Final Report

LIMITED ENERGY STUDY GEODSS FACILITY

WHITE SANDS MISSILE RANGE, NEW MEXICO

Prepared for

U.S. ARMY ENGINEER DISTRICT, MOBILE
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LIST OF ABBREVIATIONS

ACC	-	air cooled condenser
ACCU	-	air cooled condensing unit
AHU	-	air handling unit
Btu	-	British thermal unit
CHLR	-	chiller
CNW	-	condenser water
CNWR	-	condenser water return
CNWS	-	condenser water supply
COE	-	Corps of Engineers
CRUs	-	computer room units
CV	-	converter
CW	-	chilled water
CWP	-	chilled water pump
CWR	-	chilled water return
CWS	-	chilled water supply
DOE2.1d	-	Computer program used for calculating building hour energy use.
DTW	-	dual temperature water
DTWP	-	dual temperature water pump
ECO	-	Energy Conservation Opportunity
EMC	-	E M C Engineers, Inc.
F	-	fahrenheit
FEMP	-	Federal Energy Management Program
ft	-	foot, feet
ft^2	-	square feet
gal	-	gallons
gpm	-	gallons per minute
hp	-	horsepower
hr	-	hour
HRU	-	heat recovery unit

HW	-	hot water
HWP	-	hot water pump
HWR	-	hot water return
HWS	-	hot water supply
H&V	-	heating and ventilating
IR	-	infrared radiant
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hours, one thousand watt-hours
lb/hr	-	pounds per hour
LCCA	-	life cycle cost analysis
MAU	-	make-up air unit
MBtu	-	million British thermal unit
MZ	-	multizone
O&M	-	operation and maintenance
OA	-	outside air
psia	-	pounds per square inch absolute
psig	-	pounds per square inch gage
RA	-	return air
RAD	-	radiation heating system
RAF	-	return air fan
rpm	-	revolutions per minute
SOW	-	scope of work
sq ft	-	square foot
STM	-	steam
SZ	-	single zone
temp.	-	temperature
UH	-	unit heater
UMCS	-	utility monitoring and control system
VAV	-	variable air volume
VSD	-	variable speed drive
WAC	-	window air conditioner

WSMR	-	White Sands Missile Range
yr	-	year(s)

EXECUTIVE SUMMARY

AUTHORITY

This study was performed and this report prepared under Contract No. DACA01-94-D-0033, Delivery Order No. 8. The delivery order was issued by U.S. Army Engineer District, Mobile, to E M C Engineers, Inc. on 8 May 1995.

PURPOSE

The purpose of this study is to identify and evaluate Energy Conservation Opportunities (ECOs), to determine their energy savings potential and economic feasibility, and to document results for possible future funding.

BUILDING AND HVAC DATA

The Ground Based Electro-Optical Deep Space Surveillance (GEODSS) Facility, Building 34568, is a windowless, concrete block structure approximately 10,000 square feet. The building is located on the northern end of the White Sands Missile Range in central New Mexico. The building consists of a large central computer room with perimeter offices. Concrete towers at three corners of the building are topped with telescopes in movable domes. The building is occupied 24 hours per day. The building is conditioned by the following HVAC and auxiliary systems:

- The computer room is conditioned by three Computer Room Units (CRUs) each rated at 12,000 cfm. The CRUs are located within the computer room and distribute supply air via a perforated floor. Each CRU contains a fan, chilled water coil, electric reheat coil, and a humidifier. Room temperature is maintained in the 70° to 72°F range and relative humidity in the 35% to 50% range.

- The offices and hallways are conditioned by a single-zone HVAC system consisting of a fan supplying 4,770 cfm, a chilled water cooling coil, and an electric duct heater. Outside air is specified at 26% of supply air. Room temperature is maintained in the 70° to 72°F range.

- A small conference room adjacent to the offices is served by a small dedicated AHU containing a chilled water cooling coil.

- Each telescope tower is served by a dedicated 2,000 cfm AHU. Each AHU is a once-through system in which outside air is drawn in, cooled by a chilled water cooling coil, ducted to the tower, and expelled through openings in the dome. Each room thermostat is set at 40°F, but the HVAC system is incapable of reaching this temperature, given the 45°F chilled water temperature serving the cooling coil. It is desired to keep the telescope as cool as possible to minimize stabilization time when the telescope is exposed to the cold night sky. The AHUs serving the towers are operated from mid April to mid November. The AHUs are turned off in the winter.

- All eight AHUs in the building are supplied with chilled water from the central chilled water system. The chilled water system consists of two 36-ton chillers coupled to two air-cooled condensers. Chilled water is supplied to HVAC cooling coils via a primary/secondary pumping arrangement.

- Lighting is provided mainly by recessed fluorescent fixtures each containing two standard 40 watt T-12 fluorescent lamps powered by standard magnetic coil ballasts. Offices and hallways have been extensively delamped and most offices are equipped with occupancy sensors.

- Electric power is supplied to the computer room and electronic equipment associated with the telescopes through a rotating Uninterrupted Power Supply (UPS) system. The UPS system consists of a 120 volt/150 kW generator coupled to a large flywheel turned by a 250 horsepower motor. The flywheel will provide about 17 seconds of uninterrupted power, sufficient time for the emergency diesel-electric generator to come on-line in the event of an interruption to commercial power. Power to the motor was measured during the field survey. The motor was drawing about 85 amps at 281 volts with a power factor of about 0.45.

HISTORICAL ENERGY USE

Electric power is supplied to the GEODSS Facility by Socorro Electric. The facility is billed for electricity by the White Sands Missile Range at a rate of $0.0821 per kWh. There is no demand charge.

The facility is metered by a dedicated electric meter. This meter was calibrated by ZIA Electrical Products as part of this study. The meter was found to be accurate within 1.0% in its "as found" condition.

The diesel-electric generator provides backup power for the facility and is used quite often due to poor reliability of commercial service and the frequency of electrical storms.

Average site energy consumption was based on four years of utility data and is presented in Table ES-1.

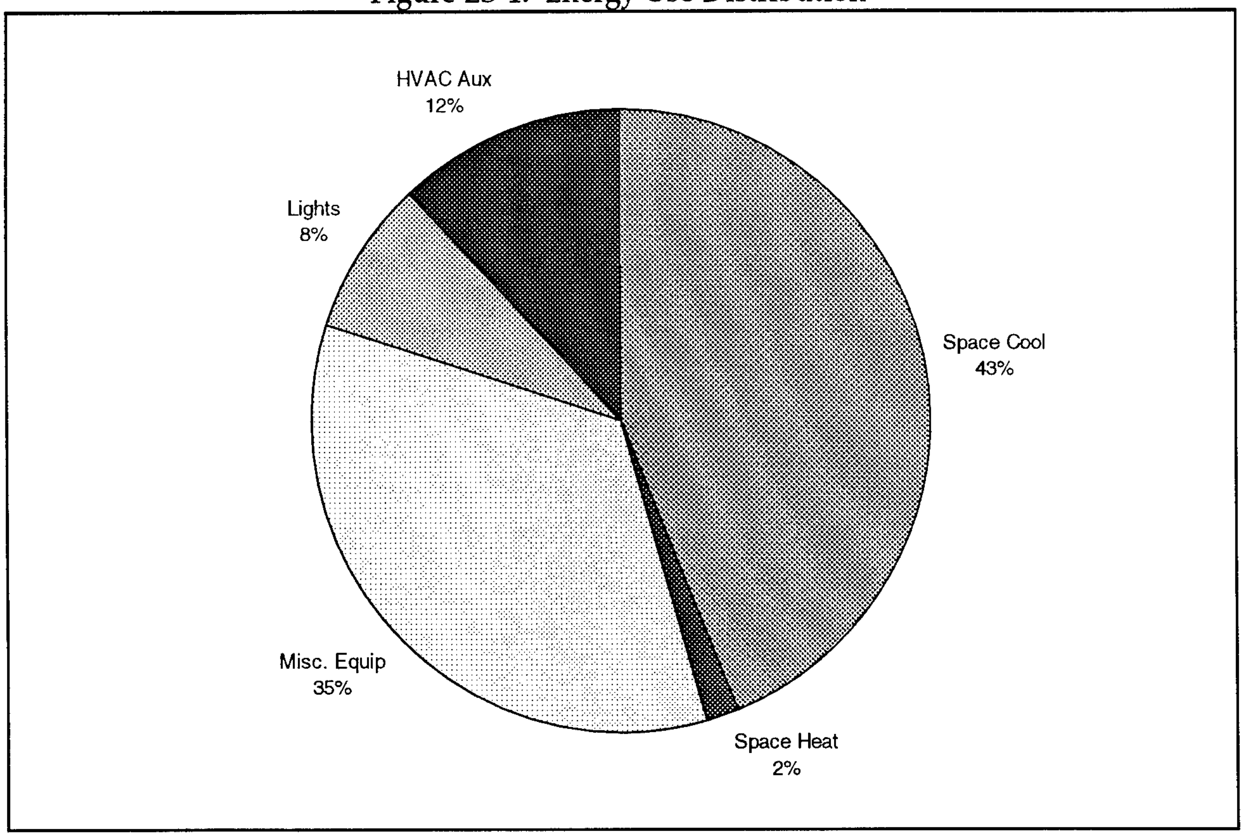
Table ES-1. Historical Energy Consumption Data

Energy Type	Annual Energy Use	Unit Energy Cost	Annual Energy Cost	Annual MBtu
Electricity	1036 MWh	$0.0821/kWh	$85,056	3536
Diesel Fuel	5932 gal	$1.03/gal	$6,110	823

BASELINE ENERGY USE

The DOE2.1d Building Energy Simulation Program was used to model the building using TMY weather for Truth or Consequences, New Mexico. Figure ES-1 presents the electric energy use distribution. Miscellaneous equipment consumes about 35% of the annual energy used at the facility. Miscellaneous equipment includes computers, office equipment, electronic equipment, cameras, and the air compressors. Space cooling consumes about 43% of the annual energy. Fans, pumps, and lighting consumes the remaining 20%. Space heating consumes less than 2% of the annual energy.

Figure ES-1. Energy Use Distribution



ENERGY CONSERVATION OPPORTUNITIES (ECOs)

The following is a brief summary of the ECOs investigated.

ECO 1: **Albedo Modification:** Repainting the exterior walls white and placing white gravel on the roof to decrease solar heat gain was found not to be cost-effective. Energy savings are minimal due to good insulation.

ECO 2: **Roof Insulation:** The existing roof insulation thickness of 4 inches is greater than the optimum insulation thickness of 2 inches.

ECO 3: **Low-Emissivity Roof Coating:** A low-emissivity coating applied to the underneath side of the roof deck was found not to be cost effective. Energy savings are minimal due to good insulation.

ECO 4: **T-8 Fluorescent Lamps:** Installing high efficiency lighting and electronic ballasts were found to be cost effective.

ECO 5: **Vortex Tube Cooling:** Cooling for the telescope cameras was found to consume a relatively large amount of energy. Correction is beyond the scope of this project.

ECO 6: **High-Efficiency Motors:** Replacing one of the existing HVAC fan motors with a more efficient motor was found to be cost effective.

ECO 7: **UPS System:** The existing system was found to be very inefficient. Two cost effective modifications are recommended.

ECO 8: **Chiller Replacement:** Replacing the existing chillers was found to be cost effective.

ECO 9: **Recirculate Air in Towers:** Recirculating room air and reducing the outside airflow rate in the camera towers was found to be cost effective. The HVAC systems are currently 100% outside air systems.

ECO 10: **Turn Off Office AHU at Night:** Installing a time clock to turn off the AHU serving the office areas in the building at night was found to be cost effective.

ECO 11: **Propane Heat:** Replacing the existing electric duct heaters with propane-fired duct furnaces was found not to be cost effective.

ECO 12: **Economizer:** Installing an economizer on AHU-2 serving the office was found not to be cost effective.

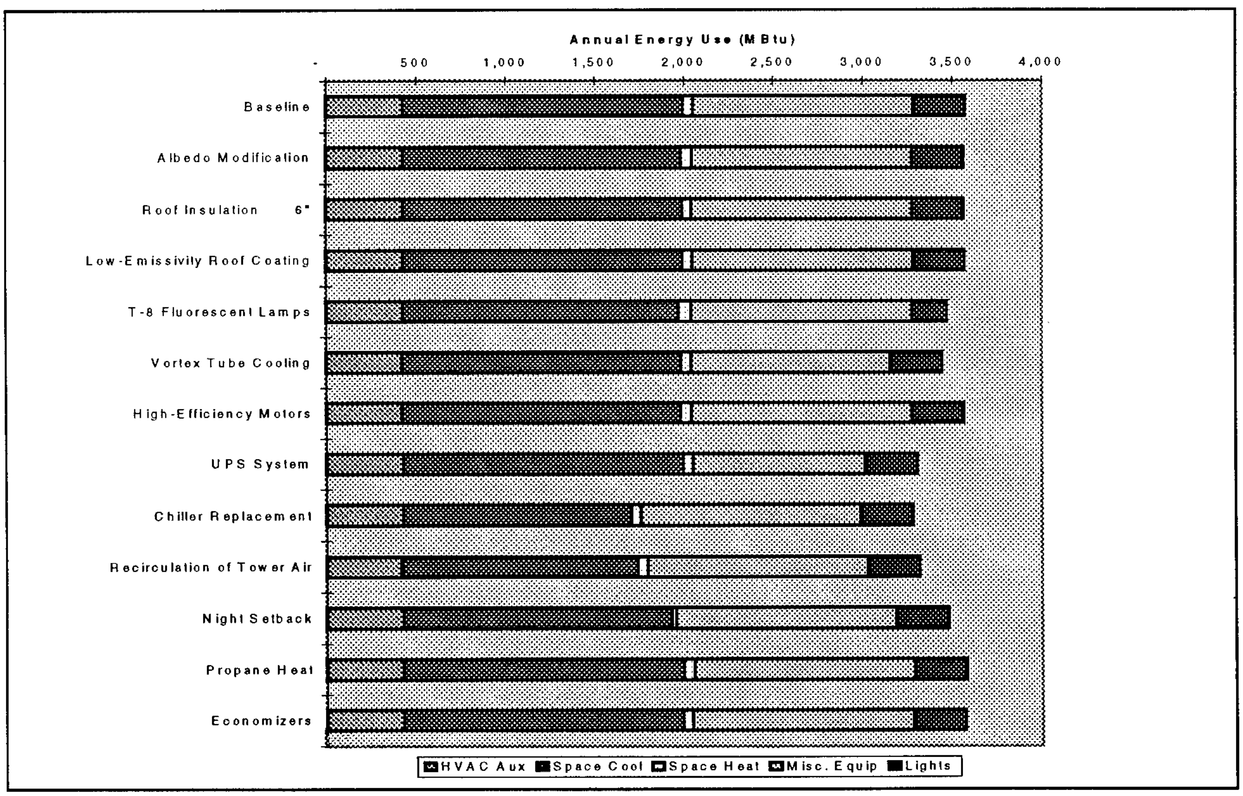
Table ES-2 on the following page presents the results of the analysis for each ECO.

Table ES-2. Summary of Results

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
1	Albedo Modification	1,532	126	0	N/A	N/A	N/A
2	Roof Insulation 6"	1,939	159	0	N/A	N/A	N/A
3	Low-Emissivity Roof Coating	900	74	0	N/A	N/A	N/A
4	T-8 Fluorescent Lamps	29,455	2,418	47	12,429	2.38	5.0
5	Vortex Tube Cooling	38,441	3,156	0	N/A	N/A	N/A
6	High-Efficiency Motors	2,197	180	0	1,753	1.55	9.7
7	UPS System	89,454	7,344	0	22,874	4.85	3.1
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.3
9	Recirculation of Tower Air	74,518	6,118	0	22,767	4.05	3.7
10	Turn Off AHU at Night	48,210	3,958	0	420	80.86	0.1
11	Propane Heat	1,199	65	0	11,182	0.08	171.7
12	Economizers	967	79	0	4,096	0.29	51.6

A graphical representation of the annual energy use for the baseline model and each of the ECOs is presented in Figure ES-2 below.

Figure ES-2. Baseline Energy Use Vs. Recommended ECO Modifications



RECOMMENDATIONS

The following ECOs are recommended for implementation.

Table ES-3. Summary of Recommended ECOs

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
10	Turn Off AHU at Night	48,210	3,958	0	420	80.86	0.09
7	UPS System	89,454	7,344	0	22,874	4.85	3.11
9	Recirculation of Tower Air	74,518	6,118	47	22,767	4.05	3.72
4	T-8 Fluorescent Lamps	29,455	2,418	0	12,429	2.38	5.04
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.30
6	High Efficiency Motors	2,197	180	0	1,753	1.55	9.72
	Overall Savings	**280,029**	**22,990**	**47**	**101,292**	**N/A**	**4.41**

The overall savings takes into account the synergistic effects of multiple ECOs. The total annual energy cost savings for combined ECOs is $22,990 per year with a resulting simple payback of 4.4 years. The combined ECOs annual energy savings is 280,029 kWh per year, 27% of the present annual energy use.

To qualify for FEMP funding, ECOs must have an SIR greater than 1.25 and a simple economic payback less than 10 years. The following ECOs are recommended for funding as a Federal Energy Management Program (FEMP) project.

Table ES-4. Summary of ECOs Recommended for FEMP Funding

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
7	UPS System	89,454	7,344	0	22,874	4.85	3.11
9	Recirculation of Tower Air	74,518	6,118	0	22,767	4.05	3.72
4	T-8 Fluorescent Lamps	29,455	2,418	47	12,429	2.38	5.04
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.30
	Combined Savings	252,877	20,761	47	157,609	2.74	5.7

The combined savings of these ECOs with synergistic effects taken into account is $20,761 per year with a resulting SIR of 2.74 and a simple payback of 5.7 years.

The following ECOs are recommended for in-house implementation by the GEODSS maintenance staff.

Table ES-5. Summary of ECOs Recommended for In-House Implementation

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
10	Turn Off AHU at Night	48,210	3,958	0	420	80.86	0.09
6	High-Efficiency Motors	2,197	180	0	1,753	1.55	9.72

The following ECOs are recommended for implementation with the installation of the new computer system, in about two years.

Table ES-6. Recommended ECO Upgrades with Computer Renovation

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
5	Vortex Tube Cooling	38,441	3,156	0	N/A	N/A	N/A

The following ECOs were not found to be cost effective:

Table ES-7. ECOs Not Recommended

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
1	Albedo Modification	1,532	126	0	N/A	N/A	N/A
2	Roof Insulation 6"	1,939	159	0	N/A	N/A	N/A
3	Low-Emissivity Roof Coating	900	74	0	N/A	N/A	N/A
11	Propane Heat	1,199	65	0	11,182	0.08	171.70
12	Economizers	967	79	0	4,096	0.29	51.60

1. INTRODUCTION

1.1 AUTHORITY FOR STUDY

This study was performed and this report prepared under Contract No. DACA01-94-D-0033, Delivery Order No. 8. The delivery order was issued by U.S. Army Engineer District, Mobile, to E M C Engineers, Inc. on 8 May 1995.

1.2 PURPOSE OF STUDY

The purpose of this study is to identify and evaluate Energy Conservation Opportunities (ECOs) for the Ground Based Electro-Optical Deep Space Surveillance (GEODSS) Facility, Building 34568, to determine their energy savings potential and economic feasibility, and to document results for possible future funding.

1.3 STATEMENT OF WORK

The following services are required by the Statement of Work contained in Appendix A:

- Perform a limited site survey.
- Evaluate selected ECOs.
- Use building energy simulations to calculate envelope and HVAC system energy savings.
- Combine selected ECOs into recommended projects taking into account the effects of multiple ECOs on energy savings and implementation costs.
- Provide a comprehensive report presenting field survey data, assumptions, methods of analysis, and results of the study.

1.4 GENERAL APPROACH

EMC attended a pre-proposal meeting at the GEODSS site in March 1995. At that meeting, EMC was given a tour of the facility and received information regarding the history of the facility, including details of present operations and problems. The meeting produced a preliminary list of ECOs to be evaluated.

A detailed field survey was completed the 1st and 2nd of June 1995. As part of the field survey, the electric meter serving the site was recalibrated and electrical measurements were made on selected electrical equipment.

The building energy use was simulated using the DOE2.1d program to produce a baseline model. The baseline model energy use was compared to historical energy use data.

Each ECO was analyzed individually. Energy savings were calculated by modifying the baseline model to reflect the proposed modification. A detailed cost estimate and a Life Cycle Cost Analysis (LCCA) were performed for each ECO.

ECOs with favorable economics were combined into recommended projects. The effects of multiple ECOs on energy savings and implementation costs were taken into account. A Form DD1391 was used to present the data and text for the recommended projects.

A comprehensive Preliminary Report was prepared presenting the field survey data, assumptions, methods of analysis, and results of the study.

1.5 LIFE CYCLE COST ANALYSIS

The Life Cycle Cost Analysis (LCCA) methodology used in this study comprised a present value analysis of capital costs, operational costs, and projected energy costs over the expected life cycle of the ECO. Uniform present value (UPV) factors and escalation rates for energy costs were taken from Energy Prices and Discount Factors for Life-Cycle Cost Analysis 1995, which is the current update to NBS Handbook 135. A 3.0% discount rate was used for the purpose of this study in compliance with FEMP guidelines.

The following UPV factors, adjusted for average fuel price escalation, were taken from the NBS 135 Supplement:

		Uniform Present Value Factor		
No. of Years	Electricity	LP Gas	Non-Energy	Applicable ECOs
10	8.58	9.60	8.53	Controls
15	12.02	14.17	11.94	Lighting Systems
20	15.08	18.58	14.88	HVAC, Weatherization

1.6 ORGANIZATION OF DOCUMENT

This report is organized as follows:

- Section 2 summarizes the existing building and HVAC data.

- Section 3 presents the energy use of the existing baseline building.
- Section 4 contains the analysis for each individual ECO.
- Section 5 summarizes the results of the analysis and makes recommendations.
- Appendix E contains a completed Form DD-1391 for use in obtaining Federal Energy Management Program (FEMP) funding for the selected project package.

2. BUILDING AND HVAC DATA

2.1 GENERAL

The GEODSS Facility (Building 34568) is a windowless, concrete block structure of approximately 10,000 square feet. The building is located on the northern end of the White Sands Missile Range (WSMR) in central New Mexico. The building consists of a large central computer room surrounded by offices on the perimeter. Concrete towers at three corners of the building are topped with telescopes in movable domes. The building is occupied continuously 24 hours per day. Field survey notes and tabulated data on the building and HVAC systems is contained in Appendix B.

2.2 COMPUTER ROOM

The computer room is in the center of the building with one wall exposed to the outside. The wall consists of concrete block, fiberglass batt insulation, and interior wall board. There are no windows. The built-up flat roof is insulated with an estimated 4 inches of polystyrene insulation supported by a metal deck. A drop acoustic ceiling is suspended about 3 feet below the metal deck.

The computer room contains a large quantity of computer equipment which contributes significant heat gain to the room.

The computer room is conditioned by three computer room units (CRUs) each rated at 12,000 cfm and 326 MBH cooling capacity. The CRUs are located within the computer room and distribute supply air via a perforated floor. Each CRU contains a fan, chilled water coil, electric reheat coil, and a humidifier. Room temperature is maintained in the 70° to 72°F range and relative humidity in the 35% to 50% range.

2.3 OFFICES

Offices and hallways are arranged along three sides of the building. Wall and roof construction is identical to the computer room and there are no windows.

The offices contain typical office equipment such as personal computers, printers, a coffee maker, a refrigerator, vending machines, and a photocopy machine. Additionally, there is some electrical test equipment for maintaining electronic equipment associated with the telescopes.

The offices and hallways are conditioned by a single-zone HVAC system consisting of a fan supplying 4770 cfm, a chilled water cooling coil, and an electric duct heater. Outside air is specified at 26% of supply air. Room temperature is maintained in the 70° to 72°F range.

2.4 CONFERENCE ROOM

A small conference room adjacent to the offices is served by a small dedicated AHU containing a chilled water cooling coil.

2.5 TOWERS

Three two-story towers topped with dome-covered telescopes are located at three corners of the building. The domes are constructed of an aluminum outer skin, about 4 inches of insulation, and an inside skin of unknown construction, possibly fiberglass. The domes are equipped with a tight fabric skirt around the perimeter to limit infiltration. There is a noticeable gap around the aperture door in the dome. The walls are 12 inch cast concrete, fiberglass batt insulation, and interior wallboard. There are no windows.

Equipment in the towers consists of a rack of electronic processing equipment, the telescope drives, and the electronic camera within the telescope. The cameras are cooled by vortex cooling tubes supplied by 90 psig compressed air. Each tower has a dedicated 5 horsepower air compressor to serve the vortex tubes.

Each tower is served by a dedicated 2,000 cfm AHU. Each AHU is a once-through system in which outside air is drawn in, cooled by a chilled water cooling coil, ducted to the tower, and expelled through openings in the dome. Each room thermostat is set at 40°F, but the HVAC system is incapable of reaching this temperature given the 45°F chilled water temperature serving the cooling coil. The result is that the cooling coils are operating at full capacity during the cooling season. It is desired to keep the telescope as cool as possible to minimize stabilization time when the telescope is exposed to the cold night sky.

The AHUs serving the towers are operated from mid-April to mid-November. The AHUs are turned off in the winter.

It is unclear why the HVAC system is a once-through system; there are no ventilation requirements for the space. We originally believed the once-through system was for the purpose of pressurization, to keep dust from infiltrating through the dome. However, the system is not operated in the winter and the openings in the dome do not appear to be large enough to require 2,000 cfm of airflow for pressurization. The once-through system has insufficient capacity to cool the OA air from 95°F to 45°F.

2.6 CENTRAL CHILLED WATER SYSTEM

All eight AHUs in the building are supplied with chilled water from the central chilled water system. The chilled water system consists of two 36 ton chillers coupled to two air-cooled condensers. Chilled water is supplied to HVAC cooling coils via a primary/secondary pumping arrangement.

2.7 LIGHTING

Interior lighting consists of the following:

- The computer room and offices are lit with recessed fluorescent fixtures each containing two standard 40 watt T-12 fluorescent lamps powered by standard magnetic coil ballasts. Offices and hallways have been extensively delamped and most offices are equipped with occupancy sensors which automatically turn lights on and off.

- Ten exit signs are located in the building each with two 20 watt incandescent lamps.

- Twelve 150 watt floodlights serve the three towers. These floodlights are operated for only 1 to 2 hours per day.

- Nine 60 watt recessed incandescent fixtures were noted at various places in the building.

- Fifty-one small, ground-level, shaded, incandescent lamps serve walkways and parking lots around the building. These lamps are rated at 15 and 25 watts at 220 volts, but are operated at 110 volts which results in actual wattages of 7.5 and 12.5.

- . The building perimeter is equipped with a high intensity security lighting system which is only activated for an intruder alert. Use of this lighting system for any other purpose is incompatible with the function of the telescopes.

2.8 ELECTRIC POWER

Electric power is supplied to the GEODSS Facility by Socorro Electric. The facility is billed for electricity by the White Sands Missile Range at a rate of $0.0821 per kWh. There is no demand charge. The rate schedule is contained in Appendix C.

The facility is metered by a dedicated electric meter. This meter was calibrated by ZIA Electrical Products as part of this study. The meter was found to be accurate within 1.0 percent in its "as found" condition. The meter was adjusted slightly during calibration for better accuracy. Meter nameplate data, calibration data, and historical meter data is contained in Appendix C.

Total power to the facility was measured during the field survey at the main breaker. The system was drawing about 250 amps at 282 volts with a power factor of about 0.63. This extremely low power factor should be corrected because utility companies have begun to penalize customers with low power factors. There currently is no power factor penalty from the utility.

Power supplied to the computer room and electronic equipment associated with the telescopes is termed "Tech power" and is routed through a rotating Uninterrupted Power Supply (UPS) system. The UPS system consists of a 120 volt/150 kW generator coupled to a large flywheel turned by a 250 horsepower electric motor. The flywheel will provide about 17 seconds of uninterrupted power, which is sufficient time for the emergency diesel-electric generator to come on-line in the event of an interruption to commercial power. Power to the motor was measured during the field survey and found to be drawing about 85 amps at 281 volts with a power factor of about 0.45. This low power factor is probably the main reason for the low power factor at the main breaker.

The diesel-electric generator is operated during thunderstorms when there is a strong possibility of commercial power interruptions, and in the event of an actual commercial power interruption.

3. BASELINE ENERGY USE

3.1 HISTORICAL ENERGY USE

Monthly electric energy purchased from Socorro electric and generated on site using the diesel-electric generator is indicated in Figure 3-1 below.

Figure 3-1. Electricity Purchased and Generated Oct 1991 to Jan 1995

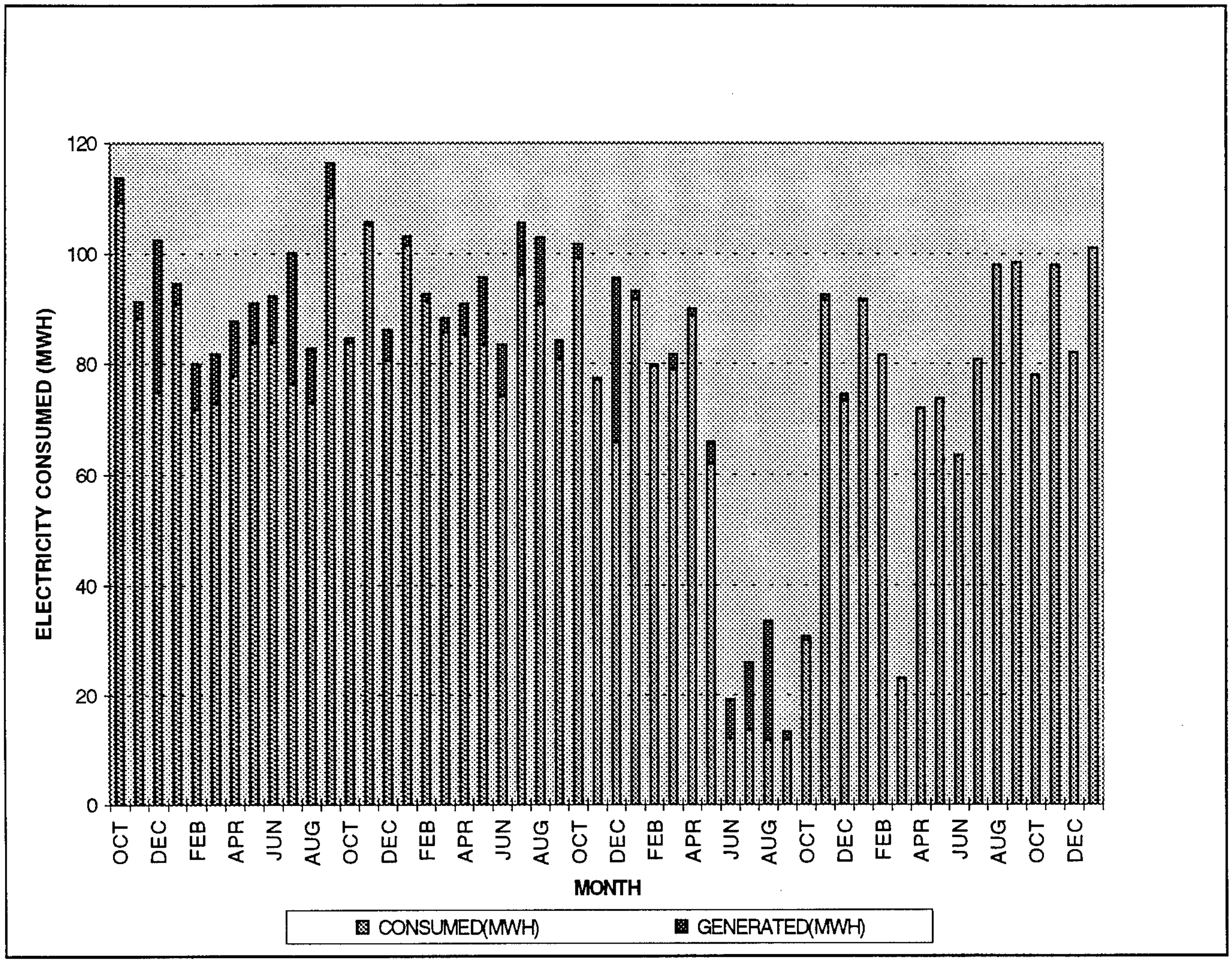


Figure 3-1 is based on facility electric meter data and diesel fuel consumption data. The fuel rate for the diesel-electric generator was assumed to be 0.064 gallons per kWh based on typical fuel rates for diesel-electric generators.

