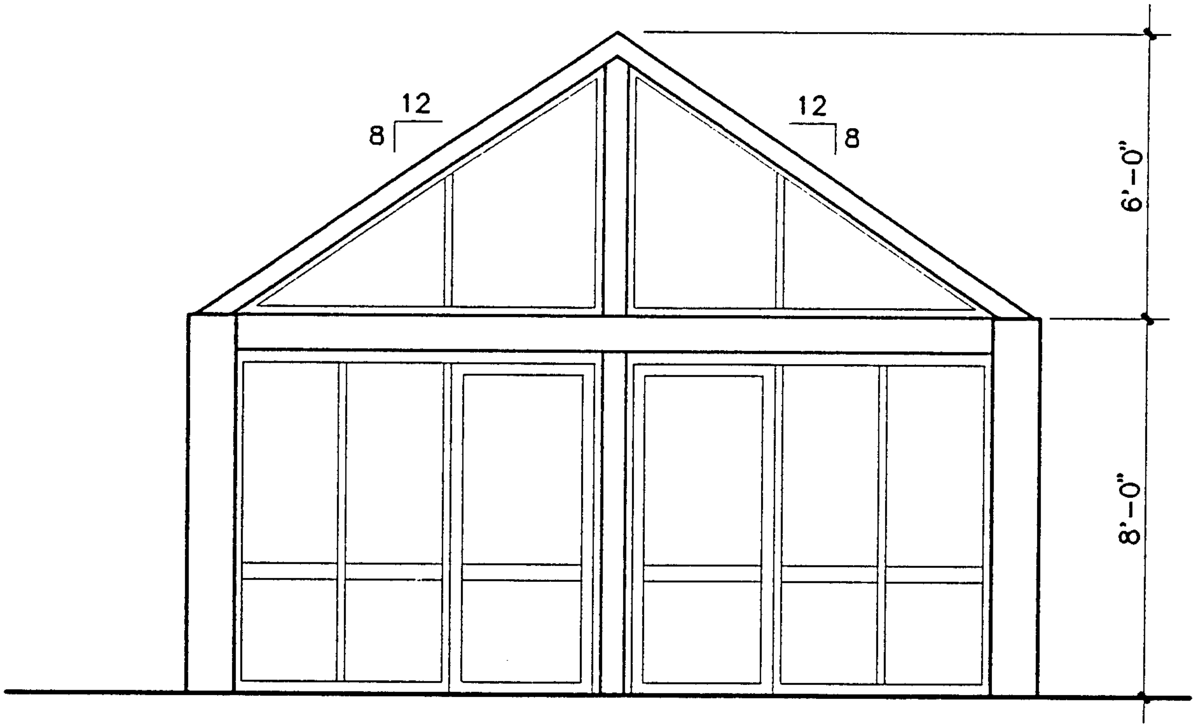


Figure A5.3

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 463A5
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	88238.
B. SIOH	$	5294.
C. DESIGN COST	$	4853.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	88547.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	88547.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	12.	$ 149.	11.16	1663.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	27.	$ 110.	16.15	1777.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		39.	$ 259.		$ 3440.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1135.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 259.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3440.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.04
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 341.88

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 OF 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A5 VESTIBULES	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 463 SOUTH DOORWAY							
DEMOLITION	1	EA			500.00	500	$500
REVOLVING DOOR	1	EA	21000	21,000	2400.00	2,400	$23,400
MAGNETIC BREAKOUTS	1	EA	2400.00	2,400	200.00	200	$2,600
BATTERY BACK UP	1	EA	1100.00	1,100	200.00	200	$1,300
ENTRANCE DOOR	1	EA	4300.00	4,300	515.00	515	$4,815
POLYCARBONATE GLAZING	271	SQ FT	4.85	1,314	2.28	618	$1,932
METAL FRAME	105	FT	6.50	683	4.16	437	$1,119
SUBTOTAL				$30,797		$4,870	$35,667
CONTINGENCY 10%			10%	$3,080	10%	$487	$3,567
SUBTOTAL				$33,877		$5,357	$39,234
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$1,186	13.0%	$696	$1,882
DIRECT COST				$35,063		$6,053	$41,116
OVERHEAD AND PROFIT			25%	$8,766	25%	$1,513	$10,279
SUBTOTAL				$43,829		$7,566	$51,395
CONSTRUCTION COST							$51,395

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 2 **OF** 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A5 VESTIBULES	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 463 NORTH DOORWAY							
EXCAVATE/DISPOSAL/TRIM	38	FT	0.63	24	2.12	81	$105
CONC. FTG. W/REBAR	38	FT	15	570	7.25	276	$846
MOBILIZATION	38	FT			2.50	95	$95
PREP EARTH BASE	180	SQ FT			0.15	27	$27
6" CRUSHED ROCK	180	SQ FT	0.20	36	0.10	18	$54
6 MIL. VAPOR BARRIER	180	SQ FT	0.05	9	0.02	4	$13
6 X 6 - 10/10 W.W.F.	180	SQ FT	0.08	14	0.12	22	$36
3500 PSI FINISH	180	SQ FT	0.94	169	0.81	146	$315
CURING	180	SQ FT	0.05	9	0.02	4	$13
JOINTS	180	SQ FT			0.04	7	$7
MOBILIZATION	180	SQ FT			0.24	43	$43
RIGID STL. FRAME/GLASS	180	SQ FT	67.50	12,150	22.50	4,050	$16,200
MOBILIZATION	180	SQ FT			0.50	90	$90
DOOR/LAMINATED GLASS	2	EA	3200.00	6,400	550.00	1,100	$7,500
SUBTOTAL				$19,382		$5,961	$25,343
CONTINGENCY 10%			10%	$1,938	10%	$596	$2,534
SUBTOTAL				$21,320		$6,557	$27,877
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$746	13.0%	$852	$1,598
DIRECT COST				$22,066		$7,409	$29,475
OVERHEAD AND PROFIT			25%	$5,516	25%	$1,852	$7,368
SUBTOTAL				$27,582		$9,261	$36,843
CONSTRUCTION COST							$36,843

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-A6 ECONOMIC ANALYSIS

BUILDING NUMBER	STEAM CONSUMPTION			ELECTRIC CONSUMPTION			TOTAL SAVINGS ($)
	BASE ENERGY (THERMS)	ECO-A6 LOAD (THERMS)	ENERGY SAVINGS (MBTU)	BASE LOAD (KW)	ECO-A6 LOAD (KW)	ENERGY SAVINGS (MBTU)	
450	3,629	3,403	23	135,466	131,720	13	$251
463	1,577	1,796	-22	83,903	82,425	5	($27)
464	2,195	2,352	-16	91,802	90,467	5	($7)
472	15,515	15,515	0	234,490	229,344	18	$218
473	2,407	2,609	-20	148,420	145,653	9	$35
475A	12,773	12,773	0	146,357	136,920	32	$401
475B	8,477	8,477	0	95,207	93,496	6	$73
475H	8,137	8,137	0	87,858	86,474	5	$59
							$1,003

ECO-A6

SOLAR WINDOW SHADING

SOLAR WINDOW SHADING

ENERGY CONSERVATION OPPORTUNITY: ECO-A6

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-A6) analyzes the energy savings associated with reducing the amount of solar gain on the buildings with cooling with the addition of a solar shading added to the windows. The addition of the solar shading would change the appearance of the exterior window facing to the south, east, and west. The window would have a dark brown tint.

SCOPE:

The ECO simulation (ECO-A6) adds solar shading film to existing windows to lessen the amount of sunlight that is allowed to pass through the window and heat up the interior. The application of this project was considered for the following buildings:

Building 450
Building 463
Building 464
Building 472
Building 473
Building 475A
Building 475B
Building 475H

MODELING TECHNIQUES:

The present solar gain on the buildings due to the lack of exterior shading was estimated by the *"Trace Ultra"* computer program simulation of the building. All of the exterior shading coefficients for the windows on the south, east, and west surfaces of the buildings were changed in the model and then an alternate run was completed to evaluate the new energy usage. The existing and ECO shading coefficients are shown in Table A6.1 The difference in the energy usage before and after the installation of the exterior shading is the energy savings for this ECO. Both the computer simulation run for the base load and the ECO are located in the appendix.

Building Number	Existing Window Type	Existing Shading Coefficient	ECO Shading Coefficient
450	Single Glazed	0.95	0.36 ?
463	Double Glazed	0.85	0.43
464	Double Glazed	0.85	0.43
472	Double Glazed	0.85	0.43
473	Double Glazed	0.85	0.43
475A	Double Glazed	0.85	0.43
475B	Double Glazed	0.85	0.43
475H	Double Glazed	0.85	0.43

Table A6.1

ECO IMPLEMENTATION:

The implementation of this ECO is not difficult and can be completed in a relatively short period of time. In the buildings being considered for the solar shading, a film is attached to the inside of the window. The film is held in place with a sticky backing.

SUMMARY:

The energy savings associated with the implementation of this ECO by building is shown below in Table A6.2 in million BTU's per year savings as determined using the computer simulation model.

The project cost is the construction cost as determined in the appendix plus 6% SIOH.

Building Number	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
450	80	$498	$2001	5.00	2.96
463	-(17)	-($53)	$2056	-(73.68)	-(0.37)
464	-(11)	($26)	$1782	-(596.00)	-(0.20)
472	18	$74	$8350	37.41	0.30
473	-(11)	$~~11~~130	$2565	85.80	-(0.03)
475A	32	$406	$8020	20.22	0.55
475B	6	$74	$2774	37.12	0.30
475H	5	$60	$2610	42.26	0.26

Table A6.2

Some of the buildings listed in Table A6.2 show a negative energy savings, which means that the building for the energy year used more energy after the implementation of the solar shading. The reason for this is those buildings are only partially cooled. Only specific zones of the entire building are cooled and the rest of the building is heated only. The solar shading will typically increase the heating costs because the building does not experience a solar gain in the winter season to help with heating. Building 450 shows a good payback for the solar shading because of the number of windows in the building. The summer season solar gain for building 450 is large relative to the other buildings.

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 450A6
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	2001.
B. SIOH	$	120.
C. DESIGN COST	$	110.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	2008.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	2008.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	9.	$	112.	11.16		1250.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	71.	$	~~290.~~	~~16.15~~		~~4684.~~
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			80.	$	~~402.~~ 112		~~$~~	~~5934.~~ 1250

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ ~~1958.~~ 843
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ ~~402.~~ 112

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ ~~5934.~~ 1250

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= ~~2.96~~ 0.62
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 ~~5.00~~ 17.9

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 463A6
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	2056.
B. SIOH	$	123.
C. DESIGN COST	$	113.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	2063.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	2063.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	5.	$ 62.	11.16	692.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	-22.	$ -90.	16.15	-1454.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		-17.	$ -28.		$ -762.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ -251.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -28.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -762.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -0.37
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -73.68

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 464A6
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	1782.
B. SIOH	$	107.
C. DESIGN COST	$	98.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	1788.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	1788.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	5.	$	62.	11.16		692.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	-16.	$	-65.	16.15		-1050.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			-11.	$	-3.		$	-358.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ -118.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -3.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -358.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -0.20
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -596.00

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 472A6
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	8350.
B. SIOH	$	501.
C. DESIGN COST	$	459.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	8379.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	8379.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	18.	$ 224.	11.16	2500.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	0.	$ 0.	16.15	0.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		18.	$ 224.		$ 2500.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 825.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 224.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2500.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.30
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 37.41

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 473A6
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	2565.
B. SIOH	$	154.
C. DESIGN COST	$	141.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	2574.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	2574.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	9.	$	112.	11.16		1250.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	-20.	$	-82.	16.15		-1324.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			-11.	$	30.		$	-74.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	11.65		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ -24.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 30.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -74.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -0.03
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 85.80

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475AA6
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	8020.
B. SIOH	$	481.
C. DESIGN COST	$	441.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	8048.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	8048.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	32.	$ 398.	11.16	4442.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	0.	$ 0.	16.15	0.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		32.	$ 398.		$ 4442.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1466.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 398.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 4442.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.55
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 20.22

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 8

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A** (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A6 **SOLAR WINDOW SHADING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 450							
SOLAR FILM	488	SQ FT	1.30	634	1.30	634	$1,269
MOBILIZATION	488	SQ FT			0.15	73	$73
SUBTOTAL				$634		$708	$1,342
CONTINGENCY 10%			10%	$63	10%	$71	$134
SUBTOTAL				$697		$779	$1,476
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$24	13.0%	$101	$125
DIRECT COST				$721		$880	$1,601
OVERHEAD AND PROFIT			25%	$180	25%	$220	$400
SUBTOTAL				$901		$1,100	$2,001
CONSTRUCTION COST							$2,001

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 2 **OF** 8

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A6 **SOLAR WINDOW SHADING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 463							
SOLAR FILM	501	SQ FT	1.30	651	1.30	651	$1,303
MOBILIZATION	501	SQ FT			0.15	75	$75
SUBTOTAL				$651		$726	$1,378
CONTINGENCY 10%			10%	$65	10%	$73	$138
SUBTOTAL				$716		$799	$1,516
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$25	13.0%	$104	$129
DIRECT COST				$741		$903	$1,645
OVERHEAD AND PROFIT			25%	$185	25%	$226	$411
SUBTOTAL				$926		$1,129	$2,056
CONSTRUCTION COST							$2,056

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 3 **OF** 8

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A6 **SOLAR WINDOW SHADING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 464							
SOLAR FILM	434	SQ FT	1.30	564	1.30	564	$1,128
MOBILIZATION	434	SQ FT			0.15	65	$65
SUBTOTAL				$564		$629	$1,194
CONTINGENCY 10%			10%	$56	10%	$63	$119
SUBTOTAL				$620		$692	$1,313
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$22	13.0%	$90	$112
DIRECT COST				$642		$782	$1,425
OVERHEAD AND PROFIT			25%	$161	25%	$196	$357
SUBTOTAL				$803		$978	$1,782
CONSTRUCTION COST							$1,782

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 4 **OF** 8

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A6 **SOLAR WINDOW SHADING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 472							
SOLAR FILM	2035	SQ FT	1.30	2,646	1.30	2,646	$5,291
MOBILIZATION	2035	SQ FT			0.15	305	$305
SUBTOTAL				$2,646		$2,951	$5,596
CONTINGENCY 10%			10%	$265	10%	$295	$560
SUBTOTAL				$2,911		$3,246	$6,156
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$102	13.0%	$422	$524
DIRECT COST				$3,013		$3,668	$6,680
OVERHEAD AND PROFIT			25%	$753	25%	$917	$1,670
SUBTOTAL				$3,766		$4,585	$8,350
CONSTRUCTION COST							$8,350

ENG. FORM 150
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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	**DATE PREPARED** 4/2/90	**SHEET** 5 **OF** 8
PROJECT USDB ENERGY STUDY	**BASIS FOR ESTIMATE** X CODE A (NO DESIGN COMPLETED) CODE B (PRELIMINARY DESIGN) CODE C (FINAL DESIGN) OTHER (SPECIFY)	
LOCATION FORT LEAVENWORTH, KS		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
DRAWING NO. NONE	**ESTIMATOR** DLS	**CHECKED BY** TOL

ECO-A6 **SOLAR WINDOW SHADING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 473							
SOLAR FILM	625	SQ FT	1.30	813	1.30	813	$1,625
MOBILIZATION	625	SQ FT			0.15	94	$94
SUBTOTAL				$813		$906	$1,719
CONTINGENCY 10%			10%	$81	10%	$91	$172
SUBTOTAL				$894		$997	$1,891
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$31	13.0%	$130	$161
DIRECT COST				$925		$1,127	$2,052
OVERHEAD AND PROFIT			25%	$231	25%	$282	$513
SUBTOTAL				$1,156		$1,409	$2,565
CONSTRUCTION COST							$2,565

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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 6 **OF** 8

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A6 **SOLAR WINDOW SHADING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475A							
SOLAR FILM	1955	SQ FT	1.30	2,542	1.30	2,542	$5,083
MOBILIZATION	1955	SQ FT			0.15	293	$293
SUBTOTAL				$2,542		$2,835	$5,376
CONTINGENCY 10%			10%	$254	10%	$283	$537
SUBTOTAL				$2,796		$3,118	$5,913
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$98	13.0%	$405	$503
DIRECT COST				$2,894		$3,523	$6,416
OVERHEAD AND PROFIT			25%	$723	25%	$881	$1,604
SUBTOTAL				$3,617		$4,404	$8,020
CONSTRUCTION COST							$8,020

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CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 7 **OF** 8

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A6 **SOLAR WINDOW SHADING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475B							
SOLAR FILM	676	SQ FT	1.30	879	1.30	879	$1,758
MOBILIZATION	676	SQ FT			0.15	101	$101
SUBTOTAL				$879		$980	$1,859
CONTINGENCY 10%			10%	$88	10%	$98	$186
SUBTOTAL				$967		$1,078	$2,045
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$34	13.0%	$140	$174
DIRECT COST				$1,001		$1,218	$2,219
OVERHEAD AND PROFIT			25%	$250	25%	$305	$555
SUBTOTAL				$1,251		$1,523	$2,774
CONSTRUCTION COST							$2,774

ENG. FORM 150
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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 8 **OF** 8

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

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CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A6 **SOLAR WINDOW SHADING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475H							
SOLAR FILM	636	SQ FT	1.30	827	1.30	827	$1,654
MOBILIZATION	636	SQ FT			0.15	95	$95
SUBTOTAL				$827		$922	$1,749
CONTINGENCY 10%			10%	$83	10%	$92	$175
SUBTOTAL				$910		$1,014	$1,924
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$32	13.0%	$132	$164
DIRECT COST				$942		$1,146	$2,088
OVERHEAD AND PROFIT			25%	$235	25%	$287	$522
SUBTOTAL				$1,177		$1,433	$2,610
CONSTRUCTION COST							$2,610

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

Product Performance Guide

IN30BR Bronze

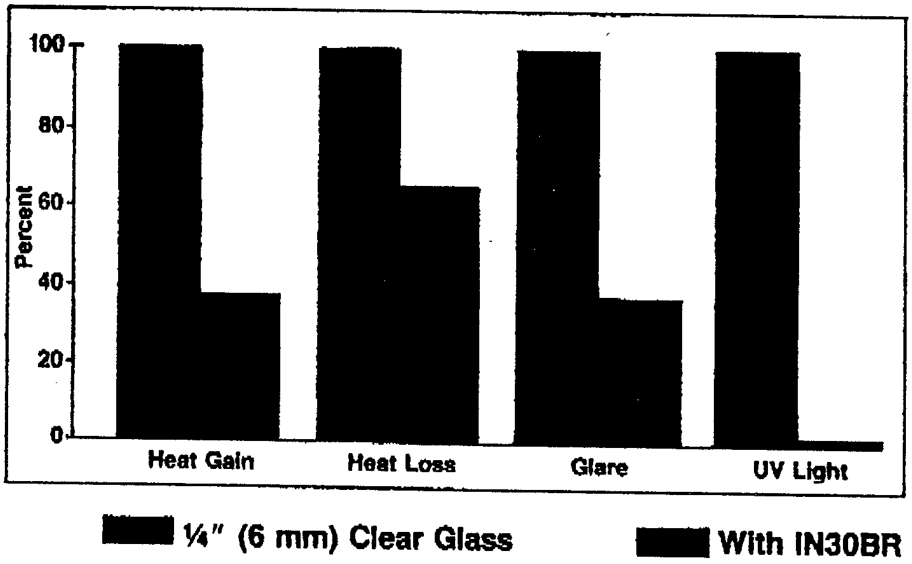
IN30BR Scotchtint™ Plus All Season Window Film

Description

IN30BR **Scotchtint** Plus All Season Window Film is designed for application to the inside of existing glass windows. Its function is to reduce the solar heat gain, ultra-violet light and glare that normally would enter through the windows. The film also reduces heat loss through the windows to the outside during the cooler months. The film remains transparent while performing these functions.

Benefits

In addition to the typical benefits on ¼" (6 mm) clear glass shown at right, the film provides increased shatter resistance.



Performance Data

Glass Type		Applied Product	Shading Coefficient	Total Solar Energy			Visible Light		UV Light	Emissivity	"U" Value
				Reflected	Absorbed	Transmitted	Reflected	Transmitted			
Single Pane	Clear	None	.94	8%	15%	77%	8%	88%	<68%	.84	1.06
		IN30BR	[redacted]	34%	43%	23%	25%	34%	< 1%	.23	.69
	Tinted	None	.69	5%	50%	45%	5%	50%	<29%	.84	1.06
		IN30BR	.31	15%	72%	13%	11%	18%	< 1%	.23	.69
Insulated Pane	Clear	None	.81	14%	26%	60%	14%	78%	<46%	.84	.50
		IN30BR	[redacted]	29%	53%	18%	28%	31%	< 1%	.23	.39
	Tinted	None	.55	8%	54%	38%	8%	45%	<21%	.84	.50
		IN30BR	.31	12%	77%	11%	11%	17%	< 1%	.23	.39

ECO-A6

SOLAR WINDOW SHADING

BUILDING 450

```
*************************************************************************
*************************************************************************
**                                                                     **
**             T R A C E   U L T R A   A N A L Y S I S                 **
**                                                                     **
**               by  CLARK RICHARDSON BISKUP                           **
**                                                                     **
*************************************************************************
*************************************************************************


      .USDB ENERGY STUDY
       LEAVENWORTH, KANSAS
       USDB
       RUSSELL G. BAEHR


      Weather File Code:            FTLVNWTH
      Location:                     LEAVENWORTH, KANSAS (USDB)
      Latitude:                      39.4  (deg)
      Longitude:                     94.9  (deg)
      Time Zone:                        6
      Elevation:                      770  (ft)
      Barometric Pressure:           29.1  (in. Hg)

      Summer Clearness Number:       0.95
      Winter Clearness Number:       0.95
      Summer Design Dry Bulb:          96  (F)
      Summer Design Wet Bulb:          77  (F)
      Winter Design Dry Bulb:           3  (F)
      Summer Ground Relectance:      0.20
      Winter Ground Relectance:      0.20

      Air Density:                 0.0739  (Lbm/cuft)
      Air Specific Heat:           0.2444  (Btu/lbm/F)
      Density-Specific Heat Prod:  1.0837  (Btu-min./hr/cuft/F)
      Latent Heat Factor:         4,770.2  (Btu-min./hr/cuft/lbm)
      Enthalpy Factor:             4.4333  (Btu-min./hr/cuft)

      Design Simulation Period: May      To October
      System Simulation Period: January  To December
      Cooling Load Methodology:     CLTD/CLF (TFM)

      Time/Date Program was Run:     3:47:50    1/11/90
      Dataset Name:                   450A26 .TM
```

AIRFLOW - ALTERNATIVE 3
ECO-A6 WINDOW SCH=.36

SYSTEM SUMMARY

(Design Airflow Quantities)

		Main					Auxil.	Room
System Number	System Type	Outside Airflow (Cfm)	Cooling Airflow (Cfm)	Heating Airflow (Cfm)	Return Airflow (Cfm)	Exhaust Airflow (Cfm)	Supply Airflow (Cfm)	Exhaust Airflow (Cfm)
1	MZ	870	8,764	8,764	8,764	8,764	0	670
2	FC	0	407	407	407	0	0	0
3	FC	0	147	147	147	0	0	0
Totals		870	9,318	9,318	9,318	8,764	0	670

CAPACITY - ALTERNATIVE 3
ECO-A6 WINDOW SCH=.36

SYSTEM SUMMARY

(Design Capacity Quantities)

		Cooling				Heating						
System Number	System Type	Main Sys. Capacity (Tons)	Aux. Sys. Capacity (Tons)	Opt. Vent Capacity (Tons)	Cooling Totals (Tons)	Main Sys. Capacity (Btuh)	Aux. Sys. Capacity (Btuh)	Preheat Capacity (Btuh)	Reheat Capacity (Btuh)	Humidif. Capacity (Btuh)	Opt. Vent Capacity (Btuh)	Heating Totals (Btuh)
1	MZ	30.5	0.0	0.0	30.5	-665,959	0	0	0	0	0	-665,959
2	FC	0.0	0.0	0.0	0.0	-27,351	0	0	0	0	0	-27,351
3	FC	0.0	0.0	0.0	0.0	-9,869	0	0	0	0	0	-9,869
Totals		30.5	0.0	0.0	30.5	-703,178	0	0	0	0	0	-703,178

ENGINEERING CHECKS - ALTERNATIVE 3
ECO-A6 WINDOW SCH=.36

ENGINEERING CHECKS

			Percent	Cooling				Heating		
System Number	Main/ Auxiliary	System Type	Outside Air	Cfm/ Sq Ft	Cfm/ Ton	Sq Ft /Ton	Btuh/ Sq Ft	Cfm/ Sq Ft	Btuh/ Sq Ft	Floor Area Sq Ft
1	Main	MZ	9.93	0.91	287.4	315.2	38.07	0.91	-69.29	9,611
2	Main	FC	0.00	2.87	********	********	0.01	2.87	-192.75	142
3	Main	FC	0.00	0.54	********	********	0.00	0.54	-36.55	270

```
  System      1       Block       MZ         -  MULTIZONE

  ************************* COOLING COIL PEAK ********************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
  Peaked at Time ==>             Mo/Hr:  7/15                               *       Mo/Hr:  7/16       *              Mo/Hr: 13/ 1
  Outside Air ==>            OADB/WB/HR:  96/ 77/112.0                      *        OADB:  96         *               OADB:   3
                                                                            *                          *
                        Space     Ret. Air  Ret. Air          Net   Percnt  *         Space     Percnt *         Space        Total    Percnt
                   Sens.+Lat.     Sensible    Latent        Total   Of Tot  *      Sensible     Of Tot *      Sensible     Sensible    Of Tot
  Envelope Loads       (Btuh)       (Btuh)    (Btuh)       (Btuh)      (%)  *        (Btuh)        (%) *        (Btuh)       (Btuh)       (%)
    Skylite Solr            0            0                      0     0.00  *             0       0.00 *             0            0      0.00
    Skylite Cond            0            0                      0     0.00  *             0       0.00 *             0            0      0.00
    Roof Cond          22,575       21,512                 44,087    12.05  *        22,293      10.21 *       -19,865      -19,865      0.00
    Glass Solar        12,755            0                 12,755     3.49  *        13,642       6.25 *             0            0      0.00
    Glass Cond          7,011            0                  7,011     1.92  *         6,947       3.18 *       -30,975      -30,975      5.13
    Wall Cond          11,126        1,625                 12,750     3.48  *        11,650       5.33 *       -30,336      -35,487      5.88
    Partition               0                                   0     0.00  *             0       0.00 *             0            0      0.00
    Exposed Floor           0                                   0     0.00  *             0       0.00 *        -8,929       -8,929      1.48
    Infiltration       80,527                              80,527    22.01  *        31,225      14.29 *      -114,593     -114,593     18.98
    Sub Total==>      133,994       23,136                157,130    42.95  *        85,757      39.26 *      -204,699     -209,850     34.76
  Internal Loads                                                            *                          *
    Lights             64,850       14,646                 79,496    21.73  *        65,153      29.83 *             0            0      0.00
    People             33,610                              33,610     9.19  *        17,165       7.86 *             0            0      0.00
    Misc               45,103            0         0       45,103    12.33  *        45,459      20.81 *             0            0      0.00
    Sub Total==>      143,563       14,646         0      158,209    43.24  *       127,778      58.50 *             0            0      0.00
  Ceiling Load          4,888       -4,888                      0     0.00  *         4,902       2.24 *        -3,119            0      0.00
  Outside Air               0            0         0       43,064    11.77  *             0       0.00 *             0      -61,281     10.15
  Sup. Fan Heat                                            10,745     2.94  *                     0.00 *                          0      0.00
  Ret. Fan Heat                          0                      0     0.00  *                     0.00 *                          0      0.00
  Duct Heat Pkup                         0                      0     0.00  *                     0.00 *                          0      0.00
  OV/UNDR Sizing            0                                   0     0.00  *             0       0.00 *      -333,525     -333,525     55.24
  Exhaust Heat                      -3,282         0       -3,282    -0.90  *                     0.00 *                        891     -0.15
  Terminal Bypass                        0         0            0     0.00  *                     0.00 *                          0      0.00
                                                                            *                          *
  Grand Total==>      282,444       29,612         0      365,865   100.00  *       218,437     100.00 *      -541,343     -603,766    100.00

----------------------------------------COOLING COIL SELECTION---------------------------------------    ---------------AREAS---------------
            Total Capacity   Sens Cap.   Coil Airfl    Entering DB/WB/HR      Leaving DB/WB/HR         Gross Total     Glass (sf)   (%)
             (Tons)   (Mbh)     (Mbh)       (cfm)    Deg F  Deg F  Grains   Deg F  Deg F  Grains      Floor     9,611
Main Clg      30.5    365.9     274.4       8,764     83.3   66.3    72.4    54.4   52.4    57.2      Part          0
Aux  Clg       0.0      0.0       0.0           0      0.0    0.0     0.0     0.0    0.0     0.0      ExFlr       225
Opt Vent       0.0      0.0       0.0           0      0.0    0.0     0.0     0.0    0.0     0.0      Roof      5,180             0     0
Totals        30.5    365.9                                                                          Wall      6,156           566     9

-----------HEATING COIL SELECTION------------     ---------AIRFLOWS (cfm)---------     --ENGINEERING CHECKS--     --TEMPERATURES (F)--
            Capacity  Coil Airfl    Ent    Lvg          Type      Cooling    Heating     Clg % OA           9.9      Type      Clg    Htg
              (Mbh)      (cfm)    Deg F  Deg F          Vent          870        870     Clg Cfm/Sqft      0.91      SADB     55.0  125.0
Main Htg     -666.0      8,764     55.0  125.0          Infil       1,627      1,627     Clg Cfm/Ton     287.45      Plenum   81.5   65.8
Aux  Htg        0.0          0      0.0    0.0          Supply      8,764      8,764     Clg Sqft/Ton    315.24      Return   81.5   67.2
Preheat         0.0      8,764     60.8   53.9          Mincfm        870        870     Clg Btuh/Sqft    38.07      Ret/OA   82.9   60.9
Reheat          0.0          0      0.0    0.0          Return      8,505      8,764     No. People          87      Runarnd  78.0   68.0
Humidif         0.0          0      0.0    0.0          Exhaust     8,764        870     Htg % OA           9.9      Fn MtrTD  0.1    0.0
Opt Vent        0.0          0      0.0    0.0          Rm Exh        670          0     Htg Cfm/Sqft      0.91      Fn BldTD  0.2    0.0
Total        -666.0                                     Auxil           0          0     Htg Btuh/Sqft   -69.29      Fn Frict  0.7    0.0
```

```
System     2     Block     FC     -  FAN COIL

************************ COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>           Mo/Hr:  7/10                         *   Mo/Hr:  7/10       *      Mo/Hr: 13/ 1
Outside Air ==>       OADB/WB/HR:  86/ 72/ 98.0                   *   OADB:  86          *      OADB:   3
                                                                  *                      *
                     Space  Ret. Air  Ret. Air       Net  Percnt  *     Space    Percnt  *     Space     Total   Percnt
                Sens.+Lat.  Sensible    Latent     Total  Of Tot  *  Sensible    Of Tot  *  Sensible  Sensible   Of Tot
Envelope Loads      (Btuh)    (Btuh)    (Btuh)    (Btuh)     (%)  *    (Btuh)       (%)  *    (Btuh)    (Btuh)      (%)
  Skylite Solr           0         0                   0    0.00  *         0      0.00  *         0         0     0.00
  Skylite Cond           0         0                   0    0.00  *         0      0.00  *         0         0     0.00
  Roof Cond              0         0                   0    0.00  *         0      0.00  *         0         0     0.00
  Glass Solar        4,680         0               4,680   63.51  *     4,680     70.66  *         0         0     0.00
  Glass Cond           671         0                 671    9.10  *       671     10.13  *    -6,571    -6,571    24.02
  Wall Cond              0         0                   0    0.00  *         0      0.00  *         0         0     0.00
  Partition              0                             0    0.00  *         0      0.00  *         0         0     0.00
  Exposed Floor          0                             0    0.00  *         0      0.00  *      -397      -397     1.45
  Infiltration         965                           965   13.10  *       344      5.20  *    -2,665    -2,665     9.75
  Sub Total==>       6,316         0               6,316   85.71  *     5,695     85.98  *    -9,633    -9,633    35.22
Internal Loads                                                    *                      *
  Lights               557       371                 928   12.60  *       557      8.41  *         0         0     0.00
  People                 0                             0    0.00  *         0      0.00  *         0         0     0.00
  Misc                   0         0         0         0    0.00  *         0      0.00  *         0         0     0.00
  Sub Total==>         557       371         0       928   12.60  *       557      8.41  *         0         0     0.00
Ceiling Load           371      -371                   0    0.00  *       371      5.61  *         0         0     0.00
Outside Air              0         0         0         0    0.00  *         0      0.00  *         0         0     0.00
Sup. Fan Heat                                        125    1.69  *                0.00  *                   0     0.00
Ret. Fan Heat                      0                   0    0.00  *                0.00  *                   0     0.00
Duct Heat Pkup                     0                   0    0.00  *                0.00  *                   0     0.00
OV/UNDR Sizing           0                             0    0.00  *         0      0.00  *   -17,718   -17,718    64.78
Exhaust Heat                       0         0         0    0.00  *                0.00  *                   0     0.00
Terminal Bypass                    0         0         0    0.00  *                0.00  *                   0     0.00
                                                                  *                      *
Grand Total==>       7,245         0         0     7,369  100.00  *     6,623    100.00  *   -27,351   -27,351   100.00

----------------------------COOLING COIL SELECTION----------------------------      -----------AREAS-----------
          Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR     Leaving DB/WB/HR     Gross Total  Glass (sf)  (%)
           (Tons)   (Mbh)     (Mbh)       (cfm)   Deg F  Deg F  Grains  Deg F  Deg F  Grains   Floor      142
Main Clg      0.0     0.0       0.0         407    78.1   64.9    73.9   62.8   62.6    87.7   Part         0
Aux  Clg      0.0     0.0       0.0           0     0.0    0.0     0.0    0.0    0.0     0.0   ExFlr       10
Opt Vent      0.0     0.0       0.0           0     0.0    0.0     0.0    0.0    0.0     0.0   Roof         0          0    0
Totals        0.0     0.0                                                                     Wall       120        120  100

----------HEATING COIL SELECTION----------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--   --TEMPERATURES (F)--
          Capacity  Coil Airfl   Ent    Lvg     Type      Cooling   Heating   Clg % OA           0.0   Type      Clg    Htg
            (Mbh)     (cfm)    Deg F  Deg F    Vent            0         0   Clg Cfm/Sqft      2.87   SADB     63.0  130.0
Main Htg    -27.4       407    68.0  130.0    Infil          38        38   Clg Cfm/Ton    *******   Plenum   86.3   68.0
Aux  Htg      0.0         0     0.0    0.0    Supply        407       407   Clg Sqft/Ton   *******   Return   78.0   68.0
Preheat       0.0       407    68.0   62.7    Mincfm          0         0   Clg Btuh/Sqft     0.01   Ret/OA   78.0   68.0
Reheat        0.0         0     0.0    0.0    Return        407       407   No. People           0   Runarnd  78.0   68.0
Humidif       0.0         0     0.0    0.0    Exhaust        38         0   Htg % OA           0.0   Fn MtrTD  0.0    0.0
Opt Vent      0.0         0     0.0    0.0    Rm Exh          0         0   Htg Cfm/SqFt      2.87   Fn BldTD  0.1    0.0
Total       -27.4                             Auxil           0         0   Htg Btuh/SqFt  -192.75   Fn Frict  0.2    0.0
```

```
Trane Air Conditioning Economics                                                                                  V 600
  By: CLARK RICHARDSON BISKUP                                                                                      PAGE   5

  System      3      Block      FC      -  FAN COIL

  ************************ COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
  Peaked at Time ==>              Mo/Hr:  7/15                     *      Mo/Hr:  7/16      *             Mo/Hr: 13/ 1
  Outside Air ==>             OADB/WB/HR:  96/ 77/112.0            *       OADB:  96        *              OADB:   3
                                                                   *                        *
                         Space    Ret. Air  Ret. Air         Net  Percnt *         Space    Percnt *         Space       Total   Percnt
                     Sens.+Lat.   Sensible    Latent       Total  Of Tot *      Sensible    Of Tot *      Sensible    Sensible   Of Tot
  Envelope Loads        (Btuh)      (Btuh)    (Btuh)      (Btuh)     (%) *        (Btuh)       (%) *        (Btuh)      (Btuh)      (%)
    Skylite Solr           0           0                       0    0.00 *             0      0.00 *             0           0     0.00
    Skylite Cond           0           0                       0    0.00 *             0      0.00 *             0           0     0.00
    Roof Cond              0           0                       0    0.00 *             0      0.00 *             0           0     0.00
    Glass Solar            0           0                       0    0.00 *             0      0.00 *             0           0     0.00
    Glass Cond             0           0                       0    0.00 *             0      0.00 *             0           0     0.00
    Wall Cond            246          47                     293    6.16 *           268      7.94 *        -1,005      -1,466    14.86
    Partition              0                                   0    0.00 *             0      0.00 *             0           0     0.00
    Exposed Floor          0                                   0    0.00 *             0      0.00 *          -793        -793     8.04
    Infiltration       2,455                               2,455   51.53 *         1,024     30.39 *        -3,804      -3,804    38.54
    Sub Total==>       2,701          47                   2,748   57.68 *         1,292     38.33 *        -5,602      -6,063    61.43
  Internal Loads                                                         *                         *
    Lights             1,183         788                   1,971   41.37 *         1,213     36.01 *             0           0     0.00
    People                 0                                   0    0.00 *             0      0.00 *             0           0     0.00
    Misc                   0           0         0             0    0.00 *             0      0.00 *             0           0     0.00
    Sub Total==>       1,183         788         0         1,971   41.37 *         1,213     36.01 *             0           0     0.00
  Ceiling Load           836        -836                       0    0.00 *           865     25.66 *          -461           0     0.00
  Outside Air              0           0         0             0    0.00 *             0      0.00 *             0           0     0.00
  Sup. Fan Heat                                               45    0.95 *                    0.00 *                         0     0.00
  Ret. Fan Heat                        0                       0    0.00 *                    0.00 *                         0     0.00
  Duct Heat Pkup                       0                       0    0.00 *                    0.00 *                         0     0.00
  OV/UNDR Sizing           0                                   0    0.00 *             0      0.00 *        -3,806      -3,806    38.57
  Exhaust Heat                         0         0             0    0.00 *                    0.00 *                         0     0.00
  Terminal Bypass                      0         0             0    0.00 *                    0.00 *                         0     0.00
                                                                         *                         *
  Grand Total==>       4,719           0         0         4,764  100.00 *         3,369    100.00 *        -9,869      -9,869   100.00

 ------------------------------------COOLING COIL SELECTION-----------------------------------    -----------------AREAS--------------
            Total Capacity   Sens Cap.  Coil Airfl   Entering DB/WB/HR      Leaving DB/WB/HR      Gross Total      Glass (sf)   (%)
            (Tons)    (Mbh)      (Mbh)       (cfm)  Deg F  Deg F  Grains  Deg F  Deg F  Grains   Floor       270
 Main Clg      0.0      0.0        0.0         147   78.1   64.9    73.9   57.0   56.3    68.9   Part          0
 Aux  Clg      0.0      0.0        0.0           0    0.0    0.0     0.0    0.0    0.0     0.0   ExFlr        20
 Opt Vent      0.0      0.0        0.0           0    0.0    0.0     0.0    0.0    0.0     0.0   Roof          0             0    0
 Totals        0.0      0.0                                                                      Wall        240             0    0

 -----------HEATING COIL SELECTION-------------   -------AIRFLOWS (cfm)-------    --ENGINEERING CHECKS--    --TEMPERATURES (F)--
            Capacity  Coil Airfl    Ent     Lvg      Type     Cooling   Heating   Clg % OA          0.0     Type      Clg     Htg
              (Mbh)      (cfm)    Deg F   Deg F     Vent            0         0   Clg Cfm/Sqft     0.54     SADB     56.8   130.0
 Main Htg       -9.9        147    68.0   130.0     Infil          54        54   Clg Cfm/Ton   *******     Plenum   87.8    62.6
 Aux  Htg        0.0          0     0.0     0.0     Supply        147       147   Clg Sqft/Ton  *******     Return   78.0    68.0
 Preheat         0.0        147    68.0    56.5     Mincfm          0         0   Clg Btuh/Sqft    0.00     Ret/OA   78.0    68.0
 Reheat          0.0          0     0.0     0.0     Return        147       147   No. People          0     Runarnd  78.0    68.0
 Humidif         0.0          0     0.0     0.0     Exhaust        54         0   Htg % OA          0.0     Fn MtrTD  0.0     0.0
 Opt Vent        0.0          0     0.0     0.0     Rm Exh          0         0   Htg Cfm/SqFt     0.54     Fn BldTD  0.1     0.0
 Total          -9.9                                Auxil           0         0   Htg Btuh/SqFt  -36.55     Fn Frict  0.2     0.0
```

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

MONTHLY ENERGY CONSUMPTION

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	STEAM (Therm)
Jan	9,846	51	652
Feb	8,722	51	585
March	10,321	51	606
April	9,280	51	304
May	10,268	51	0
June	13,790	80	0
July	15,630	87	0
Aug	15,336	79	0
Sept	10,517	73	0
Oct	9,829	51	0
Nov	9,297	51	530
Dec	8,884	51	726
Total	131,720	87	3,403

Building Energy Consumption = 78,804 (Btu/Sq Ft/Year)   Floor Area = 10,023 (Sq Ft)
Source Energy Consumption = 179,838 (Btu/Sq Ft/Year)

EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

EQUIPMENT ENERGY CONSUMPTION

Ref	Equip	Monthly Consumption												
Num	Code	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
0	LIGHTS													
	ELEC	5454	4813	5775	5133	5775	5454	5133	6096	4813	5454	5133	4813	63,847
	PK	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9
1	MISC LD													
	ELEC	2682	2366	2839	2524	2839	2682	2524	2997	2366	2682	2524	2366	31,392
	PK	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
2	MISC LD													
	GAS	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	MISC LD													
	OIL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	MISC LD													
	P STEAM	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	MISC LD													
	P HOTH2O	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	MISC LD													
	P CHILL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	EQ1170L		AC COND COMP <20 TONS											
	ELEC	0	0	0	0	0	3533	5510	3996	1486	0	0	0	14,525
	PK	0.0	0.0	0.0	0.0	0.0	24.9	31.3	24.8	19.2	0.0	0.0	0.0	31.3
1	EQ5200		CONDENSER FANS											
	ELEC	0	0	0	0	0	428	716	491	182	0	0	0	1,817
	PK	0.0	0.0	0.0	0.0	0.0	3.2	3.7	3.1	2.5	0.0	0.0	0.0	3.7
1	EQ5313		CONTROLS											
	ELEC	0	0	0	0	0	95	102	100	79	0	0	0	377
	PK	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.3
1	EQ4002		BI CENTRIF. FAN C.V.											
	ELEC	1587	1433	1587	1536	1587	1536	1587	1587	1536	1587	1536	1587	18,686
	PK	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
1	EQ4381		PROPELLER FAN											
	ELEC	33	29	35	31	35	33	31	37	29	33	31	29	389
	PK	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	EQ4371		FAN COIL SUPPLY FAN											

```
EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

    ELEC         28    26    28    22    23    21    20    23    20    65    24    28       327
    PK          0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1       0.1

  3 EQ4371            FAN COIL SUPPLY FAN
    ELEC         10     9    10     7     8     7     7     8     7     7     8    10       100
    PK          0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0       0.0

  1 EQ2101            PURCHASED DISTRICT STEAM
    P STEAM     621   556   581   299     0     0     0     0     0     0   516   687     3,260
    PK          4.6   4.5   4.3   2.1   0.0   0.0   0.0   0.0   0.0   0.0   3.2   4.7       4.7

  1 EQ5020            HEAT WATER CIRC. PUMP C.V.
    ELEC          5     5     5     4     0     0     0     0     0     0     5     5        30
    PK          0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0       0.0

  1 EQ5061            CONDENSATE RETURN PUMP
    ELEC         11    10    11     8     0     0     0     0     0     0    10    11        60
    PK          0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0       0.0

  2 CONVERTR          STEAM TO HOT WATER CONVERTER
    P STEAM      31    28    25     5     0     0     0     0     0     0    14    39       143
    PK          0.1   0.1   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1       0.1

  2 EQ5020            HEAT WATER CIRC. PUMP C.V.
    ELEC          1     1     1     0     0     0     0     0     0     0     0     1         3
    PK          0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0       0.0

  2 EQ5060            CONDENSATE RETURN PUMP
    ELEC         35    31    29    14     0     0     0     0     0     0    25    35       168
    PK          0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0       0.0
```

```
UTILITY PEAK CHECKSUMS - ALTERNATIVE 3
BASE LOAD

---------------------------------- U T I L I T Y   P E A K   C H E C K S U M S ----------------------------------

Utility   ELECTRIC DEMAND

Peak Value       86.6    (kW)
Yearly Time of Peak  15 (hr)    7 (mo)

Hour 15  Month  7

Eqp.
Ref.     Equipment                                             Utility  Percnt
Num.     Code Name                                             Demand   Of Tot
                                Equipment Description          (kW)     (%)

Cooling Equipment

  1         EQ1170L  'AC COND COMP <20 TONS                     35.3    40.80

Sub Total                                                       35.3    40.80

Sub Total                                                        0.0     0.00

Air Moving Equipment

  1                  SUMMATION OF FAN ELECTRICAL DEMAND          5.1     5.86
  2                  SUMMATION OF FAN ELECTRICAL DEMAND          0.1     0.13
  3                  SUMMATION OF FAN ELECTRICAL DEMAND          0.0     0.05

Sub Total                                                        5.2     6.03

Sub Total                                                        0.0     0.00

Miscellaneous

 Lights                                                         30.9    35.64
 Base Utilities                                                  0.0     0.00
 Misc Equipment                                                 15.2    17.52
Sub Total                                                       46.0    53.17

Grand Total                                                     86.6   100.00
```

CALIFORNIA TITLE 24 COMPLIANCE - ALTERNATIVE 3
BASE LOAD

CALIFORNIA TITLE 24 COMPLIANCE REPORT

Weather Name .... FTLVNWTH
Gross Conditioned Floor Area (sqft)...... 10,023
ACM Multiplier 1.008

ENERGY USE SUMMARY

	ELEC (kWh/yr)	DISTRICT STEAM (kBtu/yr)	PERCENT OF TOTAL ENERGY (%)	TOTAL SOURCE ENERGY (kBtu/yr)	ADJUSTED UNIT SOURCE ENERGY (kBtu/yr-sf)
Primary Heating	228.2	340,320.1	43.2	456,097.0	45.9
Primary Cooling					
Compressor	14,524.5	0.0	6.3	148,731.5	15.0
Tower/Cond Fans	1,817.0	0.0	0.8	18,606.2	1.9
Condenser Pump	0.0	0.0	0.0	0.0	0.0
Other Accessories	376.8	0.0	0.2	3,858.4	0.4
Auxiliary					
Supply Fans	19,501.6	0.0	8.4	199,697.0	20.1
Circulation Pumps	32.7	0.0	0.0	334.5	0.0
Base Utilities	0.0	0.0	0.0	0.0	0.0
Subtotal	19,534.3	0.0	8.4	200,031.5	20.1
Lighting	63,847.1	0.0	27.6	653,796.2	65.7
Receptacle	31,391.7	0.0	13.6	321,451.6	32.3
Domestic Hot Water	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0
Totals	131,719.6	340,320.1	100.0	1,802,572.4	181.3

ECO-A7

EXTERIOR WALL INSULATION

EXTERIOR WALL INSULATION

ENERGY CONSERVATION OPPORTUNITY: ECO-A7

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-A7) analyzes the energy savings associated with reducing the amount of heat transfer through the walls of the buildings located in the USDB. Energy savings can be accomplished by adding wall insulation to the exterior walls to decrease the heat transfer coefficient (U-value) of the walls.

SCOPE:

The ECO simulation (ECO-A7) adds additional insulation to the existing exterior walls of the buildings to reduce the amount of heat transfer through outside walls. The application of this project was considered for the following buildings:

Building 472
Building 475C

If the energy savings were better and showed a feasible payback for funding, more of the buildings would have been considered. However, because of the expense of adding insulation to existing walls, this ECO was not feasible.

MODELING TECHNIQUES:

The modeling technique used to calculate the energy savings associated with the implementation of this ECO was completed using the *"Trace Ultra"* computer simulation program. The existing wall U-value is entered to calculate the amount of energy used by the building at the present time. With the additional wall insulation added, a new U-value is calculated and entered into the computer model and a new energy usage is found. The difference in energy usage from the two computer runs is the energy savings that can be obtained by implementing this ECO. The two different construction methods were considered, represented two typical buildings where a payback was most probable. The building representing the standard gypboard construction was building 472. The building representing the metal clad gypboard construction was building 475C.

ECO IMPLEMENTATION:

To implement this ECO for the buildings listed above, the existing exterior wall would have to be furred out with 2X4's or 2X2's. Insulation would be added in between the furred out studs and a gypboard would be used to cover the insulation and studs. The gypboard would be painted and trimmed out to match the existing conditions. For the exterior walls in the cell barracks of the castle, where the wall are accessible to unsupervised inmates, a metal stud would be attached to the existing concrete walls, then insulated. A metal clad gypboard would be used to cover the metal studs from the floor to a height of 10'. The metal clad gypboard would be attached to the metal studs with a non-visible and non-removable fastener. Above the 10' border a standard gypboard would be used to save on some costs.

SUMMARY:

The energy savings associated with the implementation of this ECO by building is shown below in Table A7.1 in million of BTU's per year savings as determined using the computer simulation model located in Volume 3.

The project cost is the construction cost as determined in this section plus 6% SIOH.

Building Number	**Energy Savings (MBTU)**	**Cost Savings**	**Project Costs**	**Simple Payback**	**Savings to Invest Ratio**
472	229	$1,507	$61,391	54.83	0.28
475C	154	$628	$168,196	253.55	0.06

Table A7.1

This ECO project is clearly not feasible from the paybacks and savings to investment ratios seen in Table A7.1. The project costs were high relative to average structures due to the nature of the occupants of this facility. Building 475C has a higher number of payback years because the building is heated only.

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 472A7
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	57916.
B. SIOH	$	3475.
C. DESIGN COST	$	3185.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	58118.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	58118.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	15.	$ 187.	11.16	2087.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	214.	$ 873.	16.15	14099.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		229.	$ 1060.		$ 16186.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5341.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1060.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 16186.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.28
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 54.83

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475CA7
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	158675.
B. SIOH	$	9521.
C. DESIGN COST	$	8727.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	159231.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	159231.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	11.16	0.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	154.	$ 628.	16.15	10142.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		154.	$ 628.		$ 10142.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3347.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 628.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 10142.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.06
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 253.55

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

ECO-A7 **EXTERIOR WALL INSULATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 472							
2-1/2" METAL STUDS	10382	SQ FT	0.30	3,115	0.45	4,672	$7,787
2" ISOCYANURATE INSULATION	10382	SQ FT	1.00	10,382	0.30	3,115	$13,497
5/8" FIRECODE GYP. BD.	10382	SQ FT	0.28	2,907	0.47	4,880	$7,787
4" VINYL BASE	10382	SQ FT	0.07	727	0.08	831	$1,557
PAINT	10382	SQ FT	0.22	2,284	0.48	4,983	$7,267
6 MIL. VAPOR BARRIER	10382	SQ FT	0.03	311	0.07	727	$1,038
SUBTOTAL				$19,726		$19,207	$38,933
CONTINGENCY 10%			10%	$1,973	10%	$1,921	$3,894
SUBTOTAL				$21,699		$21,128	$42,827
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$759	13.0%	$2,747	$3,506
DIRECT COST				$22,458		$23,875	$46,333
OVERHEAD AND PROFIT			25%	$5,614	25%	$5,969	$11,583
SUBTOTAL				$28,072		$29,844	$57,916
CONSTRUCTION COST							$57,916

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 2 **OF** 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

ECO-A7 **EXTERIOR WALL INSULATION**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475C							
METAL CLAD GYP. BD. AND TRACK	10529	SQ FT	4.60	48,433	1.00	10,529	$58,962
2-1/2" THERMAL INSULATION	10529	SQ FT	0.25	2,632	0.10	1,053	$3,685
6 MIL. VAPOR BARRIER	10529	SQ FT	0.03	316	0.07	737	$1,053
CAULK	10529	SQ FT	0.06	632	0.14	1,474	$2,106
MOBILIZATION	10529	SQ FT			0.30	3,159	$3,159
2-1/2" METAL STUDS	11359	SQ FT	0.30	3,408	0.60	6,815	$10,223
2-1/2" BATT INSULATION	11359	SQ FT	0.25	2,840	0.10	1,136	$3,976
5/8" FIRECODE GYP. BD.	11359	SQ FT	0.28	3,181	0.57	6,475	$9,655
CAULK	11359	SQ FT	0.06	682	0.14	1,590	$2,272
PAINT	11359	SQ FT	0.22	2,499	0.48	5,452	$7,951
6 MIL. VAPOR BARRIER	11359	SQ FT	0.03	341	0.07	795	$1,136
MOBILIZATION	11359	SQ FT			0.30	3,408	$3,408
SUBTOTAL				$64,963		$42,623	$107,586
CONTINGENCY 10%			10%	$6,496	10%	$4,262	$10,758
SUBTOTAL				$71,459		$46,885	$118,344
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$2,501	13.0%	$6,095	$8,596
DIRECT COST				$73,960		$52,980	$126,940
OVERHEAD AND PROFIT			25%	$18,490	25%	$13,245	$31,735
SUBTOTAL				$92,450		$66,225	$158,675
CONSTRUCTION COST							$158,675

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PREVIOUS EDITION MAY BE USED

A9

ARCHITECTURAL REPAIRS

ARCHITECTURAL REPAIRS - A9

PURPOSE:

The architectural repair section (A9) studied any repairs that might improve the energy efficiency of the buildings architecturally. Although these projects are small in nature, their completion may help the buildings save energy. The energy savings associated with these opportunities are difficult to calculate, therefore this section serves as recommended repairs.

SCOPE:

The architectural repairs encompassed many of the buildings and are as follows:

Building 463
Building 464
Building 465
Building 466
Building 472
Building 473
Building 475
Building 475A
Building 475E

Repairs are located in different areas of each of the buildings.

SUMMARY:

To summarize, a listing of the various architectural repairs is listed and description of the repair. Following the list are cost estimates for each of the repairs.

1. In building 450 a condensate line is presently routed through the door on the first floor. The door is (108) as shown on the building plan in the field data for the building in Volume 4. The pipe needs to be re-routed through the masonry wall adjacent to the door. A hole will need to be drilled through the masonry and the piping installed through the wall. The estimated cost to complete this repair is $424.

2. In building 464 a light fixture is located directly in the way of the attic access for the building. The light fixture can be relocated to the side of the access hole to the attic. This project needs to be completed before the attic insulation project could be implemented. The estimated cost to relocate the light is $73.

3. The vestibule doors for the entrance of building 465 need to be relocated. One of the doors is located on the ground floor and needs to be moved back. The side light also needs to be moved back in conjunction with the door. The swing of the door needs to be reversed to the present swing to ensure correct people

movement. The other door that needs to be relocated is for the entrance to the first floor. To relocate the vestibule doors, the estimated cost is $1,671.

4. On the third floor of building 466, the metal ceiling panels need to be repaired. The metal panels for the area need to be demolished and metal panels are available from another area to replace the ones removed. The estimated cost to repair the ceiling is $582.

5. Building 472 needs to have an attic access in a classroom on the third floor and have door (106) on the first floor adjusted and a new lock installed. The location of the door can be seen in the field notes located under the building in Volume 4. The estimated cost for these items is $1,219.

6. A door in building 473 needs to replaced with a new metal hollow core door. The door to be replaced is (106) as seen on the first floor plan located in the field notes, Volume 4. The replacement of this door has an estimated cost of $2,132.

7. Several doors located in the rotunda (building 475) need to be replaced. The doors are seen on the building floor plans located in the field notes, Volume 4. The doors are (30A, 30C, 30E, and 30H). The estimated cost to replace these doors is $13,727.

8. Adjacent to window (201) the masonry needs to be repaired in building 475A and the vestibule door (30B) needs to be moved back to ensure a proper flow of people. The locations of the above numbered window and door can be seen in the field notes for this building, Volume 4. The estimated cost for this work is $1,221.

9. Building 475E has several plywood covered accesses that need to be replaced with a standard door. The plywood needs to be removed and a framed door installed. The estimated cost to repair the 15 places is $50,302.

All of the above stated items have included in the estimated cost finishing of any walls, doors and frames with filling and painting to match the existing surrounding walls and doors.

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

A9 **ARCHITECTURAL REPAIRS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 463							
DEMOLITION	1	EA			20.00	20	$20
DRILL 3/4" HOLE	5	HR	5.00	25	20.00	100	$125
CHECK SWING VALVE	1	EA	10.90	11	9.90	10	$21
3/4" COPPER PIPE	18	FT	1.90	34	3.00	54	$88
SEALANT	5	FT	0.60	3	1.40	7	$10
MOBILIZATION	1	EA			15.00	15	$15
SUBTOTAL				$73		$206	$279
CONTINGENCY 10%			10%	$7	10%	$21	$28
SUBTOTAL				$80		$227	$307
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$3	13.0%	$29	$32
DIRECT COST				$83		$256	$339
OVERHEAD AND PROFIT			25%	$21	25%	$64	$85
SUBTOTAL				$104		$320	$424
CONSTRUCTION COST							$424

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CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 2 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECTURAL/ENGINEER CLARK RICHARDSON & BISKUP

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CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

A9 **ARCHITECTURAL REPAIRS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 464							
MOVE LIGHT FIXTURE	1	EA			31.00	31	$31
MOBILIZATION	1	EA			15.00	15	$15
SUBTOTAL						$46	$46
CONTINGENCY 10%			10%		10%	$5	$5
SUBTOTAL						$51	$51
WORK COMP,TAX,SOC.SEC.,INS			3.50%		13.0%	$7	$7
DIRECT COST						$58	$58
OVERHEAD AND PROFIT			25%		25%	$15	$15
SUBTOTAL						$73	$73
CONSTRUCTION COST							$73

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CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 3 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

A9 ARCHITECTURAL REPAIRS	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 465							
MOVE VESTIBULE DOOR AND SIDE LIGHTS BACK							
DEMOLITION	1	EA			150.00	150	$150
INSTALLATION	1	EA			200.00	200	$200
WEATHERSTRIP DOOR	17	FT	1.40	24	2.60	44	$68
INSTALL THRESHOLD	1	EA	40.00	40	10.00	10	$50
MOBILIZATION	1	EA			50.00	50	$50
MOVE VESTIBULE DOOR (07) AND SIDE LIGHTS BACK							
DEMOLITION	1	EA			150.00	150	$150
INSTALLATION	1	EA			200.00	200	$200
WEATHERSTRIP DOOR	17	FT	1.40	24	2.60	44	$68
INSTALL THRESHOLD	1	EA	40.00	40	10.00	10	$50
REVERSE DOOR SWING	1	EA			50.00	50	$50
MOBILIZATION	1	EA			50.00	50	$50
SUBTOTAL				$128		$958	$1,086
CONTINGENCY 10%			10%	$13	10%	$96	$109
SUBTOTAL				$141		$1,054	$1,195
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$5	13.0%	$137	$142
DIRECT COST				$146		$1,191	$1,337
OVERHEAD AND PROFIT			25%	$36	25%	$298	$334
SUBTOTAL				$182		$1,489	$1,671
CONSTRUCTION COST							$1,671

ENG. FORM 150
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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 4 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

A9 **ARCHITECTURAL REPAIRS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 466							
REPAIR DAMAGED METAL CEILING PANELS							
DEMOLITION	75	SQ FT			1.00	75	$75
INSTALL METAL PANELS TAKEN FROM OTHER LOCATIONS	75	SQ FT			2.00	150	$150
PAINT	200	SQ FT	0.10	20	0.40	80	$100
MOBILIZATION	1	EA			50.00	50	$50
SUBTOTAL				$20		$355	$375
CONTINGENCY 10%			10%	$2	10%	$36	$38
SUBTOTAL				$22		$391	$413
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$1	13.0%	$51	$52
DIRECT COST				$23		$442	$465
OVERHEAD AND PROFIT			25%	$6	25%	$111	$117
SUBTOTAL				$29		$553	$582
CONSTRUCTION COST							$582

ENG. FORM 150
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CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 5 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

A9 **ARCHITECTURAL REPAIRS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 472							
INSTALL ACCESS HOLE							
DEMOLITION	1	EA			125.00	125	$125
ACCESS FRAME AND COVER	1	EA	419.00	419	23.00	23	$442
PAINT	1	EA	5.00	5	15.00	15	$20
MOBILIZATION	1	EA			75.00	75	$75
REPAIRS TO DOOR (106)							
REPLACE LOCK	1	EA	102.00	102	20.00	20	$122
ADJUST DOOR	1	EA			20.00	20	$20
MOBILIZATION	1	EA			25.00	25	$25
SUBTOTAL				$526		$303	$829
CONTINGENCY 10%			10%	$53	10%	$30	$83
SUBTOTAL				$579		$333	$912
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$20	13.0%	$43	$63
DIRECT COST				$599		$376	$975
OVERHEAD AND PROFIT			25%	$150	25%	$94	$244
SUBTOTAL				$749		$470	$1,219
CONSTRUCTION COST							$1,219

ENG. FORM 150
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PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	**DATE PREPARED** 4/2/90	**SHEET** 6 **OF** 9

PROJECT
USDB ENERGY STUDY

LOCATION
FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

A9 **ARCHITECTURAL REPAIRS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 473							
INSTALL NEW HALLOW METAL DOOR IN (106)							
REMOVE DOOR/FRAME	1	EA			100.00	100	$100
NEW DOOR/FRAME	1	EA	420.00	420	80.00	80	$500
FINISH HARDWARE	1	EA	510.00	510	90.00	90	$600
PAINT	1	EA	5.00	5	35.00	35	$40
SEALANT/CAULK	36	FT	0.60	22	1.40	50	$72
MOBILIZATION	1	EA			140.00	140	$140
SUBTOTAL				$957		$495	$1,452
CONTINGENCY 10%			10%	$96	10%	$50	$146
SUBTOTAL				$1,053		$545	$1,598
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$37	13.0%	$71	$108
DIRECT COST				$1,090		$616	$1,706
OVERHEAD AND PROFIT			25%	$272	25%	$154	$426
SUBTOTAL				$1,362		$770	$2,132
CONSTRUCTION COST							$2,132

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 7 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

A9 ARCHITECTURAL REPAIRS	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475							
INSTALL NEW HALLOW METAL DOORS IN (30A, 300, 30E, AND 30H)							
REMOVE DOOR/FRAME	4	EA			200.00	800	$800
NEW DOOR/FRAME	4	EA	840.00	3,360	160.00	640	$4,000
FINISH DOOR	4	EA	680.00	2,720	120.00	480	$3,200
PAINT	4	EA	20.00	80	80.00	320	$400
SEALANT/CAULK	160	FT	0.60	96	1.40	224	$320
MOBILIZATION	4	EA			160.00	640	$640
SUBTOTAL				$6,256		$3,104	$9,360
CONTINGENCY 10%			10%	$626	10%	$310	$936
SUBTOTAL				$6,882		$3,414	$10,296
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$241	13.0%	$444	$685
DIRECT COST				$7,123		$3,858	$10,981
OVERHEAD AND PROFIT			25%	$1,781	25%	$965	$2,746
SUBTOTAL				$8,904		$4,823	$13,727
CONSTRUCTION COST							$13,727

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 8 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

A9 **ARCHITECTURAL REPAIRS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475A							
REPAIR MASONRY WALL AT WINDOW (201)							
REMOVE BRICK	20	SQ FT			1.50	30	$30
TOOTH-IN NEW BRICK	30	SQ FT	2.09	63	3.67	110	$173
MOBILIZATION	1	EA			75.00	75	$75
MOVE VESTIBULE DOOR (30B) AND SIDE LIGHTS BACK							
DEMOLITION	1	EA			150.00	150	$150
INSTALLATION	1	EA			200.00	200	$200
WEATHERSTRIP DOOR	17	FT	1.40	24	2.60	44	$68
INSTALL THRESHOLD	1	EA	40.00	40	10.00	10	$50
MOBILIZATION	1	EA			50.00	50	$50
SUBTOTAL				$127		$669	$796
CONTINGENCY 10%			10%	$13	10%	$67	$80
SUBTOTAL				$140		$736	$876
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$5	13.0%	$96	$101
DIRECT COST				$145		$832	$977
OVERHEAD AND PROFIT			25%	$36	25%	$208	$244
SUBTOTAL				$181		$1,040	$1,221
CONSTRUCTION COST							$1,221

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 9 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR DLS

CHECKED BY TOL

A9 ARCHITECTURAL REPAIRS	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475E							
REPLACE PLYWOOD WITH WORKING DOORS							
REMOVE DOOR/FRAME	15	EA			150.00	2,250	$2,250
NEW DOOR/FRAME	15	EA	840.00	12,600	160.00	2,400	$15,000
FINISH HARDWARE	15	EA	680.00	10,200	120.00	1,800	$12,000
PAINT	15	EA	20.00	300	80.00	1,200	$1,500
8" LIGHTWEIGHT C.M.U.	40	SQ FT	1.60	64	2.20	88	$152
SEALANT/CAULK	600	FT	0.60	360	1.40	840	$1,200
MOBILIZATION	15	EA			150.00	2,250	$2,250
SUBTOTAL				$23,524		$10,828	$34,352
CONTINGENCY 10%			10%	$2,352	10%	$1,083	$3,435
SUBTOTAL				$25,876		$11,911	$37,787
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$906	13.0%	$1,548	$2,454
DIRECT COST				$26,782		$13,459	$40,241
OVERHEAD AND PROFIT			25%	$6,696	25%	$3,365	$10,061
SUBTOTAL				$33,478		$16,824	$50,302
CONSTRUCTION COST							$50,302

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-M1

SCHEDULE AIR HANDLING EQUIPMENT

SCHEDULE AIR HANDLING EQUIPMENT

ENERGY CONSERVATION OPPORTUNITY: ECO-M1

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-M1) analyzes the energy savings associated with controlling HVAC systems using Night Setback. Energy saving can be accomplished by turning down AHU's during times when spaces are unoccupied.

SCOPE:

The ECO simulation (ECO-M1) includes expanding the existing EMS system located at the USDB. Three AHU's in building 465 and eleven units located in building 464 can be added to the EMS network. This will allow these AHU's to be set back when they are not needed. Buildings 450, 463, and 473 are already controlled by the EMS system and take advantage of Night Setback. The Chilled Water and Heating Hot Water Pumps that serve buildings 463, 472 and parts of 464 and 473 are not on the EMS system and continue to run at night even though the air handlers are turned off. These pumps will show an energy savings when added to the EMS system. Buildings such as the Castle, 466, and floors 2 and 3 of 465 are domiciles and require space conditioning 24 hours a day. The air handler in the print room in building 472 is used for dehumidification and must run continuously. Therefore buildings 466, 472 and 475 A-H are not included as part of this ECO.

MODELING TECHNIQUES:

The modeling techniques used to calculate the energy saving associated with implementation of this ECO were completed using the Trace Ultra computer simulation models developed as a base load on the facility. The existing HVAC systems were scheduled to run constantly throughout the heating and cooling seasons. Then an alternative run was done scheduling the air handlers to be shut off or turned down at times when heating or cooling were not required. The difference in the energy usage for these two computer runs is the energy saving from ECO-M1. Hand calculation were done to calculate the energy saving obtained when adding the pumps in buildings The cost of implementing this ECO was calculated using an electronic spreadsheet .

ECO IMPLEMENTATION:

The Air Handling Unit in building 464 and 465 have the capability of connecting to the existing EMS system located on the USDB. These unit will require new relays located at the units and control wiring to connect them to the EMS system. The Chilled Water and Heating Hot Water pumps serving buildings 463, 472 and parts of 464 and 473 can be connected to the existing relays which control the air handlers already in these buildings.

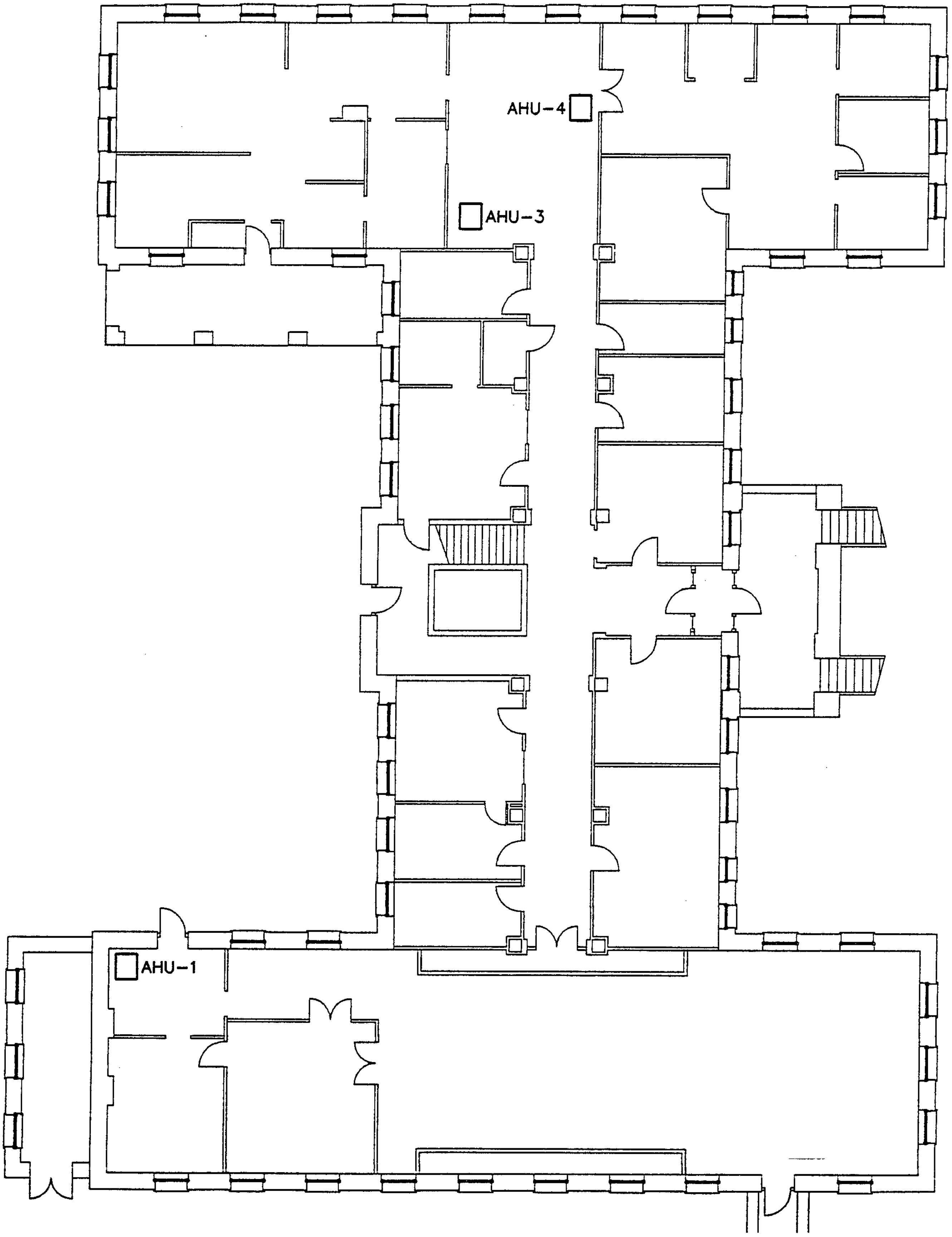
SUMMARY:

The project cost to implement this ECO shown Table M1-1are construction costs +6% SIOH.