The supporting energy consumption data is contained in Appendix C. The following problems were noted with the electric data:

- The electric meter failed and produced erroneous readings from May 1993 through October 1993, when it was replaced.

- The electric consumption for March 1994 appears to be in error.

- No fuel oil consumption data was supplied after January 1994.

Data for FY91 and FY92 appears consistent and accurate and was judged to be the best representation of energy consumption for the facility. Referring to FY91 and FY92 in Figure 3-1, the following comments apply:

- Monthly energy use throughout the year is fairly steady ranging from about 80 to 105 MWh per month. This is due to a high percentage of electric use going to steady loads which vary little from month to month. These include Tech power, lights, HVAC fans, and office equipment.

- Electricity is consistently low in February and March, probably a result of lower cooling loads and minimal heating loads.

3.2 BASELINE ENERGY SIMULATION

The DOE2.1d building energy simulation program was used to model the building. The model used TMY weather for Truth or Consequences, New Mexico. The following methods and assumptions were made in developing a baseline energy simulation which is intended to represent the existing condition of the building:

- Lighting electric loads were based on fixture counts for each zone, incandescent lamp wattages, and fluorescent fixture wattages based on catalog data for the type of lamps and ballasts in the fixture. Fixtures which had been delamped and light circuits with occupancy sensors were taken into account. Occupancy sensors were assumed to reduce energy use by 30%. The lighting schedules were based on interviews of personnel in the building.

- Equipment electric loads from office equipment were based on the equipment inventory and handbook data containing average energy use.

- Heat gain from people was based on the occupancy schedule of the building.

- Tech power electric loads were based on electrical measurements made during the field survey. The Tech power electric loads were reported to be fairly steady. These loads were varied somewhat as a means for calibrating the model to historical energy use. Tech power is used by the computers and electronic equipment in the computer room and by electronic equipment and the cameras in the towers.

- Air compressor electric loads were based on vortex tube flow which ranges from 5 to 15 cfm with an average at about 10 cfm. The compressors will supply about 20 cfm, and are thus about 50% loaded. The resulting average load is 2.12 kW per compressor. Vortex tubes and air compressors are operated from 3 p.m. to 7 a.m. daily.

- Fan electric loads were based on motor horsepower and motor loading. Motor loading was determined by measuring motor speed during the field survey and calculating motor slip which is proportional to motor load fraction.

- Chiller performance in terms of kW per ton was difficult to estimate. The chiller is a built-up system consisting of refrigerant compressors and air-cooled condensers from different manufacturers. The baseline air-cooled chiller was assumed to operate 1.43 kW per ton based on catalog data for a chiller of similar type and age.

Figure 3-2 below is a plot of historical and predicted electric energy use of the facility. As can be seen, there is good agreement between the model and historical data.

Figure 3-2. DOE2.1d Model vs. Historical Data

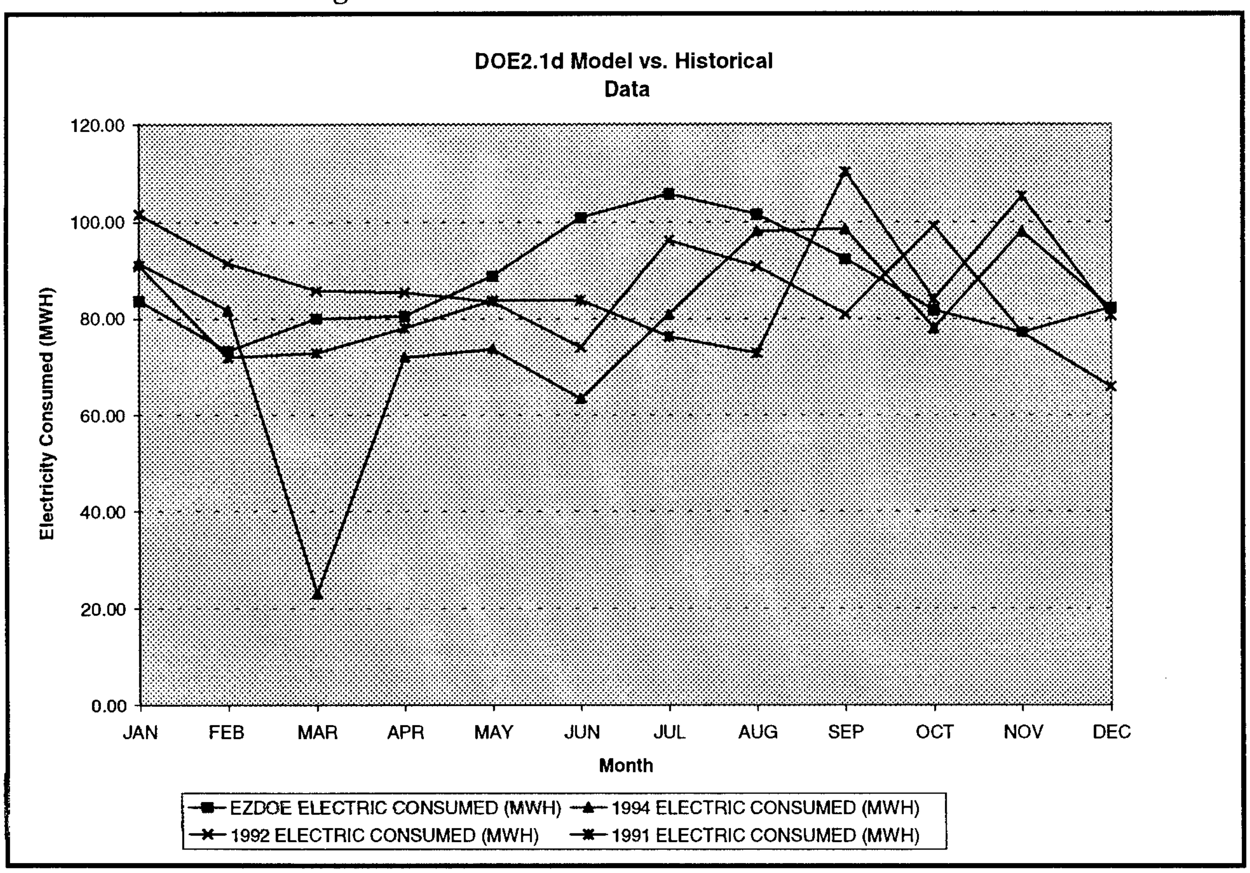


Figure 3-3 below is a graphic of the distribution of electric energy use. As can be seen miscellaneous equipment consumes about 35% of the annual energy used at the facility. Miscellaneous equipment includes computers, office equipment, electronic equipment, cameras, and the air compressors. Space cooling consumes about 43% of the annual energy. HVAC Aux, which includes fans and pumps, and lighting consumes the remaining 20%. Space heating consumes less than 2% of the annual energy.

Figure 3-3. Energy Use Distribution

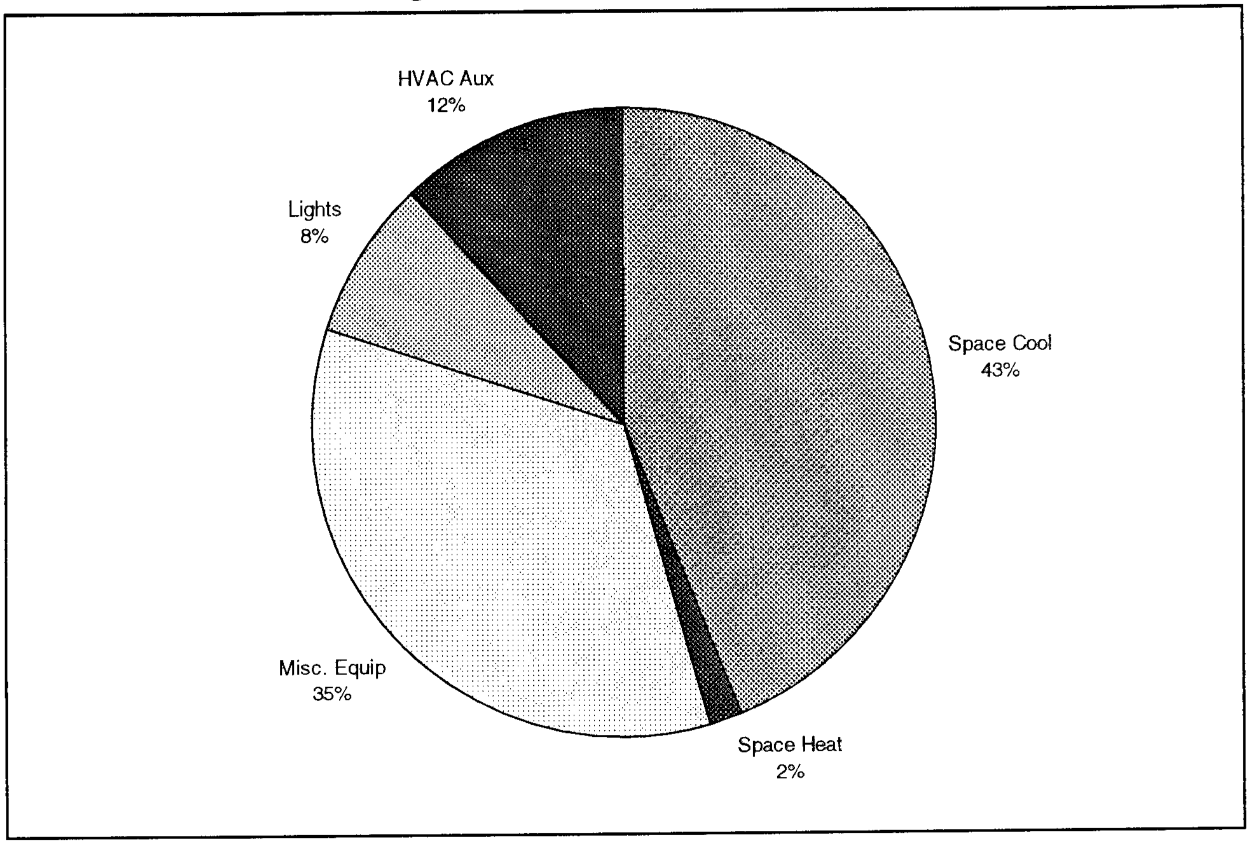


Table 3-1 below presents the annual energy use and cost for the facility.

Table 3-1. Facility Annual Energy

	Annual Electric Use (MWh)	Annual Energy Cost ($)
DOE2.1d Model	1,047	$85,981
FY91	1,010	$82,921
FY92	1,031	$84,645

4. INDIVIDUAL ECO ANALYSIS

This section contains a description and complete analysis for each ECO, including backup data. These ECOs are:

- ECO 1: Albedo Modification.
- ECO 2: Roof Insulation.
- ECO 3: Low-Emissivity Roof Coating.
- ECO 4: T-8 Fuorescent Lamps.
- ECO 5: Vortex Tube Cooling.
- ECO 6: High-Efficiency Motors.
- ECO 7: UPS System.
- ECO 8: Chiller Replacement.
- ECO 9: Recirculate Air in Towers.
- ECO 10: Turn Office AHU at Night.
- ECO 11: Propane Heat.
- ECO 12: Economizer.

4.1 ECO 1: ALBEDO MODIFICATION

Proposed Modifications: Repaint the building white and replace the gravel on the roof with white rock in order to reduce on the cooling load.

The ability of a building surface to reflect incoming electromagnetic radiation is called albedo. Dark building surfaces absorb heat while light surfaces reflect the heat and stay cooler. The absorptance of a surface is measured on a scale from 0 to 1, with an absorptance of 1 absorbing all of the radiation, while a surface with an absorptance of 0 reflects it all. A previous energy conservation study of a typical house in Sacramento, California, indicated that the total air-conditioning bill could be reduced by up to 22% if the absorptance of the walls and roof were decreased from 0.6 to 0.2.

Existing Conditions: The building, originally white, was repainted a light tan approximately two years ago. The outside doors were also changed from white to dark brown and the building's roof was also changed from white roof gravel to a medium brown roof gravel. The occupants of the building began to notice an increase in electrical consumption right after the color of the building was changed. The absorptance of the existing flat, built-up roof was assumed to be 0.6, based on the absorptance of similar colored material. The existing wall absorptivity was assumed to be 0.7.

Method of Analysis:

- The DOE 2.1d baseline model was modified and the building's energy consumption was calculated for roof and wall absorptance values of 0.29 and 0.26, respectively.

- Simulations were also run for roof and wall absorptances of 0.1 versus 0.9 to see the effect of a wider range of absorptances.

Results: The simulations (summarized in the table below) indicated that with the proposed modifications, there would be a negligible drop in the cooling load which would be partially offset by an increase in heating load. This is due to adequate insulation in the roof and walls. The total annual energy savings was estimated at 5.2 MBtu or about 1,532 kWh which would save $126 annually.

Item	Baseline	ECO
Roof Absorptance	0.70	0.29
Wall Absorptance	0.60	0.26
Heating (MBtu)	55	59
Cooling (MBtu)	1569	1560
HVAC (MBtu)	427	426
Lights (MBtu)	289	289
Misc. Equipment (MBtu)	1234	1234
Total Use (MBtu)	3,575	3,569

Recommendations: Changing the color of the walls and roof would not substantially decrease the amount of energy consumed by the building or be cost efficient. An albedo modification is not recommended. However, it is recommended that the color of the outer doors be changed for safety reasons from the current dark brown color to a lighter color that will not absorb as much heat. The doors now become so hot in the summer that building personnel have to use gloves to open the doors to avoid being burned.

```
EMC          ENGINEERS        INC.         EZDOE - ELITE SOFTWARE DEVELOPMENT INC        DOE-2.1D    8/ 7/1995     12:22:21  PDL RUN 1
  DENVER,       CO          80227          GEODSS SITE DOE EVALUATION
REPORT- BEPS  ESTIMATED BUILDING ENERGY PERFORMANCE                                      TRUTH OR CONSEQU, N
```

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                      ENERGY TYPE
                      IN SITE MBTU -   ELECTRICITY
                     CATEGORY OF USE
                        SPACE HEAT          59.02
                        SPACE COOL        1560.06
                        HVAC AUX           426.40
                        DOM HOT WTR          0.00
                        AUX SOLAR            0.00
                        LIGHTS             288.88
                        VERT TRANS           0.00
                        MISC EQUIP        1233.86
                                       ----------
                         TOTAL            3568.23

          TOTAL SITE ENERGY        3568.14 MBTU      313.0 KBTU/SQFT-YR GROSS-AREA      313.0 KBTU/SQFT-YR NET-AREA
          TOTAL SOURCE ENERGY      3568.14 MBTU      313.0 KBTU/SQFT-YR GROSS-AREA      313.0 KBTU/SQFT-YR NET-AREA
          PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =   0.4
          PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                 =100.0
          NOTE  ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
                ON THE YEARLY DEMAND.  ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.
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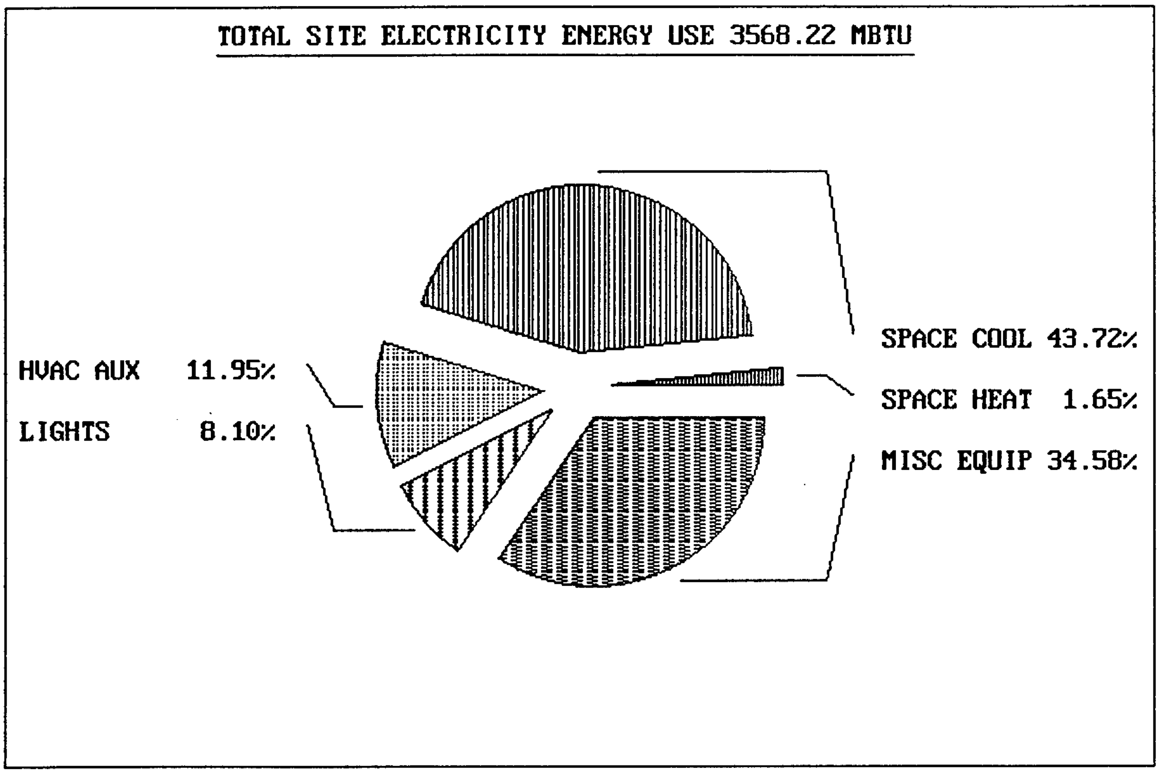


Existing and Proposed Albedo Modification

CATEGORY	EXISTING		PROPOSED		SAVINGS
	Roof	Wall	Roof	Wall	(MBTU)
Absorptance	0.6	0.7	0.29	0.26	
Heating		55.1		59.0	(3.9)
Cooling		1,569.0		1,560.1	8.9
HVAC		426.6		426.4	0.2
Lights		288.8		288.9	(0.1)
Misc Equip		1,233.9		1,233.9	-
Total Use (MBtu)		3,573.4		3,568.2	5.2

Maximum and Minimum Albedo Modification

CATEGORY	HIGHEST		LOWEST		SAVINGS
	Roof	Wall	Roof	Wall	(MBTU)
Absorptance	0.90	0.90	0.10	0.10	
Heating		51.8		61.5	(9.6)
Cooling		1,578.4		1,555.5	22.9
HVAC		426.8		426.3	0.6
Lights		288.9		288.9	-
Misc Equip		1,233.9		1,233.9	0.0
Total Use (MBtu)		3,579.8		3,565.9	13.9

ABSORPTANCE for Various Exterior Surfaces*

Material	Absorptance	Paint	Absorptance
Black concrete	0.91	Optical flat black paint	0.98
Stafford blue brick	0.89	Flat black paint	0.95
Red brick	0.88	Black lacquer	0.92
Bituminous felt	0.88	Dark gray paint	0.91
Blue gray slate	0.87	Dark blue lacquer	0.91
Roofing, green	0.86	Black oil paint	0.90
Brown concrete	0.85	Dark olive drab paint	0.89
Asphalt pavement, weathered	0.82	Dark brown paint	0.88
Wood, smooth	0.78	Dark blue-gray paint	0.88
Uncolored asbestos cement	0.75	Azure blue or dark green lacquer	0.88
Uncolored cement	0.65		
Asbestos cement, white	0.61	Medium brown paint	0.84
White marble	0.58	Medium light brown paint	0.80
Light buff brick	0.55	Borwn or green lacquer	0.79
Built-up roof, white	0.50	Medium rust paint	0.78
Bituminous felt, aluminized	0.40	Light gray oil paint	0.75
Aluminum paint	0.40	Red oil paint	0.74
Gravel	0.29	Medium dull green paint	0.59
White on galvanized iron	0.26	Medium orange paint	0.58
White glazed brick	0.25	Medium yellow paint	0.57
Polished aluminum reflector sheet	0.12	Medium blue paint	0.51
		Medium Kelly green paint	0.51
Aluminized mylar film	0.10	Light green paint	0.47
Tinned surface	0.05	White semi-gloss paint	0.30
		White gloss paint	0.25
		Silver paint	0.25
		White lacquer	0.21
		Laboratory vapor deposited coatings	0.05

*This table is a compilation of data from several sources including Passive Solar Design Analysis by J. Douglas Balcomb (US Department of Energy, Office of the Assistant Secretary for Conservation and Solar Energy, December 1979) and Ref. 3

4.2 ECO 2: ROOF INSULATION

Proposed Modifications: This ECO analysis determines the optimum thickness of rigid insulation in the roof of the building.

It is assumed that any modification to roof insulation will occur only during scheduled roof repair and/or replacement. Therefore, the only cost involved will be the material and labor cost to install the incremental thickness of rigid, polystyrene insulation. The time and labor cost of any demolition of the existing roof or the built-up roofing over the insulation was not included in the analysis.

This ECO determines the optimum balance between the energy savings and the material and labor costs of various thicknesses of rigid insulation on the roof.

Existing Conditions: The building roof consists of built-up roofing on 4 inches of rigid insulation supported by a metal deck. Beneath the roof deck is a 4 to 5 foot air space and an acoustic tile suspended ceiling. This air space is not used as a plenum for return air flow.

Method of Analysis: Analysis proceeded as follows:

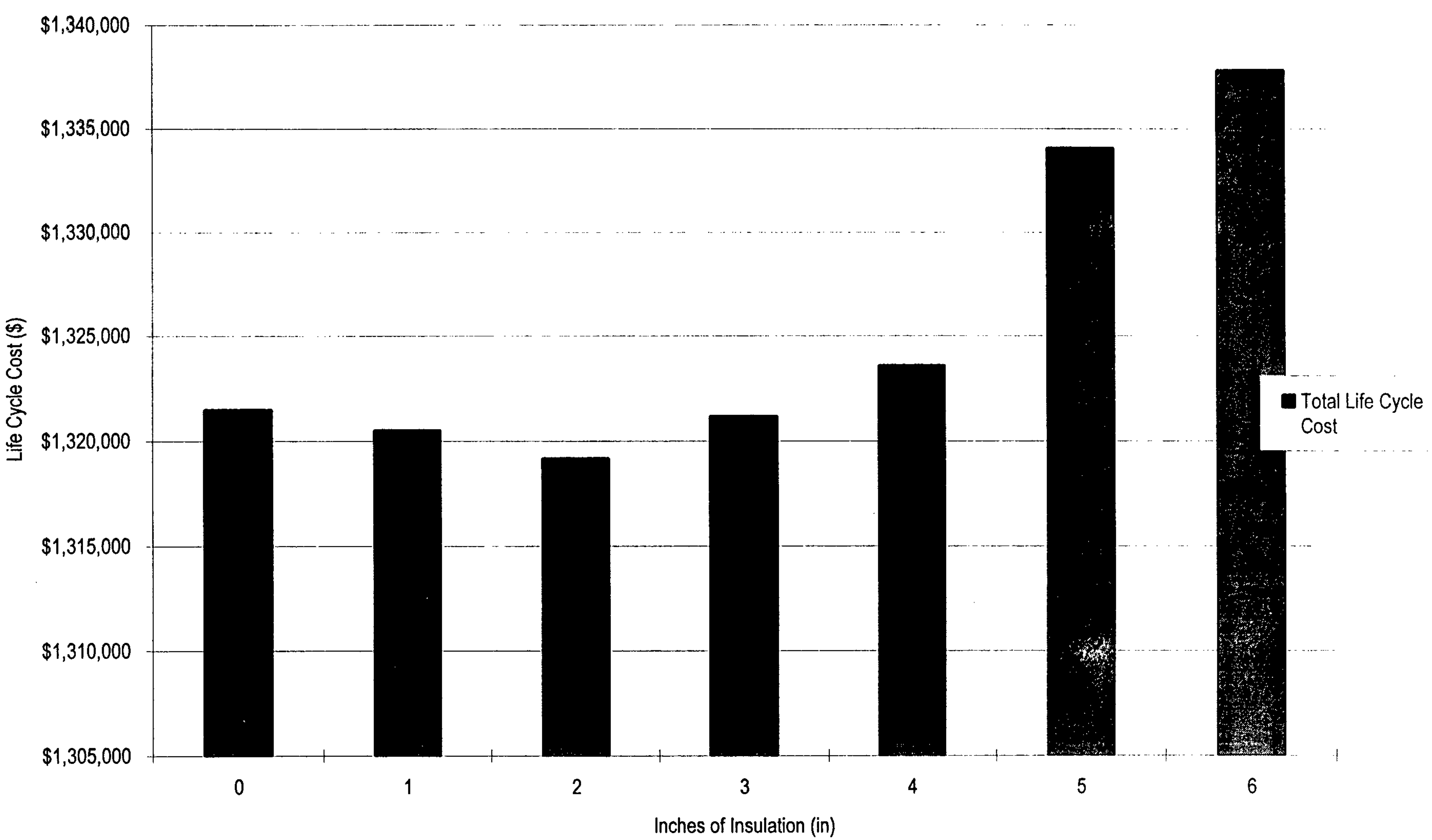
- The roof construction was determined from the building plans.
- The building was then modeled on DOE2.1d with insulation thicknesses ranging from 0 inches to 6 inches of rigid polystyrene roof insulation. The building energy consumption was calculated for each 1 inch increment of insulation.
- Using industry construction cost data, the material and labor costs for installing each insulation thickness were calculated.
- A life cycle cost analysis was performed for each thickness of insulation and the optimum thickness was then determined.

Results: The following table presents the results of the computer energy simulations. The LCCA on page 4-12 presents the results of the analysis for six different thicknesses of rigid roof insulation. The optimal insulation thickness is 2 inches, as seen on the graph of roof insulation thickness vs. the LCCA on page 4-11. In summary, additional roof insulation would not be cost effective.

Item	Equipment (MBtu)	Lights (MBtu)	HVAC Aux (MBtu)	Space Heat (Mbtu)	Space Cool (Mbtu)	Total (MBtu)
0" Roof Insulation	1233.9	288.9	427.7	103.9	1587.8	3,642.2
1" Roof Insulation	1233.9	288.9	427.0	76.4	1577.1	3,604.0
2" Roof Insulation	1233.9	288.7	427.0	64.9	1572.3	3,586.8
3" Roof Insulation	1233.9	288.9	426.7	58.9	1570.2	3,578.5
4" Roof Insulation	1233.9	288.9	426.6	55.1	1568.95	3,573.4
5" Roof Insulation	1233.9	288.9	426.6	52.5	1567.4	3,569.3
6" Roof Insulation	1233.9	288.9	426.6	50.7	1566.93	3,567.0

<u>**Recommendations**</u>: Since the building roof already contains 4 inches of rigid polystyrene insulation, any modification to existing roof insulation is unnecessary and not cost effective.