The energy savings associated with the implementation of this ECO by building is shown below in Table M1-1. A dollars per year savings as determined using the computer simulation model along with hand calculation for pump energy savings.

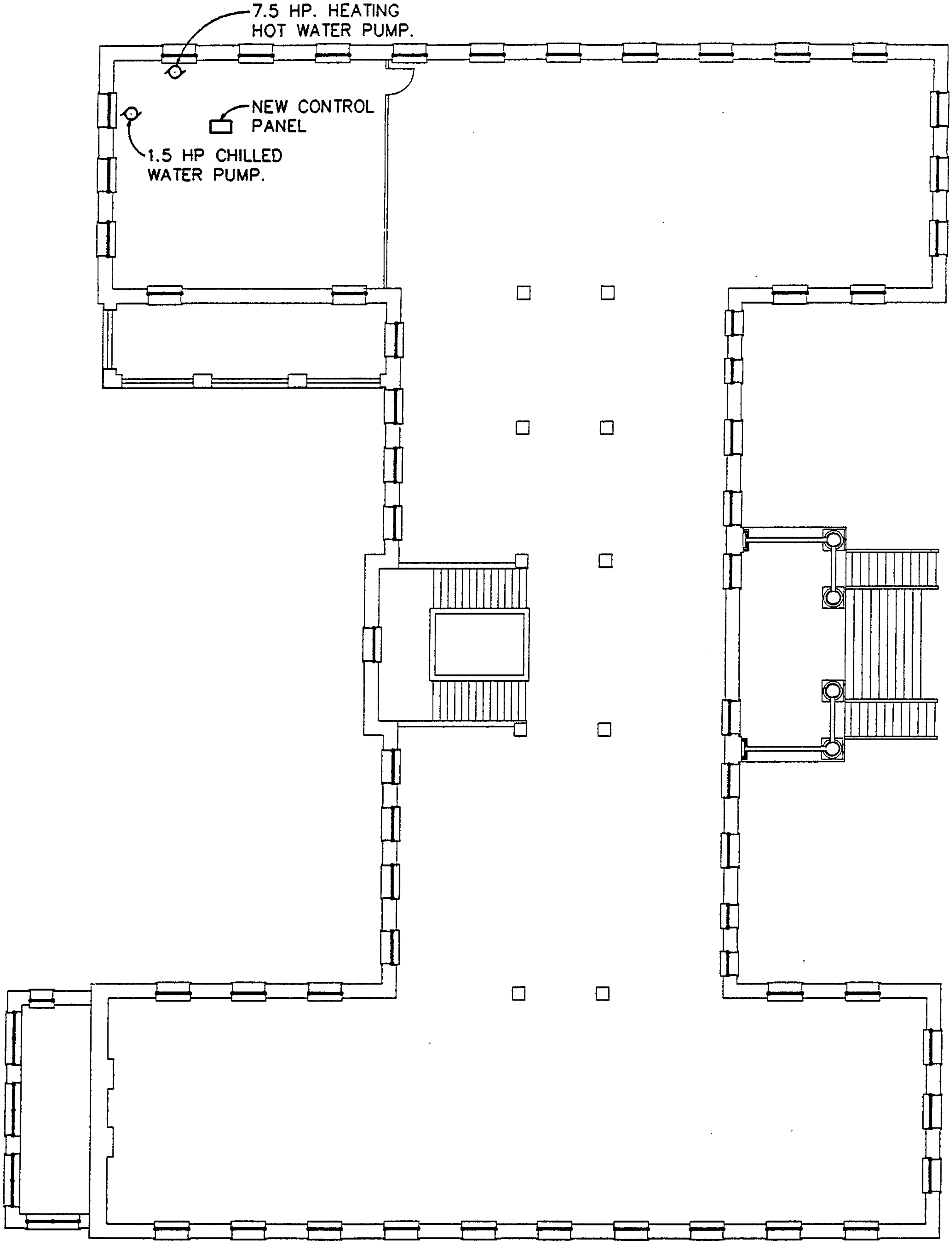
Building Number	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
463	10	$127	$491	3.76 X	2.31
464	45	$396	$9,255	21.85	.42
465	280 X	$891	$9,972	10.57 X	1.03
472	20	$248	$5,932	22.5	.39

Table M1-1



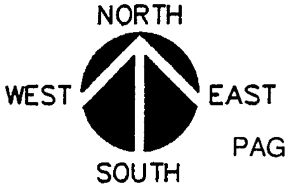
ECO-M1

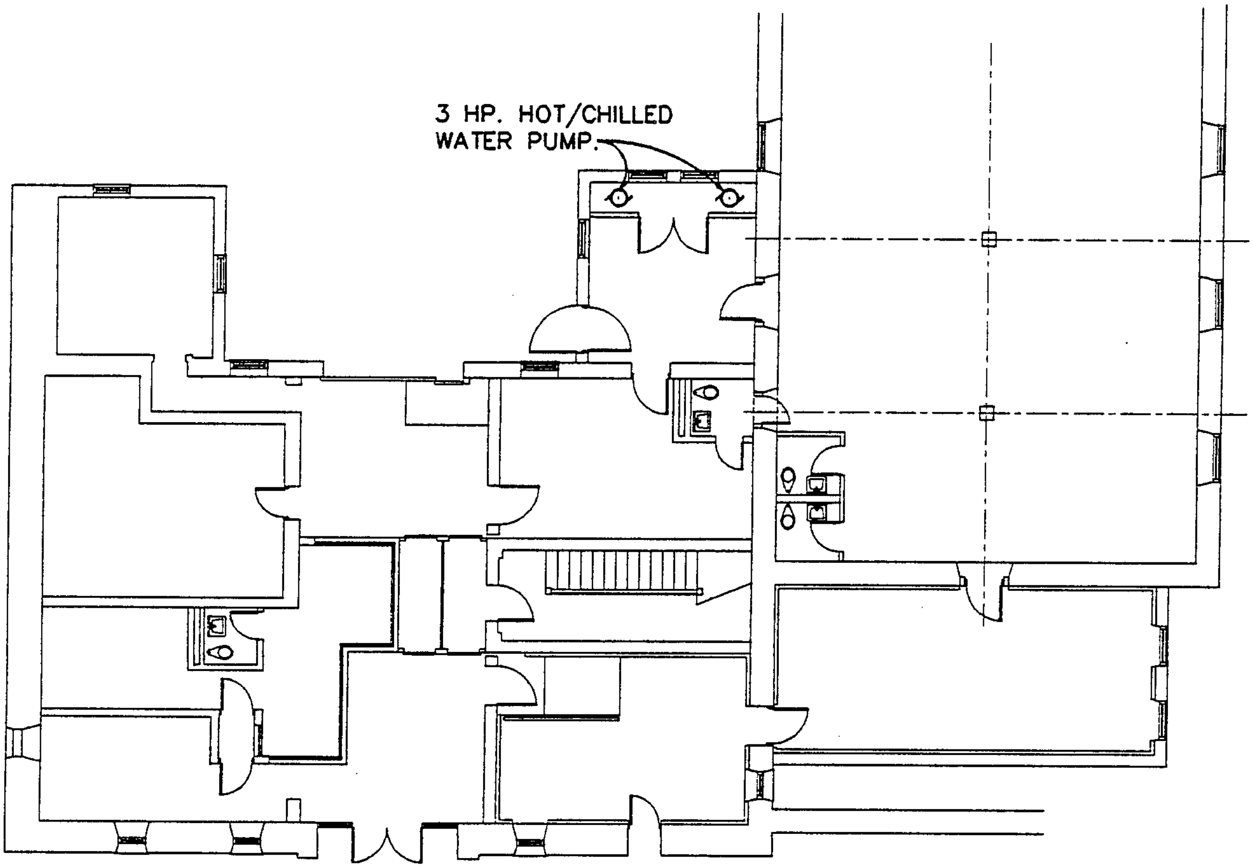
BUILDING 465
GROUND FLOOR



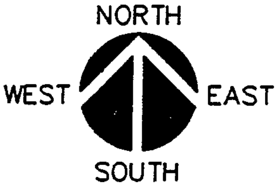
ECO-M1

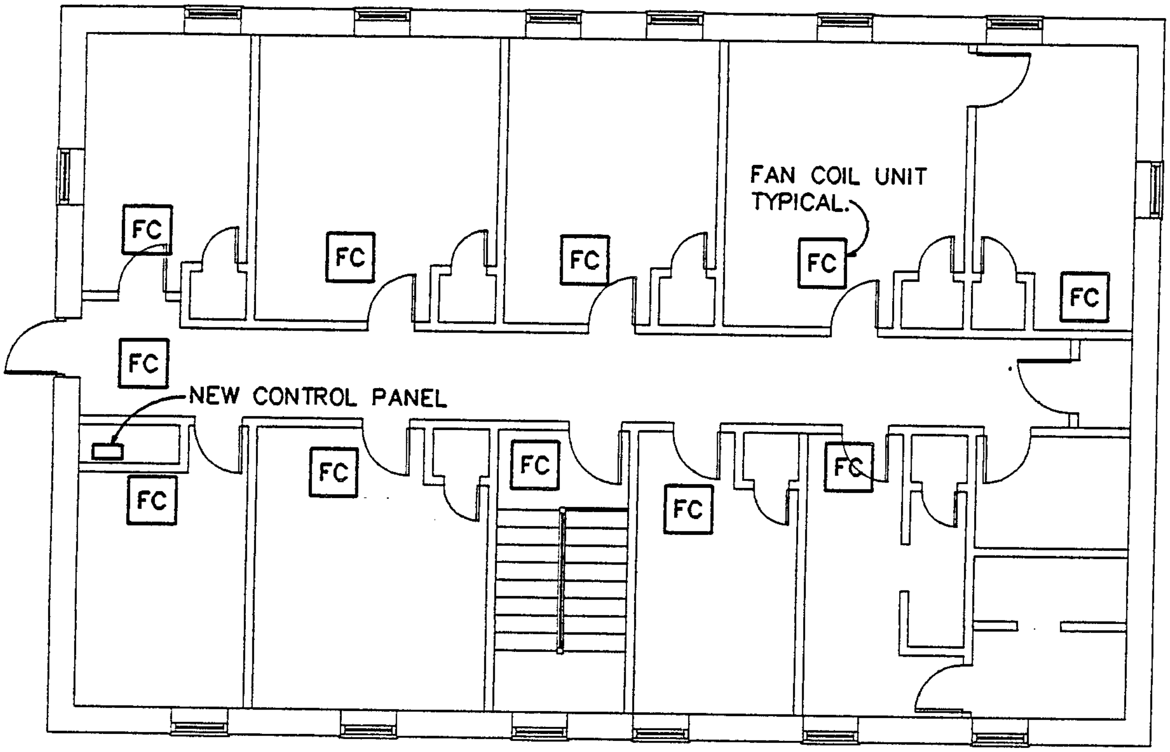
BUILDING 465 BASEMENT



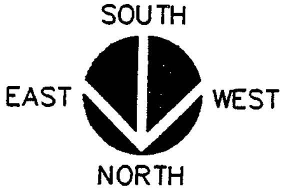


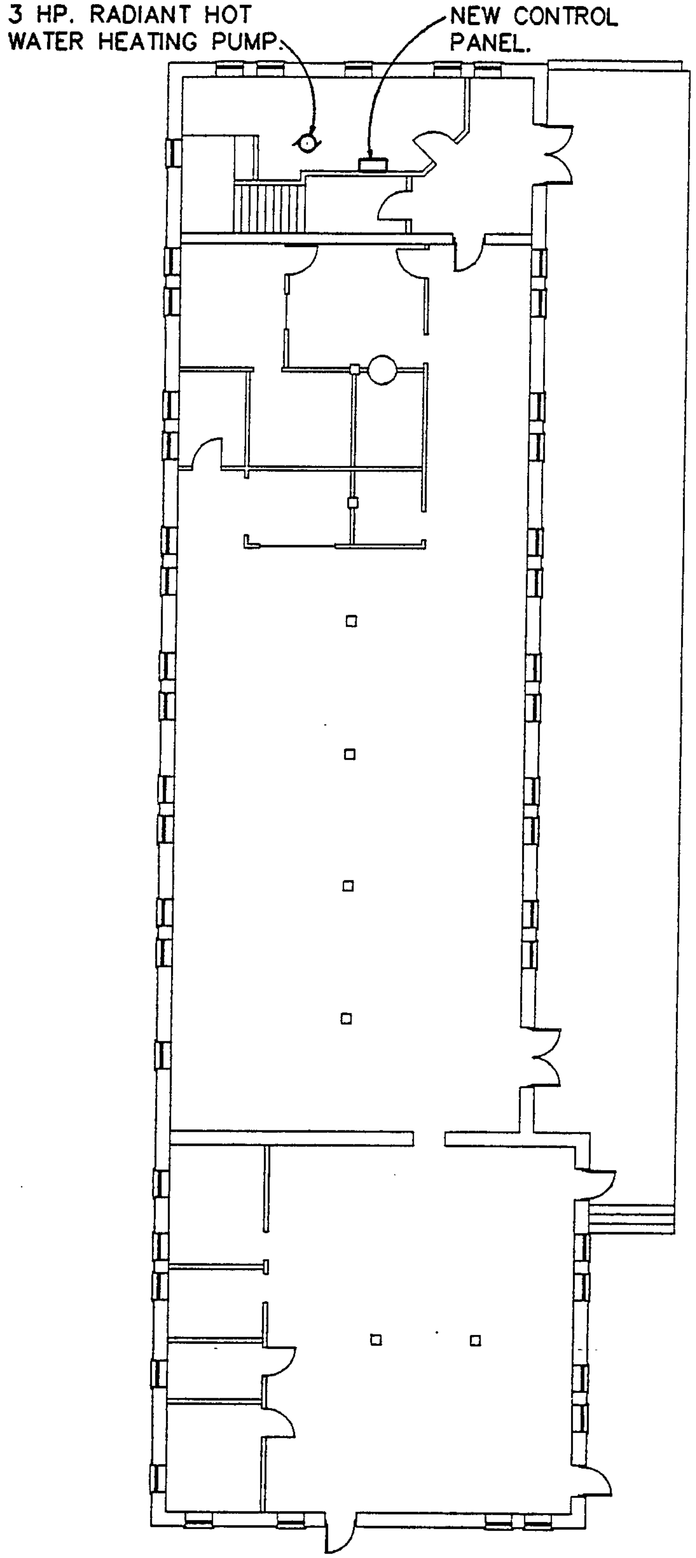
BUILDING 463
FIRST FLOOR



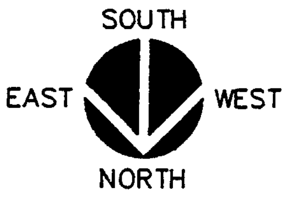


BUILDING 464
THIRD FLOOR





BUILDING 472
FIRST FLOOR



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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM1463
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	464.
B. SIOH	$	28.
C. DESIGN COST	$	26.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	466.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	466.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	10.	$ 124.	8.69	1078.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	0.	$ 0.	11.67	0.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		10.	$ 124.		$ 1078.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 356.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 124.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1078.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 2.31
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 3.76

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM1464
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	8731.
B. SIOH	$	524.
C. DESIGN COST	$	480.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	8762.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	8762.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	26.	$ 323.	8.69	2807.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	19.	$ 78.	11.67	910.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		45.	$ 401.		$ 3717.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1227.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 401.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3717.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.42
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 21.85

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM1465
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	9408.
B. SIOH	$	564.
C. DESIGN COST	$	517.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	9440.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	9440.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	19.	$	236.	8.69		2051.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	161.	$	657.	11.67		7667.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			180.	$	893.		$	9718.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3207.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 893.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 9718.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.03
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 10.57

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM1472
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	5596.
B. SIOH	$	336.
C. DESIGN COST	$	308.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5616.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5616.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	20.	$	249.	8.69		2164.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	0.	$	0.	11.67		0.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			20.	$	249.		$	2164.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	9.11		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 714.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 249.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2164.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.39
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 22.55

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 4

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**

CODE B (PRELIMINARY DESIGN)

CODE C (FINAL DESIGN)

OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M1	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 463 FIRST FLOOR START/STOP THE HOT/CHILLED							
WATER PUMP WIRE FROM EXISTING CONTROL PANEL							
18 GA. TWISTED PAIR WIRE	85	FT	0.10	$9	0.31	$26	$35
1/2" CONDUIT	85	FT	0.77	$65	1.95	$166	$231
EQUIPMENT MOUNTED CONTROL RELAY	1	EA	18.00	$18	22.00	$22	$40
SUBTOTAL				$92		$214	$306
CONTINGENCY 10%			10%	$9	10%	$21	$30
SUBTOTAL				$101		$235	$336
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$4	13.0%	$31	$35
DIRECT COST				$105		$266	$371
OVERHEAD AND PROFIT			25%	$26	25%	$67	$93
SUBTOTAL				$131		$333	$464
CONSTRUCTION COST							$464

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 2 **OF** 4

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
X **CODE A (NO DESIGN COMPLETED)**
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M1	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 464 THIRD FLOOR START/STOP THE FAN COIL UNITS							
EXTEND TRUNK TO NEW CONTROL PANEL							
CONTROL PANEL (JOHNSON FPU)	1	EA	3280.00	$3,280	450.00	$450	$3,730
18 GA. TWISTED PAIR WIRE	570	FT	0.10	$57	0.31	$177	$234
1/2" CONDUIT	570	FT	0.77	$439	1.95	$1,112	$1,550
EQUIPMENT MOUNTED CONTROL RELAY	11	EA	18.00	$198	22.00	$242	$440
SUBTOTAL				$3,974		$1,980	$5,954
CONTINGENCY 10%			10%	$397	10%	$198	$595
SUBTOTAL				$4,371		$2,178	$6,549
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$153	13.0%	$283	$436
DIRECT COST				$4,524		$2,461	$6,985
OVERHEAD AND PROFIT			25%	$1,131	25%	$615	$1,746
SUBTOTAL				$5,655		$3,076	$8,731
CONSTRUCTION COST							$8,731

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	**DATE PREPARED** 4/2/90	**SHEET** 3 **OF** 4
PROJECT USDB ENERGY STUDY	**BASIS FOR ESTIMATE** X **CODE A (NO DESIGN COMPLETED)** CODE B (PRELIMINARY DESIGN) CODE C (FINAL DESIGN) OTHER (SPECIFY)	
LOCATION FORT LEAVENWORTH, KS		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
DRAWING NO. NONE	**ESTIMATOR** MJM	**CHECKED BY** MAW

ECO-M1	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 465 START/STOP THE FAN COIL UNITS							
START/STOP HOT/CHILLED WATER PUMP EXTEND TRUNK TO NEW CONTROL PANEL							
CONTROL PANEL (JOHNSON FPU)	1	EA	2380.00	$2,380	450.00	$450	$2,830
18 GA. TWISTED PAIR WIRE	1070	FT	0.10	$107	0.31	$332	$439
1/2" CONDUIT	1070	FT	0.77	$824	1.95	$2,087	$2,910
EQUIPMENT MOUNTED RELAY	4	EA	18.00	$72	22.00	$88	$160
SUBTOTAL				$3,383		$2,956	$6,339
CONTINGENCY 10%			10%	$338	10%	$296	$634
SUBTOTAL				$3,721		$3,252	$6,973
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$130	13.0%	$423	$553
DIRECT COST				$3,851		$3,675	$7,526
OVERHEAD AND PROFIT			25%	$963	25%	$919	$1,882
SUBTOTAL				$4,814		$4,594	$9,408
CONSTRUCTION COST							$9,408

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	DATE PREPARED 4/2/90	SHEET 4 OF 4

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M1	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 472 BASEMENT START/STOP THE HOT WATER							
RADIANT HEAT PUMP EXTEND TRUNK TO NEW CONTROL PANEL							
CONTROL PANEL (JOHNSON FPU)	1	EA	1930.00	$1,930	450.00	$450	$2,380
18 GA. TWISTED PAIR WIRE	440	FT	0.10	$44	0.31	$136	$180
1/2" CONDUIT	440	FT	0.77	$339	1.95	$858	$1,197
EQUIPMENT MOUNTED CONTROL RELAY	1	EA	18.00	$18	22.00	$22	$40
SUBTOTAL				$2,331		$1,466	$3,797
CONTINGENCY 10%			10%	$233	10%	$147	$380
SUBTOTAL				$2,564		$1,613	$4,177
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$90	13.0%	$210	$300
DIRECT COST				$2,654		$1,823	$4,477
OVERHEAD AND PROFIT			25%	$663	25%	$456	$1,119
SUBTOTAL				$3,317		$2,279	$5,596
CONSTRUCTION COST							$5,596

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-M1

SCHEDULE AIR HANDLING EQUIPMENT

BUILDING 463

ECO-M1 ECONOMIC ANALYSIS

BUILDING NUMBER	STEAM CONSUMPTION			ELECTRIC CONSUMPTION			TOTAL SAVINGS ($)
	BASE ENERGY (THERMS)	ECO-M1 LOAD (THERMS)	ENERGY SAVINGS (MBTU)	BASE LOAD (KW)	ECO-M1 LOAD (KW)	ENERGY SAVINGS (MBTU)	
463	1,577	1,577	0	83,903	82,711	4	$51
464	2,195	2,006	19	91,802	84,278	26	$396
465	35,995	34,388	161	231,123	225,586	19	$891
							$1,338

CALCULATION SHEET	DATE Oct-90	SHEET 1 OF 1
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)	
LOCATION		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
ECO MEASURE ECO-M1	**COMPUTED BY** RGB	**CHECKED BY** MAW

HAND CALCULATION OF ENERGY SAVINGS ASSOCIATED WITH NIGHT SHUT DOWN OF CHILLED WATER PUMPS

BUILDING 463

3 HP. MOTOR
1 HP = 74,600 WATTS PER HOUR
ESTIMATED PUMP SAVINGS % BASED ON COMPUTER SIMULATIONS OF BUILDINGS 465 AND 464

ENERGY = HP X 74,600 WATTS/HR X 12 HR

BUILDING NUMBER	PUMP TYPE	ENERGY KW / YR	SAVINGS %	SAVINGS KW / YR	SAVINGS MBTU / YR	SAVINGS $ / YR
463	CHILLER	3612	0.33	1192	4.07	$51

ECO-M2

DRY-BULB ECONOMIZER CONTROLS

DRY-BULB ECONOMIZER CONTROLS

ENERGY CONSERVATION OPPORTUNITY: ECO-M2

(Hot Humidity) Lower Temp

PURPOSE:

This Energy Conservation Opportunity (ECO-M2) analyzes the energy savings associated with repairing and maintaining existing dry bulb economizer systems. Energy savings can be accomplished by turning off or cycling refrigeration systems and using outside air as a cooling source when outdoor temperatures are at or below 68° F. This outdoor air is then mixed with room air and cooled, if necessary, to obtain the design supply air temperature. These systems monitor and respond to dry bulb temperatures only. The implementation of this project will not include the addition of any new economizer units because all building systems compatible with air side economizers currently have that equipment installed.

SCOPE:

The ECO simulation (ECO-M2) includes the reconnecting of the economizer linkage and the replacement of controls for the existing dry bulb economizers. The application of this project was considered for 6 air handling units: building 463 (second and third floors), building 464 (first and second floors) and building 473 (second and third floors). Building 450 was not considered because it already has an operable dry bulb economizer system. The rest of the buildings have operable windows and their HVAC systems are not compatible with dry bulb economizers.

MODELING TECHNIQUES:

The modeling techniques used to calculate the energy savings associated with implementation of this ECO were completed using the "Trace" computer simulation. The existing HVAC system was set up without a dry bulb economizer. The computer model was then run with the economizer activated at or below 68° F, during the cooling season only, and a new energy usage was found. The difference in energy usage from the two computer runs is the energy savings that can be obtained by implementing ECO-M2.

ECO IMPLEMENTATION:

The Air Handling Units in buildings 463, 464 and 473 have existing dry bulb economizer capabilities. The controls to these systems are inoperable and the linkages have been disconnected. In order to implement this ECO, the old controls must be removed and replaced and linkages must be reconnected. Also, the return and outside air dampers on the air handling unit in building 463, third floor, need to be replaced.

A means of air relief may also need to be provided. Possible choices are partially open windows, exhaust dampers or exhaust fans. For this ECO simulation, it is assumed that the excess air can escape the buildings.

SUMMARY:

The project cost, energy savings, simple payback, and savings to investment ratio (S.I.R.) for implementation of this ECO by building is shown in Table M2-1. This project cost is the construction cost as determined on the Cost Estimate Form plus 6% SIOH.

Building Number	Electric Energy Savings (MBTU/yr.)	Cost Savings	Project Cost	Simple Payback	S.I.R.
463	2.155	$27	$1,547	57.3	✓ 0.15
464	15.46 .14	$193	$1,413	7.3 ✓	1.20 ✓
473	5.609 ✓	$70	$1,413	20.2	0.45

Table M2-1

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM2463
ANALYSIS DATE: 03-31-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	1459.
B. SIOH	$	88.
C. DESIGN COST	$	80.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	1464.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	1464.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	2.155	$ 27.	8.69	235.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	0.	$ 0.	11.67	0.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		2.	$ 27.		$ 235.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	9.11		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 78.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 27.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 235.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.16
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 54.22

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM2464
ANALYSIS DATE: 03-31-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	1333.
B. SIOH	$	80.
C. DESIGN COST	$	73.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	1337.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	1337.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	15.46	$	192.	8.69		1668.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	-1.114	$	-5.	11.67		-58.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			14.	$	187.		$	1610.

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

A. ANNUAL RECURRING (+/-)	$	0.
(1) DISCOUNT FACTOR (TABLE A) 9.11		
(2) DISCOUNTED SAVING/COST (3A X 3A1)	$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)	$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 531.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 187.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1610.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.20
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 7.15

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM2473
ANALYSIS DATE: 03-31-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	1333.
B. SIOH	$	80.
C. DESIGN COST	$	73.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	1337.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	1337.

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

FUEL	UNIT COST $/MBTU(1)		SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)		DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)	
A. ELECT	$	12.44	5.609	$	70.	8.69		608.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	0.	$	0.	11.67		0.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			6.	$	70.		$	608.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 201.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 70.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 608.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.45
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 19.10

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 3

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M2 **DRY-BULB ECONOMIZER CONTROLS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 463 ECONOMIZER CONTROLS FOR AHU LOCATED							
ON SECOND FLOOR NORTHEAST ENTRY							
ELECTRIC CONTROLLER	1	EA	104.00	$104	24.00	$24	$128
MIXED AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
OUTSIDE AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
MIXED AIR ELECTRIC DAMPER MOTOR	1	EA	148.00	$148	25.00	$25	$173
BUILDING 463 ECONOMIZER CONTROLS FOR AHU LOCATED							
ON THIRD FLOOR ABOVE STAIRS							
ELECTRIC CONTROLLER	1	EA	104.00	$104	24.00	$24	$128
MIXED AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
OUTSIDE AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
MIXED AIR ELECTRIC DAMPER MOTOR	1	EA	148.00	$148	25.00	$25	$173
18 X 28 RETURN AIR DAMPER	1	EA	24.00	$24	19.25	$19	$43
18 X 28 OUTSIDE AIR DAMPER	1	EA	24.00	$24	19.25	$19	$43
SUBTOTAL				$792		$214	$1,006
CONTINGENCY 10%			10%	$79	10%	$21	$100
SUBTOTAL				$871		$235	$1,106
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$30	13.0%	$31	$61
DIRECT COST				$901		$266	$1,167
OVERHEAD AND PROFIT			25%	$225	25%	$67	$292
SUBTOTAL				$1,126		$333	$1,459
CONSTRUCTION COST							**$1,459**

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 2 **OF** 3

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

DRAWING NO. NONE

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR MJM

CHECKED BY MAW

ECO-M2 **DRY-BULB ECONOMIZER CONTROLS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 464 ECONOMIZER CONTROLS FOR AHU LOCATED ON FIRST FLOOR IN BARBERSHOP							
ELECTRIC CONTROLLER	1	EA	104.00	$104	24.00	$24	$128
MIXED AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
OUTSIDE AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
MIXED AIR ELECTRIC DAMPER MOTOR	1	EA	148.00	$148	25.00	$25	$173
BUILDING 464 ECONOMIZER CONTROLS FOR AHU LOCATED ON SECOND FLOOR IN BREAKROOM							
ELECTRIC CONTROLLER	1	EA	104.00	$104	24.00	$24	$128
MIXED AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
OUTSIDE AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
MIXED AIR ELECTRIC DAMPER MOTOR	1	EA	148.00	$148	25.00	$25	$173
SUBTOTAL				$744		$176	$920
CONTINGENCY 10%			10%	$74	10%	$18	$92
SUBTOTAL				$818		$194	$1,012
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$29	13.0%	$25	$54
DIRECT COST				$847		$219	$1,066
OVERHEAD AND PROFIT			25%	$212	25%	$55	$267
SUBTOTAL				$1,059		$274	$1,333
CONSTRUCTION COST							**$1,333**

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 3 **OF** 3

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M2 DRY-BULB ECONOMIZER CONTROLS	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 473 ECONOMIZER CONTROLS FOR AHU LOCATED							
ON SECOND FLOOR HALLWAY SOUTH END							
ELECTRIC CONTROLLER	1	EA	104.00	$104	24.00	$24	$128
MIXED AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
OUTSIDE AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
MIXED AIR ELECTRIC DAMPER MOTOR	1	EA	148.00	$148	25.00	$25	$173
BUILDING 473 ECONOMIZER CONTROLS FOR AHU LOCATED							
ON THIRD FLOOR HALLWAY SOUTH END							
ELECTRIC CONTROLLER	1	EA	104.00	$104	24.00	$24	$128
MIXED AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
OUTSIDE AIR TEMPERATURE SENSOR	1	EA	60.00	$60	19.40	$19	$79
MIXED AIR ELECTRIC DAMPER MOTOR	1	EA	148.00	$148	25.00	$25	$173
SUBTOTAL				$744		$176	$920
CONTINGENCY 10%			10%	$74	10%	$18	$92
SUBTOTAL				$818		$194	$1,012
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$29	13.0%	$25	$54
DIRECT COST				$847		$219	$1,066
OVERHEAD AND PROFIT			25%	$212	25%	$55	$267
SUBTOTAL				$1,059		$274	$1,333
CONSTRUCTION COST							**$1,333**

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-M2

DRY-BULB ECONOMIZER CONTROLS

BUILDING 463

ECO-M2 ECONOMIC ANALYSIS

BUILDING NUMBER	STEAM CONSUMPTION			ELECTRIC CONSUMPTION			TOTAL SAVINGS ($)
	BASE ENERGY (THERMS)	ECO-M2 LOAD (THERMS)	ENERGY SAVINGS (MBTU)	BASE LOAD (KW)	ECO-M2 LOAD (KW)	ENERGY SAVINGS (MBTU)	
463	1,577	1,577	0	83,903	83,831	0	$3
464	2,195	2,206	-1	91,802	88,123	13	$152
473	2,407	2,407	0	148,420	148,250	1	$7
							$162

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**                                                                     **
**              T R A C E   U L T R A   A N A L Y S I S                **
**                                                                     **
**                 by  CLARK RICHARDSON BISKUP                         **
**                                                                     **
*************************************************************************
*************************************************************************


       USDB ENERGY STUDY
       LEAVENWORTH, KANSAS
       USDB
       BRIAN SCOTT

      Weather File Code:             FTLVNWTH
      Location:                      LEAVENWORTH, KANSAS (USDB)
      Latitude:                       39.4  (deg)
      Longitude:                      94.9  (deg)
      Time Zone:                         6
      Elevation:                       770  (ft)
      Barometric Pressure:            29.1  (in. Hg)

      Summer Clearness Number:        0.95
      Winter Clearness Number:        0.95
      Summer Design Dry Bulb:           96  (F)
      Summer Design Wet Bulb:           77  (F)
      Winter Design Dry Bulb:            3  (F)
      Summer Ground Relectance:       0.20
      Winter Ground Relectance:       0.20

      Air Density:                  0.0739  (Lbm/cuft)
      Air Specific Heat:            0.2444  (Btu/lbm/F)
      Density-Specific Heat Prod:   1.0837  (Btu-min./hr/cuft/F)
      Latent Heat Factor:          4,770.2  (Btu-min./hr/cuft/lbm)
      Enthalpy Factor:              4.4333  (Btu-min./hr/cuft)

      Design Simulation Period: May      To October
      System Simulation Period: January  To December
      Cooling Load Methodology:     CLTD/CLF (TFM)

      Time/Date Program was Run:    15:11:24    9/19/90
      Dataset Name:                  463-AM .TM
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AIRFLOW - ALTERNATIVE 3
ECO M2: DRY-BULB ECONOMIZER CONTROLS

SYSTEM SUMMARY

(Design Airflow Quantities)

		Main						
System Number	System Type	Outside Airflow (Cfm)	Cooling Airflow (Cfm)	Heating Airflow (Cfm)	Return Airflow (Cfm)	Exhaust Airflow (Cfm)	Auxil. Supply Airflow (Cfm)	Room Exhaust Airflow (Cfm)
1	FC	0	200	200	200	0	0	58
2	FC	0	630	630	630	0	0	45
3	FC	0	1,580	1,580	1,580	0	0	265
4	FC	0	600	600	600	0	0	45
5	FC	0	300	300	300	0	0	99
6	SZ	0	2,280	2,280	2,280	2,280	0	559
7	SZ	0	2,690	2,690	2,690	2,690	0	673
Totals		0	8,280	8,280	8,280	4,970	0	1,743

CAPACITY - ALTERNATIVE 3
ECO M2: DRY-BULB ECONOMIZER CONTROLS

SYSTEM SUMMARY

(Design Capacity Quantities)

		Cooling				Heating						
System Number	System Type	Main Sys. Capacity (Tons)	Aux. Sys. Capacity (Tons)	Opt. Vent Capacity (Tons)	Cooling Totals (Tons)	Main Sys. Capacity (Btuh)	Aux. Sys. Capacity (Btuh)	Preheat Capacity (Btuh)	Reheat Capacity (Btuh)	Humidif. Capacity (Btuh)	Opt. Vent Capacity (Btuh)	Heating Totals (Btuh)
1	FC	0.4	0.0	0.0	0.4	-10,000	0	0	0	0	0	-10,000
2	FC	0.8	0.0	0.0	0.8	0	0	-2,561	0	0	0	-2,561
3	FC	3.7	0.0	0.0	3.7	-66,910	0	0	0	0	0	-66,910
4	FC	1.3	0.0	0.0	1.3	-30,000	0	0	0	0	0	-30,000
5	FC	0.7	0.0	0.0	0.7	-15,000	0	0	0	0	0	-15,000
6	SZ	6.8	0.0	0.0	6.8	-130,000	0	0	0	0	0	-130,000
7	SZ	8.8	0.0	0.0	8.8	-165,000	0	0	0	0	0	-165,000
Totals		22.5	0.0	0.0	22.5	-416,910	0	-2,561	0	0	0	-419,471

ENGINEERING CHECKS - ALTERNATIVE 3
ECO M2: DRY-BULB ECONOMIZER CONTROLS

ENGINEERING CHECKS

				Cooling				Heating		
System Number	Main/ Auxiliary	System Type	Percent Outside Air	Cfm/ Sq Ft	Cfm/ Ton	Sq Ft /Ton	Btuh/ Sq Ft	Cfm/ Sq Ft	Btuh/ Sq Ft	Floor Area Sq Ft
1	Main	FC	0.00	1.02	480.0	470.4	25.51	1.02	-51.02	196
2	Main	FC	0.00	1.76	794.1	450.0	26.67	1.76	-7.17	357
3	Main	FC	0.00	1.76	429.3	244.0	49.18	1.76	-74.51	898
4	Main	FC	0.00	1.13	450.0	396.7	30.25	1.13	-56.71	529
5	Main	FC	0.00	0.90	450.0	502.5	23.88	0.90	-44.78	335
6	Main	SZ	0.00	1.00	336.6	336.7	35.64	1.00	-56.99	2,281
7	Main	SZ	0.00	1.18	305.1	258.7	46.38	1.18	-72.34	2,281

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Trane Air Conditioning Economics                                                                    V 600
 By: CLARK RICHARDSON BISKUP                                                                        PAGE   4

 System      1      Block       FC        - FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>           Mo/Hr:  7/15                                   *      Mo/Hr:  7/15          *            Mo/Hr: 13/ 1
Outside Air ==>          OADB/WB/HR:  96/ 77/112.0                          *       OADB:  96            *             OADB:   3
                                                                            *                            *
                         Space  Ret. Air  Ret. Air        Net   Percnt  *      Space     Percnt  *       Space      Total   Percnt
                    Sens.+Lat.  Sensible    Latent      Total   Of Tot  *   Sensible     Of Tot  *    Sensible   Sensible   Of Tot
Envelope Loads          (Btuh)    (Btuh)    (Btuh)     (Btuh)      (%)  *     (Btuh)        (%)  *      (Btuh)     (Btuh)      (%)
  Skylite Solr               0         0                    0     0.00  *          0       0.00  *           0          0     0.00
  Skylite Cond               0         0                    0     0.00  *          0       0.00  *           0          0     0.00
  Roof Cond                  0         0                    0     0.00  *          0       0.00  *           0          0     0.00
  Glass Solar            1,666         0                1,666    16.27  *      1,666      21.65  *           0          0     0.00
  Glass Cond               444         0                  444     4.34  *        444       5.77  *      -1,943     -1,943    10.80
  Wall Cond              3,265       470                3,736    36.48  *      3,265      42.44  *      -9,032    -10,548    58.67
  Partition                  0                              0     0.00  *          0       0.00  *           0          0     0.00
  Exposed Floor              0                              0     0.00  *          0       0.00  *      -1,404     -1,404     7.81
  Infiltration           3,349                          3,349    32.71  *      1,131      14.70  *      -4,085     -4,085    22.72
  Sub Total==>           8,725       470                9,195    89.79  *      6,507      84.57  *     -16,464    -17,980   100.00
Internal Loads                                                          *                        *
  Lights                   311       208                  519     5.07  *        311       4.05  *           0          0     0.00
  People                   388                            388     3.79  *        198       2.57  *           0          0     0.00
  Misc                       0         0         0          0     0.00  *          0       0.00  *           0          0     0.00
  Sub Total==>             699       208         0        907     8.85  *        509       6.62  *           0          0     0.00
Ceiling Load               678      -678                    0     0.00  *        678       8.81  *      -1,516          0     0.00
Outside Air                  0         0         0          0     0.00  *          0       0.00  *           0          0     0.00
Sup. Fan Heat                                             123     1.20  *                  0.00  *                      0     0.00
Ret. Fan Heat                         16                   16     0.16  *                  0.00  *                      0     0.00
Duct Heat Pkup                         0                    0     0.00  *                  0.00  *                      0     0.00
OV/UNDR Sizing               0                              0     0.00  *          0       0.00  *           0          0     0.00
Exhaust Heat                           0         0          0     0.00  *                  0.00  *                      0     0.00
Terminal Bypass                        0         0          0     0.00  *                  0.00  *                      0     0.00
                                                                        *                        *
Grand Total==>          10,102        16         0     10,240   100.00  *      7,694     100.00  *     -17,980    -17,980   100.00
```

```
 --------------------------------COOLING COIL SELECTION------------------------------------   -------------AREAS-------------
            Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR     Leaving DB/WB/HR     Gross Total    Glass (sf)  (%)
            (Tons)   (Mbh)     (Mbh)       (cfm)    Deg F  Deg F  Grains  Deg F  Deg F  Grains   Floor      196
 Main Clg     0.4     5.0       3.8         200     78.2   61.2    55.9   42.1   41.1    37.7    Part         0
 Aux  Clg     0.0     0.0       0.0           0      0.0    0.0     0.0    0.0    0.0     0.0    ExFlr       27
 Opt Vent     0.0     0.0       0.0           0      0.0    0.0     0.0    0.0    0.0     0.0    Roof         0          0     0
 Totals       0.4     5.0                                                                        Wall       393         48    12
```

```
 -----------HEATING COIL SELECTION-----------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--    --TEMPERATURES (F)--
            Capacity  Coil Airfl   Ent    Lvg     Type      Cooling   Heating   Clg % OA          0.0    Type       Clg    Htg
             (Mbh)      (cfm)    Deg F  Deg F     Vent            0         0   Clg Cfm/Sqft     1.02    SADB      42.5  151.0
 Main Htg    -10.0        200     68.0  151.0     Infil          58        58   Clg Cfm/Ton    480.00    Plenum    88.9   43.6
 Aux  Htg      0.0          0      0.0    0.0     Supply        200       200   Clg Sqft/Ton   470.40    Return    78.0   68.0
 Preheat       0.0        200     68.0   41.9     Mincfm        200       200   Clg Btuh/Sqft   25.51    Ret/OA    78.0   68.0
 Reheat        0.0          0      0.0    0.0     Return        200       200   No. People          1    Runarnd   78.0   68.0
 Humidif       0.0          0      0.0    0.0     Exhaust        58         0   Htg % OA          0.0    Fn MtrTD   0.1    0.0
 Opt Vent      0.0          0      0.0    0.0     Rm Exh         58         0   Htg Cfm/SqFt     1.02    Fn BldTD   0.1    0.0
 Total       -10.0                                Auxil           0         0   Htg Btuh/SqFt  -51.02    Fn Frict   0.4    0.0
```

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Trane Air Conditioning Economics                                                                    V 600
 By: CLARK RICHARDSON BISKUP                                                                         PAGE   5

 System      2     Block      FC      -  FAN COIL

 ************************* COOLING COIL PEAK ********************************* CLG SPACE PEAK ************ HEATING COIL PEAK ********
 Peaked at Time ==>           Mo/Hr:  7/15                              *      Mo/Hr:  7/15        *            Mo/Hr: 13/ 1
 Outside Air ==>          OADB/WB/HR:  96/ 77/112.0                     *       OADB:  96          *             OADB:   3
                                                                        *                          *
                      Space    Ret. Air  Ret. Air      Net   Percnt     *      Space     Percnt    *      Space      Total   Percnt
                  Sens.+Lat.   Sensible   Latent     Total   Of Tot     *   Sensible     Of Tot    *   Sensible   Sensible   Of Tot
 Envelope Loads      (Btuh)     (Btuh)    (Btuh)    (Btuh)      (%)     *     (Btuh)        (%)    *     (Btuh)     (Btuh)      (%)
   Skylite Solr           0          0                   0     0.00     *          0       0.00    *          0          0     0.00
   Skylite Cond           0          0                   0     0.00     *          0       0.00    *          0          0     0.00
   Roof Cond              0          0                   0     0.00     *          0       0.00    *          0          0     0.00
   Glass Solar            0          0                   0     0.00     *          0       0.00    *          0          0     0.00
   Glass Cond             0          0                   0     0.00     *          0       0.00    *          0          0     0.00
   Wall Cond              0          0                   0     0.00     *          0       0.00    *          0          0     0.00
   Partition              0                              0     0.00     *          0       0.00    *          0          0     0.00
   Exposed Floor          0                              0     0.00     *          0       0.00    *          0          0     0.00
   Infiltration       2,786                          2,786    51.33     *      2,054      52.95    *     -7,418     -7,418   132.63
   Sub Total==>       2,786          0               2,786    51.33     *      2,054      52.95    *     -7,418     -7,418   132.63
 Internal Loads                                                         *                          *
   Lights               819        546               1,365    25.15     *        819      21.11    *        819      1,365   -24.41
   People               840                            840    15.48     *        460      11.86    *        460        460    -8.22
   Misc                   0          0         0         0     0.00     *          0       0.00    *          0          0     0.00
   Sub Total==>       1,659        546         0     2,205    40.63     *      1,279      32.97    *      1,279      1,825   -32.63
 Ceiling Load           546       -546                   0     0.00     *        546      14.08    *        546          0     0.00
 Outside Air              0          0         0         0     0.00     *          0       0.00    *          0          0     0.00
 Sup. Fan Heat                                         386     7.12     *                  0.00    *                     0     0.00
 Ret. Fan Heat                      50                  50     0.93     *                  0.00    *                     0     0.00
 Duct Heat Pkup                      0                   0     0.00     *                  0.00    *                     0     0.00
 OV/UNDR Sizing           0                              0     0.00     *          0       0.00    *          0          0     0.00
 Exhaust Heat                        0         0         0     0.00     *                  0.00    *                     0     0.00
 Terminal Bypass                     0         0         0     0.00     *                  0.00    *                     0     0.00
                                                                        *                          *
 Grand Total==>       4,991         50         0     5,428   100.00     *      3,879     100.00    *     -5,593     -5,593   100.00

 ------------------------------------COOLING COIL SELECTION--------------------------------------      ---------------AREAS---------------
             Total Capacity    Sens Cap.  Coil Airfl     Entering DB/WB/HR       Leaving DB/WB/HR      Gross Total       Glass (sf)   (%)
            (Tons)    (Mbh)      (Mbh)       (cfm)    Deg F  Deg F  Grains    Deg F  Deg F  Grains    Floor        357
 Main Clg      0.8      9.5        7.6         630     78.2   70.2   101.8     71.9   66.1    89.8    Part           0
 Aux  Clg      0.0      0.0        0.0           0      0.0    0.0     0.0      0.0    0.0     0.0    ExFlr          0
 Opt Vent      0.0      0.0        0.0           0      0.0    0.0     0.0      0.0    0.0     0.0    Roof           0              0     0
 Totals        0.8      9.5                                                                           Wall           0              0     0

 -------------HEATING COIL SELECTION-------------     --------AIRFLOWS (cfm)--------    --ENGINEERING CHECKS--    --TEMPERATURES (F)--
            Capacity   Coil Airfl    Ent     Lvg      Type       Cooling   Heating    Clg % OA          0.0    Type       Clg    Htg
               (Mbh)        (cfm)  Deg F   Deg F      Vent             0         0    Clg Cfm/Sqft     1.76    SADB      72.3   76.2
 Main Htg        0.0          630   71.8    76.2      Infil          105       105    Clg Cfm/Ton    794.12    Plenum    82.8   72.8
 Aux  Htg        0.0            0    0.0     0.0      Supply         630       630    Clg Sqft/Ton   450.00    Return    78.0   68.0
 Preheat        -2.6          630   68.0    71.8      Mincfm         630       630    Clg Btuh/Sqft   26.67    Ret/OA    78.0   68.0
 Reheat          0.0            0    0.0     0.0      Return         630       630    No. People          2    Runarnd   78.0   68.0
 Humidif         0.0            0    0.0     0.0      Exhaust        105         0    Htg % OA          0.0    Fn MtrTD   0.1    0.0
 Opt Vent        0.0            0    0.0     0.0      Rm Exh          45         0    Htg Cfm/SqFt     1.76    Fn BldTD   0.1    0.0
 Total          -2.6                                  Auxil            0         0    Htg Btuh/SqFt   -7.17    Fn Frict   0.4    0.0
```

```
System      3      Block      FC      -  FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>             Mo/Hr:  7/15                       *     Mo/Hr:  7/15         *          Mo/Hr: 13/ 1
Outside Air ==>          OADB/WB/HR:  96/ 77/112.0                *      OADB:  96           *           OADB:   3
                                                                  *                          *
                    Space    Ret. Air   Ret. Air       Net   Percnt *     Space     Percnt *      Space      Total    Percnt
                 Sens.+Lat.  Sensible    Latent      Total   Of Tot *   Sensible    Of Tot *   Sensible   Sensible   Of Tot
Envelope Loads     (Btuh)     (Btuh)     (Btuh)     (Btuh)     (%)  *    (Btuh)       (%)  *     (Btuh)     (Btuh)      (%)
  Skylite Solr          0          0                     0    0.00  *         0      0.00  *          0          0     0.00
  Skylite Cond          0          0                     0    0.00  *         0      0.00  *          0          0     0.00
  Roof Cond             0          0                     0    0.00  *         0      0.00  *          0          0     0.00
  Glass Solar       5,753          0                 5,753    9.36  *     5,753     14.94  *          0          0     0.00
  Glass Cond        1,451          0                 1,451    2.36  *     1,451      3.77  *     -6,346     -6,346     6.51
  Wall Cond         3,260        412                 3,673    5.98  *     3,260      8.47  *    -13,163    -16,719    17.15
  Partition             0                                0    0.00  *         0      0.00  *          0          0     0.00
  Exposed Floor         0                                0    0.00  *         0      0.00  *     -3,120     -3,120     3.20
  Infiltration     42,738                           42,738   69.54  *    21,457     55.71  *    -77,482    -77,482    79.46
  Sub Total==>     53,203        412                53,616   87.24  *    31,922     82.89  *   -100,111   -103,667   106.31
Internal Loads                                                      *                          *
  Lights            3,276      2,184                 5,461    8.89  *     3,276      8.51  *      3,276      5,461    -5.60
  People            1,288                            1,288    2.10  *       718      1.86  *        690        690    -0.71
  Misc                  0          0          0          0    0.00  *         0      0.00  *          0          0     0.00
  Sub Total==>      4,564      2,184          0      6,748   10.98  *     3,994     10.37  *      3,966      6,151    -6.31
Ceiling Load        2,597     -2,597                     0    0.00  *     2,597      6.74  *     -1,372          0     0.00
Outside Air             0          0          0          0    0.00  *         0      0.00  *          0          0     0.00
Sup. Fan Heat                                          969    1.58  *                0.00  *                     0     0.00
Ret. Fan Heat                    126                   126    0.20  *                0.00  *                     0     0.00
Duct Heat Pkup                     0                     0    0.00  *                0.00  *                     0     0.00
OV/UNDR Sizing          0                                0    0.00  *         0      0.00  *          0          0     0.00
Exhaust Heat                       0          0          0    0.00  *                0.00  *                     0     0.00
Terminal Bypass                    0          0          0    0.00  *                0.00  *                     0     0.00
                                                                    *                          *
Grand Total==>     60,364        126          0     61,459  100.00  *    38,512    100.00  *    -97,517    -97,517   100.00

-----------------------------COOLING COIL SELECTION-----------------------------------   ------------AREAS------------
              Total Capacity   Sens Cap.  Coil Airfl   Entering DB/WB/HR     Leaving DB/WB/HR     Gross Total    Glass (sf)  (%)
              (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains  Deg F  Deg F  Grains  Floor      898
Main Clg        3.7     44.2      28.5      1,580      78.2   66.9    83.6   55.1   54.4    63.7  Part         0
Aux  Clg        0.0      0.0       0.0          0       0.0    0.0     0.0    0.0    0.0     0.0  ExFlr       60
Opt Vent        0.0      0.0       0.0          0       0.0    0.0     0.0    0.0    0.0     0.0  Roof         0          0    0
Totals          3.7     44.2                                                                      Wall       885        156   18

----------HEATING COIL SELECTION----------     --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--      --TEMPERATURES (F)--
             Capacity  Coil Airfl   Ent    Lvg     Type       Cooling   Heating   Clg % OA           0.0   Type       Clg    Htg
              (Mbh)      (cfm)    Deg F  Deg F     Vent             0         0   Clg Cfm/Sqft      1.76   SADB      55.5  125.0
Main Htg      -66.9      1,580     68.0  125.0     Infil        1,100     1,100   Clg Cfm/Ton     429.35   Plenum    87.1   63.2
Aux  Htg        0.0          0      0.0    0.0     Supply       1,580     1,580   Clg Sqft/Ton    244.02   Return    78.0   68.0
Preheat         0.0      1,580     68.0   54.9     Mincfm       1,580     1,580   Clg Btuh/Sqft    49.18   Ret/OA    78.0   68.0
Reheat          0.0          0      0.0    0.0     Return       1,580     1,580   No. People           3   Runarnd   78.0   68.0
Humidif         0.0          0      0.0    0.0     Exhaust      1,100         0   Htg % OA           0.0   Fn MtrTD   0.1    0.0
Opt Vent        0.0          0      0.0    0.0     Rm Exh         265         0   Htg Cfm/SqFt      1.76   Fn BldTD   0.1    0.0
Total         -66.9                                Auxil            0         0   Htg Btuh/SqFt   -74.51   Fn Frict   0.4    0.0
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Trane Air Conditioning Economics                                                                              V 600
 By: CLARK RICHARDSON BISKUP                                                                                  PAGE   7

 System      4      Block      FC       -  FAN COIL

 ************************ COOLING COIL PEAK ******************************* CLG SPACE PEAK ************ HEATING COIL PEAK ********
 Peaked at Time ==>           Mo/Hr:  7/16                         *      Mo/Hr:  7/16       *           Mo/Hr: 13/ 1
 Outside Air ==>           OADB/WB/HR:  96/ 75/105.0               *       OADB:  96         *            OADB:   3
                                                                   *                         *
                     Space   Ret. Air  Ret. Air       Net  Percnt  *      Space     Percnt  *      Space      Total   Percnt
                 Sens.+Lat.  Sensible   Latent      Total  Of Tot  *   Sensible     Of Tot  *   Sensible   Sensible   Of Tot
 Envelope Loads     (Btuh)    (Btuh)    (Btuh)     (Btuh)    (%)   *     (Btuh)      (%)    *     (Btuh)     (Btuh)     (%)
   Skylite Solr          0         0                   0    0.00   *          0      0.00   *          0          0     0.00
   Skylite Cond          0         0                   0    0.00   *          0      0.00   *          0          0     0.00
   Roof Cond             0         0                   0    0.00   *          0      0.00   *          0          0     0.00
   Glass Solar       5,933         0               5,933   25.14   *      5,933     32.71   *          0          0     0.00
   Glass Cond        1,058         0               1,058    4.48   *      1,058      5.83   *     -4,656     -4,656    15.08
   Wall Cond         3,010       532               3,542   15.01   *      3,010     16.60   *    -10,752    -13,300    43.06
   Partition             0                             0    0.00   *          0      0.00   *          0          0     0.00
   Exposed Floor         0                             0    0.00   *          0      0.00   *     -1,872     -1,872     6.06
   Infiltration      7,647                         7,647   32.40   *      2,977     16.41   *    -11,059    -11,059    35.80
   Sub Total==>     17,649       532              18,180   77.02   *     12,979     71.55   *    -28,339    -30,887   100.00
 Internal Loads                                                    *                         *
   Lights            1,167       778               1,945    8.24   *      1,167      6.44   *          0          0     0.00
   People              785                           785    3.32   *        405      2.23   *          0          0     0.00
   Misc              2,278         0         0     2,278    9.65   *      2,278     12.56   *          0          0     0.00
   Sub Total==>      4,230       778         0     5,008   21.22   *      3,850     21.23   *          0          0     0.00
 Ceiling Load        1,310    -1,310                   0    0.00   *      1,310      7.22   *     -2,548          0     0.00
 Outside Air             0         0         0         0    0.00   *          0      0.00   *          0          0     0.00
 Sup. Fan Heat                                       368    1.56   *                 0.00   *                     0     0.00
 Ret. Fan Heat                    48                  48    0.20   *                 0.00   *                     0     0.00
 Duct Heat Pkup                    0                   0    0.00   *                 0.00   *                     0     0.00
 OV/UNDR Sizing          0                             0    0.00   *          0      0.00   *          0          0     0.00
 Exhaust Heat                      0         0         0    0.00   *                 0.00   *                     0     0.00
 Terminal Bypass                   0         0         0    0.00   *                 0.00   *                     0     0.00
                                                                   *                         *
 Grand Total==>     23,189        48         0    23,604  100.00   *     18,139    100.00   *    -30,887    -30,887   100.00

 -----------------------------------COOLING COIL SELECTION-------------------------------------------    ------------AREAS-------------
            Total Capacity   Sens Cap.   Coil Airfl    Entering DB/WB/HR       Leaving DB/WB/HR         Gross Total    Glass (sf)  (%)
            (Tons)   (Mbh)     (Mbh)       (cfm)     Deg F  Deg F  Grains    Deg F  Deg F  Grains       Floor      529
 Main Clg     1.3     16.0      12.6         600      78.2   62.4   61.4      49.7   48.6   50.7        Part         0
 Aux  Clg     0.0      0.0       0.0           0       0.0    0.0    0.0       0.0    0.0    0.0        ExFlr       36
 Opt Vent     0.0      0.0       0.0           0       0.0    0.0    0.0       0.0    0.0    0.0        Roof         0          0    0
 Totals       1.3     16.0                                                                              Wall       538        114   21

 ------------HEATING COIL SELECTION------------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--    --TEMPERATURES (F)--
            Capacity  Coil Airfl   Ent    Lvg      Type     Cooling   Heating     Clg % OA          0.0     Type      Clg     Htg
              (Mbh)     (cfm)     Deg F  Deg F     Vent           0         0     Clg Cfm/Sqft     1.13     SADB     50.1   115.5
 Main Htg     -30.0        600    68.0   115.5     Infil        157       157     Clg Cfm/Ton    450.00     Plenum   85.8    52.8
 Aux  Htg       0.0          0     0.0     0.0     Supply       600       600     Clg Sqft/Ton   396.75     Return   78.0    68.0
 Preheat        0.0        600    68.0    49.5     Mincfm       600       600     Clg Btuh/Sqft   30.25     Ret/OA   78.0    68.0
 Reheat         0.0          0     0.0     0.0     Return       600       600     No. People          2     Runarnd  78.0    68.0
 Humidif        0.0          0     0.0     0.0     Exhaust      157         0     Htg % OA          0.0     Fn MtrTD  0.1     0.0
 Opt Vent       0.0          0     0.0     0.0     Rm Exh        45         0     Htg Cfm/SqFt     1.13     Fn BldTD  0.1     0.0
 Total        -30.0                                Auxil          0         0     Htg Btuh/SqFt  -56.71     Fn Frict  0.4     0.0
```

```
System     5     Block     FC     - FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>            Mo/Hr:  7/14                          *       Mo/Hr:  7/14       *            Mo/Hr: 13/ 1
Outside Air ==>           OADB/WB/HR:  96/ 77/112.0                 *        OADB:  96         *             OADB:   3
                                                                    *                          *
                     Space   Ret. Air  Ret. Air      Net   Percnt   *     Space     Percnt    *     Space     Total    Percnt
                  Sens.+Lat. Sensible   Latent      Total   Of Tot  *   Sensible    Of Tot    *   Sensible  Sensible   Of Tot
Envelope Loads       (Btuh)    (Btuh)    (Btuh)     (Btuh)    (%)   *    (Btuh)      (%)      *    (Btuh)    (Btuh)      (%)
  Skylite Solr            0         0                  0     0.00   *        0       0.00     *         0         0     0.00
  Skylite Cond            0         0                  0     0.00   *        0       0.00     *         0         0     0.00
  Roof Cond               0         0                  0     0.00   *        0       0.00     *         0         0     0.00
  Glass Solar         1,699         0              1,699    16.21   *    1,699      23.06     *         0         0     0.00
  Glass Cond            315         0                315     3.01   *      315       4.28     *    -1,445    -1,445    10.61
  Wall Cond             915       123              1,038     9.91   *      915      12.42     *    -3,362    -4,162    30.56
  Partition               0                            0     0.00   *        0       0.00     *         0         0     0.00
  Exposed Floor           0                            0     0.00   *        0       0.00     *    -1,040    -1,040     7.64
  Infiltration        4,402                        4,402    42.00   *    1,877      25.48     *    -6,973    -6,973    51.20
  Sub Total==>        7,332       123              7,455    71.12   *    4,807      65.24     *   -12,820   -13,620   100.00
Internal Loads                                                      *                          *
  Lights              1,229       819              2,048    19.54   *    1,229      16.67     *         0         0     0.00
  People                771                          771     7.36   *      391       5.31     *         0         0     0.00
  Misc                    0         0         0        0     0.00   *        0       0.00     *         0         0     0.00
  Sub Total==>        2,000       819         0    2,819    26.89   *    1,620      21.98     *         0         0     0.00
Ceiling Load            942      -942                  0     0.00   *      942      12.78     *      -800         0     0.00
Outside Air               0         0         0        0     0.00   *        0       0.00     *         0         0     0.00
Sup. Fan Heat                                        184     1.75   *                0.00     *                   0     0.00
Ret. Fan Heat                      24                 24     0.23   *                0.00     *                   0     0.00
Duct Heat Pkup                      0                  0     0.00   *                0.00     *                   0     0.00
OV/UNDR Sizing            0                            0     0.00   *        0       0.00     *         0         0     0.00
Exhaust Heat                        0         0        0     0.00   *                0.00     *                   0     0.00
Terminal Bypass                     0         0        0     0.00   *                0.00     *                   0     0.00
                                                                    *                          *
Grand Total==>       10,273        24         0   10,481   100.00   *    7,369     100.00     *   -13,620   -13,620   100.00

---------------------------------COOLING COIL SELECTION---------------------------------------    -------------AREAS-------------
            Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR      Leaving DB/WB/HR      Gross Total    Glass (sf)  (%)
            (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains    Floor     335
Main Clg      0.7     8.0       5.8         300      78.2   65.1    74.6    55.0   54.2    63.3    Part        0
Aux  Clg      0.0     0.0       0.0           0       0.0    0.0     0.0     0.0    0.0     0.0    ExFlr      20
Opt Vent      0.0     0.0       0.0           0       0.0    0.0     0.0     0.0    0.0     0.0    Roof        0            0    0
Totals        0.7     8.0                                                                          Wall      290           35   12

------------HEATING COIL SELECTION-------------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--      --TEMPERATURES (F)--
            Capacity   Coil Airfl   Ent    Lvg     Type       Cooling   Heating   Clg % OA           0.0   Type       Clg    Htg
             (Mbh)       (cfm)     Deg F  Deg F    Vent             0         0   Clg Cfm/Sqft      0.90   SADB      55.3  109.9
Main Htg     -15.0         300     68.0   109.9    Infil           99        99   Clg Cfm/Ton     450.00   Plenum    86.9   60.5
Aux  Htg       0.0           0      0.0     0.0    Supply         300       300   Clg Sqft/Ton    502.50   Return    78.0   68.0
Preheat        0.0         300     68.0    54.8    Mincfm         300       300   Clg Btuh/Sqft    23.88   Ret/OA    78.0   68.0
Reheat         0.0           0      0.0     0.0    Return         300       300   No. People           2   Runarnd   78.0   68.0
Humidif        0.0           0      0.0     0.0    Exhaust         99         0   Htg % OA           0.0   Fn MtrTD   0.1    0.0
Opt Vent       0.0           0      0.0     0.0    Rm Exh          99         0   Htg Cfm/SqFt      0.90   Fn BldTD   0.1    0.0
Total        -15.0                                 Auxil            0         0   Htg Btuh/SqFt   -44.78   Fn Frict   0.4    0.0
```

```
System      6      Peak       SZ       -  SINGLE ZONE

************************ COOLING COIL PEAK ****************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>            Mo/Hr:  7/15                            *        Mo/Hr:  7/15       *            Mo/Hr: 13/ 1
Outside Air ==>         OADB/WB/HR:  96/ 77/112.0                     *         OADB:  96         *             OADB:   3
                                                                      *                           *
                      Space    Ret. Air  Ret. Air      Net   Percnt   *      Space    Percnt      *      Space      Total   Percnt
                  Sens.+Lat.   Sensible   Latent     Total   Of Tot   *   Sensible    Of Tot      *   Sensible   Sensible   Of Tot
Envelope Loads       (Btuh)     (Btuh)    (Btuh)    (Btuh)      (%)   *     (Btuh)       (%)      *     (Btuh)     (Btuh)      (%)
  Skylite Solr            0          0                   0     0.00   *          0      0.00      *          0          0     0.00
  Skylite Cond            0          0                   0     0.00   *          0      0.00      *          0          0     0.00
  Roof Cond               0          0                   0     0.00   *          0      0.00      *          0          0     0.00
  Glass Solar        18,068          0              18,068    27.77   *     18,068     39.69      *          0          0     0.00
  Glass Cond          4,015          0               4,015     6.17   *      4,015      8.82      *    -17,556    -17,556    24.26
  Wall Cond           2,711        975               3,687     5.67   *      2,711      5.96      *     -9,374    -15,511    21.43
  Partition               0                              0     0.00   *          0      0.00      *          0          0     0.00
  Exposed Floor           0                              0     0.00   *          0      0.00      *          0          0     0.00
  Infiltration       25,366                         25,366    38.99   *     10,884     23.91      *    -39,305    -39,305    54.31
  Sub Total==>       50,160        975              51,136    78.59   *     35,679     78.37      *    -66,234    -72,372   100.00
Internal Loads                                                        *                           *
  Lights              9,182      6,122              15,304    23.52   *      9,182     20.17      *          0          0     0.00
  People              3,878                          3,878     5.96   *      1,978      4.34      *          0          0     0.00
  Misc                7,818          0         0     7,818    12.02   *      7,818     17.17      *          0          0     0.00
  Sub Total==>       20,878      6,122         0    27,000    41.50   *     18,978     41.69      *          0          0     0.00
Ceiling Load          7,097     -7,097                   0     0.00   *      7,097     15.59      *     -6,137          0     0:00
Outside Air               0          0         0         0     0.00   *          0      0.00      *          0          0     0.00
Sup. Fan Heat                                        2,795     4.30   *                 0.00      *                     0     0.00
Ret. Fan Heat                      363                 363     0.56   *                 0.00      *                     0     0.00
Duct Heat Pkup                       0                   0     0.00   *                 0.00      *                     0     0.00
OV/UNDR Sizing      -16,230                        -16,230   -24.95   *    -16,230    -35.65      *          0          0     0.00
Exhaust Heat                         0         0         0     0.00   *                 0.00      *                     0     0.00
Terminal Bypass                      0         0         0     0.00   *                 0.00      *                     0     0.00
                                                                      *                           *
Grand Total==>       61,905        363         0    65,064   100.00   *     45,524    100.00      *    -72,372    -72,372   100.00

-------------------------------COOLING COIL SELECTION------------------------------------     ----------------AREAS--------------
           Total Capacity    Sens Cap.  Coil Airfl    Entering DB/WB/HR      Leaving DB/WB/HR        Gross Total   Glass (sf)  (%)
           (Tons)    (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains   Floor     2,281
Main Clg     6.8      81.3      64.9      2,280     78.0   64.9    73.9    58.4   53.0    52.9    Part          0
Aux  Clg     0.0       0.0       0.0          0      0.0    0.0     0.0     0.0    0.0     0.0    ExFlr         0
Opt Vent     0.0       0.0       0.0          0      0.0    0.0     0.0     0.0    0.0     0.0    Roof          0           0    0
Totals       6.8      81.3                                                                        Wall      1,752         430   25

-----------HEATING COIL SELECTION------------    ---------AIRFLOWS (cfm)--------    --ENGINEERING CHECKS--    --TEMPERATURES (F)--
          Capacity   Coil Airfl   Ent     Lvg     Type      Cooling     Heating    Clg % OA          0.0    Type      Clg    Htg
            (Mbh)      (cfm)    Deg F   Deg F     Vent            0           0    Clg Cfm/Sqft     1.00    SADB     59.6   97.3
Main Htg   -130.0      2,280     68.0    97.3     Infil         558         558    Clg Cfm/Ton    336.55    Plenum   87.8   59.5
Aux  Htg      0.0          0      0.0     0.0     Supply      2,280       2,280    Clg Sqft/Ton   336.70    Return   78.0   68.0
Preheat       0.0      2,280     68.0    58.4     Mincfm      2,280       2,280    Clg Btuh/Sqft   35.64    Ret/OA   78.0   68.0
Reheat        0.0          0      0.0     0.0     Return      2,279       2,280    No. People         10    Runarnd  78.0   68.0
Humidif       0.0          0      0.0     0.0     Exhaust     2,280           0    Htg % OA          0.0    Fn MtrTD  0.1    0.0
Opt Vent      0.0          0      0.0     0.0     Rm Exh        559           0    Htg Cfm/SqFt     1.00    Fn BldTD  0.2    0.0
Total      -130.0                                 Auxil           0           0    Htg Btuh/SqFt  -56.99    Fn Frict  0.7    0.0
```

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System      7      Peak       SZ        -  SINGLE ZONE

************************* COOLING COIL PEAK ********************************* CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>           Mo/Hr:  7/15                        *     Mo/Hr:  7/15          *            Mo/Hr: 13/ 1
Outside Air ==>          OADB/WB/HR:  96/ 77/112.0               *      OADB:  96            *             OADB:   3
                                                                 *                           *
                     Space    Ret. Air  Ret. Air      Net  Percnt  *      Space   Percnt *      Space      Total   Percnt
                  Sens.+Lat.  Sensible   Latent     Total  Of Tot  *   Sensible   Of Tot *   Sensible   Sensible   Of Tot
Envelope Loads      (Btuh)     (Btuh)    (Btuh)    (Btuh)    (%)   *     (Btuh)     (%)  *     (Btuh)     (Btuh)     (%)
  Skylite Solr           0          0                   0    0.00  *          0     0.00 *          0          0     0.00
  Skylite Cond           0          0                   0    0.00  *          0     0.00 *          0          0     0.00
  Roof Cond         20,531          0              20,531   24.54  *     20,531    37.88 *    -20,375    -20,375     0.00
  Glass Solar        9,108          0               9,108   10.89  *      9,108    16.81 *          0          0     0.00
  Glass Cond         2,361          0               2,361    2.82  *      2,361     4.36 *    -10,325    -10,325     9.88
  Wall Cond          7,560          0               7,560    9.04  *      7,560    13.95 *    -26,278    -26,278    25.14
  Partition              0                              0    0.00  *          0     0.00 *          0          0     0.00
  Exposed Floor          0                              0    0.00  *          0     0.00 *          0          0     0.00
  Infiltration      30,684                         30,684   36.68  *     13,167    24.30 *    -47,546    -47,546    45.49
  Sub Total==>      70,245          0              70,245   83.98  *     52,727    97.29 *   -104,523   -104,523   100.00
Internal Loads                                                     *                         *
  Lights            12,451      4,980              17,431   20.84  *     12,451    22.97 *          0          0     0.00
  People             6,593                          6,593    7.88  *      3,363     6.20 *          0          0     0.00
  Misc               7,800          0         0     7,800    9.32  *      7,800    14.39 *          0          0     0.00
  Sub Total==>      26,843      4,980         0    31,823   38.04  *     23,613    43.57 *          0          0     0.00
Ceiling Load             0          0                   0    0.00  *          0     0.00 *          0          0     0.00
Outside Air              0          0         0         0    0.00  *          0     0.00 *          0          0     0.00
Sup. Fan Heat                                       3,298    3.94  *                0.00 *                     0     0.00
Ret. Fan Heat                     429                 429    0.51  *                0.00 *                     0     0.00
Duct Heat Pkup                      0                   0    0.00  *                0.00 *                     0     0.00
OV/UNDR Sizing     -22,146                        -22,146  -26.48  *    -22,146   -40.87 *          0          0     0.00
Exhaust Heat                        0         0         0    0.00  *                0.00 *                     0     0.00
Terminal Bypass                     0         0         0    0.00  *                0.00 *                     0     0.00
                                                                   *                         *
Grand Total==>      74,942      5,409         0    83,649  100.00  *     54,194   100.00 *   -104,523   -104,523   100.00

----------------------------------COOLING COIL SELECTION-------------------------------------       ---------------AREAS--------------
           Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR       Leaving DB/WB/HR        Gross Total    Glass (sf)   (%)
           (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains     Floor     2,281
Main Clg     8.8    105.8      85.0      2,690      78.0   64.9    73.9    58.3   51.6    47.9     Part          0
Aux  Clg     0.0      0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0     ExFlr         0
Opt Vent     0.0      0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0     Roof      3,014            0      0
Totals       8.8    105.8                                                                          Wall      2,112          253     12

------------HEATING COIL SELECTION-------------    --------AIRFLOWS (cfm)--------    --ENGINEERING CHECKS--     --TEMPERATURES (F)---
          Capacity   Coil Airfl   Ent    Lvg        Type      Cooling    Heating    Clg % OA          0.0     Type      Clg     Htg
           (Mbh)       (cfm)     Deg F  Deg F       Vent            0          0    Clg Cfm/Sqft     1.18     SADB     59.4   103.9
Main Htg   -165.0      2,690     68.0   103.9       Infil         675        675    Clg Cfm/Ton    305.12     Plenum   78.0    68.0
Aux  Htg      0.0          0      0.0     0.0       Supply      2,690      2,690    Clg Sqft/Ton   258.73     Return   78.0    68.0
Preheat       0.0      2,690     68.0    58.3       Mincfm      2,690      2,690    Clg Btuh/Sqft   46.38     Ret/OA   78.0    68.0
Reheat        0.0          0      0.0     0.0       Return      2,690      2,690    No. People         17     Runarnd  78.0    68.0
Humidif       0.0          0      0.0     0.0       Exhaust     2,690          0    Htg % OA          0.0     Fn MtrTD  0.1     0.0
Opt Vent      0.0          0      0.0     0.0       Rm Exh        673          0    Htg Cfm/SqFt     1.18     Fn BldTD  0.2     0.0
Total      -165.0                                   Auxil           0          0    Htg Btuh/SqFt  -72.34     Fn Frict  0.7     0.0
```

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

MONTHLY ENERGY CONSUMPTION

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	STEAM (Therm)
Jan	6,235	26	374
Feb	5,554	26	334
March	6,324	26	261
April	5,332	26	9
May	5,819	25	0
June	9,000	44	0
July	11,452	49	0
Aug	10,183	45	0
Sept	6,813	41	0
Oct	5,604	25	0
Nov	5,598	26	96
Dec	5,918	26	503
Total	83,831	49	1,577

Building Energy Consumption = 64,532 (Btu/Sq Ft/Year)
Source Energy Consumption = 155,397 (Btu/Sq Ft/Year)
Floor Area = 6,877 (Sq Ft)

EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

EQUIPMENT ENERGY CONSUMPTION

Ref Num	Equip Code	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
		Monthly Consumption												
0	LIGHTS													
	ELEC	3689	3286	3819	3512	3819	3641	3560	3948	3382	3689	3512	3430	43,287
	PK	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5
1	MISC LD													
	ELEC	1030	909	1090	969	1090	1046	984	1169	923	1030	969	909	12,118
	PK	5.8	5.8	5.8	5.8	5.8	5.9	5.9	5.9	5.9	5.8	5.8	5.8	5.9
2	MISC LD													
	GAS	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	MISC LD													
	OIL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	MISC LD													
	P STEAM	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	MISC LD													
	P HOTH2O	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	MISC LD													
	P CHILL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	EQ1121S		AC RECIP CHILLER 20-60 T											
	ELEC	0	0	0	0	0	2088	3731	2568	917	0	0	0	9,303
	PK	0.0	0.0	0.0	0.0	0.0	12.7	16.1	13.4	10.8	0.0	0.0	0.0	16.1
1	EQ5200		CONDENSER FANS											
	ELEC	0	0	0	0	0	254	491	317	107	0	0	0	1,168
	PK	0.0	0.0	0.0	0.0	0.0	1.6	2.4	1.7	1.5	0.0	0.0	0.0	2.4
1	EQ5001		CHILLED WATER PUMP C.V.											
	ELEC	0	0	0	0	0	168	180	176	94	0	0	0	619
	PK	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.5
1	EQ5313		CONTROLS											
	ELEC	0	0	0	0	0	95	102	100	53	0	0	0	351
	PK	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.3
2	EQ1170S		AC COND COMP <20 TONS											
	ELEC	0	0	0	0	0	547	878	594	382	0	0	0	2,400
	PK	0.0	0.0	0.0	0.0	0.0	3.5	3.7	3.5	3.1	0.0	0.0	0.0	3.7
2	EQ5200		CONDENSER FANS											

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EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

     ELEC          0     0     0     0     0    61   116    69    36     0     0     0        283
     PK          0.0   0.0   0.0   0.0   0.0   0.4   0.4   0.4   0.3   0.0   0.0   0.0        0.4

   2 EQ5313            CONTROLS
     ELEC          0     0     0     0     0    97   102   101    88     0     0     0        388
     PK          0.0   0.0   0.0   0.0   0.0   0.3   0.3   0.3   0.3   0.0   0.0   0.0        0.3

   1 EQ4371            FAN COIL SUPPLY FAN
     ELEC         18    16    17    10    10    13    18    16     8    13    14    18        170
     PK          0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1        0.1

   2 EQ4371            FAN COIL SUPPLY FAN
     ELEC         56    50    56    54    56    54    56    56    54    56    54    56        658
     PK          0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2        0.2

   2 EQ4381            PROPELLER FAN
     ELEC          0     0     0     0     0     0     0     0     0     0     0     0          0
     PK          0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0        0.0

   3 EQ4371            FAN COIL SUPPLY FAN
     ELEC        140   127   140   136   140   136   140   140   136   140   136   140      1,650
     PK          0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4        0.4

   4 EQ4371            FAN COIL SUPPLY FAN
     ELEC         45    41    43    28    29    32    48    36    25    38    37    48        451
     PK          0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2        0.2

   4 EQ4381            PROPELLER FAN
     ELEC          0     0     0     0     0     0     0     0     0     0     0     0          0
     PK          0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0        0.0

   5 EQ4371            FAN COIL SUPPLY FAN
     ELEC         19    18    19    13    15    15    24    19    14    14    13    20        203
     PK          0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1        0.1

   6 EQ4003            FC CENTRIF. FAN C.V.
     ELEC        409   365   377   269   303   341   443   399   278   286   272   444      4,185
     PK          1.7   1.7   1.7   1.7   1.7   1.7   1.7   1.7   1.7   1.7   1.7   1.7        1.7

   7 EQ4003            FC CENTRIF. FAN C.V.
     ELEC        538   481   509   322   357   412   579   476   314   337   391   564      5,281
     PK          2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0        2.0

   1 CONVERTR          STEAM TO HOT WATER CONVERTER
     P STEAM     341   304   237     9     0     0     0     0     0     0    96   456      1,443
     PK          2.5   2.5   2.5   1.2   0.0   0.0   0.0   0.0   0.0   0.0   2.1   2.6        2.6

   1 EQ5020            HEAT WATER CIRC. PUMP C.V.
     ELEC        138   125   121     9     0     0     0     0     0     0    96   138        628
     PK          0.4   0.4   0.4   0.4   0.0   0.0   0.0   0.0   0.0   0.0   0.4   0.4        0.4

   1 EQ5060            CONDENSATE RETURN PUMP
     ELEC        150   136   132    10     0     0     0     0     0     0   104   150        683
     PK          0.4   0.4   0.4   0.4   0.0   0.0   0.0   0.0   0.0   0.0   0.4   0.4        0.4

   2 EQ2101            PURCHASED DISTRICT STEAM
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EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

     P STEAM      33     30     24      0      0      0      0      0      0      0      0     47            134
     PK          0.4    0.4    0.3    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.5            0.5

   2 EQ5020                 HEAT WATER CIRC. PUMP C.V.
     ELEC          0      0      0      0      0      0      0      0      0      0      0      1              2
     PK          0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0            0.0

   2 EQ5061                 CONDENSATE RETURN PUMP
     ELEC          1      1      1      0      0      0      0      0      0      0      0      1              3
     PK          0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0            0.0
```

UTILITY PEAK CHECKSUMS - ALTERNATIVE 3
BASE LOAD

UTILITY PEAK CHECKSUMS

Utility ELECTRIC DEMAND

Peak Value 48.7 (kW)
Yearly Time of Peak 15 (hr) 7 (mo)

Hour 15 Month 7

Eqp. Ref. Num.	Equipment Code Name	Equipment Description	Utility Demand (kW)	Percnt Of Tot (%)
Cooling Equipment				
1	EQ1121S	AC RECIP CHILLER 20-60 T	19.3	39.56
2	EQ1170S	AC COND COMP <20 TONS	4.5	9.22
Sub Total			23.8	48.78
Sub Total			0.0	******
Air Moving Equipment				
1		SUMMATION OF FAN ELECTRICAL DEMAND	0.1	0.11
2		SUMMATION OF FAN ELECTRICAL DEMAND	0.2	0.35
3		SUMMATION OF FAN ELECTRICAL DEMAND	0.4	0.88
4		SUMMATION OF FAN ELECTRICAL DEMAND	0.2	0.34
5		SUMMATION OF FAN ELECTRICAL DEMAND	0.1	0.17
6		SUMMATION OF FAN ELECTRICAL DEMAND	1.7	3.45
7		SUMMATION OF FAN ELECTRICAL DEMAND	2.0	4.07
Sub Total			4.6	.9.38
Sub Total			0.0	0.00
Miscellaneous				
Lights			14.5	29.66
Base Utilities			0.0	0.00
Misc Equipment			5.9	12.19
Sub Total			20.4	41.84
Grand Total			48.7	100.00

CALIFORNIA TITLE 24 COMPLIANCE - ALTERNATIVE 3
BASE LOAD

CALIFORNIA TITLE 24 COMPLIANCE REPORT

Weather Name .... FTLVNWTH
Gross Conditioned Floor Area (sqft)...... 6,877
ACM Multiplier 1.008

ENERGY USE SUMMARY

	ELEC (kWh/yr)	DISTRICT STEAM (kBtu/yr)	PERCENT OF TOTAL ENERGY (%)	TOTAL SOURCE ENERGY (kBtu/yr)	ADJUSTED UNIT SOURCE ENERGY (kBtu/yr-sf)
Primary Heating	686.1	157,672.9	36.1	217,256.3	31.8
Primary Cooling					
Compressor	11,703.4	0.0	9.0	119,843.2	17.6
Tower/Cond Fans	1,451.1	0.0	1.1	14,859.2	2.2
Condenser Pump	0.0	0.0	0.0	0.0	0.0
Other Accessories	739.2	0.0	0.6	7,569.4	1.1
Auxiliary					
Supply Fans	12,598.3	0.0	9.7	129,007.3	18.9
Circulation Pumps	1,248.4	0.0	1.0	12,783.8	1.9
Base Utilities	0.0	0.0	0.0	0.0	0.0
Subtotal	13,846.7	0.0	10.6	141,791.0	20.8
Lighting	43,286.5	0.0	33.3	443,255.1	65.0
Receptacle	12,118.2	0.0	9.3	124,091.0	18.2
Domestic Hot Water	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0
Totals	83,331.3	157,672.9	100.0	1,068,665.3	156.6

ECO-M2

DRY-BULB ECONOMIZER CONTROLS

BUILDING 464

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**                                                                        **
**              T R A C E    U L T R A    A N A L Y S I S                 **
**                                                                        **
**                 by  CLARK RICHARDSON BISKUP                            **
**                                                                        **
****************************************************************************
****************************************************************************


       USDB ENERGY STUDY
       LEAVENWORTH, KANSAS
       USDB
       BRIAN SCOTT


      Weather File Code:              FILVNWTH
      Location:                       LEAVENWORTH, KANSAS (USDB)
      Latitude:                        39.4  (deg)
      Longitude:                       94.9  (deg)
      Time Zone:                          6
      Elevation:                        770  (ft)
      Barometric Pressure:             29.1  (in. Hg)

      Summer Clearness Number:         0.95
      Winter Clearness Number:         0.95
      Summer Design Dry Bulb:            96  (F)
      Summer Design Wet Bulb:            77  (F)
      Winter Design Dry Bulb:             3  (F)
      Summer Ground Relectance:        0.20
      Winter Ground Relectance:        0.20

      Air Density:                   0.0739  (Lbm/cuft)
      Air Specific Heat:             0.2444  (Btu/lbm/F)
      Density-Specific Heat Prod:    1.0837  (Btu-min./hr/cuft/F)
      Latent Heat Factor:           4,770.2  (Btu-min./hr/cuft/lbm)
      Enthalpy Factor:               4.4333  (Btu-min./hr/cuft)

      Design Simulation Period: May        To October
      System Simulation Period: January    To December
      Cooling Load Methodology:      CLTD/CLF (TFM)

      Time/Date Program was Run:      17:11:25    9/24/90
      Dataset Name:                     464-M .TM
```

AIRFLOW - ALTERNATIVE 3
ECO M2: DRY-BULB ECONOMIZER CONTROLS

SYSTEM SUMMARY
(Design Airflow Quantities)

		Main						
System Number	System Type	Outside Airflow (Cfm)	Cooling Airflow (Cfm)	Heating Airflow (Cfm)	Return Airflow (Cfm)	Exhaust Airflow (Cfm)	Auxil. Supply Airflow (Cfm)	Room Exhaust Airflow (Cfm)
1	SZ	0	2,027	1,110	2,027	2,027	0	495
2	SZ	0	300	232	300	0	0	124
3	FC	0	4,373	1,620	4,373	4,373	0	100
4	FC	0	300	301	300	0	0	50
5	FC	0	300	155	300	0	0	37
6	FC	0	300	200	299	0	0	48
7	FC	0	300	157	300	0	0	37
8	FC	0	893	299	893	0	0	78
9	FC	0	656	216	655	0	0	35
10	FC	0	300	230	300	0	0	55
11	FC	0	646	207	646	0	0	49
12	FC	0	300	204	299	0	0	49
13	FC	0	581	226	581	0	0	37
Totals		0	11,275	5,158	11,273	6,400	0	1,191

CAPACITY - ALTERNATIVE 3
ECO M2: DRY-BULB ECONOMIZER CONTROLS

SYSTEM SUMMARY
(Design Capacity Quantities)

		Cooling				Heating						
System Number	System Type	Main Sys. Capacity (Tons)	Aux. Sys. Capacity (Tons)	Opt. Vent Capacity (Tons)	Cooling Totals (Tons)	Main Sys. Capacity (Btuh)	Aux. Sys. Capacity (Btuh)	Preheat Capacity (Btuh)	Reheat Capacity (Btuh)	Humidif. Capacity (Btuh)	Opt. Vent Capacity (Btuh)	Heating Totals (Btuh)
1	SZ	5.2	0.0	0.0	5.2	-68,559	0	0	0	0	0	-68,559
2	SZ	1.6	0.0	0.0	1.6	-14,302	0	0	0	0	0	-14,302
3	FC	8.1	0.0	0.0	8.1	-100,085	0	0	0	0	0	-100,085
4	FC	1.5	0.0	0.0	1.5	-18,589	0	0	0	0	0	-18,589
5	FC	0.9	0.0	0.0	0.9	-9,595	0	0	0	0	0	-9,595
6	FC	0.9	0.0	0.0	0.9	-12,373	0	0	0	0	0	-12,373
7	FC	0.7	0.0	0.0	0.7	-9,674	0	0	0	0	0	-9,674
8	FC	1.5	0.0	0.0	1.5	-18,449	0	0	0	0	0	-18,449
9	FC	1.0	0.0	0.0	1.0	-13,357	0	0	0	0	0	-13,357
10	FC	1.4	0.0	0.0	1.4	-14,226	0	0	0	0	0	-14,226
11	FC	1.0	0.0	0.0	1.0	-12,772	0	0	0	0	0	-12,772
12	FC	1.0	0.0	0.0	1.0	-12,618	0	0	0	0	0	-12,618
13	FC	0.9	0.0	0.0	0.9	-13,987	0	0	0	0	0	-13,987
Totals		25.8	0.0	0.0	25.8	-318,586	0	0	0	0	0	-318,586

ENGINEERING CHECKS - ALTERNATIVE 3
ECO M2: DRY-BULB ECONOMIZER CONTROLS

ENGINEERING CHECKS

System Number	Main/ Auxiliary	System Type	Percent Outside Air	Cooling Cfm/ Sq Ft	Cfm/ Ton	Sq Ft /Ton	Btuh/ Sq Ft	Heating Cfm/ Sq Ft	Btuh/ Sq Ft	Floor Area Sq Ft
1	Main	SZ	0.00	1.03	390.0	377.2	31.82	0.57	-34.98	1,960
2	Main	SZ	0.00	0.61	184.7	301.6	39.78	0.47	-29.19	490
3	Main	FC	0.00	2.03	538.8	264.9	45.30	0.75	-46.55	2,150
4	Main	FC	0.00	0.98	196.7	200.0	59.99	0.99	-60.95	305
5	Main	FC	0.00	1.88	348.1	185.7	64.63	0.97	-59.97	160
6	Main	FC	0.00	1.45	334.4	230.7	52.01	0.97	-59.78	207
7	Main	FC	0.00	1.88	409.2	218.2	54.99	0.98	-60.46	160
8	Main	FC	0.00	2.64	576.8	218.4	54.96	0.88	-54.58	338
9	Main	FC	0.00	4.37	688.1	157.5	76.21	1.44	-89.05	150
10	Main	FC	0.00	1.26	208.3	165.2	72.63	0.97	-59.77	238
11	Main	FC	0.00	3.06	643.3	210.1	57.12	0.98	-60.53	211
12	Main	FC	0.00	1.42	288.5	202.9	59.13	0.97	-59.80	211
13	Main	FC	0.00	3.63	668.2	184.1	65.17	1.42	-87.42	160

```
 System     1      Peak      SZ      - SINGLE ZONE

************************ COOLING COIL PEAK ******************************* CLG SPACE PEAK ************ HEATING COIL PEAK ********
 Peaked at Time ==>           Mo/Hr:  7/15                  *      Mo/Hr:  7/15      *              Mo/Hr: 13/ 1
 Outside Air ==>         OADB/WB/HR:  96/ 77/112.0          *       OADB:  96        *               OADB:   3
                                                            *                        *
                      Space   Ret. Air  Ret. Air       Net   Percnt  *     Space    Percnt *     Space     Total    Percnt
                  Sens.+Lat.  Sensible   Latent      Total   Of Tot  *  Sensible    Of Tot *  Sensible  Sensible   Of Tot
 Envelope Loads      (Btuh)    (Btuh)    (Btuh)     (Btuh)      (%)  *    (Btuh)       (%) *    (Btuh)    (Btuh)      (%)
   Skylite Solr           0         0                    0     0.00  *         0      0.00 *         0         0     0.00
   Skylite Cond           0         0                    0     0.00  *         0      0.00 *         0         0     0.00
   Roof Cond              0         0                    0     0.00  *         0      0.00 *         0         0     0.00
   Glass Solar        5,746         0                5,746     9.21  *     5,746     12.59 *         0         0     0.00
   Glass Cond         1,449         0                1,449     2.32  *     1,449      3.18 *    -6,338    -6,338     9.24
   Wall Cond          4,788       341                5,129     8.22  *     4,788     10.49 *   -18,094   -20,383    29.73
   Partition              0                              0     0.00  *         0      0.00 *         0         0     0.00
   Exposed Floor          0                              0     0.00  *         0      0.00 *    -6,760    -6,760     9.86
   Infiltration      22,638                         22,638    36.30  *     9,714     21.28 *   -35,078   -35,078    51.16
   Sub Total==>      34,622       341               34,963    56.06  *    21,697     47.54 *   -66,270   -68,559   100.00
 Internal Loads                                                      *                       *
   Lights             7,003     4,669               11,672    18.72  *     7,003     15.35 *         0         0     0.00
   People             7,756                          7,756    12.44  *     3,956      8.67 *         0         0     0.00
   Misc               7,971         0         0      7,971    12.78  *     7,971     17.47 *         0         0     0.00
   Sub Total==>      22,731     4,669         0     27,400    43.94  *    18,931     41.48 *         0         0     0.00
 Ceiling Load         5,010    -5,010                    0     0.00  *     5,010     10.98 *    -2,290         0     0.00
 Outside Air              0         0         0          0     0.00  *         0      0.00 *         0         0     0.00
 Sup. Fan Heat                                           0     0.00  *                0.00 *                   0     0.00
 Ret. Fan Heat                      0                    0     0.00  *                0.00 *                   0     0.00
 Duct Heat Pkup                     0                    0     0.00  *                0.00 *                   0     0.00
 OV/UNDR Sizing           0                              0     0.00  *         0      0.00 *         0         0     0.00
 Exhaust Heat                       0         0          0     0.00  *                0.00 *                   0     0.00
 Terminal Bypass                    0         0          0     0.00  *                0.00 *                   0     0.00
                                                                     *                       *
 Grand Total==>      62,362         0         0     62,362   100.00  *    45,638    100.00 *   -68,559   -68,559   100.00

---------------------------------COOLING COIL SELECTION-------------------------------------    -------------AREAS-------------
         Total Capacity   Sens Cap.  Coil Airfl   Entering DB/WB/HR      Leaving DB/WB/HR        Gross Total    Glass (sf)  (%)
         (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains  Deg F  Deg F  Grains    Floor    1,960
Main Clg    5.2    62.4      45.6      2,027      78.0   64.9    73.9   56.1   54.7    63.7    Part         0
Aux  Clg    0.0     0.0       0.0          0       0.0    0.0     0.0    0.0    0.0     0.0    ExFlr      130
Opt Vent    0.0     0.0       0.0          0       0.0    0.0     0.0    0.0    0.0     0.0    Roof         0            0    0
Totals      5.2    62.4                                                                        Wall     1,519          155   10

------------HEATING COIL SELECTION------------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--   --TEMPERATURES (F)--
          Capacity  Coil Airfl    Ent    Lvg       Type     Cooling   Heating   Clg % OA          0.0   Type       Clg    Htg
           (Mbh)      (cfm)     Deg F  Deg F      Vent            0         0   Clg Cfm/Sqft     1.03   SADB      57.2  125.0
Main Htg   -68.6      1,110      68.0  125.0      Infil         498       498   Clg Cfm/Ton    389.99   Plenum    86.1   64.3
Aux  Htg     0.0          0       0.0    0.0      Supply      2,027     1,110   Clg Sqft/Ton   377.15   Return    78.0   68.0
Preheat      0.0      2,027      68.0   56.1      Mincfm          0         0   Clg Btuh/Sqft   31.82   Ret/OA    78.0   68.0
Reheat       0.0          0       0.0    0.0      Return      2,027     1,110   No. People         20   Runarnd   78.0   68.0
Humidif      0.0          0       0.0    0.0      Exhaust     2,027         0   Htg % OA          0.0   Fn MtrTD   0.1    0.0
Opt Vent     0.0          0       0.0    0.0      Rm Exh        495         0   Htg Cfm/SqFt     0.57   Fn BldTD   0.2    0.0
Total      -68.6                                  Auxil           0         0   Htg Btuh/SqFt  -34.98   Fn Frict   0.7    0.0
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System      2      Peak       SZ         -  SINGLE ZONE

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>             Mo/Hr:  7/15                          *    Mo/Hr:  7/15         *             Mo/Hr: 13/ 1
Outside Air ==>            OADB/WB/HR:  96/ 77/112.0                  *     OADB:  96           *              OADB:   3
                                                                      *                         *
                      Space   Ret. Air  Ret. Air      Net   Percnt  *     Space    Percnt *     Space      Total   Percnt
                 Sens.+Lat.   Sensible    Latent    Total   Of Tot  *  Sensible    Of Tot *  Sensible   Sensible   Of Tot
Envelope Loads       (Btuh)     (Btuh)    (Btuh)   (Btuh)      (%)  *    (Btuh)       (%) *    (Btuh)     (Btuh)      (%)
  Skylite Solr            0          0                  0     0.00  *         0      0.00 *         0          0     0.00
  Skylite Cond            0          0                  0     0.00  *         0      0.00 *         0          0     0.00
  Roof Cond               0      2,601              2,601    28.45  *         0      0.00 *         0     -2,966     0.00
  Glass Solar         6,867          0              6,867    75.11  *     6,867    120.68 *         0          0     0.00
  Glass Cond          1,364          0              1,364    14.92  *     1,364     23.96 *    -5,962     -5,962    41.69
  Wall Cond           1,015        -34                981    10.73  *     1,015     17.84 *    -3,665     -4,125    28.85
  Partition               0                             0     0.00  *         0      0.00 *         0          0     0.00
  Exposed Floor           0                             0     0.00  *         0      0.00 *    -1,248     -1,248     8.73
  Infiltration        5,682                         5,682    62.16  *     2,438     42.85 *         0          0     0.00
  Sub Total==>       14,928      2,567             17,495   191.37  *    11,683    205.33 *   -10,875    -14,302   100.00
Internal Loads                                                      *                         *
  Lights              1,075        717              1,792    19.60  *     1,075     18.89 *         0          0     0.00
  People                  0                             0     0.00  *         0      0.00 *         0          0     0.00
  Misc                    0          0         0        0     0.00  *         0      0.00 *         0          0     0.00
  Sub Total==>        1,075        717         0    1,792    19.60  *     1,075     18.89 *         0          0     0.00
Ceiling Load          3,284     -3,284                  0     0.00  *     3,284     57.71 *    -3,426          0     0.00
Outside Air               0          0         0        0     0.00  *         0      0.00 *         0          0     0.00
Sup. Fan Heat                                         184     2.01  *                0.00 *                    0     0.00
Ret. Fan Heat                       24                 24     0.26  *                0.00 *                    0     0.00
Duct Heat Pkup                       0                  0     0.00  *                0.00 *                    0     0.00
OV/UNDR Sizing      -10,352                       -10,352   ******  *   -10,352    ****** *         0          0     0.00
Exhaust Heat                         0         0        0     0.00  *                0.00 *                    0     0.00
Terminal Bypass                      0         0        0     0.00  *                0.00 *                    0     0.00
                                                                    *                         *
Grand Total==>        8,934         24         0    9,142   100.00  *     5,690    100.00 *   -14,302    -14,302   100.00

--------------------------------COOLING COIL SELECTION----------------------------------------   ------------AREAS------------
            Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR      Leaving DB/WB/HR     Gross Total   Glass (sf)  (%)
            (Tons)   (Mbh)     (Mbh)      (cfm)      Deg F  Deg F Grains   Deg F  Deg F Grains    Floor     490
Main Clg      1.6     19.5      16.3        300      78.0   64.9   73.9    59.9   41.3   10.0     Part        0
Aux  Clg      0.0      0.0       0.0          0       0.0    0.0    0.0     0.0    0.0    0.0     ExFlr      24
Opt Vent      0.0      0.0       0.0          0       0.0    0.0    0.0     0.0    0.0    0.0     Roof      202           0    0
Totals        1.6     19.5                                                                        Wall      436         146   34

----------HEATING COIL SELECTION------------   -------AIRFLOWS (cfm)-------   --ENGINEERING CHECKS--   --TEMPERATURES (F)--
           Capacity  Coil Airfl   Ent    Lvg      Type     Cooling  Heating   Clg % OA          0.0   Type       Clg    Htg
            (Mbh)      (cfm)    Deg F  Deg F     Vent           0        0   Clg Cfm/Sqft      0.61   SADB      60.5  125.0
Main Htg    -14.3       232     68.0  125.0      Infil        125        0   Clg Cfm/Ton     184.67   Plenum    99.2   45.9
Aux  Htg      0.0         0      0.0    0.0      Supply       300      232   Clg Sqft/Ton    301.63   Return    78.0   68.0
Preheat       0.0       300     68.0   59.9      Mincfm       300        0   Clg Btuh/Sqft    39.78   Ret/OA    78.0   68.0
Reheat        0.0         0      0.0    0.0      Return       300      232   No. People           0   Runarnd   78.0   68.0
Humidif       0.0         0      0.0    0.0      Exhaust      125        0   Htg % OA           0.0   Fn MtrTD   0.1    0.0
Opt Vent      0.0         0      0.0    0.0      Rm Exh       124        0   Htg Cfm/SqFt      0.47   Fn BldTD   0.1    0.0
Total       -14.3                                Auxil          0        0   Htg Btuh/SqFt   -29.19   Fn Frict   0.4    0.0
```

```
System     3     Block     FC      -  FAN COIL

************************ COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>            Mo/Hr:  7/15                        *    Mo/Hr:  7/16       *          Mo/Hr: 13/ 1
Outside Air ==>          OADB/WB/HR:  96/ 77/112.0                *     OADB:  96         *           OADB:   3
                                                                  *                       *
                     Space   Ret. Air  Ret. Air       Net  Percnt *     Space    Percnt   *      Space      Total   Percnt
                Sens.+Lat.   Sensible    Latent     Total  Of Tot *  Sensible    Of Tot   *   Sensible   Sensible   Of Tot
Envelope Loads      (Btuh)     (Btuh)    (Btuh)    (Btuh)     (%) *    (Btuh)       (%)   *     (Btuh)     (Btuh)      (%)
  Skylite Solr           0          0                   0    0.00 *         0      0.00   *          0          0     0.00
  Skylite Cond           0          0                   0    0.00 *         0      0.00   *          0          0     0.00
  Roof Cond              0          0                   0    0.00 *         0      0.00   *          0          0     0.00
  Glass Solar        9,844          0               9,844   10.11 *     9,604     11.88   *          0          0     0.00
  Glass Cond         2,241          0               2,241    2.30 *     2,226      2.75   *     -9,798     -9,798     9.79
  Wall Cond         13,534      1,046              14,580   14.97 *    14,104     17.44   *    -46,301    -51,827    51.78
  Partition              0                              0    0.00 *         0      0.00   *          0          0     0.00
  Exposed Floor          0                              0    0.00 *         0      0.00   *          0          0     0.00
  Infiltration      24,820                         24,820   25.49 *    10,354     12.81   *    -38,459    -38,459    38.43
  Sub Total==>      50,439      1,046              51,485   52.87 *    36,289     44.88   *    -94,558   -100,085   100.00
Internal Loads                                                    *                       *
  Lights             6,848      4,565              11,413   11.72 *     6,848      8.47   *          0          0     0.00
  People             5,817                          5,817    5.97 *     3,036      3.76   *          0          0     0.00
  Misc              28,671          0         0    28,671   29.44 *    28,997     35.87   *          0          0     0.00
  Sub Total==>      41,336      4,565         0    45,901   47.13 *    38,880     48.09   *          0          0     0.00
Ceiling Load         5,611     -5,611                   0    0.00 *     5,679      7.02   *     -5,527          0     0.00
Outside Air              0          0         0         0    0.00 *         0      0.00   *          0          0     0.00
Sup. Fan Heat                                           0    0.00 *                0.00   *                     0     0.00
Ret. Fan Heat                       0                   0    0.00 *                0.00   *                     0     0.00
Duct Heat Pkup                      0                   0    0.00 *                0.00   *                     0     0.00
OV/UNDR Sizing           0                              0    0.00 *         0      0.00   *          0          0     0.00
Exhaust Heat                        0         0         0    0.00 *                0.00   *                     0     0.00
Terminal Bypass                     0         0         0    0.00 *                0.00   *                     0     0.00
                                                                  *                       *
Grand Total==>      97,386          0         0    97,386  100.00 *    80,848    100.00   *   -100,085   -100,085   100.00

--------------------------------COOLING COIL SELECTION---------------------------------------    ---------------AREAS--------------
          Total Capacity  Sens Cap.  Coil Airfl   Entering DB/WB/HR     Leaving DB/WB/HR        Gross Total    Glass (sf)   (%)
          (Tons)   (Mbh)     (Mbh)      (cfm)   Deg F  Deg F  Grains  Deg F  Deg F  Grains    Floor     2,150
Main Clg     8.1    97.4      80.4      4,373    78.2   65.0    73.9   60.7   57.8    69.2    Part          0
Aux  Clg     0.0     0.0       0.0          0     0.0    0.0     0.0    0.0    0.0     0.0    ExFlr         0
Opt Vent     0.0     0.0       0.0          0     0.0    0.0     0.0    0.0    0.0     0.0    Roof          0           0     0
Totals       8.1    97.4                                                                      Wall      2,085         240    12

------------HEATING COIL SELECTION-------------   ---------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--    --TEMPERATURES (F)--
          Capacity   Coil Airfl    Ent     Lvg     Type       Cooling    Heating   Clg % OA          0.0    Type       Clg    Htg
             (Mbh)        (cfm)  Deg F   Deg F     Vent             0          0   Clg Cfm/Sqft     2.03    SADB      60.9  125.0
Main Htg    -100.1        1,620   68.0   125.0     Infil          546        546   Clg Cfm/Ton    538.83    Plenum    86.2   59.9
Aux  Htg       0.0            0    0.0     0.0     Supply       4,373      1,620   Clg Sqft/Ton   264.93    Return    78.0   68.0
Preheat        0.0        4,373   68.0    60.4     Mincfm           0          0   Clg Btuh/Sqft   45.30    Ret/OA    78.0   68.0
Reheat         0.0            0    0.0     0.0     Return       4,373      1,620   No. People         15    Runarnd   78.0   68.0
Humidif        0.0            0    0.0     0.0     Exhaust      4,373          0   Htg % OA          0.0    Fn MtrTD   0.1    0.0
Opt Vent       0.0            0    0.0     0.0     Rm Exh         100          0   Htg Cfm/SqFt     0.75    Fn BldTD   0.1    0.0
Total       -100.1                                 Auxil            0          0   Htg Btuh/SqFt  -46.55    Fn Frict   0.4    0.0
```

```
System      4       Block      FC       -  FAN COIL

************************* COOLING COIL PEAK ********************************* CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>             Mo/Hr:  7/15                          *     Mo/Hr:  7/15       *          Mo/Hr: 13/ 1
Outside Air ==>            OADB/WB/HR:  96/ 77/112.0                 *      OADB:  96         *            OADB:   3
                                                                     *                        *
                       Space    Ret. Air  Ret. Air      Net   Percnt *     Space    Percnt *      Space      Total    Percnt
                   Sens.+Lat.   Sensible   Latent     Total   Of Tot *   Sensible   Of Tot *   Sensible   Sensible   Of Tot
Envelope Loads        (Btuh)     (Btuh)    (Btuh)    (Btuh)      (%) *     (Btuh)      (%) *     (Btuh)     (Btuh)      (%)
  Skylite Solr             0          0                   0     0.00 *          0     0.00 *          0          0     0.00
  Skylite Cond             0          0                   0     0.00 *          0     0.00 *          0          0     0.00
  Roof Cond            7,581          0               7,581    41.43 *      7,581    53.53 *     -8,381     -8,381     0.00
  Glass Solar            602          0                 602     3.29 *        602     4.25 *          0          0     0.00
  Glass Cond             234          0                 234     1.28 *        234     1.65 *     -1,024     -1,024     5.51
  Wall Cond              910          0                 910     4.97 *        910     6.42 *     -4,254     -4,254    22.88
  Partition                0                              0     0.00 *          0     0.00 *          0          0     0.00
  Exposed Floor            0                              0     0.00 *          0     0.00 *          0          0     0.00
  Infiltration         4,985                          4,985    27.24 *      1,365     9.64 *     -4,931     -4,931    26.52
  Sub Total==>        14,312          0              14,312    78.22 *     10,693    75.49 *    -18,589    -18,589   100.00
Internal Loads                                                       *                        *
  Lights                 768        307               1,075     5.88 *        768     5.42 *          0          0     0.00
  People                   0                              0     0.00 *          0     0.00 *          0          0     0.00
  Misc                 2,703          0         0     2,703    14.77 *      2,703    19.08 *          0          0     0.00
  Sub Total==>         3,471        307         0     3,778    20.65 *      3,471    24.51 *          0          0     0.00
Ceiling Load               0          0                   0     0.00 *          0     0.00 *          0          0     0.00
Outside Air                0          0         0         0     0.00 *          0     0.00 *          0          0     0.00
Sup. Fan Heat                                           184     1.01 *                0.00 *                     0     0.00
Ret. Fan Heat                        24                  24     0.13 *                0.00 *                     0     0.00
Duct Heat Pkup                        0                   0     0.00 *                0.00 *                     0     0.00
OV/UNDR Sizing             0                              0     0.00 *          0     0.00 *          0          0     0.00
Exhaust Heat                          0         0         0     0.00 *                0.00 *                     0     0.00
Terminal Bypass                       0         0         0     0.00 *                0.00 *                     0     0.00
                                                                     *                        *
Grand Total==>        17,783        331         0    18,298   100.00 *     14,164   100.00 *    -18,589    -18,589   100.00

---------------------------------COOLING COIL SELECTION---------------------------------------    -------------AREAS-------------
             Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR     Leaving DB/WB/HR      Gross Total    Glass (sf)   (%)
             (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains  Deg F  Deg F  Grains   Floor     305
Main Clg       1.5     18.3      14.7        300      78.2   56.7    36.1   34.1   28.8    16.2   Part        0
Aux  Clg       0.0      0.0       0.0          0       0.0    0.0     0.0    0.0    0.0     0.0   ExFlr       0
Opt Vent       0.0      0.0       0.0          0       0.0    0.0     0.0    0.0    0.0     0.0   Roof      377            0     0
Totals         1.5     18.3                                                                       Wall      174           25    14

-----------HEATING COIL SELECTION-------------     --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--     --TEMPERATURES (F)---
             Capacity   Coil Airfl   Ent    Lvg     Type        Cooling   Heating   Clg % OA          0.0      Type      Clg    Htg
               (Mbh)      (cfm)     Deg F  Deg F    Vent              0         0   Clg Cfm/Sqft     0.98      SADB     34.4  125.0
Main Htg       -18.6        301      68.0  125.0    Infil            70        70   Clg Cfm/Ton    196.74      Plenum   78.0   68.0
Aux  Htg         0.0          0       0.0    0.0    Supply          300       301   Clg Sqft/Ton   200.02      Return   78.0   68.0
Preheat          0.0        300      68.0   33.9    Mincfm          300         0   Clg Btuh/Sqft   59.99      Ret/OA   78.0   68.0
Reheat           0.0          0       0.0    0.0    Return          300       301   No. People          0      Runarnd  78.0   68.0
Humidif          0.0          0       0.0    0.0    Exhaust          70         0   Htg % OA          0.0      Fn MtrTD  0.1    0.0
Opt Vent         0.0          0       0.0    0.0    Rm Exh           50         0   Htg Cfm/SqFt     0.99      Fn BldTD  0.1    0.0
Total          -18.6                                Auxil             0         0   Htg Btuh/SqFt  -60.95      Fn Frict  0.4    0.0
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System      5      Block      FC        -  FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>              Mo/Hr:  7/15                       *      Mo/Hr:  7/15       *              Mo/Hr: 13/ 1
Outside Air ==>           OADB/WB/HR:  96/ 77/112.0                *       OADB:  96         *               OADB:   3
                                                                   *                         *
                      Space   Ret. Air  Ret. Air       Net  Percnt *    Space     Percnt     *     Space     Total    Percnt
                   Sens.+Lat. Sensible   Latent      Total  Of Tot *  Sensible    Of Tot     *   Sensible  Sensible   Of Tot
Envelope Loads       (Btuh)    (Btuh)    (Btuh)     (Btuh)    (%)  *   (Btuh)       (%)      *    (Btuh)    (Btuh)      (%)
  Skylite Solr            0         0                    0    0.00 *         0      0.00     *         0         0     0.00
  Skylite Cond            0         0                    0    0.00 *         0      0.00     *         0         0     0.00
  Roof Cond           3,982         0                3,982   38.51 *     3,982     48.41     *    -4,402    -4,402     0.00
  Glass Solar           302         0                  302    2.92 *       302      3.68     *         0         0     0.00
  Glass Cond            118         0                  118    1.14 *       118      1.43     *      -514      -514     5.36
  Wall Cond             443         0                  443    4.29 *       443      5.39     *    -2,073    -2,073    21.61
  Partition               0                              0    0.00 *         0      0.00     *         0         0     0.00
  Exposed Floor           0                              0    0.00 *         0      0.00     *         0         0     0.00
  Infiltration        2,024                          2,024   19.57 *       722      8.77     *    -2,606    -2,606    27.16
  Sub Total==>        6,869         0                6,869   66.43 *     5,567     67.67     *    -9,595    -9,595   100.00
Internal Loads                                                     *                         *
  Lights              1,038       415                1,453   14.05 *     1,038     12.61     *         0         0     0.00
  People                388                            388    3.75 *       198      2.40     *         0         0     0.00
  Misc                1,424         0         0      1,424   13.77 *     1,424     17.31     *         0         0     0.00
  Sub Total==>        2,849       415         0      3,264   31.56 *     2,659     32.33     *         0         0     0.00
Ceiling Load              0         0                    0    0.00 *         0      0.00     *         0         0     0.00
Outside Air               0         0         0          0    0.00 *         0      0.00     *         0         0     0.00
Sup. Fan Heat                                          184    1.78 *                0.00     *                   0     0.00
Ret. Fan Heat                      24                   24    0.23 *                0.00     *                   0     0.00
Duct Heat Pkup                      0                    0    0.00 *                0.00     *                   0     0.00
OV/UNDR Sizing            0                              0    0.00 *         0      0.00     *         0         0     0.00
Exhaust Heat                        0         0          0    0.00 *                0.00     *                   0     0.00
Terminal Bypass                     0         0          0    0.00 *                0.00     *                   0     0.00
                                                                   *                         *
Grand Total==>        9,718       439         0     10,341  100.00 *     8,226    100.00     *    -9,595    -9,595   100.00

-------------------------------COOLING COIL SELECTION-----------------------------------------   ---------------AREAS--------------
          Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR      Leaving DB/WB/HR       Gross Total    Glass (sf)   (%)
          (Tons)   (Mbh)    (Mbh)       (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains     Floor       160
Main Clg    0.9     10.3     8.8         300      78.2   62.2    60.4    52.3   49.8    50.9      Part          0
Aux  Clg    0.0      0.0     0.0           0       0.0    0.0     0.0     0.0    0.0     0.0      ExFlr         0
Opt Vent    0.0      0.0     0.0           0       0.0    0.0     0.0     0.0    0.0     0.0      Roof        198            0     0
Totals      0.9     10.3                                                                          Wall         85           13    15

-------------HEATING COIL SELECTION-------------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--   --TEMPERATURES (F)--
           Capacity  Coil Airfl   Ent    Lvg        Type      Cooling   Heating    Clg % OA          0.0     Type      Clg     Htg
            (Mbh)      (cfm)     Deg F  Deg F       Vent            0         0    Clg Cfm/Sqft     1.88     SADB     52.7   125.0
Main Htg    -9.6        155      68.0   125.0       Infil          37        37    Clg Cfm/Ton    348.14     Plenum   78.0    68.0
Aux  Htg     0.0          0       0.0     0.0       Supply        300       155    Clg Sqft/Ton   185.67     Return   78.0    68.0
Preheat      0.0        300      68.0    52.1       Mincfm        300         0    Clg Btuh/Sqft   64.63     Ret/OA   78.0    68.0
Reheat       0.0          0       0.0     0.0       Return        300       155    No. People         1     Runarnd  78.0    68.0
Humidif      0.0          0       0.0     0.0       Exhaust        37         0    Htg % OA          0.0     Fn MtrTD  0.1     0.0
Opt Vent     0.0          0       0.0     0.0       Rm Exh         37         0    Htg Cfm/SqFt     0.97     Fn BldTD  0.1     0.0
Total       -9.6                                    Auxil           0         0    Htg Btuh/SqFt  -59.97     Fn Frict  0.4     0.0
```

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System      6      Block      FC      -  FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>          Mo/Hr:  7/15                       *      Mo/Hr:  7/15       *          Mo/Hr: 13/ 1
Outside Air ==>         OADB/WB/HR:  96/ 77/112.0              *      OADB:   96         *          OADB:    3
                                                               *                         *
                  Space    Ret. Air  Ret. Air      Net  Percnt *     Space     Percnt *     Space      Total   Percnt
               Sens.+Lat.  Sensible   Latent     Total  Of Tot *   Sensible    Of Tot *   Sensible   Sensible  Of Tot
Envelope Loads   (Btuh)     (Btuh)    (Btuh)    (Btuh)    (%)  *    (Btuh)       (%)  *    (Btuh)     (Btuh)     (%)
  Skylite Solr        0          0                  0    0.00  *         0      0.00  *         0          0     0.00
  Skylite Cond        0          0                  0    0.00  *         0      0.00  *         0          0     0.00
  Roof Cond       5,148          0              5,148   47.82  *     5,148     61.79  *    -5,691     -5,691     0.00
  Glass Solar       302          0                302    2.81  *       302      3.63  *         0          0     0.00
  Glass Cond        118          0                118    1.09  *       118      1.41  *      -514       -514     4.16
  Wall Cond         611          0                611    5.68  *       611      7.34  *    -2,858     -2,858    23.10
  Partition           0                             0    0.00  *         0      0.00  *         0          0     0.00
  Exposed Floor       0                             0    0.00  *         0      0.00  *         0          0     0.00
  Infiltration    2,539                         2,539   23.58  *       917     11.00  *    -3,311     -3,311    26.76
  Sub Total==>    8,718          0              8,718   80.98  *     7,096     85.17  *   -12,373    -12,373   100.00
Internal Loads                                                 *                         *
  Lights          1,038        415              1,453   13.49  *     1,038     12.45  *         0          0     0.00
  People            388                           388    3.60  *       198      2.37  *         0          0     0.00
  Misc                0          0         0        0    0.00  *         0      0.00  *         0          0     0.00
  Sub Total==>    1,425        415         0    1,840   17.09  *     1,235     14.83  *         0          0     0.00
Ceiling Load          0          0                  0    0.00  *         0      0.00  *         0          0     0.00
Outside Air           0          0         0        0    0.00  *         0      0.00  *         0          0     0.00
Sup. Fan Heat                                     184    1.71  *                0.00  *                    0     0.00
Ret. Fan Heat                   24                 24    0.22  *                0.00  *                    0     0.00
Duct Heat Pkup                   0                  0    0.00  *                0.00  *                    0     0.00
OV/UNDR Sizing        0                             0    0.00  *         0      0.00  *         0          0     0.00
Exhaust Heat                     0         0        0    0.00  *                0.00  *                    0     0.00
Terminal Bypass                  0         0        0    0.00  *                0.00  *                    0     0.00
                                                               *                         *
Grand Total==>   10,143        439         0   10,766  100.00  *     8,331    100.00  *   -12,373    -12,373   100.00

-----------------------------COOLING COIL SELECTION---------------------------------------     -------------AREAS-------------
          Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR      Leaving DB/WB/HR     Gross Total    Glass (sf)  (%)
          (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains  Floor     207
Main Clg    0.9     10.8      9.0        300      78.2   62.4    61.4    52.0   49.6    50.3   Part        0
Aux  Clg    0.0      0.0      0.0          0       0.0    0.0     0.0     0.0    0.0     0.0   ExFlr       0
Opt Vent    0.0      0.0      0.0          0       0.0    0.0     0.0     0.0    0.0     0.0   Roof      256             0    0
Totals      0.9     10.8                                                                       Wall      113            13   11

------------HEATING COIL SELECTION-----------   ---------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--     --TEMPERATURES (F)--
          Capacity  Coil Airfl   Ent    Lvg      Type      Cooling   Heating     Clg % OA          0.0     Type       Clg    Htg
           (Mbh)      (cfm)     Deg F  Deg F     Vent            0         0     Clg Cfm/Sqft     1.45     SADB      52.4  125.0
Main Htg   -12.4       200      68.0  125.0      Infil          47        47     Clg Cfm/Ton    334.38     Plenum    78.0   68.0
Aux  Htg     0.0         0       0.0    0.0      Supply        300       200     Clg Sqft/Ton   230.72     Return    78.0   68.0
Preheat      0.0       300      68.0   51.8      Mincfm        300         0     Clg Btuh/Sqft   52.01     Ret/OA    78.0   68.0
Reheat       0.0         0       0.0    0.0      Return        299       200     No. People          1     Runarnd   78.0   68.0
Humidif      0.0         0       0.0    0.0      Exhaust        47         0     Htg % OA          0.0     Fn MtrTD   0.1    0.0
Opt Vent     0.0         0       0.0    0.0      Rm Exh         48         0     Htg Cfm/SqFt     0.97     Fn BldTD   0.1    0.0
Total      -12.4                                 Auxil           0         0     Htg Btuh/SqFt  -59.78     Fn Frict   0.4    0.0
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Trane Air Conditioning Economics                                                                          V 600
 By: CLARK RICHARDSON BISKUP                                                                              PAGE  10

 System      7      Block      FC      -  FAN COIL

 ************************ COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
 Peaked at Time ==>              Mo/Hr:  7/15                      *       Mo/Hr:  7/15       *           Mo/Hr: 13/ 1
 Outside Air ==>        OADB/WB/HR:  96/ 77/112.0                  *        OADB:  96         *            OADB:   3
                                                                   *                          *
                  Space    Ret. Air  Ret. Air      Net   Percnt    *     Space     Percnt     *     Space      Total    Percnt
               Sens.+Lat.  Sensible   Latent     Total   Of Tot    *   Sensible    Of Tot     *   Sensible   Sensible   Of Tot
 Envelope Loads  (Btuh)     (Btuh)    (Btuh)    (Btuh)     (%)     *    (Btuh)       (%)      *    (Btuh)     (Btuh)      (%)
   Skylite Solr       0          0                   0    0.00     *         0      0.00      *         0          0     0.00
   Skylite Cond       0          0                   0    0.00     *         0      0.00      *         0          0     0.00
   Roof Cond      3,982          0               3,982   45.26     *     3,982     55.73      *    -4,402     -4,402     0.00
   Glass Solar      302          0                 302    3.44     *       302      4.23      *         0          0     0.00
   Glass Cond       118          0                 118    1.34     *       118      1.65      *      -514       -514     5.32
   Wall Cond        460          0                 460    5.23     *       460      6.44      *    -2,152     -2,152    22.24
   Partition          0                              0    0.00     *         0      0.00      *         0          0     0.00
   Exposed Floor      0                              0    0.00     *         0      0.00      *         0          0     0.00
   Infiltration   1,861                          1,861   21.15     *       722     10.10      *    -2,606     -2,606    26.94
   Sub Total==>   6,722          0               6,722   76.41     *     5,584     78.15      *    -9,674     -9,674   100.00
 Internal Loads                                                    *                          *
   Lights           768        307               1,075   12.22     *       768     10.75      *         0          0     0.00
   People             0                              0    0.00     *         0      0.00      *         0          0     0.00
   Misc             793          0         0       793    9.01     *       793     11.10      *         0          0     0.00
   Sub Total==>   1,561        307         0     1,868   21.23     *     1,561     21.85      *         0          0     0.00
 Ceiling Load         0          0                   0    0.00     *         0      0.00      *         0          0     0.00
 Outside Air          0          0         0         0    0.00     *         0      0.00      *         0          0     0.00
 Sup. Fan Heat                                     184    2.09     *                0.00      *                    0     0.00
 Ret. Fan Heat                  24                  24    0.27     *                0.00      *                    0     0.00
 Duct Heat Pkup                  0                   0    0.00     *                0.00      *                    0     0.00
 OV/UNDR Sizing       0                              0    0.00     *         0      0.00      *         0          0     0.00
 Exhaust Heat                    0         0         0    0.00     *                0.00      *                    0     0.00
 Terminal Bypass                 0         0         0    0.00     *                0.00      *                    0     0.00
                                                                   *                          *
 Grand Total==>   8,283        331         0     8,798  100.00     *     7,144    100.00      *    -9,674     -9,674   100.00

 ----------------------------------COOLING COIL SELECTION-------------------------------------------    -------------AREAS--------------
             Total Capacity   Sens Cap.  Coil Airfl     Entering DB/WB/HR       Leaving DB/WB/HR        Gross Total    Glass (sf)   (%)
             (Tons)   (Mbh)     (Mbh)      (cfm)      Deg F  Deg F  Grains   Deg F  Deg F  Grains       Floor       160
 Main Clg      0.7      8.8       7.7        300      78.2   63.5    66.8    55.7   53.6    59.7        Part          0
 Aux  Clg      0.0      0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0        ExFlr         0
 Opt Vent      0.0      0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0        Roof        198            0    0
 Totals        0.7      8.8                                                                             Wall         88           13   14

 ------------HEATING COIL SELECTION-------------    --------AIRFLOWS (cfm)--------    --ENGINEERING CHECKS--     --TEMPERATURES (F)---
            Capacity  Coil Airfl   Ent     Lvg      Type       Cooling   Heating      Clg % OA         0.0     Type       Clg    Htg
             (Mbh)      (cfm)    Deg F   Deg F      Vent            0         0       Clg Cfm/Sqft    1.88     SADB      56.0  125.0
 Main Htg     -9.7        157     68.0   125.0      Infil          37        37       Clg Cfm/Ton   409.18     Plenum    78.0   68.0
 Aux  Htg      0.0          0      0.0     0.0      Supply        300       157       Clg Sqft/Ton  218.23     Return    78.0   68.0
 Preheat       0.0        300     68.0    55.5      Mincfm        300         0       Clg Btuh/Sqft  54.99     Ret/OA    78.0   68.0
 Reheat        0.0          0      0.0     0.0      Return        300       157       No. People       0       Runarnd   78.0   68.0
 Humidif       0.0          0      0.0     0.0      Exhaust        37         0       Htg % OA         0.0     Fn MtrTD   0.1    0.0
 Opt Vent      0.0          0      0.0     0.0      Rm Exh         37         0       Htg Cfm/SqFt    0.98     Fn BldTD   0.1    0.0
 Total        -9.7                                  Auxil           0         0       Htg Btuh/SqFt -60.46     Fn Frict   0.4    0.0
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Trane Air Conditioning Economics                                                                            V 600
 By: CLARK RICHARDSON BISKUP                                                                               PAGE  11

 System      8      Block      FC       -  FAN COIL

 ********************** COOLING COIL PEAK ****************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
 Peaked at Time ==>        Mo/Hr:  7/15                     *      Mo/Hr:  7/15       *          Mo/Hr: 13/ 1
 Outside Air ==>       OADB/WB/HR:  96/ 77/112.0            *       OADB:  96         *           OADB:   3
                                                            *                         *
                        Space  Ret. Air Ret. Air       Net  Percnt *      Space   Percnt *      Space       Total   Percnt
                   Sens.+Lat.  Sensible   Latent     Total  Of Tot *   Sensible   Of Tot *   Sensible    Sensible   Of Tot
 Envelope Loads     (Btuh)    (Btuh)   (Btuh)    (Btuh)     (%) *     (Btuh)      (%) *     (Btuh)      (Btuh)      (%)
   Skylite Solr         0         0                  0    0.00 *          0     0.00 *          0           0     0.00
   Skylite Cond         0         0                  0    0.00 *          0     0.00 *          0           0     0.00
   Roof Cond        9,407         0              9,407   50.64 *      9,407    61.39 *     -9,292      -9,292     0.00
   Glass Solar         36         0                 36    0.19 *         36     0.23 *          0           0     0.00
   Glass Cond         118         0                118    0.63 *        118     0.77 *       -508        -508     2.75
   Wall Cond        1,169         0              1,169    6.30 *      1,169     7.63 *     -3,154      -3,154    17.10
   Partition            0                            0    0.00 *          0     0.00 *          0           0     0.00
   Exposed Floor        0                            0    0.00 *          0     0.00 *          0           0     0.00
   Infiltration     3,546                        3,546   19.09 *      1,521     9.93 *     -5,494      -5,494    29.78
   Sub Total==>    14,275         0             14,275   76.85 *     12,251    79.95 *    -18,449     -18,449   100.00
 Internal Loads                                                *                       *
   Lights           3,072     1,229              4,300   23.15 *      3,072    20.05 *          0           0     0.00
   People               0                            0    0.00 *          0     0.00 *          0           0     0.00
   Misc                 0         0        0         0    0.00 *          0     0.00 *          0           0     0.00
   Sub Total==>     3,072     1,229        0     4,300   23.15 *      3,072    20.05 *          0           0     0.00
 Ceiling Load           0         0                  0    0.00 *          0     0.00 *          0           0     0.00
 Outside Air            0         0        0         0    0.00 *          0     0.00 *          0           0     0.00
 Sup. Fan Heat                                       0    0.00 *                0.00 *                      0     0.00
 Ret. Fan Heat                    0                  0    0.00 *                0.00 *                      0     0.00
 Duct Heat Pkup                   0                  0    0.00 *                0.00 *                      0     0.00
 OV/UNDR Sizing         0                            0    0.00 *          0     0.00 *          0           0     0.00
 Exhaust Heat                     0        0         0    0.00 *                0.00 *                      0     0.00
 Terminal Bypass                  0        0         0    0.00 *                0.00 *                      0     0.00
                                                               *                       *
 Grand Total==>    17,347     1,229        0    18,576  100.00 *     15,323   100.00 *    -18,449     -18,449   100.00

 ------------------------------COOLING COIL SELECTION------------------------------   -------------AREAS-------------
             Total Capacity  Sens Cap.  Coil Airfl   Entering DB/WB/HR     Leaving DB/WB/HR    Gross Total   Glass (sf)  (%)
              (Tons)   (Mbh)     (Mbh)      (cfm)   Deg F  Deg F Grains   Deg F  Deg F Grains  Floor       338
 Main Clg        1.5    18.6      16.6        893    78.2   65.0   73.9    61.8   58.3   69.5  Part          0
 Aux  Clg        0.0     0.0       0.0          0     0.0    0.0    0.0     0.0    0.0    0.0  ExFlr         0
 Opt Vent        0.0     0.0       0.0          0     0.0    0.0    0.0     0.0    0.0    0.0  Roof        418           0     0
 Totals          1.5    18.6                                                                   Wall        128          18    14

 ----------HEATING COIL SELECTION----------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--    --TEMPERATURES (F)--
            Capacity  Coil Airfl   Ent    Lvg      Type     Cooling  Heating   Clg % OA          0.0    Type      Clg    Htg
              (Mbh)      (cfm)   Deg F  Deg F    Vent           0        0   Clg Cfm/Sqft     2.64    SADB     62.2  125.0
 Main Htg      -18.4        299   68.0  125.0    Infil         78       78   Clg Cfm/Ton    576.76    Plenum   78.0   68.0
 Aux  Htg        0.0          0    0.0    0.0    Supply       893      299   Clg Sqft/Ton   218.35    Return   78.0   68.0
 Preheat         0.0        893   68.0   61.6    Mincfm         0        0   Clg Btuh/Sqft   54.96    Ret/OA   78.0   68.0
 Reheat          0.0          0    0.0    0.0    Return       893      299   No. People          0    Runarnd  78.0   68.0
 Humidif         0.0          0    0.0    0.0    Exhaust       78        0   Htg % OA          0.0    Fn MtrTD  0.1    0.0
 Opt Vent        0.0          0    0.0    0.0    Rm Exh        78        0   Htg Cfm/SqFt     0.88    Fn BldTD  0.1    0.0
 Total         -18.4                             Auxil          0        0   Htg Btuh/SqFt  -54.58    Fn Frict  0.4    0.0
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System       9        Block      FC         -  FAN COIL

************************** COOLING COIL PEAK ********************************** CLG SPACE PEAK ************* HEATING COIL PEAK ********
Peaked at Time ==>              Mo/Hr:  7/15                        *       Mo/Hr:  7/16        *            Mo/Hr: 13/ 1
Outside Air ==>             OADB/WB/HR:  96/ 77/112.0               *        OADB:  96          *             OADB:   3
                                                                    *                           *
                     Space   Ret. Air  Ret. Air     Net   Percnt    *      Space     Percnt     *      Space     Total   Percnt
                 Sens.+Lat.  Sensible   Latent     Total  Of Tot    *    Sensible    Of Tot     *    Sensible  Sensible  Of Tot
Envelope Loads      (Btuh)    (Btuh)    (Btuh)    (Btuh)     (%)    *     (Btuh)       (%)      *     (Btuh)    (Btuh)     (%)
  Skylite Solr           0         0                   0    0.00    *          0       0.00     *          0         0    0.00
  Skylite Cond           0         0                   0    0.00    *          0       0.00     *          0         0    0.00
  Roof Cond          4,568         0               4,568   39.96    *      4,442      42.68     *     -4,113    -4,113    0.00
  Glass Solar        1,588         0               1,588   13.89    *      1,688      16.23     *          0         0    0.00
  Glass Cond           235         0                 235    2.06    *        234       2.25     *     -1,028    -1,028    7.70
  Wall Cond          1,684         0               1,684   14.73    *      1,755      16.87     *     -5,821    -5,821   43.58
  Partition              0                             0    0.00    *          0       0.00     *          0         0    0.00
  Exposed Floor          0                             0    0.00    *          0       0.00     *          0         0    0.00
  Infiltration       1,546                         1,546   13.52    *        645       6.20     *     -2,395    -2,395   17.93
  Sub Total==>       9,620         0               9,620   84.15    *      8,764      84.22     *    -13,357   -13,357  100.00
Internal Loads                                                      *                           *
  Lights                 0         0                   0    0.00    *          0       0.00     *          0         0    0.00
  People               388                           388    3.39    *        202       1.95     *          0         0    0.00
  Misc               1,424         0         0     1,424   12.45    *      1,440      13.84     *          0         0    0.00
  Sub Total==>       1,811         0         0     1,811   15.85    *      1,642      15.78     *          0         0    0.00
Ceiling Load             0         0                   0    0.00    *          0       0.00     *          0         0    0.00
Outside Air              0         0         0         0    0.00    *          0       0.00     *          0         0    0.00
Sup. Fan Heat                                          0    0.00    *                  0.00     *                    0    0.00
Ret. Fan Heat                      0                   0    0.00    *                  0.00     *                    0    0.00
Duct Heat Pkup                     0                   0    0.00    *                  0.00     *                    0    0.00
OV/UNDR Sizing           0                             0    0.00    *          0       0.00     *          0         0    0.00
Exhaust Heat                       0         0         0    0.00    *                  0.00     *                    0    0.00
Terminal Bypass                    0         0         0    0.00    *                  0.00     *                    0    0.00
                                                                    *                           *
Grand Total==>      11,432         0         0    11,432  100.00    *     10,406     100.00     *    -13,357   -13,357  100.00

-------------------------------COOLING COIL SELECTION---------------------------------------    -------------AREAS-------------
          Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR      Leaving DB/WB/HR      Gross Total    Glass (sf)  (%)
          (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains   Floor      150
Main Clg    1.0     11.4      10.4        656      78.2   65.0    73.9    63.0   59.4    72.5   Part         0
Aux  Clg    0.0      0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0   ExFlr        0
Opt Vent    0.0      0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0   Roof       185         0    0
Totals      1.0     11.4                                                                        Wall       229        25   11

-----------HEATING COIL SELECTION-----------    --------AIRFLOWS (cfm)--------    --ENGINEERING CHECKS--     --TEMPERATURES (F)--
          Capacity   Coil Airfl   Ent    Lvg      Type     Cooling   Heating    Clg % OA          0.0     Type      Clg    Htg
           (Mbh)       (cfm)    Deg F  Deg F     Vent          0         0      Clg Cfm/Sqft      4.37    SADB     63.4  125.0
Main Htg   -13.4        216      68.0  125.0     Infil        34        34      Clg Cfm/Ton     688.12    Plenum   78.0   68.0
Aux  Htg     0.0          0       0.0    0.0     Supply      656       216      Clg Sqft/Ton    157.46    Return   78.0   68.0
Preheat      0.0        656      68.0   62.8     Mincfm        0         0      Clg Btuh/Sqft    76.21    Ret/OA   78.0   68.0
Reheat       0.0          0       0.0    0.0     Return      655       216      No. People           1    Runarnd  78.0   68.0
Humidif      0.0          0       0.0    0.0     Exhaust      34         0      Htg % OA           0.0    Fn MtrTD  0.1    0.0
Opt Vent     0.0          0       0.0    0.0     Rm Exh       35         0      Htg Cfm/SqFt      1.44    Fn BldTD  0.1    0.0
Total      -13.4                                 Auxil         0         0      Htg Btuh/SqFt   -89.05    Fn Frict  0.4    0.0
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 System     10      Block      FC        -  FAN COIL

************************ COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>            Mo/Hr:  7/15                        *     Mo/Hr:  7/15       *            Mo/Hr: 13/ 1
Outside Air ==>           OADB/WB/HR:  96/ 77/112.0               *      OADB:  96         *             OADB:    3
                                                                  *                        *
                     Space    Ret. Air  Ret. Air     Net  Percnt  *      Space   Percnt    *     Space      Total   Percnt
                  Sens.+Lat.  Sensible   Latent    Total  Of Tot  *   Sensible   Of Tot    *  Sensible   Sensible   Of Tot
Envelope Loads     (Btuh)     (Btuh)    (Btuh)    (Btuh)    (%)   *     (Btuh)     (%)     *    (Btuh)     (Btuh)      (%)
  Skylite Solr          0          0                  0    0.00   *          0     0.00    *         0          0     0.00
  Skylite Cond          0          0                  0    0.00   *          0     0.00    *         0          0     0.00
  Roof Cond         7,260          0              7,260   42.00   *      7,260    51.26    *    -6,536     -6,536     0.00
  Glass Solar         529          0                529    3.06   *        529     3.74    *         0          0     0.00
  Glass Cond          118          0                118    0.68   *        118     0.83    *      -514       -514     3.61
  Wall Cond           889          0                889    5.14   *        889     6.28    *    -3,302     -3,302    23.21
  Partition             0                             0    0.00   *          0     0.00    *         0          0     0.00
  Exposed Floor         0                             0    0.00   *          0     0.00    *         0          0     0.00
  Infiltration      3,987                         3,987   23.06   *      1,073     7.57    *    -3,874     -3,874    27.23
  Sub Total==>     12,782          0             12,782   73.95   *      9,868    69.68    *   -14,226    -14,226   100.00
Internal Loads                                                    *                        *
  Lights                0          0                  0    0.00   *          0     0.00    *         0          0     0.00
  People                0                             0    0.00   *          0     0.00    *         0          0     0.00
  Misc              4,295          0         0    4,295   24.85   *      4,295    30.32    *         0          0     0.00
  Sub Total==>      4,295          0         0    4,295   24.85   *      4,295    30.32    *         0          0     0.00
Ceiling Load            0          0                  0    0.00   *          0     0.00    *         0          0     0.00
Outside Air             0          0         0        0    0.00   *          0     0.00    *         0          0     0.00
Sup. Fan Heat                                       184    1.06   *                0.00    *                    0     0.00
Ret. Fan Heat                     24                 24    0.14   *                0.00    *                    0     0.00
Duct Heat Pkup                     0                  0    0.00   *                0.00    *                    0     0.00
OV/UNDR Sizing          0                             0    0.00   *          0     0.00    *         0          0     0.00
Exhaust Heat                       0         0        0    0.00   *                0.00    *                    0     0.00
Terminal Bypass                    0         0        0    0.00   *                0.00    *                    0     0.00
                                                                  *                        *
Grand Total==>     17,077         24         0   17,285  100.00   *     14,163   100.00    *   -14,226    -14,226   100.00

---------------------------------COOLING COIL SELECTION-----------------------------------------     -------------AREAS-------------
          Total Capacity   Sens Cap.. Coil Airfl   Entering DB/WB/HR      Leaving DB/WB/HR       Gross Total     Glass (sf)   (%)
          (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains   Floor      238
Main Clg     1.4    17.3      14.4        300      78.2   56.2    34.3    34.1   30.0    19.2   Part         0
Aux  Clg     0.0     0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0   ExFlr        0
Opt Vent     0.0     0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0   Roof       294             0     0
Totals       1.4    17.3                                                                        Wall       128            13    10

------------HEATING COIL SELECTION------------     --------AIRFLOWS (cfm)--------    --ENGINEERING CHECKS--      --TEMPERATURES (F)--
           Capacity   Coil Airfl    Ent     Lvg     Type      Cooling    Heating    Clg % OA          0.0      Type        Clg     Htg
            (Mbh)       (cfm)      Deg F   Deg F    Vent            0          0    Clg Cfm/Sqft     1.26      SADB       34.4   125.0
Main Htg    -14.2         230       68.0   125.0    Infil          55         55    Clg Cfm/Ton    208.27      Plenum     78.0    68.0
Aux  Htg      0.0           0        0.0     0.0    Supply        300        230    Clg Sqft/Ton   165.23      Return     78.0    68.0
Preheat       0.0         300       68.0    33.9    Mincfm        300          0    Clg Btuh/Sqft   72.63      Ret/OA     78.0    68.0
Reheat        0.0           0        0.0     0.0    Return        300        230    No. People          0      Runarnd    78.0    68.0
Humidif       0.0           0        0.0     0.0    Exhaust        55          0    Htg % OA          0.0      Fn MtrTD    0.1     0.0
Opt Vent      0.0           0        0.0     0.0    Rm Exh         55          0    Htg Cfm/Sqft     0.97      Fn BldTD    0.1     0.0
Total       -14.2                                   Auxil           0          0    Htg Btuh/Sqft  -59.77      Fn Frict    0.4     0.0
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System     11     Block     FC     - FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>            Mo/Hr:  7/15                  *     Mo/Hr:  7/15       *          Mo/Hr: 13/ 1
Outside Air ==>           OADB/WB/HR:  96/ 77/112.0         *      OADB:  96         *           OADB:   3
                                                            *                        *
                    Space    Ret. Air  Ret. Air      Net  Percnt *     Space  Percnt *      Space      Total   Percnt
                 Sens.+Lat.  Sensible   Latent     Total  Of Tot *  Sensible  Of Tot *   Sensible   Sensible   Of Tot
Envelope Loads     (Btuh)     (Btuh)    (Btuh)    (Btuh)    (%)  *    (Btuh)     (%)  *     (Btuh)     (Btuh)      (%)
  Skylite Solr          0          0                  0    0.00  *         0    0.00  *          0          0     0.00
  Skylite Cond          0          0                  0    0.00  *         0    0.00  *          0          0     0.00
  Roof Cond         6,445          0              6,445   53.47  *     6,445   59.63  *     -5,802     -5,802     0.00
  Glass Solar       1,054          0              1,054    8.75  *     1,054    9.75  *          0          0     0.00
  Glass Cond          234          0                234    1.94  *       234    2.17  *     -1,024     -1,024     8.02
  Wall Cond           690          0                690    5.73  *       690    6.39  *     -2,564     -2,564    20.08
  Partition             0                             0    0.00  *         0    0.00  *          0          0     0.00
  Exposed Floor         0                             0    0.00  *         0    0.00  *          0          0     0.00
  Infiltration      2,182                         2,182   18.10  *       936    8.66  *     -3,381     -3,381    26.47
  Sub Total==>     10,606          0             10,606   87.99  *     9,360   86.61  *    -12,772    -12,772   100.00
Internal Loads                                                   *                    *
  Lights                0          0                  0    0.00  *         0    0.00  *          0          0     0.00
  People                0                             0    0.00  *         0    0.00  *          0          0     0.00
  Misc              1,448          0         0    1,448   12.01  *     1,448   13.39  *          0          0     0.00
  Sub Total==>      1,448          0         0    1,448   12.01  *     1,448   13.39  *          0          0     0.00
Ceiling Load            0          0                  0    0.00  *         0    0.00  *          0          0     0.00
Outside Air             0          0         0        0    0.00  *         0    0.00  *          0          0     0.00
Sup. Fan Heat                                         0    0.00  *              0.00  *                     0     0.00
Ret. Fan Heat                      0                  0    0.00  *              0.00  *                     0     0.00
Duct Heat Pkup                     0                  0    0.00  *              0.00  *                     0     0.00
OV/UNDR Sizing          0                             0    0.00  *         0    0.00  *          0          0     0.00
Exhaust Heat                       0         0        0    0.00  *              0.00  *                     0     0.00
Terminal Bypass                    0         0        0    0.00  *              0.00  *                     0     0.00
                                                                 *                    *
Grand Total==>     12,053          0         0   12,053  100.00  *    10,808  100.00  *    -12,772    -12,772   100.00

-------------------------------COOLING COIL SELECTION-------------------------------------    --------------AREAS--------------
           Total Capacity   Sens Cap.  Coil Airfl   Entering DB/WB/HR     Leaving DB/WB/HR      Gross Total    Glass (sf)  (%)
           (Tons)   (Mbh)     (Mbh)      (cfm)    Deg F  Deg F  Grains  Deg F  Deg F  Grains   Floor     211
Main Clg     1.0     12.1      10.8        646     78.2   65.0    73.9   62.2   59.0    72.0   Part        0
Aux  Clg     0.0      0.0       0.0          0      0.0    0.0     0.0    0.0    0.0     0.0   ExFlr       0
Opt Vent     0.0      0.0       0.0          0      0.0    0.0     0.0    0.0    0.0     0.0   Roof      261           0    0
Totals       1.0     12.1                                                                       Wall      115          25   22

-------------HEATING COIL SELECTION-------------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--   --TEMPERATURES (F)--
          Capacity  Coil Airfl   Ent    Lvg       Type      Cooling   Heating     Clg % OA          0.0   Type       Clg    Htg
           (Mbh)      (cfm)     Deg F  Deg F      Vent            0         0     Clg Cfm/Sqft     3.06   SADB      62.6  125.0
Main Htg    -12.8       207      68.0  125.0      Infil          48        48     Clg Cfm/Ton    643.30   Plenum    78.0   68.0
Aux  Htg      0.0         0       0.0    0.0      Supply        646       207     Clg Sqft/Ton   210.07   Return    78.0   68.0
Preheat       0.0       646      68.0   62.0      Mincfm          0         0     Clg Btuh/Sqft   57.12   Ret/OA    78.0   68.0
Reheat        0.0         0       0.0    0.0      Return        646       207     No. People          0   Runarnd   78.0   68.0
Humidif       0.0         0       0.0    0.0      Exhaust        48         0     Htg % OA          0.0   Fn MtrTD   0.1    0.0
Opt Vent      0.0         0       0.0    0.0      Rm Exh         49         0     Htg Cfm/SqFt     0.98   Fn BldTD   0.1    0.0
Total       -12.8                                 Auxil           0         0     Htg Btuh/SqFt  -60.53   Fn Frict   0.4    0.0
```

```
System     12     Block     FC       -  FAN COIL

************************ COOLING COIL PEAK ******************************* CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>           Mo/Hr:  7/15                          *     Mo/Hr:  7/15       *              Mo/Hr: 13/ 1
Outside Air ==>           OADB/WB/HR:  96/ 77/112.0                *      OADB:  96         *               OADB:   3
                                                                   *                        *
                  Space    Ret. Air  Ret. Air        Net  Percnt   *     Space     Percnt   *     Space      Total   Percnt
                Sens.+Lat.  Sensible   Latent      Total  Of Tot   *   Sensible    Of Tot   *   Sensible   Sensible  Of Tot
Envelope Loads    (Btuh)    (Btuh)    (Btuh)      (Btuh)    (%)    *    (Btuh)      (%)     *    (Btuh)     (Btuh)     (%)
  Skylite Solr         0         0                     0    0.00   *         0      0.00    *         0          0    0.00
  Skylite Cond         0         0                     0    0.00   *         0      0.00    *         0          0    0.00
  Roof Cond        6,445         0                 6,445   51.66   *     6,445     62.49    *    -5,802     -5,802    0.00
  Glass Solar        529         0                   529    4.24   *       529      5.13    *         0          0    0.00
  Glass Cond         118         0                   118    0.94   *       118      1.14    *      -514       -514    4.08
  Wall Cond          786         0                   786    6.30   *       786      7.63    *    -2,921     -2,921   23.15
  Partition            0                               0    0.00   *         0      0.00    *         0          0    0.00
  Exposed Floor        0                               0    0.00   *         0      0.00    *         0          0    0.00
  Infiltration     2,892                           2,892   23.18   *       936      9.08    *    -3,381     -3,381   26.80
  Sub Total==>    10,770         0                10,770   86.32   *     8,814     85.47    *   -12,618    -12,618  100.00
Internal Loads                                                     *                        *
  Lights               0         0                     0    0.00   *         0      0.00    *         0          0    0.00
  People               0                               0    0.00   *         0      0.00    *         0          0    0.00
  Misc             1,499         0         0       1,499   12.01   *     1,499     14.53    *         0          0    0.00
  Sub Total==>     1,499         0         0       1,499   12.01   *     1,499     14.53    *         0          0    0.00
Ceiling Load           0         0                     0    0.00   *         0      0.00    *         0          0    0.00
Outside Air            0         0         0           0    0.00   *         0      0.00    *         0          0    0.00
Sup. Fan Heat                                        184    1.47   *                0.00    *                    0    0.00
Ret. Fan Heat                   24                    24    0.19   *                0.00    *                    0    0.00
Duct Heat Pkup                   0                     0    0.00   *                0.00    *                    0    0.00
OV/UNDR Sizing         0                               0    0.00   *         0      0.00    *         0          0    0.00
Exhaust Heat                     0         0           0    0.00   *                0.00    *                    0    0.00
Terminal Bypass                  0         0           0    0.00   *                0.00    *                    0    0.00
                                                                   *                        *
Grand Total==>    12,268        24         0      12,476  100.00   *    10,313    100.00    *   -12,618    -12,618  100.00

-------------------------------------COOLING COIL SELECTION-----------------------------------------    ---------------AREAS-------------
         Total Capacity   Sens Cap.  Coil Airfl   Entering DB/WB/HR       Leaving DB/WB/HR          Gross Total      Glass (sf)   (%)
         (Tons)   (Mbh)     (Mbh)      (cfm)    Deg F  Deg F  Grains   Deg F  Deg F  Grains         Floor      211
Main Clg   1.0     12.5      10.5        300     78.2   60.4   52.2     45.9   44.5   42.3          Part         0
Aux  Clg   0.0      0.0       0.0          0      0.0    0.0    0.0      0.0    0.0    0.0          ExFlr        0
Opt Vent   0.0      0.0       0.0          0      0.0    0.0    0.0      0.0    0.0    0.0          Roof       261            0     0
Totals     1.0     12.5                                                                             Wall       115           13    11

-------------HEATING COIL SELECTION-------------    ---------AIRFLOWS (cfm)--------    --ENGINEERING CHECKS--    --TEMPERATURES (F)--
          Capacity  Coil Airfl    Ent     Lvg      Type        Cooling     Heating    Clg % OA          0.0    Type       Clg    Htg
           (Mbh)      (cfm)      Deg F   Deg F     Vent              0           0    Clg Cfm/Sqft     1.42    SADB      46.3  125.0
Main Htg   -12.6       204       68.0   125.0      Infil            48          48    Clg Cfm/Ton    288.55    Plenum    78.0   68.0
Aux  Htg     0.0         0        0.0     0.0      Supply          300         204    Clg Sqft/Ton   202.95    Return    78.0   68.0
Preheat      0.0       300       68.0    45.7      Mincfm          300           0    Clg Btuh/Sqft   59.13    Ret/OA    78.0   68.0
Reheat       0.0         0        0.0     0.0      Return          299         204    No. People          0    Runarnd   78.0   68.0
Humidif      0.0         0        0.0     0.0      Exhaust          48           0    Htg % OA          0.0    Fn MtrTD   0.1    0.0
Opt Vent     0.0         0        0.0     0.0      Rm Exh           49           0    Htg Cfm/SqFt     0.97    Fn BldTD   0.1    0.0
Total      -12.6                                   Auxil             0           0    Htg Btuh/SqFt  -59.80    Fn Frict   0.4    0.0
```

```
System     13      Block      FC       -  FAN COIL

************************ COOLING COIL PEAK ******************************* CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>                Mo/Hr:  7/15                    *      Mo/Hr:  7/15        *            Mo/Hr: 13/ 1
Outside Air ==>            OADB/WB/HR:  96/ 77/112.0              *       OADB:  96          *             OADB:   3
                                                                  *                          *
                     Space   Ret. Air  Ret. Air       Net  Percnt *     Space     Percnt     *     Space     Total    Percnt
                Sens.+Lat.  Sensible    Latent     Total  Of Tot  *  Sensible     Of Tot     *  Sensible  Sensible    Of Tot
Envelope Loads      (Btuh)    (Btuh)    (Btuh)    (Btuh)     (%)  *    (Btuh)        (%)     *    (Btuh)    (Btuh)       (%)
  Skylite Solr           0         0                   0    0.00  *         0       0.00     *         0         0      0.00
  Skylite Cond           0         0                   0    0.00  *         0       0.00     *         0         0      0.00
  Roof Cond          4,889         0               4,889   46.89  *     4,889      51.64     *    -4,402    -4,402      0.00
  Glass Solar        1,109         0               1,109   10.63  *     1,109      11.71     *         0         0      0.00
  Glass Cond           235         0                 235    2.26  *       235       2.48     *    -1,028    -1,028      7.35
  Wall Cond          2,179         0               2,179   20.90  *     2,179      23.02     *    -5,951    -5,951     42.55
  Partition              0                             0    0.00  *         0       0.00     *         0         0      0.00
  Exposed Floor          0                             0    0.00  *         0       0.00     *         0         0      0.00
  Infiltration       1,682                         1,682   16.13  *       722       7.62     *    -2,606    -2,606     18.63
  Sub Total==>      10,094         0              10,094   96.80  *     9,134      96.48     *   -13,987   -13,987    100.00
Internal Loads                                                    *                          *
  Lights                 0         0                   0    0.00  *         0       0.00     *         0         0      0.00
  People                 0                             0    0.00  *         0       0.00     *         0         0      0.00
  Misc                 334         0         0       334    3.20  *       334       3.52     *         0         0      0.00
  Sub Total==>         334         0         0       334    3.20  *       334       3.52     *         0         0      0.00
Ceiling Load             0         0                   0    0.00  *         0       0.00     *         0         0      0.00
Outside Air              0         0         0         0    0.00  *         0       0.00     *         0         0      0.00
Sup. Fan Heat                                          0    0.00  *                 0.00     *                   0      0.00
Ret. Fan Heat                      0                   0    0.00  *                 0.00     *                   0      0.00
Duct Heat Pkup                     0                   0    0.00  *                 0.00     *                   0      0.00
OV/UNDR Sizing           0                             0    0.00  *         0       0.00     *         0         0      0.00
Exhaust Heat                       0         0         0    0.00  *                 0.00     *                   0      0.00
Terminal Bypass                    0         0         0    0.00  *                 0.00     *                   0      0.00
                                                                  *                          *
Grand Total==>      10,428         0         0    10,428  100.00  *     9,467     100.00     *   -13,987   -13,987    100.00

--------------------------------COOLING COIL SELECTION--------------------------------------    ---------------AREAS--------------
           Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR     Leaving DB/WB/HR      Gross Total   Glass  (sf)   (%)
           (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains   Floor     160
Main Clg     0.9     10.4       9.5         581     78.2   65.0    73.9    62.6   59.3    72.4   Part        0
Aux  Clg     0.0      0.0       0.0           0      0.0    0.0     0.0     0.0    0.0     0.0   ExFlr       0
Opt Vent     0.0      0.0       0.0           0      0.0    0.0     0.0     0.0    0.0     0.0   Roof      198           0     0
Totals       0.9     10.4                                                                        Wall      234          25    11

-------------HEATING COIL SELECTION-------------     ---------AIRFLOWS (cfm)---------    --ENGINEERING CHECKS--    --TEMPERATURES (F)--
           Capacity  Coil Airfl    Ent     Lvg       Type      Cooling    Heating     Clg % OA          0.0    Type         Clg    Htg
            (Mbh)      (cfm)     Deg F   Deg F       Vent            0          0     Clg Cfm/SqFt     3.63    SADB        63.0  125.0
Main Htg    -14.0        226      68.0   125.0       Infil          37         37     Clg Cfm/Ton    668.18    Plenum      78.0   68.0
Aux  Htg      0.0          0       0.0     0.0       Supply        581        226     Clg SqFt/Ton   184.13    Return      78.0   68.0
Preheat       0.0        581      68.0    62.4       Mincfm          0          0     Clg Btuh/SqFt   65.17    Ret/OA      78.0   68.0
Reheat        0.0          0       0.0     0.0       Return        581        226     No. People          0    Runarnd     78.0   68.0
Humidif       0.0          0       0.0     0.0       Exhaust        37          0     Htg % OA          0.0    Fn MtrTD     0.1    0.0
Opt Vent      0.0          0       0.0     0.0       Rm Exh         37          0     Htg Cfm/SqFt     1.42    Fn BldTD     0.1    0.0
Total       -14.0                                    Auxil           0          0     Htg Btuh/SqFt  -87.42    Fn Frict     0.4    0.0
```