Roof Insulation Thickness vs. Life Cycle Cost



E M C Engineers, Inc.
EMC #1406-008
GEODSS Site, White Sands Missile Range, NM

LIFE CYCLE COST ANALYSIS
ECO # 2
ROOF INSULATION

LCCECOS.XLS
Prepared By: EMS
8/22/95
Checked By:

Economic Life (yrs)
20

Electric Energy Cost	
0.0821	$/kWh

Construction Cost - Roof Insulation Replacement

Building No.	34568						
Roof Insulation Thickness (inches)	0	1	2	3	4	5	6
Roof R-value including Plenum	4.50	9.00	13.50	18.00	22.50	25.00	29.50
Roof Area (sqft)	9413.33	9413.33	9413.33	9413.33	9413.33	9413.33	9413.33
Material Cost Per sqft	0	0.69	0.95	1.21	1.47	2.16	2.42
Total Material Cost	$0	$6,495	$8,943	$11,390	$13,838	$20,333	$22,780
Labor Hours Per SqFt	0.000	0.005	0.006	0.008	0.008	0.010	0.012
Labor Rate	0.00	47.07	56.48	75.31	75.31	94.13	112.96
Total Labor Cost	$0	$1,038	$1,245	$1,661	$1,661	$2,076	$2,491
Total Cost	$0	$7,533	$10,188	$13,051	$15,498	$22,408	$25,271
Overhead and Profit, Contingency, etc.	$0	$4,188	$5,664	$7,256	$8,616	$12,458	$14,049
Total Project Cost	$0	$11,721	$15,852	$20,306	$24,114	$34,866	$39,320

Rigid Roof Insulation Thickness	0	1	2	3	4	5	6
Investment Costs							
Construction Cost	$0	$11,721	$15,852	$20,306	$24,114	$34,866	$39,320
SIOH (6.0%)	$0	$703	$951	$1,218	$1,447	$2,092	$2,359
Design Cost (6.0%)	$0	$703	$951	$1,218	$1,447	$2,092	$2,359
Total Construction Cost	$0	$13,128	$17,754	$22,743	$27,008	$39,050	$44,039
Total Investment	$0	$13,128	$17,754	$22,743	$27,008	$39,050	$44,039
Annual Energy Use							
Electric Energy (kWh)	1,067,393	1,056,005	1,051,181	1,048,770	1,047,272	1,046,005	1,045,006
Electric Demand (kW)	0	0	0	0	0	0	0
Annual Energy Cost							
Electric Energy (kWh)	$87,633	$86,698	$86,302	$86,104	$85,981	$85,877	$85,795
Electric Demand (kW)	0	0	0	0	0	0	0
Discount Factors (Region 4)							
Electric Energy	15.08	15.08	15.08	15.08	15.08	15.08	15.08
Electric Demand	0	0	0	0	0	0	0
Discounted Energy Cost							
Electric Energy	$1,321,505	$1,307,406	$1,301,434	$1,298,449	$1,296,594	$1,295,025	$1,293,788
Electric Demand	0	0	0	0	0	0	0
Total Discounted Cost	$1,321,505	$1,307,406	$1,301,434	$1,298,449	$1,296,594	$1,295,025	$1,293,788
Total Life Cycle Cost	$1,321,505	$1,320,534	$1,319,188	$1,321,191	$1,323,602	$1,334,076	$1,337,827

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	103.87
SPACE COOL	1587.78
HVAC AUX	427.69
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3642.08

```
TOTAL SITE ENERGY      3642.09 MBTU    319.5 KBTU/SQFT-YR GROSS-AREA     319.5 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY    3642.09 MBTU    319.5 KBTU/SQFT-YR GROSS-AREA     319.5 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =   1.3
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =100.0
NOTE   ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
       ON THE YEARLY DEMAND.  ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.
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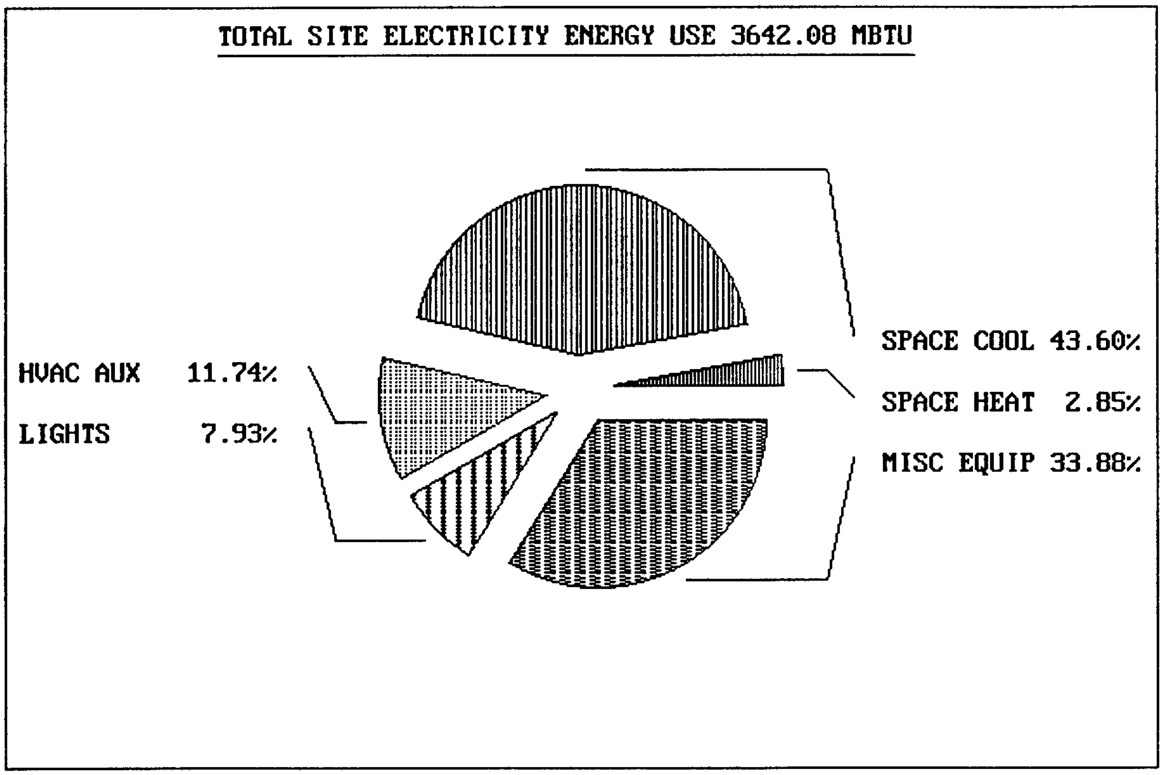

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	76.39
SPACE COOL	1577.06
HVAC AUX	427.04
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3603.23

```
TOTAL SITE ENERGY       3603.18 MBTU    316.1 KBTU/SQFT-YR GROSS-AREA    316.1 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY     3603.18 MBTU    316.1 KBTU/SQFT-YR GROSS-AREA    316.1 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =   0.7
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED               =100.0
NOTE  ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
      ON THE YEARLY DEMAND.  ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.
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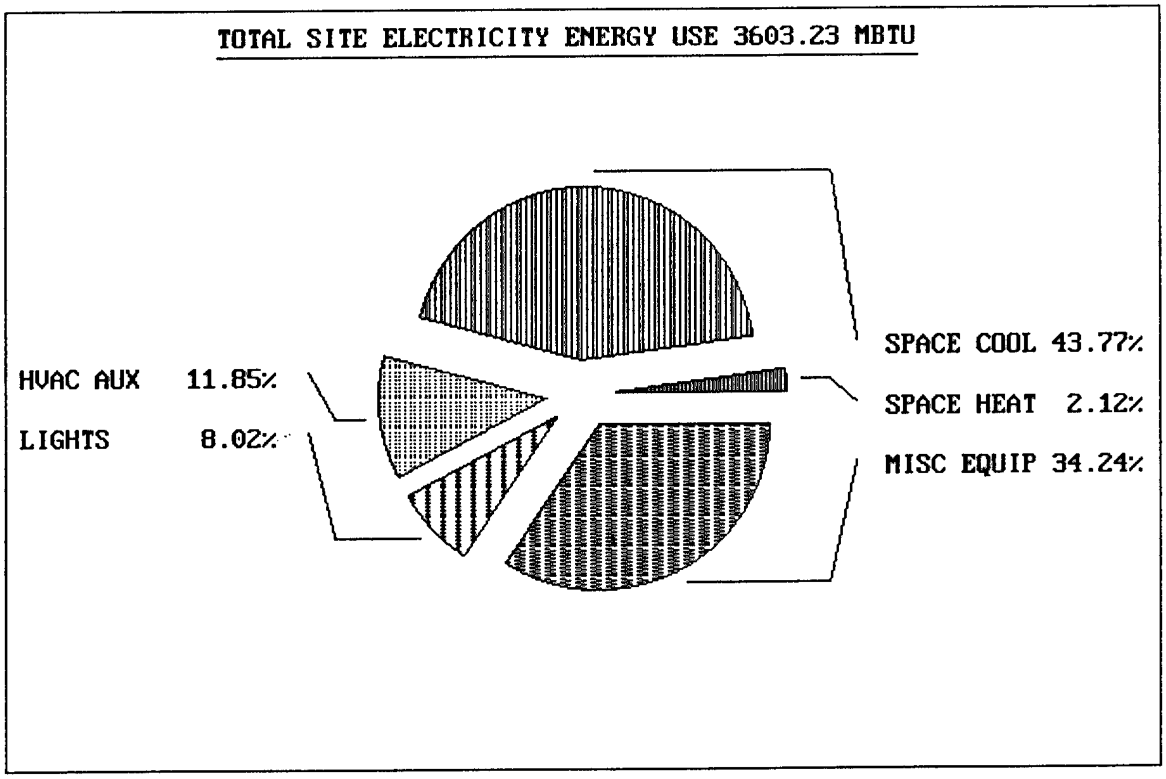

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	64.96
SPACE COOL	1572.27
HVAC AUX	426.82
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3586.79

```
TOTAL SITE ENERGY     3586.71 MBTU   314.7 KBTU/SQFT-YR GROSS-AREA   314.7 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY   3586.71 MBTU   314.7 KBTU/SQFT-YR GROSS-AREA   314.7 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.5
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =100.0
NOTE  ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
      ON THE YEARLY DEMAND.  ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.
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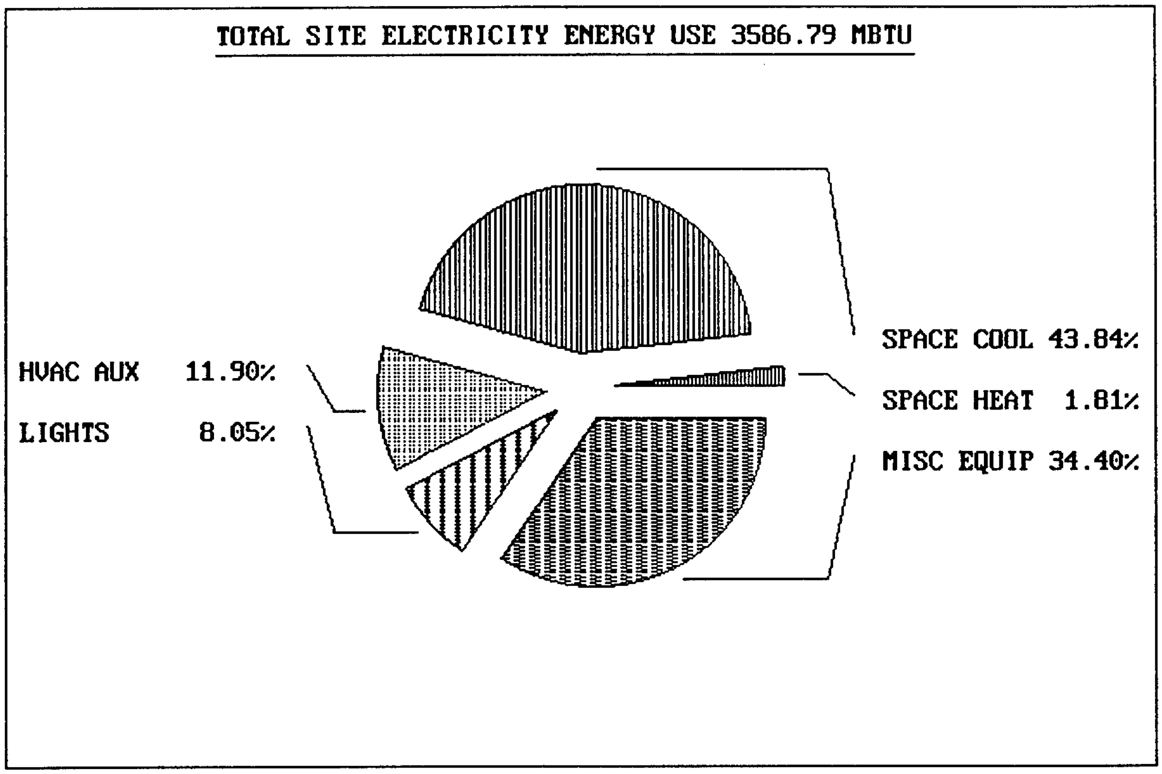
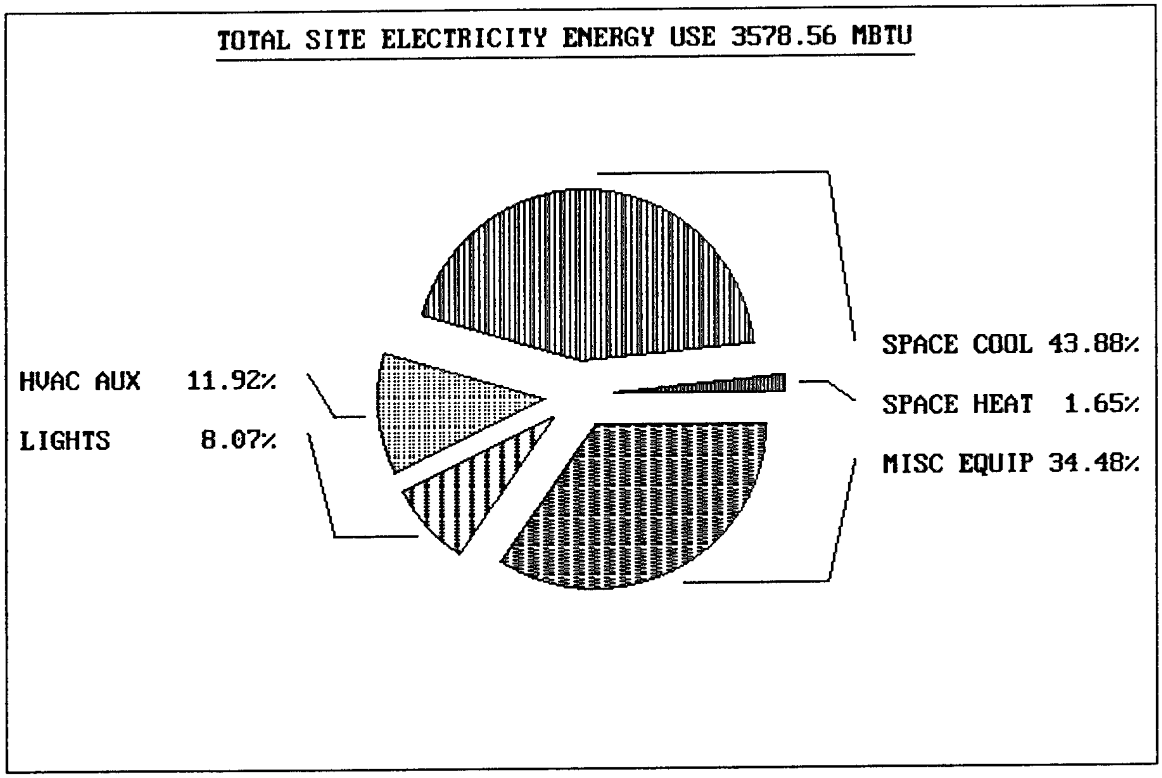


ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	58.92
SPACE COOL	1570.20
HVAC AUX	426.70
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3578.56

TOTAL SITE ENERGY 3578.48 MBTU 313.9 KBTU/SQFT-YR GROSS-AREA 313.9 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 3578.48 MBTU 313.9 KBTU/SQFT-YR GROSS-AREA 313.9 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED =100.0
NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.



ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	55.12
SPACE COOL	1568.95
HVAC AUX	426.63
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3573.45

```
TOTAL SITE ENERGY      3573.36 MBTU    313.5 KBTU/SQFT-YR GROSS-AREA     313.5 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY    3573.36 MBTU    313.5 KBTU/SQFT-YR GROSS-AREA     313.5 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                 =100.0
NOTE  ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
      ON THE YEARLY DEMAND.  ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.
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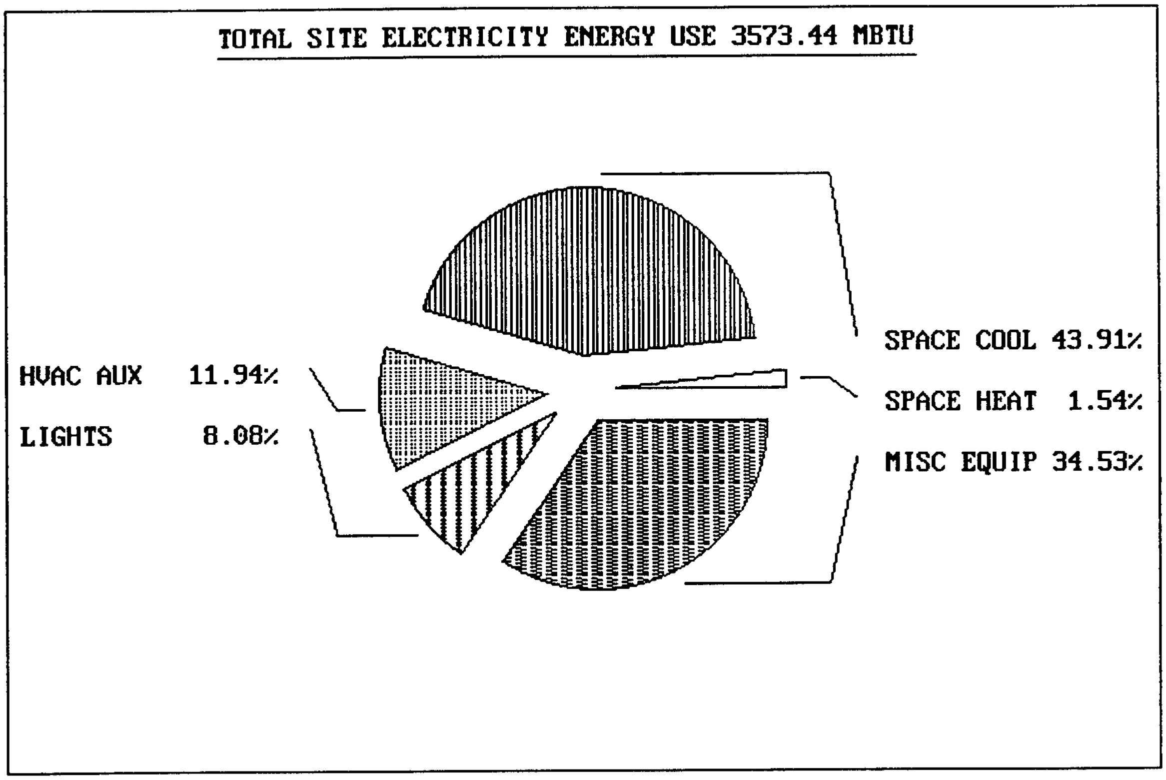
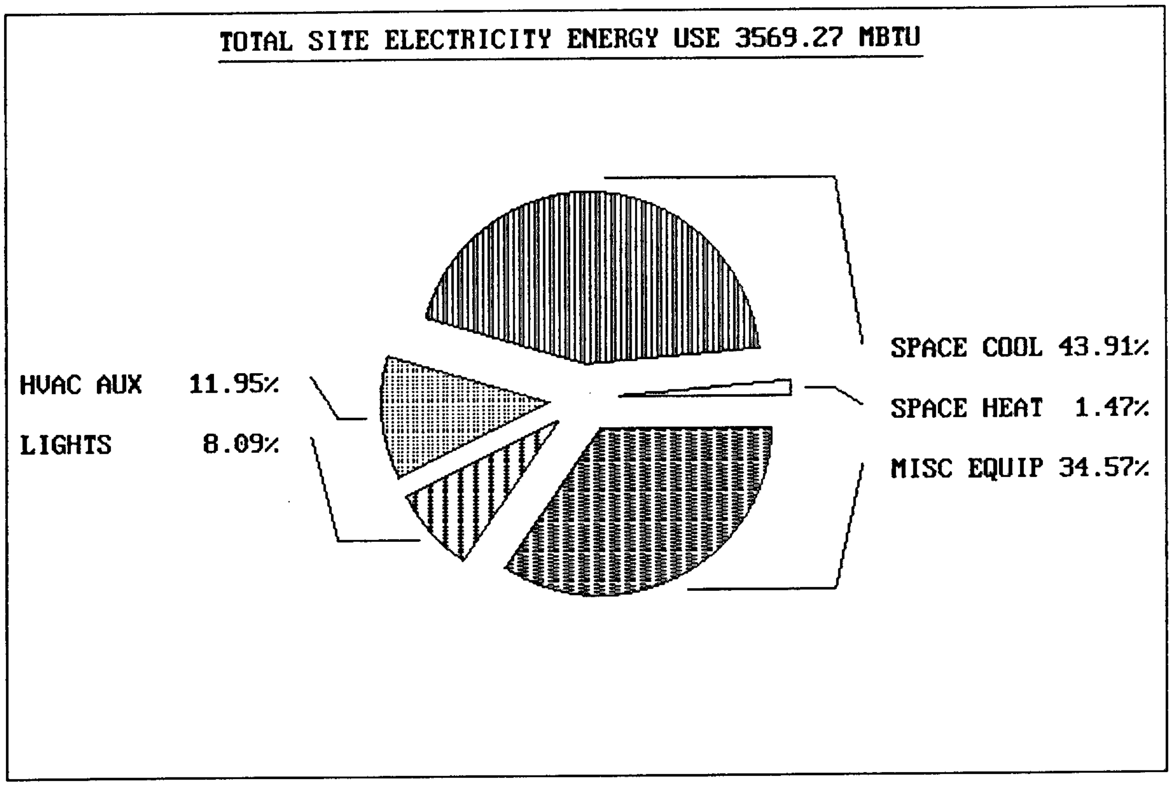


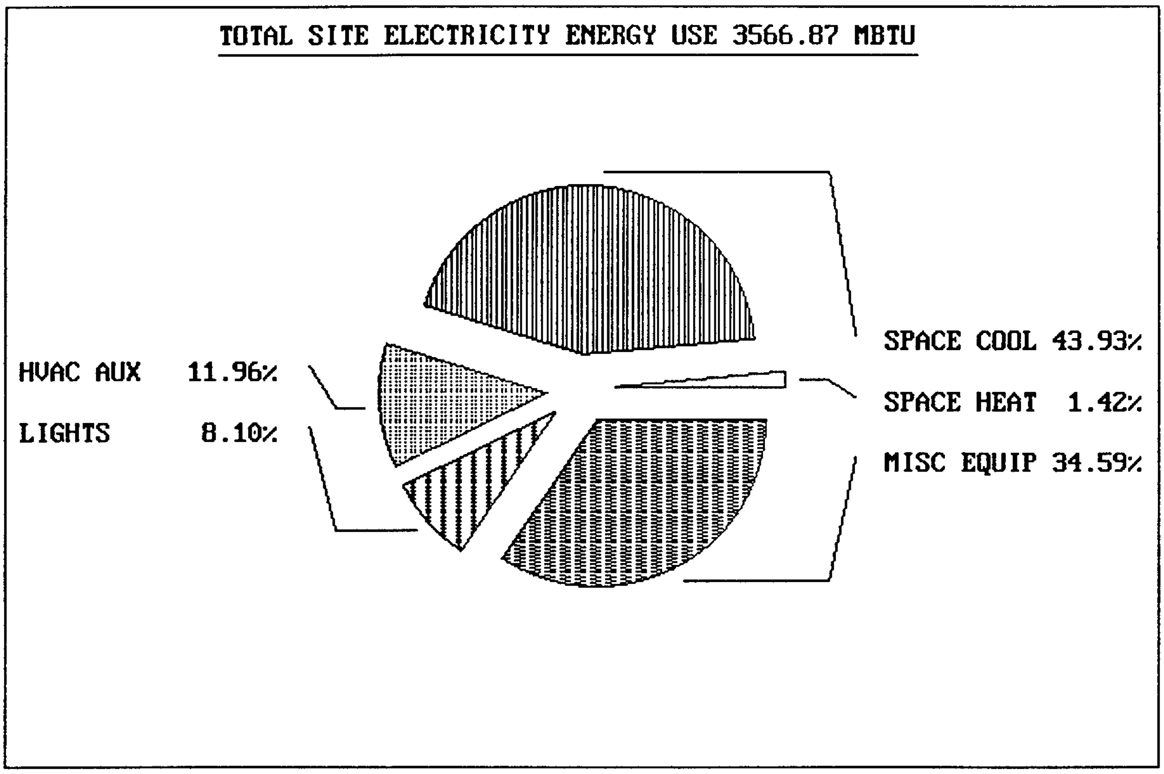
ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	52.53
SPACE COOL	1567.42
HVAC AUX	426.59
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3569.28

TOTAL SITE ENERGY 3569.18 MBTU 313.1 KBTU/SQFT-YR GROSS-AREA 313.1 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 3569.18 MBTU 313.1 KBTU/SQFT-YR GROSS-AREA 313.1 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED =100.0
NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.



ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	50.65
SPACE COOL	1566.93
HVAC AUX	426.55
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3566.86

```
TOTAL SITE ENERGY      3566.78 MBTU    312.9 KBTU/SQFT-YR GROSS-AREA    312.9 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY    3566.78 MBTU    312.9 KBTU/SQFT-YR GROSS-AREA    312.9 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =100.0
NOTE  ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
      ON THE YEARLY DEMAND.  ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.
```



072 200 | Roof & Deck Insulation

Ref	Line	Description	Crew	Daily Output	Man-Hours	Unit	1995 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P
203	1755	3 1/2" thick R25	1 Rofc	1,000	.008	S.F.	.85	.18		1.03	1.26
	1765	Tapered for drainage	↓	1,400	.006	B.F.	.41	.13		.54	[illegible]
	1900	Extruded Polystyrene									
	1910	15 PSI compressive strength, 1" thick R5	1 Rofc	1,500	.005	S.F.	.29	.12		.41	.54
	1920	2" thick R10		1,250	.006		.52	.14		.66	.83
	1930	3" thick R15		1,000	.008		.73	.18		.91	1.12
	1932	4" thick R20		1,000	.008	↓	.97	.18		1.15	1.39
	1934	Tapered for drainage		1,500	.005	B.F.	.34	.12		.46	.59
	1940	25 PSI compressive strength, 1" thick R5		1,500	.005	S.F.	.31	.12		.43	.56
	1942	2" thick R10		1,250	.006		.57	.14		.71	.89
	1944	3" thick R15		1,000	.008		.83	.18		1.01	1.23
	1946	4" thick R20		1,000	.008	↓	1.09	.18		1.27	1.52
	1948	Tapered for drainage		1,500	.005	B.F.	.38	.12		.50	.64
	1950	40 PSI compressive strength, 1" thick R5		1,500	.005	S.F.	.36	.12		.48	.62
	1952	2" thick R10		1,250	.006		.68	.14		.82	1.01
	1954	3" thick R15		1,000	.008		1	.18		1.18	1.42
	1956	4" thick R20		1,000	.008	↓	1.32	.18		1.50	1.77
	1958	Tapered for drainage		1,400	.006	B.F.	.48	.13		.61	.76
	1960	60 PSI compressive strength, 1" thick R5		1,450	.006	S.F.	.42	.12		.54	.68
	1962	2" thick R10		1,200	.007		.78	.15		.93	1.13
	1964	3" thick R15		975	.008		1.15	.18		1.33	1.60
	1966	4" thick R20		950	.008	↓	1.53	.19		1.72	2.02
	1968	Tapered for drainage		1,400	.006	B.F.	.58	.13		.71	.87
	1970	115 PSI compressive strength, 1" thick R5		1,400	.006	S.F.	.90	.13		1.03	1.22
	1972	2" thick R10		1,150	.007		1.78	.15		1.93	2.24
	1974	3" thick R15		950	.008		2.65	.19		2.84	3.26
	1976	4" thick R20		900	.009	↓	3.53	.20		3.73	4.24
	1978	Tapered for drainage		1,400	.006	B.F.	.97	.13		1.10	1.3[illegible]
	2010	Expanded polystyrene, 1#/CF density, 3/4" thick R2.89		1,500	.005	S.F.	.16	.12		.28	[illegible]
	2020	1" thick R3.85		1,500	.005		.16	.12		.28	.40
	2100	2" thick R7.69		1,250	.006		.27	.14		.41	.56
	2110	3" thick R11.49		1,250	.006		.39	.14		.53	.69
	2120	4" thick R15.38		1,200	.007		.50	.15		.65	.82
	2130	5" thick R19.23		1,150	.007		.63	.15		.78	.97
	2140	6" thick R23.26		1,150	.007	↓	.74	.15		.89	1.09
	2150	Tapered for drainage	↓	1,500	.005	B.F.	.28	.12		.40	.53
	2400	Composites with 2" EPS									
	2410	1" Fiberboard	1 Rofc	950	.008	S.F.	.58	.19		.77	.98
	2420	7/16" Oriented strand board		800	.010		.68	.22		.90	1.16
	2430	1/2" Plywood		800	.010		.72	.22		.94	1.20
	2440	1" Perlite	↓	800	.010	↓	.60	.22		.82	1.07
	2450	Composites with 1 1/2" polyisocyanurate									
	2460	1" Fiberboard	1 Rofc	800	.010	S.F.	.70	.22		.92	1.18
	2470	1" Perlite		850	.009		.72	.21		.93	1.17
	2480	7/16" Oriented strand board	↓	800	.010	↓	.82	.22		1.04	1.31

072 400 | Exterior Insulation

Ref	Line	Description	Crew	Daily Output	Man-Hours	Unit	Mat.	Labor	Equip.	Total	Total Incl O&P
401	0010	SANDWICH PANELS See division 061-281									
402	0010	EXTERIOR INSULATION FINISH SYSTEM									
	0100	Field applied, 1" EPS insulation	J-1	295	.136	S.F.	1.46	3	.13	4.59	6.70
	0110	2" EPS insulation		295	.136		1.63	3	.13	4.76	6.90
	0120	3" EPS insulation		295	.136		1.80	3	.13	4.93	7.1[illegible]
	0130	4" EPS insulation		295	.136		1.97	3	.13	5.10	7[illegible]
	0140	Premium finish add	↓	1,265	.032	↓	.22	.70	.03	.95	1.43

4.3 ECO 3: LOW EMISSIVITY ROOF COATING

Proposed Modifications: Install a low emissivity roof coating on the outer and underside of the roof in order to reduce the cooling load.

A low emissivity coating on the underside of the roof forms a radiant barrier that restricts the transfer of heat across the airspace. A low emissivity surface does not radiate energy, thus preventing radiant heat transfer. The barrier should be installed shiny side down so that dust will not collect on it and cause its effectiveness to be reduced. It also needs to have an airspace separating the shiny side from other building materials so that it will effectively eliminate the exchange of heat between itself and the other material. This will reduce the amount of heat that is transferred between building components and lessen the cooling load.

The product evaluated is LO/MIT-l, a silver-colored, low emissivity coating that reflects both heat and light. It is a radiant barrier coating that will create a surface emissivity of 0.21 - 0.26 with an 81% - 85% reflectivity. When placed on the outer surface at the roof, the coating reduces solar heat gain.

Existing Conditions: No type of radiant barrier exists now. The roof is a built-up type supported by 4 inches of rigid polystyrene insulation on a metal deck with a suspended acoustic tile ceiling that hangs 4 to 5 feet below the bottom of the roof.

Method of Analysis:

- Information was obtained from several Denver area roofing contractors on various reflective and light-colored roofing materials. The information included technical data on the material's absorptance as well as material and labor costs for installation or application.

- Information was also received from the USAED in Mobile, Alabama, concerning low emissivity roof coatings.

- The DOE2.1d baseline simulation was modified to include the low emissivity coating. The building energy consumption was calculated with the low emissivity coating in-place.

Results: The computer energy simulation revealed that a slight drop occurs in the cooling and heating loads of 3.1 MBtu or 900 kWh annually with a resulting annual energy cost savings of $74.

Item	Baseline (MBtu)	ECO (MBtu)
Heating	55	53
Cooling	1569	1568
HVAC	427	427
Lights	289	289
Misc. Equipment	1234	1234
Total Use (MBtu)	3,574	3,571

Recommendations: A low-emissivity roof coating is not recommended because the savings are too small for this to be a cost-effective ECO.