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

MONTHLY ENERGY CONSUMPTION

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	STEAM (Therm)
Jan	6,250	32	533
Feb	5,533	32	471
March	6,435	32	341
April	5,196	31	9
May	6,032	32	0
June	10,028	58	0
July	13,143	65	0
Aug	11,418	59	0
Sept	6,997	51	0
Oct	5,756	33	0
Nov	5,652	32	150
Dec	5,683	32	702
Total	88,123	65	2,206

Building Energy Consumption = 77,355 (Btu/Sq Ft/Year)

Floor Area = 6,740 (Sq Ft)

Source Energy Consumption = 177,527 (Btu/Sq Ft/Year)

EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

EQUIPMENT ENERGY CONSUMPTION

Ref Num	Equip Code	Monthly Consumption Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
0	LIGHTS													
	ELEC	2157	1903	2284	2030	2284	2157	2030	2411	1903	2157	2030	1903	25,249
	PK	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2
1	MISC LD													
	ELEC	2959	2611	3133	2785	3133	2972	2797	3322	2622	2959	2785	2611	34,691
	PK	16.7	16.7	16.7	16.7	16.7	16.8	16.8	16.8	16.8	16.7	16.7	16.7	16.8
2	MISC LD													
	GAS	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	MISC LD													
	OIL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	MISC LD													
	P STEAM	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	MISC LD													
	P HOTH2O	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	MISC LD													
	P CHILL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	EQ1121S		AC RECIP CHILLER 20-60 T											
	ELEC	0	0	0	0	0	3090	5720	3608	1367	0	0	0	13,785
	PK	0.0	0.0	0.0	0.0	0.0	21.4	27.5	22.5	15.0	0.0	0.0	0.0	27.5
1	EQ5200		CONDENSER FANS											
	ELEC	0	0	0	0	0	382	735	449	162	0	0	0	1,728
	PK	0.0	0.0	0.0	0.0	0.0	2.6	3.2	2.7	2.0	0.0	0.0	0.0	3.2
1	EQ5001		CHILLED WATER PUMP C.V.											
	ELEC	0	0	0	0	0	415	541	468	237	0	0	0	1,660
	PK	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.0	0.0	0.0	0.7
1	EQ5313		CONTROLS											
	ELEC	0	0	0	0	0	171	223	193	98	0	0	0	685
	PK	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.3
1	EQ4003		FC CENTRIF. FAN C.V.											
	ELEC	203	183	192	131	147	285	362	330	224	227	131	207	2,622
	PK	0.8	0.8	0.8	0.8	0.8	1.5	1.5	1.5	1.5	1.5	0.8	0.8	1.5
2	EQ4371		FAN COIL SUPPLY FAN											

```
EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

     ELEC          23     20     18     11     13     32     46     37     20     13     14     26          272
     PK           0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1          0.1

   3 EQ4371              FAN COIL SUPPLY FAN
     ELEC         116    104    105     71    214    235    289    268    189    173     74    123        1,961
     PK           0.4    0.4    0.4    0.4    1.2    1.2    1.2    1.2    1.2    1.2    0.4    0.4          1.2

   4 EQ4371              FAN COIL SUPPLY FAN
     ELEC          33     30     30     16     16     20     25     21     14     43     25     36          309
     PK           0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1          0.1

   5 EQ4371              FAN COIL SUPPLY FAN
     ELEC          17     15     15      8     16     19     25     20     10     20     13     18          197
     PK           0.0    0.0    0.0    0.0    0.1    0.1    0.1    0.1    0.1    0.0    0.0    0.0          0.1

   6 EQ4371              FAN COIL SUPPLY FAN
     ELEC          22     20     20     11     15     19     27     20      9     32     17     24          235
     PK           0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1          0.1

   7 EQ4371              FAN COIL SUPPLY FAN
     ELEC          17     16     16      8     16     18     26     20      9     23     13     19          200
     PK           0.0    0.0    0.0    0.0    0.1    0.1    0.1    0.1    0.1    0.0    0.0    0.0          0.1

   8 EQ4371              FAN COIL SUPPLY FAN
     ELEC          31     27     27     15     48     55     78     61     28     27     22     33          453
     PK           0.1    0.1    0.1    0.1    0.2    0.2    0.2    0.2    0.2    0.1    0.1    0.1          0.2

   9 EQ4371              FAN COIL SUPPLY FAN
     ELEC          21     19     18     10     35     45     60     53     28     17     14     23          343
     PK           0.1    0.1    0.1    0.1    0.2    0.2    0.2    0.2    0.2    0.2    0.1    0.1          0.2

  10 EQ4371              FAN COIL SUPPLY FAN
     ELEC          20     17     17     12     16     19     24     23     15     14     13     23          213
     PK           0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1          0.1

  11 EQ4371              FAN COIL SUPPLY FAN
     ELEC          19     17     16     10     35     36     54     46     26     28     12     21          320
     PK           0.1    0.1    0.1    0.1    0.2    0.2    0.2    0.2    0.2    0.2    0.1    0.1          0.2

  12 EQ4371              FAN COIL SUPPLY FAN
     ELEC          19     17     16     10     16     18     26     22     14     12     12     21          204
     PK           0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1    0.1          0.1

  13 EQ4371              FAN COIL SUPPLY FAN
     ELEC          23     20     20     11     26     39     56     47     23     12     15     25          316
     PK           0.1    0.1    0.1    0.1    0.2    0.2    0.2    0.2    0.2    0.2    0.1    0.1          0.2

   1 CONVERTR            STEAM TO HOT WATER CONVERTER
     P STEAM      533    471    341      9      0      0      0      0      0      0    150    702        2,206
     PK           2.5    2.5    2.4    0.2    0.0    0.0    0.0    0.0    0.0    0.0    1.4    2.6          2.6

   1 EQ5020              HEAT WATER CIRC. PUMP C.V.
     ELEC         273    246    244     27      0      0      0      0      0      0    221    273        1,284
     PK           0.4    0.4    0.4    0.4    0.0    0.0    0.0    0.0    0.0    0.0    0.4    0.4          0.4

   1 EQ5060              CONDENSATE RETURN PUMP
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EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 3
BASE LOAD

     ELEC          296    268    265     29      0      0      0      0      0      0    241    296         1,395
     PK            0.4    0.4    0.4    0.4    0.0    0.0    0.0    0.0    0.0    0.0    0.4    0.4           0.4
```

UTILITY PEAK CHECKSUMS - ALTERNATIVE 3
BASE LOAD

UTILITY PEAK CHECKSUMS

Utility ELECTRIC DEMAND

Peak Value 64.8 (kW)
Yearly Time of Peak 15 (hr) 7 (mo)

Hour 15 Month 7

Eqp. Ref. Num.	Equipment Code Name	Equipment Description	Utility Demand (kW)	Percnt Of Tot (%)
Cooling Equipment				
1	EQ1121S	AC RECIP CHILLER 20-60 T	31.7	49.00
Sub Total			31.7	49.00
Sub Total			0.0	******
Air Moving Equipment				
1		SUMMATION OF FAN ELECTRICAL DEMAND	1.5	2.31
2		SUMMATION OF FAN ELECTRICAL DEMAND	0.1	0.13
3		SUMMATION OF FAN ELECTRICAL DEMAND	1.2	1.84
4		SUMMATION OF FAN ELECTRICAL DEMAND	0.1	0.13
5		SUMMATION OF FAN ELECTRICAL DEMAND	0.1	0.13
6		SUMMATION OF FAN ELECTRICAL DEMAND	0.1	0.13
7		SUMMATION OF FAN ELECTRICAL DEMAND	0.1	0.13
8		SUMMATION OF FAN ELECTRICAL DEMAND	0.2	0.38
9		SUMMATION OF FAN ELECTRICAL DEMAND	0.2	0.28
10		SUMMATION OF FAN ELECTRICAL DEMAND	0.1	0.13
11		SUMMATION OF FAN ELECTRICAL DEMAND	0.2	0.27
12		SUMMATION OF FAN ELECTRICAL DEMAND	0.1	0.13
13		SUMMATION OF FAN ELECTRICAL DEMAND	0.2	0.24
Sub Total			4.0	6.20
Sub Total			0.0	0.00
Miscellaneous				
Lights			12.2	18.83
Base Utilities			0.0	0.00
Misc Equipment			16.8	25.97
Sub Total			29.0	44.81
Grand Total			64.8	100.00

CALIFORNIA TITLE 24 COMPLIANCE - ALTERNATIVE 3
BASE LOAD

CALIFORNIA TITLE 24 COMPLIANCE REPORT

Weather Name	FTLVNWTH
Gross Conditioned Floor Area (sqft)......	6,740
ACM Multiplier	1.008

ENERGY USE SUMMARY

	ELEC (kWh/yr)	DISTRICT STEAM (kBtu/yr)	PERCENT OF TOTAL ENERGY (%)	TOTAL SOURCE ENERGY (kBtu/yr)	ADJUSTED UNIT SOURCE ENERGY (kBtu/yr-sf)
Primary Heating	1,395.4	220,607.6	43.2	308,432.5	46.1
Primary Cooling					
Compressor	13,784.9	0.0	9.0	141,157.5	21.1
Tower/Cond Fans	1,727.7	0.0	1.1	17,692.0	2.6
Condenser Pump	0.0	0.0	0.0	0.0	0.0
Other Accessories	685.5	0.0	0.4	7,019.5	1.0
Auxiliary					
Supply Fans	7,645.7	0.0	5.0	78,292.1	11.7
Circulation Pumps	2,943.8	0.0	1.9	30,144.7	4.5
Base Utilities	0.0	0.0	0.0	0.0	0.0
Subtotal	10,589.5	0.0	6.9	108,436.8	16.2
Lighting	25,249.1	0.0	16.5	258,551.6	38.7
Receptacle	34,691.2	0.0	22.7	355,238.9	53.1
Domestic Hot Water	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0
Totals	88,123.4	220,607.6	100.0	1,196,528.9	178.9

ECO-M2

DRY-BULB ECONOMIZER CONTROLS

BUILDING 473

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**                                                                         **
**           T R A C E   U L T R A   A N A L Y S I S                       **
**                                                                         **
**              by  CLARK RICHARDSON BISKUP                                **
**                                                                         **
*****************************************************************************
*****************************************************************************


        USDB ENERGY STUDY
        LEAVENWORTH, KANSAS
        USDB
        BRIAN SCOTT


       Weather File Code:              FTLVNWTH
       Location:                       LEAVENWORTH, KANSAS (USDB)
       Latitude:                        39.4  (deg)
       Longitude:                       94.9  (deg)
       Time Zone:                          6
       Elevation:                        770  (ft)
       Barometric Pressure:             29.1  (in. Hg)

       Summer Clearness Number:         0.95
       Winter Clearness Number:         0.95
       Summer Design Dry Bulb:            96  (F)
       Summer Design Wet Bulb:            77  (F)
       Winter Design Dry Bulb:             3  (F)
       Summer Ground Relectance:        0.20
       Winter Ground Relectance:        0.20

       Air Density:                   0.0739  (Lbm/cuft)
       Air Specific Heat:             0.2444  (Btu/lbm/F)
       Density-Specific Heat Prod:    1.0837  (Btu-min./hr/cuft/F)
       Latent Heat Factor:           4,770.2  (Btu-min./hr/cuft/lbm)
       Enthalpy Factor:               4.4333  (Btu-min./hr/cuft)

       Design Simulation Period: May      To October
       System Simulation Period: January  To December
       Cooling Load Methodology:     CLTD/CLF (TFM)

       Time/Date Program was Run:      9:58:45    9/25/90
       Dataset Name:                    473-M .TM
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AIRFLOW - ALTERNATIVE 2
BASE LOAD

SYSTEM SUMMARY
(Design Airflow Quantities)

		Main					Auxil.	Room
System Number	System Type	Outside Airflow (Cfm)	Cooling Airflow (Cfm)	Heating Airflow (Cfm)	Return Airflow (Cfm)	Exhaust Airflow (Cfm)	Supply Airflow (Cfm)	Exhaust Airflow (Cfm)
1	FC	0	400	304	400	0	0	50
2	FC	0	300	0	300	0	0	17
3	FC	0	800	0	800	0	0	137
4	FC	0	300	0	300	0	0	51
5	FC	0	300	53	300	0	0	23
6	FC	0	300	79	300	0	0	37
7	FC	0	300	0	300	0	0	30
8	FC	0	200	0	200	0	0	34
9	SZ	0	1,600	669	1,599	0	0	434
10	FC	0	600	209	600	0	0	98
11	SZ	0	4,910	2,541	4,910	4,910	0	1,037
12	SZ	0	5,900	2,929	5,900	5,900	0	1,183
Totals		0	15,910	6,783	15,908	10,810	0	3,132

CAPACITY - ALTERNATIVE 2
BASE LOAD

SYSTEM SUMMARY
(Design Capacity Quantities)

		Cooling				Heating						
System Number	System Type	Main Sys. Capacity (Tons)	Aux. Sys. Capacity (Tons)	Opt. Vent Capacity (Tons)	Cooling Totals (Tons)	Main Sys. Capacity (Btuh)	Aux. Sys. Capacity (Btuh)	Preheat Capacity (Btuh)	Reheat Capacity (Btuh)	Humidif. Capacity (Btuh)	Opt. Vent Capacity (Btuh)	Heating Totals (Btuh)
1	FC	0.9	0.0	0.0	0.9	-18,767	0	0	0	0	0	-18,767
2	FC	0.6	0.0	0.0	0.6	0	0	-22,807	0	0	0	-22,807
3	FC	2.2	0.0	0.0	2.2	0	0	-47,137	0	0	0	-47,137
4	FC	0.8	0.0	0.0	0.8	0	0	-17,446	0	0	0	-17,446
5	FC	0.2	0.0	0.0	0.2	-3,024	0	-1,300	0	0	0	-4,325
6	FC	0.6	0.0	0.0	0.6	-4,858	0	0	0	0	0	-4,858
7	FC	0.4	0.0	0.0	0.4	0	0	-21,779	0	0	0	-21,779
8	FC	0.7	0.0	0.0	0.7	0	0	-9,923	0	0	0	-9,923
9	SZ	1.5	0.0	0.0	1.5	-40,932	0	-955	0	0	0	-41,887
10	FC	1.3	0.0	0.0	1.3	-12,027	0	-2,589	0	0	0	-14,616
11	SZ	13.7	0.0	0.0	13.7	-156,944	0	0	0	0	0	-156,944
12	SZ	16.0	0.0	0.0	16.0	-180,898	0	0	0	0	0	-180,898
Totals		38.9	0.0	0.0	38.9	-417,451	0	-123,936	0	0	0	-541,386

ENGINEERING CHECKS - ALTERNATIVE 2
BASE LOAD

ENGINEERING CHECKS

System Number	Main/ Auxiliary	System Type	Percent Outside Air	Cooling				Heating		Floor Area Sq Ft
				Cfm/ Sq Ft	Cfm/ Ton	Sq Ft /Ton	Btuh/ Sq Ft	Cfm/ Sq Ft	Btuh/ Sq Ft	
1	Main	FC	0.00	0.69	444.4	643.3	18.65	0.52	-32.41	579
2	Main	FC	0.00	3.85	486.5	126.5	94.87	0.00	-292.39	78
3	Main	FC	0.00	1.30	371.0	286.1	41.94	0.00	-76.40	617
4	Main	FC	0.00	1.32	375.5	285.4	42.05	0.00	-76.52	228
5	Main	FC	0.00	2.88	1,420.3	492.4	24.37	0.51	-41.58	104
6	Main	FC	0.00	1.79	495.2	277.3	43.27	0.47	-28.92	168
7	Main	FC	0.00	2.19	837.8	382.6	31.36	0.00	-158.97	137
8	Main	FC	0.00	1.31	286.0	218.8	54.84	0.00	-64.86	153
9	Main	SZ	0.00	0.82	1,035.6	1,262.1	9.51	0.34	-21.48	1,950
10	Main	FC	0.00	1.36	464.5	340.6	35.23	0.48	-33.22	440
11	Main	SZ	0.00	1.17	359.0	306.2	39.19	0.61	-37.47	4,188
12	Main	SZ	0.00	1.41	368.7	261.7	45.85	0.70	-43.19	4,188

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Trane Air Conditioning Economics                                                              V 600
 By: CLARK RICHARDSON BISKUP                                                                  PAGE   4

 System     1     Block     FC      -  FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>             Mo/Hr:  7/15                      *     Mo/Hr:  7/16      *           Mo/Hr: 13/ 1
Outside Air ==>          OADB/WB/HR:  96/ 77/112.0               *      OADB:  96        *             OADB:   3
                                                                 *                       *
                     Space  Ret. Air  Ret. Air      Net  Percnt  *     Space   Percnt   *     Space      Total   Percnt
                 Sens.+Lat. Sensible   Latent     Total  Of Tot  *  Sensible   Of Tot   *  Sensible   Sensible   Of Tot
Envelope Loads      (Btuh)    (Btuh)   (Btuh)    (Btuh)     (%)  *    (Btuh)      (%)   *    (Btuh)     (Btuh)      (%)
  Skylite Solr           0         0                  0    0.00  *         0     0.00   *         0          0     0.00
  Skylite Cond           0         0                  0    0.00  *         0     0.00   *         0          0     0.00
  Roof Cond              0         0                  0    0.00  *         0     0.00   *         0          0     0.00
  Glass Solar        2,402         0              2,402   11.47  *     2,402    16.47   *         0          0     0.00
  Glass Cond           732         0                732    3.49  *       727     4.98   *    -3,195     -3,195    17.02
  Wall Cond            642       155                797    3.80  *       649     4.45   *    -2,255     -3,187    16.98
  Partition              0                            0    0.00  *         0     0.00   *         0          0     0.00
  Exposed Floor          0                            0    0.00  *         0     0.00   *    -3,370     -3,370    17.95
  Infiltration       7,057                        7,057   33.70  *     2,427    16.64   *    -9,016     -9,016    48.04
  Sub Total==>      10,833       155             10,988   52.47  *     6,206    42.53   *   -17,836    -18,767   100.00
Internal Loads                                                   *                      *
  Lights             2,117     1,411              3,528   16.85  *     2,117    14.51   *         0          0     0.00
  People             3,102                        3,102   14.82  *     1,619    11.10   *         0          0     0.00
  Misc               3,045         0        0     3,045   14.54  *     3,080    21.11   *         0          0     0.00
  Sub Total==>       8,264     1,411        0     9,676   46.20  *     6,816    46.72   *         0          0     0.00
Ceiling Load         1,566    -1,566                  0    0.00  *     1,569    10.75   *      -931          0     0.00
Outside Air              0         0        0         0    0.00  *         0     0.00   *         0          0     0.00
Sup. Fan Heat                                       245    1.17  *                0.00   *                    0     0.00
Ret. Fan Heat                     32                 32    0.15  *                0.00   *                    0     0.00
Duct Heat Pkup                     0                  0    0.00  *                0.00   *                    0     0.00
OV/UNDR Sizing           0                            0    0.00  *         0     0.00   *         0          0     0.00
Exhaust Heat                       0        0         0    0.00  *                0.00   *                    0     0.00
Terminal Bypass                    0        0         0    0.00  *                0.00   *                    0     0.00
                                                                 *                      *
Grand Total==>      20,664        32        0    20,941  100.00  *    14,590   100.00   *   -18,767    -18,767   100.00

-------------------------------COOLING COIL SELECTION-----------------------------------      -------------AREAS-------------
           Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR    Leaving DB/WB/HR     Gross Total    Glass (sf)  (%)
           (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains  Deg F  Deg F  Grains  Floor      579
Main Clg     0.9     10.8      7.7         400      78.2   62.0   59.7    44.0   42.9   40.3   Part         0
Aux  Clg     0.0      0.0      0.0           0       0.0    0.0    0.0     0.0    0.0    0.0   ExFlr       65
Opt Vent     0.0      0.0      0.0           0       0.0    0.0    0.0     0.0    0.0    0.0   Roof         0         0     0
Totals       0.9     10.8                                                                      Wall       805        86    11

-----------HEATING COIL SELECTION-------------   ---------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--    --TEMPERATURES (F)--
           Capacity  Coil Airfl    Ent     Lvg                                                             
             (Mbh)     (cfm)     Deg F   Deg F    Type        Cooling   Heating   Clg % OA           0.0     Type       Clg    Htg
Main Htg     -18.8        304     68.0   125.0    Vent              0         0   Clg Cfm/Sqft      0.69     SADB      44.3  125.0
Aux  Htg       0.0          0      0.0     0.0    Infil           128       128   Clg Cfm/Ton     444.44     Plenum    86.5   62.9
Preheat        0.0        400     68.0    43.8    Supply          400       304   Clg Sqft/Ton    643.33     Return    78.0   68.0
Reheat         0.0          0      0.0     0.0    Mincfm          400         0   Clg Btuh/Sqft    18.65     Ret/OA    78.0   68.0
Humidif        0.0          0      0.0     0.0    Return          400       304   No. People           8     Runarnd   78.0   68.0
Opt Vent       0.0          0      0.0     0.0    Exhaust         128         0   Htg % OA           0.0     Fn MtrTD   0.1    0.0
Total        -18.8                                Rm Exh           50         0   Htg Cfm/SqFt      0.52     Fn BldTD   0.1    0.0
                                                  Auxil             0         0   Htg Btuh/SqFt   -32.41     Fn Frict   0.4    0.0
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System      2     Block      FC      -  FAN COIL

************************ COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>           Mo/Hr:  7/15                   *     Mo/Hr:  7/16          *            Mo/Hr:  0/ 0
Outside Air ==>         OADB/WB/HR:  96/ 77/112.0           *      OADB:  96            *             OADB:  0
                                                            *                           *
                    Space   Ret. Air  Ret. Air      Net  Percnt *     Space     Percnt *      Space      Total   Percnt
                Sens.+Lat.  Sensible   Latent     Total  Of Tot *  Sensible     Of Tot *   Sensible   Sensible   Of Tot
Envelope Loads     (Btuh)    (Btuh)    (Btuh)    (Btuh)     (%) *    (Btuh)        (%) *     (Btuh)     (Btuh)      (%)
  Skylite Solr          0         0                   0    0.00 *         0       0.00 *          0          0     0.00
  Skylite Cond          0         0                   0    0.00 *         0       0.00 *          0          0     0.00
  Roof Cond             0         0                   0    0.00 *         0       0.00 *          0          0     0.00
  Glass Solar           0         0                   0    0.00 *         0       0.00 *          0          0     0.00
  Glass Cond            0         0                   0    0.00 *         0       0.00 *          0          0     0.00
  Wall Cond           112        32                 145    4.89 *       111       4.70 *          0          0     0.00
  Partition             0                             0    0.00 *         0       0.00 *          0          0     0.00
  Exposed Floor         0                             0    0.00 *         0       0.00 *          0          0     0.00
  Infiltration        532                           532   18.01 *       322      13.62 *          0          0     0.00
  Sub Total==>        644        32                 677   22.90 *       434      18.32 *          0          0     0.00
Internal Loads                                                  *                      *
  Lights              156       104                 259    8.78 *       156       6.57 *          0          0     0.00
  People              388                           388   13.12 *       202       8.55 *          0          0     0.00
  Misc              1,424         0         0     1,424   48.17 *     1,440      60.82 *          0          0     0.00
  Sub Total==>      1,967       104         0     2,071   70.07 *     1,798      75.95 *          0          0     0.00
Ceiling Load          136      -136                   0    0.00 *       136       5.74 *          0          0     0.00
Outside Air             0         0         0         0    0.00 *         0       0.00 *          0          0     0.00
Sup. Fan Heat                                       184    6.22 *                 0.00 *                     0     0.00
Ret. Fan Heat                    24                  24    0.81 *                 0.00 *                     0     0.00
Duct Heat Pkup                    0                   0    0.00 *                 0.00 *                     0     0.00
OV/UNDR Sizing          0                             0    0.00 *         0       0.00 *          0          0     0.00
Exhaust Heat                      0         0         0    0.00 *                 0.00 *                     0     0.00
Terminal Bypass                   0         0         0    0.00 *                 0.00 *                     0     0.00
                                                                *                      *
Grand Total==>      2,748        24         0     2,955  100.00 *     2,367     100.00 *          0          0     0.00

-------------------------------COOLING COIL SELECTION------------------------------------   -------------AREAS-------------
           Total Capacity   Sens Cap.  Coil Airfl   Entering DB/WB/HR    Leaving DB/WB/HR    Gross Total     Glass (sf)  (%)
           (Tons)   (Mbh)    (Mbh)      (cfm)     Deg F  Deg F Grains  Deg F  Deg F Grains   Floor        78
Main Clg     0.6     7.4      6.4        300      78.2   68.9   94.7   70.4   61.8   71.3    Part          0
Aux  Clg     0.0     0.0      0.0          0       0.0    0.0    0.0    0.0    0.0    0.0    ExFlr         8
Opt Vent     0.0     0.0      0.0          0       0.0    0.0    0.0    0.0    0.0    0.0    Roof          0          0     0
Totals       0.6     7.4                                                                     Wall         99          0     0

-----------HEATING COIL SELECTION-----------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--      --TEMPERATURES (F)--
           Capacity  Coil Airfl   Ent    Lvg     Type     Cooling   Heating    Clg % OA          0.0      Type       Clg    Htg
            (Mbh)      (cfm)     Deg F  Deg F    Vent           0         0    Clg Cfm/Sqft     3.85      SADB      70.7    0.0
Main Htg     0.0          0       0.0    0.0     Infil         17         0    Clg Cfm/Ton    486.49      Plenum    83.5    0.0
Aux  Htg     0.0          0       0.0    0.0     Supply       300         0    Clg Sqft/Ton   126.49      Return    78.0    0.0
Preheat    -22.8        300       0.0   70.2     Mincfm       300         0    Clg Btuh/Sqft   94.87      Ret/OA    78.0    0.0
Reheat       0.0          0       0.0    0.0     Return       300         0    No. People          1      Runarnd   78.0    0.0
Humidif      0.0          0       0.0    0.0     Exhaust       17         0    Htg % OA          0.0      Fn MtrTD   0.1    0.0
Opt Vent     0.0          0       0.0    0.0     Rm Exh        17         0    Htg Cfm/SqFt     0.00      Fn BldTD   0.1    0.0
Total      -22.8                                 Auxil          0         0    Htg Btuh/SqFt -292.39      Fn Frict   0.4    0.0
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System      3     Block     FC       -  FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>          Mo/Hr:  7/15                    *     Mo/Hr:  7/15        *              Mo/Hr:  0/ 0
Outside Air ==>         OADB/WB/HR:  96/ 77/112.0           *      OADB:  96          *               OADB:   0
                                                            *                         *
                    Space   Ret. Air  Ret. Air    Net  Percnt *    Space    Percnt *     Space     Total  Percnt
                Sens.+Lat.  Sensible   Latent    Total  Of Tot *  Sensible   Of Tot *  Sensible  Sensible  Of Tot
Envelope Loads     (Btuh)    (Btuh)    (Btuh)   (Btuh)    (%) *    (Btuh)      (%) *    (Btuh)    (Btuh)     (%)
  Skylite Solr          0         0                  0   0.00 *         0     0.00 *         0         0    0.00
  Skylite Cond          0         0                  0   0.00 *         0     0.00 *         0         0    0.00
  Roof Cond             0         0                  0   0.00 *         0     0.00 *         0         0    0.00
  Glass Solar       2,001         0              2,001   7.73 *     2,001    10.01 *         0         0    0.00
  Glass Cond          406         0                406   1.57 *       406     2.03 *         0         0    0.00
  Wall Cond           343        95                439   1.70 *       343     1.72 *         0         0    0.00
  Partition             0                            0   0.00 *         0     0.00 *         0         0    0.00
  Exposed Floor         0                            0   0.00 *         0     0.00 *         0         0    0.00
  Infiltration      6,672                        6,672  25.78 *     2,672    13.37 *         0         0    0.00
  Sub Total==>      9,422        95              9,518  36.78 *     5,423    27.12 *         0         0    0.00
Internal Loads                                                *                    *
  Lights            2,801     1,868              4,669  18.04 *     2,801    14.01 *         0         0    0.00
  People            2,715                        2,715  10.49 *     1,385     6.93 *         0         0    0.00
  Misc              8,422         0         0    8,422  32.54 *     8,422    42.12 *         0         0    0.00
  Sub Total==>     13,938     1,868         0   15,805  61.08 *    12,608    63.06 *         0         0    0.00
Ceiling Load        1,963    -1,963                  0   0.00 *     1,963     9.82 *         0         0    0.00
Outside Air             0         0         0        0   0.00 *         0     0.00 *         0         0    0.00
Sup. Fan Heat                                      490   1.90 *               0.00 *                   0    0.00
Ret. Fan Heat                    64                 64   0.25 *               0.00 *                   0    0.00
Duct Heat Pkup                    0                  0   0.00 *               0.00 *                   0    0.00
OV/UNDR Sizing          0                            0   0.00 *         0     0.00 *         0         0    0.00
Exhaust Heat                      0         0        0   0.00 *               0.00 *                   0    0.00
Terminal Bypass                   0         0        0   0.00 *               0.00 *                   0    0.00
                                                              *                    *
Grand Total==>     25,323        64         0   25,877 100.00 *    19,993   100.00 *         0         0    0.00

-------------------------------COOLING COIL SELECTION-----------------------------------   ---------------AREAS--------------
          Total Capacity  Sens Cap.  Coil Airfl   Entering DB/WB/HR     Leaving DB/WB/HR    Gross Total     Glass (sf)   (%)
          (Tons)   (Mbh)    (Mbh)      (cfm)    Deg F  Deg F  Grains  Deg F  Deg F  Grains  Floor      617
Main Clg    2.2     25.9     20.5        800     78.2   64.0    69.2   54.6   53.0    59.3  Part         0
Aux  Clg    0.0      0.0      0.0          0      0.0    0.0     0.0    0.0    0.0     0.0  ExFlr       41
Opt Vent    0.0      0.0      0.0          0      0.0    0.0     0.0    0.0    0.0     0.0  Roof         0            0    0
Totals      2.2     25.9                                                                    Wall       333           43   13

------------HEATING COIL SELECTION-------------   ---------AIRFLOWS (cfm)---------   --ENGINEERING CHECKS--      --TEMPERATURES (F)--
          Capacity  Coil Airfl    Ent    Lvg      Type    Cooling    Heating       Clg % OA          0.0       Type      Clg    Htg
            (Mbh)      (cfm)    Deg F  Deg F      Vent          0          0       Clg Cfm/Sqft     1.30       SADB     54.9    0.0
Main Htg     0.0          0      0.0    0.0       Infil       137          0       Clg Cfm/Ton    370.99       Plenum   88.0    0.0
Aux  Htg     0.0          0      0.0    0.0       Supply      800          0       Clg Sqft/Ton   286.12       Return   78.0    0.0
Preheat    -47.1        800      0.0   54.4       Mincfm      800          0       Clg Btuh/Sqft   41.94       Ret/OA   78.0    0.0
Reheat       0.0          0      0.0    0.0       Return      800          0       No. People          7       Runarnd  78.0    0.0
Humidif      0.0          0      0.0    0.0       Exhaust     137          0       Htg % OA          0.0       Fn MtrTD  0.1    0.0
Opt Vent     0.0          0      0.0    0.0       Rm Exh      137          0       Htg Cfm/SqFt     0.00       Fn BldTD  0.1    0.0
Total      -47.1                                  Auxil         0          0       Htg Btuh/SqFt  -76.40       Fn Frict  0.4    0.0
```

```
System      4      Block      FC       -  FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>            Mo/Hr:  7/16                         *      Mo/Hr:  7/16        *          Mo/Hr:  0/ 0
Outside Air ==>          OADB/WB/HR:  96/ 75/105.0                 *       OADB:  96          *           OADB:   0
                                                                   *                          *
                       Space   Ret. Air  Ret. Air       Net  Percnt *     Space     Percnt *     Space     Total   Percnt
                  Sens.+Lat.   Sensible    Latent     Total  Of Tot *  Sensible     Of Tot *  Sensible  Sensible   Of Tot
Envelope Loads       (Btuh)     (Btuh)    (Btuh)    (Btuh)     (%) *    (Btuh)        (%) *    (Btuh)    (Btuh)      (%)
  Skylite Solr            0          0                  0    0.00 *         0       0.00 *         0         0     0.00
  Skylite Cond            0          0                  0    0.00 *         0       0.00 *         0         0     0.00
  Roof Cond               0          0                  0    0.00 *         0       0.00 *         0         0     0.00
  Glass Solar         2,136          0              2,136   22.29 *     2,136      27.64 *         0         0     0.00
  Glass Cond            202          0                202    2.11 *       202       2.62 *         0         0     0.00
  Wall Cond             230         46                276    2.88 *       230       2.98 *         0         0     0.00
  Partition               0                             0    0.00 *         0       0.00 *         0         0     0.00
  Exposed Floor           0                             0    0.00 *         0       0.00 *         0         0     0.00
  Infiltration        2,047                         2,047   21.36 *       967      12.51 *         0         0     0.00
  Sub Total==>        4,616         46              4,662   48.63 *     3,536      45.75 *         0         0     0.00
Internal Loads                                                     *                          *
  Lights              1,245        830              2,075   21.65 *     1,245      16.11 *         0         0     0.00
  People              1,177                         1,177   12.28 *       607       7.86 *         0         0     0.00
  Misc                1,464          0         0    1,464   15.27 *     1,464      18.95 *         0         0     0.00
  Sub Total==>        3,886        830         0    4,716   49.20 *     3,316      42.91 *         0         0     0.00
Ceiling Load            876       -876                  0    0.00 *       876      11.34 *         0         0     0.00
Outside Air               0          0         0        0    0.00 *         0       0.00 *         0         0     0.00
Sup. Fan Heat                                         184    1.92 *                  0.00 *                   0     0.00
Ret. Fan Heat                       24                 24    0.25 *                  0.00 *                   0     0.00
Duct Heat Pkup                       0                  0    0.00 *                  0.00 *                   0     0.00
OV/UNDR Sizing            0                             0    0.00 *         0       0.00 *         0         0     0.00
Exhaust Heat                         0         0        0    0.00 *                  0.00 *                   0     0.00
Terminal Bypass                      0         0        0    0.00 *                  0.00 *                   0     0.00
                                                                   *                          *
Grand Total==>        9,378         24         0    9,586  100.00 *     7,728     100.00 *         0         0     0.00

----------------------------------COOLING COIL SELECTION----------------------------------     ----------------AREAS----------------
          Total Capacity   Sens Cap.  Coil Airfl   Entering DB/WB/HR      Leaving DB/WB/HR       Gross Total      Glass (sf)   (%)
          (Tons)   (Mbh)     (Mbh)      (cfm)    Deg F  Deg F  Grains   Deg F  Deg F  Grains    Floor       228
Main Clg     0.8     9.6       7.9        300     78.2   65.0    73.9    53.9   53.0    60.3    Part          0
Aux  Clg     0.0     0.0       0.0          0      0.0    0.0     0.0     0.0    0.0     0.0    ExFlr        19
Opt Vent     0.0     0.0       0.0          0      0.0    0.0     0.0     0.0    0.0     0.0    Roof          0            0     0
Totals       0.8     9.6                                                                        Wall        234           22     9

------------HEATING COIL SELECTION------------   --------AIRFLOWS (cfm)--------   ---ENGINEERING CHECKS---   ---TEMPERATURES (F)---
          Capacity  Coil Airfl   Ent     Lvg     Type      Cooling   Heating    Clg % OA          0.0    Type       Clg    Htg
            (Mbh)     (cfm)     Deg F   Deg F    Vent            0         0    Clg Cfm/Sqft     1.32    SADB      54.2    0.0
Main Htg      0.0         0      0.0     0.0     Infil          51         0    Clg Cfm/Ton    375.54    Plenum    90.1    0.0
Aux  Htg      0.0         0      0.0     0.0     Supply        300         0    Clg Sqft/Ton   285.41    Return    78.0    0.0
Preheat     -17.4       300      0.0    53.7     Mincfm        300         0    Clg Btuh/Sqft   42.05    Ret/OA    78.0    0.0
Reheat        0.0         0      0.0     0.0     Return        300         0    No. People          3    Runarnd   78.0    0.0
Humidif       0.0         0      0.0     0.0     Exhaust        51         0    Htg % OA          0.0    Fn MtrTD   0.1    0.0
Opt Vent      0.0         0      0.0     0.0     Rm Exh         51         0    Htg Cfm/SqFt     0.00    Fn BldTD   0.1    0.0
Total       -17.4                                Auxil           0         0    Htg Btuh/SqFt  -76.52    Fn Frict   0.4    0.0
```

```
System     5     Block     FC       -  FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>            Mo/Hr:  7/15                            *     Mo/Hr:  7/15       *            Mo/Hr: 13/ 1
Outside Air ==>         OADB/WB/HR:  96/ 77/112.0                     *      OADB:  96         *             OADB:   3
                                                                      *                        *
                       Space  Ret. Air  Ret. Air       Net  Percnt  *     Space    Percnt  *     Space     Total   Percnt
                  Sens.+Lat.  Sensible    Latent     Total  Of Tot  *  Sensible    Of Tot  *  Sensible  Sensible   Of Tot
Envelope Loads        (Btuh)    (Btuh)    (Btuh)    (Btuh)     (%)  *    (Btuh)       (%)  *    (Btuh)    (Btuh)      (%)
  Skylite Solr             0         0                   0    0.00  *         0      0.00  *         0         0     0.00
  Skylite Cond             0         0                   0    0.00  *         0      0.00  *         0         0     0.00
  Roof Cond                0         0                   0    0.00  *         0      0.00  *         0         0     0.00
  Glass Solar              0         0                   0    0.00  *         0      0.00  *         0         0     0.00
  Glass Cond             191         0                 191    7.55  *       191     10.83  *      -837      -837    25.72
  Wall Cond               84        19                 103    4.06  *        84      4.76  *      -243      -364    11.20
  Partition                0                             0    0.00  *         0      0.00  *         0         0     0.00
  Exposed Floor            0                             0    0.00  *         0      0.00  *      -432      -432    13.27
  Infiltration         1,009                         1,009   39.79  *       449     25.39  *    -1,620    -1,620    49.81
  Sub Total==>         1,284        19               1,303   51.40  *       724     40.98  *    -3,131    -3,253   100.00
Internal Loads                                                      *                      *
  Lights                 614       410               1,024   40.40  *       614     34.77  *         0         0     0.00
  People                   0                             0    0.00  *         0      0.00  *         0         0     0.00
  Misc                     0         0         0         0    0.00  *         0      0.00  *         0         0     0.00
  Sub Total==>           614       410         0     1,024   40.40  *       614     34.77  *         0         0     0.00
Ceiling Load             428      -428                   0    0.00  *       428     24.24  *      -121         0     0.00
Outside Air                0         0         0         0    0.00  *         0      0.00  *         0         0     0.00
Sup. Fan Heat                                          184    7.26  *                0.00  *                   0     0.00
Ret. Fan Heat                       24                  24    0.94  *                0.00  *                   0     0.00
Duct Heat Pkup                       0                   0    0.00  *                0.00  *                   0     0.00
OV/UNDR Sizing             0                             0    0.00  *         0      0.00  *         0         0     0.00
Exhaust Heat                         0         0         0    0.00  *                0.00  *                   0     0.00
Terminal Bypass                      0         0         0    0.00  *                0.00  *                   0     0.00
                                                                    *                      *
Grand Total==>         2,327        24         0     2,535  100.00  *     1,767    100.00  *    -3,253    -3,253   100.00

-----------------------------COOLING COIL SELECTION---------------------------------------   ------------AREAS------------
           Total Capacity  Sens Cap.  Coil Airfl    Entering DB/WB/HR       Leaving DB/WB/HR      Gross Total   Glass (sf)  (%)
           (Tons)   (Mbh)     (Mbh)       (cfm)   Deg F  Deg F  Grains   Deg F  Deg F  Grains   Floor       104
Main Clg      0.2     2.5       2.0         300    78.2   65.4    76.3    72.2   62.9    73.5   Part          0
Aux  Clg      0.0     0.0       0.0           0     0.0    0.0     0.0     0.0    0.0     0.0   ExFlr         8
Opt Vent      0.0     0.0       0.0           0     0.0    0.0     0.0     0.0    0.0     0.0   Roof          0            0    0
Totals        0.2     2.5                                                                       Wall        102           20   20

-----------HEATING COIL SELECTION------------   -------AIRFLOWS (cfm)-------   --ENGINEERING CHECKS--      --TEMPERATURES (F)--
           Capacity  Coil Airfl    Ent    Lvg   Type       Cooling  Heating   Clg % OA            0.0   Type       Clg    Htg
              (Mbh)       (cfm)  Deg F  Deg F   Vent             0        0   Clg Cfm/Sqft       2.88   SADB      72.6  125.0
Main Htg       -3.0          53   72.0  125.0   Infil           23       23   Clg Cfm/Ton     1420.35   Plenum    91.0   64.3
Aux  Htg        0.0           0    0.0    0.0   Supply         300       53   Clg Sqft/Ton     492.39   Return    78.0   68.0
Preheat        -1.3         300   68.0   72.0   Mincfm         300        0   Clg Btuh/Sqft     24.37   Ret/OA    78.0   68.0
Reheat          0.0           0    0.0    0.0   Return         300       53   No. People            0   Runarnd   78.0   68.0
Humidif         0.0           0    0.0    0.0   Exhaust         23        0   Htg % OA            0.0   Fn MtrTD   0.1    0.0
Opt Vent        0.0           0    0.0    0.0   Rm Exh          23        0   Htg Cfm/SqFt       0.51   Fn BldTD   0.1    0.0
Total          -4.3                             Auxil            0        0   Htg Btuh/SqFt    -41.58   Fn Frict   0.4    0.0
```

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System      6      Block      FC        -  FAN COIL

************************** COOLING COIL PEAK ********************************** CLG SPACE PEAK ************* HEATING COIL PEAK ********
Peaked at Time ==>          Mo/Hr:  7/14                          *        Mo/Hr:  7/10          *                Mo/Hr: 13/ 1
Outside Air ==>          OADB/WB/HR:  96/ 77/112.0                *         OADB:  86            *                 OADB:   3
                                                                  *                              *
                        Space    Ret. Air   Ret. Air      Net   Percnt *     Space     Percnt *      Space      Total    Percnt
                     Sens.+Lat.  Sensible    Latent      Total  Of Tot *   Sensible    Of Tot *   Sensible   Sensible   Of Tot
Envelope Loads          (Btuh)    (Btuh)     (Btuh)     (Btuh)    (%)  *    (Btuh)       (%)  *     (Btuh)     (Btuh)      (%)
  Skylite Solr               0         0                    0    0.00  *         0      0.00  *          0          0     0.00
  Skylite Cond               0         0                    0    0.00  *         0      0.00  *          0          0     0.00
  Roof Cond                  0         0                    0    0.00  *         0      0.00  *          0          0     0.00
  Glass Solar            1,090         0                1,090   14.99  *     1,875     31.85  *          0          0     0.00
  Glass Cond               194         0                  194    2.67  *        97      1.65  *       -890       -890    18.31
  Wall Cond                164        26                  190    2.61  *       154      2.61  *       -440       -634    13.05
  Partition                  0                              0    0.00  *         0      0.00  *          0          0     0.00
  Exposed Floor              0                              0    0.00  *         0      0.00  *       -728       -728    14.99
  Infiltration           1,746                          1,746   24.03  *       337      5.72  *     -2,606     -2,606    53.65
  Sub Total==>           3,194        26                3,221   44.31  *     2,462     41.83  *     -4,664     -4,858   100.00
Internal Loads                                                         *                        *
  Lights                 1,229       819                2,048   28.17  *     1,180     20.04  *          0          0     0.00
  People                   385                            385    5.30  *       173      2.93  *          0          0     0.00
  Misc                   1,407         0          0     1,407   19.36  *     1,262     21.44  *          0          0     0.00
  Sub Total==>           3,022       819          0     3,841   52.84  *     2,614     44.41  *          0          0     0.00
Ceiling Load               845      -845                    0    0.00  *       810     13.76  *       -194          0     0.00
Outside Air                  0         0          0         0    0.00  *         0      0.00  *          0          0     0.00
Sup. Fan Heat                                             184    2.53  *                0.00  *                     0     0.00
Ret. Fan Heat                         24                   24    0.33  *                0.00  *                     0     0.00
Duct Heat Pkup                         0                    0    0.00  *                0.00  *                     0     0.00
OV/UNDR Sizing               0                              0    0.00  *         0      0.00  *          0          0     0.00
Exhaust Heat                           0          0         0    0.00  *                0.00  *                     0     0.00
Terminal Bypass                        0          0         0    0.00  *                0.00  *                     0     0.00
                                                                       *                        *
Grand Total==>           7,061        24          0     7,269  100.00  *     5,886    100.00  *     -4,858     -4,858   100.00

---------------------------------COOLING COIL SELECTION-----------------------------------------   ---------------AREAS--------------
            Total Capacity    Sens Cap.  Coil Airfl     Entering DB/WB/HR       Leaving DB/WB/HR       Gross Total     Glass (sf)  (%)
            (Tons)    (Mbh)     (Mbh)     (cfm)      Deg F  Deg F  Grains    Deg F  Deg F  Grains    Floor      168
Main Clg      0.6      7.3       6.0        300       78.2   64.3    70.6     59.7   56.3    64.5    Part         0
Aux  Clg      0.0      0.0       0.0          0        0.0    0.0     0.0      0.0    0.0     0.0    ExFlr       14
Opt Vent      0.0      0.0       0.0          0        0.0    0.0     0.0      0.0    0.0     0.0    Roof         0             0    0
Totals        0.6      7.3                                                                           Wall       164            22   13

-------------HEATING COIL SELECTION---------------   ---------AIRFLOWS (cfm)---------   --ENGINEERING CHECKS--       --TEMPERATURES (F)--
            Capacity   Coil Airfl   Ent      Lvg     Type        Cooling    Heating    Clg % OA           0.0     Type       Clg     Htg
             (Mbh)       (cfm)     Deg F    Deg F    Vent              0          0    Clg Cfm/Sqft      1.79     SADB      59.9   125.0
Main Htg      -4.9          79      68.0    125.0    Infil            37         37    Clg Cfm/Ton     495.24     Plenum    93.9    64.4
Aux  Htg       0.0           0       0.0      0.0    Supply          300         79    Clg Sqft/Ton    277.33     Return    78.0    68.0
Preheat        0.0         300      68.0     59.3    Mincfm          300          0    Clg Btuh/Sqft    43.27     Ret/OA    78.0    68.0
Reheat         0.0           0       0.0      0.0    Return          300         79    No. People           1     Runarnd   78.0    68.0
Humidif        0.0           0       0.0      0.0    Exhaust          37          0    Htg % OA           0.0     Fn MtrTD   0.1     0.0
Opt Vent       0.0           0       0.0      0.0    Rm Exh           37          0    Htg Cfm/SqFt      0.47     Fn BldTD   0.1     0.0
Total         -4.9                                   Auxil             0          0    Htg Btuh/SqFt   -28.92     Fn Frict   0.4     0.0
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```
System      7     Block      FC      -  FAN COIL

************************* COOLING COIL PEAK ********************************* CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>            Mo/Hr:  7/15                      *     Mo/Hr:  7/16       *              Mo/Hr:  0/ 0
Outside Air ==>           OADB/WB/HR:  96/ 77/112.0             *      OADB:  96         *               OADB:   0
                                                                *                        *
                      Space    Ret. Air  Ret. Air        Net   Percnt *      Space    Percnt *      Space     Total   Percnt
                  Sens.+Lat.   Sensible   Latent       Total   Of Tot *   Sensible    Of Tot *   Sensible  Sensible   Of Tot
Envelope Loads       (Btuh)     (Btuh)    (Btuh)      (Btuh)     (%)  *     (Btuh)      (%)  *     (Btuh)    (Btuh)      (%)
  Skylite Solr            0          0                     0    0.00  *          0     0.00  *          0         0     0.00
  Skylite Cond            0          0                     0    0.00  *          0     0.00  *          0         0     0.00
  Roof Cond               0          0                     0    0.00  *          0     0.00  *          0         0     0.00
  Glass Solar             0          0                     0    0.00  *          0     0.00  *          0         0     0.00
  Glass Cond              0          0                     0    0.00  *          0     0.00  *          0         0     0.00
  Wall Cond               0          0                     0    0.00  *          0     0.00  *          0         0     0.00
  Partition               0                                0    0.00  *          0     0.00  *          0         0     0.00
  Exposed Floor           0                                0    0.00  *          0     0.00  *          0         0     0.00
  Infiltration        1,114                            1,114   25.93  *        578    17.03  *          0         0     0.00
  Sub Total==>        1,114          0                 1,114   25.93  *        578    17.03  *          0         0     0.00
Internal Loads                                                        *                      *
  Lights                663        442                 1,106   25.74  *        672    19.78  *          0         0     0.00
  People                397                              397    9.24  *        209     6.16  *          0         0     0.00
  Misc                1,472          0         0       1,472   34.26  *      1,488    43.84  *          0         0     0.00
  Sub Total==>        2,533        442         0       2,975   69.24  *      2,369    69.78  *          0         0     0.00
Ceiling Load            442       -442                     0    0.00  *        448    13.19  *          0         0     0.00
Outside Air               0          0         0           0    0.00  *          0     0.00  *          0         0     0.00
Sup. Fan Heat                                            184    4.28  *                0.00  *                    0     0.00
Ret. Fan Heat                       24                    24    0.56  *                0.00  *                    0     0.00
Duct Heat Pkup                       0                     0    0.00  *                0.00  *                    0     0.00
OV/UNDR Sizing            0                                0    0.00  *          0     0.00  *          0         0     0.00
Exhaust Heat                         0         0           0    0.00  *                0.00  *                    0     0.00
Terminal Bypass                      0         0           0    0.00  *                0.00  *                    0     0.00
                                                                      *                      *
Grand Total==>        4,089         24         0       4,297  100.00  *      3,395   100.00  *          0         0     0.00

------------------------------------COOLING COIL SELECTION------------------------------------  ---------------AREAS--------------
           Total Capacity  Sens Cap.  Coil Airfl    Entering DB/WB/HR      Leaving DB/WB/HR     Gross Total    Glass (sf)   (%)
           (Tons)   (Mbh)    (Mbh)      (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains   Floor     137
Main Clg     0.4     4.3      3.6        300      78.2   67.5    87.0    67.2   63.3    83.5    Part        0
Aux  Clg     0.0     0.0      0.0          0       0.0    0.0     0.0     0.0    0.0     0.0    ExFlr       0
Opt Vent     0.0     0.0      0.0          0       0.0    0.0     0.0     0.0    0.0     0.0    Roof        0           0     0
Totals       0.4     4.3                                                                        Wall        0           0     0

------------HEATING COIL SELECTION------------  --------AIRFLOWS (cfm)--------  --ENGINEERING CHECKS--   --TEMPERATURES (F)--
          Capacity  Coil Airfl   Ent    Lvg     Type      Cooling    Heating  Clg % OA         0.0   Type       Clg    Htg
           (Mbh)      (cfm)     Deg F  Deg F    Vent            0          0  Clg Cfm/Sqft    2.19   SADB      67.6    0.0
Main Htg     0.0          0      0.0    0.0     Infil          30          0  Clg Cfm/Ton   837.83   Plenum    88.2    0.0
Aux  Htg     0.0          0      0.0    0.0     Supply        300          0  Clg Sqft/Ton  382.61   Return    78.0    0.0
Preheat    -21.8        300      0.0   67.0     Mincfm        300          0  Clg Btuh/Sqft  31.36   Ret/OA    78.0    0.0
Reheat       0.0          0      0.0    0.0     Return        300          0  No. People         1   Runarnd   78.0    0.0
Humidif      0.0          0      0.0    0.0     Exhaust        30          0  Htg % OA         0.0   Fn MtrTD   0.1    0.0
Opt Vent     0.0          0      0.0    0.0     Rm Exh         30          0  Htg Cfm/SqFt    0.00   Fn BldTD   0.1    0.0
Total      -21.8                                Auxil           0          0  Htg Btuh/SqFt -158.97  Fn Frict   0.4    0.0
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System      8     Block     FC       -  FAN COIL

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>          Mo/Hr:  7/16                       *      Mo/Hr:  7/16       *            Mo/Hr:  0/ 0
Outside Air ==>         OADB/WB/HR:  96/ 75/105.0              *       OADB:  96         *             OADB:   0
                                                               *                         *
                     Space   Ret. Air  Ret. Air      Net  Percnt *     Space    Percnt *      Space      Total   Percnt
                Sens.+Lat.  Sensible   Latent      Total  Of Tot *   Sensible   Of Tot *   Sensible   Sensible   Of Tot
Envelope Loads      (Btuh)    (Btuh)   (Btuh)     (Btuh)    (%)  *     (Btuh)     (%)  *     (Btuh)     (Btuh)     (%)
  Skylite Solr           0         0                 0    0.00  *          0     0.00  *          0          0     0.00
  Skylite Cond           0         0                 0    0.00  *          0     0.00  *          0          0     0.00
  Roof Cond              0         0                 0    0.00  *          0     0.00  *          0          0     0.00
  Glass Solar        2,136         0             2,136   25.46  *      2,136    31.15  *          0          0     0.00
  Glass Cond           202         0               202    2.41  *        202     2.95  *          0          0     0.00
  Wall Cond            144        15               159    1.89  *        144     2.10  *          0          0     0.00
  Partition              0                           0    0.00  *          0     0.00  *          0          0     0.00
  Exposed Floor          0                           0    0.00  *          0     0.00  *          0          0     0.00
  Infiltration       1,847                       1,847   22.02  *        645     9.40  *          0          0     0.00
  Sub Total==>       4,330        15             4,344   51.78  *      3,127    45.59  *          0          0     0.00
Internal Loads                                                  *                      *
  Lights             1,245       830             2,075   24.73  *      1,245    18.15  *          0          0     0.00
  People               392                         392    4.68  *        202     2.95  *          0          0     0.00
  Misc               1,440         0        0    1,440   17.16  *      1,440    20.99  *          0          0     0.00
  Sub Total==>       3,077       830        0    3,907   46.57  *      2,887    42.09  *          0          0     0.00
Ceiling Load           845      -845                 0    0.00  *        845    12.32  *          0          0     0.00
Outside Air              0         0        0        0    0.00  *          0     0.00  *          0          0     0.00
Sup. Fan Heat                                      123    1.46  *                0.00  *                     0     0.00
Ret. Fan Heat                     16                16    0.19  *                0.00  *                     0     0.00
Duct Heat Pkup                     0                 0    0.00  *                0.00  *                     0     0.00
OV/UNDR Sizing           0                           0    0.00  *          0     0.00  *          0          0     0.00
Exhaust Heat                       0        0        0    0.00  *                0.00  *                     0     0.00
Terminal Bypass                    0        0        0    0.00  *                0.00  *                     0     0.00
                                                                *                      *
Grand Total==>       8,252        16        0    8,390  100.00  *      6,859   100.00  *          0          0     0.00

-------------------------------COOLING COIL SELECTION----------------------------------------  ---------------AREAS---------------
        Total Capacity    Sens Cap.  Coil Airfl    Entering DB/WB/HR     Leaving DB/WB/HR       Gross Total     Glass (sf)  (%)
        (Tons)    (Mbh)     (Mbh)      (cfm)     Deg F  Deg F  Grains   Deg F  Deg F  Grains   Floor    153
Main Clg   0.7      8.4       7.0        200      78.2   60.6    53.1    46.0   44.6    42.6   Part       0
Aux  Clg   0.0      0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0   ExFlr     14
Opt Vent   0.0      0.0       0.0          0       0.0    0.0     0.0     0.0    0.0     0.0   Roof       0              0    0
Totals     0.7      8.4                                                                        Wall     158             22   14

-------------HEATING COIL SELECTION--------------  --------AIRFLOWS (cfm)--------  --ENGINEERING CHECKS--  --TEMPERATURES (F)--
         Capacity   Coil Airfl   Ent     Lvg       Type     Cooling    Heating   Clg % OA         0.0   Type      Clg    Htg
          (Mbh)       (cfm)     Deg F   Deg F      Vent          0          0    Clg Cfm/Sqft     1.31   SADB     46.4    0.0
Main Htg    0.0           0      0.0     0.0       Infil        34          0    Clg Cfm/Ton    286.04   Plenum   95.4    0.0
Aux  Htg    0.0           0      0.0     0.0       Supply      200          0    Clg Sqft/Ton   218.82   Return   78.0    0.0
Preheat    -9.9         200      0.0    45.8       Mincfm      200          0    Clg Btuh/Sqft   54.84   Ret/OA   78.0    0.0
Reheat      0.0           0      0.0     0.0       Return      200          0    No. People         1   Runarnd  78.0    0.0
Humidif     0.0           0      0.0     0.0       Exhaust      34          0    Htg % OA         0.0   Fn MtrTD  0.1    0.0
Opt Vent    0.0           0      0.0     0.0       Rm Exh       34          0    Htg Cfm/SqFt    0.00   Fn BldTD  0.1    0.0
Total      -9.9                                    Auxil         0          0    Htg Btuh/SqFt -64.86   Fn Frict  0.4    0.0
```

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System      9      Peak       SZ        -  SINGLE ZONE

************************ COOLING COIL PEAK ****************************** CLG SPACE PEAK *********** HEATING COIL PEAK ********
Peaked at Time ==>            Mo/Hr:  7/15                        *     Mo/Hr:  7/15         *          Mo/Hr: 13/ 1
Outside Air ==>           OADB/WB/HR:  96/ 77/112.0               *      OADB:  96           *           OADB:   3
                                                                  *                          *
                         Space  Ret. Air  Ret. Air       Net  Percnt *     Space   Percnt *     Space     Total  Percnt
                    Sens.+Lat.  Sensible    Latent     Total  Of Tot *  Sensible   Of Tot *  Sensible  Sensible  Of Tot
Envelope Loads          (Btuh)    (Btuh)    (Btuh)    (Btuh)     (%) *    (Btuh)      (%) *    (Btuh)    (Btuh)     (%)
  Skylite Solr               0         0                   0    0.00 *         0     0.00 *         0         0    0.00
  Skylite Cond               0         0                   0    0.00 *         0     0.00 *         0         0    0.00
  Roof Cond                  0         0                   0    0.00 *         0     0.00 *         0         0    0.00
  Glass Solar            3,853         0               3,853   20.78 *     3,853    26.71 *         0         0    0.00
  Glass Cond               609         0                 609    3.29 *       609     4.23 *    -2,665    -2,665    6.45
  Wall Cond              1,075       439               1,514    8.17 *     1,075     7.45 *    -2,911    -4,100    9.92
  Partition                  0                             0    0.00 *         0     0.00 *         0         0    0.00
  Exposed Floor              0                             0    0.00 *         0     0.00 *    -4,066    -4,066    9.84
  Infiltration          10,347                        10,347   55.81 *     8,446    58.56 *   -30,500   -30,500   73.79
  Sub Total==>          15,884       439              16,323   88.04 *    13,983    96.96 *   -40,142   -41,331  100.00
Internal Loads                                                       *                    *
  Lights                     0         0                   0    0.00 *         0     0.00 *         0         0    0.00
  People                     0                             0    0.00 *         0     0.00 *         0         0    0.00
  Misc                       0         0         0         0    0.00 *         0     0.00 *         0         0    0.00
  Sub Total==>               0         0         0         0    0.00 *         0     0.00 *         0         0    0.00
Ceiling Load               439      -439                   0    0.00 *       439     3.04 *    -1,189         0    0.00
Outside Air                  0         0         0         0    0.00 *         0     0.00 *         0         0    0.00
Sup. Fan Heat                                          1,962   10.58 *               0.00 *                   0    0.00
Ret. Fan Heat                          255                 255    1.37 *               0.00 *                   0    0.00
Duct Heat Pkup                           0                   0    0.00 *               0.00 *                   0    0.00
OV/UNDR Sizing               0                             0    0.00 *         0     0.00 *         0         0    0.00
Exhaust Heat                             0         0         0    0.00 *               0.00 *                   0    0.00
Terminal Bypass                          0         0         0    0.00 *               0.00 *                   0    0.00
                                                                     *                    *
Grand Total==>          16,323       255         0    18,540  100.00 *    14,422   100.00 *   -41,331   -41,331  100.00

----------------------------------COOLING COIL SELECTION---------------------------------   ------------AREAS------------
           Total Capacity   Sens Cap.  Coil Airfl   Entering DB/WB/HR     Leaving DB/WB/HR    Gross Total   Glass (sf)  (%)
           (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F Deg F Grains    Deg F Deg F Grains   Floor   1,950
Main Clg     1.5     18.5      16.6      1,600      78.0  70.8  105.6     68.6  67.7  103.7   Part        0
Aux  Clg     0.0      0.0       0.0          0       0.0   0.0    0.0      0.0   0.0    0.0   ExFlr      78
Opt Vent     0.0      0.0       0.0          0       0.0   0.0    0.0      0.0   0.0    0.0   Roof        0           0    0
Totals       1.5     18.5                                                                     Wall      977          65    7

----------HEATING COIL SELECTION-----------   --------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--        --TEMPERATURES (F)--
            Capacity  Coil Airfl  Ent    Lvg      Type      Cooling   Heating   Clg % OA            0.0   Type       Clg    Htg
             (Mbh)      (cfm)    Deg F  Deg F     Vent            0         0   Clg Cfm/Sqft       0.82   SADB      69.7  125.0
Main Htg     -40.9        669    68.6   125.0     Infil         433       433   Clg Cfm/Ton     1035.60   Plenum    78.7   66.1
Aux  Htg       0.0          0     0.0     0.0     Supply      1,600       669   Clg Sqft/Ton    1262.13   Return    78.0   68.0
Preheat       -1.0      1,600    68.0    68.6     Mincfm      1,600         0   Clg Btuh/Sqft      9.51   Ret/OA    78.0   68.0
Reheat         0.0          0     0.0     0.0     Return      1,599       669   No. People           50   Runarnd   78.0   68.0
Humidif        0.0          0     0.0     0.0     Exhaust       433         0   Htg % OA            0.0   Fn MtrTD   0.1    0.0
Opt Vent       0.0          0     0.0     0.0     Rm Exh        434         0   Htg Cfm/SqFt       0.34   Fn BldTD   0.2    0.0
Total        -41.9                                Auxil           0         0   Htg Btuh/SqFt    -21.48   Fn Frict   0.7    0.0
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System    10      Block      FC        -  FAN COIL

************************ COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>              Mo/Hr:  7/15                          *     Mo/Hr:  7/15         *              Mo/Hr: 13/ 1
Outside Air ==>            OADB/WB/HR:  96/ 77/112.0                  *      OADB:  96           *               OADB:   3
                                                                      *                          *
                       Space   Ret. Air  Ret. Air       Net  Percnt  *      Space     Percnt  *      Space      Total   Percnt
                  Sens.+Lat.   Sensible    Latent     Total  Of Tot  *   Sensible     Of Tot  *   Sensible   Sensible   Of Tot
Envelope Loads       (Btuh)     (Btuh)    (Btuh)    (Btuh)     (%)  *     (Btuh)        (%)  *     (Btuh)     (Btuh)      (%)
  Skylite Solr            0          0                   0    0.00  *          0       0.00  *          0          0     0.00
  Skylite Cond            0          0                   0    0.00  *          0       0.00  *          0          0     0.00
  Roof Cond               0          0                   0    0.00  *          0       0.00  *          0          0     0.00
  Glass Solar           610          0                 610   12.94  *        610      17.20  *          0          0     0.00
  Glass Cond            300          0                 300    6.36  *        300       8.45  *     -1,310     -1,310    10.13
  Wall Cond             523        201                 724   15.36  *        523      14.76  *     -1,717     -2,377    18.38
  Partition               0                              0    0.00  *          0       0.00  *          0          0     0.00
  Exposed Floor           0                              0    0.00  *          0       0.00  *     -2,340     -2,340    18.10
  Infiltration        2,665                          2,665   56.53  *      1,912      53.92  *     -6,903     -6,903    53.39
  Sub Total==>        4,097        201               4,298   91.18  *      3,344      94.33  *    -12,270    -12,930   100.00
Internal Loads                                                      *                          *
  Lights                  0          0                   0    0.00  *          0       0.00  *          0          0     0.00
  People                  0                              0    0.00  *          0       0.00  *          0          0     0.00
  Misc                    0          0         0         0    0.00  *          0       0.00  *          0          0     0.00
  Sub Total==>            0          0         0         0    0.00  *          0       0.00  *          0          0     0.00
Ceiling Load            201       -201                   0    0.00  *        201       5.67  *       -660          0     0.00
Outside Air               0          0         0         0    0.00  *          0       0.00  *          0          0     0.00
Sup. Fan Heat                                          368    7.80  *                  0.00  *                     0     0.00
Ret. Fan Heat                       48                  48    1.01  *                  0.00  *                     0     0.00
Duct Heat Pkup                       0                   0    0.00  *                  0.00  *                     0     0.00
OV/UNDR Sizing            0                              0    0.00  *          0       0.00  *          0          0     0.00
Exhaust Heat                         0         0         0    0.00  *                  0.00  *                     0     0.00
Terminal Bypass                      0         0         0    0.00  *                  0.00  *                     0     0.00
                                                                    *                          *
Grand Total==>        4,298         48         0     4,714  100.00  *      3,545     100.00  *    -12,930    -12,930   100.00

--------------------------------COOLING COIL SELECTION---------------------------------    -------------AREAS-------------
             Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR    Leaving DB/WB/HR      Gross Total   Glass (sf)  (%)
             (Tons)   (Mbh)     (Mbh)      (cfm)     Deg F  Deg F Grains  Deg F  Deg F Grains  Floor      440
Main Clg       1.3     15.5     13.0        600      78.2   70.0  100.7   72.2   62.8   72.9   Part         0
Aux  Clg       0.0      0.0      0.0          0       0.0    0.0    0.0    0.0    0.0    0.0   ExFlr       45
Opt Vent       0.0      0.0      0.0          0       0.0    0.0    0.0    0.0    0.0    0.0   Roof         0           0    0
Totals         1.3     15.5                                                                    Wall       567          32    6

-----------HEATING COIL SELECTION-------------    ---------AIRFLOWS (cfm)--------   --ENGINEERING CHECKS--   --TEMPERATURES (F)--
            Capacity   Coil Airfl    Ent    Lvg     Type      Cooling    Heating   Clg % OA          0.0   Type       Clg    Htg
              (Mbh)      (cfm)     Deg F  Deg F    Vent            0          0   Clg Cfm/Sqft     1.36   SADB      72.5  125.0
Main Htg      -12.0        209      72.0  125.0    Infil          98         98   Clg Cfm/Ton    464.52   Plenum    79.4   63.3
Aux  Htg        0.0          0       0.0    0.0    Supply        600        209   Clg Sqft/Ton   340.65   Return    78.0   68.0
Preheat        -2.6        600      68.0   72.0    Mincfm        600          0   Clg Btuh/Sqft   35.23   Ret/OA    78.0   68.0
Reheat          0.0          0       0.0    0.0    Return        600        209   No. People          8   Runarnd   78.0   68.0
Humidif         0.0          0       0.0    0.0    Exhaust        98          0   Htg % OA          0.0   Fn MtrTD   0.1    0.0
Opt Vent        0.0          0       0.0    0.0    Rm Exh         98          0   Htg Cfm/SqFt     0.48   Fn BldTD   0.1    0.0
Total         -14.6                                Auxil           0          0   Htg Btuh/SqFt  -33.22   Fn Frict   0.4    0.0
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System    11     Peak     SZ      -  SINGLE ZONE

************************ COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>          Mo/Hr:  7/15                          *       Mo/Hr:  7/16         *              Mo/Hr: 13/ 1
Outside Air ==>          OADB/WB/HR:  96/ 77/112.0                *        OADB:  96           *               OADB:   3
                                                                  *                            *
                      Space    Ret. Air  Ret. Air       Net  Percnt *      Space    Percnt *      Space      Total   Percnt
                  Sens.+Lat.  Sensible   Latent       Total  Of Tot *   Sensible    Of Tot *   Sensible   Sensible   Of Tot
Envelope Loads       (Btuh)    (Btuh)    (Btuh)      (Btuh)     (%) *     (Btuh)       (%) *     (Btuh)     (Btuh)      (%)
  Skylite Solr            0         0                     0    0.00 *          0      0.00 *          0          0     0.00
  Skylite Cond            0         0                     0    0.00 *          0      0.00 *          0          0     0.00
  Roof Cond               0         0                     0    0.00 *          0      0.00 *          0          0     0.00
  Glass Solar        24,134         0                24,134   18.97 *     25,382     28.06 *          0          0     0.00
  Glass Cond          3,883         0                 3,883    3.05 *      3,858      4.26 *    -16,981    -16,981    10.82
  Wall Cond          18,061     2,420                20,482   16.10 *     18,310     20.24 *    -53,853    -66,849    42.59
  Partition               0                               0    0.00 *          0      0.00 *          0          0     0.00
  Exposed Floor           0                               0    0.00 *          0      0.00 *          0          0     0.00
  Infiltration       47,186                          47,186   37.08 *     19,685     21.76 *    -73,115    -73,115    46.59
  Sub Total==>       93,265     2,420                95,685   75.19 *     67,235     74.33 *   -143,948   -156,944   100.00
Internal Loads                                                      *                          *
  Lights             19,298    12,866                32,164   25.28 *     19,298     21.33 *          0          0     0.00
  People              8,919                           8,919    7.01 *      4,655      5.15 *          0          0     0.00
  Misc               20,547         0         0      20,547   16.15 *     20,792     22.98 *          0          0     0.00
  Sub Total==>       48,765    12,866         0      61,631   48.43 *     44,745     49.46 *          0          0     0.00
Ceiling Load         15,286   -15,286                     0    0.00 *     15,346     16.96 *    -12,996          0     0.00
Outside Air               0         0         0           0    0.00 *          0      0.00 *          0          0     0.00
Sup. Fan Heat                                         6,020    4.73 *                 0.00 *                     0     0.00
Ret. Fan Heat                     783                   783    0.61 *                 0.00 *                     0     0.00
Duct Heat Pkup                      0                     0    0.00 *                 0.00 *                     0     0.00
OV/UNDR Sizing      -36,866                         -36,866  -28.97 *    -36,866    -40.75 *          0          0     0.00
Exhaust Heat                        0         0           0    0.00 *                 0.00 *                     0     0.00
Terminal Bypass                     0         0           0    0.00 *                 0.00 *                     0     0.00
                                                                    *                          *
Grand Total==>      120,449       783         0     127,252  100.00 *     90,460    100.00 *   -156,944   -156,944   100.00

-------------------------------COOLING COIL SELECTION-------------------------------------   -------------AREAS-------------
           Total Capacity   Sens Cap.  Coil Airfl    Entering DB/WB/HR     Leaving DB/WB/HR     Gross Total     Glass (sf)   (%)
           (Tons)   (Mbh)     (Mbh)      (cfm)    Deg F  Deg F  Grains   Deg F  Deg F  Grains   Floor     4,188
Main Clg    13.7    164.1     132.8      4,910     78.0   64.9    73.9    60.1   53.8    53.6   Part          0
Aux  Clg     0.0      0.0       0.0          0      0.0    0.0     0.0     0.0    0.0     0.0   ExFlr         0
Opt Vent     0.0      0.0       0.0          0      0.0    0.0     0.0     0.0    0.0     0.0   Roof          0           0     0
Totals      13.7    164.1                                                                      Wall      3,521         416    12

-----------HEATING COIL SELECTION-----------   -------AIRFLOWS (cfm)-------   --ENGINEERING CHECKS--      --TEMPERATURES (F)--
         Capacity  Coil Airfl    Ent     Lvg     Type      Cooling   Heating  Clg % OA          0.0       Type      Clg    Htg
          (Mbh)      (cfm)    Deg F   Deg F    Vent            0         0  Clg Cfm/Sqft      1.17       SADB     61.0  125.0
Main Htg  -156.9     2,541    68.0   125.0    Infil        1,038     1,038  Clg Cfm/Ton     359.01       Plenum   89.5   58.2
Aux  Htg     0.0         0     0.0     0.0    Supply       4,910     2,541  Clg Sqft/Ton    306.22       Return   78.0   68.0
Preheat      0.0     4,910    68.0    59.9    Mincfm       4,910         0  Clg Btuh/Sqft    39.19       Ret/OA   78.0   68.0
Reheat       0.0         0     0.0     0.0    Return       4,910     2,541  No. People          23       Runarnd  78.0   68.0
Humidif      0.0         0     0.0     0.0    Exhaust      4,910         0  Htg % OA           0.0       Fn MtrTD  0.1    0.0
Opt Vent     0.0         0     0.0     0.0    Rm Exh       1,037         0  Htg Cfm/SqFt      0.61       Fn BldTD  0.2    0.0
Total     -156.9                              Auxil            0         0  Htg Btuh/SqFt   -37.47       Fn Frict  0.7    0.0
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System    12      Peak       SZ        -  SINGLE ZONE

************************* COOLING COIL PEAK ******************************** CLG SPACE PEAK ************ HEATING COIL PEAK ********
Peaked at Time ==>             Mo/Hr:  7/15                          *   Mo/Hr:  7/16        *          Mo/Hr: 13/ 1
Outside Air ==>          OADB/WB/HR:  96/ 77/112.0                   *    OADB:  96          *           OADB:    3
                                                                     *                       *
                   Space    Ret. Air  Ret. Air        Net   Percnt   *     Space    Percnt   *      Space      Total   Percnt
               Sens.+Lat.   Sensible    Latent      Total   Of Tot   *  Sensible    Of Tot   *   Sensible   Sensible   Of Tot
Envelope Loads     (Btuh)     (Btuh)    (Btuh)     (Btuh)      (%)   *    (Btuh)       (%)   *     (Btuh)     (Btuh)      (%)
  Skylite Solr          0          0                    0     0.00   *         0      0.00   *          0          0     0.00
  Skylite Cond          0          0                    0     0.00   *         0      0.00   *          0          0     0.00
  Roof Cond        17,656          0               17,656    10.74   *    17,387     15.68   *    -17,495    -17,495     0.00
  Glass Solar      24,192          0               24,192    14.72   *    25,443     22.94   *          0          0     0.00
  Glass Cond        3,893          0                3,893     2.37   *     3,867      3.49   *    -17,021    -17,021     9.41
  Wall Cond        21,053          0               21,053    12.81   *    21,342     19.25   *    -62,772    -62,772    34.70
  Partition             0                               0     0.00   *         0      0.00   *          0          0     0.00
  Exposed Floor         0                               0     0.00   *         0      0.00   *          0          0     0.00
  Infiltration     53,959                          53,959    32.82   *    22,510     20.30   *    -83,610    -83,610    46.22
  Sub Total==>    120,753          0              120,753    73.46   *    90,551     81.66   *   -180,898   -180,898   100.00
Internal Loads                                                       *                       *
  Lights           24,382      9,753               34,135    20.77   *    24,382     21.99   *          0          0     0.00
  People           11,634                          11,634     7.08   *     6,072      5.48   *          0          0     0.00
  Misc             17,309          0         0     17,309    10.53   *    17,506     15.79   *          0          0     0.00
  Sub Total==>     53,325      9,753         0     63,078    38.37   *    47,960     43.25   *          0          0     0.00
Ceiling Load            0          0                    0     0.00   *         0      0.00   *          0          0     0.00
Outside Air             0          0         0          0     0.00   *         0      0.00   *          0          0     0.00
Sup. Fan Heat                                       7,234     4.40   *                0.00   *                     0     0.00
Ret. Fan Heat                    940                  940     0.57   *                0.00   *                     0     0.00
Duct Heat Pkup                     0                    0     0.00   *                0.00   *                     0     0.00
OV/UNDR Sizing    -27,619                         -27,619   -16.80   *   -27,619    -24.91   *          0          0     0.00
Exhaust Heat                       0         0          0     0.00   *                0.00   *                     0     0.00
Terminal Bypass                    0         0          0     0.00   *                0.00   *                     0     0.00
                                                                     *                       *
Grand Total==>    146,460     10,693         0    164,387   100.00   *   110,892    100.00   *   -180,898   -180,898   100.00

-----------------------------------COOLING COIL SELECTION--------------------------------------   ---------------AREAS--------------
          Total Capacity   Sens Cap.   Coil Airfl   Entering DB/WB/HR      Leaving DB/WB/HR        Gross Total    Glass (sf)   (%)
          (Tons)   (Mbh)     (Mbh)       (cfm)    Deg F  Deg F  Grains   Deg F  Deg F  Grains      Floor     4,188
Main Clg   16.0    192.0     155.5       5,900     78.0   64.9    73.9    59.7   54.1    55.5      Part          0
Aux  Clg    0.0      0.0       0.0           0      0.0    0.0     0.0     0.0    0.0     0.0      ExFlr         0
Opt Vent    0.0      0.0       0.0           0      0.0    0.0     0.0     0.0    0.0     0.0      Roof      5,176             0    0
Totals     16.0    192.0                                                                           Wall      3,236           417   13

------------HEATING COIL SELECTION-------------    ---------AIRFLOWS (cfm)---------   --ENGINEERING CHECKS--     --TEMPERATURES (F)--
           Capacity   Coil Airfl   Ent     Lvg      Type      Cooling   Heating     Clg % OA            0.0    Type      Clg    Htg
            (Mbh)       (cfm)     Deg F   Deg F     Vent            0         0     Clg Cfm/Sqft       1.41    SADB     60.7  125.0
Main Htg   -180.9       2,929     68.0   125.0      Infil       1,187     1,187     Clg Cfm/Ton      368.74    Plenum   78.0   68.0
Aux  Htg      0.0           0      0.0     0.0      Supply      5,900     2,929     Clg Sqft/Ton     261.74    Return   78.0   68.0
Preheat       0.0       5,900     68.0    59.5      Mincfm      5,900         0     Clg Btuh/Sqft     45.85    Ret/OA   78.0   68.0
Reheat        0.0           0      0.0     0.0      Return      5,900     2,929     No. People           30    Runarnd  78.0   68.0
Humidif       0.0           0      0.0     0.0      Exhaust     5,900         0     Htg % OA            0.0    Fn MtrTD  0.1    0.0
Opt Vent      0.0           0      0.0     0.0      Rm Exh      1,183         0     Htg Cfm/SqFt       0.70    Fn BldTD  0.2    0.0
Total      -180.9                                   Auxil           0         0     Htg Btuh/SqFt    -43.19    Fn Frict  0.7    0.0
```

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 2
BASE LOAD

MONTHLY ENERGY CONSUMPTION

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	STEAM (Therm)
Jan	10,633	53	611
Feb	9,547	54	532
March	10,846	54	374
April	8,658	54	6
May	10,038	54	0
June	17,624	91	0
July	20,992	99	0
Aug	19,393	92	0
Sept	12,050	84	0
Oct	9,581	54	0
Nov	8,926	53	70
Dec	9,962	54	814
Total	148,250	99	2,407

Building Energy Consumption = 58,199 (Btu/Sq Ft/Year)
Source Energy Consumption = 143,339 (Btu/Sq Ft/Year)

Floor Area = 12,830 (Sq Ft)

EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 2
BASE LOAD

EQUIPMENT ENERGY CONSUMPTION

Ref Num	Equip Code	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
		Monthly Consumption												
0	LIGHTS													
	ELEC	5281	4672	5554	4987	5554	5260	5007	5828	4713	5281	4987	4733	61,857
	PK	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3
1	MISC LD													
	ELEC	2947	2601	3121	2774	3121	3260	3069	3644	2877	2947	2774	2601	35,736
	PK	16.7	16.7	16.7	16.7	16.7	18.9	18.9	18.9	18.9	16.7	16.7	16.7	18.9
2	MISC LD													
	GAS	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	MISC LD													
	OIL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	MISC LD													
	P STEAM	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	MISC LD													
	P HOTH2O	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	MISC LD													
	P CHILL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	EQ1121S		AC RECIP CHILLER 20-60 T											
	ELEC	0	0	0	0	0	5342	7352	5435	2105	0	0	0	20,233
	PK	0.0	0.0	0.0	0.0	0.0	28.1	32.1	27.0	20.7	0.0	0.0	0.0	32.1
1	EQ5200		CONDENSER FANS											
	ELEC	0	0	0	0	0	645	967	671	244	0	0	0	2,528
	PK	0.0	0.0	0.0	0.0	0.0	3.6	4.7	3.4	2.8	0.0	0.0	0.0	4.7
1	EQ5001		CHILLED WATER PUMP C.V.											
	ELEC	0	0	0	0	0	984	1017	1017	594	0	0	0	3,612
	PK	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0	3.0	0.0	0.0	0.0	3.0
1	EQ5313		CONTROLS											
	ELEC	0	0	0	0	0	99	102	102	60	0	0	0	363
	PK	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.3
2	EQ1170S		AC COND COMP <20 TONS											
	ELEC	0	0	0	0	0	0	439	195	33	0	0	0	668
	PK	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.4	1.3	0.0	0.0	0.0	1.6
2	EQ5200		CONDENSER FANS											

```
EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 2
BASE LOAD

    ELEC        0     0     0     0     0     0    58    24     4     0     0     0       86
    PK        0.0   0.0   0.0   0.0   0.0   0.0   0.2   0.2   0.2   0.0   0.0   0.0      0.2

  2 EQ5313              CONTROLS
    ELEC        0     0     0     0     0     0   102    86    21     0     0     0      209
    PK        0.0   0.0   0.0   0.0   0.0   0.0   0.3   0.3   0.3   0.0   0.0   0.0      0.3

  1 EQ4371              FAN COIL SUPPLY FAN
    ELEC       20    18    18    13    15    28    35    35    21    17    13    13      246
    PK        0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1      0.1

  2 EQ4371              FAN COIL SUPPLY FAN
    ELEC        0     1    15    13    15    24    18    18    13    14    13    12      157
    PK        0.0   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1      0.1

  3 EQ4371              FAN COIL SUPPLY FAN
    ELEC       12    33    39    35    39    69    48    48    35    37    35    33      462
    PK        0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2   0.2      0.2

  4 EQ4371              FAN COIL SUPPLY FAN
    ELEC        0     0    15    13    15    25    17    18    13    14    13    12      154
    PK        0.0   0.0   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1      0.1

  5 EQ4371              FAN COIL SUPPLY FAN
    ELEC        4     3     4     2     3    10    19    18    10     4     2     4       83
    PK        0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.1   0.1   0.1   0.0   0.0      0.1

  6 EQ4371              FAN COIL SUPPLY FAN
    ELEC        4     3     4     3    15    23    19    18    13    14    13    10      140
    PK        0.0   0.0   0.0   0.0   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1      0.1

  7 EQ4371              FAN COIL SUPPLY FAN
    ELEC       14    12    15    13    15    15    16    17    13    14    13    12      169
    PK        0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1      0.1

  8 EQ4371              FAN COIL SUPPLY FAN
    ELEC        0     7    10     9    10    17    11    12     9     9     9     8      110
    PK        0.0   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1   0.1      0.1

  9 EQ4003              FC CENTRIF. FAN C.V.
    ELEC       95    85    87    36    26    26   364   189    55    28    31   108    1,130
    PK        0.5   0.5   0.5   0.5   0.5   0.5   1.2   1.2   1.2   0.5   0.5   0.5      1.2

 10 EQ4371              FAN COIL SUPPLY FAN
    ELEC       11    10    10     4     3     3    10    28     6     3     3    11      102
    PK        0.1   0.1   0.1   0.1   0.1   0.1   0.2   0.2   0.2   0.1   0.1   0.1      0.2

 11 EQ4003              FC CENTRIF. FAN C.V.
    ELEC      503   448   456   300   579   878  1094   959   573   546   303   533    7,172
    PK        1.9   1.9   1.9   1.9   3.6   3.6   3.6   3.6   3.6   3.6   1.9   1.9      3.6

 12 EQ4003              FC CENTRIF. FAN C.V.
    ELEC      590   527   552   346   630   916  1226  1030   637   652   402   624    8,133
    PK        2.2   2.2   2.2   2.2   4.4   4.4   4.4   4.4   4.4   4.4   2.2   2.2      4.4

  1 CONVERTR            STEAM TO HOT WATER CONVERTER
```

```
EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 2
BASE LOAD

      P STEAM     611    532    374      6      0      0      0      0      0      0     70    814        2,407
      PK          4.4    4.4    4.4    1.7    0.0    0.0    0.0    0.0    0.0    0.0    3.7    4.4          4.4

   1  EQ5020             HEAT WATER CIRC. PUMP C.V.
      ELEC        940    919    773     89      0      0      0      0      0      0    257   1017        3,994
      PK          3.0    3.0    3.0    3.0    0.0    0.0    0.0    0.0    0.0    0.0    3.0    3.0          3.0

   1  EQ5060             CONDENSATE RETURN PUMP
      ELEC        213    208    175     20      0      0      0      0      0      0     58    231          906
      PK          0.7    0.7    0.7    0.7    0.0    0.0    0.0    0.0    0.0    0.0    0.7    0.7          0.7
```

```
UTILITY PEAK CHECKSUMS - ALTERNATIVE 2
BASE LOAD

-------------------------------------- UTILITY PEAK CHECKSUMS --------------------------------------

Utility    ELECTRIC DEMAND

Peak Value          99.2    (kW)
Yearly Time of Peak  15 (hr)    7 (mo)

Hour 15  Month  7

Eqp.                                                                   Utility  Percnt
Ref.      Equipment                                                     Demand  Of Tot
Num.      Code Name                      Equipment Description           (kW)     (%)

Cooling Equipment

  1         EQ1121S   AC RECIP CHILLER 20-60 T                           40.0    40.36
  2         EQ1170S   AC COND COMP <20 TONS                               2.1     2.08

Sub Total                                                                42.1    42.44

Sub Total                                                                 0.0   ******

Air Moving Equipment

  1                   SUMMATION OF FAN ELECTRICAL DEMAND                  0.1     0.11
  2                   SUMMATION OF FAN ELECTRICAL DEMAND                  0.1     0.08
  3                   SUMMATION OF FAN ELECTRICAL DEMAND                  0.2     0.22
  4                   SUMMATION OF FAN ELECTRICAL DEMAND                  0.1     0.08
  5                   SUMMATION OF FAN ELECTRICAL DEMAND                  0.1     0.08
  6                   SUMMATION OF FAN ELECTRICAL DEMAND                  0.1     0.08
  7                   SUMMATION OF FAN ELECTRICAL DEMAND                  0.1     0.08
  8                   SUMMATION OF FAN ELECTRICAL DEMAND                  0.1     0.05
  9                   SUMMATION OF FAN ELECTRICAL DEMAND                  1.2     1.19
 11                   SUMMATION OF FAN ELECTRICAL DEMAND                  3.6     3.65
 12                   SUMMATION OF FAN ELECTRICAL DEMAND                  4.4     4.39

Sub Total                                                                 9.9    10.03

Sub Total                                                                 0.0     0.00

Miscellaneous

 Lights                                                                  28.3    28.50
 Base Utilities                                                           0.0     0.00
 Misc Equipment                                                          18.9    19.04
Sub Total                                                                47.1    47.53

Grand Total                                                              99.2   100.00
```

CALIFORNIA TITLE 24 COMPLIANCE - ALTERNATIVE 2
BASE LOAD

CALIFORNIA TITLE 24 COMPLIANCE REPORT

Weather Name	FTLVNWTH
Gross Conditioned Floor Area (sqft)......	12,830
ACM Multiplier	1.008

ENERGY USE SUMMARY

	ELEC (kWh/yr)	DISTRICT STEAM (kBtu/yr)	PERCENT OF TOTAL ENERGY (%)	TOTAL SOURCE ENERGY (kBtu/yr)	ADJUSTED UNIT SOURCE ENERGY (kBtu/yr-sf)
Primary Heating	906.1	240,718.4	32.7	330,236.8	25.9
Primary Cooling					
Compressor	20,900.9	0.0	9.6	214,025.3	16.8
Tower/Cond Fans	2,614.5	0.0	1.2	26,772.2	2.1
Condenser Pump	0.0	0.0	0.0	0.0	0.0
Other Accessories	572.4	0.0	0.3	5,861.4	0.5
Auxiliary					
Supply Fans	18,057.3	0.0	8.3	184,907.0	14.5
Circulation Pumps	7,606.2	0.0	3.5	77,887.2	6.1
Base Utilities	0.0	0.0	0.0	0.0	0.0
Subtotal	25,663.4	0.0	11.7	262,794.2	20.6
Lighting	61,856.7	0.0	28.3	633,414.1	49.8
Receptacle	35,735.9	0.0	16.3	365,936.9	28.8
Domestic Hot Water	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0
Totals	148,250.0	240,718.4	100.0	1,839,041.0	144.5

ECO-M3

SERVICE STEAM PIPING AND TRAPS

STEAM PIPING AND TRAPS
ENERGY CONSERVATION OPPORTUNITY: ECO-M3

PURPOSE:

The purpose of this Energy Conservation Opportunity (ECO-M3) is to calculate the savings realized by servicing the steam piping and the steam traps. Steam traps are designed to hold steam in the heating device until it gives up its latent heat, and to separate condensate from the steam supply. The steam trap then allows the liquid condensate to discharge and return to the boilers where it is reheated into steam.

Steam traps are mechanical devices that wear with time, and eventually fail. Steam trap failure can occur in the open position, or in the closed position. When a trap fails in the closed position it is usually noticed and repaired quickly. This is because condensate backs up into the heating device, reducing the efficiency of the heat transfer surface, and the heating device can no longer function properly.

More commonly, steam traps fail in the open position, and trap failure is not as readily apparent. An open steam trap needlessly wastes energy by allowing steam to escape through a vent line to the atmosphere, or by condensing in the condensate piping. Condensate piping is normally installed in chases, tunnels, mechanical rooms or other unconditioned spaces. When condensate is allowed to give up its latent heat to these areas, it translates into increased energy costs.

Steam traps must also vent air from the piping system to the atmosphere to prevent the corrosive effects of oxygen on the pipe, which will eventually lead to the premature failure of the piping system.

Steam trap, and steam piping maintenance and repair are vital to the control of energy usage. The frequency of steam trap inspection depends on the steam supply pressure, and the type of trap. Steam traps operating at pressures between 30 psig and 120 psig, should be inspected monthly. Steam traps operating at pressures below 30 psig should be inspected on a semi-annual basis. When faulty steam traps are discovered they should be repaired, or replaced with a new steam trap.

There are three methods available for the inspection of steam traps as follows:

1) Temperature Testing.

2) Sonic Testing.

3) Manual Inspection.

Due to the cost of the temperature and sonic testing equipment, the specialized training required for their operation, and the changing maintenance personnel at the USDB, the first two methods are not advisable "in house". Temperature and sonic testing can be performed reliable by a trap testing service. Manual inspection involves the installation of a test valve downstream from each steam trap, to observe the steam and condensate as they escape the test valve.

The following is a guideline of what to look for when manually testing steam traps:

Condensate Discharge

1) Intermittent condensate discharge from disc traps indicates normal operation.

2) Thermostatic traps can have a continuous discharge under heavy load, or an intermittent discharge of condensate under light load.

3) The inverted bucket trap can also have a continuous, or intermittent discharge of condensate depending upon the load. When an inverted bucket trap operates under a **very** small load, it can have a continuous condensate discharge, and will display a "dribbling effect".

Flash Steam

Condensate under pressure is able to hold more heat (BTU's) per pound than condensate at atmospheric pressure. When the condensate is discharged from the steam trap, this extra heat is re-evaporated into steam (flash steam).

1) Flash steam should not be mistaken for steam leakage through the steam trap.

2) Flash steam "floats" out intermittently (each time condensate discharges) as a "whitish cloud".

3) A leaking steam trap, manifests a continuous "blue" stream blowing out of the steam trap.

SCOPE:

Steam is delivered to the various buildings by a system of insulated high pressure steam pipes located in tunnels. Condensate is returned through piping located in the same system of tunnels by gravity to the boilers located in the boiler plant.

MODELING TECHNIQUES:

Table M3-1 below indicates the amount of steam lost through various steam traps when the trap has failed. These losses are based on total steam trap failure.

TABLE M3-1

Type of Steam Trap	Condensate Capacity Lbs./Hr.	Steam Loss Lbs./Hr.
Disc	300-900	55-170
Float & Thermostatic	350-650	65-170
Thermostatic	600-1900	110-350
Inverted Bucket:		
With 5/16" orifice	350	35
With restricted orifice	350	35

A steam trap can fail in the wide open position, but it will not waste live steam 24 hours a day, 365 days a year. The trap will still handle the condensate load for which it was selected, and will also only pass live steam when the steam to the device is turned on, and then somewhat proportional to the degree of opening of the control valve.

Energy lost through leaking steam traps must be adjusted for seasonal usage. The following two examples are given for 350 lbs./hr. capacity steam traps.

EXAMPLE #1

A bucket trap serving a steam main that is operational for the entire year would waste:

35 lbs./hr. X 8760 hrs./yr. X $5.75/1000 lbs. of steam) = $1763 a year.

EXAMPLE #2

A float and thermostatic trap serving a heating coil operating only during the heating months would lose:

65 lbs./hr. X 4380 hrs./yr. X 0.5 (system modulation factor) X ($5.75/1000 lbs. of steam) = $819 a year.

ECO IMPLEMENTATION:

The figures above demonstrate the economic loss that can be experienced because of steam trap failure. If only ten steam traps within a facility failed, the cost for the wasted steam could be $10,000 per year.

Calculation Sheet M3-1 shows the cost of installing test valves on steam traps, and the money saved assuming a 10% failure rate, and the cost of inspecting the traps.

Calculation Sheet M3-2 shows the cost of having an outside service inspection performed on the steam traps. The prices were obtained from Hughes Machinery Company, the local representative of Armstrong steam traps. The life cycle cost analysis summary sheet indicates the cost of inspection, and dollar savings from replacing traps based on a 100 trap system.

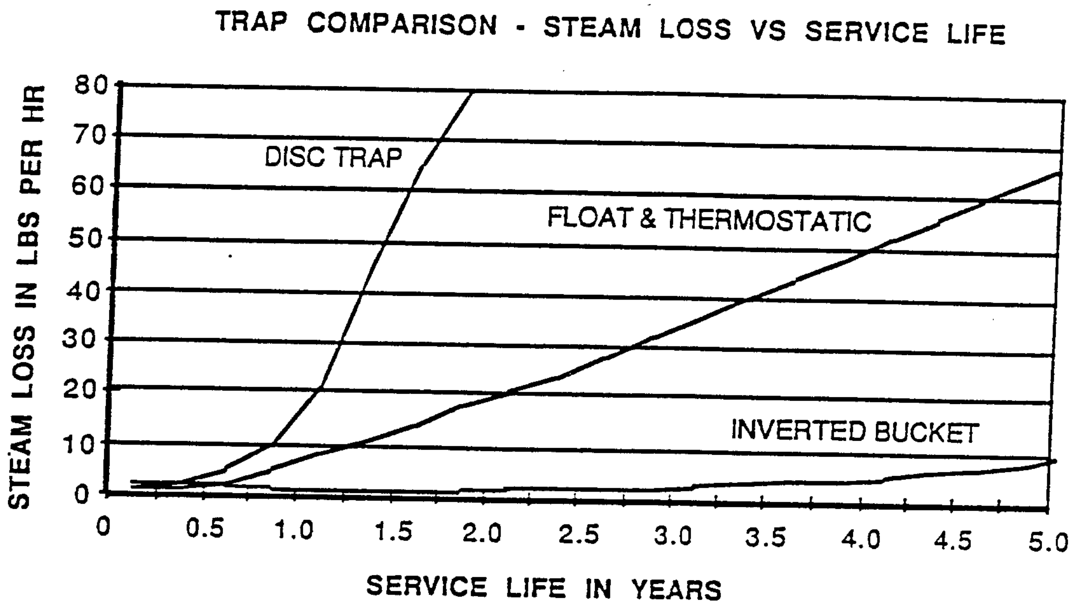
SUMMARY:

The life cycle cost summary sheet indicates the cost to install the trap testing valves, the cost of inspection, and the dollar savings from replacing the steam traps based on a 100 trap system.

A construction cost of $15,738 for in-house steam trap testing gives a 4.55 savings to investment ratio, and a 2.56 year simple payback.

An outside testing service is recommended at a cost of $16,150. The payback and SIR are essentially the same as in-house testing.

The graph of steam trap comparison is published by Armstrong Machine Works.



Steam losses over the service life of traps, Test conditions were 150 psig steam inlet pressure, 0 psig outlet pressure

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET 1 OF 1

PROJECT
USDB ENERGY STUDY

LOCATION
FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO.

ESTIMATOR TGD

CHECKED BY

	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
INSTALL TEST VALVE (PER TRAP)							
CREW 1 STEAM FITTER, 1 APPRENTICE							
DISCONNECT EXISTING PIPE	1.00	MH	$22.27	$22	$20.00	$20	$42
INSTALL TEE AND TEST LINE	0.75	MH	$22.27	$17	$5.40	$4	$21
INSTALL GLOBE VALVE	0.75	MH	$22.27	$17	$17.10	$13	$30
SUBTOTAL				$56		$37	$93
CONTINGENCY 10%			10%	$6	10%	$4	$10
SUBTOTAL				$62		$41	$103
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$2	13.0%	$5	$7
DIRECT COST				$64		$46	$110
OVERHEAD AND PROFIT			25%	$16	25%	$11	$27
SUBTOTAL				$80		$57	$137
CONSTRUCTION COST PER TRAP							$137

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CALCULATION SHEET	DATE March,1987	SHEET 1 OF 1
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	BASIS FOR CALCULATION X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)	
LOCATION		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
ECO MEASURE STEAM TRAP PROGRAM - OWNER TESTING	COMPUTED BY TGD	CHECKED BY

COST OF STEAM AT FORT LEAVENWORTH - USDB

ENTHALPY OF WATER AT 160° F. =	128 BTU/LBM
ENTHALPY OF STEAM AT 120 PSIG =	1,192 BTU/LBM
STEAM EFFICIENCY =	74%
NATURAL GAS COST =	$4.00 MCF
HEAT CONTENT OF NAT. GAS =	1,000,000 BTU/MCF
((1192-128)*$4.00)/0.74*1,000)	$5.75 PER THOUSAND LB STEAM

COST OF INSPECTING TRAPS AFTER TEST VALVES ARE INSTALLED.

ASSUMING AN AVERAGE OF 50 TRAPS PER DAY 8 HOURS PER DAY.

8 MH X $36.75 PER HOUR = $294 PER DAY

$294 / 50 TRAPS PER DAY = $5.88 PER TRAP

COST OF INSTALLING TEST VALVES ON EACH TRAP = $137

SAVINGS FROM TRAP INSPECTION

USING 100 TRAPS AS A BASE WITH A 10% FAILURE RATE; 350 LB/HR F&T TRAP

COST OF INSPECTING TRAPS ONCE DURING THE HEATING SEASON 100 X $5.88 = $588/YEAR

NUMBER OF TRAPS FAILED 100 X 10% = 10 TRAPS

COST OF REPAIRING TRAPS 10 X $145 = $1,450/YEAR

TOTAL COST OF INSPECTING AND REPAIRING TRAPS = $2,038 /YEAR

65 lbs/hr x 4380 hrs/yr x 0.5 (sys. modulation factor) = 142,350 LBS OF STM/YEAR/TRAP

# of steam x (1192-128)/1,000,000 = 151 MBTU/YEAR/TRAP

@ $5.75/1000 # steam = $868/YEAR/PER TRAP

ENERGY LOST DUE TO FAILED TRAPS 10 X 151 = 1510 MBTU/YEAR

COST OF STEAM LOST DUE TO FAILED TRAPS 10 X $868 = $8,680/YEAR

INITIAL INVESTMENT FOR TEST VALVES 100 X $137 = $13,700

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM3
ANALYSIS DATE: 03-23-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	15738.
B. SIOH	$	944.
C. DESIGN COST	$	866.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	15793.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	15793.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	0.	$	0.	8.69		0.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	1510.	$	6161.	11.67		71899.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			1510.	$	6161.		$	71899.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 23727.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 6161.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 71899.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 4.55
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 2.56

CALCULATION SHEET	DATE March,1987	SHEET 1 OF 1
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	BASIS FOR CALCULATION X HAND ___ COMPUTER ___ CONTRACTOR BID OTHER (SPECIFY)	
LOCATION		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
ECO MEASURE STEAM TRAP PROGRAM - OWNER TESTING	COMPUTED BY TGD	CHECKED BY

COST OF STEAM AT FORT LEAVENWORTH - USDB

ENTHALPY OF WATER AT 160° F. =	128 BTU/LBM
ENTHALPY OF STEAM AT 120 PSIG =	1,192 BTU/LBM
STEAM EFFICIENCY =	74%
NATURAL GAS COST =	$4.00 MCF
HEAT CONTENT OF NAT. GAS =	1,000,000 BTU/MCF
((1192-128)*$4.00)/0.74*1,000)	$5.75 PER THOUSAND LB STEAM

COST OF INSPECTING TRAPS USING AN OUTSIDE TESTING SERVICE.

ASSUMING AN AVERAGE OF 50 TRAPS PER DAY, 8 HOURS PER DAY.
THE COST IS A FLAT FEE OF $500 PER DAY.

$500/50 TRAPS = $10 PER TRAP

COST OF INSTALLING TEST VALVES ON EACH TRAP = $137

SAVINGS FROM TRAP INSPECTION

USING 100 TRAPS AS A BASE WITH A 10% FAILURE RATE; 350 LB/HR F&T TRAP

COST OF INSPECTING TRAPS ONCE DURING THE HEATING SEASON	100 X $10	= $1,000/YEAR
NUMBER OF TRAPS FAILED	100 X 10%	= 10 TRAPS
COST OF REPAIRING TRAPS	10 X $145	= $1,450/YEAR
TOTAL COST OF TESTING AND REPAIRING TRAPS		= $2,450 /YEAR
65 lbs/hr x 4380 hrs/yr x 0.5 (sys. modulation factor) =	142,350 LBS OF STM/YEAR/TRAP	
# of steam x (1192-128)/1,000,000		= 151 MBTU/YEAR/TRAP
@ $5.75/1000 # steam		= $868/YEAR/PER TRAP
ENERGY LOST DUE TO FAILED TRAPS	10 X 151 =	1510 MBTU/YEAR
COST OF STEAM LOST DUE TO FAILED TRAPS	10 X $868 =	$8,680/YEAR
INITIAL INVESTMENT FOR TEST VALVES	100 X $137 =	$13,700

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: USDBAE
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7 CENSUS: 2
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM3
ANALYSIS DATE: 03-23-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	16150.
B. SIOH	$	969.
C. DESIGN COST	$	888.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	16206.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	16206.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	8.69	0.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	1510.	$ 6161.	11.67	71899.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		1510.	$ 6161.		$ 71899.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 23727.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 6161.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 71899.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 4.44
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 2.63

ECO-M5

EXHAUST HEAT RECOVERY

EXHAUST HEAT RECOVERY

ENERGY CONSERVATION OPPORTUNITY: ECO-M5

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-M5) analyzes the energy savings associated with the installation of heat recovery units to preheat outside air. Energy savings can be accomplished by using exhaust air to preheat outside air used for ventilation. Heat recovery coils can be used to transfer heat energy from the exhaust air to the ventilation air stream.

SCOPE:

The ECO simulation (ECO-M5) includes the installation of heat recovery units in the exhaust air stream and the outside air intake air stream. The application of this ECO was considered for the following buildings.

Building	475C	Building 475D
Building	475G	Building 475F

Heat recovery units were also considered for reclaiming heat from steam tunnel vents but there was not a viable use for the heat energy. None of the other buildings in the USDB have a substantial amount of exhaust air which could be used for heat recovery.

MODELING TECHNIQUES:

The total energy savings associated with ECO-M5 was calculated using computer models of Q-Dot air to air units, Z-Duct air to air heat pipe units and Run Around Coil Loop heat recovery units. The Q-Dot unit had the best payback because of it's low maintenance and high energy savings. The Run Around Coil Loop system has a high efficiency but it's high operation and maintenance costs reduce it's energy savings. The Z-Duct system, like the Q-Dot units are somewhat maintenance free, but for this application the Q-Dot unit was more efficient. The installed cost estimates for all the systems were done using manufacture quotes along with Means Mechanical Cost Data. Table M5-1 compares all three heat recovery systems on a one building bases.

ECO IMPLEMENTATION:

The implementation of this ECO will include the installation of heat recovery units in buildings 475C, 475D, 475G, and 475F. The energy savings in BTU's per year were taken directly from the computer models and were converted manually into a dollar per year value. A difficulty factor of 2 was added to the installation cost of each unit because of the height at which the systems are to be installed. The repair and maintenance of the rest of the air handling equipment in these buildings are not included in this project but must be done before this ECO is valid.

SUMMARY:

This project cost is the construction cost is 6% SIOH.

The energy savings associated with the implementation of this ECO by building is shown below in Table M5-1. A MBTU's per year savings as determined using the computer simulation model.

Don't Agree!

System Type	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
Q-Dot	453.2	$2,130	$12,908	6.66	1.76
Z-Duct	293.7	$1,568	$13,563	10.81	1.08
Coil Loop	300.9	$953	$16,273	12.81	0.92

Table M5-1

CALCULATION SHEET

DATE Mar-90

SHEET 1 **0F OF** 1

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

BASIS FOR CALCULATION

X **HAND**
COMPUTER
CONTRACTOR BID
OTHER (SPECIFY)

LOCATION FORT LEAVENWORTH, KANSAS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

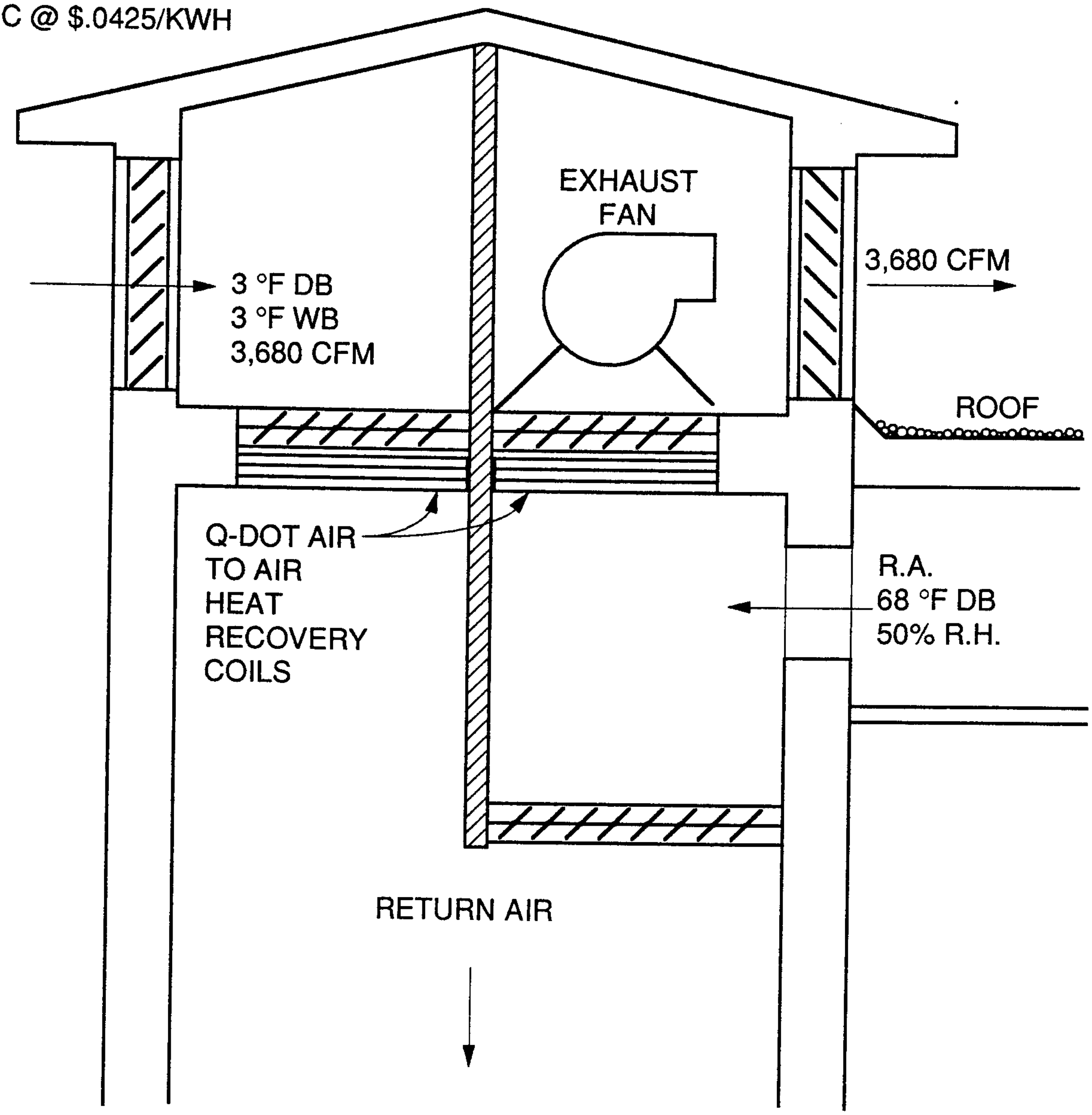
ECO MEASURE ECO-M5: HEAT RECOVERY

COMPUTED BY RGB

CHECKED BY MAW

OPERATED: 24 HR./DAY, NOVEMBER THROUGH MARCH

STEAM @ $.53/THERM
ELEC @ $.0425/KWH



Q-DOT HEAT RECOVERY SYSTEM TYPICAL SECTION BUILD

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM5Q
ANALYSIS DATE: 03-19-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	12178.
B. SIOH	$	731.
C. DESIGN COST	$	670.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	12221.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	12221.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	1.	$	12.	8.69		104.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	453.	$	1848.	11.67		21566.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			454.	$	1860.		$	21670.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	9.11		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 7151.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1860.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 21670.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.77
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 6.57

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM5Z
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	12795.
B. SIOH	$	768.
C. DESIGN COST	$	704.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	12840.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	12840.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	-1.	$ -12.	8.69	-104.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	294.	$ 1200.	11.67	14004.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		293.	$ 1188.		$ 13900.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 4587.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1188.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 13900.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.08
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 10.81

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM5CL
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	15352.
B. SIOH	$	921.
C. DESIGN COST	$	844.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	15405.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	15405.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	-2.	$ -25.	8.69	-217.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	301.	$ 1228.	11.67	14331.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		299.	$ 1203.		$ 14114.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 4658.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1203.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 14114.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.92
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 12.81

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET 1 **OF**

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. ECO-M5

ESTIMATOR RGB

CHECKED BY **MAW**

	QUANTITY		MATERIAL		LABOR		TOTAL COST
Q-Dot Air to Air Heat Recovery System	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Q-Dot Air to Air Units	1	EA	$3,467	$3,467	$2,000	$2,000	$5,467
MISC. CONTROLS	1	EA	$400	$400	$100	$100	$500
SEALED SHEET METAL BLOCK OFF	63	SQ. FT	$2	$126	$12	$756	$882
PROP. FAN W/ SHEET METAL HOUSING	1	EA	$900	$900	$500	$500	$1,400
SUBTOTAL				$4,893		$3,356	$8,249
CONTINGENCY 10%			10%	$489	10%	$336	$825
SUBTOTAL				$5,382		$3,692	$9,074
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$188	13.0%	$480	$668
DIRECT COST				$5,570		$4,172	$9,742
OVERHEAD AND PROFIT			25%	$1,393	25%	$1,043	$2,436
SUBTOTAL				$6,963		$5,215	$12,178
CONSTRUCTION COST							$12,178

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET OF 1

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

DRAWING NO. ECO-M5

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR RGB

CHECKED BY **MAW**

Z-Duct Air to Air Heat Recovery System	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Z-Duct Air to Air Units	1	EA	$3,900	$3,900	$2,000	$2,000	$5,900
MISC. CONTROLS	1	EA	$400	$400	$100	$100	$500
SEALED SHEET METAL BLOCK OFF	63	SQ. FT	$2	$126	$12	$756	$882
PROP. FAN W/ SHEET METAL HOUSING	1	EA	$900	$900	$500	$500	$1,400
SUBTOTAL				$5,326		$3,356	$8,682
CONTINGENCY 10%			10%	$533	10%	$336	$869
SUBTOTAL				$5,859		$3,692	$9,551
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$205	13.0%	$480	$685
DIRECT COST				$6,064		$4,172	$10,236
OVERHEAD AND PROFIT			25%	$1,516	25%	$1,043	$2,559
SUBTOTAL				$7,580		$5,215	$12,795
CONSTRUCTION COST							$12,795

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET OF
1

PROJECT
USDB ENERGY STUDY

LOCATION
FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

DRAWING NO.
ECO-M5

ESTIMATOR
RGB

CHECKED BY
MAW

BASIS FOR ESTIMATE

- X **CODE A (NO DESIGN COMPLETED)**
- ____ CODE B (PRELIMINARY DESIGN)
- ____ CODE C (FINAL DESIGN)
- OTHER (SPECIFY)

Exhaust Run Around Heat Recovery Loop	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
GLYCOL COILS	2	EA	$1,910	$3,820	$270	$540	$4,360
GLYCOL PUMP	1	EA	$370	$370	$132	$132	$502
PUMP SUPPORT	1	EA	$500	$500	$300	$300	$800
EXPANSION TANK	1	EA	$710	$710	$120	$120	$830
GLYCOL PIPE	25	LF	$4	$100	$8	$200	$300
PIPE INSULATION	25	LF	$2	$53	$2	$42	$94
TEES	2	EA	$3	$6	$24	$48	$54
ELLBOWS	4	EA	$2	$8	$15	$60	$68
BUTTERFLY VALVES	2	EA	$54	$108	$44	$88	$196
SUCTION DIFFUSER	1	EA	$152	$152	$55	$55	$207
THERMOMETER	3	EA	$6	$18	$19	$57	$75
TEMPERATURE TRANSMITTER	1	EA	$216	$216	$44	$44	$260
DIFF. PRESS. SWITCH W/ INDICATOR	1	EA	$403	$403	$28	$28	$431
PRESSURE GAUGES	3	EA	$12	$36	$6	$18	$54
SEALED SHEET METAL BLOCK OFF	63	SQ. FT	$2	$126	$12	$756	$882
PROP. FAN W/ SHEET METAL HOUSING	1	EA	$900	$900	$500	$500	$1,400
SUBTOTAL				$7,525		$2,988	$10,513
CONTINGENCY 10%			10%	$753	10%	$299	$1,052
SUBTOTAL				$8,278		$3,287	$11,565
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$290	13.0%	$427	$717
DIRECT COST				$8,568		$3,714	$12,282
OVERHEAD AND PROFIT			25%	$2,142	25%	$928	$3,070
SUBTOTAL				$10,710		$4,642	$15,352
CONSTRUCTION COST							$15,352

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-M6

INSULATE DUCTWORK

DUCTWORK INSULATION

ENERGY CONSERVATION OPPORTUNITY: ECO-M6

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-M6) analyzes the energy savings associated with reducing the amount of heat transfer through the walls of the ductwork that carries air from the air handling equipment to the space being conditioned. The ductwork can lose or gain heat from the unconditioned spaces through which it is routed, thus not providing the required air temperature at the air outlet.

SCOPE:

The implementation of this ECO simulation (ECO-M6) would have to be to ductwork that exists that is routed in unconditioned spaces. The only buildings that contain central air handling equipment with ductwork to the space to be conditioned are:

- Building 463
- Building 465
- Building 472
- Building 473
- Building 475
- Building 475C
- Building 475D
- Building 475E
- Building 475F
- Building 475G

MODELING TECHNIQUE:

The modeling technique used to calculate the energy savings associated with insulating the ductwork located in unconditioned spaces, is a heat transfer calculation including the heat transfer coefficient of the ductwork walls and the temperature difference between the air inside and outside the ductwork. If the ductwork is located in conditioned spaces, then the addition of insulation to the ductwork will not effectively change the amount of energy used to condition the entire building because the temperature difference is zero. NOT TRUE.

SUMMARY:

The easiest method of insulating ductwork is on the outside of the metal. Another method is to insulate the ductwork on the inside of the metal. The insulation on the inside of the ductwork is typical when new ductwork is installed. To insulate the inside of existing ductwork is difficult and seldom feasible. All of the ductwork attached to air handling units, with the exception of the castle, is routed through conditioned spaces, thus no energy savings is present. The ductwork for the air handling units located in the castle are concealed in the exterior walls of the structure. Because of changes in direction and transitions, insulating the inside of the ductwork is not feasible. The ductwork would have to be removed and re-installed with interior insulated ductwork, which is not cost effective. This ECO is not feasible under the present conditions.

ECO-M10

CENTRAL PLANT COOLING

CENTRAL CHILLER PLANT:

ENERGY CONSERVATION OPPORTNITY: ECO-M10

PURPOSE:

The purpose of this Energy Conservation Opportunity (ECO-M10) is to calculate the savings realized by installing a 400 ton centrifugal chiller to serve the air conditioning requirements for the USDB facility. The central chiller would replace the air cooled condensing units, and window mounted air conditioners that currently serve the buildings listed below.

SCOPE:

This project (ECO-M10) was considered for the following buildings:

Building	450
Building	463
Building	464
Building	465
Building	472
Building	473
Building	475A
Building	475B
Building	475H

MODELING TECHNIQUES:

The modeling technique used for ECO-M10 assumes that the existing equipment kilowatt per ton is 1.5 which is typical for air cooled condensers, and the central chiller plant kilowatt per ton is estimated at 0.95. The building energy use was calculated using the Trace Ultra energy simulation program.

ECO IMPLEMENTATION:

The removal of the existing air cooled condensing units, direct expansion cooling coils, the air cooled chiller serving the buildings at the south gate, and the window air conditioners is required to implement this ECO.

Installation of a centrifugal chiller, chilled water pump, condenser water pump, cooling tower, and accessories at building #474 is required for ECO-M10. The chilled water distribution piping will be installed in the existing piping tunnels.

SUMMARY:

The installation of a central chiller plant will save 64,330 kWh of electrical energy per year, and will cost $444,452 for the construction. A savings investment ratio of 0.05 disqualifies this project from consideration. The estimated simple payback is approximately 163 years.

CALCULATION SHEET

DATE Apr-90

SHEET 1 **OF** 1

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

LOCATION

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

ECO MEASURE
ECO-M10

BASIS FOR CALCULATION

X HAND
COMPUTER
CONTRACTOR BID
OTHER (SPECIFY)

COMPUTED BY MJM

CHECKED BY MAW

THE CAPACITY OF COOLING PER BUILDING IS:

BUILDING	TONS CLG
450	32
463	22
464	26
465	17
472	69
473	39
475A	39
475B	28
475E	92
475H	20
TOTAL	384 TONS

INSTALL A 400 TON CENTRIFUGAL CHILLER IN THE BOILER PLANT

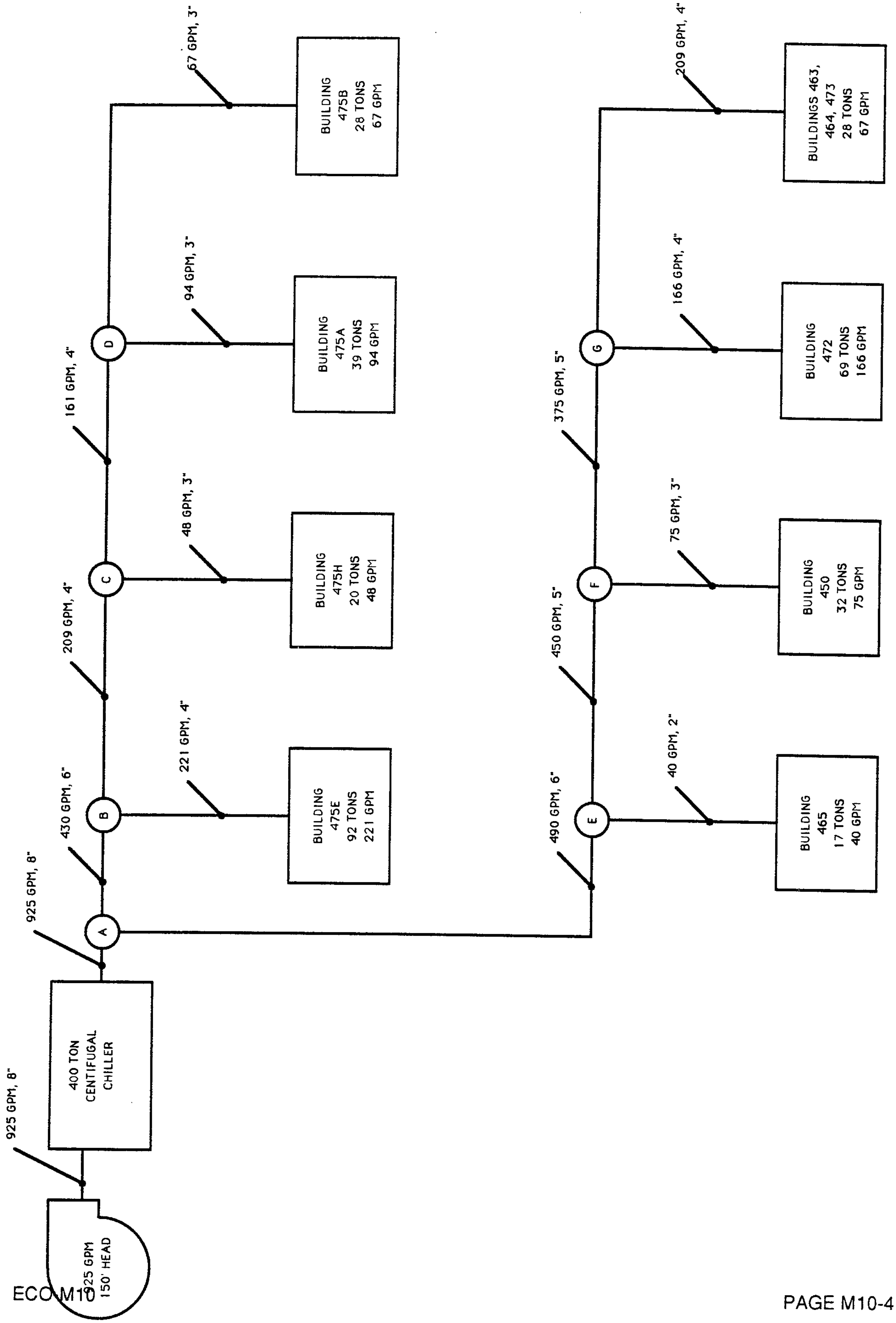
USING A TYPICAL DELTA TEMPERATURE OF 10°F

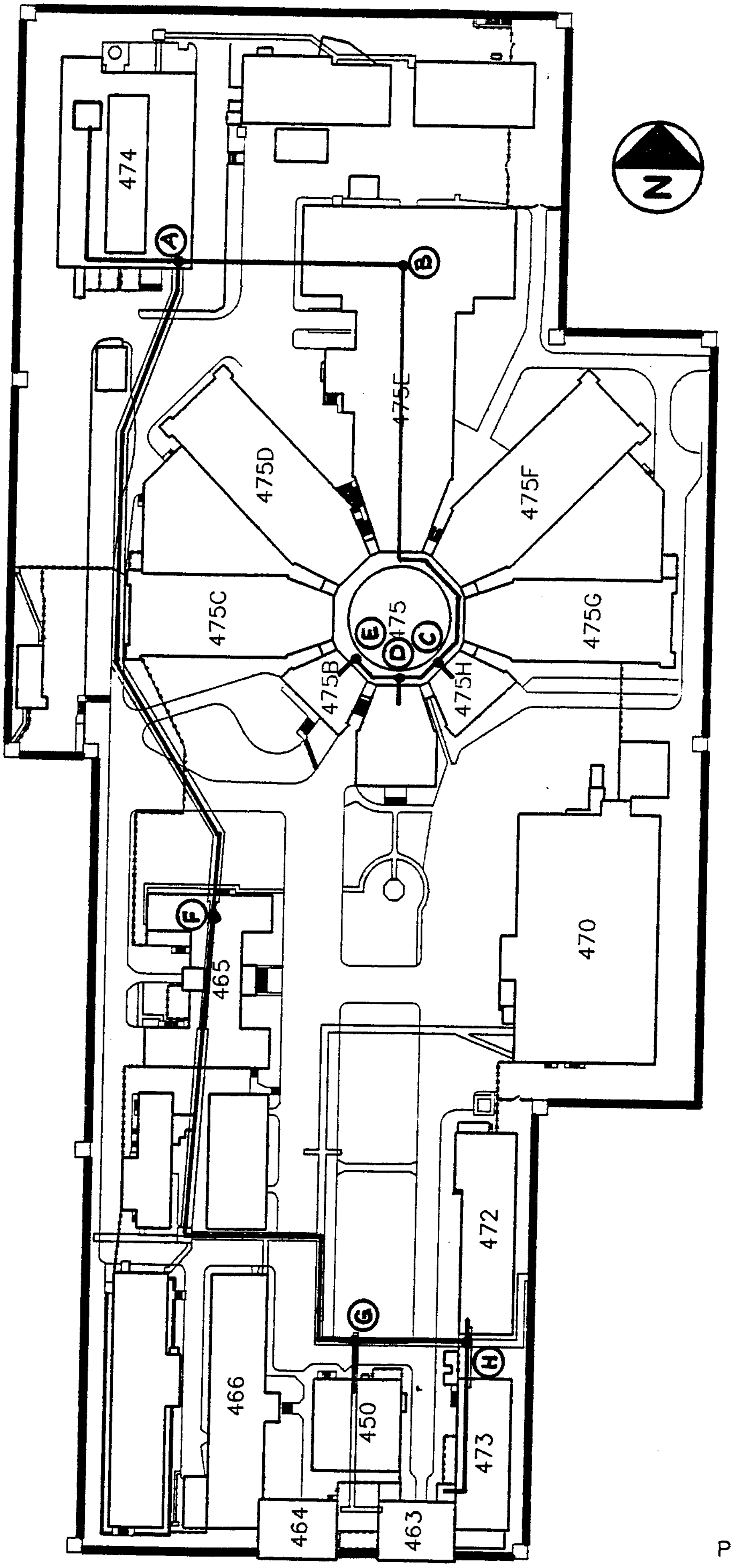
ENERGY = (GPM) (CP) (ΔT)
ENERGY = (384 TONS) (12,000 BTUH/TON) = 4,608,000 BTUH
CP = 1.O FOR WATER
$\Delta T = 10°$ F
GPM = (ENERGY) / (CP) (ΔT) (500 LB MIN / GAL HOUR)
GPM = 4,608,000 / 5000
GPM = 921.6

PUMP TO BE SIZED FOR 925 GPM

USING THE FOLLOWING SPREADSHEET, PIPE SIZES, NUMBER OF FITTINGS, AND FRICTION LOSS CAN BE DETERMINED.

THE PUMP WILL BE A 925 GPM, 150' HEAD END SUCTION.


925 GPM 150' HEAD
925 GPM, 8"
400 TON CENTRIFUGAL CHILLER
925 GPM, 8"
A
430 GPM, 6"
B
221 GPM, 4"
BUILDING 475E 92 TONS 221 GPM
209 GPM, 4"
C
48 GPM, 3"
BUILDING 475H 20 TONS 48 GPM
161 GPM, 4"
D
94 GPM, 3"
BUILDING 475A 39 TONS 94 GPM
67 GPM, 3"
BUILDING 475B 28 TONS 67 GPM
490 GPM, 6"
E
40 GPM, 2"
BUILDING 465 17 TONS 40 GPM
450 GPM, 5"
F
75 GPM, 3"
BUILDING 450 32 TONS 75 GPM
375 GPM, 5"
G
166 GPM, 4"
BUILDING 472 69 TONS 166 GPM
209 GPM, 4"
BUILDINGS 463, 464, 473 28 TONS 67 GPM


N
474
A
B
475E
475D
475F
475C
475
475G
E
D
C
475B
475H
F
465
470
472
G
H
466
450
473
464
463

CALCULATION SHEET		**DATE** Mar-90	**SHEET** 1 **OF** 1
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X **HAND** **COMPUTER** **CONTRACTOR BID** **OTHER (SPECIFY)**	
LOCATION	BUILDING 474		
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	CENTRAL PLANT COOLING ECO-M10	**COMPUTED BY** TGD	**CHECKED BY** MAW

<u>CHILLED WATER PUMP:</u>	625 GPM @ 150 FT. HEAD	
	50 H.P. MOTOR - 1750 RPM - 480/60/3 - 65 F.L.A.	
	[(65 A.) (480 V.) (√3)] / 1,000 =	54 KW
<u>CONDENSER WATER PUMP:</u>	1200 GPM @ 75 FT. HEAD	
	30 H.P. MOTOR - 1750 RPM - 480/60/3 - 40 F.L.A.	
	[(40 A.) (480 V.) (√3)] / 1,000 =	33 KW
<u>COOLING TOWER FAN:</u>	20 H.P. MOTOR - 1750 RPM - 480/60/3 - 27 F.L.A.	
	[(27 A.) (480 V.) (√3)] / 1,000 =	22 KW
(0.9 POWER FACTOR) x (0.8 MOTOR EFFICIENCY) =		0.72 ELECTRICAL FACTOR
(39KW + 24KW + 16KW) x (0.72) =		78 KW FOR AUXILLARY EQUIPMENT
<u>400 TON CHILLER:</u>	0.75 KW / TON	
78 KW / 400 TON =		0.20 KW / TON FOR AUXILLARY EQUIPMENT
0.75 + 0.20 =		0.95 KW / TON OVERALL EFFICIENCY FOR 400 TON CENTRIFUGAL CHILLER SYSTEM:
<u>EXISTING COOLING EQUIPENT:</u>	1.5 KW / TON	
0.95 / 1.5 =		63% FUTURE ELECTRICAL ENERGY USEAGE WITH CENTRAL CHILLER PLANT:
<u>PRESENT ENERGY USED FOR COOLING:</u>	173,865 KWH	
<u>PROJECTED ENERGY USEAGE FOR COOLING:</u>	109,535 KWH	
<u>ANNUAL ELECTRICAL SAVINGS:</u>	64,330 KWH	
<u>ANNUAL ENERGY SAVINGS:</u>	220 MBTU	

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM10
ANALYSIS DATE: 03-19-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	444542.
B. SIOH	$	26673.
C. DESIGN COST	$	24450.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	446099.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	446099.

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

FUEL	UNIT COST $/MBTU(1)		SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)		DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)	
A. ELECT	$	12.44	220.	$	2737.	8.69		23785.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	0.	$	0.	11.67		0.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			220.	$	2737.		$	23785.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 7849.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= __________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 2737.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 23785.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.05
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 162.99

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M10 **CENTRAL PLANT COOLING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
400 TON CENTRIFUGAL CHILLER							
EXPANSION TANK AND TOWER	400	TON	260.13	$104,052	80.75	$32,300	$136,352
925 GPM PUMP, 150' HEAD	1	EA	1650.00	$1,650	390.00	$390	$2,040
8" BLACK STEEL PIPE, HANGERS, INSUL	160	FT	18.18	$2,909	22.17	$3,547	$6,456
6" BLACK STEEL PIPE, HANGERS, INSUL	1620	FT	12.20	$19,764	18.19	$29,468	$49,232
5" BLACK STEEL PIPE, HANGERS, INSUL	1400	FT	10.19	$14,266	13.86	$19,404	$33,670
4" BLACK STEEL PIPE, HANGERS, INSUL	1360	FT	7.45	$10,132	12.25	$16,660	$26,792
3" BLACK STEEL PIPE, HANGERS, INSUL	400	FT	5.32	$2,128	10.84	$4,336	$6,464
8" BLACK STEEL ELL	13	EA	66.00	$858	135.00	$1,755	$2,613
6" BLACK STEEL ELL	14	EA	37.00	$518	110.00	$1,540	$2,058
5" BLACK STEEL ELL	13	EA	37.00	$481	110.00	$1,430	$1,911
4" BLACK STEEL ELL	10	EA	14.90	$149	70.00	$700	$849
3" BLACK STEEL ELL	10	EA	9.00	$90	50.00	$500	$590
8" BLACK STEEL TEE	1	EA	91.00	$91	220.00	$220	$311
6" BLACK STEEL TEE	1	EA	50.00	$50	185.00	$185	$235
5" BLACK STEEL TEE	3	EA	50.00	$150	185.00	$555	$705
4" BLACK STEEL TEE	3	EA	27.00	$81	115.00	$345	$426
8" BUTTERFLY VALVE	4	EA	200.00	$800	120.00	$480	$1,280
6" BUTTERFLY VALVE	2	EA	140.00	$280	110.00	$220	$500
5" BUTTERFLY VALVE	2	EA	120.00	$240	110.00	$220	$460
4" BUTTERFLY VALVE	8	EA	86.00	$688	70.00	$560	$1,248
3" GATE VALVE	10	EA	105.00	$1,050	27.00	$270	$1,320

ENG. FORM 150
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CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 2 **OF** 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M10	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 450 COOLING COIL REPLACEMENT	1	EA	1130.00	$1,130	435.00	$435	$1,565
BUILDING 450 REFRIGERATION DEMOLITION	2	TON			395.00	$790	$790
BUILDING 465 REFRIGERATION DEMOLITION	3	TON			395.00	$1,185	$1,185
BUILDING 472 COOLING COIL REPLACEMENT	1	EA	440.00	$440	88.00	$88	$528
BUILDING 472 REFRIGERATION DEMOLITION	2	TON			395.00	$790	$790
BUILDING 475A FAN COIL UNIT INSTALLATION	11746	SQ FT	0.74	$8,645	0.07	$865	$9,510
BUILDING 475B FAN COIL UNIT INSTALLATION	7400	SQ FT	0.74	$5,446	0.07	$545	$5,991
BUILDING 475H FAN COIL UNIT INSTALLATION	6744	SQ FT	0.74	$4,964	0.07	$496	$5,460
SUBTOTAL				$181,052		$120,279	$301,330
CONTINGENCY 10%			10%	$18,105	10%	$12,028	$30,133
SUBTOTAL				$199,157		$132,307	$331,463
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$6,970	13.0%	$17,200	$24,170
DIRECT COST				$206,127		$149,507	$355,633
OVERHEAD AND PROFIT			25%	$51,532	25%	$37,377	$88,909
SUBTOTAL				$257,659		$186,884	$444,542
CONSTRUCTION COST							$444,542

ENG. FORM 150
1AVC-59

ECO-M11

CASTLE AIR SYSTEM REPAIR

CASTLE AIR SYSTEM REPAIRS

ENERGY CONSERVATION OPPORTUNITY: ECO-M11

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-M5) analyzes the energy savings associated with removal of air stratification in the castle domiciles. Stratification occurs in areas with high ceilings when hot air rises to the upper levels and there is no way for it to be circulated back down. Stratification in the castle domiciles is causing the upper levels to become over heated by an estimated 10°. An energy savings can be seen by repairing the return air systems which pulls the hot air from the upper levels and circulates it down through the lower levels. The implementation of this project will not change the number or capacity of any of the existing air handling systems.

SCOPE:

The ECO simulation (ECO-M11) includes the repair and maintenance of the existing air handling systems. The application of this ECO was considered for the following buildings.

Building	475C	Building 475D
Building	475G	Building 475F

The existing AHU's in these buildings are currently operating with no return air from the space. The doors of the fan room have been removed allowing the AHUs to pull in air from the pipe tunnels, chases or from wherever it finds the least amount of resistance. Replacing the doors and sealing off the fan rooms will allow the AHU's to pull warm return air from the top levels of these buildings. This will create proper air circulation and eliminate the air stratification. An energy savings will be seen by eliminating the over heating of the top levels of these buildings.

MODELING TECHNIQUES:

The energy savings associated with this ECO was calculated using a computer simulation developed as a base load on the facility. The existing HVAC systems were simulated to heat the top three tiers of each building to 10° above the 68° setpoint. The temperature was then set to 68° and the simulation was ran again to find the difference in energy use. The difference in the energy usage for these two computer runs is the energy savings for ECO-M11. The cost repairing these AHU's were done using Means Mechanical Cost Data.

ECO-M11 ECONOMIC ANALYSIS

BUILDING NUMBER	STEAM CONSUMPTION			ELECTRIC CONSUMPTION			TOTAL SAVINGS ($)
	BASE ENERGY (THERMS)	ECO-M11 LOAD (THERMS)	ENERGY SAVINGS (MBTU)	BASE LOAD (KW)	ECO-M11 LOAD (KW)	ENERGY SAVINGS (MBTU)	
475C	13,472	10,745	273	45,478	45,427	0	$1,115
475D	15,188	12,422	277	53,358	53,317	0	$1,130
475F	15,926	12,856	307	53,357	53,324	0	$1,254
475G	12,853	10,380	247	45,481	45,427	0	$1,011
							$4,510

ECO IMPLEMENTATION:

The implementation of this ECO will include the installation of new doors on the fan rooms of each building. All pipe chases passing through the fan rooms will need to be sealed along with any other openings which presently exist. This will restore the return air system back to it's original design which will in turn eliminate any air stratification within these buildings.

SUMMARY:

The probable construction cost to implement this ECO by building is shown in Table M11-1. This project cost is the construction cost as determined in the appendix plus 6% SIOH.

The energy savings associated with the implementation of this ECO by building is shown below in Table M11-1 on a dollars per year savings as determined using the computer simulation model.

Building Number	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
475C	273 ✓	$1,458	$1,779	1.51	7.72
475D	277 ✓	$1,474	$1,779	1.49	7.83
475F	307 ✓	$1,641	$1,779	1.34	8.68
475G	247 ✓	$1,323	$1,779	1.67	6.99

Table M11-1

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM11C
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	1678.
B. SIOH	$	101.
C. DESIGN COST	$	92.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	1684.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	1684.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	0.	$	0.	8.69		0.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	273.	$	1114.	11.67		13000.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			273.	$	1114.		$	13000.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 4290.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1114.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 13000.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 7.72
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 1.51

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM11D
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	1678.
B. SIOH	$	101.
C. DESIGN COST	$	92.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	1684.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	1684.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	8.69	0.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	277.	$ 1130.	11.67	13187.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		277.	$ 1130.		$ 13187.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 4352.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1130.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 13187.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 7.83
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 1.49

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM11F
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	1678.
B. SIOH	$	101.
C. DESIGN COST	$	92.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	1684.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	1684.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	0.	$	0.	8.69		0.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	307.	$	1253.	11.67		14623.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			307.	$	1253.		$	14623.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	9.11		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 4826.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1253.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 14623.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 8.68
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 1.34

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM11G
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	1678.
B. SIOH	$	101.
C. DESIGN COST	$	92.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	1684.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	1684.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	8.69	0.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	247.	$ 1008.	11.67	11763.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		247.	$ 1008.		$ 11763.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3882.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1008.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 11763.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 6.99
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 1.67

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET **OF**
1

PROJECT
USDB ENERGY STUDY

LOCATION
FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE
____X____ **CODE A (NO DESIGN COMPLETED)**
________ CODE B (PRELIMINARY DESIGN)
________ CODE C (FINAL DESIGN)
________ OTHER (SPECIFY)

DRAWING NO.
NONE

ESTIMATOR
RGB

CHECKED BY
MAW

ECO-M11	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
METAL DOORS	2	EA	$137	$274	$80	$160	$434
SHEET METAL ≈	50	SQ FT	$1	$63	$1	$70	$133
CAULKING MASONRY ≈	400	LF	$1	$224	$1	$336	$560
SUBTOTAL				$560		$566	$1,126
CONTINGENCY 10%			10%	$56	10%	$57	$113
SUBTOTAL				$616		$623	$1,239
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$22	13.0%	$81	$103
DIRECT COST				$638		$704	$1,342
OVERHEAD AND PROFIT			25%	$160	25%	$176	$336
SUBTOTAL				$798		$880	$1,678
CONSTRUCTION COST							**$1,678**

ENG. FORM 150
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ECO-M12

REDUCE STEAM DISTRIBUTION PRESSURE

REDUCE STEAM DISTRIBUTION PRESSURE
ENERGY CONSERVATION OPPORTUNITY: ECO-M12

PURPOSE:

The purpose of this Energy Conservation Opportunity (ECO-M12) is to calculate the savings realized by reducing the steam pressure for the USDB facility. The laundry requires 120 psig steam, while the space heating requirements can be served by 80 psig steam.

SCOPE:

Steam is delivered to the various buildings by a system of insulated high pressure steam pipes located in tunnels. The steam pressure at the boilers is maintained at 120 psig. The steam pressure is reduced at the individual buildings to the pressure required for space heating and/or any process usage.

Steam must be delivered at a pressure high enough to overcome the system resistance losses, while maintaining sufficient pressure to equal or exceed the downstream pressure requirement.

Reducing the steam pressure for energy savings will decrease the density of the steam in the steam piping. The steam will take up more volume in the pipes, making it a tighter squeeze to pass through the orifice plates used to measure steam flow.

Because the orifice plate sees a greater pressure drop for a given flow, the signal sent to the chart recorder will be greater also, and the chart will read proportionally higher. The orifice plates will have to be replaced for each steam recorder to reflect steam flow rates, accurately at a reduced steam pressure.

Steam trap capacities will also be reduced, due to the reduced differential pressure across the steam traps orifice. The traps affected will be the traps located in the Powerhouse, and the traps serving steam mains upstream of the pressure reducing valves.

Generally traps, and drip legs serving steam mains are oversized by the design engineer, and a reduction in steam pressure will not have an adverse effect the traps performance.

Nevertheless, lowering thesteam trap condensate handling capacity could cause water to back up into the the steam mains. This could possibly result in water hammer, if a slug of condensate is picked up by fast moving steam traveling over the surface of the condensate. Since water hammer can cause extensive damage to the system, the exact capacity of each trap effected by steam pressure reduction must be determined.

MODELING TECHNIQUES:

MODELING TECHNIQUES:

The modeling techniques used to calculate the energy savings for ECO-M12 were derived from "Improving Boiler Efficiency" by S. G. Dukelow. Boiler efficiency is increased by lowering the operating steam pressure, because the flue gases leave the boiler at a lower temperaure.

The saturation temperature of steam at 120 psig is 350°F., and the corresponding flue gas temperature is 450°F. Reducing the operating pressure of the boiler to 80 psig, reduces the saturation temperature of the steam to 324°F., and the corresponding flue gas temperature is reduced to 424°F.

The total heat content or enthalpy of steam at 120 psig is 1,192.4 btu/lb., while 80 psig steam has an enthalpy of 1,186.3 btu/lb. The 80 psig steam also has a higher latent heat content per pound than the 120 psig steam. While the 120 psig steam has more total heat per pound than the 80 psig steam, this heat is never fully realized at the heat exchanger.

As the steam pressure is reduced prior to delivery to the heat exchanger, the extra btu's are converted into superheated steam. This superheated steam is all sensible heat and is promptly dissipated before it can be recovered at the heat exchanger.

The modeling technique assumes that the steam consumption remains constant for the facility, and the cost of producing steam is reduced due to the increased boiler efficiency.

ECO IMPLEMENTATION:

The implementation of ECO-M12 can be accomplished when the existing boilers are replaced. The existing facility is served by three 580 H.P. steam boilers operating at 120 psig steam pressure. We recommend installing two 435 H.P., and one 870 H.P. steam boilers.

The 870 H.P., and one 435 H.P. boiler would be operated at 80 psig pressure, and would serve the space heating requirements of the facility. The remaining 435 H.P. boiler would be operated at 120 psig and would be dedicated to serving the laundry.

SUMMARY:

Since ECO-M12 can be implemented at the time the existing steam boilers are replaced, there are no associated costs for execution, and the energy savings can be realized within the next two years.

CALCULATION SHEET	DATE Mar-90	SHEET 1 OF 1
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	BASIS FOR CALCULATION X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)	
LOCATION STEAM PLANT		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
ECO MEASURE ECO M12	COMPUTED BY TGD	CHECKED BY MAW

STEAM PRESSURE	ENTHALPY BTU/LB. OF STEAM	SYSTEM EFFICIENCY	STEAM COST PER 1000 LBS.	ESTIMATED ANNUAL SAVINGS
120 PSIG	1,192.4	74.000%	$5.754	NONE
115 PSIG	1,191.7	74.094%	$5.742	$652
110 PSIG	1,191.0	74.188%	$5.731	$1,249
105 PSIG	1,190.4	74.282%	$5.721	$1,792
100 PSIG	1,189.6	74.376%	$5.709	$2,443
95 PSIG	1,188.8	74.470%	$5.698	$3,040
90 PSIG	1,188.0	74.564%	$5.686	$3,692
85 PSIG	1,187.2	74.658%	$5.675	$4,289
80 PSIG	1,186.3	74.752%	$5.663	$4,941

AVERAGE STEAM USE 148,750 LBS PER DAY

SYSTEM EFFICIENCY CALCULATED FROM:

IMPROVING BOILER EFFICIENCY BY S.G. DUKELOW

SPONSORED BY KANSAS STATE UNIVERSITY AND KANSAS ENERGY OFFICE

CHAPTER 6: EFFECT OF BOILER STEAM PRESSURE ON FLUE GAS TEMPERATURE AND BOILER EFFICIENCY

ECO-M14

SERVICE CONDENSATE RETURN SYSTEM

CONDENSATE RETURN SYSTEM SERVICE:
ENERGY CONSERVATION OPPORTUNITY
ECO-M14

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-M14) analyzes the energy savings associated with reducing the amount of heat transfer through the walls of condensate return piping. The piping transfers heat to its surroundings because of a temperature difference between the fluid, and the ambient space temperature through which it is routed. This loss of heat from the hot condensate to the ambient air in the piping tunnels causes increased use of natural gas at the boiler.

SCOPE:

This Energy Conservation Opportunity (ECO-M14) involves the condensate return piping from building #475 (Castle Building). The condensate return system for this building consists of approximately 700 feet of 6" and 8" steel piping, approximately 600 feet of this piping is uninsulated, and 100 feet of piping will need to be replaced.

MODELING TECHNIQUES:

The modeling techniques used to calculate the energy savings for ECO-M14 were derived by measuring the present condensate return temperature, and estimating the future condensate return temperature by using a computer spreadsheet.

The average daily steam consumption was derived by summing 25% of the average winter rate of 370,000 lbs. per day, and 75% of the average summer rate of 75,000 lbs. per day.

The steam tunnel that exits the west wall of the boiler plant serves the Castle Building #475, which includes the laundry facility. The estimated annual steam load served by this tunnel is 50% of the total system load.

ECO IMPLEMENTATION:

The implementation of this Energy Conservation Opportunity (ECO-M14) requires the replacement of approximately 100 feet of 8" condensate return piping installed at the floor level of the piping tunnel. Various fittings are required along with pipe racks for support of the piping.

400 feet of insulation is required for the 6" dia. piping, and 200 feet of insulation is required for the 8" dia. piping to reduce the amount of heat transfered to the tunnel air. A difficulty factor has been added to the construction cost for limited work area, and accessability.

The existing condensate piping has holes drilled in the pipe that must be repaired prior to installation of the insulation.

SUMMARY:

The condition of the condensate piping system in the west tunnel is questionable, and may warrant replacement. Energy conservation can be realized without total replacement of this piping system.

CALCULATION SHEET	DATE Mar-90		SHEET 0F 1 1
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)		
LOCATION			
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP			
ECO MEASURE SERVICE CONDENSATE RETURN SYSYTEM ECO-M14	**COMPUTED BY** TGD		**CHECKED BY** MAW

INIT TEMP	AMB TEMP	INSUL THICK	WIND VEL	PIPE DIA	INSULATION CHARACTERISTIC				PIPE LEN	FLOW #/HR	SPEC HEAT	EMISS	FINAL TEMP	TOTAL HL
					T 1	CON1	T2	CON 2						
212	75	2	1	8.625	460	0.5	100	0.25	700	6200	1.05	0.9	201.1	71,040
212	75	0.001	1	8.625	460	0.5	100	0.25	700	6200	1.05	0.9	154.9	371,640

CALCULATION SHEET	**DATE** Mar-90	**SHEET** 1 **0F** 1
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)	
LOCATION		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
ECO MEASURE SERVICE CONDENSATE RETURN SYSYTEM ECO-M14	**COMPUTED BY** TGD	**CHECKED BY**

120 PSIG STEAM PRESSURE:	1192.4 BTU/LB. ENTHALPY
155°F CONDENSATE RETURN TEMPERATURE:	123 BTU/LB. ENTHALPY
201°F CONDENSATE RETURN TEMPERATURE:	169 BTU/LB. ENTHALPY
SYSTEM EFFCIENCY:	74%
AVERAGE DAILY STEAM CONSUMPTION:	148,750 LBS.
STEAM LOAD SERVED BY WEST TUNNEL:	50%
DAYS PER YEAR:	365

(1192.4 - 123) - (1192.4 - 169) / 0.74 = 62.16 BTU/LB.

(62.16 X 148,750 X .5 X 365)/1,000,000 = 1,687 MBTU/YEAR

CONSTRUCTION COST ESTIMATE

DATE PREPARED Mar-90

SHEET 1 **OF** 1

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

__X__ **CODE A (NO DESIGN COMPLETED)**
_____ CODE B (PRELIMINARY DESIGN)
_____ CODE C (FINAL DESIGN)
_____ OTHER (SPECIFY)

DRAWING NO.

ESTIMATOR TGD

CHECKED BY MAW

	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
6" DIA. - 2" THICK FIBERGLASS INSULATION	400	LF	$5.87	$2,348	$3.45	$1,380	$3,728
ALUMINUM JACKET	400	LF	$0.54	$216	$2.87	$1,148	$1,364
8" DIA. SCH. 80 STEEL PIPE	60	LF	$37.66	$2,260	$22.00	$1,320	$3,580
2" THICK FIBERGLASS INSULATION	200	LF	$7.25	$1,450	$4.31	$862	$2,312
ALUMINUM JACKET	200	LF	$0.54	$108	$2.87	$574	$682
PIPE RACKS	6	EA	$400	$2,400	$200	$1,200	$3,600
REPAIR HOLES IN PIPING	3	DAYS			$252	$756	$756
8" DIA. TEE	2	EA	$71	$142	$71	$142	$284
8" DIA. 90° ELBOW	2	EA	$100	$200	$140	$280	$480
DEMOLITION	60	LF			$3.95	$237	$237
SUBTOTAL				$9,124		$7,899	$17,023
DIFFICULTY FACTOR 50%					50%	$3,950	$3,950
SUBTOTAL						$11,849	$20,973
CONTINGENCY 10%			10%	$912	10%	$1,185	$2,097
SUBTOTAL				$10,036		$13,034	$23,070
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$351	13.0%	$1,694	$2,045
DIRECT COST				$10,387		$14,728	$25,115
OVERHEAD AND PROFIT			25%	$2,597	25%	$3,682	$6,279
SUBTOTAL				$12,984		$18,410	$31,394
CONSTRUCTION COST							$31,394

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM14
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	31394.
B. SIOH	$	1884.
C. DESIGN COST	$	1727.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	31505.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	31505.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44		$ 0.	8.69	0.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	1687.	$ 6883.	11.67	80325.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		1687.	$ 6883.		$ 80325.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 26507.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= __________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 6883.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 80325.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 2.55
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 4.58

ECO-M15

BOILER PLANT MODIFICATIONS

BOILER PLANT MODIFICATIONS:

ENERGY CONSERVATION OPPORTUNITY: ECO-M15

PURPOSE:

The purpose of this Energy Conservation Opportunity (ECO-M15) is to analyze the energy savings that may be realized by implementing the following:

1) Recover heat from the boiler flue gases, and transfer that heat to the boiler feed water.
2) Recover heat from the boiler blowdown cycle, and transfer that heat to the boiler feed water.
3) Install automatic boiler blowdown controls.
4) Increase the efficiency of the three high-pressure steam boilers currently serving the USDB.
5) Change the feedwater chemistry program of the three steam boilers currently serving the USDB.
6) Clean the tubes of the three steam boilers currently serving the USDB.
7) Install oxygen trim controls on the boilers at the USDB.

Within the next two years the (3) existing steam boilers are to be replaced with (3) new steam boilers. The existing boilers are capable of producing 20,000 lbs./hr each when burning natural gas. Using fuel oil as an energy source the boilers will produce steam at the rate of 10,000 lbs./hr. each. (2) 15,000 lb./hr. and (1) 30,000 lb./hr. boilers will provide operating flexibility to the facility. (1) 15,000 lb./hr. boiler can be operated at 120 psig pressure and dedicated to serve the laundry. The 30,000 lb./hr. and one of the 15,000 lb./hr. boilers would operate at 80 psig and serve the space heating requirements of the USDB. The total capacity of the steam generation system would not be changed, and the maximum hourly load of 30,000 lb./hr. could still be satisfied while burning fuel oil.

SCOPE:

This Energy Conservation Opportunity (ECO-M15) involves three existing forced draft type, natural gas fired, steam boilers located in the boiler plant Building #474. The boilers are capable of 20,000 lbs./hr. continuous steam production when using natural gas as an energy source.

Each boilers is capable of 10,000 lbs./hr. continuous steam production when using # 6 fuel oil as an energy source. Field measurements indicate that the flue gas temperature of the boilers is 450° F using natural gas.

Steam is delivered to the various buildings by a system of insulated high pressure steam pipes located in tunnels. Generally, the steam pressure is reduced at the individual buildings and is used for space heating by one of two different means.

Some of the buildings utilize air handlers that are equipped with steam heating coils. Other buildings supply the steam to a heat exchanger where it is used to raise the temperature of the hot water, which is circulated by an electrically driven pump through terminal units. Terminal units consist of convectors, fan coils or air handlers equipped with hot water coils.

Condensate is returned through piping located in the same system of tunnels by gravity to the condensate pumps located in the boiler plant. The condensate pumps lift the condensate up to the deaerator, where it is heated to 220°F to release oxygen before being returned to the boilers. Boiler make-up water is also introduced into the system at the deaerator. The boiler feed pumps discharge the feedwater into the boilers through the boiler pump controls.

Outside air used for combustion in the boilers is introduced into the boiler plant by one or more different means as follows:

a. Manually opening an overhead door.

b. Manually opening windows.

c. Airflow from the piping tunnels into the boiler plant.

The products of combustion are carried by insulated breeching to a masonry stack adjacent to the boiler plant structure, where they are discharged to the atmosphere.

1) Installing a boiler fuel economizer reduces fuel consumption by extracting heat from hot flue gases and transferring that heat to another source where the heat can be reclaimed in one of several different ways:

   a. To preheat the boiler feedwater.

   b. To preheat the make-up air used for combustion.

   c. To heat domestic hot water.

   We will consider utilizing this heat to preheat the boiler feedwater. Utilization of the extracted heat to preheat combustion air is not an option, because there is not a single fixed outside air intake duct, plenum or opening available for installation a heat exchanger coil.

Utilizing the heat for domestic water heating purposes is not viable. Domestic water heating is accomplished at the various buildings inside the USDB facility, and not at a central location such as the boiler plant.

2) A blowdown heat recovery unit reduces fuel consumption in two separate ways:

   a. First, by extracting heat from the hot boiler blowdown water, and by using that energy to heat the make-up water for the boilers.

   b. A second means by which the unit reduces fuel consumption is by capturing the flash steam which is produced when the boiler water pressure is reduced from the boiler operating pressure to atmospheric pressure and transferring that steam to the deaerator.

3) Installing automatic boiler blowdown controls is not a valid energy conservation opportunity. The (3) existing steam boilers are presently equipped with automatic blowdown controls. The existing blowdown system operates on an intermittent cycle controlled by a measurement of the total dissolved solids.

The existing blowdown rate for the steam boilers is approximately 0.7 gallons per minute. The existing blowdown controls are adequate, and there is not an opportunity to conserve energy by modifying, or replacing these existing controls.

4) An increase in boiler efficiency can be accomplished in two ways:

   a. Reducing stack losses.

   b. Reducing heat lost from the outside surfaces of the boilers.

Reducing stack losses means reducing flue gas temperature. This can be accomplished by controlling the amount of combustion air allowed into the combustion chamber. Any increase over the optimum air quantity for combustion will reduce not the efficiency of combustion itself, but rather the rate of heat transfer to the boiler of furnace; an increase in the stack temperatures will also occur.

The ideal amount of excess air is approximately 15%. Field measurements on boilers at the USDB indicated 37% excess air and 80% combustion efficiency. Oxygen trim controls will be discussed later. Another way to reduce flue gas temperature, which is not directly related to the boilers themselves, is to recover heat from the flue gases. This was discussed in #1.

The only way to reduce heat loss from the outside surfaces of the boilers is to apply insulation to them. Because the boilers are to be replaced soon, the cost of insulating the existing boilers would outweigh any energy savings that would be realized in the short time before they are replaced.

5) Improving the boiler feedwater chemistry program so that the boilers operate more efficiently due to cleaner tubes and less frequent blowdowns is not a valid energy conservation opportunity.

Currently, a chemical water treatment system is used that employs a polymer which attaches itself to the suspended solids and forms large "clumps". This action makes the blowdown process efficient, resulting in a minimum amount of water flow to accomplish the removal of the solids and scale from the steam system.

6) Annual cleaning of the boiler tubes in order to increase boiler efficiencies, thereby decreasing boiler energy consumption is currently a part of the maintenance of the steam system.

The water tubes for the (3) existing steam boilers are acid cleaned yearly, and a visual inspection of boiler #3 showed the tube walls to be clean and free from deposits, or scale accumulation

7) Installing oxygen trim controls on the boilers allows the quantity of air introduced with the fuel to be adjusted to its optimum operating point. This air quantity is important because too little air results in incomplete combustion and reduced efficiency.

Too much air allows complete combustion, but wastes heat up the stack by increasing the volume of exhaust. Because the inefficiency of incomplete combustion is much worse than the inefficiency of excess air, the units are adjusted to allow excess air of approximately 40% with a control error band of 35%.

The ideal amount of excess air is approximately 15%. Boiler oxygen trim controls measure the stack temperature, and the amount of excess air in the exhaust gas. The amount of excess air is directly related to these two factors. The oxygen trim control unit automatically adjusts the quantity of air or fuel to keep the excess of air to 15%.

MODELING TECHNIQUES:

Boiler stack economizer calculations were done by hand using an existing feedwater temperature of 220°F from the deaerator, and a new feedwater temperature of 232.6°F. The new feedwater temperature was determined by a manufacturer of econimizers. The savings were estimated by using the difference in enthalpy of the two feedwater temperatures.

The water meter for the make-up water system indicates approximately 3,000 gallons per day is used during the winter months to replenish the water lost due to blowdown and system leakage. We must estimate that 83% of the make-up water is blowdown, and the remaining 17% is leakage.

There is no water meter available that can measure water flow in the process of flashing off steam as its pressure is reduced from 120 psig to atmospheric pressure. Nor could a water meter withstand the 350°F saturation temperature of 120 psig steam and the solids or scale coming from a pressurized boiler for any length of time.

83% of 3,000 gallons equals approximately 2,500 gallons of blowdown per day for the winter months. The winter steam production for the USDB is 370,000 pounds per day, and using 2,500 gallons as the blowdown quanity the blowdown rate is equal to 5% of the boiler steam production.

The yearly average steam production is estimated to be 148,750 lbs./day, or 6,198 lbs./hour. This number is used for calculation of energy savings for heat recovery for the boiler blowdown.

Boiler oxygen trim control calculations were done by hand. First, field measurements of boiler combustion air were taken with a combustion analyzer. This device monitors oxygen, carbon dioxide, and percent of excess air to calculate a combustion efficiency.

Next, a new combustion efficiency was found for 15% excess air, the amount allowed into the combustion chambers by the oxygen trim controls. The difference between the two combustion efficiencies was the percentage of energy savings.

ECO IMPLEMENTATION:

The construction cost estimate for the boiler stack economizer includes the material and installation costs for the economizer coil unit, piping modifications, pipe insulation, valves and accessories.

The construction cost estimate for the blowdown heat recovery includes the material and installation costs for the packaged heat recovery unit, piping modifications, pipe insulation, valves and accessories.

Oxygen trim controls can either be purchased as part of a package with future boilers or installed (at a higher cost) on the existing boilers. For the purpose of this study, we are assuming installation of the controls on the existing boilers.

SUMMARY:

The project costs shown in Table M15-1 are the construction costs plus 6% SIOH. Each valid option in this ECO was considered as a separate project.

The energy savings associated with the implementation of this ECO is also shown in Table M15-1 on a MBTU per year and dollars per year savings as determined by hand calculations.

We recommend installing blowdown heat recovery on the (3) new boilers at the time of replacement, because the payback period does not warrant the installation on the present boilers.

We recommend using a boiler stack fuel economizer on the new 15,000 lb./hr. boiler serving the laundry with 120 psig steam. The saturated temperature for 120 psig steam is 350° F., and the flue gas must be approximately 450° F. to transfer the heat from the fuel to the water in the boiler. This flue gas temperature is higher than the temperature for the (2) 80 psig boilers. The laundry boiler also operates on a year-round basis.

The cost for blowdown heat recovery is $24,370 and the savings to investment ratio is 1.79, and the simple payback is 6 1/2 years. The cost for the boiler stack economizer is $22,852 with a savings to investment ratio is 1.92, and the simple payback is 6 years.

Oxygen trim controls were found to have a payback of 2.67 years. However, if the boilers are to be replaced within a period of time that is close to this, we recommend that the controls not be purchased until the new boilers are purchased. At that time, the controls can be bought as part of a package with the boilers.

Project	Energy Savings (MBTU/yr)	Energy Savings ($/yr)	Project Cost ($)	Simple Payback (years)	Savings to Investment Ratio
Economizer H.R.	925	3,774	22,852	6.08	1.92
Blowdown H.R.	917	3,741	24,370	6.54	1.79
O2 Trim Controls	3,397	13,860	39,077	2.67	4.37

Table M15-1

CALCULATION SHEET		**DATE** Mar-90	**SHEET** 1 **OF** 1
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** __X__ **HAND** _____ **COMPUTER** _____ **CONTRACTOR BID** **OTHER (SPECIFY)**	
LOCATION			
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECONOMIZER ECO-M15	**COMPUTED BY** TGD	**CHECKED BY**

220.0°F BOILER FEEDWATER TEMPERATURE: 188.0 BTU/LB. ENTHALPY

232.6°F BOILER FEEDWATER TEMPERATURE: 200.6 BTU/LB. ENTHALPY

SYSTEM EFFCIENCY: 74%

AVERAGE DAILY STEAM CONSUMPTION: 148,750 LBS.

DAYS PER YEAR: 365

(200.6 - 188.0) / 0.74 = 17.03 BTU/LB.

(17.03 X 148,750 X 365)/1,000,000 = 925 MBTU/YEAR

CALCULATION SHEET	**DATE** Mar-90	**SHEET** 1 **OF** 1
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X **HAND** ☐ **COMPUTER** ☐ **CONTRACTOR BID** **OTHER (SPECIFY)**	
LOCATION		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
ECO MEASURE BLOWDOWN HEAT RECOVERY ECO-M15	**COMPUTED BY** TGD	**CHECKED BY** MAW

BLOWDOWN INLET TEMPERATURE:	350°F
BLOWDOWN OUTNLET TEMPERATURE:	100°F
TEMPERATURE DIFFERNTIAL:	250°F
AVERAGE STEAM PRODUCTION:	148,750 LBS./DAY
AVERAGE STEAM PRODUCTION PER HOUR:	6,198
BLOWDOWN RATE:	5%
SYSTEM EFFICIENCY:	74%
MBTU:	1,000,000
24 HOURS x 365 DAYS =	8760
[(250 x 6198 x 0.05) / (0.74 x 1,000,000)] x 8760 =	917 OK

C_p water = 1 Btu/# / °F

917 MBTU SAVINGS PER YEAR

$$\frac{°F \times \cancel{\#steam}/\cancel{HR} \times \frac{\#\,BLOWDOWN}{\cancel{\#\,Steam}}}{\eta \times MBTU} \times \cancel{HR}$$

CALCULATION SHEET

DATE Mar-90

SHEET 1 **OF** 1

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

LOCATION FORT LEAVENWORTH, KANSAS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

ECO MEASURE ECO-M15 O2 TRIM CONTROLS

BASIS FOR CALCULATION
X **HAND**
COMPUTER
CONTRACTOR BID
OTHER (SPECIFY)

COMPUTED BY BMS

CHECKED BY MAW

BUILDING 474 - CENTRAL HEATING PLANT

TEST DATA, BOILER #2

% OXYGEN	6.3 %
STACK TEMPERATURE	450 ° F
% EXCESS AIR	37. %
EFFICIENCY	80.50%
%CO 2	8.3 %

STEAM PRODUCTION, ACCORDING TO BOILER PLANT OPERATORS:

SUMMER	75,000 LBS/DAY
WINTER	370,000 LBS/DAY
AVERAGE (CALCULATED)	148,750 LBS/DAY

BOILER TRIM CONTROL REDUCES EXCESS AIR TO 15%

FROM "GAS COMBUSTION EFFICIENCY CHART" PUBLISHED BY COOPERATIVE EXTENSION SERVICE, KANSAS STATE UNIVERSITY, MANHATTAN KS.:

15% EXCESS AIR AT 317°F = 84.50% COMBUSTION EFF.

84.50% - 80.50% = 4.00% INCREASE IN COMB. EFF.

ENTHALPY OF STEAM LEAVING BOILERS	1192.4 BTU/LB
ENTHALPY OF CONDENSATE RETURNING TO BOILERS	128 BTU/LB
ENTHALPY DIFFERENCE	1064.4 BTU/LB

148,750 LBS/DAY X 1,064 BTU/LB X 365 DAYS/YR > 0.000001 MBTU/BTU =

57,769 MBTU/YR.

THIS TRANSLATES TO GAS CONSUMPTIONS OF

57,769 / 80.50% = 71,763 MBTU/YR.

AND

57,769 / 84.50% = 68,366 MBTU/YR. WITH O2 TRIM CONTROLS.

SAVINGS

71,763 - 68,366 = 3,397 MBTU/YR.

4.08 X 3,397 = $13,860 PER YEAR