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	53.31
SPACE COOL	1567.73
HVAC AUX	426.59
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3570.38

```
TOTAL SITE ENERGY       3570.29 MBTU    313.2 KBTU/SQFT-YR GROSS-AREA    313.2 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY     3570.29 MBTU    313.2 KBTU/SQFT-YR GROSS-AREA    313.2 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =100.0
NOTE  ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
      ON THE YEARLY DEMAND.  ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.
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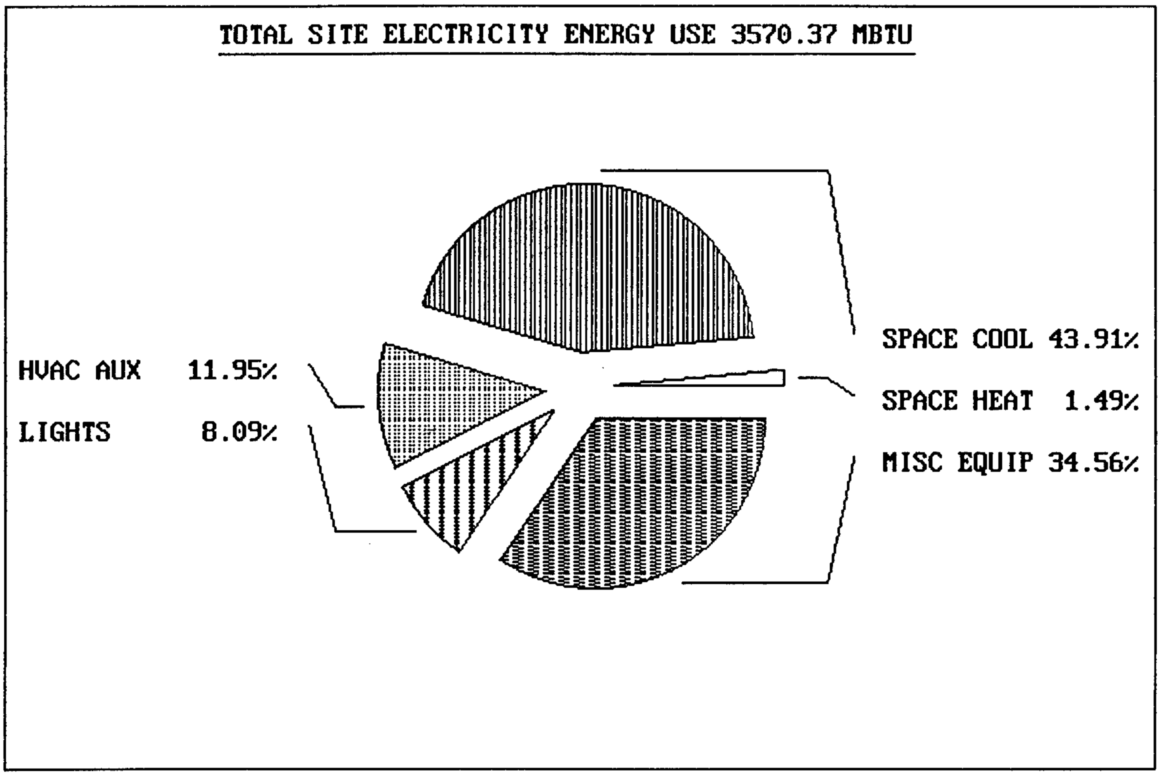

E M C Engineering, Inc.
EMC #1406-008
GEODSS Site, White Sands Missile Range, NM

LIFE CYCLE COST ANALYSIS
LOW EMISSIVITY COATING

ECO-3.XLS
Prepared By: EMS
11/20/95
Checked By:______

Economic Life(Years)	10

Simulation	Energy Consumed (MBTU)	Energy Consumed (kWh)
Baseline Model	3573.45	1047011.40
LowEmissivity Coating	3570.37	1046190.60
Savings	3.08	902.4
Cost Savings		$74,087

Annual Electric Energy Savings (kWh)	902.4
Total Annual Energy Cost Savings	$74,087

Florida Solar Energy Center, Cape Canaveral, (407) 783-0300

LO/MIT-I T.M.

RADIANT BARRIER COATING

For Energy Conservation and Light Reflection

LO/MIT-I is a silver colored, non-thickness dependent, low emissivity coating. Its superb ability to reflect both heat (infrared radiation) and light make it an excellent, low cost substitute for metallic foils or metallized plastic films. High temperature tolerance, excellent adhesion and the ability to produce uniformly low emissivities on a wide variety of substrates make LO/MIT-I unique in the field of high technology coatings.

OPTICAL CHARACTERISTICS

Laboratory application of LO/MIT-I on glass substrates has lowered emissivity from .86 to .22 and increased spectral reflectivity from 7.3% to 85%. LO/MIT-I can be applied to a wide variety of substrates and normally will create a surface emissivity of .21-.26, and a spectral reflectivity of 81%-85%, depending on the substrate used. The chart on the rear of this bulletin shows optical properties on specific materials.

CONSTITUENTS

Aromatic hydrocarbons, aliphatic ketones, proprietary pigments and binders.

SOLVENT

Solsolv 301 or xylene.

VISCOSITY

29 seconds #1 Zahn's cup.

HARDNESS

Extremely strong 3H hardness after 24 hour room temperature cure. Hardness increases with age.

DEGRADATION & OUTGASSING

Unaffected by UV or elevated temperatures. Thermally tolerant to 1000° F (538°C). No outgassing when correctly cured.

COVERAGE

400-800 square feet/gallon, depending on surface and application method.

CLEAN UP

Clean application equipment with Solsolv 301 or Xylene. Use Isopropyl Alcohol for operator clean up and removal from clothing.

MIXING

Coating supplied ready for use. No thinning is required or suggested. Shake well before using. If possible, agitate during application.

SURFACE PREPARATION

Normally, adhesion is the only factor that will be affected by surface preparation. Optical properties will remain constant except on surfaces that are very porous such as brick and cement. To improve optical properties on porous substrates, appropriate fillers and primers may be used to increase surface smoothness. This will also increase coverage. On metallic substrates, such as cold rolled or galvanized steel, that may be subject to possible corrosion or oxidation, appropriate primers should be used before applying LO/MIT-I. Where a surface is already primed or painted, apply a test patch of LO/MIT-I to ascertain that the prepared surface is compatible with the solvents used in LO/MIT-I. Plastics may require surface treatment to increase adhesion and should be tested for compatibility with LO/MIT-I. Most building materials, such as wood, plasterboard, paper faced insulation batts, fibrous ceiling tiles and painted metal roof decking require no surface preparation except that they be clean and dust free. Masonry surfaces should be allowed to cure for one month prior to the application of LO/MIT-I.

Any surface preparation questions not answered in this section should be referred to our Technical Services Department.

APPLICATION

Air Atomization: Use DeVilbiss pressure gun #JGA-502-704-FX; gun pressure of 30 psi (2.11 kg/cm²); tank pressure of 4-6 psi (.14-.42 kg/cm²). Remote paint supply pots should be equipped with an air driven agitator to keep coating thoroughly mixed during application.-OR-DeVilbiss suction gun #JGA-502-43-FF, gun pressure of 25 psi (1.76 kg/cm²). Needle adjustment = ½ open. Hold spray gun 8-14" from work. Spraying at the lower pressure (25-30 psi) indicated will lessen overspray and effect better coverage. Use 2 horsepower or larger compressor.

Airless and Electrostatic: Test airless and electrostatic equipment for compatability with LO/MIT-I before using. Remote paint supply pots should be equipped with an air driven agitator to keep coating thoroughly mixed during application.

Portable Compression Sprayer: The SOLEC Model LS-1 portable compression sprayer is a low cost, self-contained coating application device for the field application of LO/MIT-I to roof decks, cinder block walls, attics, or new construction where power is unavailable. Ask for Bulletin LS-1.

Brush and Roller: LO/MIT-I may also be applied using a solvent resistant paintbrush or roller. However, coverage may be substantially reduced.

Note: Good ventilation is necessary for operator safety and drying and curing of the applied coating.

DRYING AND CURE

Coating will skin dry within one minute after application. Drying to touch will generally occur within 15 minutes to one hour depending on ambient temperature and humidity. Curing can be accelerated by application of heat up to 500°F (260°C) for 4 to 30 minutes. Experimentation will determine the best curing procedures for your particular environment.

STORAGE

Keep at room temperature in tightly sealed container. Keep out of direct sunlight to avoid pressure increase in container. Full containers will remain usable for 1 year from date of manufacture.

CAUTION

Contains flammable solvents. Do not expose to elevated heat or open flames. Use with adequate ventilation and avoid excessive breathing of vapor or spray mist. Avoid contact with eyes. OSHA regulations, Sections 1915.24—Painting, 1915.25—Flammable Liquids and 1915.82—Respiratory Protection give additional helpful safety suggestions.

FIRST AID

Remove from skin using isopropyl alcohol and warm soapy water. In case of contact with eyes, flush with clean water for at least 15 minutes and get medical attention. If swallowed, get immediate medical attention. If headache, dizziness or nausea result from excessive inhalation of vapors, remove to fresh air and administer oxygen if necessary.

SOLAR ENERGY CORPORATION, BOX 3065, PRINCETON, NJ 08543-3065, U.S.A.

PACKAGING

Steel containers. Quarts, gallons, 5 gallon tight head pails. Weights including containers: Quart (.95 liters) = 2.5 lbs. (1.13 kilos), Gallons (3.79 liters) = 8.2 lbs. (4.24 kilos), 5 gallons (18.93 liters) = 42.5 lbs. (21.66 kilos).

ORDERING AND PRICING INFORMATION

Contact factory at 609-883-7700 for name of your local distributor, pricing and availability. F.O.B. Ewing, N.J. Shipping and packaging extra. Available for export.

Terms: Net 30 days for D&B rated firms.

U.S. GOVERNMENT PURCHASERS:

LO/MIT-I is available through GSA: Contract #TFTC-89-CK-NIIS-01 effective 7/1/89–Section Heading: 80 Brushes, Paint, Sealers & Adhesives. GSA, Proc. Div. (9FTP10-C-M) GSA Center, Auburn, WA 98001.

TECHNICAL SERVICES DEPARTMENT

Contact factory at 609-883-7700, 9-5 pm, EST
or fax 609-497-0182, 24 hours a day.

ACCESSORIES & ADDITIONAL PRODUCTS

LS-1, Modified Compression Sprayer, a low cost, self-contained, coating application device.
SOLKOTE HI/SORB-II, spray applied selective coating.
SOLKLEAN 101, Production metal cleaner.
SOLKLEAN 201, Water based aluminum conversion coating.
SOLSOLV 301, Low cost replacement solvent for Xylene.
ISOPROPYL ALCOHOL, For clean-up of LO/MIT-I coatings.

IMPORTANT NOTICE TO PURCHASER

This bulletin is an introductory summary of LO/MIT-I Radiant Barrier Coating. The information provided is based upon typical installation conditions and tests we believe to be reliable. However, due to a wide variety of possible use conditions, SOLEC does not guarantee that typical values expressed will necessarily be obtained. The following is made in lieu of warranties, expressed or implied, including merchantability.

Seller's only obligation shall be to replace such quantity of the product proved to be defective. Seller shall not be liable for any injury, loss or damage, direct or consequential, arising out of the use of or inability to use the product. Before using, user shall determine the suitability of the product for their intended use, and user assumes all risk and liability whatsoever in connection therewith.

No statement or recommendation shall have any force or effect unless in an agreement signed by officers of seller and user.

RESEARCH FACILITIES

The Solar Energy Corporation maintains a complete laboratory for the analysis of optical coatings. Our low cost services for the analysis of optical surfaces are used by many large manufacturers. Please contact us for prices.

LO/MIT/NOTES

The Solar Energy Corporation maintains a continuing research program in spray applied optical surfaces. Pertinent data is published in the form of bulletins called LO/MIT/NOTES. These bulletins are available, free to our customers and other interested parties. Please write us to have your name placed on our mailing list.

OPTICAL PROPERTIES OF SELECTED SUBSTRATES

Substrate	Emissivity Before LO/MIT Applied	Emissivity After LO/MIT Applied	Diffuse Reflectivity Before LO/MIT Applied	Diffuse Reflectivity After LO/MIT Applied
brick (red clay)	.92	.36	36%	71%
cement block	.93	.37	32	86
glass (soda lime)	.86	.22	7.3	85
galvanized steel (bright)	.03	.25	77	84
galvanized steel (dull paint lock)	.57	.26	15	82
paper (kraft)	.80	.24	48	81
plasterboard	.90	.21	55	85
plywood	.72	.22	46	81
poly carbonate (clear)	.84	.22	8.8	84
polypropylene (opaque)	.90	.23	8.1	84
steel, cold rolled, primed	.87	.25	22	83
steel, cold rolled, unprimed	.10	.23	57	84
steel, 316 stainless	.19	.23	59	84

LO/MIT-I Application Ideas

Aircraft
LO/MIT-I is extremely lightweight (less than .05 oz./ft²). It may be effectively used as a heat shield on many aircraft components including wiring harnesses, cowlings, fire walls and electronic components. It is also an excellent coating for balloon fabrics.

Automotive
LO/MIT-I may be used as a low cost, lightweight heat shield on many automotive components including wiring harnesses, battery boxes, exhaust systems, air conditioning ducts, fire walls, intake manifolds, fuel pumps, rubber hoses, shock absorber boots, floor pans, electronic and plastic components.

Building and Construction
LO/MIT-I is a low cost substitute for metallic or metallized plastic foils. Wherever these products are used for energy conservation in new or retrofit construction, spray application of LO/MIT-I will generally prove to be as effective at half the cost. In many instances, where it may be impractical to staple or tack reflective radiant barriers, LO/MIT-I may be easily spray applied.

Daylighting
Since LO/MIT-I exhibits a high diffuse reflectivity on many building materials, it may be effectively used to enhance daylighting and lower illumination costs.

Energy Conservation
The use of LO/MIT-I on ceiling and wall surfaces can result in substantial heating and cooling energy savings. (See Radiant Barriers, Building and Construction, Metal Buildings.) Also, in factory buildings and warehouses, the application of LO/MIT-I to interior ceiling surfaces may raise winter radiant temperatures and increase ceiling reflectivity, thereby lowering both heating and lighting costs.

Metal Buildings
LO/MIT-I, when applied to the exterior of metal buildings, has been known to lessen building skin temperatures in excess of 30°F (16°C) in 95°F (35°C) ambient environments. This can lead to substantial decreases in heating and air conditioning costs.

Ovens, Process Piping, Power Generation Equipment
LO/MIT-I when applied to the exterior surfaces of boilers, ovens or high temperature process piping can effectively block thermal radiation and may lead to substantial efficiency increases.

Plastics
Whenever plastics are subjected to elevated temperatures, surface application of LO/MIT-I may lessen degradation due to adverse thermal environments. In many cases, lower cost and lower weight plastics may be used when they are coated with LO/MIT-I.

Radiant Barriers
Recent tests by the Florida Solar Energy Center (FSEC) indicate that the role of radiant heat transfer, particularly in hot sunny climates, may be much more important than recently recognized. In these climates, heat gain prevention is often more critical to the energy performance of a building than stopping heat loss. Application of LO/MIT-I to the undersides of roofs and cavity wall surfaces creates an extremely effective radiant barrier that may lead to substantial energy savings at lower installed per square foot costs than aluminum foil or metallized plastic films.

Reflectors
LO/MIT-I exhibits excellent diffuse reflectivity on many substrates. It may be used as a low cost reflective surface in lighting fixtures, control panels and many other applications where reflectivity is needed.

Roof Coating
LO/MIT-I will lower roof skin temperatures 20-40°F. It is unaffected by UV radiation and highly reflective to infrared. It will greatly extend roof life and may be brushed, rolled or spray applied to bitumen, PVC, rubber, asphalt, tar and gravel, foam, shingle, tile, steel and most other roofing surfaces. It is hydrophobic and tends to be self-cleaning. Field testing in Southern climates has shown energy savings from 15% to in excess of 30% when LO/MIT-I is used as a reflective roof coating.

Selective Surfaces
High emissivity surfaces such as glass or cement, when coated with LO/MIT-I, exhibit low emissivities of .22-.30. By overcoating the LO/MIT-I surface with SOLKOTE Hi/Sorb-II spray applied selective coating, a semi-selective surface exhibiting emissivities of .42-.50 and absorptivities of 95 to 97% may be achieved. At an installed cost of 12 to 17 cents per square foot, substantial cost savings can be achieved over the use of selective metal foils.

4.4 ECO 4: T-8 FLUORESCENT LIGHTING

Proposed Modifications: Install high-efficiency T-8 fluorescent lamps driven by high frequency electronic ballasts into existing fixtures..

T-8 fluorescent lamps use rare earth phosphors to increase the lumen efficiency of the lamp. T-8 fluorescent lamps will not operate off standard or energy-saving magnetic ballasts, although there is a rapid-start magnetic ballast available specifically designed for T-8 fluorescent lamps. However, T-8 fluorescent lamps are most effective when used with high frequency, electronic ballasts which increase lumen efficiency in addition to minimizing ballast energy consumption.

Existing Conditions: Fluorescent lighting fixtures in the building are equipped with standard 40 Watt lamps and Magnetek magnetic ballasts.

Method of Analysis:

- The number and type of lighting fixtures in the building were tabulated during the field survey. They were used to develop input data for the Baseline energy simulation program and as a basis for cost estimates. Existing lighting fixture wattage was estimated based on fixture manufacturer's data.

- Lighting schedules were obtained from building managers at the time of the field survey.

- Lighting fixture wattage for T-8 fluorescent lamps and ballasts was estimated from lamp manufacturer's data. Total lighting electrical use with the T-8 fluorescent lighting modification was computed for the building.

- Annual electric energy savings were calculated by modifying the Baseline DOE2.1d computer simulation with the T-8 fluorescent lighting parameters, and subtracting the modified baseline computer simulation from the baseline computer simulation. The DOE2.1d model automatically calculates reductions in cooling loads and increases in heating loads to give an overall energy savings with the T-8 fluorescent lighting in-place.

- Any fixtures that are presently delamped remained delamped in the computer simulations.

- Use of T-8 fluorescent lighting will result in an estimated 3% reduction in lumen output.

- Added annual maintenance costs were calculated based on a rated life of 20,000 hours for existing F-40D lamps and new T-8 fluorescent lamps. Maintenance costs for ballasts were based on a rated life of 60,000 hours.

- Lamp costs were provided by Conserve-a-Watt. Unit lamp costs for existing F-40D lamps and T-8 four-foot straight fluorescent lamps were $1.68 and $4.90, respectively.

Results: The energy savings and economic results are summarized in the following table. The LCCA is presented on page 4-31. The T-8 fluorescent lamps can be installed with a project SIR of 3.31, a simple payback of 3.6 years, and an annual savings of $2,418.

Annual Electric Energy Savings (kWh)	29,455
Total Annual Energy Cost Savings	$2,418
Annual Maintenance Cost Savings	$47
Investment Cost	$12,429
Savings-to-Investment Ratio (SIR)	2.38
Simple Payback (Years)	5.0

Recommendations: This ECO is recommended for implementation. High-efficiency T-8 fluorescent lamps driven by high frequency electronic ballasts are recommended for the building.

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	69.45
SPACE COOL	1547.35
HVAC AUX	426.10
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	196.29
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3473.05

```
TOTAL SITE ENERGY      3473.00 MBTU    304.7 KBTU/SQFT-YR GROSS-AREA    304.7 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY    3473.00 MBTU    304.7 KBTU/SQFT-YR GROSS-AREA    304.7 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.5
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =100.0
NOTE  ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
      ON THE YEARLY DEMAND.  ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.
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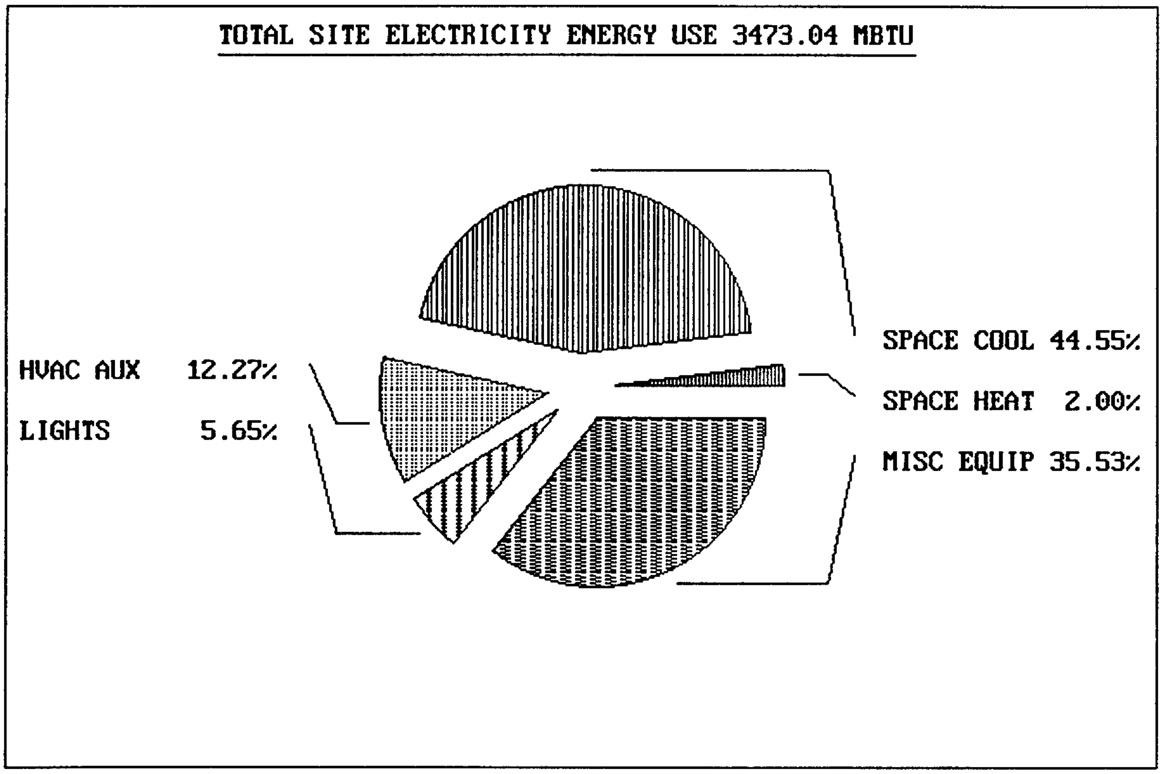


1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Nov-95
3. INSTALLATION AND LOCATION GEODSS Site, White Sands Missile Range, NM		
4. PROJECT TITLE ECIP: Upgrade Lighting Systems		5. PROJECT NUMBER 1406.008

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

LOCATION: GEODSS Site, White Sands Missile Range, NM REGION: 4 PROJECT NO: 1406.008
PROJECT TITLE: ECIP: UPGRADE LIGHTING SYSTEMS FISCAL YEAR: 1995
DISCRETE PORTION NAME: TOTAL
ANALYSIS DATE: 11/09/95 ECONOMIC LIFE: 15 PREPARED BY: E. Smith

1. INVESTMENT

A. CONSTRUCTION COST		=	$11,098	
B. SIOH COST	(6.0% of 1A)	=	$666	
C. DESIGN COST	(6.0% of 1A)	=	$666	
D. TOTAL COST	(1A +1B +1C)	=	$12,429	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		=	$0	
F. PUBLIC UTILITY COMPANY REBATE		=	$0	
G. TOTAL INVESTMENT	(1D -1E -1F)	=	------->	$12,429

2. ENERGY SAVINGS (+) OR COST (-):
DATE OF NISTR-4942-1 USED FOR DISCOUNT FACTORS: JUL '95

ENERGY SOURCE	FUEL COST $/kWh (1)	SAVINGS kWh (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. ELECT	$0.0821	29,455	$2,418	12.02	$29,067	
B. DIST	$0.00	0	$0	-	$0	
C. NAT GAS	$0.00	0	$0	-	$0	
D. REFUS	$0.00	0	$0	-	$0	
E. COAL	$0.00	0	$0	-	$0	
F. OTHER			$0	-	$0	
G. DEMAND SAVINGS		0	$0	-	$0	
H. TOTAL		29,455	$2,418		-------->	$29,067

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

A. ANNUAL RECURRING (+/-) $47
1 DISCOUNT FACTOR (From Table A) = 11.94
2 DISCOUNTED SAVINGS (+) / COST (-) (3A x 3A1) = $560

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE B)	DISCOUNTED SAVINGS/COST (4)
a. MATERIAL: NONE	$0	0	0.00	$0
b. MATERIAL: NONE	$0	0	0.00	$0
c. MATERIAL: NONE	$0	0	0.00	$0
d. TOTAL	$0			$0

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-) (3A2 + 3Bd4) = $560

4. FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bd1/Economic Life))	$2,465
5. SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	5.04
6. TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$29,628
7. DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	2.38

ENGINEER'S OPINION OF PROBABLE COST			SHEET 1 OF 1
AREA	ACTIVITY	LOCATION White Sands Missile Range, NM	AMENDMENT NO.
PROJECT TITLE T-8 Lighting Installation GEODSS, Energy Conservation Survey		CONTRACT NO. DACA01-94-D-0033	

Line No.	Item Description	Unit of Measure	No. of Units	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Manhrs/ Unit	LABOR COST Total Manhrs	LABOR COST Labor Cost/ Manhour	LABOR COST Total Labor Cost	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	Replace lamps	ea	294	$4.90	$1,441	0.08	24.50	$18.50	$453	$0.00	$0	$6.44	$1,894
2	Replace ballasts	ea	147	$15.15	$2,227	0.08	12.25	$18.50	$227	$0.00	$0	$16.69	$2,454
3	Travel to Socorro	hrs	6		$0	1.00	6.00	$18.50	$111	$0.00	$0	$18.50	$111
4	Travel to job site	hrs	4		$0	1.00	4.00	$18.50	$74	$0.00	$0	$18.50	$74
5	Travel to lamp disposal site	hrs	2		$0	1.00	2.00	$18.50	$37	$0.00	$0	$18.50	$37
6	Load old lamps in truck	hrs	2		$0	1.00	2.00	$18.50	$37	$0.00	$0	$18.50	$37
7	Lodging and per diem	days	5		$0		0.00	$18.50	$0	$100.00	$500	$100.00	$500
8	Milage	miles	600		$0		0.00	$18.50	$0	$0.30	$180	$0.30	$180
9					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
10					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
11					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
12					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
13					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
14					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
15					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
16					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
17					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
18					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
19					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
20					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
21					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
22					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
23					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
24					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
25					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
26					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
27					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
28					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
29					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
30					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
31					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
32					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
33					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
34					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
35					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
36					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
37					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
38					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
39	**SUBCONTRACTOR SUBTOTAL**				$3,668		$51		$939		$680		$5,287
40	LABOR BURDEN	%	30		$0				$282		$204		$486
41	SUBTOTAL				$3,668				$1,221		$884		$5,772
42	OVERHEAD	%	12.0		$440				$146		$106		$693
43	SUBTOTAL				$4,108				$1,367		$990		$6,465
44	PROFIT	%	12		$493				$164		$119		$776
45	**SUBCONTRACTOR TOTAL**				$4,601				$1,531		$1,109		$7,241
46	OVERHEAD	%	10.95		$504				$168		$121		$793
47	SUBTOTAL				$5,104				$1,699		$1,230		$8,033
48	PROFIT	%	8		$408				$136		$98		$643
49	SUBTOTAL				$5,513				$1,835		$1,329		$8,676
50	BOND	%	0.737		$41				$14		$10		$64
51	SUBTOTAL				$5,553				$1,848		$1,339		$8,740
52	N. M. TAX	%	5.8125		$323				$107		$78		$508
53	SUBTOTAL				$5,876				$1,956		$1,416		$9,248
54	CONTINGENCY	%	20		$1,175				$391		$283		$1,850
55	**GRAND TOTAL**				$7,052				$2,347		$1,700		$11,098

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
EMS		E M C Engineers, Inc.	11/22/95

LIFE CYCLE COST ANALYSIS

T-8 LAMPS
BALLASTS

Economic Life (yrs)
15

	0
Building No.	34568

Investment Costs

Construction Cost	$11,098
SIOH (6.0%)	$666
Design Cost (6.0%)	$666
Salvage Value of Existing Equipment	$0
Public Utility Company Rebate	$0
Total Investment	$12,429

Current Situation (Baseline) Annual Energy Use

Lights	288.88
Space Cool	1,568.95
Space Heat	55.12
HVAC Aux	426.63
Misc. Equip	1,233.86
Total (MBtu)	3,573.44
Electric Energy (kWh)	1,047,008

Proposed Situation Annual Energy Use with ECO

Lights	196.17
Space Cool	1,547.35
Space Heat	69.45
HVAC Aux	426.10
Misc. Equip	1,233.84
Total (MBtu)	3,472.91
Electric Energy (kWh)	1,017,553

Annual Energy Savings

Electric Energy (kWh)	29,455

Annual Energy Cost Savings

Electric Energy	$2,418
Electric Demand	$0
Total Annual Energy Cost Savings	$2,418

Discount Factors

Electric Energy	12.02

Discounted Energy Cost Savings

Electric Energy	$29,067

Non-Energy Savings(+)/Cost(-)

Existing Annual Ballast Replacement Cost Savings	$353
Lamp Replacement Cost Savings	($306)
Annual Recurring Savings(+)/Cost(-)	$47
Discount Factor	11.94
Discounted Non-Energy Savings(+)/Cost(-)	$560

Life Cycle Cost Summary

Simple Payback (yrs)	5.0
Total Net Discounted Savings	$29,628
Savings to Investment Ratio (SIR)	2.38
Adjusted Internal Rate of Return (AIRR)	10.2%

LIFE CYCLE COST ANALYSIS

T-8 LAMPS
BALLASTS

Building No.	34568

Energy Type	Unit Energy Cost	UPW Discount Factors (1) Region 4		
Economic Life of ECO (yrs)		10	15	20
Electric Energy	0.0821 ($/kWh)	8.58	12.02	15.08
Electric Demand	0 ($/kW)	0	0	0
Annual Recurring Non-Energy Savings		8.53	11.94	14.88

(1) NISTIR 4942-1 Energy Prices and Discount Factors for Life-Cycle Cost Analysis 1995

DESCRIPTION	LAMP TYPE	NO. LAMPS	LAMP WATTS	EXISTING FIXTURE WATTS	T-8 FIXTURE WATTS
4' RECESSED FLUORESCENT	FLUOR	2	40	89	58

ber of Fixtures

4' RECESSED FLUORESCENT-2 LAMP	147

Annual Operating Hours Calculation

Baseline Lighting Electric Demand (kW)	13.1
Baseline Lighting Electric Energy (kWh)	84,641
Annual Operating Hours	6,470

Replacement of Lamps

Number of Lamps 4' Straight Tube	294
Lamp Life	20,000
Lamp Replacements per Year	95
Replacement Cost Per Lamp	$6.44
Incremental Replacement Cost per Lamp	$3.22
Incremental Annual Lamp Replacement Cost	$306
Total Annual Lamp Replacement Cost Savings	($306)

Replacement of Existing Ballasts

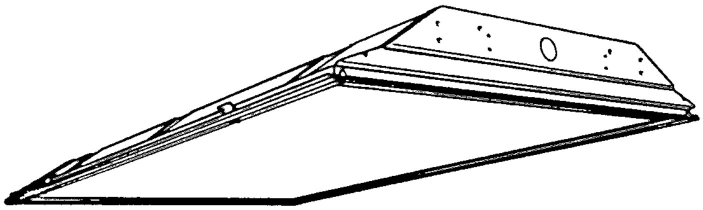
Number of Ballasts	147
Ballast Life (hrs)	60,000
Ballast Replacements Per Year	16
Replacement Cost Per Ballast	$15.15
Labor Hours Per Ballast	0.33
Labor Cost Per Ballast	$7.13
Total Annual Ballast Replacement Cost	$353

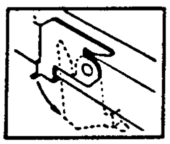
Replacement of New Ballasts

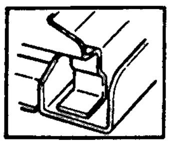
No replacement for first 15 years.

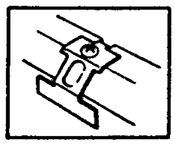
GRID TROFFER
2' x 4' • 2 LAMPS • RAPID START | **2GT 240**

FEATURES




OPPOSING CAM LATCHES


INTERLOCKING CORNERS


STURDY T-HINGES

- Opposing, rotary-action cam latches for secure door closing. Latches finished after fabrication with smooth, durable, white nylon coating.
- T-hinges die-embossed for maximum strength. Door frame can be hinged or latched from either side.
- Door frame corners screwed together for rigidity —ensures tight fit and easy lens replacement.
- Full-depth end plates secured by screws and unique interlocking corner detail.
- Shielding media completely framed in all door types. Diffusers 100% UV-stabilized acrylic plastic except as noted.
- Urethane foam gasket seals fully between door frame and housing—eliminates light leaks.
- Pressure-lock lampholders secured by snap-in socket track for simplified maintenance.

SPECIFICATIONS

Ballast

Thermally-protected, resetting, Class P, HPF ballast standard. Sound rating A, CBM/ETL certified, UL listed. Advance, GE or Universal installed unless otherwise specified.

Wiring & Electrical

AWM, TFN or THHN wire used throughout, rated for required temperatures. All ballast leads extend minimum of 6" through access plate.
Input watts: standard 89, energy-saving 69.

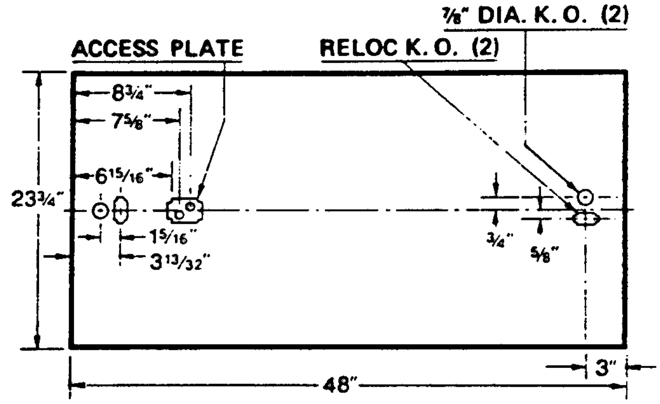
Materials

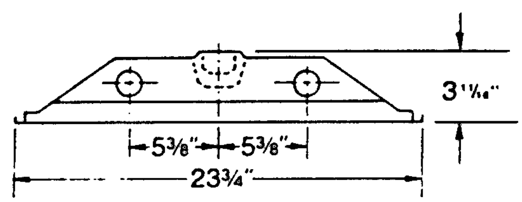
Metal parts die-formed from heavy-gauge steel. Housing die-embossed for added rigidity. Metal gauges: channel and end plates 22-gauge; steel door frame 20-gauge; channel cover and socket track 24-gauge.

Finish

Five-stage, iron-phosphate pretreatment ensures superior paint adhesion and rust resistance. High-gloss, baked white enamel finish (88% gloss, 86% reflectance). Salt spray test 250 hours. Hardness minimum 2H.

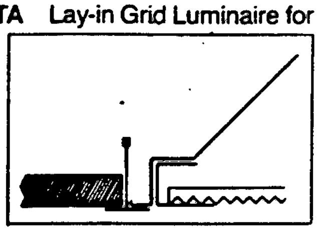
UL listed and labeled I.B.E.W.—A.F. of L.
Fixture guaranteed for one year against mechanical defects in manufacture.



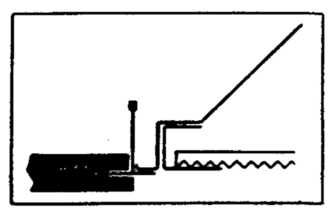


Dimensions and specifications subject to change without notice.

MOUNTING DATA Lay-in Grid Luminaire for use in:


Exposed Grid Tee Ceilings

Minimum 5 5/8" plenum depth required for installation


Concealed Grid Tee Ceilings

Approval

Job Information

LITHONIA®

SHEET 2GT 240

2GT 240

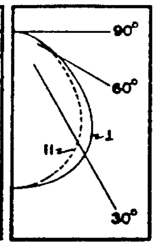
GRID TROFFER
2′ x 4′ • 2 LAMPS • RAPID START

PHOTOMETRICS

2GT 240 A12*

COEFFICIENTS OF UTILIZATION — ZONAL CAVITY

Pfc	20%													
Pcc	80%				70%				50%			30%		
Pw	70%	50%	30%	10%	70%	50%	30%	10%	50%	30%	10%	50%	30%	10%
1	85	81	78	76	82	80	77	75	76	74	72	73	72	70
2	78	72	68	64	76	71	67	63	68	65	62	66	63	60
3	72	65	59	55	70	64	58	54	61	57	53	59	56	53
4	66	58	52	47	65	57	51	47	55	50	46	54	49	46
5	61	52	45	41	59	51	45	41	49	44	40	48	43	40
6	56	47	40	36	55	46	40	36	45	39	35	43	39	35
7	52	42	36	31	51	42	36	31	40	35	31	39	34	31
8	48	38	32	27	47	37	31	27	36	31	27	36	31	27
9	44	34	28	24	43	34	28	24	33	27	24	32	27	23
10	41	31	25	21	40	31	25	21	30	25	21	29	24	21



*Standard ballast, F40T12/CW lamps (3150 lumens)

Spacing criteria: II = 1.2 x mounting height; ⊥ = 1.3 x mounting height

Full report available. Request ITL 27058

For photometrics on other configurations, see Technical Data section or Lithonia representative

CANDLEPOWER

ANGLE	ALONG	22.5°	45.0°	67.5°	ACROSS
0	1946	1948	1948	1946	1948
5	1933	1948	1946	1943	1947
10	1909	1925	1927	1933	1941
15	1864	1888	1900	1918	1927
20	1800	1835	1862	1893	1903
25	1709	1756	1798	1844	1852
30	1592	1647	1705	1765	1777
35	1448	1506	1564	1643	1661
40	1273	1327	1381	1475	1497
45	1077	1128	1188	1271	1282
50	877	931	986	1052	1042
55	698	742	774	822	809
60	549	569	579	620	619
65	418	414	399	444	456
70	328	310	272	320	344
75	262	236	204	241	272
80	185	163	142	171	195
85	96	91	69	96	106
90	0	0	0	0	0

ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% FIXTURE
0-30	1550	24 2	31 6
30-60	2586	40 5	52 7
60-90	772	12 0	15 7
0-90	4910	76.7	100 0

TYPICAL VCP PERCENTAGES

ROOM SIZE (FEET)	HEIGHT ALONG 8.5′	HEIGHT ALONG 10.0′	HEIGHT ACROSS 8.5′	HEIGHT ACROSS 10.0′
20 x 20	70	75	68	73
30 x 30	63	67	63	66
30 x 60	55	58	54	57
60 x 30	66	69	65	69
60 x 60	56	59	55	58

ORDERING INFORMATION

Example: 2GT 240 RN A12 120 ES GLR

Explanation of Catalog Number: 2GT 240

Series — 2GT

No. Lamps — 2

Lamp Wattage — 40

VOLTAGE 120 or 277

Others available—consult factory

FRAME TYPE

FLUSH STEEL	FLUSH ALUMINUM	REGRESSED ALUMINUM
(Leave Blank)	FN-Natural FM-Matte black FW-White	RN-Natural RM-Matte black RW-White

Cam-action spring-loaded latch standard on aluminum door frames

DIFFUSER TYPE

A12	#12 pattern acrylic
A12.125	#12 pattern acrylic, .125" thick
A19	#19 pattern acrylic, .156" thick
K20	#20 pattern acrylic, .140" thick
3E	KSH 3-E pattern
IM	Injection-molded acrylic, .150" thick
84Y	Holophane 8224 with overlay
AC	Dropped dish, matte white acrylic

For complete list of lenses and louvers, see OPTIONS AND ACCESSORIES section

OPTIONS

ES	Energy-saving ballasts (Advance Mark III, Universal SLH or GE Maximiser I)
GLR	Internal fast-blow fusing
EL	Self-contained emergency lighting
LP	F40 CW lamps (installed)
SLP	Energy-saving lamps (installed, 34W, full light output, 3050 lumens)
SW	Stretch-Wrap (palletized in cartons)
JP	Job Palletized (uncartoned)
FR	Suitable for UL listed fire-rated ceilings

For details and complete list of options, see OPTIONS AND ACCESSORIES section

FIXTURE SCHEDULE

TYPE	CATALOG NUMBER

REMARKS

LITHONIA®

DIVISION OF LITHONIA LIGHTING
BOX A • CONYERS, GEORGIA 30207 • 404 922-9000

4.5 ECO 5: VORTEX TUBE

Proposed Modifications: The vortex tube cooling system is part of the telescope camera system and can only be modified through redesign of the camera which is beyond the scope of this project. However, the vortex tube cooling system has very poor efficiency and is a major energy user. The cameras are scheduled for replacement in about two years. The purpose of this evaluation is to quantify energy use and energy costs for this system.

Existing Conditions: Each vortex tube in each camera is operated by a separate 5 hp air compressor. The compressors are interconnected in case of a compressor failure. Since the compressors are not fully loaded, the maintenance crew keeps one compressor off-line and uses the other two to provide the air needed to cool the cameras. Even then the compressors are still not operating at capacity.

Flow through the vortex tubes is seasonally adjusted to maintain the desired temperature range in the camera. Compressed air pressure supplied to the vortex tubes are manually adjusted at a throttling valve at each camera. Pressures are varied from 40 to 80 psig.

Based on discussions with building personnel, it was assumed that the compressors operate about 50% of the time between the hours of 3 p.m. and 7 a.m. throughout the year. Under these conditions, the air compressors consume 38,441 kWh annually at an annual cost of $3,156.

Recommendations: It is recommended that the new cameras be cooled with a more efficient cooling system.

Vortex Tube Energy Use

Specifications state that vortex tubes should provide 5 scfm of 0 to 10 degree C air for each camera.

A 5 horsepower air compressor will provide about 18 scfm of 140 psig air.

Building personnel report varying pressures to vortex tubes from 40 to 80 psig depending on the season.

Flow thru orifice given by:

cfm = 31.5 * C * D * D * sqrt(Ro * DP) / Ro

where
cfm is cubic feet per minute at upstream conditions
C is discharge coefficient of 0.6
D is diameter in inches
Ro is upstream density in lbm/ft3
DP is pressure drop across orifice in psia

Orifice diameter (inches) 0.08

Air Properties			Air Flow Calculations	
Pressure (psia)	Pressure (psig)	Density (lbm/ft3)	Flow (cfm)	Flow (scfm)
12.2	0	0.0623	0	0
52.2	40	0.2663	1.4824	6.3371
72.2	60	0.3684	1.5437	9.1279
92.2	80	0.4704	1.5774	11.9107
132.2	120	0.6745	1.6134	17.4676

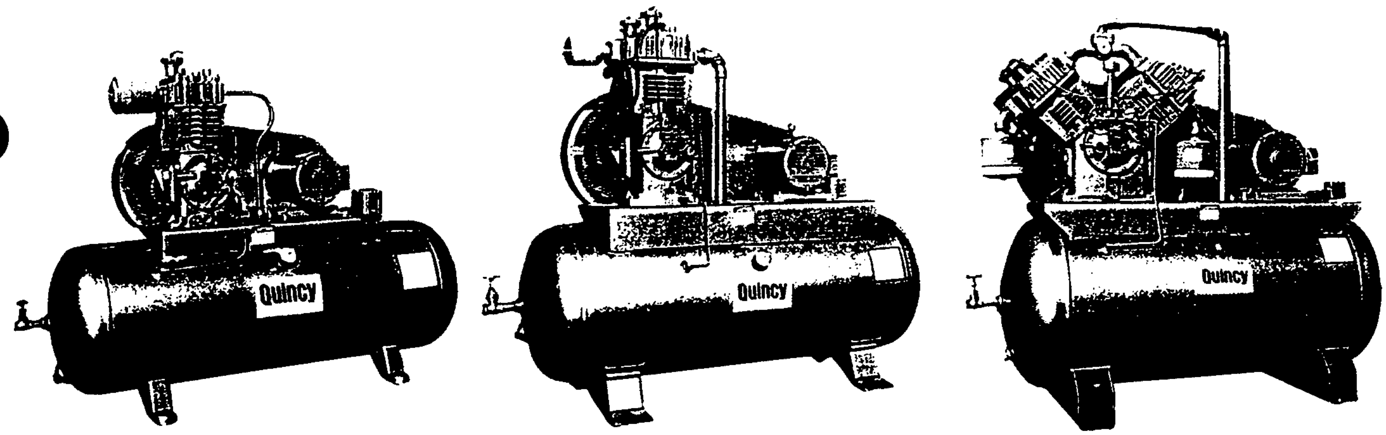
At full load, air compressors draw the following kW:

kW = HP * 0.746 / 0.85 = 4.39

where
HP is motor horsepower
0.746 is conversion to kW
0.85 is motor efficiency

Assume each compressor operates 50% of the time from 3 pm to 7 am, 365 days per year.
Annual operating hours = 5840

Annual electricity use = 3 * kW * hours * 50% =	38,441	kWh
Cost per kWh	0.0821	$/kWh
Annual electricity cost	$3,156	



QR-25 Series Tank Mounted Two-Stage Compressors

Quincy two-stage tank mounted compressors are furnished with Safe-Q-Lube pressure lubrication system. Start-stop mechanism includes Quincy patented loadless starting. Pressure gauge, safety valve, tank drain, shut-off valve, enclosed belt guard, pressure switch and inlet filter are standard equipment. Tanks conform to ASME and National Board specifications for 200 PSI working pressure. Electric motors of the finest quality are standard equipment. Dual control is standard on tank mounted units — 10 HP and larger.

SPECIFICATIONS—PRESSURE LUBRICATED

MODEL	MOTOR OR ENG. H.P.	CU. FT. DISPL. MIN.	CU. FT. FREE AIR MIN.	STD. PRESS. SWITCH SETTING	SIZE BORE & STROKE IN.	OPER. SPEED R.P.M.	REC. SIZE		APPROX. SHIPPING WEIGHT LBS.
							IN.	GAL.	
F310-60	1½ 2	6.90 9.10	4.80 6.30	140-175 140-175	3½ & 2×2½	500 660	20×48	60	560 595
F310-80	1½ 2	6.90 9.10	4.80 6.30	140-175 140-175	3½ & 2×2½	500 660	20×63	80	660 695
F325	3 5	13.90 23.30	10.70 18.00	140-175 140-175	4½ & 2½×3	500 840	20×63	80	765 785
F340	7½	34.30	26.10	140-175	5¼ & 3×3½	780	20×63	80	1185
† F350	10	52.00	37.40	140-175	6 & 3¼×3½	900	24×72	120	1495
† F370	10 15	52.00 69.60	37.40 50.10	120-150 120-150	6 & 3¼×4	790 1070	24×72	120	1600 1670
† F390-120	10 15 20	57.30 78.70 90.00	44.10 60.60 69.30	120-150 120-150 120-150	7½ & 4×4	560 770 870	24×72	120	1920 1970 2000
† F390-200	10 15 20	57.30 78.70 90.00	44.10 60.60 69.30	120.150 120-150 120-150	7½ & 4×4	560 770 870	30×75½	200	2320 2370 2390
†*DF390	10 15 20	57.30 78.70 90.00	44.10 60.60 69.30	120-150 120-150 120-150	7½ & 4×4	560 770 870	24×72	120	2145 2200 2300

TWO CYLINDER MODELS

†These units are equipped with dual control. Standard VD pilot setting is 130-140 PSIG.
*These units are base mounted with separate vertical air receivers.
NOTE: Performance data is based on maximum 110% motor load.

SPECIFICATIONS—PRESSURE LUBRICATED

MODEL	MOTOR OR ENG. H.P.	CU. FT. DISPL. MIN.	CU. FT. FREE AIR MIN.	STD. PRESS. SWITCH SETTING	SIZE BORE & STROKE IN.	OPER. SPEED R.P.M.	REC. SIZE		APPROX. SHIPPING WEIGHT LBS.
							IN.	GAL.	
† F5105	15 20	87.50 107.00	64.70 79.20	120-150 120-150	6 & 3¼×3½	760 940	30×75½	200	2550 2600
†*DF5105	15 20	87.50 107.00	64.70 79.20	120-150 120-150	6 & 3¼×3½	760 940	24×72	120	2500 2550
† F5120	20 25	113.00 123.00	84.70 93.00	120-150 120-150	6 & 3¼×4	870 940	30×75½	200	2625 2715
†*DF5120	20 25	113.00 123.00	84.70 93.00	120-150 120-150	6 & 3¼×4	870 940	24×72	120	2600 2650

FOUR CYLINDER MODELS

†These units are equipped with dual control. Standard VD pilot setting is 130-140 PSIG.
*These units are base mounted with separate vertical air receivers.
NOTE: Performance data is based on maximum 110% motor load.

4.6 ECO 6: PREMIUM EFFICIENCY MOTORS

Proposed Modifications: Install premium efficiency electric motors on HVAC equipment.

Existing Conditions: Most existing motors in the building are standard efficiency motors in the 1.0 to 7.5 horsepower range. A large 250 horsepower motor is used to turn a rotating UPS system.

Method of Analysis: Analysis proceeded as follows:

- Complete electrical measurements were made on the 250 horsepower motor including voltages, amps, power factor, and operating speed. The motor was found to be 11% loaded, operating with a 65% efficiency and a 45% power factor. This motor was evaluated in ECO 7 -Uninterruptible Power Supply Modifications.
- Nameplate data was collected for all motors.
- Speed measurements were made on accessible motors. Speed measurements were used to calculate motor slip which is proportional to the load fraction on the motor.
- Annual baseline electricity use was calculated based on the nameplate horsepower, annual operating hours, and speed measurements.
- Efficiencies and costs for premium motors were based on data provided by four motor manufacturers. Data from three manufacturers was averaged to produce the average efficiency and costs for each standard size of motor.
- Electric demand, annual electric use, and energy savings were calculated based on the load fractions, efficiencies, and operating hours of the premium efficiency motors.
- Annual maintenance costs for standard and premium motors were assumed to be the same.
- Installation costs were based on Means 1995 Electrical Cost Data and included a 20% remote location cost.

Results:

The 5 horsepower fan motor on AHU-2 was found to be a good candidate for replacement with a premium efficiency motor. Results are summarized in the following table.

Annual Electric Energy Savings (kWh)	2,197
Total Annual Energy Cost Savings	$180
Annual Maintenance Cost Savings	$0
Investment Cost	$1753
Savings-to-Investment Ratio (SIR)	1.55
Simple Payback (Years)	9.7

Analysis results for other motors follow.

Recommendation: Replace the 5 horsepower fan motor on AHU-2 serving the office area with a premium efficiency motor.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Nov-95
3. INSTALLATION AND LOCATION GEODSS Site, White Sands Missile Range, NM		
4. PROJECT TITLE ECIP: Upgrade Lighting Systems		5. PROJECT NUMBER 1406.008

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

LOCATION: GEODSS Site, White Sands Missile Range, NM   REGION: 4   PROJECT NO: 1406.008
PROJECT TITLE: ECIP: PREMIUM EFFICIENCY MOTORS   FISCAL YEAR: 1995
DISCRETE PORTION NAME: TOTAL
ANALYSIS DATE: 11/09/95   ECONOMIC LIFE: 15   PREPARED BY: E. Smith

1. INVESTMENT

A.	CONSTRUCTION COST	=	$1,567	
B.	SIOH COST	(6.0% of 1A) =	$94	
C.	DESIGN COST	(6.0% of 1A) =	$94	
D.	TOTAL COST	(1A +1B +1C) =	$1,755	
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	=	$0	
F.	PUBLIC UTILITY COMPANY REBATE	=	$0	
G.	TOTAL INVESTMENT	(1D -1E -1F) =	------->	$1,755

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

DATE OF NISTR-4942-1 USED FOR DISCOUNT FACTORS: JUL '95

	ENERGY SOURCE	FUEL COST $/kWh (1)	SAVINGS kWh (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELECT	$0.0821	2,197	$180	15.08	$2,720	
B.	DIST	$0.00	0	$0	-	$0	
C.	NAT GAS	$0.00	0	$0	-	$0	
D.	REFUS	$0.00	0	$0	-	$0	
E.	COAL	$0.00	0	$0	-	$0	
F.	OTHER			$0	-	$0	
G.	DEMAND SAVINGS		0	$0	-	$0	
H.	TOTAL		2,197	$180		-------->	$2,720

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

A. ANNUAL RECURRING (+/-)		$0		
1 DISCOUNT FACTOR	(From Table A) =		11.94	
2 DISCOUNTED SAVINGS (+) / COST (-)	(3A x 3A1) =			$0

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE B)	DISCOUNTED SAVINGS/COST (4)
a. MATERIAL: NONE	$0	0	0.00	$0
b. MATERIAL: NONE	$0	0	0.00	$0
c. MATERIAL: NONE	$0	0	0.00	$0
d. TOTAL	$0			$0

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

4.	FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bd1/Economic Life))	$180
5.	SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	9.73
6.	TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$2,720
7.	DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	1.55

HP	PREMIUM EFFICIENCY MOTOR EFFICIENCY NEMA (7)	(1)	(2)	(3)	(4)	AVG 1,3&4	STANDARD EFFICIENCY MOTOR EFFICIENCY (1)	(2)	(3)	(4)	AVG 1,3&4	PREMIUM EFFICIENCY MOTOR COSTS (1)	(2)	(3)	(4)	AVG 1,3&4	HANDLE (hrs)	INSTALL (hrs)	BASE (5) LABOR ($)	TOTAL COST (6) ($)
1.0	82.5%	86.5%	78.5%	86.5%	85.5%	86.2%	78.5%	78.5%	77.0%	77.0%	77.5%	$319	$289	$362	$395	$359	2.00	1.78	$82	$802
1.5	84.0%	86.5%	81.5%	86.5%	85.5%	86.2%	77.0%	81.5%	77.0%	78.5%	77.5%	$354	$302	$402	$410	$389	2.50	1.78	$92	$876
2.0	84.0%	86.5%	81.5%	86.5%	86.5%	86.5%	80.0%	81.5%	80.0%	82.5%	80.8%	$387	$323	$442	$430	$420	2.67	1.78	$96	$940
3.0	87.5%	88.5%	85.5%	88.5%	89.5%	88.8%	84.0%	85.5%	84.0%	81.5%	83.2%	$429	$383	$490	$451	$457	3.50	1.78	$114	$1,040
5.0	87.5%	89.5%	85.5%	89.5%	90.2%	89.7%	86.0%	85.5%	85.5%	84.0%	85.2%	$502	$453	$678	$478	$553	4.20	1.78	$129	$1,242
7.5	89.5%	91.7%	87.5%	91.7%	91.0%	91.5%	87.0%	86.5%	86.5%	85.5%	86.3%	$685	$919	$776	$651	$704	5.33	1.91	$156	$1,567
10	89.5%	91.7%	89.5%	91.7%	91.7%	91.7%	87.5%	87.5%	87.5%	87.5%	87.5%	$825	$1,078	$815	$732	$791	6.67	2.00	$187	$1,782
15	91.0%	92.4%	91.0%	92.4%	92.4%	92.4%	89.0%	88.5%	88.5%	87.5%	88.3%	$1,088	$1,350	$1,232	$1,045	$1,122	8.00	2.50	$227	$2,457
20	91.0%	93.0%	91.7%	93.0%	93.0%	93.0%	89.5%	87.5%	90.2%	88.5%	89.4%	$1,368	$1,682	$1,535	$1,266	$1,390	10.67	3.08	$297	$3,073
25	92.4%	93.0%	93.0%	93.0%	94.1%	93.4%	90.2%	90.2%	90.2%	89.5%	90.0%	$1,610	$2,000	$1,828	$1,658	$1,699	11.40	3.20	$316	$3,669
30	92.4%	93.6%	93.0%	93.6%	94.1%	93.8%	90.6%	91.0%	90.2%	90.2%	90.3%	$1,874	$2,325	$2,125	$1,969	$1,989	13.30	3.33	$359	$4,279
40	93.0%	94.1%	93.6%	94.1%	94.5%	94.2%	91.0%	91.7%	91.0%	91.0%	91.0%	$2,486	$3,105	$2,823	$2,574	$2,628	16.00	4.00	$432	$5,574
50	93.0%	94.1%	94.1%	94.1%	95.0%	94.4%	92.0%	91.7%	91.7%	91.7%	91.8%	$3,053	$3,812	$3,467	$2,900	$3,140	17.78	5.00	$492	$6,617
60	93.6%	94.5%	94.1%	94.5%	95.0%	94.7%	92.4%	91.0%	93.0%	92.4%	92.6%	$4,374	$5,472	$4,974	$4,501	$4,616	19.00	5.71	$534	$9,382
75	94.1%	94.5%	94.5%	94.5%	95.0%	94.7%	93.6%	93.0%	94.1%	92.4%	93.4%	$5,548	$6,936	$6,305	$5,260	$5,704	20.00	6.67	$576	$11,441
100	94.5%	94.6%	95.0%	94.6%	95.0%	94.7%	93.0%	91.7%	93.0%	93.0%	93.0%	$6,860	$8,572	$7,790	$7,180	$7,277	24.00	8.89	$711	$14,550

Totally enclosed, fan cooled, squirrel cage
(1) Westinghouse Optim HE
(2) Magnetek Louis Allis Spartan
(3) TECO Max-E1
(4) Baldor Super-E

(5) Labor cost for electrician from Means Electrical Cost Data 1993 is $24.95/hr.
(6) Includes 20% site & location factor, 15% overhead, 10% profit, and 20% contingency.
(7) NEMA Standard MG 1, Table 12.6C

Energy Type	Unit Energy Cost	UPW Discount Factors (1)		
Economic Life of ECO (yrs)		10	15	20
Electric Energy	0.0821 ($/kWh)	8.58	12.02	15.08
Annual Recurring Non-Energy Savings		8.53	11.94	14.88

(1) NISTIR 85-3273-7 EDnergy Prices and Discount Factors for Life-Cycle Cost Analysis 1995
Discount rate = 3%, Region 4

escripti	Nameplate Data HP	Rated Volts (Volts)	FLA (Amps)	Phase	Rated Speed (rpm)	Field Measurements Voltage A-B (Volts)	B-C (Volts)	C-A (Volts)	Current A (Amps)	B (Amps)	C (Amps)	Power Factor	Motor (rpm)	Fan (rpm)	Motor Sync (rpm)	Calculated Values (2) Load Fraction (%)	(1) Input Power (kW)	(3) Output Power (kW)	(4) Motor Effic. (%)
Generat	250	480	285	3	1770	487	486	485	86	91	81	45.0	1796.6	N/A	1800	11%	32.58	21.14	65%
Generat	250	210	N/A	3	1800	210.3	210.5	210.7	79	52	67	96.9	1796.6	N/A	1800	#DIV/0!	23.32	N/A	N/A
Conden	1.5	115	3	3	N/A							N/A	N/A	N/A	1800	70%	0.97	0.78	81%
Refrig C	5	460	7.3	3	1750							N/A	N/A	N/A	1800	70%	3.02	2.61	86%
Refrig C	5	460	7.3	3	1750							N/A	N/A	N/A	1800	70%	3.02	2.61	86%
Chilled	1	208	3.3	3	1725							N/A	N/A	N/A	1800	70%	0.67	0.52	78%
Chilled	1	208	3.3	3	1725							N/A	N/A	N/A	1800	70%	0.67	0.52	78%
Chilled	1	208	3.3	3	1725							N/A	N/A	N/A	1800	70%	0.67	0.52	78%
Chilled	1	208	3.3	3	1725							N/A	N/A	N/A	1800	70%	0.67	0.52	78%
Air Com	5	208	15.4	3	1750							N/A	N/A	N/A	1800	70%	3.02	2.61	86%
Air Com	5	208	15.4	3	1750							N/A	N/A	N/A	1800	70%	3.02	2.61	86%
Air Com	5	208	15.4	3	1750							N/A	N/A	N/A	1800	70%	3.02	2.61	86%
AHU-2	**5**	**460**	**7.3**	**3**	**1730**							**N/A**	**1727.6**	**N/A**	**1800**	**103%**	**4.47**	**3.86**	**86%**
AHU-3	3	230	8.36	3	1760							N/A	1781.7	1393	1800	46%	1.20	1.02	85%
AHU-4	3	230	9.8	3	1740							N/A	1768.9	1255.7	1800	52%	1.36	1.16	85%
AHU-5	3	230	9	3	1740							N/A	1766.2	1370	1800	56%	1.48	1.26	85%
AHU-6	7.5	480	11	3	1750							N/A	N/A	N/A	1800	70%	4.48	3.92	88%
AHU-7	7.5	480	11	3	1750							N/A	N/A	N/A	1800	70%	4.48	3.92	88%
AHU-8	7.5	480	11	3	1750							N/A	N/A	N/A	1800	70%	4.48	3.92	88%
AHU-9	0.33	230	2.9	3								N/A	N/A	N/A	1800	70%	0.22	0.17	78%

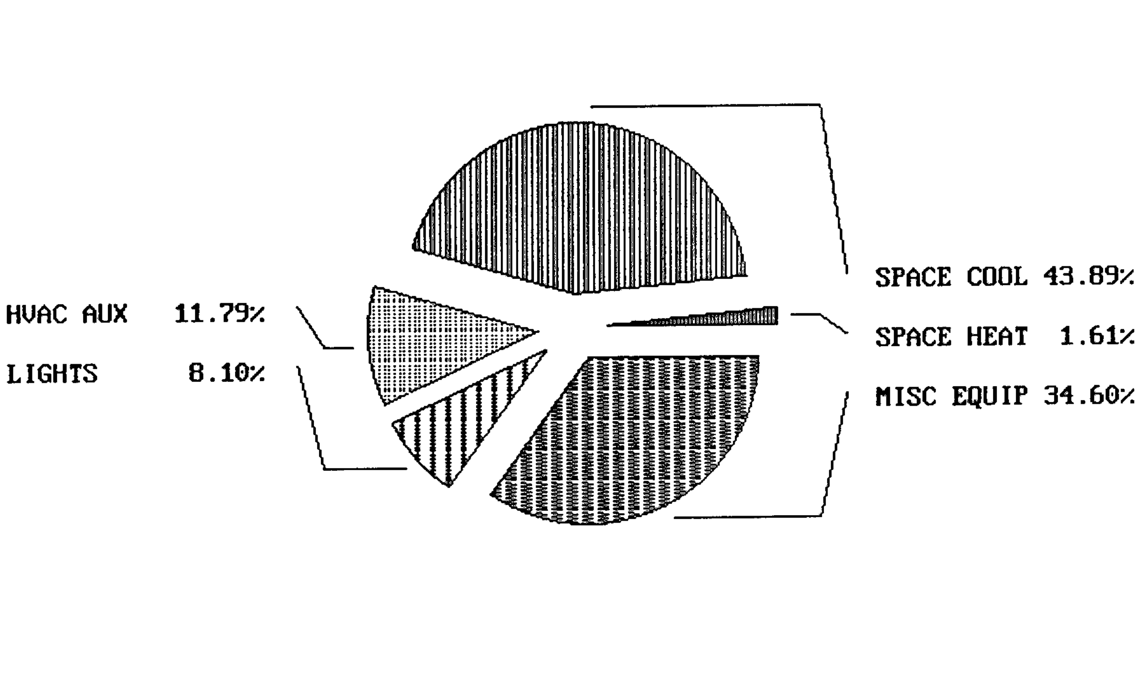
New Motor Selection	Savings	Life Cycle Cost Summary

(5) Output Power (hp)	(6) New Motor (hp)	(7) Motor Effic. (%)	(8) Load Fraction (%)	(9) Input Power (kW)	Annual peratin Hours	Electric Demand Savings (kW)	Annual Energy Savings (kWh)	Demand Cost Savings ($)	Energy Cost Savings ($)	Annual Cost Savings ($)	Installed Cost ($)	Utility Incentive ($)	nvestmen Cost ($)	Simple Payback	Discounted Cost Savings ($)	SIR	Rate of Return (AIRR)
28.3	250	0.938	11%	22.54	8760	10.03	87,906	$0	$7,217	$7,217	$14,550	$0	######	2.3	$108,834	6.69	14.4%
N/A	250	N/A	N/A	N/A	N/A	N/A	N/A	$0	N/A	N/A	N/A	$0	N/A	N/A	N/A	N/A	N/A
1.1	1.5	0.862	70%	0.91	4380	0.06	263	$0	$22	$22	$876	$0	$980	45.4	$325	0.33	-1.6%
3.5	5	0.897	70%	2.91	4380	0.11	502	$0	$41	$41	$1,242	$0	$1,389	33.7	$621	0.45	-0.1%
3.5	5	0.897	70%	2.91	4380	0.11	502	$0	$41	$41	$1,242	$0	$1,389	33.7	$621	0.45	-0.1%
0.7	1	0.862	70%	0.61	4380	0.07	297	$0	$24	$24	$802	$0	$897	36.8	$368	0.41	-0.5%
0.7	1	0.862	70%	0.61	4380	0.07	297	$0	$24	$24	$802	$0	$897	36.8	$368	0.41	-0.5%
0.7	1	0.862	70%	0.61	4380	0.07	297	$0	$24	$24	$802	$0	$897	36.8	$368	0.41	-0.5%
0.7	1	0.862	70%	0.61	4380	0.07	297	$0	$24	$24	$802	$0	$897	36.8	$368	0.41	-0.5%
3.5	5	0.897	70%	2.91	4380	0.11	502	$0	$41	$41	$1,242	$0	$1,389	33.7	$621	0.45	-0.1%
3.5	5	0.897	70%	2.91	4380	0.11	502	$0	$41	$41	$1,242	$0	$1,389	33.7	$621	0.45	-0.1%
3.5	5	0.897	70%	2.91	4380	0.11	502	$0	$41	$41	$1,242	$0	$1,389	33.7	$621	0.45	-0.1%
5.2	**5**	**0.915**	**103%**	**4.22**	**8760**	**0.25**	**2,197**	**$0**	**$180**	**$180**	**$1,567**	**$0**	**$1,753**	**9.7**	**$2,720**	**1.55**	**6.3%**
1.4	3	0.862	46%	1.19	5136	0.01	72	$0	$6	$6	$876	$0	$980	166.6	$89	0.09	-7.8%
1.6	3	0.865	52%	1.34	5136	0.02	108	$0	$9	$9	$940	$0	$1,051	118.7	$134	0.13	-6.2%
1.7	3	0.865	56%	1.46	5136	0.02	117	$0	$10	$10	$940	$0	$1,051	109.2	$145	0.14	-5.8%
5.3	7.5	0.915	70%	4.28	8760	0.19	1,700	$0	$140	$140	$1,567	$0	$1,753	12.6	$2,105	1.20	5.0%
5.3	7.5	0.915	70%	4.28	8760	0.19	1,700	$0	$140	$140	$1,567	$0	$1,753	12.6	$2,105	1.20	5.0%
5.3	7.5	0.915	70%	4.28	8760	0.19	1,700	$0	$140	$140	$1,567	$0	$1,753	12.6	$2,105	1.20	5.0%
0.2	0.33	0.862	70%	0.20	8760	0.02	196	$0	$16	$16	$802	$0	$897	55.8	$243	0.27	-2.6%

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	57.53
SPACE COOL	1565.05
HVAC AUX	420.43
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3565.76

TOTAL SITE ENERGY 3565.62 MBTU 312.8 KBTU/SQFT-YR GROSS-AREA 312.8 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 3565.62 MBTU 312.8 KBTU/SQFT-YR GROSS-AREA 312.8 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED =100.0
NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.