```
Hughes Machinery                        [illegible]
PROPOSAL 322-00253-0-0                  TULSA, OKLAHOMA           PRINTED 03/08/90
RUN 00                                                            TIME     18 HRS 55 MINS
                                                                  CUST. REFERENCE

                              RETROMISER FUEL ECONOMIZER
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[illegible]LL PERFORMANCE

COUNTER CURRENT FLOW
FLUID CIRCULATED IN TUBES IS WATER
HEAT EXCHANGED           175591.     BTU/HR
U EXTERNAL                  6.573 BTU/HR-SQFT-F
U BARE TUBE                61.962 BTU/HR-SQFT-F
LMTD                      118.1   DEG F
BARE TUBE SURFACE          27.    SQFT
MAX FIN TEMP              311.    DEG F
MAX TUBE WALL TEMP        258.    DEG F
BOILER FLUID SAT TEMP     350.    DEG F


           PERFORMANCE SPECIFICATIONS
             TUBE SIDE    GAS SIDE

FLUID ENTERING  15417.     18423.      LB/HR
TEMP IN           220.0      365.0     DEG F
TEMP OUT          232.6      324.9     DEG F
PRES IN           170.0 PSIG 14.7      PSIA
PRES DROP           1.8 PSI    .23     IN WATER
VELOCITY            4.1      38.4      FT/SEC
MASS VEL          245.2       1.7      LB/SQ FT/SEC
DEN[illegible]TY           59.435     .0477 LB/CUFT
VI[illegible]SITY              .262     .0202 CPS
SPEC HEAT           1.0045    2703 BTU/LB F
FOULING FACTOR       .0010    .0010
                               HR SQFT F/BTU
```

```
OVERALL CONSTRUCTION

HORIZONTAL GAS FLOW
DIMENSIONS
     DEPTH           3'- 7 1/2"
     WIDTH           6'-11 1/2"
     HEIGHT          2'- 7 5/8"
     NOZZLE C-C      1'- 1 1/2"
     DRAWING NO RA-208
NO OF SOOT BLOWER LANES  1
NOZZLE SIZE  2.0 IN., 300 RFWN
EFF SURFACE AREA         252. SQFT
WEIGHT OF LIQUID          86. LB
WEIGHT OF UNIT(DRY)     1934. LB

CONSTRUCTION SPECIFICATIONS
        TUBE SIDE

DESIGN PRESSURE        490. PSI
TEST PRESSURE          735. PSI
DESIGN TEMPERATURE     700. DEG
DUCT OPENING
     HEIGHT            1'- 6"
     WIDTH             4'- 3"