TOTAL SITE ELECTRICITY ENERGY USE 3565.75 MBTU



4.7 ECO 7: UNINTERRUPTED POWER SUPPLY MODIFICATION

__Proposed Modifications__: It is proposed to replace or modify the existing Uninterrupted Power Supply (UPS) system for more efficient operation. Two options were evaluated:

- Option 1: Modify the existing rotating UPS with a smaller motor.
- Option 2: Replace the existing rotating UPS with a static UPS.

__Existing Conditions__: Presently, the existing UPS system consists of a 250 horsepower motor which turns a large flywheel coupled to an electric generator. The system receives 480 volts and delivers a maximum of 150 kW of 208 volt power. The system will provide at least 17 seconds of uninterrupted power if the electricity to the motor is interrupted. The lag time is needed for start up of the emergency generator. This is important because the site is over 18 miles away from the substation and the electricity supply is not always reliable.

Even though the existing UPS system is capable of supplying 150 kW of power, the requirements are reported to be a maximum of 44 kW. Electrical measurements indicated that the system was supplying only 23 kW at the time of the field survey. About 33 kW was being supplied to the motor in order to produce the 23 kW. The power factor at the motor was measured at 45%.

Assuming the power loss in the system remains at 10 kW, the annual energy cost for it is about $7200. At this time, the Socorro Electric Company has not yet started to penalize WSMR for poor power factor, but they have started selectively penalizing other customers and will likely penalize WSMR soon. Poor power factor also increases power line losses and voltage drop. White Sands must pay for any line losses downstream of the utility meter which could be significant depending on the location of the meter.

An analysis of the two options stated above is presented below.

__Option 1:__

The existing 250 horsepower motor could be replaced with a 100 horsepower motor which should include a soft start system. The soft start, or variable speed drive, system would allow the motor to bring a non-rotating flywheel up to speed without damaging the motor. It may take twice as long to get the flywheel up to speed as with the 250 hp motor, but that should not significantly affect the operation of the facility. Based on the reported maximum demand of 44 kW, the maximum size motor required is about 56 horsepower. Use of a 100 horsepower motor would provide a good safety margin.

Measurements on the existing 250 hp motor at the time of the field survey indicated that the motor was 11% loaded and was operating with a 65% efficiency and a 45% power factor.

The new 100 hp motor operating at the same conditions would be 28% loaded and operate with a 94% efficiency and a power factor of 68%.

Option 2:

The existing rotating UPS system could be replaced with a static UPS system. The rotating UPS is a technology that is nearly obsolete. A static UPS system consists of an electronic and battery cabinet typically installed in the computer room which provides power line protection and a battery backup. At 40 kW, the smallest battery cabinet will provide 13 minutes of uninterrupted power as opposed to 17 seconds for the existing rotating UPS.

The static UPS operates with a 92% efficiency down to about 25% load. At 10% load, the efficiency is still in the high eighties. Two static UPS systems were priced:

- A 64 kW system for $58,000
- A 100 kW system for $68,000

Installation is typically in the range of 25 to 50% of equipment cost.

Analysis: Analysis proceeded as follows:

- Existing energy use was based on electrical field measurements at the time of the field survey.
- Energy use with the proposed modifications was based on data from the MotorMaster data base and from the static UPS manufacturer.
- Equipment and installation costs were based on local supplier quotes and estimates of installation time.
- Maintenance costs were assumed to be $0.01/kWh for electrical motors and generators associated with the static UPS and $0.03/kWh for the diesel-electric generator. The diesel-electric generator currently produces about 95,000 kWh of electricity annually. It was assumed that operation of the diesel-electric generator during thunderstorms would not be necessary with the static UPS system.
- A spreadsheet was used to calculate energy cost savings and ECO economics.

Results:

Results for both options are summarized in the following table:

	Option 1	Option 2
Annual Electric Energy Savings (kWh)	89,454	85,172
Total Annual Energy Cost Savings	$7344	$6993
Annual Maintenance Cost (Savings)	0	$4909
Investment Cost	22,847	97,292
Savings-to-Investment Ratio (SIR)	4.85	1.83
Simple Payback (Years)	3.1	13.9

Recommendations:

Of the two options, Option 1 - New 100 hp Motor, is recommended. This modification is the most cost effective.

E M C Engineers, Inc.
EMC#1406-008
GEODSS, White Sands Missile Range
DACA 63-92-C-0152

MOTOR DATA

UPS-ECO.XLS
Prepared by: D Jones
11/9/95
Checked by:_______

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Apr-95
3. INSTALLATION AND LOCATION GEODSS Site, White Sands Missile Range, NM		
4. PROJECT TITLE ECIP: Upgrade Lighting Systems		5. PROJECT NUMBER

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

LOCATION: GEODSS Site, White Sands Missile Range, NM — REGION: 4 — PROJECT NO: 1413-001
PROJECT TITLE: ECIP: UPGRADE UPS SYSTEM — FISCAL YEAR 1995
DISCRETE PORTION NAME: TOTAL
ANALYSIS DATE: 11/09/95 — ECONOMIC LIFE: 20 — PREPARED B D Jones

1. INVESTMENT

A.	CONSTRUCTION COST	= =	$20,491	
B.	SIOH COST	(5.5% of 1A) =	$1,127	
C.	DESIGN COST	(6.0% of 1A) =	$1,229	
D.	TOTAL COST	(1A +1B +1C) =	$22,847	
E.	SALVAGE VALUE OF EXISTING EQUIPMENT =			
F.	PUBLIC UTILITY COMPANY REBATE =			
G.	TOTAL INVESTMENT	(1D -1E -1F) =	------->	$22,847

2. ENERGY SAVINGS (+) OR COST (-):
DATE OF NISTR-4942-1 USED FOR DISCOUNT FACTORS: OCT '94

	ENERGY SOURCE	FUEL COST $/kWh (1)	SAVINGS kWh (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELEC	$0.0821	89,454	$7,344	15.08	$110,750	
B.	DIST						
C.	NAT GAS						
D.	REFUS						
E.	COAL						
F.	OTHER						
G.	DEMAND SAVINGS		10.21				
H.	TOTAL		89,454	$7,344		-------->	$110,750

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

A. ANNUAL RECURRING (+/-)
1 DISCOUNT FACTOR (From Table A) =
2 DISCOUNTED SAVINGS (+) / COST (-) (3A x 3A1) =

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE B)	DISCOUNTED SAVINGS/COST (4)
a. MATERIAL: NONE				
b. MATERIAL: NONE				
c. MATERIAL: NONE				
d. TOTAL				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-) (3A2 + 3Bd4) =

4.	FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bd1/Economic Life))	$7,344
5.	SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	3.11
6.	TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$110,750
7.	DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	4.85

Description			New 100 Horsepower Motor Driver	New 100 Horsepower Motor Generator	New 64 kW Static UPS System Driver	New 64 kW Static UPS System Generator
Nameplate Data						
Horsepower			250	250	250	250
Rated Volts		(Volts)	480	480	480	480
FLA		(Amps)	285	285	285	285
Phase			3	3	3	3
Full Load Speed		(rpm)	1770	1770	1770	1770
Field Measurements						
Voltage	A-B	(Volts)	487	210.3	487	210.3
	B-C	(Volts)	486	210.5	486	210.5
	C-A	(Volts)	485	210.7	485	210.7
Current	A	(Amps)	86	79	86	79
	B	(Amps)	91	52	91	52
	C	(Amps)	81	67	81	67
Power Factor	A		0.465	0.969	0.465	0.969
	B		0.47	0.999	0.47	0.999
	C		0.42	0.967	0.42	0.967
Motor Speed		(rpm)	1796.6	1796.6	1796.6	1796.6
Calculated Values						
Motor Load Fraction		(%)	11%	N/A	11%	N/A
Output Power		(kW)	21.14	N/A	21.14	N/A
Input Power		(kW)	32.70	23.54	32.70	23.54
Motor Sync Speed		(rpm)	1800	1800	1800	1800
Motor Efficiency		(%)	65%	N/A	65%	N/A
			New 100 Horsepower Motor		New 64 kW Static UPS System	
Output Power		(hp)	28.3	N/A	28.3	N/A
Horsepower		(hp)	100	N/A	N/A	N/A
Motor Efficiency		(%)	94%	N/A	92%	N/A
Motor Load Fraction		(%)	28%	N/A	N/A	N/A
Input Power		(kW)	22.49	N/A	22.97	N/A
Energy Savings						
Annual Operating Hours			8760	N/A	8760	N/A
Demand Savings		(kW)	10.21	N/A	9.72	N/A
Annual Energy Savings		(kWh)	89,454	N/A	85,172	N/A
Demand Cost Savings		($)		N/A		N/A
Energy Cost Savings		($)	$7,344	N/A	$6,993	N/A
Annual Cost Savings		($)	$7,344	N/A	$6,993	N/A
Installed Cost		($)	$20,491	N/A	$87,000	N/A
Maintenance Savings						
Diesel Generator		($)		N/A	$2,850	N/A
UPS Driver		($)		N/A	$2,059	N/A
UPS Generator		($)		N/A	$2,059	N/A
Static UPS		($)		N/A	($2,059)	N/A
	Total	($)		N/A	$4,909	N/A
Life Cycle Cost Summary						
Investment Cost		($)	$22,847	N/A	$97,292	N/A
Simple Payback		(yrs)	3.1	N/A	13.9	N/A
Life Cycle Cost Savings		($)	$110,750	N/A	$178,488	N/A
SIR			4.85	N/A	1.83	N/A
Rate of Return		(AIRR)	12.5%	N/A	7.2%	N/A

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		White Sands Missile Range, NM	

PROJECT TITLE UPS Modification
GEODSS, Energy Conservation Survey

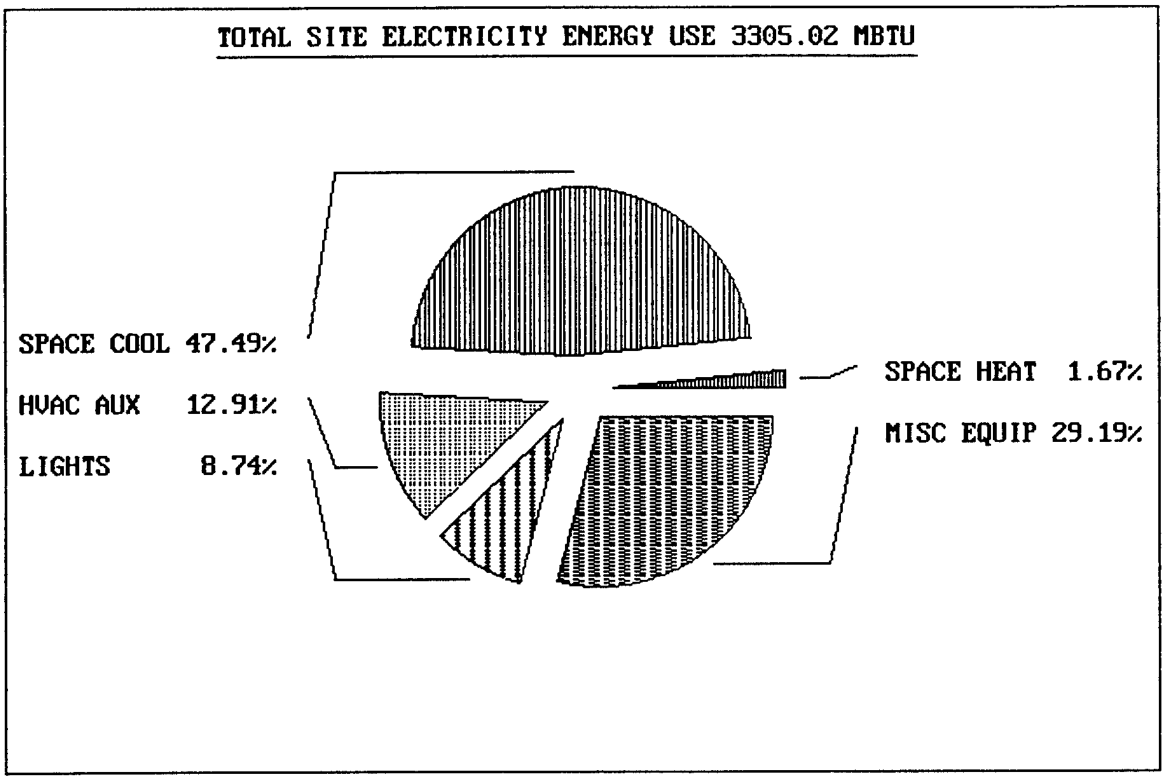
CONTRACT NO. DACA01-94-D-0033

				MATERIAL COST		LABOR COST				EQUIPMENT COST		TOTAL COST	
Line No	Item Description	Unit of Measure	No. of Units	Unit Cost	Total	Manhrs/ Unit	Total Manhrs	Labor Cost/ Manhour	Total Labor Cost	Unit Cost	Total	Unit Cost	Total
1	Replace 250 hp motor with 100 hp motor				$0	0.00	0.00	$18.50	$0	$0.00	$0	$0.00	$0
2	Electric motor, 100 hp, Premium efficiency	ea	1	$2,365	$2,365	20.00	20.00	$18.50	$370	$0.00	$0	$2,735	$2,735
3	Starter, 100 hp, Soft start	ea	1	$4,450	$4,450	48.00	48.00	$18.50	$888	$0.00	$0	$5,338	$5,338
4	Remove existing motor	ea	1	$0.00	$0	8.00	8.00	$18.50	$148	$0.00	$0	$148.00	$148
5	Travel to Socorro	hrs	12		$0	1.00	12.00	$18.50	$222	$0.00	$0	$18.50	$222
6	Travel to job site	hrs	8		$0	1.00	8.00	$18.50	$148	$0.00	$0	$18.50	$148
7	Lodging and per diem	days	10		$0		0.00	$18.50	$0	$100.00	$1,000	$100.00	$1,000
8	Milage	miles	600		$0		0.00	$18.50	$0	$0.30	$180	$0.30	$180
9					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
10					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
11					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
12					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
13					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
14					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
15					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
16					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
17					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
18					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
19					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
20					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
21					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
22					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
23					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
24					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
25					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
26					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
27					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
28					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
29					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
30					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
31					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
32					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
33					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
34					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
35					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
36					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
37					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
38					$0		0.00	$18.50	$0	$0.00	$0	$0.00	$0
39	SUBCONTRACTOR SUBTOTAL				$6,815		$96		$1,776		$1,180		$9,771
40	LABOR BURDEN	%	30		$0				$533		$354		$887
41	SUBTOTAL				$6,815				$2,309		$1,534		$10,658
42	OVERHEAD	%	12.0		$818				$277		$184		$1,279
43	SUBTOTAL				$7,633				$2,586		$1,718		$11,937
44	PROFIT	%	12		$916				$310		$206		$1,432
45	SUBCONTRACTOR TOTAL				$8,549				$2,896		$1,924		$13,369
46	OVERHEAD	%	10.95		$936				$317		$211		$1,464
47	SUBTOTAL				$9,485				$3,213		$2,135		$14,833
48	PROFIT	%	8		$759				$257		$171		$1,187
49	SUBTOTAL				$10,244				$3,470		$2,306		$16,020
50	BOND	%	0.737		$75				$26		$17		$118
51	SUBTOTAL				$10,319				$3,496		$2,323		$16,138
52	N. M. TAX	%	5.8125		$600				$203		$135		$938
53	SUBTOTAL				$10,919				$3,699		$2,458		$17,076
54	CONTINGENCY	%	20		$2,184				$740		$492		$3,415
55	GRAND TOTAL				$13,103				$4,439		$2,949		$20,491

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
EMS		E M C Engineers, Inc.	11/22/95

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	55.12
SPACE COOL	1569.61
HVAC AUX	426.65
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	964.77
TOTAL	3305.03

TOTAL SITE ENERGY 3304.94 MBTU 289.9 KBTU/SQFT-YR GROSS-AREA 289.9 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 3304.94 MBTU 289.9 KBTU/SQFT-YR GROSS-AREA 289.9 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED =100.0
NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.



CRITERIA: Horsepower 250
Speed (RPM) 1800
Enclosure .... Totally Enclosed

Manufacturer: Toshiba
Model: STD EFF
Catalog: B2504FLF4BM
List Price ($): 13448

	Full	3/4	1/2	1/4
Efficiency (%):	94.1	93.9	92.9	n/a
Power factor:	87.5	86.3	81.7	n/a

Full Load RPM: 1780
Voltage Rating: 460
Frame Size: 505UZ
Features: n/a
Warranty (yrs): n/a
Service Factor: 1.15

	FL	BD	LR
Torque (ft-lb):	738	1705	2214

	Idle	FL	LR
Current (amps):	72.0	285	1820

CRITERIA: Horsepower 100
Speed (RPM) 1800
Enclosure .... Totally Enclosed

Manufacturer: Reliance
Model: TEFC U-FRAME STD EFF
Catalog: P44G611
List Price ($): 7343

	Full	3/4	1/2	1/4
Efficiency (%):	95.8	96.1	95.9	94.0
Power factor:	90.5	89.1	84.4	68.0

Full Load RPM: 1786
Voltage Rating: 460
Frame Size: 445U
Features: U-Frame
Warranty (yrs): 1
Service Factor: 1.15

	FL	BD	LR
Torque (ft-lb):	294	687	406

	Idle	FL	LR
Current (amps):	n/a	108	677

Facsimile Cover Sheet

To: Dennis Jones

Company: EMC

Phone:

Fax: 985-2527

From: Bill Kirkendoll

Company: GE SUPPLY, DENVER

Phone: 303-572-7115

Fax: 303-572-7120

Date: 7/13/95

Pages including this cover page: 5

Comments: Estimated Quote on 100 hp Motor & Solid State Soft Start Starter

Good Luck!

Bill

GE Supply

William M. Kirkendoll
Rocky Mountain Region Motor Specialist

425 Quivas St., Denver, CO 80204
303 572-7115, 1 800 332-5853, Fax 303 572-7120

GE Supply
Quotation

General Electric Company

Unless otherwise stated, this quotation expires 30 days from its date, may be modified or withdrawn by GE Supply prior to any acceptance and supersedes all previous quotations and agreements relating to this transaction. All communications should refer to the quotation number and be addressed to our office at the above address.

TO EMC Engineers, Inc
2750 S. Wadsworth Blvd
Suite C-200
Denver CO 80227
Attn: Dennis Jones

GE SUPPLY QUOTE NUMBER: WMK7139500
JOB/PROJECT:
CUSTOMER REQUEST FOR QUOTE:
DATE: 7/13/95
TIME:
PAGE:

LINE NO | PART NUMBER | DESCRIPTION | QUANTITY | UNIT PRICE | U/M | EXTENDED AMOUNT

GE Supply is pleased to offer the following quotation:

I will offer an estimated Price with the following assumptions:

1. Motor RPM - 1800
2. Motor Enclosure - Open dripproof
3. Nema Load Inertia - 441 Lb-ft^2
(with a large Flywheel the WK^2 or Load inertia is critical.)

Item 1. 100 hp, 1800 RPM, Energy Saver ODP, 404T Frame, 230/460/3/60 (1) $2,365.00 each

Item 2. 100 hp GE ASTAT-CD Solid State Reduced Voltage Starter, Nema1 (1) $4,450.00 each

Delivery: Motor is stock subject to Prior sale
The Starter is 4 weeks.

Freight: Prepaid to Denver

Best Regards, Bill Kirkendall

SALE OF ANY GOODS COVERED BY THIS QUOTATION IS EXPRESSLY CONDITIONED UPON THE TERMS AND CONDITIONS CONTAINED OR REFERRED TO HEREIN, INCLUDING THOSE SET FORTH ON THE BACK OF THIS LETTER AND THOSE CONTAINED IN ANY ATTACHMENTS HERETO.

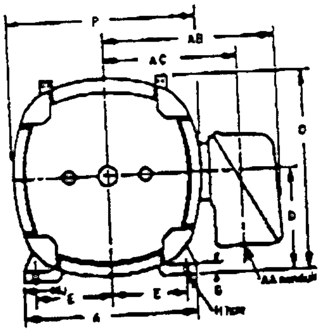
JC107 Rev (3-90)

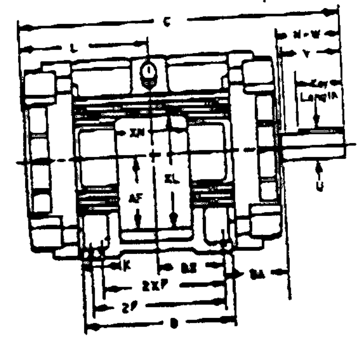
Dripproof

Frames 182 - 449, Type K, KS, KG, KGS and KR 3 Phase

Dimensions

DIMENSIONS—For ESTIMATING ONLY





Dimensions in Inches

Frame	Approximate Net Wt in Lb	Shaft: Keyway Width	Shaft: Keyway Depth	Shaft: Key Length	Shaft: N-W	Shaft: U ①	Shaft: V ②	Mounting ⑥: E	Mounting ⑥: H	Mounting ⑥: BA	Mounting ⑥: BS	Mounting ⑥: 2F	Mounting ⑥: 2XF	A	B	C	D ③	G	J	K	L	O	P
182T	64	0.250	0.125	1.75	2.76	1.126	2.60	3.75	0.406	2.75	2.26	.....	4.50	8.68	6.64	14.68	4.50	0.54	1.60	2.38	5.82	9.18	9.34
184T	80	.250	.125	1.75	2.75	1.125	2.50	3.75	.406	2.75	2.75	5.50	.....	8.88	6.64	14.68	4.50	.64	1.60	2.38	6.32	9.18	9.34
213T	120	.312	.156	2.38	3.38	1.375	3.12	4.25	.408	3.60	3.50	.....	5.60	9.60	8.00	17.26	5.25	.60	1.30	2.80	6.88	10.44	10.34
215T	125	.312	.156	2.38	3.38	1.375	3.12	4.25	.408	3.50	3.50	7.00	.....	9.60	8.00	17.26	5.25	.60	1.30	2.80	6.88	10.44	10.34
254T	190	.375	.188	2.88	4.00	1.625	3.75	5.00	.531	4.25	5.00	.....	8.25	11.20	11.30	22.31	6.25	.70	1.50	3.35	9.06	12.44	12.28
256T	220	.376	.188	2.88	4.00	1.625	3.75	5.00	.531	4.25	5.00	10.00	.....	11.20	11.30	22.31	6.26	.70	1.50	3.35	9.06	12.44	12.28
284TS	295	.375	.188	1.88	3.25	1.625	3.00	6.50	.530	4.76	5.50	.....	9.50	12.40	12.80	23.56	7.00	.80	1.70	3.30	10.06	13.94	13.76
284T	295	.600	.250	3.26	4.62	1.875	4.38	6.50	.530	4.75	5.60	.....	9.50	12.40	12.80	24.84	7.00	.80	1.70	3.30	10.06	13.94	13.76
286TS	325	.375	.188	1.88	3.25	1.625	3.00	6.50	.530	4.75	5.50	11.00	.....	12.40	12.80	23.56	7.00	.80	1.70	3.30	10.06	12.94	13.78
286T	325	.500	.250	3.25	4.62	1.875	4.38	6.50	.630	4.75	5.60	11.00	.....	12.40	12.80	24.94	7.00	.80	1.70	3.30	10.06	13.94	13.78
324TS	435	.500	.250	2.00	3.76	1.876	3.50	6.25	.658	5.25	6.00	.....	10.50	14.40	13.20	26.06	8.00	1.00	1.70	3.60	11.08	15.94	15.72
324T	435	.500	.250	3.88	6.25	2.126	5.00	6.26	.656	5.25	6.00	.....	10.60	14.40	13.80	27.56	8.00	1.00	1.70	3.60	11.06	15.94	15.72
326TS	450	.500	.250	2.00	3.76	1.875	3.50	6.25	.656	5.26	6.00	12.00	.....	14.40	13.80	26.06	8.00	1.00	1.70	3.60	11.08	15.94	15.72
326T	450	.500	.250	3.88	5.26	2.125	5.00	6.25	.656	5.25	6.00	12.00	.....	14.40	13.80	27.56	8.00	1.00	1.70	3.60	11.08	15.94	15.72
364TS	650	.600	.250	2.00	3.75	1.876	3.50	7.00	.690	5.88	6.12	.....	11.25	16.00	14.40	27.68	9.00	1.10	2.20	3.40	11.81	17.94	17.68
364T	650	.625	.312	4.25	6.85	2.375	5.62	7.00	.690	5.88	6.12	.....	11.25	16.00	14.40	29.68	9.00	1.10	2.20	3.40	11.81	17.94	17.68
365TS	700	.500	.250	2.00	3.75	1.875	3.50	7.00	.690	5.88	6.12	12.25	.....	16.00	14.40	27.68	9.00	1.10	2.20	3.40	11.81	17.94	17.83
365T	700	.625	.312	4.25	5.88	2.375	5.62	7.00	.690	5.88	6.12	12.25	.....	16.00	14.40	29.69	9.00	1.10	2.20	3.40	11.81	17.94	17.88
404TS	925	.500	.250	2.75	4.26	2.125	4.00	8.00	.810	6.62	6.88	.....	12.25	18.00	16.00	31.08	10.00	1.30	2.40	4.10	13.31	19.94	19.64
→ 404T	925	.750	.375	5.62	7.26	2.875	7.00	8.00	.810	6.62	6.88	.....	12.25	18.00	16.00	34.06	10.00	1.30	2.40	4.10	13.31	19.94	19.64
405TS	950	.500	.250	2.75	4.25	2.125	4.00	8.00	.810	6.62	6.88	13.76	.....	18.00	16.00	31.06	10.00	1.30	2.40	4.10	13.31	19.94	19.64
405T	950	.750	.375	5.62	7.26	2.875	7.00	8.00	.810	6.62	6.82	13.76	.....	18.00	16.00	34.06	10.00	1.30	2.40	4.10	13.31	19.94	19.64
444TS	1225	.625	.312	3.00	4.75	2.375	4.50	9.00	.810	7.50	8.25	.....	14.50	20.00	18.80	36.06	11.00	1.50	2.80	4.90	15.66	21.94	21.60
444T	1225	.875	.437	6.88	8.50	3.375	8.25	9.00	.810	7.50	8.26	.....	14.50	20.00	18.80	39.81	11.00	1.50	2.60	4.90	15.66	21.94	21.60
446TS	1300	.625	.312	3.00	4.75	2.375	4.50	9.00	.810	7.60	8.25	16.50	.....	20.00	18.80	36.06	11.00	1.60	2.80	4.90	16.56	21.94	21.60
445T	1300	.875	.437	6.88	8.50	3.376	8.25	9.00	.810	7.50	8.25	16.50	.....	20.00	18.80	39.81	11.00	1.60	2.60	4.90	16.56	21.94	21.60
449TS	1690	.625	.312	3.00	4.75	2.375	4.50	9.00	.810	7.50	12.50	25.00	.....	20.00	27.30	44.56	11.00	1.60	2.60	4.90	19.81	21.94	21.60
449T	1690	.875	.437	6.88	8.50	3.375	8.25	9.00	.810	7.50	12.50	25.00	.....	20.00	27.30	48.31	11.00	1.50	2.80	4.80	19.81	21.94	21.60
449LL	1690	.875	.437	4.60	8.75	3.375	9.50	9.00	.810	7.50	12.50	25.00	.....	20.00	27.30	48.56	11.00	1.60	2.80	4.90	19.81	21.64	21.60

CONDUIT BOX DIMENSIONS

Frame	Nominal Hp	Approx Vol	Dimensions in Inches: AA	AB	AC	AF	XL	XN
STANDARD CONDUIT BOX ④								
182-184	5	32	0.50	7.03	6.06	1.32	2.64	6.12
213-215	10	30	.50	8.66	7.20	2.38	5.00	3.62
254-256	20	78	1.25	10.31	8.25	3.50	6.06	5.52
284-286	30	137	1.50	12.53	9.78	4.38	7.59	6.26
324-326	60	370	2.00	15.20	11.46	6.44	10.69	8.56
364-365	75	370	3.00	18.26	12.51	6.44	10.69	8.56
404-405	125	700	3.00	19.01	14.88	7.00	11.76	10.00
444-449	200	700	3.00	20.32	16.19	7.00	11.75	10.00
444-449	250-300	1600	4.00	21.56	16.44	7.00	13.68	17.00
444-449	350-400	1500	4.00	21.58	16.44	7.00	13.68	17.00
444-449	450-500	1500	2—3.00	21.56	16.44	7.00	13.68	17.00
444-449	800	1600	2—4.00	21.56	16.44	7.00	13.68	17.00
OVERSIZE CONDUIT BOX								
182-184	5	32	0.50	7.03	6.06	1.32	2.64	6.12
213-215	10	78	1.25	8.31	7.26	3.50	6.06	6.52
254-256	20	137	1.50	12.16	9.41	4.38	7.59	6.26
284-286	30	370	2.00	13.83	10.19	6.44	10.69	8.56
324-326	50	370	3.00	15.20	11.46	6.44	10.69	8.56
364-365	76	700	3.00	18.01	13.88	7.00	11.76	10.00
404-405	125	925	4.00	18.43	14.13	7.00	13.16	14.12
444-449	200	925	4.00	19.74	15.44	7.00	13.16	14.12
444-449	260-300	2500	2—4.00	21.54	16.44	7.00	13.68	27.25
444-449	360-400	2600	2—4.00	21.54	16.44	7.00	13.68	27.25
444-449	450-500	2600	2—4.00	21.54	16.44	7.00	13.68	27.25
444-449	600	2500	2—4.00	21.54	16.44	7.00	13.88	27.26

① Shaft diameters 1½ inches and smaller will come within the limits of +0.000 inch −0.0005 inch; diameters 1⅝ inches and larger +0.000 inch −0.001 inch.

② "V" represents length of straight part of shaft extension.

③ Tolerance on "D" dimensions will be:
On Frames 182T-326T +0.000 inch−0.032 inch.
On Frames 364-449T +0.000 inch−0.060 inch.

④ Oversized conduit box will be provided for 125 hp and larger for less than 380 volts.

⑤ Hole for ½ inch conduit with knockouts for 0.75 and 1.00-inch conduit.

⑥ Motor feet have 2 holes-per-foot allowing NEMA F-1 or F-2 assembly while maintaining critical NEMA mounting dimensions.

Providing mounting conditions permit, conduit box may be turned so that entrance can be made upward, downward, or from either side.

Weights shown are approximate shipping weights and should be used for estimating only.

Premium Efficiency, Energy $aver® Motors

Type KS, NEMA Design B, Continuous

40 C Ambient, 60 Hertz, 460 Volts, 3-phase, 1.15 Service Factor

Performance Data

Dripproof, Rolled Steel Frames 182-286, Aluminum Frames 324-449

Horse power	Full-load RPM	Amperes: Full-load @ 460v	Amperes: Full-load @ 200v	Amperes: NEMA Locked Rotor (max.)	NEMA Code Letter	Torque: Full-load Lb.-ft.	Torque: NEMA BT %FL (min.)	Torque: NEMA BD %FL (min.)	Efficiency ⑥: FL Nominal ①	Efficiency ⑥: FL Guaranteed (min.)	Efficiency ⑥: 3/4 load ①	Efficiency ⑥: 1/2-load ①	Power Factor ①: Full-load	Power Factor ①: 3/4-load	Power Factor ①: 1/2-load	Max. KVAR ②	No Load dBA Sound Press. ① ⑤
1 1/2	1170	2.3	4.8	20.0	M	6.7	165	250	87.5	85.5	88.8	86.8	72.0	66.0	53.2	1.0	51
2	1165	2.9	6.4	25.0	L	9.0	160	240	87.5	85.5	89.0	87.6	74.0	68.2	55.6	.9	51
3	1765	3.9	8.6	32.0	K	8.9	215	260	90.2	88.5	91.4	90.2	80.0	75.4	64.0	1.5	55
	1175	4.2	9.2	32.0	K	13.4	155	230	89.5	87.5	89.9	88.1	75.0	70.0	58.1	1.7	57
5	3520	6.2	13.6	46.0	J	7.5	150	215	89.5	87.5	92.1	91.6	85.5	85.0	76.6	1.8	68
	1765	6.6	14.6	46.0	J	15.0	185	225	89.5	87.5	90.9	90.5	80.0	76.8	66.2	2.2	55
	1170	6.9	15.4	46.0	J	22.5	150	215	89.5	87.5	88.8	88.5	76.0	71.5	59.9	2.8	57
7 1/2	3500	9.2	20.8	63.5	H	11.3	140	200	89.5	87.5	92.1	92.2	86.0	86.3	78.8	2.2	68
	1765	9.4	22.2	63.5	H	22.3	175	215	91.7	90.2	92.9	92.6	81.5	80.6	73.0	2.5	61
	1180	10.8	23.6	63.5	H	33.4	150	205	91.7	90.2	92.6	91.4	71.5	67.5	56.1	4.4	59
10	3530	12.0	27.4	81.0	H	14.9	135	200	90.2	88.5	92.1	91.7	87.0	87.6	80.9	2.8	70
	1760	12.7	29.8	81.0	H	29.8	180	200	91.7	90.2	93.1	92.9	80.5	79.3	71.5	3.6	61
	1175	14.3	31.4	81.0	H	44.6	150	200	91.7	90.2	92.7	91.7	71.5	67.2	55.8	5.9	59
15	3520	17.5	40.8	116.0	G	22.4	130	200	91.0	89.5	92.8	92.8	88.5	89.7	84.9	3.3	70
	1770	18.8	43.4	116.0	G	44.5	160	200	93.0	91.7	94.1	93.7	81.5	80.0	72.0	5.3	66
	1180	19.9	46.6	116.0	G	66.8	140	200	92.4	91.0	92.5	91.6	76.5	74.7	65.6	6.6	61
20	3540	23.2	52.8	145.0	G	29.6	130	200	92.4	91.0	94.3	93.9	87.5	88.5	82.9	4.8	71
	1770	24.4	56.8	145.0	G	59.3	150	200	93.6	92.4	94.5	94.2	82.0	81.0	73.5	6.8	66
	1175	26.7	64.6	145.0	G	89.4	135	200	92.4	91.0	93.8	93.6	76.0	75.1	66.7	8.2	61
	885	26.2	-	145.0	G	118.6	125	200	92.4	91.0	93.2	92.9	77.5	74.3	64.1	9.0	64
25	3540	28.1	64.6	182.5	G	37.1	130	200	93.0	91.7	94.8	94.6	89.5	90.8	86.4	4.9	71
	1775	29.8	70.4	182.5	G	74.0	150	200	94.1	93.0	94.9	94.6	83.5	77.9	59.0	6.9	67
	1180	30.0	-	182.5	G	111.4	135	200	93.8	92.7	94.4	94.5	83.5	83.0	76.5	7.2	64
	885	32.5	-	182.5	G	148.5	125	200	92.4	91.4	93.2	93.2	78.0	75.3	65.6	10.6	64
30	3560	33.2	76.2	217.5	G	44.2	130	200	93.6	92.4	94.6	93.9	90.5	91.6	87.8	5.6	73
	1770	36.0	85.4	217.5	G	88.9	150	200	94.1	93.0	94.9	94.6	83.0	83.5	78.0	8.2	67
	1180	36.0	-	217.5	G	133.7	135	200	93.6	92.7	94.6	94.7	83.5	82.8	76.2	8.7	64
	890	39.5	-	217.5	G	176.9	125	200	93.6	92.7	94.2	93.8	76.0	72.9	62.3	12.2	66
40	3560	44.2	101.6	290.0	G	59.0	125	200	93.6	92.4	94.8	94.5	90.5	91.6	87.8	7.3	73
	1780	45.5	-	290.0	G	118.0	140	200	94.5	93.7	95.4	95.4	87.0	86.5	80.9	9.9	70
	1185	46.6	-	290.0	G	176.9	135	200	94.1	93.3	94.5	94.2	85.5	84.3	77.8	9.8	66
	890	53.3	-	290.0	G	236.0	125	200	93.6	92.7	94.0	93.5	75.0	71.5	60.6	17.8	66
50	3560	54.3	-	362.5	G	73.7	120	200	93.0	92.0	93.6	92.9	92.0	93.6	92.0	6.5	79
	1780	57.2	-	362.5	G	146.7	140	200	94.5	93.7	95.4	95.5	88.5	85.8	79.8	12.8	70
	1185	58.2	-	362.5	G	221.2	135	200	94.1	93.3	94.7	94.5	86.5	84.5	78.1	12.1	66
	890	59.3	-	362.5	G	295.5	125	200	93.6	92.7	94.8	95.0	84.0	82.6	76.4	13.0	69
60	3565	65.9	-	435.0	G	88.4	120	200	93.6	92.7	94.0	93.4	91.0	93.1	90.3	9.1	79
	1790	69.1	-	435.0	G	176.2	140	200	95.4	94.7	95.4	94.8	85.5	84.2	77.7	15.4	73
	1190	68.2	-	435.0	G	264.7	135	200	95.0	94.3	95.6	95.4	85.5	84.4	77.9	14.7	69
	890	71.4	-	435.0	G	354.7	125	200	94.1	93.3	96.0	95.1	83.6	82.4	75.2	15.8	69
75	3575	80.7	-	542.5	G	110.2	105	200	94.5	93.7	95.1	94.6	92.0	93.3	90.7	10.4	83
	1790	87.1	-	542.5	G	220.3	140	200	95.4	94.7	95.6	95.1	84.5	83.5	76.7	20.3	73
	1190	85.5	-	542.5	G	330.7	135	200	95.4	94.7	95.9	95.7	86.0	84.9	78.6	17.7	69
	890	88.0	-	542.5	G	443.5	125	200	94.5	93.7	95.3	95.3	84.6	83.3	77.3	17.5	69
100	3575	110.0	-	725.0	G	146.9	105	200	94.5	93.7	95.2	94.9	89.5	90.5	86.1	20.8	83
	1790	115.0	-	725.0	G	293.2	125	200	96.2	95.7	96.2	95.7	85.0	82.9	74.9	30.4	78
	1190	110.0	-	725.0	G	440.7	126	200	95.4	94.7	96.0	95.8	89.0	88.7	84.3	18.1	69
	890	117.0	-	725.0	G	591.8	125	200	95.0	94.3	95.3	95.2	84.0	82.5	75.2	26.4	69
125	3570	136.0	-	907.5	G	183.8	100	200	95.0	94.3	94.6	93.9	90.0	91.7	88.6	19.6	93
	1785	135.0	-	907.5	G	368.2	110	200	95.4	94.7	96.0	96.1	90.5	90.7	87.4	19.7	78
	1190	138.0	-	907.5	G	550.9	125	200	95.4	94.7	96.1	96.0	88.5	88.5	84.3	22.8	69
	890	149.0	-	907.5	G	739.3	120	200	95.0	94.3	95.5	95.5	82.5	80.3	71.6	37.5	69

① Average expected values — do not use as guaranteed values. Efficiency, speed, torque, power factor and sound values are the same for 200, 230, or 575 volts. Current values vary inversely with voltage.

② Recommended maximum capacitor rating when capacitor and motor are switched as a unit.

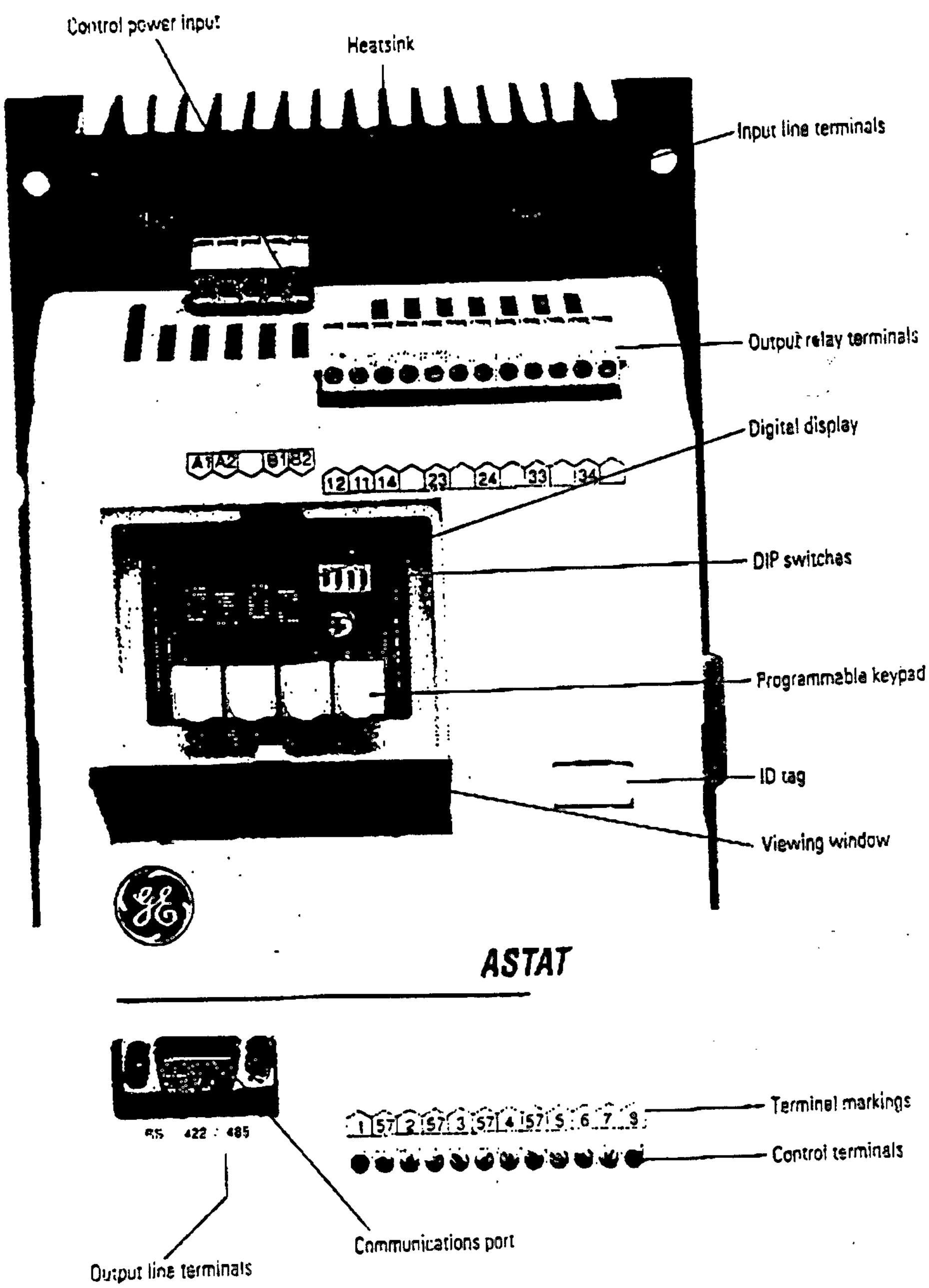
⑤ Sound Power dBA - re 10^{-12} watts; Sound Pressure (dBA) measured in a free field with a reference pressure of 0.00002 pascals, average reading at three feet.

⑥ Tested in accordance with IEEE Standard 112, Test Method B, using accuracy improvement by segregated loss determination including stray load loss improvement as specified in NEMA standard MG1-12.53a.

ASTAT-CD Soft Starter

New

- Advanced microprocessor technology for reliability and versatility
- Heavy-duty, rugged construction
- Simplified setup using keypad and digital display
- Easy-to-read alphanumeric digital display shows status of working conditions and provides diagnostics when fault conditions occur
- User-configurable for most applications including pump control, DC injection braking, slow speed and soft start
- Outstanding diagnostics capability means easy maintenance, reduced downtime; 17 fault codes
- Integral electronic overload relay for optimum motor protection; selectable for standard or heavy-duty applications
- RS-422/485 communications link available for remote operation
- Energy saving mode reduces power costs and reactive power
- User-configurable output relay for increased versatility
- Built-in Snubbers and MOVs protect against harmful voltage spikes



SUPPORTEK, INC.

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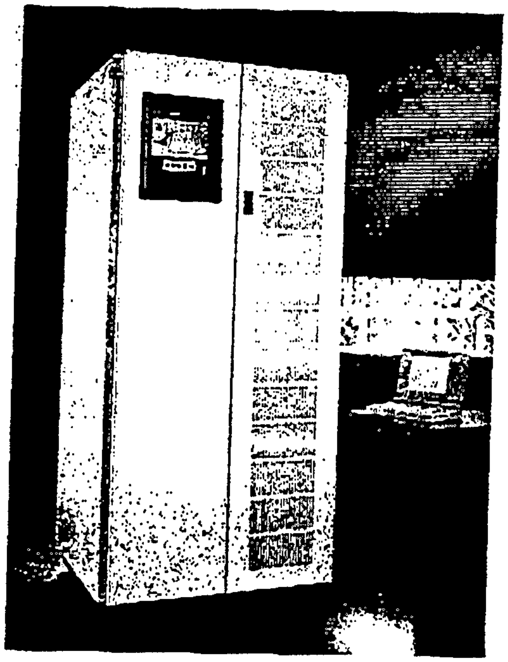
Budget Prices

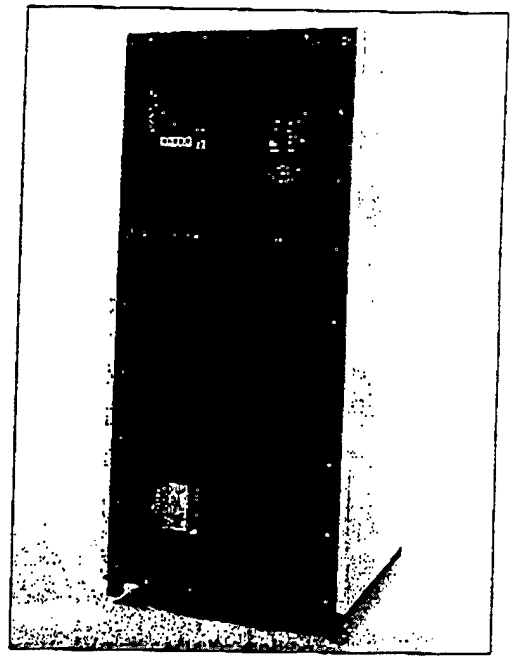
Model 80	80 kVA/64 kWh	$58,000
Model 125	125 kVA/100 kWh	$68,000

Add 50% for installation

Powerware® Plus 80 On-line Uninterruptible Power System

Model 50	50kVA / 40kW
Model 65	65kVA / 52kW
Model 80	80kVA / 64kW





The Exide Electronics Powerware Plus 80 combines on-line UPS technology with the latest in network communications. A complete solution for your mission-critical applications. For use in both mainframe and client/server environments, the Plus 80 gives you:

- Continuous on-line protection
- Superior system reliability
- World class quality
- Flexible network communications

The Exide Electronics Powerware Plus 80 UPS provides power protection through superior on-line technology, flexible communications and user-friendly operation. A variety of options allows easy integration of the Plus 80 into centralized or remote monitoring systems, and network adapters provide LAN connectivity and SNMP compatibility. Other communications options include remote terminal capabilities, remote monitoring panel and remote emergency power-off, which are available through standard RS-232 and RS-485 ports.

Powerful, yet easy to understand. The Powerware Plus 80's monitor panel features a large easy-to-read LCD, push-button controls, operational metering features, utility statistics and intelligent alarm management. These features allow you to quickly monitor UPS operations and the status of the supported system. A battery monitoring and test system proactively identifies the battery time available should a loss of utility power occur.

The Powerware Plus 80 is equipped with intelligent controls, dual-feed input capability, self-diagnostics, redundant fans and redundant control power supplies. The integration of insulated gate bipolar transistors (IGBTs) into a high speed inverter lets the Plus 80 more effectively support demanding non-linear loads, such as PCs, laser printers and industrial motor drives.

Powerware Plus 80 Performance Characteristics

		Model 50					Model 65					Model 80				
		50kVA/40kW					65kVA/52kW					80kVA/64kW				
Input Voltage †	Volts	480	480	208	600	400	480	480	208	600	400	480	480	208	600	400
Output Voltage †	Volts	208	480	208	208	400	208	480	208	208	400	208	480	208	208	400
Input Voltage Range																
Minimum	Volts	408	408	177	510	340	408	408	177	510	340	408	408	177	510	340
Maximum	Volts	528	528	229	660	440	528	528	229	660	440	528	528	229	660	440
Input / Output Frequency	Hz	60	60	60	60	50/60	60	60	60	60	50/60	60	60	60	60	50/60
AC Input (With input filter)																
Nominal Amps	Amps	56	56	128	45	69	72	72	167	58	90	89	89	205	72	106
Maximum Amps	Amps	69	69	160	56	86	90	90	208	72	112	111	111	256	89	133
AC Input (Without input filter)																
Nominal Amps	Amps	66	66	150	52	81	85	85	196	68	105	105	105	241	84	126
Maximum Amps	Amps	82	82	188	65	101	106	106	245	85	131	131	131	301	105	157
Bypass Input																
Nominal Amps	Amps	60	60	139	48	74	78	78	180	63	97	96	96	222	77	115
AC Output																
Nominal Amps	Amps	139	60	139	139	74	180	78	180	180	97	222	96	222	222	115
10 Minutes Max.	Amps	174	75	174	174	93	225	98	225	225	121	278	120	278	278	144
DC Link																
Nominal DC Voltage	Volts	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480
Float Voltage	Volts	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
End of Discharge	Volts	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401
Maximum Amps	Amps	100	100	100	100	100	130	130	130	130	130	160	160	160	160	160
Physical Attributes (w/o batt.)																
Installed Weight ††	Lbs	2000	2000	2475	3400	2475	2000	2000	2475	3400	2475	2000	2000	2475	3400	2475
Installed Width	Inches	34	34	34	58	34	34	34	34	58	34	34	34	34	58	34
Systems Efficiencies																
@ 100% Load	%	92	92	91	91	91	92	92	91	91	91	92	92	90	90	91
@ 75% Load	%	92	92	90	90	90	92	92	91	91	91	92	92	91	91	91
@ 50% Load	%	91	91	88	88	88	92	92	89	89	89	92	92	90	90	90
Full Load Heat Dissipation																
BTU/Hr. (x1000)		11.9	11.9	13.5	13.5	13.5	15.4	15.4	17.6	17.6	17.6	19.0	19.0	24.3	24.3	21.6
KCal/Hr. (x1000)		3.00	3.00	3.40	3.40	3.40	3.89	3.89	4.43	4.43	4.43	4.79	4.79	6.12	6.12	5.45
Inverter Efficiency (Full Load)	%	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93

† Easily adjustible for 380, 400 or 415 VAC Input/Output, 50 or 60 Hz

†† All cabinets are 73.5 inches (1867 mm) high and 31.5 inches (800 mm) in depth

Powerware Plus 80 Battery Protection Time At 25°C (In Minutes)

Battery Cabinet	Nominal DC Voltage	Total Battery Cabinets	Output Load on UPS in kW: 20	26	32	40	52	64	Weight (lbs.)	Width (in.)
5508	480	1	38	25	19	13	8	5	2,225	24
8008	480	1	60	45	35	26	16	12	3,325	36
5516	480	2	90	60	52	39	27	19	4,450	48
8016	480	2	125	95	80	60	46	35	6,650	72
8024	480	3	185	140	115	95	70	59	9,975	108
8032	480	4	240+	190	155	125	95	80	13,300	144

·All battery cabinets are 73.5 inches (1867mm) high and 31.5 inches (800mm) in depth; Line-up configuration

nsai

LR SN 180 9001

UL LISTED

UL LISTED

Specifications subject to change without notice.

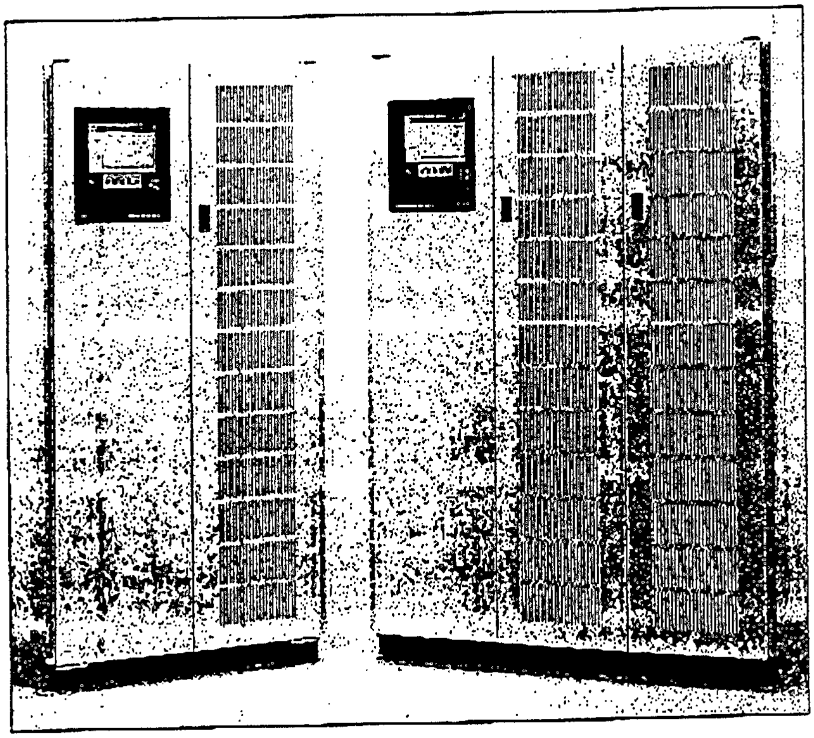
1-800-554-3448 (Toll-free in US & Canada) World Headquarters, 8521 Six Forks Road, Raleigh, NC 27615 USA

Telephone (US): 1-919-872-3020; Fax (US): 1-800-75-EXIDE; International Telephone: 1-919-870-3150; International Fax: 1-919-870-3300

PLS08FXA 5/95

Powerware® Plus 150 On-line Uninterruptible Power System

Model 100	100kVA / 80kW
Model 125	125kVA / 100kW
Model 150	150kVA / 120kW



Powerware Plus 40 / 50 / 65 / 80 (left)
Powerware Plus 125 / 150 (right)

The Exide Electronics Powerware Plus 150 combines on-line UPS technology with the latest in network communications. A complete solution for your mission-critical applications. For use in both mainframe and client/server environments, the Plus 150 gives you:

- Continuous on-line protection
- Superior system reliability
- World class quality
- Flexible network communications

The Exide Electronics Powerware Plus 150 UPS provides power protection through superior on-line technology, flexible communications and user-friendly operation. A variety of options allows easy integration of the Plus 150 into centralized or remote monitoring systems, and network adapters provide LAN connectivity and SNMP compatibility. Other communications options include remote terminal capabilities, remote monitoring panel and remote emergency power-off, which are available through standard RS-232 and RS-485 ports.

Powerful, yet easy to understand. The Powerware Plus 150's monitor panel features a large easy-to-read LCD, push-button controls, operational metering features, utility statistics and intelligent alarm management. These features allow you to quickly monitor UPS operations and the status of the supported system. A battery monitoring and test system proactively identifies the battery time available, should a loss of utility power occur.

The Powerware Plus 150 is equipped with intelligent controls, dual-feed input capability, self-diagnostics, redundant fans and redundant control power supplies. The integration of insulated gate bipolar transistors (IGBTs) into a high speed inverter lets the Plus 150 more effectively support demanding non-linear loads, such as PCs, laser printers and industrial motor drives.

EXIDE ELECTRONICS
Strategic Power Management

Powerware Plus 150 Performance Characteristics

		Model 100 100kVA/80kW					Model 125 125kVA/100kW					Model 150 150kVA/120kW				
Input Voltage †	Volts	480	480	208	600	400	480	480	208	600	400	480	480	208	600	400
Output Voltage †	Volts	208	480	208	208	400	208	480	208	208	400	208	480	208	208	400
Input Voltage Range																
Minimum	Volts	408	408	177	510	340	408	408	177	510	340	408	408	177	510	340
Maximum	Volts	528	528	229	660	440	528	528	229	660	440	528	528	229	660	440
Input / Output Frequency	Hz	60	60	60	60	50/60	60	60	60	60	50/60	60	60	60	60	50/60
AC Input (With input filter)																
Nominal Amps	Amps	111	111	256	89	134	139	139	320	111	168	166	166	384	134	200
Maximum Amps	Amps	139	139	320	111	168	174	174	400	139	210	208	208	480	167	250
AC Input (Without input filter)																
Nominal Amps	Amps	130	130	302	105	158	163	163	377	130	198	196	196	452	157	235
Maximum Amps	Amps	163	163	377	131	198	204	204	471	163	247	245	245	565	196	294
Bypass Input																
Nominal Amps	Amps	120	120	278	96	146	150	150	347	120	182	180	180	416	144	217
AC Output																
Nominal Amps	Amps	278	120	278	278	146	347	150	347	347	182	416	180	416	416	217
10 Minutes Max.	Amps	348	150	348	348	183	434	188	434	434	228	520	225	520	520	271
DC Link																
Nominal DC Voltage	Volts	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480
Float Voltage	Volts	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
End of Discharge	Volts	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401
Maximum Amps	Amps	200	200	200	200	200	250	250	250	250	250	300	300	300	300	300
Physical Attributes (w/o batt.)																
Installed Weight ††	Lbs	3150	3150	5000	5000	3975	3150	3150	5000	5000	3975	3150	3150	5000	5000	3975
Installed Width	Inches	49	49	73	73	49	49	49	73	73	49	49	49	73	73	49
Systems Efficiencies																
@ 100% Load	%	92	92	91	91	91	92	92	91	91	91	92	92	90	90	91
@ 75% Load	%	92	92	90	90	90	92	92	91	91	91	92	92	91	91	91
@ 50% Load	%	91	91	88	88	88	92	92	89	89	89	92	92	90	90	90
Full Load Heat Dissipation																
BTU/Hr. (x1000)		23.6	23.8	27.0	27.0	27.0	29.7	29.7	33.8	33.8	33.8	35.6	35.6	45.5	45.5	40.5
KCal/Hr. (x1000)		5.99	5.99	6.81	6.81	6.81	7.48	7.48	8.51	8.51	8.51	8.98	8.98	11.47	11.47	10.21
Inverter Efficiency (Full Load)	%	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93

† Easily adjustible for 380, 400 or 415 VAC Inut/Output, 50 or 60 Hz

†† All cabinets are 73.5 inches (1867 mm) high and 31.5 inches (800 mm) in depth

Powerware Plus 150 Battery Protection Time At 25°C (In Minutes)

Battery Cabinet	Nominal DC Voltage	Total Battery Cabinets	Output Load on UPS in kW 40	50	60	80	100	120	Weight (lbs.)	Width (in.)
5508	480	1	14	9	5	N/A	N/A	N/A	2,225	24
8008	480	1	28	20	15	9	5	N/A	3,325	36
5516	480	2	38	28	21	14	9	5	4,450	48
8016	480	2	60	48	40	27	20	15	6,650	72
8024	480	3	90	70	60	46	35	28	9,975	108
8032	480	4	120	95	80	60	49	40	13,300	144

All battery cabinets are 73.5 inches (1867mm) high and 31.5 inches (800mm) in depth; Line-up configuration

cifications subject to change without notice.

previously mentioned corporate names and brands are registered as trademarks by their respective companies.

1-800-554-3448 (Toll-free in US & Canada) World Headquarters, 8521 Six Forks Road, Raleigh, NC 27615 USA
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PLS10FXA 5/95

4.8 ECO 8: CHILLER REPLACEMENT

__Proposed Modifications__: Replace the current chillers with more efficient and environment-friendly chillers. The proposed chillers are scroll air-cooled 40-ton chillers.

The main advantage of a scroll air-cooled chiller is its part-load efficiency is very high compared to the existing chillers. This is important for the GEODDS site since it operates at partial loads the majority of the year. The proposed chillers at full-load use 1.51 kW/ton, but at half load this ratio drops to 1.02 kW/ton.

__Existing Conditions__: The current chillers at full-load use 1.43 kW/ton. At half-load, this ratio increases to 1.72 kW/ton. These chillers also use R-22 refrigerant as their coolant which has been linked to the destruction of the ozone layer.

__Method of Analysis__: Analysis proceeded as follows:

- The nameplate information of the chillers was obtained during the field survey, as were the specifications on the replacement chillers.
- Manufacturer's specifications were used to determine the tonnages and kW consumed of both existing and proposed chillers at part-loads.
- The baseline computer model was modified to reflect the replacement of the current chillers with scroll air-cooled chillers.
- The savings from the avoided cost of replacing the existing chillers in 10 years, at the end of their expected useful life, was included in the analysis.

__Results__: Replacing the chillers will result in large energy and cost savings. The LCCA is summarized in the following table.