NUMBER OF TUBES        12
NUMBER OF ROWS          3
TUBES PER ROW           4
PARALLEL STREAMS        1
TUBE PITCH            4.500 IN (SQ)
     OUTSIDE DIA      2.000 IN
     MIN TUBE WALL     .105 IN
     LEN OVERALL      4'-10"
     LEN EFF.         4'- 3"
     MATERIAL        SA-178-A
FIN THICKNESS          .060 IN
     PITCH            4.00  FINS/IN
     HEIGHT            .750 IN
     MATERIAL        C/STL
INSULATION           MIN WOOL
     SIDES           2.0   IN
     HEADER BOX      2.0   IN
INTERMEDIATE TUBE SUPPORTS
     QUANTITY        0
     TYPE            LATTICE
CASING
     THICKNESS        .1340 IN
     MATERIAL        C.S.
TYPE OF RETURN       180 DEG. BEND
```

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM15
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	22852.
B. SIOH	$	1371.
C. DESIGN COST	$	1257.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	22932.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	22932.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	8.69	0.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	925.	$ 3774.	11.67	44043.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		925.	$ 3774.		$ 44043.

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

A. ANNUAL RECURRING (+/-)		$ 0.
(1) DISCOUNT FACTOR (TABLE A)	9.11	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 14534.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 3774.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 44043.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.92
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 6.08

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM15
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	24370.
B. SIOH	$	1462.
C. DESIGN COST	$	1340.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	24455.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	24455.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	0.	$	0.	8.69		0.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	917.	$	3741.	11.67		43657.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			917.	$	3741.		$	43657.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	9.11		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 14407.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 3741.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 43657.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.79
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 6.54

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM15O2
ANALYSIS DATE: 03-28-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	36865.
B. SIOH	$	2212.
C. DESIGN COST	$	2028.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	36995.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	36995.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	8.69	0.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	3397.	$ 13860.	11.67	161746.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		3397.	$ 13860.		$ 161746.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 53376.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 13860.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 161746.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 4.37
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 2.67

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET 1 **OF** 1

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

DRAWING NO. ECONOMIZER ECO-M15

ESTIMATOR TGD

CHECKED BY

BASIS FOR ESTIMATE

__X__ **CODE A (NO DESIGN COMPLETED)**
____ CODE B (PRELIMINARY DESIGN)
____ CODE C (FINAL DESIGN)
OTHER (SPECIFY)

	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BOILER STACK ECONOMIZER	1	EA	$8,345	$8,345	$3,500	$3,500	$11,845
2" BOILER FEEDWATER PIPING	200	LF	$2.36	$472	$5.50	$1,100	$1,572
1 1/2" THICK PIPE INSULATION	200	LF	$3.21	$642	$1.81	$362	$1,004
2" BALL VALVES	8	EA	$68	$544	$41	$328	$872
THERMOMETERS	2	EA	$55	$110	$7.55	$15	$125
PRESSURE GAUGES	2	EA	$70	$140	$6.15	$12	$152
SUBTOTAL				$10,253		$5,317	$15,570
CONTINGENCY 10%			10%	$1,025	10%	$532	$1,557
SUBTOTAL				$11,278		$5,849	$17,127
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$395	13.0%	$760	$1,155
DIRECT COST				$11,673		$6,609	$18,282
OVERHEAD AND PROFIT			25%	$2,918	25%	$1,652	$4,570
SUBTOTAL				$14,591		$8,261	$22,852
CONSTRUCTION COST							**$22,852**

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED Mar-90

SHEET 1 **OF** 1

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
______ CODE B (PRELIMINARY DESIGN)
______ CODE C (FINAL DESIGN)
______ OTHER (SPECIFY)

DRAWING NO. BLOWDOWN HEAT RECOVERY ECO-M15

ESTIMATOR TGD

CHECKED BY MAW

	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BLOWDOWN RECOVERY UNIT	1	EA	$9,900	$9,900	$4,950	$4,950	$14,850
2" BLOWDOWN PIPING	100	LF	$2.36	$236	$5.50	$550	$786
1 1/2" THICK PIPE INSULATION	100	LF	$3.21	$321	$1.81	$181	$502
2" BALL VALVES	3	EA	$68	$204	$41	$123	$327
THERMOMETERS	2	EA	$55	$110	$7.55	$15	$125
SUBTOTAL				$10,771		$5,819	$16,590
CONTINGENCY 10%			10%	$1,077	10%	$582	$1,659
SUBTOTAL				$11,848		$6,401	$18,249
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$415	13.0%	$832	$1,247
DIRECT COST				$12,263		$7,233	$19,496
OVERHEAD AND PROFIT			25%	$3,066	25%	$1,808	$4,874
SUBTOTAL				$15,329		$9,041	$24,370
CONSTRUCTION COST							**$24,370**

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED Mar-90

SHEET **OF** 1

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

DRAWING NO. NONE

BASIS FOR ESTIMATE

__X__ **CODE A (NO DESIGN COMPLETED)**
____ CODE B (PRELIMINARY DESIGN)
____ CODE C (FINAL DESIGN)
____ OTHER (SPECIFY)

ESTIMATOR BMS

CHECKED BY MAW

ECO-M15	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
OXYGEN TRIM CONTROL	3	EA	$2,100	$6,300	$5,985	$17,955	$24,255
SUBTOTAL				$6,300		$17,955	$24,255
CONTINGENCY 10%			10%	$630	10%	$1,796	$2,426
SUBTOTAL				$6,930		$19,751	$26,681
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$243	13.0%	$2,568	$2,811
DIRECT COST				$7,173		$22,319	$29,492
OVERHEAD AND PROFIT			25%	$1,793	25%	$5,580	$7,373
SUBTOTAL				$8,966		$27,899	$36,865
CONSTRUCTION COST							**$36,865**

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-M24

CONVERT FROM STEAM TO HOT WATER

CONVERT STEAM TO HOT WATER

ENERGY CONSERVATION OPPORTUNITY: ECO-M24

PURPOSE:

The purpose of this Energy Conservation Opportunity M24 is to analyze the energy savings that may be obtained by converting the existing high pressure steam system to a hot water heating system. High temperature hot water system are desirable because of reduced thermal losses and better control. Line losses such as leaks, thermal transmission and trap blow through make steam systems less efficient. New Hot Water Boilers are more efficient at partial loads than the existing Steam Boilers located at the USDB.

SCOPE:

ECO-M24 includes replacing the portion of existing steam system used for space heating and replacing it with a hot water heating system. Some existing steam capacity will need to remain to handle the laundry and the domestic hot water system. The application of this project was considered for the following buildings:

Building	463	Building	475B
Building	464	Building	475C
Building	465	Building	475D
Building	466	Building	475E
Building	472	Building	475F
Building	473	Building	475G
Building	475	Building	475H
Building	475A		

New supply and return piping will be added and connected to the existing hot water systems in each building. Steam coils in Castle buildings will be removed and replaced with hot water coils, controls, and connecting piping.

MODELING TECHNIQUES:

The modeling techniques used to simulate this ECO were using the assumption that a Savings to Investment Ratio of at least 1would be required. It is difficult to estimate the exact efficiencies of both system without a complete design so an alternative approach was taken. First a cost estimate of the new hot water system was generated using the heating loads obtained by the computer models created for this study. The project cost, the yearly pumping costs and the fuel costs were entered into the Life Cycle Cost Analysis program. The energy saving in MBTU's was adjusted to obtain an SIR of 1. The existing heating loads divided by the energy saving required gives the total improved efficiency of the hot water system. This improvement in efficiency of 83% is not obtainable thus eliminating the cost effectiveness of this ECO.

ECO IMPLEMENTATION:

Because of the large construction cost and yearly operating costs involved with this ECO a payback was not obtainable.

CALCULATION SHEET		**DATE** Mar-90	**SHEET 0F** 1 1
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X **HAND** **COMPUTER** **CONTRACTOR BID** **OTHER (SPECIFY)**	
LOCATION			
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECO-M24	**COMPUTED BY** RGB	**CHECKED BY** MAW

HAND CALCULATION OF ENERGY SAVINGS ASSOCIATED WITH HOT WATER HEATING SYSTEM
HOT WATER SYSTEM CALCULATED TO SERVE ALL BUILDING INCLUDED IN THIS STUDY

PROJECT COST = $634,367

PUMP ENERGY
75 HP. MOTOR
1 HP = 746 WATTS
75 X 746 = 55.95 KW
HOT WATER PUMP RUN TIME = 4380 HR /YR

ENERGY = 55.95 KW X 4,380 HR = 245,061 KW
= 836.4 MBTU'S

PUMP ENERGY = 836.4 MBTU'S PER YEAR

FROM LIFE CYCLE COST ANALYSIS W/ SIR = 1

REQUIRED YEARLY SAVINGS =15,300 MBTU OF NATURAL GAS
= $ 62,424 PER YEAR

PRESENT HEATING ENERGY USAGE / YR **= 18,522 MBTU**
= $ 98,907 PER YEAR

INCREASED EFFICIENCY OF NEW SYSTEM TO OBTAIN SIR = 1

15,300 MBTU / 18,533 MBTU = 83%

REQUIRED 83 % INCREASE IN EFFICIENCY IS NOT POSSIBLE

CALCULATION SHEET

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

LOCATION

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

ECO MEASURE
ECO-M24

DATE Mar-90

SHEET 1 **0F** 1

BASIS FOR CALCULATION
X HAND
COMPUTER
CONTRACTOR BID
OTHER (SPECIFY)

COMPUTED BY RGB

CHECKED BY MAW

THE HEATING CAPACITY PER BUILDING IS:

BUILDING	MBH HTG.
450	0.817
463	0.419
464	0.319
465	2.257
466	0.795
472	0.849
473	0.541
475	1.555
475A	0.667
475B	0.464
475C	1.539
475D	1.646
475E	5.317
475F	1.648
475G	1.556
475H	0.446
TOTAL	20.835 MILLION BTUH

INSTALL 3 15 MILLION BTUH HOT WATER BOILERS

USING A HOT WATER TEMPERATURE OF 180° TO 200°
USING A TYPICAL DELTA TEMPERATURE OF 10°F

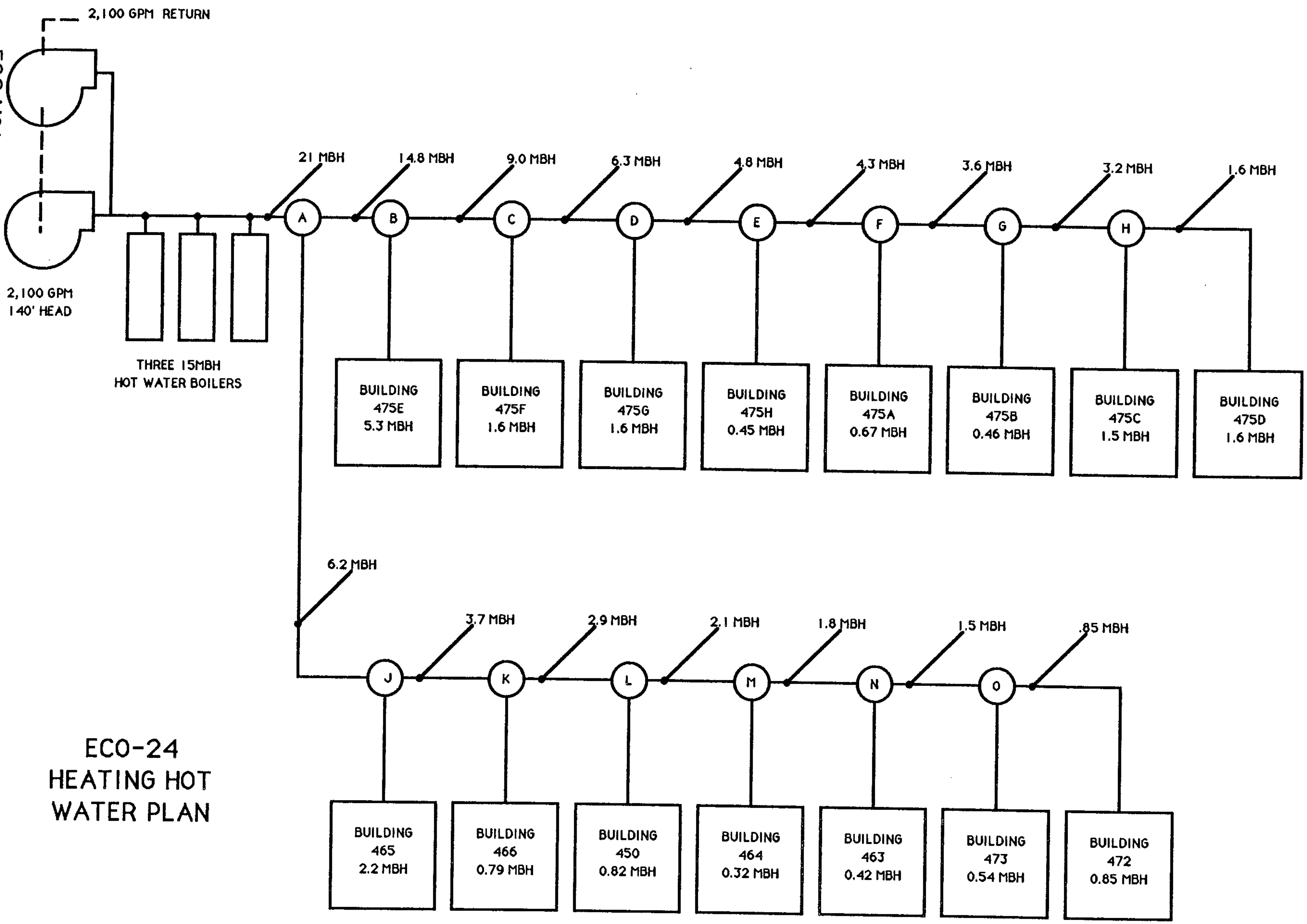
ENERGY = 20,835,000 BTUH

$\Delta T = 20°$ F
GPM = (ENERGY) / (ΔT) (500 LB MIN / GAL HOUR)
GPM = 20,835,000 / 10,000
GPM = 2083.5

PUMP TO BE SIZED FOR 2,100 GPM

USING THE FOLLOWING SPREADSHEET, PIPE SIZES, NUMBER OF FITTINGS, AND FRICTION LOSS CAN BE DETERMINED.

THE PUMP WILL BE A 2,100 GPM, 140' HEAD END SUCTION.



ECO-24
HEATING HOT
WATER PLAN

HEATING HOT WATER PIPING WORKSHEET

PATH DESCRIPTION	MILL BTUH	GPM	PIPE SIZE	FEET	ELL	FRCT/ ELL	ELL FRCT	TEE	FRCT/ TEE	TEE FRCT	VALVE	FRCT/ VALVE	VALVE FRCT	TOTAL FEET	HEAD 4'/100'
PUMP TO BOILER	21	2100	12"	20	10	7.0	70	3	24.0	72	6	3.2	19.2	181.2	7.2
BOILER TO A	21	2100	12"	60	3	7.0	21	1	24.0	24	2	3.2	6.4	111.4	4.5
A TO B	13	1330	10	200	9	5.7	51.3	1	18.0	18	1	3.2	3.2	272.5	10.9
B TO BLDG 475E	5	530	8"	20	2	4.2	8.4		12.0	0	2	2.9	5.8	34.2	1.4
B TO C	8	800	10"	450	2	4.2	8.4	1	12.0	12	1	2.9	2.9	473.3	18.9
C TO BLDG 475F	2	160	2"	20	2	3.4	6.8		9.4	0	2	2.8	5.6	32.4	1.3
C TO D	6	630	8"	40	2	4.2	8.4	1	12.0	12	1	2.9	2.9	63.3	2.5
D TO BLDG 475G	2	160	2"	20	2	3.4	6.8		9.4	0	2	2.8	5.6	32.4	1.3
D TO E	5	480	6"	40	2	4.2	8.4	1	12.0	12	1	2.9	2.9	63.3	2.5
E TO BLDG 475H	2	160	2"	20	2	3.4	6.8		9.4	0	2	2.8	5.6	32.4	1.3
E TO F	4	430	6"	40	2	3.4	6.8	1	9.4	9.4	1	2.8	2.8	59	2.4
F TO BLDG 475A	1	67	2"	20	2	3.4	6.8		9.4	0	2	2.8	5.6	32.4	1.3
F TO G	4	360	4"	40	2	3.4	6.8	1	9.4	9.4	1	2.8	2.8	59	2.4
G TO BLDG 475B	0	46	2"	20	2	3.4	6.8		9.4	0	2	2.8	5.6	32.4	1.3
G TO H	3	320	4"	40	2	3.4	6.8	1	9.4	9.4	1	2.8	2.8	59	2.4
H TO BLDG 475C	2	150	2"	20	2	3.4	6.8		9.4	0	2	2.8	5.6	32.4	1.3
H TO BLDG 475D	2	160	2"	20	2	3.4	6.8		9.4	0	2	2.8	5.6	32.4	1.3
A TO J	6	600	8"	610	12	5.7	68.4	1	18.0	18	1	3.2	3.2	699.6	28.0
J TO BLDG 465	2	225	4"	20	2	3.6	7.2		12.0	0	2	2.6	5.2	32.4	1.3
J TO K	4	370	4"	190	9	5.0	45	1	12.0	12	1	3.1	3.1	250.1	10.0
K TO BLDG 466	1	79	2"	40	2	5.0	10	1	6.0	6	1	3.1	3.1	59.1	2.4
K TO L	3	291	4"	210	9	5.0	45	1	6.6	6.6	1	3.1	3.1	264.7	10.6
L TO BLDG 450	1	82	2"	80	2	3.4	6.8		6.0	0	2	2.8	5.6	92.4	3.7
L TO M	2	210	4"	100	4	5.0	20	2	12.0	24	1	3.1	3.1	147.1	5.9
M TO BLDG 464	0	32	2"	20	4	5.0	20	2	6.0	12	1	3.1	3.1	55.1	2.2
M TO N	2	180	2"	100	4	5.0	20	2	6.6	13.2	1	3.1	3.1	136.3	5.5
N TO BLDG 463	0	42	2"	20	4	5.0	20	2	6.0	12	1	3.1	3.1	55.1	2.2
N TO O	2	150	2"	50	4	5.0	20	2	6.6	13.2	1	3.1	3.1	86.3	3.5
O TO BLDG 473	1	54	2"	20	4	5.0	20	2	6.0	12	1	3.1	3.1	55.1	2.2
0 TO BLDG 472	1	82	2"	150	8	4.2	33.6	2	6.0	12	2	2.9	5.8	201.4	8.1

LARGE PRESSURE DROP PATH TOTAL 69.1

TOTAL PRESSURE DROP INCLUDING RETURN **X (2) 138.2**

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	634367.
B. SIOH	$	38062.
C. DESIGN COST	$	34890.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	636587.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	636587.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	-836.	$ -10400.	8.69	-90376.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	15300.	$ 62424.	11.67	728488.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		14464.	$ 52024.		$ 638112.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 210577.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 52024.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 638112.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.00
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 12.24

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/30/90

SHEET 1 **OF** 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

DRAWING NO. NONE

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR RGB

CHECKED BY MAW

ECO-M10 CENTRAL PLANT COOLING	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
15,000 MBTU HOT WATER BOILER	3	EA	45500.00	$136,500	10000.00	$30,000	$166,500
BOILER START UP	3	EA			3000.00	$9,000	$9,000
2100 GPM PUMP, 140' HEAD @75 hp	2	EA	3300.00	$6,600	780.00	$1,560	$8,160
12" BLACK STEEL PIPE, HANGERS, INSUL~	160	FT	31.10	$4,976	40.25	$6,440	$11,416
10" BLACK STEEL PIPE, HANGERS, INSUL~	1300	FT	26.20	$34,060	28.12	$36,556	$70,616
8" BLACK STEEL PIPE, HANGERS, INSUL	1340	FT	18.18	$24,361	22.17	$29,708	$54,069
4" BLACK STEEL PIPE, HANGERS, INSUL~	1360	FT	12.20	$16,592	18.19	$24,738	$41,330
2" BLACK STEEL PIPE, HANGERS, INSUL ≈	400	FT	8.60	$3,440	10.25	$4,100	$7,540
12" BLACK STEEL ELL	13	EA	120.00	$1,560	210.00	$2,730	$4,290
10" BLACK STEEL ELL	14	EA	80.00	$1,120	160.00	$2,240	$3,360
8" BLACK STEEL ELL	13	EA	66.00	$858	135.00	$1,755	$2,613
4" BLACK STEEL ELL	10	EA	26.00	$260	45.00	$450	$710
2" BLACK STEEL ELL	10	EA	15.00	$150	25.00	$250	$400
12" BLACK STEEL TEE	1	EA	150.00	$150	290.00	$290	$440
10" BLACK STEEL TEE	1	EA	132.00	$132	260.00	$260	$392
8" BLACK STEEL TEE	3	EA	91.00	$273	220.00	$660	$933
6" BLACK STEEL TEE	3	EA	50.00	$150	185.00	$555	$705
4" BLACK STEEL TEE	3	EA	27.00	$81	115.00	$345	$426
10" BUTTERFLY VALVE	4	EA	200.00	$800	120.00	$480	$1,280
8" BUTTERFLY VALVE	2	EA	140.00	$280	110.00	$220	$500
4" GATE VALVE	10	EA	105.00	$1,050	27.00	$270	$1,320

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/30/90

SHEET 2 **OF** 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A** (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR RGB

CHECKED BY MAW

ECO-M10 **CENTRAL PLANT COOLING**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDINGS 475C,D,F,G STEAM COIL REPLACEMENT	8	EA	1750.00	$14,000	435.00	$3,480	$17,480
BUILDINGS 475C,D,F,G STEAM COIL DEMOLITION	8	EA			395.00	$3,160	$3,160
EXISTITING CONDENSATE LINE DEMOLITION	2400	LF			6.60	$15,840	$15,840
PARTIAL EXISTING STEAM PIPE DEMOLITION	1000	LF			6.60	$6,600	$6,600
SUBTOTAL				$247,393		$181,687	$429,080
CONTINGENCY 10%			10%	$24,739	10%	$18,169	$42,908
SUBTOTAL				$272,132		$199,856	$471,988
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$9,525	13.0%	$25,981	$35,506
DIRECT COST				$281,657		$225,837	$507,494
OVERHEAD AND PROFIT			25%	$70,414	25%	$56,459	$126,873
SUBTOTAL				$352,071		$282,296	$634,367
CONSTRUCTION COST							$634,367

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-M25

CONVERT FROM STEAM TO COGENERATION

COGENERATION POTENTIAL AT THE USDB

ENERGY CONSERVATION OPPORTUNITY: ECO-25

PURPOSE:

This ECO was investigated to determine the potential cost savings provided by a natural gas cogeneration system. Cogeneration is the practice of generating electricity on-site with an engine-generator set, and recovering the heat from the engine to produce steam or hot water. The steam is used for heating, or processes. At the USDB, those processes are the laundry and kitchen facilities.

SCOPE:

An analysis of the economics of a cogeneration system requiring investigation of, system configuration, fuel prices, financing, fuel availability, and energy requirements. Because of the large capital investment, (0.5 to 5 million dollars) and the impact of operating costs, a very detailed analysis must be performed before funding is considered. The scope of this study is to determine if the investment in a complete cogeneration feasibility study is justified. The cogeneration system would provide electricity for the entire Disciplinary Barracks. The system would be located in the existing boiler plant and be tied into the existing steam system.

CONSIDERATIONS:

In most cases, the feasibility of cogeneration depends on the facility electrical and thermal loads, and how they interrelate. This is especially true when the cost of both electricity and gas are moderate, as they are at the USDB. A natural gas fired system was the only system considered because of the low cost of gas compared to fuel oil or coal in this region.

The thermal load is much greater than the electrical load. A gas turbine cogeneration system would have the most desirable thermal to electrical output for this load situation. A gas turbine would be capable of generating the high pressure steam required at the USDB and providing all of the electricity for the USDB and some additional for the main Post.

Another approach would be to install.a gas reciprocating engine cogeneration system. This type of system has a high electrical output compared to thermal load, but the excess power can be absorbed by the grid serving the rest of the Post. The main drawback of the reciprocating engine systems is that the majority of the thermal output is in engine jacket heat. This temperature is usually around 350°F, which results in either high temperature hot water or low pressure 15 psig steam. Because all of the steam generated at the USDB is 120 psig, there is no real use for the steam generated.

Because the main Post is capable of using excess electricity,the major obstacle to an efficient cogeneration operation at the USDB is the variability of the thermal load. The base load that operates year-round is the laundry facility, which only operates 8 to 10 hours during the day. In the summer, the steam load drops to almost nothing at night. The most efficient system offering the best return on investment would be a cogeneration system tied into a central plant with absorption chillers using the waste heat for cooling purposes.

Table M25-1 indicates the energy use analysis for a gas turbine engine cogeneration system installed at the USDB. The system is base loaded to provide steam to the laundry facility during the day during summer and winter, and space heating during night in the winter. The KW size of the unit was changed up and down to maximize savings. An 800 KW provides the most energy savings. A Payback Analysis shown below.

PAYBACK ANALYSIS:

Assumptions

Electrical Requirements	800 KW
Capital Investment ($1500/KW)	$1.2 Million
Hours of Operation	6570 Hours
Natural Gas Costs	$4.08/MBTU
Electricity Cost from Grid	4.25¢/KWH
Heat Rate	14,000 BTU/KWH

Economic Analysis

Cost Items

Fuel	$282,950
O&M	$20,867
Total	$303,816

Savings

Elec. Savings	$136,435
Thermal Savings	$224,519
Total	$361,954

Net Savings Per Year	$58,138
Simple Payback:	21 years

Heat Rate	14000 Btu/Kwh
Cogen Size	800 KW
Eff. Stm Prod	60%
Cost of Fuel	$4.08 MBTU
Cost of Exist Stm.	$5.50 MBTU
Cost of Exist Elec	$0.0425 Kwh

	Hrs/Day Operation	Days/ Month	Hrs/Month Operation	USDB Thermal Load MBTU	USDB Electical Load Kwh	Cogen. Therm Energy Available MBTU	Cogen. Ther Energy Used MBTU	Cogen. Elec. Energy Used Kwh	
January	24	31	744	10478	265000	5000	5000	595200	
February	24	28	672	9520	237000	4516	4516	322560	
March	24	31	744	9300	270000	5000	5000	357120	
April	12	30	360	4500	240000	2419	2419	172800	
May	12	31	372	2418	240000	2500	2418	178560	
June	12	30	360	2250	340000	2419	2250	172800	
July	12	31	372	2387	384000	2500	2387	178560	
August	12	31	372	2387	374000	2500	2387	178560	
September	12	30	360	2340	280000	2419	2340	172800	
October	12	31	372	2449	223000	2500	2449	178560	
November	24	30	720	6300	240000	4838	4838	345600	
December	24	31	744	12028	250000	5000	5000	357120	
			6192				41003	3210240	

Fuel Cost of Cogeneration Unit.	$282,950	Elec. Saved	$136,435
O&M Cost = 0.0065 per Kwh	$20,867	Steam Saved	$225,519
Total Operating Cost	$303,816	Total Saved	$361,954

Dollar Savings Per year $58,138 per year

TABLE M25-1

ECO-M26

REDUCE HOT WATER TEMPERATURE

REDUCE HOT WATER TEMPERATURE

ENERGY CONSERVATION OPPORTUNITY: ECO-M26

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-M26) analyzes the energy savings associated with reduction of the domestic hot water temperature. The implementation of this project will not change the number or capacity of any of the hot water heating equipment.

SCOPE:

The ECO simulation (ECO-M26) makes changes only to the temperature setpoint of the existing hot water heaters and does not encompass any modification or replacement of any existing equipment. The application of this project was considered for the following buildings and their connecting tunnel:

Building 450
Building 463
Building 464
Building 465
Building 466
Building 472
Building 473
Building 475
Building 475A
Building 475C
Building 475D
Building 475E
Building 475F
Building 475G

MODELING TECHNIQUES:

The modeling techniques used to calculate the energy savings for ECO-M26 were derived from "Guidelines for Saving Energy in Existing Buildings." The domestic hot water temperatures for the above buildings were found to range between 170° and 185°. ASPE suggests a domestic hot water temperature of around 140°. Trends to reduce hot water temperature between 110° and 120° have been stopped because these temperatures have been linked to the proliferation of Legionnaires' Disease. An energy savings can be seen by reducing the domestic hot water temperature. Tables M26-1a and M26-1b show the BTUH loss per lineal foot of pipe for different water temperatures. Tables M26-2a and M26-2b use a reduced hot water temperature of 140° to show the energy savings on a per lineal foot bases. The lineal feet of pipe for each building was field estimated to calculate the total possible energy savings in line losses because of reduced hot water temperature.

Domestic water within the USDB is always mixed to a using temperature of under 140°. The equation for mixed water temperature is:

$$t_m = (Q_1 \times t_1)+(Q_2 \times t_2) / Q_1 + Q_2$$

t_m= temperature of the mixture
t_1 = temperature of flow Q_1
t_2 = temperature of flow Q_2

Using a constant (tm) and (t_2) and comparing a range of hot water temperatures (t_1) to the existing hot water temperature it can be seen that as the hot water temperature drops the flow of hot water increases while the cold water flow decreases. The energy usage stays the same because of the energy savings of not having to heat the water to as high a temperature is offset by the fact that more hot water is used. Actual calculations are shown in Table M26-3.

ECO IMPLEMENTATION:

The implementation of this ECO consists of having the USDB maintenance staff change the setpoint for all the hot water heaters within the DB to 140°. This will show an energy savings with no cost to the USDB.

SUMMARY:

Reducing the Domestic Hot Water from 180° to 140° will reduce the amount of heat energy radiating from the hot water piping to its surroundings. The reduction in temperature will also decrease the total capacity of the hot water system. This may cause problems which would call for added capacity or the return to a higher temperature. ECO-M30 also reduces radiation loss in domestic hot water piping by insulating all bare pipe within the USDB. If M30 is implemented it will reduce the effectiveness of this ECO. ECO-M26 does not effect the amount of heat energy consumption at the point of use.

Location	Cost Savings	Project Cost of Construction
475	$92	$0
Castle Domiciles	$210	$0
475E	$134	$0
Tunnels	$299	$0

CALCULATION SHEET

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

LOCATION

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

ECO MEASURE
ECO-M26

DATE Mar-90
SHEET 1 **OF** 5

BASIS FOR CALCULATION
X **HAND**
COMPUTER
CONTRACTOR BID
OTHER (SPECIFY)

COMPUTED BY RGB
CHECKED BY MAW

TEST DATA, BTUH LOSS PER LINEAL FOOT
REF: Guidlines for Saving Energy in Existing Buildings
Federal Energy Administration Office of Energy Conservation and Environment

Tables were developed from fig. 44 of the Guidlines for Saving Energy in Existing Buildings

Ambient Temperature 68° F
BTUH Loss per lineal foot of bare pipe

Bare Pipe

Pipe Size	180° Water	160° Water	140° Water	120° Water
3/4"	85	70	55	39
1"	105	85	66	46
1-1/4"	126	104	81	57
1-1/2"	150	121	95	67
2"	171	140	110	80
2-1/2"	205	169	133	94

Table M26-1a

Ambient Temperature 68° F
BTUH Loss per lineal foot of insulated pipe

1/2" Fiberglass Insulation

Pipe Size	180° Water	160° Water	140° Water	120° Water
3/4"	20	15	11	8
1"	21	17	12	9
1-1/4"	26	20	16	11
1-1/2"	30	24	19	13
2"	36	30	23	15
2-1/2"	45	35	27	20

Table M26-1b

CALCULATION SHEET		DATE Mar-90	SHEET 2 OF 5
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	BASIS FOR CALCULATION	
LOCATION		X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)	
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECO-M26	COMPUTED BY RGB	CHECKED BY MAW

TEST DATA, BTUH LOSS PER LINEAL FOOT
REF: Guidlines for Saving Energy in Existing Buildings
Federal Energy Administration Office of Energy Conservation and Environment

Tables were developed from fig. 44 of the Guidlines for Saving Energy in Existing Buildings

Ambient Temperature 68° F
BTUH Loss per lineal foot of bare pipe

Bare Pipe

Pipe Size	Btuh loss @ 180°	Btuh loss @ 140°	Btuh Savings	Hours per Year	$ Savings per L.F.
3/4"	85	55	30	4380	$0.70
1"	105	66	39	4380	$0.91
1-1/4"	126	81	45	4380	$1.05
1-1/2"	150	95	55	4380	$1.29
2"	171	110	61	4380	$1.43
2-1/2"	205	133	72	4380	$1.68

Table M26-2a

Ambient Temperature 68° F
BTUH Loss per lineal foot of insulated pipe

1/2" Fiberglass Insulation

Pipe Size	Btuh loss @ 180°	Btuh loss @ 140°	Btuh Savings	Hours per Year	$ Savings per L.F.
3/4"	20	15	5	4380	$0.12
1"	22	17	5	4380	$0.12
1-1/4"	26	20	6	4380	$0.14
1-1/2"	30	24	6	4380	$0.14
2"	36	30	6	4380	$0.14
2-1/2"	45	35	10	4380	$0.23

Table M26-2b

CALCULATION SHEET

DATE Mar-90

SHEET 3 **OF** 5

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

LOCATION

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

ECO MEASURE
ECO-M26

BASIS FOR CALCULATION

X **HAND**
___ **COMPUTER**
___ **CONTRACTOR BID**
OTHER (SPECIFY)

COMPUTED BY RGB

CHECKED BY MAW

REDUCED DOMESTIC HOT WATER TEMPERATURE

Tm= (Q1*T1) +(Q2*T2) / (Q1+Q2)

Tm = mixed water temperature
T1= temperature of fl (Cold Water Temp.)

Assumption:
Tm =110
T1= 40°
T2= X

Tm (°)	T1 (°)	Q1 (Gal.)	T2 (°)	Q2 (Gal.)
110.00	40.00	68.18	**180.00**	**31.82**
110.00	40.00	66.67	**170.00**	**33.33**
110.00	40.00	65.00	**160.00**	**35.00**
110.00	40.00	63.16	**150.00**	**36.84**
110.00	40.00	61.11	**140.00**	**38.89**
110.00	40.00	58.82	**130.00**	**41.18**
110.00	40.00	56.25	**120.00**	**43.75**

Table M26-3

CALCULATION SHEET		**DATE** Mar-90	**SHEET OF** 4 5
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X **HAND** **COMPUTER** **CONTRACTOR BID** **OTHER (SPECIFY)**	
LOCATION			
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECO-M26	**COMPUTED BY** RGB	**CHECKED BY** MAW

TEST DATA, BTUH LOSS PER LINEAL FOOT
REF: Guidlines for Saving Energy in Existing Buildings
Federal Energy Administration Office of Energy Conservation and Environment

Tables derived from Tables M26-2a and M26-2b
Length of pipe estimated from field inspection and plans.

Building 475

Pipe Size	Feet of Bare Pipe	$ Savings per Ft.	Feet of Insulated	$ Savings per FT.		$ Savings Year
3/4"		$0.70		$0.12		$0
1"		$0.91		$0.12		$0
1-1/4"	60	$1.05		$0.14		$63
1-1/2"	20	$1.29	20	$0.14		$29
2"		$1.29		$0.14		$0

Energy Savings = **$92.00**

Buildings 475C ,475D, 475F, 475G

Pipe Size	Feet of Bare Pipe	$ Savings per Ft.	Feet of Insulated	$ Savings per FT.		$ Savings Year
3/4"		$0.70		$0.23		$0
1"		$0.91		$0.23		$0
1-1/4"	200	$1.05	0	$0.28		$210
1-1/2"		$1.29		$0.28		$0
2"		$1.29		$0.28		$0

Energy Savings = **$210.00**

CALCULATION SHEET		DATE Mar-90	SHEET OF 5 5
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION**	
LOCATION		X HAND ___ COMPUTER ___ CONTRACTOR BID OTHER (SPECIFY)	
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECO-M26	**COMPUTED BY** RGB	**CHECKED BY** MAW

TEST DATA, BTUH LOSS PER LINEAL FOOT
REF: Guidlines for Saving Energy in Existing Buildings
Federal Energy Administration Office of Energy Conservation and Environment

Tables derived from Tables M26-2a and M26-2b
Length of pipe estimated from field inspection and plans.

Building 475E

Pipe Size	Feet of Bare Pipe	$ Savings per Ft.	Feet of Insulated	$ Savings per FT.		$ Savings Year
3/4"		$0.70		$0.12		$0
1"		$0.91		$0.12		$0
1-1/4"	100	$1.05		$0.14		$105
1-1/2"	20	$1.29	20	$0.14		$29
2"		$1.29		$0.14		$0

Energy Savings = **$134.00**

Tunnels between building 468, 466, 467, 463, 464, 472, 473

Pipe Size	Feet of Bare Pipe	$ Savings per Ft.	Feet of Insulated	$ Savings per FT.		$ Savings Year
3/4"		$0.70		$0.23		$0
1"		$0.91	180	$0.23		$41
1-1/4"	60	$1.05	90	$0.28		$88
1-1/2"	55	$1.29	355	$0.28		$170
2"		$1.29		$0.28		$0

Energy Savings = **$299.00**

ECO-M29

DECENTRALIZE HOT WATER SYSTEM

DECENTRALIZE HOT WATER SYSTEM

ENERGY CONSERVATION OPPORTUNITY: ECO-M29

PURPOSE:

The purpose of ECO-M29 is to analyze the energy savings associated with decentralizing the hot water heating system. A central system involves additional branch piping which is a source of heat loss. As hot water sits in the branch piping its temperature is reduced below its desired level. When hot water is needed the faucet is turned on and let run until the water increases to its desired temperature. This waste of water is reduced in a decentralized hot water system due to the fact that the hot water heater is located closer to the point of use. Decentralization of the domestic hot water system will eliminate all connecting hot water piping and the energy loss associated with it.

SCOPE:

ECO-M29 involves removal of the existing central domestic hot water heater located in building 468 and serving buildings 450, 463, 464, 466, 467, 468, 472, and 473. These building will be supplied by individual hot water heaters located in each building:

Building	450	Building	467
Building	463	Building	468
Building	464	Building	472
Building	466	Building	473

New hot water heat exchangers will be connected to the existing steam lines routed through each building. Buildings 450, 463, 473, and 472 have low hot water usage so small electric instantaneous hot water heaters were used. These units are placed at the point of use and only require energy when hot water is being used. The Castle buildings already have individual hot water heat exchangers so they were not applicable for this ECO.

MODELING TECHNIQUES:

The energy loss through branch piping was calculated in Table M29-2. The total gallons of wasted hot water was estimated in Table M29-3 and converted to dollars per year. The sum of these two calculations total the energy savings associated with ECO-M29. A cost estimate for ECO-M29 was prepared using Manufactures Data along with Means Plumbing Cost Data. The cost estimate was prepared per building, but the yearly savings is estimated on a system wide bases. Because of this, Table M29-1 compares the total cost to the total energy savings for this ECO.

ECO IMPLEMENTATION:

The Implementation of ECO-M29 includes the removal of the central hot water system located in building 468. Installation of new hot water heaters are as follows:

Building 450	4-Instantaneous Point of Use Hot Water Heaters
Building 463	5-Instantaneous Point of Use Hot Water Heaters
Building 464	Steam to Hot Water Heat Exchanger
Building 466	Steam to Hot Water Heat Exchanger
Building 467	2-Instantaneous Point of Use Hot Water Heaters
Building 468	Steam to Hot Water Heat Exchanger
Building 472	5-Instantaneous Point of Use Hot Water Heaters
Building 473	5-Instantaneous Point of Use Hot Water Heaters

SUMMARY:

The probable construction cost to implement this ECO is shown in Table M29-1. This project cost is the construction cost as determined on the ECO-M24 Cost Estimate Sheet.

The energy savings associated with the implementation of this ECO by building is shown below in Table M29-1 on a dollars per year savings as determined on ECO-M24 Calculation Sheet. This project cost is the construction cost plus 6% SIOH.

ECO-M24	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
Hot Water System	243	$1,296	$20,740	19.85	.59

Table M29-1

CALCULATION SHEET		**DATE** Mar-90	**SHEET OF** 1 1
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)	
LOCATION			
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECO-M30	**COMPUTED BY** RGB	**CHECKED BY** MAW

TEST DATA, BTUH LOSS PER LINEAL FOOT
REF: Guidlines for Saving Energy in Existing Buildings
Federal Energy Administration Office of Energy Conservation and Environment

Table was developed from fig. 44 of the Guidlines for Saving Energy in Existing Buildings

Ambient Temperature 68° F
Domestic Hot Water Temperature 180°

Pipe Size	Feet of Bare Pipe	BTUH Loss Bare Pipe	Feet of Insulated	BTUH Loss Insulated	Total BTUH Loss	Hours per Year	$ Savings per Year
3/4"	0	85	0	19	0	8760	$0
1"	15	105	75	23	3300	8760	$154
1-1/4"	15	126	75	26	3840	8760	$180
1-1/2"	25	150	330	31	13980	8760	$654

Table M29-2

Energy Savings = **$988.00**

Gallons of Hot Water Wated Per Day
Estimated that entire lines are evacuated twice per day
BTU =Gallons x 8.33 x 140°

Pipe Size	Feet of Pipe	Gal. per Ft. of Pipe	Total Gal. per Day	Total Gal. per Year	Total MBTU per Year	Total $ per Year
3/4"	800	0.023	36.8	13432	15.66	$84
1"	180	0.04	14.4	5256	6.13	$33
1-1/4"	90	0.063	11.34	4139	4.83	$26
1-1/2"	355	0.102	72.42	26433	30.82	$165

Table M29-3

Energy Savings = **$308.00**

Total Energy Savings = **$1,296**

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM29
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	19599.
B. SIOH	$	1176.
C. DESIGN COST	$	1078.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	19668.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	19668.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	8.69	0.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	243.	$ 991.	11.67	11565.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		243.	$ 991.		$ 11565.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3816.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 991.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 11565.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.59
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 19.85

CONSTRUCTION COST ESTIMATE	**DATE PREPARED** Mar-90	**SHEET OF** 1
PROJECT USDB ENERGY STUDY	**BASIS FOR ESTIMATE**	
LOCATION FORT LEAVENWORTH, KS	X **CODE A (NO DESIGN COMPLETED)** CODE B (PRELIMINARY DESIGN) CODE C (FINAL DESIGN) OTHER (SPECIFY)	
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
DRAWING NO. NONE	ESTIMATOR RGB	CHECKED BY **MAW**

STEAM TO HOT WATER HEAT EXCHANGES AND INSTANTANEOUS ELECTRIC HOT WATER HEATERS	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 450							
INSTANTANEOUS HOT WATER HEATER	4	EA	$145	$580	$120	$480	$1,060
BUILDING 463							
INSTANTANEOUS HOT WATER HEATER	5	EA	$145	$725	$120	$600	$1,325
BUILDING 464							
STEAM TO HOT WATER HEAT EXCHANGER	1	EA	$1,100	$1,100	$168	$168	$1,268
CONTROL VALVES, THERMOMETER, ECT.	1	EA	$670	$670	$240	$240	$910
BUILDING 466							
STEAM TO HOT WATER HEAT EXCHANGER	1	EA	$2,150	$2,150	$670	$670	$2,820
CONTROL VALVES, THERMOMETER, ECT.	1	EA	$890	$890	$310	$310	$1,200
BUILDING 467							
INSTANTANEOUS HOT WATER HEATER	2	EA	$145	$290	$120	$240	$530
BUILDING 468							
STEAM TO HOT WATER HEAT EXCHANGER	1	EA	$700	$700	$134	$134	$834
CONTROL VALVES, THERMOMETER, ECT.	1	EA	$520	$520	$260	$260	$780
BUILDING 472							
INSTANTANEOUS HOT WATER HEATER	5	EA	$145	$725	$120	$600	$1,325
BUILDING 473							
INSTANTANEOUS HOT WATER HEATER	5	EA	$145	$725	$120	$600	$1,325
SUBTOTAL				$9,075		$4,302	$13,377
CONTINGENCY 10%			10%	$908	10%	$430	$1,338
SUBTOTAL				$9,983		$4,732	$14,715
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$349	13.0%	$615	$964
DIRECT COST				$10,332		$5,347	$15,679
OVERHEAD AND PROFIT			25%	$2,583	25%	$1,337	$3,920
SUBTOTAL				$12,915		$6,684	$19,599
CONSTRUCTION COST							**$19,599**

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-M30

DOMESTIC WATER PIPE INSULATION

DOMESTIC WATER PIPE INSULATION

ENERGY CONSERVATION OPPORTUNITY: ECO-M30

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-M30) analyzes the energy savings associated with reducing the amount of heat transfer through the walls of domestic hot water piping. Domestic hot water piping can lose heat to its surroundings because of a temperature difference between the water and the ambient space temperature through which it is routed. A reduction in the hot water temperature at the point of use will cause an increase in hot water usage thus causing an increase in energy.

SCOPE:

The implementation of this ECO-M6 simulation includes all piping that exists without insulation and is exposed to unconditioned spaces. The piping considered in this ECO is located in the Castle and in the pipe tunnels connecting the building around the South Gate. Hot water piping contained inside the rest of the buildings considered in this study is located in concealed chases which are not accessible for insulating.

MODELING TECHNIQUES:

The modeling techniques used to calculate the energy savings associated with the addition of pipe insulation was figured on a savings per foot of pipe. Tables M30-1 and M30-2 give the BTUH per lineal foot heat loss through bare and insulated pipe. The existing hot water temperature of 185° was used along with an ambient space temperature of 68°. Table M30-3 gives the energy savings and the installed cost of the insulation on a lineal foot bases. A visual inspection was done to estimate the percentage of domestic hot water piping that was uninsulated.

ECO IMPLEMENTATION:

To implement this ECO for the buildings listed above, the existing uninsulated pipe would have to be insulated using 1/2" fiberglass pipe insulation. A difficulty factor of 2 was added to the labor cost because of the confined areas at which the hot water piping is located.

SUMMARY:

The energy savings associated with the implementation of this ECO by building is shown below in Table M30.1 in million BTU's savings as determined using the computer simulation model.

The probable construction cost to implement this ECO by building is shown in Table M30.1. This project cost is the construction cost plus 6% SIOH.

Building Number	Energy Savings (BTUH)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
Castle Buildings	147	$787	$1,447	2.28	5.11
Pipe Tunnels	55	$293	$481	2.03	5.75

Table M30.1

CALCULATION SHEET

PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**DATE** Mar-90	**SHEET** 1 **OF** 2
LOCATION		**BASIS FOR CALCULATION** X HAND ___ COMPUTER ___ CONTRACTOR BID OTHER (SPECIFY)	
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECO-M30	**COMPUTED BY** RGB	**CHECKED BY** MAW

TEST DATA, BTUH LOSS PER LINEAL FOOT
REF: Guidlines for Saving Energy in Existing Buildings
Federal Energy Administration Office of Energy Conservation and Environment

Table was developed from fig. 44 of the Guidlines for Saving Energy in Existing Buildings

Ambient Temperature 68° F
Domestic Hot Water Temperature 180°

Pipe Size	BTUH Loss Bare Pipe	BTUH Loss Insulated	BTUH Savings	Hours per Year	$ Savings per L.F.
3/4"	85	19	66	4380	$1.54
1"	105	23	82	4380	$1.92
1-1/4"	126	26	100	4380	$2.34
1-1/2"	150	31	119	4380	$2.78
2"	171	37	134	4380	$3.13
2-1/2"	250	45	205	4380	$4.79

CALCULATION SHEET

DATE Mar-90

SHEET 2 **OF** 2

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

LOCATION

ARCHITECT/ENGINEER
CLARK RICHARDSON & BISKUP

ECO MEASURE
ECO-M30

BASIS FOR CALCULATION

X HAND
COMPUTER
CONTRACTOR BID
OTHER (SPECIFY)

COMPUTED BY RGB

CHECKED BY MAW

TEST DATA, BTUH LOSS PER LINEAL FOOT
REF: Guidlines for Saving Energy in Existing Buildings
Federal Energy Administration Office of Energy Conservation and Environment

Tables derived from Tables M26-2a and M26-2b
Length of pipe estimated from field inspection and plans.

Castle Buildings

Pipe Size	Feet of Bare Pipe	$ Savings per Ft.	$ Savings Year
3/4"	80	$1.54	$123
1"		$1.92	$0
1-1/4"	260	$2.34	$608
1-1/2"	20	$2.78	$56
2"		$3.13	$0

Energy Savings = **$787.00**

Pipe Tunnels

Pipe Size	Feet of Bare Pipe	$ Savings per Ft.	$ Savings Year
3/4"		$1.54	$0
1"		$1.92	$0
1-1/4"	60	$2.34	$140
1-1/2"	55	$2.78	$153
2"		$3.13	$0

Energy Savings = **$293.00**

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM30CB
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	1365.
B. SIOH	$	82.
C. DESIGN COST	$	75.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	1370.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	1370.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	8.69	0.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	147.	$ 600.	11.67	7002.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		147.	$ 600.		$ 7002.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2311.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 600.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 7002.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 5.11
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 2.28

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM30PT
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	454.
B. SIOH	$	27.
C. DESIGN COST	$	25.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	455.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	455.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	0.	$ 0.	8.69	0.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	55.	$ 224.	11.67	2614.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		55.	$ 224.		$ 2614.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 863.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 224.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2614.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 5.75
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 2.03

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET 1 **OF**

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

- __X__ **CODE A (NO DESIGN COMPLETED)**
- ____ CODE B (PRELIMINARY DESIGN)
- ____ CODE C (FINAL DESIGN)
- OTHER (SPECIFY)

DRAWING NO. Castle Buildings

ESTIMATOR R.G.B.

CHECKED BY M.A.W.

1/2" FIBERGLASS PIPE INSULATION W/ ALL SERVICE JACKET	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
3/4" PIPE	80	L. F.	$0.87	$69.60	$1.44	$115.20	$184.80
1-1/4" PIPE	260	L. F.	$1.01	$262.60	$1.57	$408.20	$670.80
1-1/2" PIPE	20	L. F.	$1.10	$22.00	$1.57	$31.40	$53.40
SUBTOTAL				$354		$555	$909
CONTINGENCY 10%			$0.10	$35	10%	$55	$90
SUBTOTAL				$389		$610	$999
WORK COMP,TAX,SOC.SEC.,INS			$0.04	$14	13.0%	$79	$93
DIRECT COST				$403		$689	$1,092
OVERHEAD AND PROFIT			$0.25	$101	25%	$172	$273
SUBTOTAL				$504		$861	$1,365
CONSTRUCTION COST							$1,365

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET **OF** 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. Pipe Tunnels

ESTIMATOR R.G.B.

CHECKED BY M.A.W.

1/2" FIBERGLASS PIPE INSULATION W/ ALL SERVICE JACKET	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
1-1/4" PIPE	60	L. F.	$1.01	$60.60	$1.57	$94.20	$154.80
1-1/2" PIPE	55	L. F.	$1.10	$60.50	$1.57	$86.35	$146.85
SUBTOTAL				$121		$181	$302
CONTINGENCY 10%			$0.10	$12	10%	$18	$30
SUBTOTAL				$133		$199	$332
WORK COMP,TAX,SOC.SEC.,INS			$0.04	$5	13.0%	$26	$31
DIRECT COST				$138		$225	$363
OVERHEAD AND PROFIT			$0.25	$35	25%	$56	$91
SUBTOTAL				$173		$281	$454
CONSTRUCTION COST							$454

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-M31

HEAT RECOVERY FOR LAUNDRY

HEAT RECOVERY FOR LAUNDRY

ENERGY CONSERVATION OPPORTUNITY: ECO-M31

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-M31) analyzes energy savings possibilities from heat recovery from equipment in the laundry facility at the USDB. Because the laundry facility is beingrelocated, we are only making general recommendations based on the most up-to-date information available for laundry equipment in the USDB at this time.

SCOPE:

The ECO simulation (ECO-M31) investigates possibilities for heat recovery from laundry wash water, dryers, and irons (presses). Heat recovery applications in similar laundry facilities will be investigated and their feasibility at the USDB will be discussed.

Laundry wash water heat may be recovered in two ways; either by recycling dirty wash water and attempting to clean it by mechanical and chemical means or by using a system designed for recovering heat only (not water).

Disadvantages to recycling dirty wash water are that they require complicated hardware and expensive chemicals. High initial cost, high operating costs, and more maintenance problems rule this out as a possibility.

Heat reclamation systems, however, are simpler to install, operate, and maintain because they have fewer mechanical components and controls (see Fig. 1). Spent hot wash water is dumped first to a channel leading to a sump pit. Before it reaches the pit, it passes through a series of screens to remove lint and other solids. The dirty water is then pumped from the sump into the shell of a heat exchanger where it passes over a series of helical coil heat exchangers. Fresh (cold) water inside the coils passes in the opposite direction. Typically, dirty hot water enters the shell of the heat exchanger at 135° F and exits at 85° F while cold fresh water enters the heat exchanger at 60° F and exits at 110° F. This preheated fresh water then enters a water heater where it is brought up to 180° F and stored in a stratified storage tank for use upon demand. Some designs facilitate the washdown of heat exchanger coils without the need for disassembly of the unit. Typically, these units are installed in concrete troughs to permit washdown of the coils in place. These cleanings, which normally take less than 15 minutes, require no tools and are typically done weekly.

Heat recovery from dryer exhaust can be accomplished by means of air-to-air heat exchangers. Hot, lint-laden air exhausted from the dryers would enter a counterflow heat exchanger on one side while cooler outside air enters from the opposite side.

This supply would then be used as preheated make-up air for the dryers. Plates in the heat transfer matrix separate the two air streams and act as a heat transfer surface. The main problems inherent in systems such as this are related to lint and moisture in the air. However, these problems are addressed by careful selection of heat exchanger materials and adequate plate spacing.

Heat recovery from the nine dryers in the USDB laundry could best be done, but at a prohibitive cost, by nine heat recovery units (HRU's) which would only operate when their respective dryer was running. This would maximize the utilization of waste heat, taking it only from an active dryer and transferring it to make-up air for that same dryer. On the other hand, a central heat recovery unit (see Fig. 2) serving all nine dryers would be removing and supplying air at a constant rate, so that if some dryers are not operating, lower exhaust temperatures would reduce the amount of waste (and recoverable) heat.available. The ideal arrangement of dryers for a central HRU would be side-by side, against a wall with an insulated plenum space and room for exhaust ductwork inside. Make-up air preheated by the HRU would be dumped into the plenum for direct use by the dryers. This type of layout would be much better than dumping make-up air into the occupied space during the heating season, because it could be used year-round and it more efficiently utilizes the heat recovered. For this reason, we recommend that special consideration is given to layout of the dryers if this ECO is to be implemented.

Heat recovery from steam irons/presses is not a valid consideration. They do not waste enough heat in a form that is easily recovered. Their function is to apply heat, moisture, and pressure directly to pieces of laundry. Because this process transfers heat efficiently and without much waste, there is no opportunity for heat recovery here.

MODELING TECHNIQUES:

Energy savings associated with implementation of this ECO were calculated using performance data from manufacturers of helical coil heat exchangers and air-to air heat recovery units.

ECO IMPLEMENTATION:

The best opportunity for implementation of this ECO would be when the laundry facility reaches a permanent location. This way, heat recovery systems can be incorporated into the design more readily than trying to incorporate them into an existing facility.

This implementation would include installation of a wastewater heat recovery system, a new semi-instantaneous water heater, and the associated pumps, piping, and accessories required for proper operation of the system. If dryer heat recovery is to be implemented, installation of an 18,000 cfm air-to-air heat recovery unit, and associated controls, ductwork and accessories would be required.

SUMMARY:

The project cost is the construction cost, plus 6% SIOH. Wastewater heat recovery and dryer exhaust heat recovery were considered as separate projects.

The energy savings associated with the implementation of this ECO by project is also shown in Table M31-1 in MBTU's per year savings as determined by hand calculations.

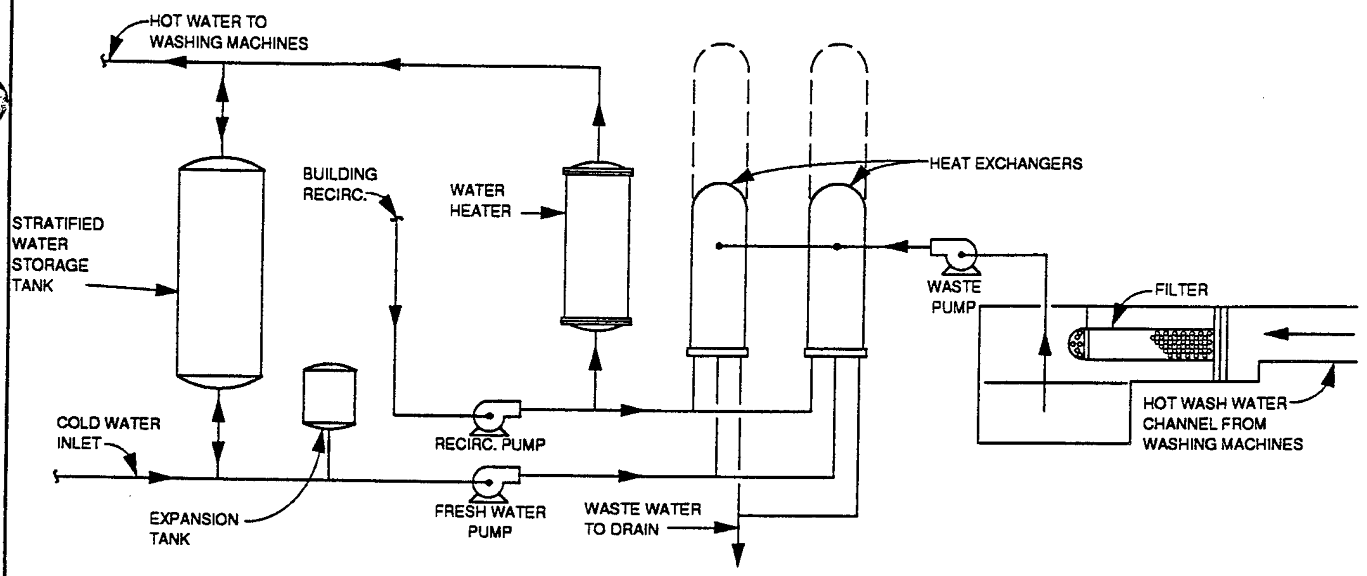
The simple payback for both ECO projects is shown in Table M31-1.

The savings to investment ratio (SIR) for both ECO projects is shown in Table M31-1.

We recommend wash water heat recovery, but dryer exhaust heat recovery is not as feasible. High first cost and space constraints make it a less attractive alternative.

Project	Gas Energy Savings (MBTU/yr.)	Electric Energy Savings (MBTU/yr.)	Cost Savings ($/yr.)	Project Cost ($)	Simple Payback (years)	Savings to Invest Ratio
Wash water H.R.	3,878	-6.43	15,742	43,829	2.78	4.18
Dryer Exhaust H.R	2,821	-73.5	10,597	111,688	10.54	1.13

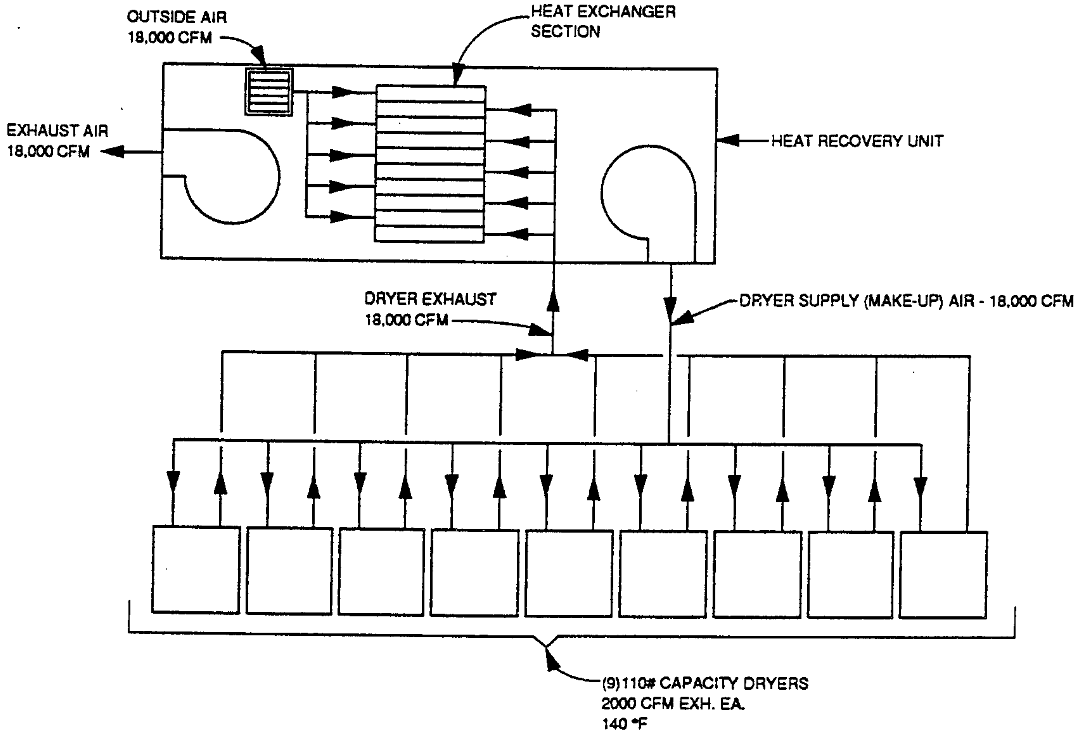
Table M31-1



WASH WATER HEAT RECOVERY SCHEMATIC

NOT TO SCALE

Fig. 1



DRYER EXHAUST HEAT RECOVERY SCHEMATIC

NOT TO SCALE

Fig. 2

CALCULATION SHEET	DATE Mar-90	SHEET 1 OF 1
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	BASIS FOR CALCULATION X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)	
LOCATION FORT LEAVENWORTH, KANSAS		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
ECO MEASURE ECO-M31 WASH WATER HEAT RECOVERY	COMPUTED BY BMS	CHECKED BY MAW

GIVEN:

HOT WATER USE TEMP., °F	160
AVERAGE COLD WATER INLET TEMPERATURE, °F	50
GALLONS WATER/LB. OF LAUNDRY	2.5
PERCENT OF WASTE WATER THAT IS HOT	70
HOURS OF OPERATION PER WEEK	40
ELECTRICITY COST, DOLLARS/MBTU	12.44
GAS COST IN DOLLARS/MBTU	4.08
BOILER SEASONAL EFFICIENCY, %	74

CALCULATED WASTE WATER TEMP., °F	127
WASTE WATER TEMP USED IN ANALYSIS, °F	124

BASED ON HEAT EXCHANGER MANUFACTURER'S PERFORMANCE DATA FOR 30 GPM UNIT:

SHELL SIDE TEMPERATURE, °F IN/OUT	124 / 91
TUBE SIDE TEMPERATURE, °F IN/OUT	50 / 96

STEAM HEAT RECOVERED, MBTU/YR:	2,870
GAS HEAT RECOVERED, MBTU/YR:	3,878

(2) 30 GPM UNITS ARE REQUIRED.

PUMP ENERGY CALCULATION FOR THIS ECO

FRESH WATER PUMP CAPACITY, GPM:	60
FRESH WATER PUMP HEAD, FT. W:	38
FRESH WATER PUMP EFFICIENCY, %:	65
WASTE WATER PUMP CAPACITY, GPM:	84
WASTE WATER PUMP HEAD, FT. W:	10
WASTE WATER PUMP EFFICIENCY, %:	65
FRESH WATER PUMP POWER CONSUMPTION, WATTS:	662
FRESH WATER PUMP ENERGY USE, MBTU/YEAR:	4.70
WASTE WATER PUMP POWER CONSUMPTION, WATTS:	244
WASTE WATER PUMP ENERGY USE, MBTU/YEAR:	1.73
TOTAL PUMP ENERGY, MBTU/YR.:	6.43

NET ENERGY SAVINGS FOR WASH WATER H.R., MBTU/YR.: 3,872

NET ENERGY SAVINGS, $/YR: 15,742

CALCULATION SHEET

DATE Mar-90

SHEET 1 **OF** 2

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

LOCATION FORT LEAVENWORTH, KANSAS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

ECO MEASURE ECO-M31 DRYER EXHAUST HEAT RECOVERY

BASIS FOR CALCULATION

X **HANDCOMPUTER**
____ **COMPUTER**
____ **CONTRACTOR BID**
OTHER (SPECIFY)

COMPUTED BY BMS

CHECKED BY MAW

AIR-TO-AIR HEAT RECOVERY UNIT PERFORMANCE DATA:

SUMMER (EFFECTIVENESS = 57.95%)

SUPPLY SIDE:

INLET TEMPERATURE (°F) =	95
OUTLET TEMPERATURE (°F) =	121.07
CFM =	18,000
W (LB. W./LB. D.A.) =	0.0168
ΔP (IN. W.G.) =	0.99

EXHAUST SIDE:

INLET TEMPERATURE (°F) =	140
OUTLET TEMPERATURE (°F) =	114.12
CFM =	18,000
W (LB. W./LB. D.A.) =	0.0398
ΔP (IN. W.G.) =	1.01

WINTER (EFFECTIVENESS = 65.36%)

SUPPLY SIDE:

INLET TEMPERATURE (°F) =	0
OUTLET TEMPERATURE (°F) =	91.5
CFM =	18000
W (LB. W./LB. D.A.) =	0.0001
ΔP (IN. W.G.) =	0.87

EXHAUST SIDE:

INLET TEMPERATURE (°F) =	140
OUTLET TEMPERATURE (°F) =	89.55
CFM =	18000
INLET W (LB. W./LB. D.A.) =	0.0398
OUTLET W (LB. W./LB. D.A.) =	0.0306
ΔP (IN. W.G.) =	0.97
WATER CONDENSED (LB./HR.)	699

ASSUMPTIONS MADE FOR YEAR-ROUND HEAT RECOVERY BIN ANALYSIS

1) AMOUNT OF WATER CONDENSED FROM DRYER EXHAUST VS. OUTDOOR AIR DRY-BULB TEMPERATURE IS A LINEAR RELATIONSHIP.
2)HEAT EXCHANGER EFFECTIVEDNESS VS. OUTDOOR AIR DRY-BULB TEMPERATURE IS A LINEAR RELATIONSHIP.

THEREFORE:

$$\Delta Q = E \text{ X } 1.08 \text{ X } 18000 \text{ X } (140 - T_{c,i})$$

WHERE:
ΔQ = HEAT TRANSFERRED BETWEEN AIR STREAMS
E = EFFECTIVENESS
$= .6536 - (T_{c,i}/95) \text{ X } (.6536 - .5795)$
$T_{c,i}$ = OUTSIDE AIR DRY-BULB TEMPERATURE

THIS FORM ULA WAS USED TO CALCULATE HEAT RECOVERY IN THE BIN ANALYSIS ON THE NEXT PAGE.

CALCULATION SHEET	DATE Mar-90	SHEET 2 OF 2
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)	
LOCATION FORT LEAVENWORTH, KANSAS		
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP		
ECO MEASURE ECO-M31 DRYER EXHAUST HEAT RECOVERY	**COMPUTED BY** BMS	**CHECKED BY** MAW

DRYER HEAT RECOVERY ANALYSIS USING ASHRAE MODIFIED BIN METHOD

TEMP. BIN	AVG. DB TEMP	BIN HOURS/YEAR			STEAM MBTU'S RECOV.
		01 TO 08	09 TO 16	05:30 TO 13:30	
105/109	107	0	3	1	0.37
100/104	102	0	15	7	2.97
95/99	97	0	51	25	12.08
90/94	92	1	127	62	33.66
85/89	87	6	203	101	60.95
80/84	82	56	265	142	94.41
75/79	77	162	262	165	119.94
70/74	72	257	236	173	136.63
65/69	67	274	209	164	139.95
60/64	62	264	195	154	141.33
55/59	57	230	190	144	141.53
50/54	52	197	185	135	141.58
45/49	47	181	177	127	141.65
40/44	42	188	169	125	147.85
35/39	37	226	175	136	170.13
30/34	32	248	151	129	170.26
25/29	27	214	113	103	143.12
20/24	22	150	76	71	103.66
15/19	17	103	52	48	73.49
10/14	12	67	33	31	49.70
5/9	7	50	20	21	35.19
0/4	2	23	8	9	15.74
-5/-1	-3	14	3	5	9.12
-10/-6	-8	4	0	1	1.90
-15/-11	-13	1	0	0	0.00
TOTALS		2916	2918	2079	2087

BOILER SEASONAL EFFICIENCY:	**74%**
GAS COST, $/MBTU:	**4.08**
TOTAL ANNUAL GAS SAVINGS, MBTU:	**2820**
ELECTRICITY COST, $/MBTU:	**12.44**
FAN AIR HORSEPOWER ADDED:	**13.9**
ANNUAL FAN ENERGY CONSUMPTION, MBTU:	**73.5**

TOTAL ESTIMATED ANNUAL SAVINGS, $ = 10,591

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM31W
ANALYSIS DATE: 03-27-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	43829.
B. SIOH	$	2630.
C. DESIGN COST	$	2411.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	43983.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	43983.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	-6.	$	-75.	8.69		-652.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	3878.	$	15822.	11.67		184643.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			3872.	$	15747.		$	183991.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 60717.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 15747.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 183991.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 4.18
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 2.79

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOM31D
ANALYSIS DATE: 03-27-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	111688.
B. SIOH	$	6701.
C. DESIGN COST	$	6143.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	112079.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	112079.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	-74.	$ -921.	8.69	-8003.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	2821.	$ 11510.	11.67	134322.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		2747.	$ 10589.		$ 126319.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 41685.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 10589.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 126319.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.13
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 10.58

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET **OF** 1

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

DRAWING NO. NONE

BASIS FOR ESTIMATE

- ☒ **CODE A (NO DESIGN COMPLETED)**
- ☐ CODE B (PRELIMINARY DESIGN)
- ☐ CODE C (FINAL DESIGN)
- ☐ OTHER (SPECIFY)

ESTIMATOR BMS

CHECKED BY MAW

ECO-M31	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
WASH WATER HEAT RECOVERY SYSTEM							
HELICAL COIL HEAT EXCHANGER	2	EA	$9,500	$19,000	$1,010	$2,020	$21,020
FRESH WATER PUMP (59 GPM, 50 FT. HD.)	1	EA	$1,070	$1,070	$180	$180	$1,250
WASTE WATER PUMP (94 GPM, 10 FT. HD.)	1	EA	$500	$500	$40	$40	$540
STRATIFIED WATER STORAGE TANK	1	EA	$6,500	$6,500	$355	$355	$6,855
2" SCHEDULE 40 STEEL PIPING & ACCESSORIES	100	LF	$3	$289	$6	$555	$844
SUBTOTAL				$27,359		$3,150	$30,509
CONTINGENCY 10%			10%	$2,736	10%	$315	$3,051
SUBTOTAL				$30,095		$3,465	$33,560
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$1,053	13.0%	$450	$1,503
DIRECT COST				$31,148		$3,915	$35,063
OVERHEAD AND PROFIT			25%	$7,787	25%	$979	$8,766
SUBTOTAL				$38,935		$4,894	$43,829
CONSTRUCTION COST							$43,829

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET OF 2

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

- __X__ **CODE A (NO DESIGN COMPLETED)**
- ____ CODE B (PRELIMINARY DESIGN)
- ____ CODE C (FINAL DESIGN)
- ____ OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR BMS

CHECKED BY MAW

ECO-M31	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
DRYER EXHAUST HEAT RECOVERY SYSTEM							
18,000 CFM HEAT RECOVERY UNIT & CONTROLS	1	EA	$71,220	$71,220	$4,280	$4,280	$75,500
DUCTWORK & ACCESSORIES	825	LB	$1	$652	$2	$1,774	$2,426
SUBTOTAL				$71,872		$6,054	$77,926
CONTINGENCY 10%			10%	$7,187	10%	$605	$7,792
SUBTOTAL				$79,059		$6,659	$85,718
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$2,767	13.0%	$866	$3,633
DIRECT COST				$81,826		$7,525	$89,351
OVERHEAD AND PROFIT			25%	$20,456	25%	$1,881	$22,337
SUBTOTAL				$102,282		$9,406	$111,688
CONSTRUCTION COST							$111,688

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-M39

WATER HEATING HEAT PUMPS

WATER HEATING HEATPUMPS

ENERGY CONSERVATION OPPORTUNITY: ECO-M39

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-M39) analyzes the energy savings associated with installing water heating heatpumps to condition the interior spaces.

SCOPE:

The ECO simulation (ECO-M39) replaces any space conditioning equipement with water source heatpumps. The replacement of space conditioning equipment can be completed in any of the buildings being considered that meet interior space conditions. The application of this ECO was considered for all of the buildings that presently have cooling in the spaces:

Building 450
Building 463
Building 464
Building 465
Building 472
Building 473
Building 475A
Building 475B
Building 475H

MODELING TECHNIQUES:

The modeling technique used to calculated the energy savings for this ECO was calculated using hand calculations. The efficiencies of the existing systems can be determined from the computer simulation printouts. Table M39.1 gives the existing heating and cooling systems efficiencies versus the heatpump system efficiencies. The data for the heatpump efficiencies was determined from a heatpump installation study[3] that was considered similar in capacity to the buildings in the USDB.

Building Number	Existing Cooling Efficiency (KWh/Ton)	Existing Heating Efficiency (thrm/Btuh)	Heatpump Cooling Efficiency (KWh/Ton)	Heatpump Heating Efficiency (thrm/thrm)
450	1.30	0.85	1.1	0.85
463	1.35	0.83	1.1	0.85
464	1.35	0.83	1.1	0.85
465	1.45	0.78	1.1	0.85
472	1.30	0.77	1.1	0.85
473	1.35	0.83	1.1	0.85
475A	1.48	0.85	1.1	0.85
475B	1.48	0.85	1.1	0.85
475H	1.48	0.85	1.1	0.85

Table M39.1

With the known yearly heating and cooling load from the computer simulations, a yearly energy savings was determined in Table M39.2. Table M39.3 displays the total energy savings in MBTU and the cost savings in dollars.

Building Number	Existing Cooling Energy (KWh/yr)	Existing Heating Energy (thrm/yr)	Heatpump Cooling Energy (KWh/yr)	Heatpump Heating Energy (thrm/yr)
450	17,892	3,629	15,139	3,629
463	11,514	1,577	9,382	1,540
464	18,063	2,195	14,718	2,143
465	12,914	35,995	9,797	33,031
472	38,980	15,515	32,983	14,054
473	26,906	2,407	21,923	2,407
475A	22,868	12,773	16,996	12,773
475B	14,139	8,477	10,509	8,477
475H	10,589	8,137	7,870	8,137

Table M39.2

ECO IMPLEMENTATION:

To implement this ECO, a considerable amount of mechanical demolition and new retrofit is necessary. Some of the buildings have existing piping to areas for heatpumps which can be utilized for the condenser water. In this case the installation of the heatpumps is average. In other buildings, the means of cooling in done by package window air conditioners. In these cases, the piping for the condenser water loop will be installed for each heatpump location. A heatpump would be installed in every location of the window air conditioner.

SUMMARY:

The energy savings associated with the implementation of this ECO by building is shown below in Table M39.3 in million BTU's per year savings as determined in the calculation section of this section.

The project cost is the construction cost as determined in the cost estimate plus 6% SIOH.

Building Number	Energy Savings (MBTU)	Cost Savings	Project Cost	Simple Payback	Savings to Invest Ratio
450	9	$117	$77,691	656.70	0.01
463	11	$106	$56,779	521.87	0.02
464	16	$163	$63,266	34.46	0.34
465	307	$1,342	$41,353	29.11	0.39
472	166	$851	$169,273	189.65	0.06
473	17	$212	$91,436	410.25	0.02
475A	20	$249	$103,019	391.68	0.02
475B	12	$154	$64,902	412.37	0.02
475H	9	$115	49,791	420.35	0.02

Table M39.3

None of the buildings considered for this ECO show a payback that is feasible for implementing the ECO. One of the reasons for not showing a good payback, is that the condenser water that is used to loop through the heatpumps is not available and a fluid cooler or water tower has to be installed. The project cost is very high for this ECO because of the conditions of the work areas and that some piping for the buildings has to be installed. To make the payback even less favorable, the heatpumps have a higher maintenance cost than the existing equipment.

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 450M39
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	73293.
B. SIOH	$	4398.
C. DESIGN COST	$	4031.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	73550.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	73550.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	9.	$	112.	8.69		973.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	0.	$	0.	11.67		0.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			9.	$	112.		$	973.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 321.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 112.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 973.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.01
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 656.70

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 463M39
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	53565.
B. SIOH	$	3214.
C. DESIGN COST	$	2946.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	53753.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	53753.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	7.	$ 87.	8.69	756.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	4.	$ 16.	11.67	187.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		11.	$ 103.		$ 943.

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

A. ANNUAL RECURRING (+/-)		$ 0.
(1) DISCOUNT FACTOR (TABLE A)	9.11	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 311.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 103.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 943.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.02
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 521.87

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 464M39
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	59685.
B. SIOH	$	3581.
C. DESIGN COST	$	3283.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	59894.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	59894.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 2.00	11.	$ 22.	8.69	191.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 343.24	5.	$ 1716.	11.67	20026.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		16.	$ 1738.		$ 20217.

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

A. ANNUAL RECURRING (+/-)		$ 0.
(1) DISCOUNT FACTOR (TABLE A)	9.11	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 6672.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE))		$ 1738.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)		$ 20217.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= (IF < 1 PROJECT DOES NOT QUALIFY)	0.34	
7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4	34.46	

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 465M39
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	39012.
B. SIOH	$	2341.
C. DESIGN COST	$	2146.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	39149.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	39149.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	11.	$	137.	8.69		1191.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	296.	$	1208.	11.67		14097.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			307.	$	1345.		$	15288.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5045.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1345.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 15288.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.39
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 29.11

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 472M39
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	159692.
B. SIOH	$	9582.
C. DESIGN COST	$	8783.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	160251.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	160251.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	20.	$	249.	8.69		2164.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	146.	$	596.	11.67		6955.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			166.	$	845.		$	9119.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3009.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 845.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 9119.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.06
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 189.65

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 473M39
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	86261.
B. SIOH	$	5176.
C. DESIGN COST	$	4744.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	86563.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	86563.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	17.	$ 211.	8.69	1834.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	0.	$ 0.	11.67	0.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		17.	$ 211.		$ 1834.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 605.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 211.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1834.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.02
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 410.25

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475AM39
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	97188.
B. SIOH	$	5831.
C. DESIGN COST	$	5345.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	97528.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	97528.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	20.	$ 249.	8.69	2164.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	0.	$ 0.	11.67	0.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		20.	$ 249.		$ 2164.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 714.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 249.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2164.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.02
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 391.68

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475BM39
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	61228.
B. SIOH	$	3674.
C. DESIGN COST	$	3368.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	61443.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	61443.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	12.	$	149.	8.69		1295.
B. DIST	$	.00	0.	$	0.	12.42		0.
C. RESID	$	.00	0.	$	0.	12.21		0.
D. NAT G	$	4.08	0.	$	0.	11.67		0.
E. COAL	$	.00	0.	$	0.	10.36		0.
F. TOTAL			12.	$	149.		$	1295.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 427.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 149.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1295.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.02
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 412.37

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: 475HM39
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 15 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	46915.
B. SIOH	$	2815.
C. DESIGN COST	$	2580.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	47079.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	47079.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	9.	$ 112.	8.69	973.
B. DIST	$ .00	0.	$ 0.	12.42	0.
C. RESID	$ .00	0.	$ 0.	12.21	0.
D. NAT G	$ 4.08	0.	$ 0.	11.67	0.
E. COAL	$ .00	0.	$ 0.	10.36	0.
F. TOTAL		9.	$ 112.		$ 973.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 321.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 112.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 973.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 0.02
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 420.35

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 1 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

DRAWING NO. NONE

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR MJM

CHECKED BY MAW

ECO-M39 **WATER HEATING HEATPUMPS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 450 , 32 TONS OF COOLING, FLUID COOLER LOCATED ON NORTH SIDE OF BUILDING, PUMP IN EXISTING MECHANICAL ROOM, COST ON A SQUARE FOOT BASIS.	9200	SQFT	$3	$23,276	$2	$14,352	$37,628
DEMOLISH EXISTING HVAC EQUIPMENT, COST ON A SQUARE FOOT BASIS.	9200	SQFT			$1	$11,500	$11,500
SUBTOTAL				$23,276		$25,852	$49,128
CONTINGENCY 10%			10%	$2,328	10%	$2,585	$4,913
SUBTOTAL				$25,604		$28,437	$54,041
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$896	13.0%	$3,697	$4,593
DIRECT COST				$26,500		$32,134	$58,634
OVERHEAD AND PROFIT			25%	$6,625	25%	$8,034	$14,659
SUBTOTAL				$33,125		$40,168	$73,293
CONSTRUCTION COST							$73,293

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 2 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M39 **WATER HEATING HEATPUMPS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 463 , 22 TONS OF COOLING,							
FLUID COOLER LOCATED ON NORTH SIDE							
OF BUILDING, PUMP IN EXISTING							
HEAT EXCHANGER ROOM, COST ON A							
SQUARE FOOT BASIS.	7700	SQFT	$3	$19,481	$2	$12,012	$31,493
DEMOLISH EXISTING HVAC EQUIPMENT,							
COST ON A SQUARE FOOT BASIS.	7700	SQFT			$1	$4,620	$4,620
SUBTOTAL				$19,481		$16,632	$36,113
CONTINGENCY 10%			10%	$1,948	10%	$1,663	$3,611
SUBTOTAL				$21,429		$18,295	$39,724
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$750	13.0%	$2,378	$3,128
DIRECT COST				$22,179		$20,673	$42,852
OVERHEAD AND PROFIT			25%	$5,545	25%	$5,168	$10,713
SUBTOTAL				$27,724		$25,841	$53,565
CONSTRUCTION COST							$53,565

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 3 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A** (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M39 WATER HEATING HEATPUMPS	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 464 , 26 TONS OF COOLING,							
FLUID COOLER LOCATED ON NORTH SIDE							
OF BUILDING, PUMP IN EXISTING							
FIRST FLOOR CLOSET, COST ON A							
SQUARE FOOT BASIS.	6700	SQFT	$3	$22,043	$2	$14,204	$36,247
DEMOLISH EXISTING HVAC EQUIPMENT,							
COST ON A SQUARE FOOT BASIS.	6700	SQFT			$1	$4,020	$4,020
SUBTOTAL				$22,043		$18,224	$40,267
CONTINGENCY 10%			10%	$2,204	10%	$1,822	$4,026
SUBTOTAL				$24,247		$20,046	$44,293
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$849	13.0%	$2,606	$3,455
DIRECT COST				$25,096		$22,652	$47,748
OVERHEAD AND PROFIT			25%	$6,274	25%	$5,663	$11,937
SUBTOTAL				$31,370		$28,315	$59,685
CONSTRUCTION COST							$59,685

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	**DATE PREPARED** 4/2/90	**SHEET** 4 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M39 **WATER HEATING HEATPUMPS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 465 , 17 TONS OF COOLING, FLUID COOLER LOCATED ON WEST SIDE OF BUILDING, PUMP IN EXISTING MECHANICAL ROOM, COST ON A SQUARE FOOT BASIS.	4897	SQFT	$3	$12,389	$2	$7,639	$20,029
DEMOLISH EXISTING HVAC EQUIPMENT, COST ON A SQUARE FOOT BASIS.	4897	SQFT			$1	$6,121	$6,121
SUBTOTAL				$12,389		$13,761	$26,150
CONTINGENCY 10%			10%	$1,239	10%	$1,376	$2,615
SUBTOTAL				$13,628		$15,137	$28,765
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$477	13.0%	$1,968	$2,445
DIRECT COST				$14,105		$17,105	$31,210
OVERHEAD AND PROFIT			25%	$3,526	25%	$4,276	$7,802
SUBTOTAL				$17,631		$21,381	$39,012
CONSTRUCTION COST							$39,012

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1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 5 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A** **(NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M39 **WATER HEATING HEATPUMPS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 472 , 69 TONS OF COOLING,							
FLUID COOLER LOCATED ON SOUTH SIDE							
OF BUILDING, PUMP IN EXISTING							
MECHANICAL ROOM, COST ON A SQUARE							
FOOT BASIS.	19300	SQFT	$3	$58,479	$2	$37,635	$96,114
DEMOLISH EXISTING HVAC EQUIPMENT,							
COST ON A SQUARE FOOT BASIS.	19300	SQFT			$1	$11,580	$11,580
SUBTOTAL				$58,479		$49,215	$107,694
CONTINGENCY 10%			10%	$5,848	10%	$4,922	$10,770
SUBTOTAL				$64,327		$54,137	$118,464
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$2,251	13.0%	$7,038	$9,289
DIRECT COST				$66,578		$61,175	$127,753
OVERHEAD AND PROFIT			25%	$16,645	25%	$15,294	$31,939
SUBTOTAL				$83,223		$76,469	$159,692
CONSTRUCTION COST							$159,692

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 6 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M39 **WATER HEATING HEATPUMPS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 473 , 39 TONS OF COOLING,							
FLUID COOLER LOCATED ON NORTH SIDE							
OF BUILDING, PUMP IN BLDG 463							
MECHANICAL ROOM, COST ON A SQUARE							
FOOT BASIS.	12400	SQFT	$3	$31,372	$2	$19,344	$50,716
DEMOLISH EXISTING HVAC EQUIPMENT,							
COST ON A SQUARE FOOT BASIS.	12400	SQFT			$1	$7,440	$7,440
SUBTOTAL				$31,372		$26,784	$58,156
CONTINGENCY 10%			10%	$3,137	10%	$2,678	$5,815
SUBTOTAL				$34,509		$29,462	$63,971
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$1,208	13.0%	$3,830	$5,038
DIRECT COST				$35,717		$33,292	$69,009
OVERHEAD AND PROFIT			25%	$8,929	25%	$8,323	$17,252
SUBTOTAL				$44,646		$41,615	$86,261
CONSTRUCTION COST							$86,261

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 7 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M39 WATER HEATING HEATPUMPS	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475A , 39 TONS OF COOLING, FLUID COOLER LOCATED ON NORTH SIDE OF CASTLE, PUMP IN ROTUNDA MECHANICAL ROOM, COST ON A SQUARE FOOT BASIS.	11746	SQFT	$3	$35,590	$2	$22,905	$58,495
DEMOLISH EXISTING HVAC EQUIPMENT, COST ON A SQUARE FOOT BASIS.	11746	SQFT			$1	$7,048	$7,048
SUBTOTAL				$35,590		$29,952	$65,543
CONTINGENCY 10%			10%	$3,559	10%	$2,995	$6,554
SUBTOTAL				$39,149		$32,947	$72,097
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$1,370	13.0%	$4,283	$5,653
DIRECT COST				$40,519		$37,230	$77,750
OVERHEAD AND PROFIT			25%	$10,130	25%	$9,308	$19,438
SUBTOTAL				$50,649		$46,538	$97,188
CONSTRUCTION COST							$97,188

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 8 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M39 **WATER HEATING HEATPUMPS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475B, 28 TONS OF COOLING, FLUID COOLER LOCATED ON NORTH SIDE OF CASTLE, PUMP IN ROTUNDA MECHANICAL ROOM, COST ON A SQUARE FOOT BASIS.	7400	SQFT	$3	$22,422	$2	$14,430	$36,852
DEMOLISH EXISTING HVAC EQUIPMENT, COST ON A SQUARE FOOT BASIS.	7400	SQFT			$1	$4,440	$4,440
SUBTOTAL				$22,422		$18,870	$41,292
CONTINGENCY 10%			10%	$2,242	10%	$1,887	$4,129
SUBTOTAL				$24,664		$20,757	$45,421
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$863	13.0%	$2,698	$3,561
DIRECT COST				$25,527		$23,455	$48,982
OVERHEAD AND PROFIT			25%	$6,382	25%	$5,864	$12,246
SUBTOTAL				$31,909		$29,319	$61,228
CONSTRUCTION COST							$61,228

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 4/2/90

SHEET 9 **OF** 9

PROJECT USDB ENERGY STUDY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

BASIS FOR ESTIMATE

X **CODE A (NO DESIGN COMPLETED)**
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. NONE

ESTIMATOR MJM

CHECKED BY MAW

ECO-M39 **WATER HEATING HEATPUMPS**	QUANTITY		MATERIAL		LABOR		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BUILDING 475H, 20 TONS OF COOLING,							
FLUID COOLER LOCATED ON NORTH SIDE							
OF CASTLE, PUMP IN ROTUNDA							
MECHANICAL ROOM, COST ON A SQUARE							
FOOT BASIS.	6744	SQFT	$3	$17,062	$2	$10,521	$27,583
DEMOLISH EXISTING HVAC EQUIPMENT,							
COST ON A SQUARE FOOT BASIS.	6744	SQFT			$1	$4,046	$4,046
SUBTOTAL				$17,062		$14,567	$31,629
CONTINGENCY 10%			10%	$1,706	10%	$1,457	$3,163
SUBTOTAL				$18,768		$16,024	$34,792
WORK COMP,TAX,SOC.SEC.,INS			3.50%	$657	13.0%	$2,083	$2,740
DIRECT COST				$19,425		$18,107	$37,532
OVERHEAD AND PROFIT			25%	$4,856	25%	$4,527	$9,383
SUBTOTAL				$24,281		$22,634	$46,915
CONSTRUCTION COST							$46,915

ENG. FORM 150
1AVC-59

PREVIOUS EDITION MAY BE USED

ECO-E1

LIGHTING LEVELS

LIGHTING LEVELS

ENERGY CONSERVATION OPPORTUNITY: ECO-E1

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-E1) analyzes energy savings associated with lighting level reduction. Project implementation may change existing light fixture layout and new motion detector installation. Project implementation will not affect any high security area light fixtures because of associated high and material labor costs.

SCOPE:

This ECO simulation removes or relocates existing light fixtures and installs motion detectors. The application of this project was considered for the following buildings:

Building 450
Building 463
Building 464
Building 465
Building 466
Building 472
Building 473
Building 474
Building 475A
Building 475B
Building 475E
Building 475H

MODELING TECHNIQUES:

The modeling technique used to justify the existing light fixture removal or modification was the study of lighting energy usage measured in watts per square foot. Army Regulation No. 11-27, Section 3-8b; requires that during working hours, overhead lighting will be reduced to 50 foot-candles at work areas, and 10 or less foot-candles in nonworking areas as prescribed in DOD 4270.1-M. On the average, a lighting level of 50 foot-candles uses about 1.5 watts per square foot. Based on this value, our studies show that USDB lighting levels are in general at or below this level. Original lighting design made extensive use of daylighting and kept artificial lighting to a minimum Therefore, USDB lighting levels cannot be efficiently reduced by removing or modifying existing light fixtures.

Motion sensor installation can be justified in some instances, but lighting use patterns affect potential savings. Some examples of potential savings are shown on page E1-3. The modeling technique for this portion is based on low security fixtures in low security areas. Payback times for fixtures in higher security areas are significantly longer because of higher labor and material costs.

ECO IMPLEMENTATION:

As discussed in the modeling technique section, fixture and lamp removal is not recommended, so no implementation of that option will be discussed.

Motion sensor installation within a space includes the following: demolition of existing switch and associated circuitry; installation of a motion sensor and associated circuitry; and motion sensor calibration. Motion sensors should only be installed after study of lighting use patterns in that space.

SUMMARY:

We believe motion sensors can be installed at a good payback rate in conference-type rooms (may include chapels) where lighting loads are high and where the room may be unoccupied 30% of the time.

Motion sensor installation is not recommended in office spaces because lighting loads are generally low. We do not recommend motion sensor installation in spaces that are considered high security because of higher labor costs associated with those spaces.

Payback calculations for various rooms are shown on page E1-3. Only those rooms with SIR values greater than one are used in life cycle cost analysis.

Sample calculation for typical room installations are shown on page E1-4.

Life cycle cost analysis for this ECO is shown on page E1-5.

CALCULATION SHEET

DATE Mar-90

SHEET 1 **OF** 1

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

ECO MEASURE ECO-E1

BASIS FOR CALCULATION
X HAND
COMPUTER
CONTRACTOR BID
OTHER (SPECIFY)

COMPUTED BY DJG

CHECKED BY MAW

BASED ON THE FOLLOWING INFORMATION:
$200.62 FOR TYPICAL MOTION SENSOR INSTALLATION
$0.0425 PER KWH ELECTRICITY COST
11.16 25-YEAR DISCOUNT FACTOR

BUILDING # AND ROOM TYPE	LIGHTING WATTS	ANNUAL NORMAL HOURS	ANNUAL HOURS SAVED	ANNUAL KWH SAVED	ANNUAL SAVINGS	PAYBACK IN YEARS	SIR
450 CONFERENCE ROOM	1280	2080	624	799	$33.96	5.9	1.9
475A CONFERENCE ROOM	640	2080	624	399	$16.96	11.8	0.9
475A CHAPEL	1620	2080	624	1011	$42.97	4.7	2.4
475E CONFERENCE ROOM	480	2080	624	300	$12.75	15.7	0.7
475B CHAPEL	1500	2080	624	936	$39.78	5.0	2.2
475H CHAPEL	800	2080	624	499	$21.21	9.5	1.2
TOTAL (SIR >1)	5200	2080	624	3245	$137.91	8.7	1.3

CALCULATION SHEET		DATE Mar-90	SHEET 1 OF 1
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	BASIS FOR CALCULATION X HAND COMPUTER CONTRACTOR BID OTHER (SPECIFY)	
LOCATION	FORT LEAVENWORTH, KS		
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECO-E1	COMPUTED BY DJG	CHECKED BY MAW

AVERAGE PAYBACK TIME FOR REPLACING EXISTING SWITCHES WITH INFRARED MOTION SENSORS FOR VARIOUS SPACES

ALL COSTS ARE BASED ON MEANS CONSTRUCTION/DEMOLITION COST DATA
ELECTRICITY COST FOR FORT LEAVENWORTH USDB IS $0.0425 PER KWH

MOTION SENSOR INSTALLATION COST

DEMO EXISTING SWITCH BOX	$2.66
DEMO 8' EMT WITH WIRING	$5.76
INSTALL 20', 3/4" EMT	$53.60
INSTALL 40', #12 CONDUCTORS	$13.60
INSTALL MOTION SENSOR	$125.00
TOTAL COST PER INSTALLATION	$200.62

POSSIBLE ENERGY SAVINGS FOR TYPICAL CONFERENCE ROOM

LIGHTING LOAD	720 WATTS
ANNUAL LIGHTING TIME	3750 HOURS
ANNUAL COST @ $0.0425 PER KWH	$114.75
ANNUAL SAVINGS IF LIGHTS ARE OFF 30% OF TIME	$34.43
COST OF INSTALLATION	$200.62
PAYBACK TIME	5.8 YEARS

POSSIBLE ENERGY SAVINGS FOR TYPICAL SMALL OFFICE ROOM

LIGHTING LOAD	320 WATTS
ANNUAL LIGHTING TIME	3750 HOURS
ANNUAL COST @ $0.0425 PER KWH	$51.00
ANNUAL SAVINGS IF LIGHTS ARE OFF 25% OF TIME	$12.75
COST OF INSTALLATION	$200.62
PAYBACK TIME	15.7 YEARS

NOTE: SAVINGS ARE VERY DEPENDENT ON SEVERAL ITEMS, WHICH INCLUDE THE FOLLOWING:

1) CURRENT PRACTICES IN SWITCHING LIGHTS OFF. IF PEOPLE NORMALLY TURN LIGHTS OFF WHEN NOT IN USE, ENERGY SAVINGS WILL BE MINIMAL.
2) AMOUNT OF TIME THAT LIGHTS WILL NOT BE IN USE. THE ABOVE ESTIMATES MAY VARY AND ACTUAL SAVINGS WILL FLUCTUATE ACCORDINGLY.

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

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

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOE1
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	802.
B. SIOH	$	48.
C. DESIGN COST	$	44.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	805.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	805.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	11.	$ 137.	11.16	1529.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	0.	$ 0.	16.15	0.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		11.	$ 137.		$ 1529.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 505.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 137.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1529.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.90
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 5.88

ECO-E2

ENERGY EFFICIENT LIGHTING SYSTEMS

ENERGY EFFICIENT LIGHTING SYSTEMS

ENERGY CONSERVATION OPPORTUNITY: ECO-E2

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-E2) analyzes energy savings associated with converting existing lighting systems to energy efficient lighting systems. Project implementation may include component replacement in existing lighting systems to energy efficient units or a complete changeover to more efficient light sources.

SCOPE:

This ECO simulation replaces existing light fixture components with efficient units and replaces inefficient light source systems with efficient light source systems. The application of this project was considered for the following buildings:

Building	450	Building	475A
Building	463	Building	475B
Building	464	Building	475C
Building	465	Building	475D
Building	466	Building	475E
Building	472	Building	475F
Building	473	Building	475G
Building	474	Building	475H
Building	475		

MODELING TECHNIQUES:

The modeling technique used to justify light fixture component replacement was based on the removal of the existing light fixture component and replacement with a more efficient unit. Currently, USDB personnel are replacing 40w fluorescent lamps with 34w fluorescent lamps. Energy savings associated with the lamp change are not totally reallized until the existing ballasts are replaced with energy efficient units.

The modeling technique used to justify light source conversion was based on the removal of the existing incandescent lamp and replacement with a new fluorescent adapter and lamp.

Conversion to HID lamp sources was not investigated due to the extremely high first costs associated with the installation of HID light fixtures.

ECO IMPLEMENTATION:

Option 1: ECO implementation will include ballast and lamp replacement in existing light fixtures with high efficiency units as maintenance requires.

Option 2: Existing incandescent sources will be replaced with fluorescent lamp conversion kits and will be mounted in existing light fixtures.

SUMMARY:

Energy savings due to incandescent/fluorescent light source conversion by building are shown on Table E2.1.

Option 1 probable construction cost has been calculated on page E2-3. Based on these figures, we recommend that existing lighting components be replaced with energy efficient models only as existing components fail. This can be done during regular lighting maintenance by USDB maintenance personnel.

Option 2 probable construction cost has been calculated on page E2-4. Field work indicated that incandescent fixtures are used on a regular basis only in building 475A stairwell. We recommend replacement of these fixtures.

Life cycle costs associated with this ECO are shown on page E2-5.

Building Number	MBTU/Yr. Savings	Energy Savings	Project Cost	Simple Payback	Savings to Invest Ratio
475A	8	$100	$131	1.24	9.00

Table E2.1

CALCULATION SHEET		**DATE** Mar-90	**SHEET 0F** 1 1
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION**	
LOCATION	FORT LEAVENWORTH, KS	X **HAND** **COMPUTER** **CONTRACTOR BID** **OTHER (SPECIFY)**	
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECO-E2	**COMPUTED BY** DJG	**CHECKED BY** MAW

AVERAGE PAYBACK TIME FOR RELAMPING AND REBALLASTING FLUORESCENT LIGHT FIXTURES

ALL COSTS ARE BASED ON MEANS CONSTRUCTION/DEMOLITION COST DATA

ELECTRICITY COST FOR FORT LEAVENWORTH USDB IS $0.0425 PER KWH

ASSUME FIXTURES ARE ON FOR 365 DAYS x 12 HOURS PER DAY = 4380 HOURS PER YEAR

2 LAMP FLUORESCENT LIGHT FIXTURE

COST TO REBALLAST LIGHT FIXTURE		$58.00
COST TO RELAMP LIGHT FIXTURE WITH 34W LAMPS	$9.25 x 2 =	$18.50
TOTAL COST PER FIXTURE		$76.50

ELECTRICITY SAVINGS

8W PER LAMP x 2 LAMPS PER FIXTURE = 16W PER FIXTURE PER HOUR

= 0.016 KWH PER FIXTURE

$0.0425 PER KWH x 0.016 KWH x 4380 HRS = $2.98 PER YEAR

SIMPLE PAYBACK

TOTAL COST PER FIXTURE	$76.50
ELECTRICITY SAVINGS PER YEAR	$2.98
SIMPLE PAYBACK IN YEARS	25.7

4 LAMP FLUORESCENT LIGHT FIXTURE

COST TO REBALLAST LIGHT FIXTURE	$58.00 x 2 =	$116.00
COST TO RELAMP LIGHT FIXTURE WITH 34W LAMPS	$9.25 x 4 =	$37.00
TOTAL COST PER FIXTURE		$153.00

ELECTRICITY SAVINGS

8W PER LAMP x 4 LAMPS PER FIXTURE = 32W PER FIXTURE PER HOUR

= 0.032 KWH PER FIXTURE

$0.0425 PER KWH x 0.032 KWH x 4380 HRS = $5.97 PER YEAR

SIMPLE PAYBACK

TOTAL COST PER FIXTURE	$153.00
ELECTRICITY SAVINGS PER YEAR	$5.97
SIMPLE PAYBACK IN YEARS	25.6

CALCULATION SHEET	DATE Mar-90	SHEET 1 OF 1
PROJECT USDB ENERGY SAVINGS OPPORTUNITY SURVEY	BASIS FOR CALCULATION	
LOCATION FORT LEAVENWORTH, KS	X HAND COMPUTER	
ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP	CONTRACTOR BID OTHER (SPECIFY)	
ECO MEASURE ECO-E2	COMPUTED BY DJG	CHECKED BY MAW

CALCULATIONS FOR RETROFITTING INCANDESCENT FIXTURES TO FLUORESCENT FIXTURES
BUILDING 475A STAIRWELL

ALL COSTS ARE BASED ON MEANS CONSTRUCTION/DEMOLITION COST DATA

ELECTRICITY COST FOR FORT LEAVENWORTH USDB IS $0.0425 PER KWH

ASSUME FIXTURES ARE ON FOR 365 DAYS x 24 HOURS PER DAY = 8760 HOURS PER YEAR

DESCRIPTION	NUMBER (EACH)	INSTALLED COST	TOTAL COST	ENERGY USE (W)	TOTAL ENERGY USE
ADAPTER BALLAST	6	$11.00	$66	3	18
13W DOUBLE TWIN TUBE FLUORESCENT LAMP	6	$5.84	$35	13	78
LABOR	6	$3.75	$23	0	0
TOTAL			$124		0.096KW

EXISTING ELECTRICITY USAGE = 6 LAMPS x 60W PER LAMP = 360 W OR .36KW/H
NEW ELECTRICITY USAGE = 0.096 KW/H
TOTAL ELECTRICTY SAVED = 0.36 KW/H - 0.096 KW/H = 0.264 KW/H

YEARLY SAVINGS = 0.264 KW/H x $0.0425 /KWH x 8760 HOURS/YEAR = $98.29 PER YEAR

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOE2
ANALYSIS DATE: 03-23-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	124.
B. SIOH	$	7.
C. DESIGN COST	$	7.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	124.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	124.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	8.	$ 100.	11.16	1116.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	0.	$ 0.	16.15	0.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		8.	$ 100.		$ 1116.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 368.
A IF 3D1 IS = OR > 3C GO TO ITEM 4.
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 100.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1116.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 9.00
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 1.24

ECO-E3

ENERGY EFFICIENT MOTORS

ENERGY EFFICIENT MOTORS

ENERGY CONSERVATION OPPORTUNITY: ECO-E3

PURPOSE:

This Energy Conservation Opportunity simulation (ECO-E3) analyzes energy savings in replacing inefficient motors with energy efficient motors. This project includes investigating any power factor charges the USDB is charged.

SCOPE:

This ECO simulation (ECO-E3) determines motor sizes that can be replaced to conserve electricity. This project also determines methods of power factor reduction if the USDB pays a high power factor penalty. The application of this project was considered for the following buildings:

Building 463
Building 464
Building 465
Building 472
Building 473
Building 474
Building 475
Building 475C
Building 475D
Building 475F
Building 475G

MODELING TECHNIQUES:

The Fort Leavenworth USDB power supplier (KPL Gas Service) was contacted. The supplier confirmed that Fort Leavenworth would be charged a power factor penalty, but added that the Fort maintains a power factor of near 100% (or 1) and has not been charged a power factor penalty in the past. Therefore, no changes are required in the USDB power factor.

The modeling technique used to justify motor replacement with high efficiency motors was based on the removal of existing low efficiency motors, replacing them with high efficiency motors, and analyzing energy saved per year based on estimated running time. A sample Life Cycle Cost analysis showing how the SIR's were calculated on each individual motoris included on page E3-21.

ECO IMPLEMENTATION:

ECO implementation will include removal of motors and replacement with high efficiency motors.

SUMMARY:

Because the Fort Leavenworth complex power factor is nearly 100% (or 1) at all times, no power factor correction is recommended.

Average efficiencies and energy savings for various motor sizes and their associated payback times are shown on page E3-3.

Efficiency and watt loss data for various motor sizes are shown on page E3-4.

Energy savings, SIR's, and payback times for various motors in USDB buildings are shown on pages E3-5 and E3-6.

Installation costs for various motor sizes are shown on pages E3-7 to E3-19.

Life cycle cost analysis for this ECO is shown on page E3-20. Only those motors with an SIR of greater than one are included in the analysis.

RECOMMENDATIONS

We recommend replacement of all motors listed on pages E3-5 and E3-6 where calculated SIR values are greater than one. All of the motors listed on those pages are nearing the end of efficient life. Therefore, we recommend that all new motors installed at the USDB during regular maintenance and replacement be high efficiency motors.

AVERAGE EFFICIENCIES AND ENERGY SAVINGS FOR VARIOUS MOTOR SIZES

STANDARD VS HIGH EFFICIENCY

PAYBACKS FOR REPLACING AN EXISTING MOTOR

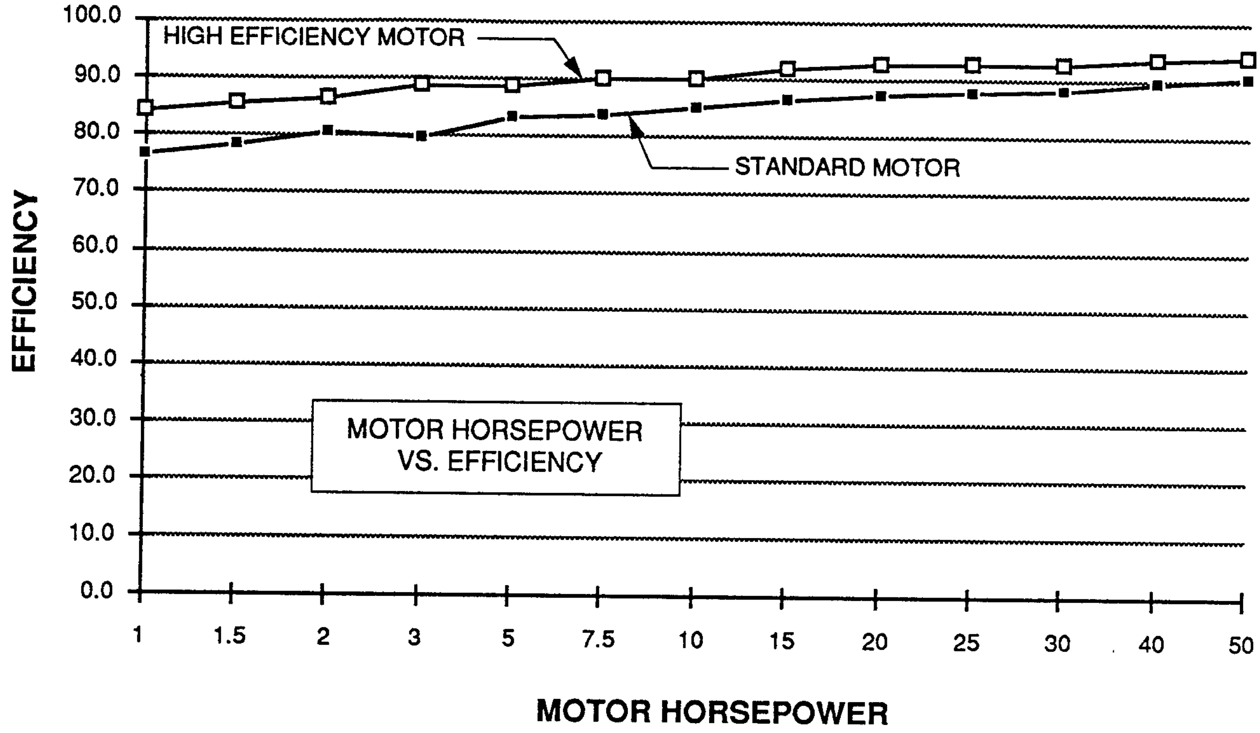
HORSE-POWER	STANDARD MOTOR EFFICIENCY	HI EFF MOTOR EFFICIENCY	STANDARD MOTOR WATT LOSS	HI EFF MOTOR WATT LOSS	WATT LOSS DIFFERENCE	INSTALLED HI EFF MTR COST
1	76.5	84.0	229	142	87	$420
1.5	78.5	85.5	306	190	117	$442
2	80.8	86.5	355	233	122	$466
3	79.9	88.5	563	291	272	$582
5	83.1	89.5	759	438	321	$644
7.5	83.8	90.2	1082	608	474	$820
10	85.0	90.2	1316	811	506	$966
15	86.5	91.7	1746	1013	734	$1,255
20	87.5	93.0	2131	1123	1008	$1,527
25	88.0	93.0	2543	1404	1139	$1,780
30	88.1	93.0	3023	1685	1338	$2,030
40	89.4	93.6	3538	2040	1498	$2,623
50	90.4	94.1	3961	2339	1622	$3,232

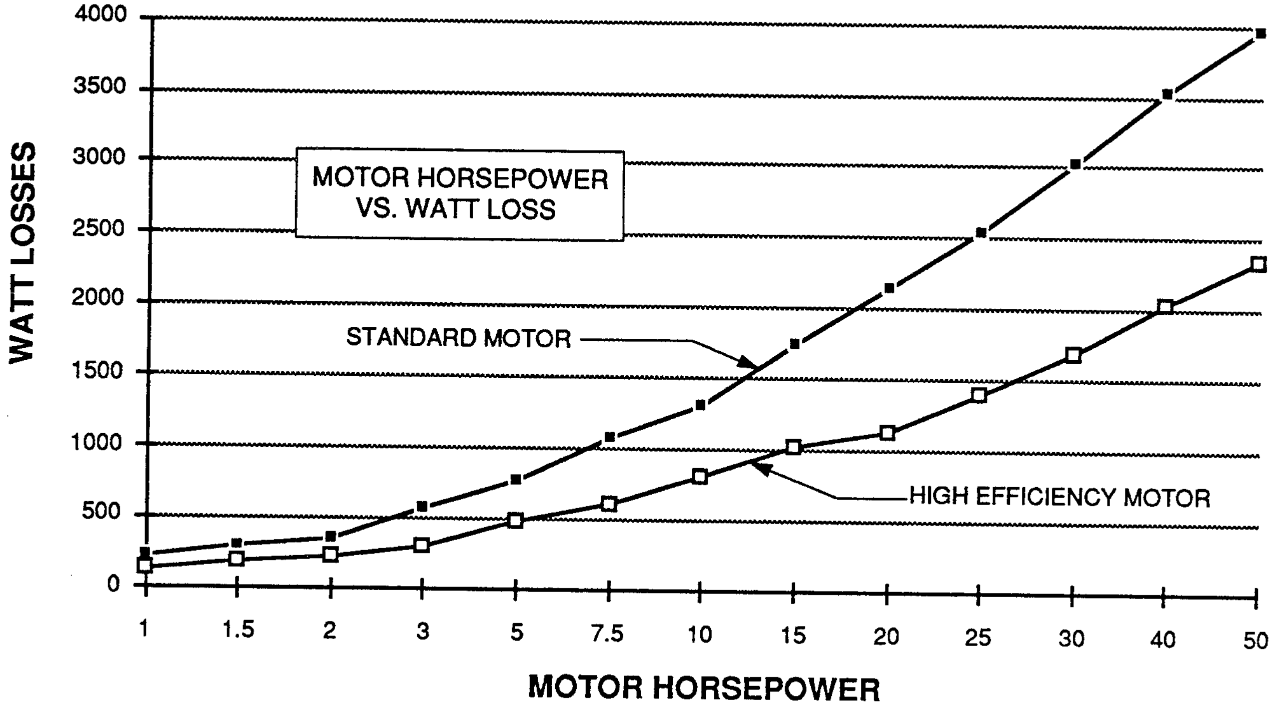
HORSE-POWER	8760 HOURS				5000 HOURS			
	ENERGY SAVINGS	COST SAVINGS	SIMPLE PAYBACK	SIR	ENERGY SAVINGS	COST SAVINGS	SIMPLE PAYBACK	SIR
1	763	$32	13.0	0.9	435	$19	22.7	0.5
1.5	1,022	$43	10.2	1.1	584	$25	17.8	0.6
2	1,066	$45	10.3	1.1	608	$26	18.0	0.6
3	2,384	$101	5.7	1.9	1,361	$58	10.1	1.1
5	2,812	$119	5.4	2.0	1,605	$68	9.4	1.2
7.5	4,150	$176	4.6	2.4	2,369	$101	8.1	1.4
10	4,432	$188	5.1	2.2	2,530	$108	9.0	1.2
15	6,426	$273	4.6	2.4	3,668	$156	8.1	1.4
20	8,834	$375	4.1	2.7	5,042	$214	7.1	1.5
25	9,981	$424	4.2	2.6	5,697	$242	7.4	1.5
30	11,725	$498	4.1	2.7	6,692	$284	7.1	1.5
40	13,120	$558	4.7	2.3	7,489	$318	8.2	1.3
50	14,212	$604	5.4	2.1	8,112	$345	9.4	1.2

HORSE-POWER	4380 HOURS				2920 HOURS			
	ENERGY SAVINGS	COST SAVINGS	SIMPLE PAYBACK	SIR	ENERGY SAVINGS	COST SAVINGS	SIMPLE PAYBACK	SIR
1	381	$16	25.9	0.4	254	$11	38.9	0.3
1.5	511	$22	20.3	0.5	341	$14	30.5	0.4
2	533	$23	20.6	0.5	355	$15	30.9	0.4
3	1,192	$51	11.5	1.0	795	$34	17.2	0.6
5	1,406	$60	10.8	1.0	937	$40	16.2	0.7
7.5	2,075	$88	9.3	1.2	1,383	$59	13.9	0.8
10	2,216	$94	10.3	1.1	1,477	$63	15.4	0.7
15	3,213	$137	9.2	1.2	2,142	$91	13.8	0.8
20	4,417	$188	8.1	1.4	2,945	$125	12.2	0.9
25	4,991	$212	8.4	1.3	3,327	$141	12.6	0.9
30	5,862	$249	8.1	1.4	3,908	$166	12.2	0.9
40	6,560	$279	9.4	1.2	4,373	$186	14.1	0.8
50	7,106	$302	10.7	1.0	4,737	$201	16.1	0.7

25 YEAR DISCOUNT FACTOR = 11.16

ELECTRICITY COST = 4.25¢/KWH





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CALCULATION SHEET

DATE Mar-90

SHEET 0F 1 2

PROJECT USDB
ENERGY SAVINGS OPPORTUNITY SURVEY

BASIS FOR CALCULATION
X HAND
COMPUTER
CONTRACTOR BID
OTHER (SPECIFY)

LOCATION FORT LEAVENWORTH, KS

ARCHITECT/ENGINEER CLARK RICHARDSON & BISKUP

ECO MEASURE ECO-E3

COMPUTED BY DJG

CHECKED BY MAW

BUILDING # AND MOTOR DESCRIPTION	HP	OPER. HOURS/ YEAR	SAVINGS PER YEAR MBTU'S	SAVINGS PER YEAR DOLLARS	INSTALLED COST	SIR	PAYBACK YEARS
BUILDING 463 FAN	1.5	4380	1.7	$21.15	$442	0.5	20.9
BUILDING 463 CONDENSING UNIT	5	4380	4.8	$59.71	$644	1.0	10.8
BUILDING 464 FAN	1.5	4380	1.7	$21.15	$442	0.5	20.9
BUILDING 464 FAN	1.5	4380	1.7	$21.15	$442	0.5	20.9
BUILDING 465 COMPRESSOR	5	5000	5.5	$68.42	$644	1.2	9.4
BUILDING 465 COMPRESSOR	5	5000	5.5	$68.42	$644	1.2	9.4
BUILDING 465 COLD WATER PUMP	1.5	4380	1.7	$21.15	$442	0.5	20.9
BUILDING 465 HOT WATER PUMP	7.5	4380	7.1	$88.32	$820	1.2	9.3
BUILDING 465 AIR HANDLING UNIT	2	4380	1.8	$22.39	$466	0.5	20.8
BUILDING 465 AIR HANDLING UNIT	1	4380	1.3	$16.17	$420	0.4	26.0
BUILDING 465 AIR HANDLING UNIT	1	4380	1.3	$16.17	$420	0.4	26.0
BUILDING 472 HOT WATER PUMP	3	4380	4.1	$51.00	$582	1.0	11.4
BUILDING 472 FAN	1.5	4380	1.7	$21.15	$442	0.5	20.9
BUILDING 473 HOT WATER PUMP	3	4380	4.1	$51.00	$582	1.0	11.4
BUILDING 473 HOT WATER PUMP	5	4380	4.8	$59.71	$644	1.0	10.8
BUILDING 474 BOILER FEED PUMP	40	8760	44.8	$557.31	$2,623	2.4	4.7
BUILDING 474 FAN	10	8760	15.1	$187.84	$966	2.2	5.1
BUILDING 474 FAN	10	8760	15.1	$187.84	$966	2.2	5.1
BUILDING 474 FAN	10	8760	15.1	$187.84	$966	2.2	5.1
BUILDING 474 CONDENSATE PUMP	10	8760	15.1	$187.84	$966	2.2	5.1
BUILDING 474 CONDENSATE PUMP	10	8760	15.1	$187.84	$966	2.2	5.1
BUILDING 474 AIR COMPRESSOR	3	8760	8.1	$100.76	$582	1.9	5.8
BUILDING 474 AIR COMPRESSOR	25	8760	34.1	$424.20	$1,780	2.7	4.2

25-YEAR DISCOUNT FACTOR= 11.16

CALCULATION SHEET		**DATE** Mar-90	**SHEET OF** 2 2
PROJECT	USDB ENERGY SAVINGS OPPORTUNITY SURVEY	**BASIS FOR CALCULATION** X **HAND** **COMPUTER** **CONTRACTOR BID** **OTHER (SPECIFY)**	
LOCATION	FORT LEAVENWORTH, KS		
ARCHITECT/ENGINEER	CLARK RICHARDSON & BISKUP		
ECO MEASURE	ECO-E3	**COMPUTED BY** DJG	**CHECKED BY** MAW

BUILDING # AND MOTOR DESCRIPTION	HP	OPER. HOURS/ YEAR	SAVINGS PER YEAR MBTU'S	SAVINGS PER YEAR DOLLARS	INSTALLED COST	SIR	PAYBACK YEARS
BUILDING 475 ROTUNDA CONDENSING UNIT	3	4380	4.1	$51.00	$582	1.0	11.4
BUILDING 475 ROTUNDA CONDENSING UNIT	7.5	4380	7.1	$88.32	$820	1.2	9.3
BUILDING 475C FAN	5	4380	4.8	$59.71	$644	1.0	10.8
BUILDING 475C FAN	5	4380	4.8	$59.71	$644	1.0	10.8
BUILDING 475D FAN	5	4380	4.8	$59.71	$644	1.0	10.8
BUILDING 475D FAN	5	4380	4.8	$59.71	$644	1.0	10.8
BUILDING 475F FAN	5	4380	4.8	$59.71	$644	1.0	10.8
BUILDING 475F FAN	5	4380	4.8	$59.71	$644	1.0	10.8
BUILDING 475G FAN	5	4380	4.8	$59.71	$644	1.0	10.8
BUILDING 475G FAN	5	4380	4.8	$59.71	$644	1.0	10.8
TOTAL (SIR > 1)			248	$3,085.00	$20,929	1.6	6.8

25-YEAR DISCOUNT FACTOR= 11.16

CONSTRUCTION COST ESTIMATE

DATE PREPARED 16-Mar-90

SHEET 1 OF 1

PROJECT **ENERGY SAVING OPPORTUNITY SURVEY**

LOCATION **FORT LEAVENWORTH, KANSAS**

ARCHITECT/ENGINEER **CLARK, RICHARSON, & BISKUP**

DRAWING NO. **1 HORSEPOWER MOTOR REPLACE**

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$44.00	$44		$0	$44
1 HP ENERGY EFFICIENT MOTOR	1	EA	$40.00	$40	$148.00	$148	$188
MOTOR CONNECTION	1	EA	$23.00	$23	$3.15	$3	$26
SUBTOTAL				$107		$151	$258
CONTINGENCY			10%	$11	10%	$15	$26
				$118		$166	$284
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$16	3.50%	$6	$22
DIRECT COST				$134		$172	$306
OVERHEAD & PROFIT						25.0%	$76
CONSTRUCTION COST							$382
SIOH						10.0%	$38
TOTAL PROJECT COST							$420

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT **ENERGY SAVING OPPORTUNITY SURVEY**

LOCATION **FORT LEAVENWORTH, KANSAS**

ARCHITECT/ENGINEER **CLARK, RICHARSON, & BISKUP**

DRAWING NO. **1.5 HORSEPOWER MOTOR REPLACE**

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$44.00	$44		$0	$44
1.5 HP ENERGY EFFICIENT MOTOR	1	EA	$40.00	$40	$162.00	$162	$202
MOTOR CONNECTION	1	EA	$23.00	$23	$3.15	$3	$26
SUBTOTAL				$107		$165	$272
CONTINGENCY			10%	$11	10%	$17	$27
				$118		$182	$299
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$16	3.50%	$6	$22
DIRECT COST				$134		$188	$322
OVERHEAD & PROFIT						25.0%	$80
CONSTRUCTION COST							$402
SIOH						10.0%	$40
TOTAL PROJECT COST							$442

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT **ENERGY SAVING OPPORTUNITY SURVEY**

LOCATION **FORT LEAVENWORTH, KANSAS**

ARCHITECT/ENGINEER **CLARK, RICHARSON, & BISKUP**

BASIS FOR ESTIMATE
X CODE A (NO DESIGN COMPLETED)
____ CODE B (PRELIMINARY DESIGN)
____ CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. **2 HORSEPOWER MOTOR REPLACE**

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$44.00	$44		$0	$44
2 HP ENERGY EFFICIENT MOTOR	1	EA	$40.00	$40	$177.00	$177	$217
MOTOR CONNECTION	1	EA	$23.00	$23	$3.15	$3	$26
SUBTOTAL				$107		$180	$287
CONTINGENCY			10%	$11	10%	$18	$29
				$118		$198	$316
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$16	3.50%	$7	$23
DIRECT COST				$134		$205	$339
OVERHEAD & PROFIT						25.0%	$85
CONSTRUCTION COST							$423
SIOH						10.0%	$42
TOTAL PROJECT COST							**$466**

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT
ENERGY SAVING OPPORTUNITY SURVEY

LOCATION
FORT LEAVENWORTH, KANSAS

ARCHITECT/ENGINEER
CLARK, RICHARSON, & BISKUP

DRAWING NO.
3 HORSEPOWER MOTOR REPLACE

ESTIMATOR DJG

CHECKED BY MAW

BASIS FOR ESTIMATE
X CODE A (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$44.00	$44		$0	$44
3 HP ENERGY EFFICIENT MOTOR	1	EA	$40.00	$40	$245.00	$245	$285
MOTOR CONNECTION	1	EA	$28.00	$28	$3.70	$4	$32
SUBTOTAL				$112		$249	$361
CONTINGENCY			10%	$11	10%	$25	$36
				$123		$274	$397
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$17	3.50%	$10	$26
DIRECT COST				$140		$283	$423
OVERHEAD & PROFIT						25.0%	$106
CONSTRUCTION COST							$529
SIOH						10.0%	$53
TOTAL PROJECT COST							$582

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT **ENERGY SAVING OPPORTUNITY SURVEY**

LOCATION **FORT LEAVENWORTH, KANSAS**

ARCHITECT/ENGINEER **CLARK, RICHARSON, & BISKUP**

DRAWING NO. **5 HORSEPOWER MOTOR REPLACE**

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$44.00	$44		$0	$44
5 HP ENERGY EFFICIENT MOTOR	1	EA	$40.00	$40	$285.00	$285	$325
MOTOR CONNECTION	1	EA	$28.00	$28	$3.70	$4	$32
SUBTOTAL				$112		$289	$401
CONTINGENCY			10%	$11	10%	$29	$40
				$123		$318	$441
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$17	3.50%	$11	$28
DIRECT COST				$140		$329	$469
OVERHEAD & PROFIT						25.0%	$117
CONSTRUCTION COST							$586
SIOH						10.0%	$59
TOTAL PROJECT COST							$644

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT **ENERGY SAVING OPPORTUNITY SURVEY**

LOCATION **FORT LEAVENWORTH, KANSAS**

ARCHITECT/ENGINEER **CLARK, RICHARSON, & BISKUP**

DRAWING NO. **7.5 HORSEPOWER MOTOR REPLACE**

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$44.00	$44		$0	$44
7.5 HP ENERGY EFFICIENT MOTOR	1	EA	$43.00	$43	$388.00	$388	$431
MOTOR CONNECTION	1	EA	$33.00	$33	$4.40	$4	$37
SUBTOTAL				$120		$392	$512
CONTINGENCY			10%	$12	10%	$39	$51
				$132		$432	$564
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$18	3.50%	$15	$33
DIRECT COST				$150		$447	$597
OVERHEAD & PROFIT						25.0%	$149
CONSTRUCTION COST							$746
SIOH						10.0%	$75
TOTAL PROJECT COST							$820

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT
ENERGY SAVING OPPORTUNITY SURVEY

LOCATION
FORT LEAVENWORTH, KANSAS

ARCHITECT/ENGINEER
CLARK, RICHARSON, & BISKUP

BASIS FOR ESTIMATE
X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO.
10 HORSEPOWER MOTOR REPLACE

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$44.00	$44		$0	$44
10 HP ENERGY EFFICIENT MOTOR	1	EA	$45.00	$45	$468.00	$468	$513
MOTOR CONNECTION	1	EA	$43.00	$43	$4.40	$4	$47
SUBTOTAL				$132		$472	$604
CONTINGENCY			10%	$13	10%	$47	$60
				$145		$520	$665
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$20	3.50%	$18	$38
DIRECT COST				$165		$538	$703
OVERHEAD & PROFIT						25.0%	$176
CONSTRUCTION COST							$878
SIOH						10.0%	$88
TOTAL PROJECT COST							$966

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT ENERGY SAVING OPPORTUNITY SURVEY

LOCATION FORT LEAVENWORTH, KANSAS

ARCHITECT/ENGINEER CLARK, RICHARSON, & BISKUP

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO. 15 HORSEPOWER MOTOR REPLACE

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$44.00	$44		$0	$44
15 HP ENERGY EFFICIENT MOTOR	1	EA	$57.00	$57	$625.00	$625	$682
MOTOR CONNECTION	1	EA	$55.00	$55	$5.65	$6	$61
SUBTOTAL				$156		$631	$787
CONTINGENCY			10%	$16	10%	$63	$79
				$172		$694	$865
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$23	3.50%	$24	$47
DIRECT COST				$195		$718	$913
OVERHEAD & PROFIT						25.0%	$228
CONSTRUCTION COST							$1,141
SIOH						10.0%	$114
TOTAL PROJECT COST							$1,255

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT **ENERGY SAVING OPPORTUNITY SURVEY**

LOCATION **FORT LEAVENWORTH, KANSAS**

ARCHITECT/ENGINEER **CLARK, RICHARSON, & BISKUP**

DRAWING NO. **20 HORSEPOWER MOTOR REPLACE**

BASIS FOR ESTIMATE
X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$55.00	$55		$0	$55
20 HP ENERGY EFFICIENT MOTOR	1	EA	$70.00	$70	$754.00	$754	$824
MOTOR CONNECTION	1	EA	$67.00	$67	$10.60	$11	$78
SUBTOTAL				$192		$765	$957
CONTINGENCY			10%	$19	10%	$76	$96
				$211		$841	$1,052
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$29	3.50%	$29	$58
DIRECT COST				$240		$870	$1,110
OVERHEAD & PROFIT						25.0%	$278
CONSTRUCTION COST							$1,388
SIOH						10.0%	$139
TOTAL PROJECT COST							$1,527

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE	DATE PREPARED 3/16/90	SHEET 1 OF 1

PROJECT
ENERGY SAVING OPPORTUNITY SURVEY

LOCATION
FORT LEAVENWORTH, KANSAS

ARCHITECT/ENGINEER
CLARK, RICHARSON, & BISKUP

DRAWING NO.
25 HORSEPOWER MOTOR REPLACE

ESTIMATOR
DJG

CHECKED BY
MAW

BASIS FOR ESTIMATE
X CODE A (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
___ OTHER (SPECIFY)

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$55.00	$55		$0	$55
25 HP ENERGY EFFICIENT MOTOR	1	EA	$72.00	$72	$914	$914	$986
MOTOR CONNECTION	1	EA	$67.00	$67	$10.60	$11	$78
SUBTOTAL				$194		$925	$1,119
CONTINGENCY			10%	$19	10%	$92	$112
				$213		$1,017	$1,230
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$29	3.50%	$36	$64
DIRECT COST				$242		$1,053	$1,295
OVERHEAD & PROFIT						25.0%	$324
CONSTRUCTION COST							$1,619
SIOH						10.0%	$162
TOTAL PROJECT COST							$1,780

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT
ENERGY SAVING OPPORTUNITY SURVEY

LOCATION
FORT LEAVENWORTH, KANSAS

ARCHITECT/ENGINEER
CLARK, RICHARSON, & BISKUP

BASIS FOR ESTIMATE
X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

DRAWING NO.
30 HORSEPOWER MOTOR REPLACE

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$55.00	$55		$0	$55
30 HP ENERGY EFFICIENT MOTOR	1	EA	$76.00	$76	$1,069	$1,069	$1,145
MOTOR CONNECTION	1	EA	$67.00	$67	$10.60	$11	$78
SUBTOTAL				$198		$1,080	$1,278
CONTINGENCY			10%	$20	10%	$108	$128
				$218		$1,188	$1,405
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$29	3.50%	$42	$71
DIRECT COST				$247		$1,229	$1,476
OVERHEAD & PROFIT						25.0%	$369
CONSTRUCTION COST							$1,845
SIOH						10.0%	$185
TOTAL PROJECT COST							**$2,030**

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT **ENERGY SAVING OPPORTUNITY SURVEY**

LOCATION **FORT LEAVENWORTH, KANSAS**

ARCHITECT/ENGINEER **CLARK, RICHARSON, & BISKUP**

DRAWING NO. **40 HORSEPOWER MOTOR REPLACE**

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
CODE B (PRELIMINARY DESIGN)
CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$60.00	$60		$0	$60
40 HP ENERGY EFFICIENT MOTOR	1	EA	$91.00	$91	$1,390	$1,390	$1,481
MOTOR CONNECTION	1	EA	$82.00	$82	$30.00	$30	$112
SUBTOTAL				$233		$1,420	$1,653
CONTINGENCY			10%	$23	10%	$142	$165
				$256		$1,562	$1,818
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$35	3.50%	$55	$89
DIRECT COST				$291		$1,617	$1,908
OVERHEAD & PROFIT						25.0%	$477
CONSTRUCTION COST							$2,384
SIOH						10.0%	$238
TOTAL PROJECT COST							$2,623

ENG. FORM 150
1AVC-59

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3/16/90

SHEET 1 OF 1

PROJECT **ENERGY SAVING OPPORTUNITY SURVEY**

LOCATION **FORT LEAVENWORTH, KANSAS**

ARCHITECT/ENGINEER **CLARK, RICHARSON, & BISKUP**

DRAWING NO. **50 HORSEPOWER MOTOR REPLACE**

BASIS FOR ESTIMATE

X CODE A (NO DESIGN COMPLETED)
___ CODE B (PRELIMINARY DESIGN)
___ CODE C (FINAL DESIGN)
OTHER (SPECIFY)

ESTIMATOR DJG

CHECKED BY MAW

	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
MOTOR REMOVAL	1	EA	$60.00	$60		$0	$60
50 HP ENERGY EFFICIENT MOTOR	1	EA	$115.00	$115	$1,753	$1,753	$1,868
MOTOR CONNECTION	1	EA	$82.00	$82	$30.00	$30	$112
SUBTOTAL				$257		$1,783	$2,040
CONTINGENCY			10%	$26	10%	$178	$204
				$283		$1,961	$2,244
WORK COMP, SOC. SEC., INS., TAXES			13.50%	$38	3.50%	$69	$107
DIRECT COST				$321		$2,030	$2,351
OVERHEAD & PROFIT						25.0%	$588
CONSTRUCTION COST							$2,939
SIOH						10.0%	$294
TOTAL PROJECT COST							$3,232

ENG. FORM 150
1AVC-59

Sample for 10 hp

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOE3
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

1. INVESTMENT

A. CONSTRUCTION COST	$	20929.
B. SIOH	$	1256.
C. DESIGN COST	$	1151.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	21002.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	21002.

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

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 12.44	248.	$ 3085.	11.16	34429.
B. DIST	$ .00	0.	$ 0.	17.19	0.
C. RESID	$ .00	0.	$ 0.	17.12	0.
D. NAT G	$ 4.08	0.	$ 0.	16.15	0.
E. COAL	$ .00	0.	$ 0.	13.92	0.
F. TOTAL		248.	$ 3085.		$ 34429.

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

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 11362.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 3085.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 34429.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.64
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 6.81

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

STUDY: USDBAE
LCCID 1.035
CENSUS: 2

INSTALLATION & LOCATION: FORT LEAVENWORTH - USDB REGION NOS. 7
PROJECT NO. & TITLE: 1496
FISCAL YEAR 1990 DISCRETE PORTION NAME: ECOE3
ANALYSIS DATE: 03-30-90 ECONOMIC LIFE 25 YEARS PREPARED BY: CRB

1. INVESTMENT

A. CONSTRUCTION COST	$	878.
B. SIOH	$	53.
C. DESIGN COST	$	48.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	881.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	881.

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

FUEL		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)		ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)		DISCOUNTED SAVINGS(5)
A. ELECT	$	12.44	15.	$	187.	11.16		2087.
B. DIST	$	.00	0.	$	0.	17.19		0.
C. RESID	$	.00	0.	$	0.	17.12		0.
D. NAT G	$	4.08	0.	$	0.	16.15		0.
E. COAL	$	.00	0.	$	0.	13.92		0.
F. TOTAL			15.	$	187.		$	2087.

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

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	11.65		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4)		$	0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 689.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ________
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 187.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2087.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 2.37
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 4.71

REFERENCES

REFERENCES

1. COOLING AND HEATING LOAD CALCULATION MANUAL, American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329.

2. ASHRAE HANDBOOK, 1981 FUNDEMENTALS, American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329.

3. ENERGY ENGINEERING, Journal of the Association of Energy Engineers, The Fairmont Press, Inc., 700 Indian Trail, Lilburn, GA 30247.

4. ASHRAE HANDBOOK, 1977 FUNDEMENTALS, American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., 345 East 47th Street, New York, NY 10017.

SCOPE OF WORK

GENERAL SCOPE OF WORK

ENERGY SURVEY FOR THE

UNITED STATES DISCIPLINARY BARRACKS (USDB)

AT

FORT LEAVENWORTH, KANSAS

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

SCOPE OF WORK
ENERGY SURVEY FOR THE UNITED STATES DISCIPLINARY BARRACKS (USDB) AT FORT LEAVENWORTH, KANSAS

ENERGY ENGINEERING ANALYSIS PROGRAM

TABLE OF CONTENTS

1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1.1 Perform a complete energy audit and analysis of the USDB.

1.2 Identify all Energy Conservation Opportunities (ECOs) including low cost/no cost ECOs and perform complete evaluations of each.

1.3 Prepare programming documentation [DD Form 1391, Life Cycle Cost Analysis Summary Sheet with backup calculations and Project Development Brochure (PDB)] for any Energy Conservation Investment Program (ECIP) and MCA projects.

1.4 Prepare implementation documentation for all justifiable energy conservation opportunities.

1.5 List and prioritize all recommended energy conservation opportunities.

1.6 Prepare a comprehensive report which will document the work accomplished, the results and the recommendations.

2. GENERAL

2.1 An energy study, including a detailed energy survey, shall be accomplished for the USDB. The study shall integrate the results of and any available data from prior or ongoing energy conservation studies, projects, designs, or plans with work done under this contract. This Scope of Work is not intended to prescribe the details in which the studies are to be conducted or limit the AE in the exercise of his professional engineering expertise, good judgment or investigative ingenuity. However, the information and analysis outlined herein are considered to be minimum essentials for adequate performance of this study. The study shall include a comprehensive energy report documenting study methods and results.

2.2 An Energy Engineering Analysis Program (EEAP) study has been accomplished for the installation at which the USDB is located. The portions of the study applicable to the USDB, if any, shall be incorporated into this study. This report shall list the recommended USDB related ECOs from the previous study. This list shall identify the previous study, summarize the USDB related ECOs and the anticipated energy savings, and identify the fiscal year for which the project was or is programmed. The backup calculations and project documentation from the previous study shall be reproduced and included as a appendix to the report. Any USDB related ECOs shall be reevaluated under this contract. Any USDB related ECOs recommended from the previous studies but not implemented nor programmed for implementation shall be updated in accordance with the latest ECIP guidance.

2.3 The AE shall ensure that all methods of energy conservation pertaining to USDB, which will reduce the energy consumption of the installation in compliance with the Army Facilities Energy Plan, have been considered and documented. All methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as physical facilities. All new and updated energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunities considered infeasible shall be documented in the report with reasons for eliminating. A list of general energy conservation opportunities (ECOs) is included as Annex A to this scope. This list shall be considered and the evaluation of each ECO documented in the report. This list is not intended to be restrictive but only to assure that at least these opportunities are addressed in the report. Some of the energy conservation opportunities in Annex A may not be applicable. A statement to that effect in the report is all that is required.

2.4 The study shall consider the use of all energy sources. The energy sources include electric, natural gas, liquefied petroleum gas, bulk oil, other oil products, steam when procured, gasoline, coal, solar, etc.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance," described in a letter from DAEN-MPO-U, 10 August 1982 and revised by letters from DAEN-ZCF-U, 4 March 1985 and 11 June 1986, establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. Construction cost escalation for DD Form 1391 submission shall be calculated using the guidelines contained in AR 415-17 and the latest Tri-Service MCP index. The Tri-Service MCP Index, when updated, is contained in the latest applicable edition of the Engineer Improvement Recommendation System (EIRS) bulletin.

2.6 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP or MCA funding, and determining, in coordination with installation personnel, the appropriate packaging and implementation approach for all feasible ECOs.

2.7 All recommended ECOs, including maintenance, operation and low cost , no cost opportunities shall be ranked in order of highest to lowest Savings Investment Ratio (SIR). Projects, after they are determined, shall be categorized by type and ranked within each category in order of highest to lowest SIR.

2.8 Projects which qualify for ECIP funding shall be identified, separately listed, prioritized by Saving Investment Ratio (SIR).

2.9 All energy conservation opportunities shall be listed and prioritized by SIR.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer of the Fort Leavenworth DEH will designate an individual who will serve as the point of contact for obtaining information and assisting in establishing contacts with the proper individuals and organizations as necessary in the accomplishment of the work required under this contract.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of work. The AE and/or the designated representative(s) shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records.

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a r+eproducible copy of the record or receipt.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government/furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of receipt.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Engineering and Housing and USDB representative before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall thoroughly brief and describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from the Director of Engineering and Housing and USDB representatives.

3.7.2 Exit. The exit interview shall include a thorough briefing describing the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Engineering and Housing and USDB representatives.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor, superintendency and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities (ECO') shall be included in one of the following categories and presented in the report as such.

5.1 ECIP Projects. To qualify as an ECIP project, and ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $200,000, a Saving Investment Ratio (SIR) greater than one and a simple payback period of less than ten years. The overall project, and each discrete part of the project, shall have a SIR greater than one. For all projects meeting the above criteria, complete programming documentation will be required. Programming documentation shall consist of a DD Form 1391, Life Cycle Cost Analysis Summary Sheet(s) (with necessary backup data to verify the numbers presented), and a project development brochure (PDB). A Life Cycle Cost Analysis Summary Sheet shall be developed for each ECO and for the overall project when more than one ECO is combined. For projects and ECOs developed from previous studies, the backup data shall consist of copies of the original calculation and analysis, with new pages updating and revising the original calculation and analysis. In addition, the backup data shall include as much of the following as is available: The increment of work the project or ECO was developed under in the previous study, title(s) of the project(s), the energy to cost (E/C) ratio, the benefit to cost (B/C) ratio, the current working estimate (CWE), and the payback period. This information shall be included as part of the backup data. The purpose of this information is to provide a means to prevent duplication of projects in any future reports.

5.2 MCA Projects. To qualify as a MCA project, and ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $200,000 and a Saving Investment Ratio (SIR) greater than one. The overall project, and each discrete part of the project, shall have a SIR greater than one. For all projects meeting the above criteria, complete programming documentation will be required. Programming documentation shall consist of a DD Form 1391, Life Cycle Cost Analysis Summary Sheet(s) (with necessary backup data to verify the numbers presented), and a project development brochure (PDB). A Life Cycle Cost Analysis Summary Sheet shall be developed for each ECO and for the overall project when more than one ECO is combined.

5.3 Non-ECIP Projects. Projects which normally do not meet ECIP criteria, but which have an overall SIR greater than one shall be documented. The Life Cycle Cost Analysis Summary Sheet shall be completed through and including line 6 for all projects or ECOs. Each project shall be analyzed to determine if it is feasible even if it does not meet ECIP criteria. These ECOs or projects may not meet the nonenergy qualification test. For projects or ECOs which meet this criteria, the Life Cycle Cost Analysis Summery Sheet, completely filled out, with all the necessary backup data to verify the numbers presented, a complete description of the project and the simple payback period shall be included in the report. Additionally, these projects shall have the necessary documentation prepared, in accordance with the requirements of the Government's representative, for one of the following categories:

a. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost not over $100,000 and a simple payback period of two years or less.

b. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a total cost greater than $100,000 and a simple payback period of four years or less.

c. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a total cost of more than;$3,000 and a simple payback period of four years or less.

The programs are all described in detail in AR 5-4, Change No. 1.

d. Regular Military Construction Army (MCA) Program. This program is for projects which have a total cost greater than $200,,000 and a simple payback period of ten to twenty-five years. Projects or ECOs which qualify for this program shall be economically analyzed in accordance with the requirements for Special Directed Studies in Engineering Technical Letter (ETL) 1110-3-332.

e. Low Cost/No Cost Projects. These are projects which the Director of Engineering and Housing can perform with his funds.

5.4 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The general Scope of Work is intended to apply to contract efforts for the USDB included under this contract except as modified by the detailed Scope of Work. The detailed Scope of Work is contained in Annex B.

7. WORK TO BE ACCOMPLISHED

7.1 Audit and Analysis

7.1.1 Audit. The audit consists of gathering data and inspecting the USDB in the field. These activities shall be closely coordinated with the Government's representative, the Director of Engineering and Housing and USDB representatives. The AE shall become familiar with the USDB and undertake field trips to obtain required data. The AE shall document his field surveys on forms developed for the survey, or standard forms, and submit the completed forms as part of the report. Data sources shall be identified and assumptions clearly stated and justified. Data collected during the audit shall be in sufficient detail to identify all the major energy using equipment and processes. The AE shall measure and record the voltage and amperage of all motors one horsepower and larger. The information gathered shall be compared to the name plate data to determine whether the motor is being properly utilized. Data should be gathered when the motor is loaded. Air handling system supply, return and exhaust air quantities, temperatures, relative humidities, lighting levels, and similar data shall be based on measurements made during the audit and not on "as-built" drawings. All test and/or measurement equipment shall be properly calibrated prior to its use. Operating sequences for equipment, control schedules, facility operating hours, methods of operation, and past performance records should also be obtained during the audit.

FEA SUPPORT

7.1.2 Analysis. The energy analysis is a comprehensive study of the USDB's energy usage. It includes a detailed investigation of the facilities operation, its environment and its equipment. The energy analysis shall provide the following types of information: (a) a baseline of energy usage of the existing USDB, (b) peak heating and cooling loads, (c) energy usage by systems (lighting, heating, cooling, domestic hot water, etc.), (d) a basis for evaluating ECOs, and (e) a baseline of energy usage of the USDB after incorporation of all recommended ECOs. The AE shall develop graphic presentations, i.e., graphs and charts, which depict a complete energy consumption picture for the USDB as they are now and after implementation of the recommended energy conservation opportunities.

7.1.3 Computer Modeling. The analysis shall use computer modeling. Computer modeling shall be used to incorporate field survey data, weather data, occupancy schedules, building construction data, energy distribution systems and equipment data into a model of the total facility. The computer program shall be used to develop load profiles, calculate energy savings, and evaluate energy conservation opportunities. The computer program shall be capable of analyzing the energy requirements of buildings, performance of heating, cooling, and ventilating equipment, (energy distribution systems, and energy conversion equipment.) The computer results shall be verified by comparing them to any available utility bills or records. The computer program shall analyze the facility on an hour-by-hour basis rather than the bin data method of bin data to simulate an hour-by-hour analysis.

Unless the Building Loads Analysis and Systems Thermodynamic (BLAST) program is used, the AE shall submit a sample computer run with an explanation of all input and output data and a summary of program methodology and energy evaluation capabilities for approval by the Contracting Officer prior to use of the program for analysis. The computer program used must be comparable to the BLAST program.

7.2 Identify ECOs. All methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures and maintenance practices as well as the physical facilities. A list of energy conservation opportunities is included as Annex A to this scope. This list is not intended to e restrictive but only to assure that at least these opportunities are considered in the report. Each of the items shall be considered and discussed in the report. Those items on the list which are not practical, have been previously accomplished, are inappropriate or can be eliminated from detailed analysis based on preliminary analysis shall be listed in the report along with the reason for elimination from further analysis. All potential ECOs which are not eliminated by preliminary considerations shall be thoroughly documented and evaluated as to technical and economic feasibility. The AE shall provide all data needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. A Life Cycle Cost Analysis Summary Sheet shall be prepared for each ECO and included as part of the supporting data for ECOs which would replace the existing heating, ventilating, and air conditioning (HVAC) system or significantly change it (such as converting a multizone system to a variable air volume (HVAV system) the AE is required to run a computer simulation to analyze the system and to determine the energy savings. This requirement to use computer modeling applies only to heated and air conditioned or air conditioned only buildings which exceed 8,000 square feet or heated only buildings in excess of 20,000 square feet. The computer program shall analyze the building on an hour-by- hour basis rather than the bin data method or bin data to simulate an hour-by-hour analysis. Unless the Building Loads Analysis and System Termodynamic (BLAST) program is used, the AE shall submit a sample computer run with an explanation of all input and output data and a summary of program methodology and energy evaluation capabilities for approval of the Contracting Officer prior to use of the program for analysis. The computer program used must be comparable to the BLAST program.

7.3 Prepare Programming Documentation for ECIP Projects. For ECOs which meet ECIP criteria or ECOs which can be combined to meet ECIP criteria, complete programming documentation shall be prepared. Complete programming documentation consists of DD Form 1391, PDB and supporting data. These forms shall be separate from the report. They shall be bound similarly to the final report in a manner which will facilitate repeated disassembly and reassembly. A sample programming document shall be submitted for review and approval with the interim submittal. This sample shall be submitted and approved prior to the preparation of any other programming documentation. To the degree possible, the project selected for the sample submission shall be typical of the majority of subsequent projects to be submitted. The sample shall consist of complete programming documentation with primary emphasis on format and manner of presentation rather than precise accuracy of cost estimates and energy saving data.

7.3.1 Military Construction Project Data (DD Form 1391). These documents shall be prepared in accordance with AR 415-15 and the supplemental requirements in Annex C. A complete DD Form 1391 shall be prepared for each project. The form shall include a statement that the project results from an EEAP study. Documents shall be complete as required for submission to higher DA headquarters. These programming documents will require review and signatures by the proper installation personnel. All documents shall be completed except for the required signatures.

7.3.2 Project Development Brochure (PDB). Preparation of the PDB requires the AE to delineate the functional requirements of the project as related to the specific site. The AE shall prepare PDBs in accordance with AR 415-20 and TM 5-800-3. Most projects will not require all the forms and checklists included in the Technical Manual (TM). Only that information needed for the project shall be included. The PDB-I format described in the TM shall be used for whatever information is needed.

7.3.3 Supporting Data. The AE shall provide all data and calculations needed to support the recommended project. Descriptions of the products, manufacturers catalog cuts,pertinent drawings and sketches shall also be included. A Life Cycle Cost Analysis Summary Sheet shall be prepared for each ECIP project and each discrete part of the project and included as part of the supporting data.

7.4 Prepare Implementation Documentation. For feasible projects or ECOs which normally do not meet ECIP criteria, implementation documentation shall be prepared. Each feasible project or ECO shall be individually packaged and fully documented and included as a separate section in the volume containing the programming documentation. Each project or ECC shall have a complete description of the changes required, economic justifications, sketches, and other backup data included as a section in the report. The documentation required will be as determined by the Governments's representative. Documentation required will be in the categories listed in paragraph 5.3. For the QRIP, OSD PIF and PECIP projects, documentation shall be prepared in accordance with the requirements of AR 5-4, Change No. 1. For MCA projects the documentation required by ETL 1110-3-332 shall be included in lieu of the ECIP Life Cycle Cost Analysis. For low cost/no cost projects which the Director of Engineering and Housing personnel can perform, the following information shall be provided.

a. Brief description of the project.

b. Brief description of the reasons for the modification.

c. Specific instructions for performing the modification.

d. Estimated dollar and energy saving per year.

e. Estimated man-hours and labor and materials costs. Costs shall be calculated for the current calendar year and so marked. Man-hours shall be listed by trade. For projects that would repair and existing system so that it will function properly, also include the estimated man-hours by trade and labor and material costs necessary to maintain the system in that condition. Some of the simple practical modifications may be developed on a per unit basis.

An example of this type of modification would be the repair or replacement of steam traps on an as needed basis. As a rule, however, the AE should develop complete projects, if at all possible, rather than per unit modifications. Separate sheets for each project showing the above information shall be prepared and included in the report.

7.5 List and Prioritize All Projects.

7.5.1 The AE shall list and prioritize all energy conservation opportunities by saving investment ratios.

7.5.2 The AE shall list and prioritize all projects by types of projects and savings investments ratios.

7.6 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. The AE shall give a formal presentation of all but the final submittal to; installation, command, and other government personnel. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. The AE shall provide all comments and written notification of the action taken on each comment to all reviewing agencies within three weeks after the review meeting. It is anticipated that each presentation and review conference will require approximately one working day. The presentation and review conferences will be at the installation on the date(s) agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.6.1 Interim Submittal. An interim report shall be submitted for review after completion of the field survey and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings and SIRs of all ECOs shall be included. The simple payback period of all ECOs shall be calculated and shown in the report. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. During the review period, the Government's representative shall coordinate with the Director of Engineering and Housing and provide the AE with direction for packaging or combining ECOs for programming purposes. A sample programming document (DD Form 1391, PDB, and supporting data) for one ECIP project shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they should be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.6.2 Prefinal Submittal. The AE shall prepare and submit the prefinal report when all work under this contract is complete. The AE shall submit the Scope of Work for the installation studied, and any modifications to the Scope of Work, as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The report shall include an order of priority by SIR in which the recommended ECOs should be accomplished. Completed programming and implementation documents for all recommended new projects shall be included. The programming and implementation documents shall be ready for review and signature by the installation commander. The prefinal report, Executive Summary, and all appendices will be bound in standard three-ring binders which will allow repeated which will allow repeated disassembly and reassembly. The prefinal submittal shall be arranged to include (a) a separately bound Executive Summary, to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (see Annex D for minimum requirements), (b) the narrative report containing a copy of the Executive Summary at the beginning of the volume and describing in detail what was accomplished and the results of this study, (c) appendices to include the detailed calculations and all backup material and (d) the programming and implementation documentation. A list of all projects and ECOs developed during this study shall be included in the Executive Summary and shall include the following data from the Life Cycle Cost Analysis Sheet: the cost construction plus SIOH), the annual energy savings type and amount), the annual dollar savings, the SIR and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost. The simple payback period shall also be shown for these projects and ECOs.

7.6.3 Final Submittal. Any revisions or corrections resulting from comments made during the review of the prefinal report or during the presentation shall be incorporated into the final report. These revisions or corrections may be in the form of replacement pages, which may be inserted in the prefinal report, or complete new volumes. Pen and ink changes or errata sheets will not be acceptable. If replacement pages are to be issued, it shall be clearly stated with the prefinal submittal that the submitted documents will be changed only to comply with the comments made during the prefinal conference and that the volumes issued at the time of the prefinal submittal should be retained. Failure to do so will require resubmission of the complete volumes. If new volumes are submitted, they shall be in standard three-ring binders and shall contain all the information presented in the prefinal report with any necessary changes made. Detailed instructions of what to do with the replacement pages should be securely attached to the replacement pages.

ANNEX A
ENERGY CONSERVATION OPPORTUNITIES

Heating, ventilating, and air conditioning

1. Shut off air handing units whenever possible.
2. Reduce outside air intake when air must be heated or cooled before use.
3. Repair and maintain steam lines and steam traps.
4. Use outside air for free cooling whenever possible. (Dry bulb economizers)
5. Recover heating or cooling with energy recovery units.
6. Insulate ducts and piping.
7. Install night setback controls.
8. Install computerize energy monitoring and control system (EMCS). (Cycle fans and pumps, shead loads during peak use, etc.)
9. Maintain equipment (clean coils, maintain filters, repair and/or maintain equipment and controls).
10. Convert separate AC units to central plant.
11. Replace Current ventilation with new ventilation or replace current ventilation with new windows and HVAC.

Boiler plant

1. Reduce steam distribution pressure.
2. Increase boiler efficiency.
3. Repair, replace, or install condensate return system.
4. Insulate boiler and boiler piping.
5. Install economizer.
6. Install air preheater.
7. Check boilerfeed water chemistry program.
8. Clean boiler tubes.
9. Blowdown controls.
10. Boiler and chiller control modifications.
11. Water treatment to prevent tube fouling.
12. Blowdown heat recovery.
13. Oxygen trim controls.
14. Convert complete DB heating system from high pressure steam to hot water.
15. Convert high pressure steam to co-generation.

Lighting

1. Reduce lighting levels.
2. Convert to energy efficient systems.

Building envelope

1. Reduce infiltration by caulking and weather-stripping.
2. Install insulated glass or double glazed windows.
3. Install roof insulation.
4. Install loading dock seals.
5. Install vestibules on entrances.
6. Reduce window heat gain by solar shading, screening, curtains, or blinds.
7. Install wall insulation.
8. Prevent air stratification.

Electrical equipment

1. Install capacitors and synchronous motor to increase power factor.
2. Convert to energy efficient motors.

Plumbing

1. Reduce domestic hot water temperature.
2. Install flow restrictions. (Shower & sinks).
3. Install faucets which automatically shut off water flow.
4. Decentralize hot water heating.
5. Add pipe insulation.

Laundry

1. Install heat reclamation system for laundry wash water.
2. Install heat reclamation system on dryers.
3. Install heat reclamation system on irons.

Kitchen

1. Shut off range hood exhaust whenever possible.
2. Install high-efficiency steam control valves.
3. Shut off equipment and appliances whenever possible.
4. Install makeup air supply for exhaust.
5. Install heat reclamation system for exhaust heat.
6. Turn off lights in coolers.
7. Water heating heat pump.

ANNEX B

ENERGY SURVEY FOR THE
UNITED STATES DISCIPLINARY BARRACKS (USDB)
ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)
FORT LEAVENWORTH, KANSAS

DETAILED SCOPE OF WORK

1. Brief Description of Work. This project involves a coordinated energy study, including a detailed energy survey for the United States Disciplinary Barracks (USDB) at Fort Leavenworth, Kansas. This study shall integrate the results of all prior to ongoing energy conservation. projects, designs or plans with work done under this contract.

2. Authorization. This project is authorized by CEHND-ED-PM letter dated 29 Nov 88, subject: Energy Engineering Analysis Program (EEAP) FY89 Budget.

3. Services to be performed by the Contractor. The A-E shall perform and shall assume responsibility for the accuracy of the work and completeness of the following services in connection with the above project in accordance with the General Scope of Work as amended by criteria and instruction listed herein. Quality of work accomplished under this contract will be a determining factor in consideration of the A/E for future work.

a. POC at Fort Leavenworth will be Mr. Richard Wilms at 913-684-5639.

b. POC at Kansas City District will be Mr. Robert McCormick at 816-426-2782.

c. POC at USDB will be Capt. Doane at 913-684-2560.

d. ECIP projects shall be estimated to and programmed for implementation as FY 95 projects.

e. Five 1391/PDB will be prepared. Should more or less be required, suitable adjustment to the contract price will be made.

f. The AE shall develop a long range plan to identify all projects needed to make the USDB complex an energy saving institution. Projects shall be grouped in accordance with existing funding guidance.

5. Distribution. Fifteen (15) sets of each submittal shall be furnished to reviewers in accordance with the following distribution schedule:

Commander
U.S. Army Engineer District, Kansas City
ATTN: CEMRKED-MF/McCormick
700 Federal Building
Kansas City, MO 64106-2896
5 copies

Commander
Missouri River Division
ATTN: CEMRDED-MA/Whelchel
PO Box 103, Downtown Station
Omaha, Nebraska 68101-0103
2 copies

Commander
CAC & Ft. Leavenworth
ATTN: ATZL-GEH
Building 85
Ft. Leavenworth, KS 66027-5020
5 copies

Commander
USACE-CEEC-EE/Mr. D. Beranek
20 Massachusetts Avenue, NW
Washington, DC 20314
1 copy

Commander
HQ, TRADOC
ATTN: ATEN-FE
Fort Monroe, VA 23351
1 copy

Transmission of documents will be by express mail or other expedient means. Only two (2) copies of the survey forms will be provided, one to CEMRK-ED-MF and one to Fort Leavenworth.

6. Data, Information and Services to be Furnished by the Government. The Government will furnish the following data, information, and services:

a. A/E Instructions.

b. Energy Conservation Investment Program (ECIP) Guidance, dated 10 Aug 82 , and revisions dated 4 Mar 85 and 11 June 86.

c. ETLs 1110-3-254, Use of Electric Power Comfort Space Heating, 1110-3-282, Energy Conservation, 1110-3-294, Interior Design Temperatures, 1110-3-318, Procedures for Programming Energy Monitoring and Control Systems (EMCS) Funded through the MCA Program, 1110-3-332, Economic Studies, 1110-3-354, Direct Digital Control of HVAC Systems and 1110-3-364, Storm Windows.

d. TM 5-785, Engineering Weather Data, TM 5-800-2, General Criteria Preparation of Cost Estimates, TM 5-800-3, Project Development Brochure and TM 5-815-2, Energy Monitoring and Control Systems (EMCS).

e. AR 415-15, Military Construction Army (MCA) Program Development, AR 415-17, Cost Estimating for Military Programming, AR 415-20, Construction Project Development and Design Approval, AR 415-28, Department of the Army Facility Classes and Construction Categories, AR 415-35, Construction, Minor Construction, AR 420-10, General Provisions, Organization, Functions and Personnel, and AR 5-4, Change No. 1, Department of the Army Productivity Improvement Program.

f. An example of a currently completed programming document for an ECIP project.

7. Completion Schedule. The A/E shall complete the work and services for each increment as follows:

a. Interim submittal - within one hundred and eighty (180) calendar days of Notice to Proceed.

b. Prefinal Submittal - within sixty (60) calendar days of the interim submittal presentation and review conference.

c. Final submittal - within sixty (60) calendar days after prefinal submittal presentation and review conference.

The A/E shall allow a period of approximately forty five (45) days for review by Government forces for each submission. Presentation of each submission will occur upon completion of the review period for that submission.

8. Method of Payment.

a. Title I Services - Design. Payment for design work and services will be made in accordance with the following procedures:

Partial Payment. The Architect-Engineer shall prepare and submit to the U.S. Army Engineer District, Kansas City, partial payment estimates using ENG Form 93, which shall serve as the request for payment. All partial payments shall be based on work completed as of the 15th day of the report month and shall be submitted to the office of the Contracting Officer by the 18th day of the month. The pay estimate shall be submitted with ENG Form 93, in accordance with the "Instructions for Completion of ENG Form 93 - Payment Estimate, "dated 5 January 1983. The U.S. Army Engineer District, Kansas City, will prepare supporting payment documents after obtaining necessary approvals and forward all documents to the U.S. Army Engineer District, Omaha, for issuance of the payment check. All questions, regarding payments shall be directed to the U.S. Army Engineer District, Kansas City.

b. Additional Conferences. Payment for furnishing the services of technically qualified representatives to attend conferences other than the review conferences specified above, when so requested in writing by the Contracting Officer, will be made at rate per hour for the discipline involved plus travel expenses computed in accordance with Government Joint Travel Regulations. Payment for attending additional conferences shall be made after submittal of a separate ENG Form 93, which shall not be assigned a partial payment estimate number.

9. Video Record. The government reserves the right to make a video record of the presentation.

ANNEX C

REQUIRED DD FORM 1391 DATA

To facilitate ECIP project approval, the following supplemental data shall be provided:

a. In title block, clearly identify projects as "ECIP."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive listing of buildings, zones, or areas including building numbers, square foot floor areas, designated temporary or permanent, and usage.

d. List references, assumptions and provide calculations to support dollar and energy savings, and indicate any added costs.

(1) If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage floor area, window and wall area for each exposure.

(2) Identify weather data source.

(3) Identify infiltration assumptions before and after improvements.

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

e. Claims for boiler efficiency improvements much identify data to support present properly adjusted boiler operation and future expected efficiency. If full replacement of boilers is indicated, explain rejection of alternatives such as replace burners, nonfunctioning controls, etc. Assessment of the complete existing installation is required to make accurate determinations of required retrofit actions.

f. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

g. An ECIP Life Cycle Cost Analysis Summary Sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

h. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period.

i. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

j. For each temporary building included in the project. Separate documentation is required showing (1) a minimum 10-year continuing need, based on the installation's annual real property utilization survey, for active building retention after retrofit, (2) the specific retrofit action applicable, and (3) an economic analysis supporting the specific retrofit.

k. Nonappropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

l. Any requirements required by ECIP guidance dated 10 August 1982 and any revisions thereto. Note that unescalated costs/savings are to be used in the economic analysis.

m. The five digit category code number for all ECIP projects developed under this scope of work is 80000.

ANNEX D

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, similar facilities, sizes, etc.).

3. Present Energy Consumption.

   - Total Annual Energy Used.

   - Source Energy Consumption.

     Electricity - KWH, Dollars, BTU
     Fuel Oil - GALS, Dollars, BTU
     Natural Gas - THERMS, Dollars, BTU
     Propane - GALS, Dollars, BTU
     Other - QTY, Dollars, BTU

   - Energy Consumption by Systems.

4. Historical Energy Consumption.

5. Energy Conservation Analysis.

   - ECOs Investigated.

   - ECOs Recommended.

   - ECOs Rejected. (Provide economics or reasons)

   - ECIP Projects Developed. (Provide list)*

   - Non-ECIP Projects Developed. (Provide list)*

   - Operational or Policy Change Recommendations.

* Include the following data from the Life Cycle Cost Analysis Summary Sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost. Show the simple payback period for all ECOs.

6. Energy and Cost Savings.

   - Total Potential Energy and Cost Savings.

   - Percentage of Energy Conserved.

   - Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

7. Energy Plan.

- o Project Breakouts with Total Cost and SIR.
- o Schedule of Energy Conservation Project Implementation.

MEETING MINUTES

CLARK, RICHARDSON AND BISKUP
Consulting Engineers, Inc.
2701 ROCKCREEK PARKWAY • SUITE 111 • NORTH KANSAS CITY, MO 64117
TELEPHONE (816) 472-7200 FAX: (816) 472-1385

October 23, 1989

Department of the Army
Kansas City District, Corps of Engineers
700 Federal Building
601 East 12th St.
Kansas City, Missouri 64106

Attn: MRKED-MF/Robert McCormick

Re: Energy Engineering Analysis for the United States Disciplinary Barracks. Notes from the initial meeting.

Bob,

The enclosed notes are from our first meeting with Ft. Leavenworth personnel where we discussed the procedures required for us to gain and maintain access inside the USDB for the field work required for this project.

I would also like to request the government furnished information outlined on page 16 of Annex B of the scope of work. We would appreciate this information as soon as possible.

If you have any questions please call myself or Gary Transmeier at 472-7200.

Sincerely,

Mark A. Wendland, P.E.
Clark Richardson & Biskup

cc.. Rich Willms - Ft Leavenworth DEH
Tom Lance - Architects Consortium

DOYLE E. CLARK, P.E. • GERALD L. RICHARDSON, P.E. • JEFFREY A. BISKUP, P.E.

MEETING NOTES

PROJECT: Energy Survey for the United States Disciplinary Barracks

DATE: October 16, 1989

SUBJECT: Entry Interview

ATTENDING:

Mark Wendland - CRB
Tom Lance -Architects Consortium
Rich Willms - Ft. Leavenworth DEH
Gary Transmeier - CRB
Dave Scott - Architects Consortium
Captain Doane - USDB

Requirements for access to USDB

1. CRB will send names and SS numbers of persons requiring access to the USDB to Rich W. by 10/18/89. Security check is expected to take 10 working days from the receipt of the information.

2. Cameras are allowed in the USDB, however no pictures of inmates are allowed. Rich will explore the possibility of Ft. Leavenworth developing the pictures and clearing them for the A/E's use.

3. Tools are allowed, ie: wrenches, screwdrivers, measuring equipment etc., however they should be kept to the minimum number required for that days work and be in a locked case when they are not in use. Additionally, a property pass will be carried identifying which tools are carried into the USDB so they can be checked out when leaving the facility. The tools will also be engraved or marked with the CRB logo to help identify tools. We understand that if a tool is lost or stolen, we should immediately notify Captain Doane. Ladders can be used inside the facility, however the A/E will need to schedule their use with Captain Doane at least 1 day in advance.

4. Parking and entrance to the facility will be by the west personnel gate. Cars should be registered with the Provo office.

5. Hours of access should be from 8:00 AM to 11:30 AM and from 12:30 PM to 4:30 PM to avoid delays and interference with transfer schedules of inmates working outside the facility. Access at all hours is allowed however the west gate closes at 5:00 PM and the south or main entrance will be used. We do not anticipate needing access other than the hours scheduled.

6. The only holiday that may interfere with the field work, is November 10, 1989, veterans day. We will work around that holiday

7. If an alarm is sounded while A/E personnel are inside the facility, the personnel are to proceed directly to the west gate and will be escorted out of the facility. If exiting at the west gate is not possible, go to Captain Doane's office in building 467. His number is 684-2560.

8. A/E field personnel should stay in pairs and travel with a guard thru maximum security areas. All field personnel will carry a small card identifying the person, describing the project and identifying Captain Doane as our USDB contact to help facilitate the interface between field personnel and USDB personnel.

General Project Information

9. Outside contractor labor rates should be used for all cost estimates.

10. In the medical sections of building 465 equipment shutdowns should be scheduled.

11. A schedule of the areas we intend to survey and the days we will be there will be given to Captain Doane to help identify possible coordination problems with other work in the facility.

12. The kitchen areas are known to have inadequate ventilation. Building 463, (Visitor Center) is also known to be inadequate.

MEETING NOTES:

DATE: 1-29-90

ATTENDING:
Dave Anaya - DEH
Fred Murawski - USDB
Mike Mahoney - CRB
Mark Wendland - CRB

SUBJECT: USDB - ECO Development

A list of Applicable Buildings for Each ECO was passed out. (See attached list.) ECO's are divided into Architectural, Mechanical and Electrical classifications. The buildings that applied to each ECO are listed under that ECO. Each ECO was discussed along with the buildings listed under it, .and modifications to the lists were made based on the discussion. ECO's were modified and buildings were deleted and added based on the information from Dave. Anaya. and Fred Murawski.

1. Castle will be considered in terms of ventilation only. No mechanical cooling.

2. Better funding opportunities exist for new work packages with construction costs of less than $200,000. Repair work can go to $2,000,000.

3. The existing Castle is currently being modified. 2 tier (old laundry) will become a craft shop. 3 tier (mess) will be remodeled. All other tier functions will remain.

4. Buildings 465, 474 and Castle have all had new roofs, in the last five years. 6" of insulation was added at that time.

5. The only dock door to consider is on building 470, which is not part of the study. We will still provide an ECO on the door.

6. Window tinting for solar shading ECO is not a security problem.

7. On applicable ECO's separate out the cost of adding prison inmate construction.

8. In some cases avoided costs can be used to improve paybacks. Only if the cost would already have to be incurred by the USDB at some point within the payback period.

9. Use ACA prison standards for minimum ventilation requirements.

10. Buildings 463 and 473 have no warm up capability. Existing systems are to small.
11. Synergistic effects will be modeled for the Final Submittal once the initial savings have been determined for the Interim Submittal.

12. Previous maintenance experience indicates that installing flow restricters and automatic shut off valves are not acceptable.

CLARK, RICHARDSON AND BISKUP
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TELEPHONE (816) 483-0600 FAX: (816) 483-0111

CRB

DATE: February 14, 1990 **CRB #1496**

LOCATION: Fort Leavenworth

ATTENDEES:

Richard Willms	Fort Leavenworth DEH
Captain Doane	USDB
[redacted]	[redacted]
Tom Lance	ACI
David Scott	ACI

SUBJECT: USDB Energy Study

ITEMS:

1. ACI gave Captain Doane a sample of the metal clad gypboard that would be used for an interior skin if insulation were added to the castle cell barracks. Captain Doane stated that the metal clad gypboard would only be necessary for the castle cell wings 475C, D, F, G and 475E in the gym and mess hall. The metal clad gypboard is only necessary from the floor to 10'. Above 10' a standard gypboard is sufficient. All other buildings in the USDB that are being considered for wall insulation can have standard gypboard.

2. ACI discussed the replacement of single pane windows with a double glazed window with a better coefficient of heat transfer. Captain Doane stated that some of the buildings in the USDB are considered historical and cannot have any exterior changes made to them. Captain Doane will get a list of the historical buildings to CRB. Richard Willms will get a copy of the window specification presently being used by the Fort Leavenworth DEH to CRB.

3. ACI discussed the use of exterior shading on the windows of the buildings to cut down on the solar load. A low "e" film cover would be acceptable. Only those windows with surfaces facing the sun with a large solar gain need to have the window film installed. The windows facing north do not need the film.

4. ACI showed feasible ideas for vestibules on buildings 463 (south gate) and the castle. Richard Willms stated he would like to see improvements to the existing vestibules in the castle. He also stated he would like to see a revolving door on the south of building 463 and a new vestibule on the north door. Captain Doane stated he would get the bullet resistant glass type requirements for the south door on building 463 to CRB.

5. CRB briefly stated that the base load modeling was completed and that CRB had started writing the ECO reports. Not all of the ECO reports require the use of the computer model for the buildings.

The items listed above represent our interpretation of the meeting events. Please contact Michael Mahoney if there are any additions or revisions to the above items.

Michael J. Mahoney

Michael J. Mahoney