Annual Electric Energy Savings (kWh)	85,453
Total Annual Energy Cost Savings	$7,016
Annual Maintenance Cost Savings	$0
Discounted Replacement Cost Savings	$93,865
Investment Cost	$99,539
Savings-to-Investment Ratio (SIR)	2.01
Simple Payback (Years)	8.30

Recommendations: The current chillers should be replaced by two 30-ton scroll chillers. The GEODSS site will see an approximate 8% decrease in energy consumption.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Apr-95
3. INSTALLATION AND LOCATION GEODSS Site, White Sands Missile Range, NM		
4. PROJECT TITLE ECIP: Upgrade Lighting Systems		5. PROJECT NUMBER

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

LOCATION: GEODSS Site, White Sands Missile Range, NM — REGION: 4 — PROJECT N 1413-001
PROJECT TITLE: ECIP: REPLACE CHILLERS — FISCAL YEA 1995
DISCRETE PORTION NAME: TOTAL
ANALYSIS DATE: 11/10/95 — ECONOMIC LIFE: 20 — PREPARED B D Jones

1\. INVESTMENT

A.	CONSTRUCTION COST	= =	$89,272	
B.	SIOH COST	(5.5% of 1A) =	$4,910	
C.	DESIGN COST	(6.0% of 1A) =	$5,356	
D.	TOTAL COST	(1A +1B +1C) =	$99,539	
E.	SALVAGE VALUE OF EXISTING EQUIPMENT =			
F.	PUBLIC UTILITY COMPANY REBATE =			
G.	TOTAL INVESTMENT	(1D -1E -1F) =	------->	$99,539

2\. ENERGY SAVINGS (+) OR COST (-):
DATE OF NISTR-4942-1 USED FOR DISCOUNT FACTORS: OCT '94

	ENERGY SOURCE	FUEL COST $/kWh (1)	SAVINGS kWh (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	ISCOUNTED SAVINGS (5)	
A.	ELEC	$0.0821	85,456	$7,016	15.08	$105,800	
B.	DIST						
C.	NAT GAS						
D.	REFUS						
E.	COAL						
F.	OTHER						
G.	DEMAND SAVINGS						
H.	TOTAL		85,456	$7,016		-------->	$105,800

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

A. ANNUAL RECURRING (+/-)
1 DISCOUNT FACTOR (From Table A) =
2 DISCOUNTED SAVINGS (+) / COST (-) (3A x 3A1) =

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE B)	DISCOUNTED SAVINGS/COST (4)
a. AVOIDED COST OF CHILLER REPLA	$99,539	2	0.943	$93,865
b. MATERIAL: NONE				
c. MATERIAL: NONE				
d. TOTAL	$99,539			$93,865

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-) (3A2 + 3Bd4) = $93,865

4.	FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bd1/Economic Life))	$11,993
5.	SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	8.30
6.	TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$199,665
7.	DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	2.01

Existing Reciprocating Chiller

Specified capacity 428,750 Btuh
35.73 tons

Full load performance
0.274 Btu in/Btu out — DOE default for reciprocating chiller
0.96 kW/ton — DOE default for reciprocating chiller
1.43 kW/ton — Carrier 30GB-40 Air cooled chiller
115 EAT, 45 LWT

Part load performance %kW = 0.0881 + 1.138 * PLR - 0.2258 * PLR^2
where PLR is part load ratio — DOE default for reciprocating chiller

PLR	TONS	kW	kW / Ton	% kW
1.00	31.3	44.80	1.43	1.00
0.75	23.5	36.49	1.55	0.81
0.50	15.7	26.91	1.72	0.60
0.25	7.8	16.06	2.05	0.36

Proposed Scroll Chiller

Selected Model CCAD-40
Condenser CAUC-C50
Part load performance

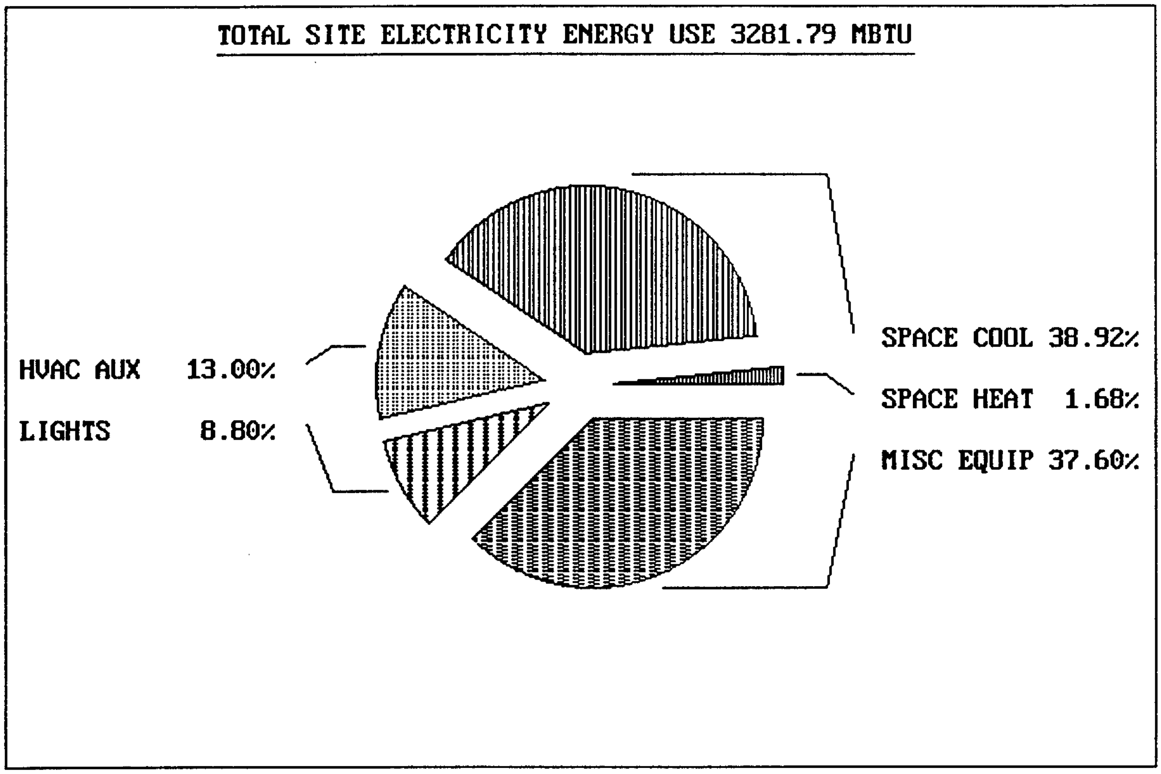
PLR	TONS	kW	kW / Ton	% kW
1.00	34.4	52.00	1.51	1.000
0.75	25.8	32.46	1.26	0.624
0.50	17.2	17.63	1.02	0.339
0.25	8.6	8.67	1.01	0.167

Energy Savings

Current Energy Use (MBTU)	3573.45
Proposed Energy Use (MBTU)	3281.79
Annual Energy Savings (MBTU)	291.66
Annual Energy Savings (kWh)	85,456
Annual Cost Savings ($)	$7,015.91
UPV Factor (20 years)	15.08
Discounted Energy Savings	**$105,800**

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	55.12
SPACE COOL	1277.30
HVAC AUX	426.63
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3281.79

TOTAL SITE ENERGY 3281.71 MBTU 287.9 KBTU/SQFT-YR GROSS-AREA 287.9 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 3281.71 MBTU 287.9 KBTU/SQFT-YR GROSS-AREA 287.9 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED =100.0
NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.



ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		White Sands Missile Range, NM	

PROJECT TITLE	CONTRACT NO.
Replace Chiller GEODSS, Energy Conservation Survey	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	No. of Units	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Manhrs/ Unit	LABOR COST Total Manhrs	LABOR COST Labor Cost/ Manhour	LABOR COST Total Labor Cost	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	Trane 30-ton Scroll Chiller CCAD-30	Ea.	2	$16,338	$32,675	118.00	236.00	$22.99	$5,426	$0.00	$0	$19,050	$38,101
2	with Condenser CAUC-C40	Ea.	2	$0.00	$0	0.00	0.00	$22.99	$0	$0.00	$0	$0	$0
3					$0	0.00	0.00	$22.99	$0	$0.00	$0	$0	$0
4	Travel to Socorro	hrs	24		$0	1.00	24.00	$22.99	$552	$0.00	$0	$22.99	$552
5	Demolition	Ea.	2	$0.00	$0	16.00	32.00	$22.99	$736	$0.00	$0	$367.84	$736
6	Travel to job site	hrs	30		$0	1.00	30.00	$22.99	$690	$0.00	$0	$22.99	$690
7	Lodging and per diem	days	30		$0		0.00	$22.99	$0	$100.00	$3,000	$100.00	$3,000
8	Milage	miles	600		$0		0.00	$22.99	$0	$0.30	$180	$0.30	$180
9					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
10					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
11					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
12					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
13					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
14					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
15					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
16					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
17					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
18					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
19					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
20					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
21					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
22					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
23					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
24					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
25					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
26					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
27					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
28					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
29					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
30					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
31					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
32					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
33					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
34					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
35					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
36					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
37					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
38					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
39	SUBCONTRACTOR SUBTOTAL				$32,675		322		$7,403		$3,180		$43,258
40	LABOR BURDEN	%	30		$0				$2,221		$954		$3,175
41	SUBTOTAL				$32,675				$9,624		$4,134		$46,433
42	OVERHEAD	%	12.0		$3,921				$1,155		$496		$5,572
43	SUBTOTAL				$36,596				$10,778		$4,630		$52,005
44	PROFIT	%	12		$4,392				$1,293		$556		$6,241
45	SUBCONTRACTOR TOTAL				$40,988				$12,072		$5,186		$58,245
46	OVERHEAD	%	10.95		$4,488				$1,322		$568		$6,378
47	SUBTOTAL				$45,476				$13,394		$5,754		$64,623
48	PROFIT	%	8		$3,638				$1,071		$460		$5,170
49	SUBTOTAL				$49,114				$14,465		$6,214		$69,793
50	BOND	%	0.737		$362				$107		$46		$514
51	SUBTOTAL				$49,476				$14,572		$6,260		$70,307
52	N. M. TAX	%	5.8125		$2,876				$847		$364		$4,087
53	SUBTOTAL				$52,351				$15,419		$6,623		$74,394
54	CONTINGENCY	%	20		$10,470				$3,084		$1,325		$14,879
55	GRAND TOTAL				$62,822				$18,503		$7,948		$89,272

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
EMS		E M C Engineers, Inc.	11/10/95

157 | Air Conditioning and Ventilation

157 100 | A.C. & Vent. Units

	157 100 A.C. & Vent. Units	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1995 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
15	80 ton cooling	Q-8	.10	320	Ea.	42,800	8,925	525	52,250	61,500	190
152	100 ton cooling		.09	355		49,700	9,925	585	60,210	70,500	
1540	120 ton cooling		.08	400		55,000	11,200	655	66,855	78,500	
1560	135 ton cooling		.07	457		62,500	12,800	750	76,050	89,500	
1580	150 ton cooling		.07	457		66,500	12,800	750	80,050	93,500	
1600	175 ton cooling		.06	533		76,500	14,900	875	92,275	108,000	
1620	200 ton cooling		.05	640		88,500	17,900	1,050	107,450	126,000	
1640	225 ton cooling		.05	640		94,000	17,900	1,050	112,950	132,000	
1660	250 ton cooling		.04	800		102,500	22,300	1,300	126,100	148,000	
4000	Packaged chiller, with remote air cooled condensers incl.										
4020	15 ton cooling	Q-7	.35	91.429	Ea.	12,300	2,550		14,850	17,400	
4030	20 ton cooling		.32	100		14,200	2,800		17,000	20,000	
4040	25 ton cooling		.30	106		16,900	2,975		19,875	23,200	
4050	30 ton cooling		.27	118		19,200	3,300		22,500	26,200	
4060	40 ton cooling		.22	145		24,900	4,050		28,950	33,500	
4070	50 ton cooling		.18	177		27,900	4,950		32,850	38,300	
4080	60 ton cooling		.14	228		30,400	6,375		36,775	43,200	
4090	70 ton cooling		.12	266		37,900	7,450		45,350	53,000	
4100	80 ton cooling		.11	290		38,900	8,125		47,025	55,000	
4110	90 ton cooling		.10	320		51,000	8,925		59,925	69,500	
4120	100 ton cooling		.09	355		56,500	9,925		66,425	77,000	
4130	110 ton cooling	Q-8	.08	400		58,000	11,200	655	69,855	81,500	
4140	120 ton cooling		.07	457		59,500	12,800	750	73,050	86,000	
4150	140 ton cooling		.06	533		66,000	14,900	875	81,775	96,500	
0010	WINDOW UNIT AIR CONDITIONERS										195
4000	Portable/window, 15 amp 125V grounded receptacle required										
4060	5000 BTUH	1 Carp	8	1	Ea.	275	24.50		299.50	345	
134	6000 BTUH		8	1		350	24.50		374.50	425	
4480	8000 BTUH		6	1.333		465	33		498	565	
4500	10,000 BTUH		6	1.333		525	33		558	635	
4520	12,000 BTUH	L-2	8	2		560	43.50		603.50	685	
4600	Window/thru-the-wall, 15 amp 230V grounded receptacle required										
4780	17,000 BTUH	L-2	6	2.667	Ea.	745	58		803	915	
4940	25,000 BTUH		4	4		980	87		1,067	1,225	
4960	29,000 BTUH		4	4		1,175	87		1,262	1,450	

157 200 | System Components

	157 200 System Components	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
010	COILS, FLANGED										201
100	Basic water or condenser coils										
110	Copper tubes, alum. fins, galv. end sheets										
112	H is finned height, L is finned length										
120	3/8" x .016 tube, .0065 AL fins										
130	2 row, 8 fins per inch										
140	4" H x 12" L	Q-5	48	.333	Ea.	255	8.80		263.80	294	
150	4" H x 24" L		24	.667		275	17.55		292.55	330	
160	4"H x 48"L		12	1.333		355	35		390	445	
170	4"H x 72"L		8	2		390	52.50		442.50	510	
180	6"H x 12"L		32	.500		266	13.15		279.15	315	
190	6"H x 24"L		16	1		287	26.50		313.50	355	
200	6"H x 48"L		8	2		375	52.50		427.50	495	
210	6"H x 72"L		5.33	3.002		420	79		499	580	
220	10"H x 12"L		19.30	.829		290	22		312	355	
30	10"H x 24"L		9.60	1.667		315	44		359	415	
40	10"H x 48"L		4.80	3.333		420	88		508	595	
50	10"H x 72"L		3.20	5		470	132		602	715	

MECHANICAL 15

TRANE™

6675 S. Kenton St., Suite 118
Englewood, CO 80111

FAX COVER SHEET

DATE:	September 29, 1995	**TIME:**	1:10 PM
TO:	**Dennis Jones** **EMC Engineers**	**PHONE:** **FAX:**	 .
FROM:	Gerry L. Boarman The Trane Company	**PHONE:** **FAX:**	303-705-9100 303-649-9195
RE:			
CC:			

Number of pages including cover sheet: 1

Message

Dennis,

Sorry for the delay.

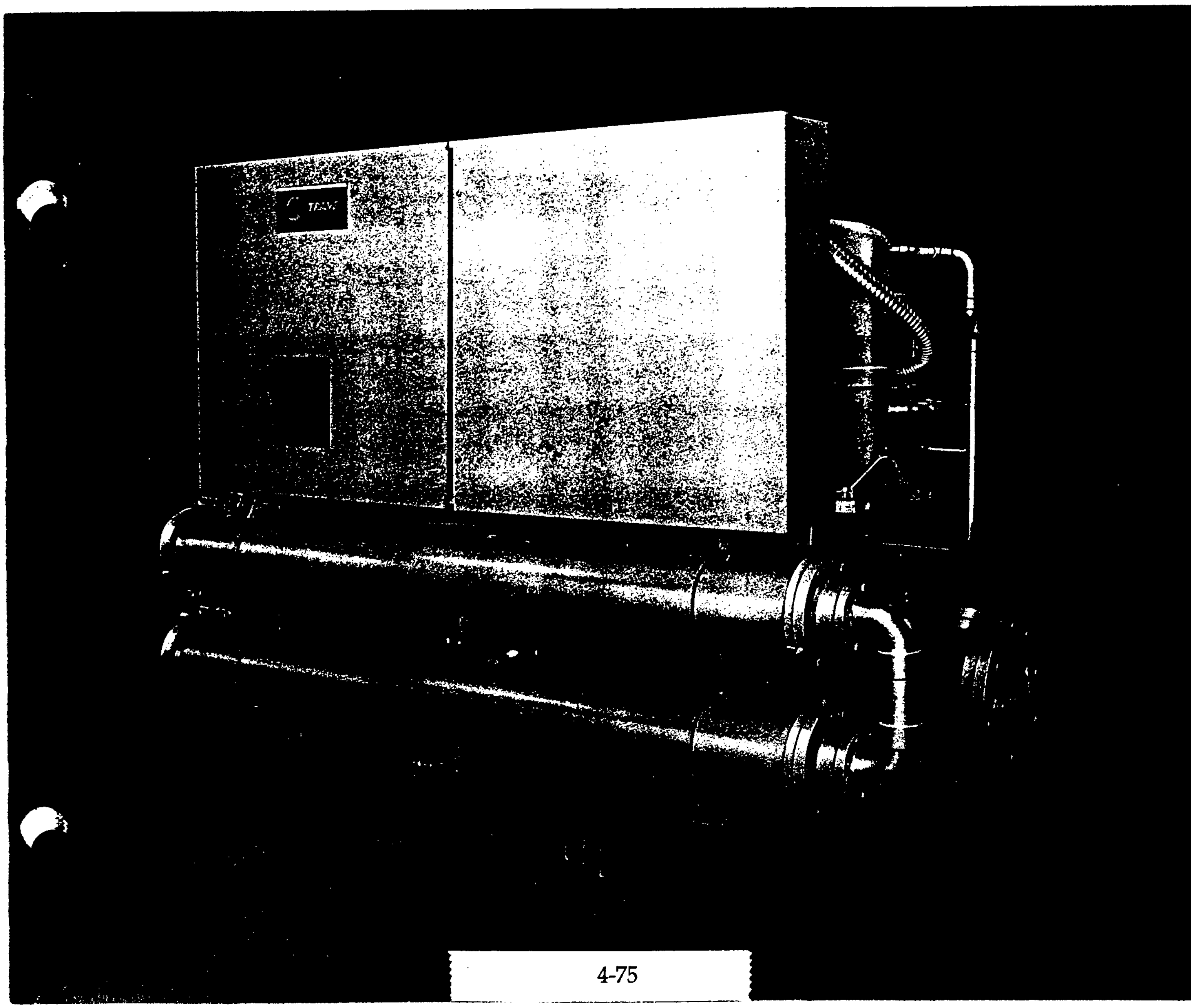
The budget for 2-30 ton compressor chillers and associated 40 ton air cooled condensers is $ 32,675.00 Please let me know what else I can get for you and thank you for the opportunity.

TRANE™

SLC-DS-1
January 1994
First Printing

Cold Generator® Scroll Liquid Chillers

20 to 60 Tons Water Cooled and Condenserless



Features and Benefits

Leading in Efficiency and Reliability With State-Of-The-Art Scroll Compressor Technology

Reliability
The Trane Cold Generator® water chiller with many new improvements, now brings an exciting new compressor to the commercial market — the Trane 3-D™ Scroll compressor. Trane has designed the scroll compressor to be a leader in reliability. HERE'S HOW:

- Simple design with 64 percent fewer parts than equal capacity reciprocating compressor.
- 3-D Scroll compliance allows liquid and dirt to pass through without damaging compressor (liquid slugging resistant).
- Advanced microelectronics protect both compressor and motor from typical electrical fault conditions.
- Scroll compressors have less than a third the torque variations of a reciprocating compressor.
- Years of laboratory testing have optimized compressor and chiller systems reliability.
- Water-Cooled Cold Generators are 100 percent RUN TESTED at the factory.

Efficiency
The energy efficiency of the Cold Generator liquid chiller results in energy costs lower than any other comparable chiller. Full load efficiencies are typical of reciprocating chillers, but part load efficiencies are simply unmatched by any other manufacturer.

Superior efficiencies are obtained by combining many of the traditional Cold Generator chiller energy efficient features with the Trane 3-D scroll compressor technology. HERE'S HOW:

- Scroll compressor's positive displacement design
- Dual refrigerant circuits (40-60 ton units)
- Multiple compressors
- Optimum system design
- Reduced Friction
- No Valves
- Advanced Heat Transfer Surfaces

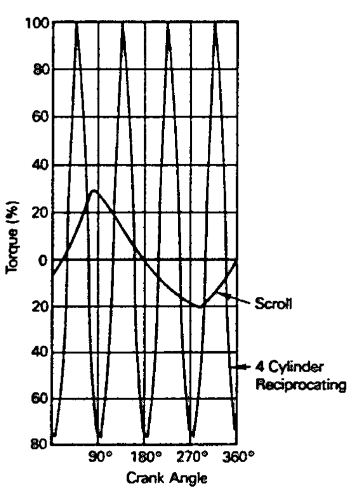
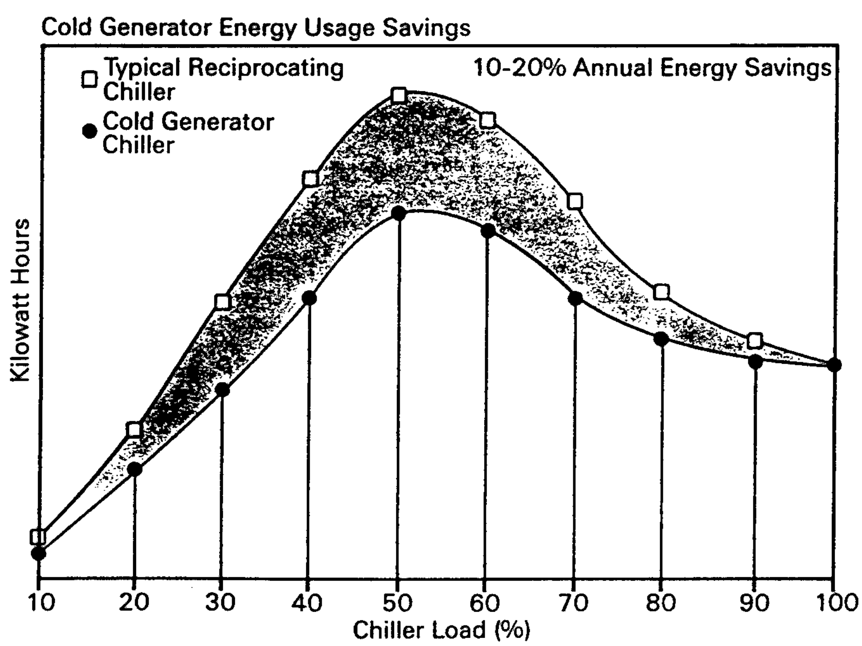


Chart illustrates low torque variation of 3-D scroll compressor vs reciprocating compressor.



Graph illustrates Trane Cold Generator chiller's superior annual energy costs vs typical reciprocating chillers.

Trane 3-D™ Compliance Scroll Compressor — Maximum Efficiency with Enhanced Reliability

How Does 3-D Compliance Work?
The 3-D compressor has a patented tip seal on the tip of each spiral. The tip seal acts like a piston ring to provide sealing between high and low pressure chambers without wearing the mating surfaces.

Radial compliance is achieved with a swing link mechanism that allows the spiral walls on the disks to touch without wear. The swing link joins the motor shaft and the orbiting scroll disk.

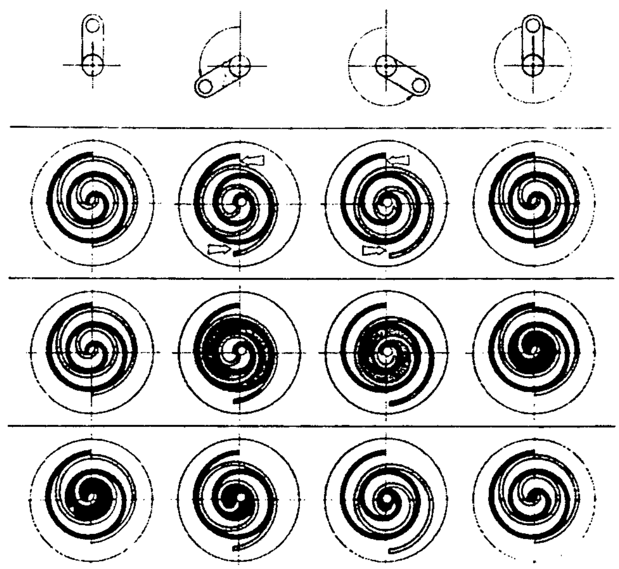
In normal operation this contact provides sealing between high and low pressure cavities. However, if a contaminant such as dirt or liquid refrigerant enters the compression chamber, the swing link allows the spiral walls to separate in the radial direction and pass the contamination without harm to the compressor.

General
The 3-D compressor has two scrolls. The top scroll is fixed and the bottom scroll orbits. Each scroll has walls in a spiral shape that mesh.

Inlet-First Orbit
As the bottom scroll orbits, two refrigerant gas pockets are formed and enclosed.

Compression-Second Orbit
The refrigerant gas is compressed as the volume is reduced closer to the center of the scroll.

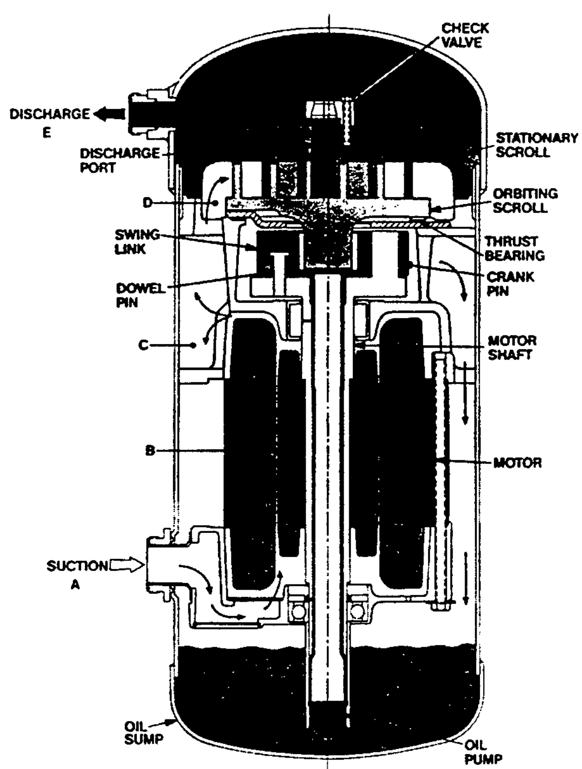
Discharge-Third Orbit
The gas is compressed further and discharged through a small port in the center of the fixed scroll.



Scroll Principal Components
This is a cutaway view of a hermetic, scroll compressor, showing the relative positions of the principal components. Shown is a Trane 10-ton, 3600 rpm, scroll compressor as an example.

The principle of operation of this example compressor is as follows: The suction gas is drawn into the compressor at A. The gas then passes through the gap between the rotor and stator, B, cooling the motor, before it enters the compressor housing, C. Here, the velocity of the gas is reduced, causing a separation of the entrained oil from the gas stream. The gas then enters the intake chamber, D, that encircles the scrolls.

Finally, the suction gas is drawn into the scroll assembly where it is compressed and discharged into the dome of the compressor. The dome of this example compressor acts as a hot gas muffler which dampens the pulsations before the gas enters the discharge line, E.



Performance Data

Table 16-1 — CCAD Performance Data, 42 F Leaving Chilled Water Temperature

		Entering Condenser Air Temperature											
		85			95			105			115		
Unit Size	Condenser Size	Tons	Kw	EER	Tons	Kw	EER	Tons	Kw	EER	Tons	Kw	EER
20	CAUC-C20	19.4	19.5	11.8	18.4	21.6	10.1	17.3	23.9	8.6	16.1	26.6	7.2
20	CAUC-C25	19.7	18.6	12.6	18.7	20.6	10.8	17.6	23.0	9.1	16.5	25.5	7.7
25	CAUC-C25	24.1	24.9	11.5	22.8	27.6	9.9	21.5	30.6	8.4	20.0	34.0	7.0
25	CAUC-C30	24.5	23.4	12.5	23.3	26.0	10.7	22.0	28.9	9.1	20.6	32.1	7.7
30	CAUC-C30	28.8	29.1	11.8	27.3	32.2	10.1	25.7	35.7	8.6	24.1	39.6	7.3
30	CAUC-C40	29.2	27.0	12.9	27.8	29.9	11.1	26.3	33.2	9.5	24.7	36.9	8.0
40	CAUC-C40	38.7	38.8	11.9	36.7	43.0	10.2	34.5	47.8	8.6	32.2	53.2	7.2
40	CAUC-C50	39.1	37.4	12.5	37.1	41.6	10.6	35.0	46.2	9.0	32.7	51.4	7.6
50	CAUC-C50	47.6	50.2	11.3	45.1	55.6	9.7	42.5	61.8	8.2	39.7	68.4	6.9
50	CAUC-C60	48.4	47.0	12.3	46.0	52.2	10.5	43.5	58.2	8.9	40.8	64.6	7.6
60	CAUC-C60	56.9	58.4	11.6	54.0	64.8	10.0	50.9	71.8	8.5	47.6	79.8	7.1
60	CAUC-C80	57.5	53.6	12.8	54.7	59.6	11.0	51.8	66.4	9.3	48.6	73.8	7.9

Table 16-2 — CCAD Performance Data, 44 F Leaving Chilled Water Temperature

		Entering Condenser Air Temperature											
		85			95			105			115		
Unit Size	Condenser Size	Tons	Kw	EER	Tons	Kw	EER	Tons	Kw	EER	Tons	Kw	EER
20	CAUC-C20	20.0	19.7	12.1	19.0	21.8	10.4	17.8	24.2	8.8	16.6	26.8	7.4
20	CAUC-C25	20.4	18.8	12.9	19.3	20.8	11.0	18.2	23.2	9.3	17.1	25.7	7.9
25	CAUC-C25	24.9	25.1	11.8	23.6	27.9	10.1	22.2	30.9	8.6	20.7	34.3	7.2
25	CAUC-C30	25.3	23.7	12.7	24.1	26.3	10.9	22.7	29.2	9.3	21.3	32.4	7.9
30	CAUC-C30	29.7	29.4	12.1	28.2	32.6	10.3	26.6	36.1	8.8	24.9	40.0	7.4
30	CAUC-C40	30.2	27.2	13.2	28.8	30.2	11.4	27.2	33.5	9.7	25.6	37.2	8.2
40	CAUC-C40	39.9	39.2	12.1	37.8	43.4	10.4	35.6	48.2	8.8	33.3	53.6	7.4
40	CAUC-C50	40.3	37.8	12.7	38.3	42.0	10.9	36.1	46.6	9.2	33.8	51.8	7.8
50	CAUC-C50	49.1	50.6	11.6	46.6	56.2	9.9	43.9	62.2	8.4	41.0	69.0	7.1
50	CAUC-C60	50.0	47.4	12.6	47.5	52.6	10.8	44.9	58.6	9.2	42.2	65.2	7.7
60	CAUC-C60	58.7	58.5	12.0	55.7	65.4	10.2	52.6	72.6	8.7	49.2	80.6	7.3
60	CAUC-C80	59.3	54.0	13.1	56.5	60.0	11.3	53.5	66.8	9.6	50.3	74.4	8.1

Table 16-3 — CCAD Performance Data, 45 F Leaving Chilled Water Temperature

		Entering Condenser Air Temperature											
		85			95			105			115		
Unit Size	Condenser Size	Tons	Kw	EER	Tons	Kw	EER	Tons	Kw	EER	Tons	Kw	EER
20	CAUC-C20	20.3	19.8	12.2	19.3	21.9	10.5	18.1	24.3	8.9	16.9	26.9	7.5
20	CAUC-C25	20.7	18.9	13.0	19.6	20.9	11.2	18.5	23.3	9.5	17.3	25.8	8.0
25	CAUC-C25	25.3	25.3	11.9	24.0	28.0	10.2	22.6	31.1	8.7	21.1	34.4	7.3
25	CAUC-C30	25.8	23.8	12.9	24.5	26.4	11.1	23.1	29.3	9.4	21.7	32.5	8.0
30	CAUC-C30	30.2	29.5	12.2	28.7	32.7	10.5	27.0	36.3	8.9	25.3	40.2	7.5
30	CAUC-C40	30.7	27.3	13.4	29.2	30.3	11.5	27.7	33.7	9.8	26.0	37.4	8.3
40	CAUC-C40	40.5	39.4	12.3	38.4	43.6	10.5	36.2	48.4	8.9	33.8	53.8	7.5
40	CAUC-C50	40.9	38.0	12.8	38.9	42.0	11.1	36.7	46.8	9.4	34.4	52.0	7.9
50	CAUC-C50	49.9	50.8	11.7	47.3	56.4	10.0	44.6	62.6	8.5	41.7	69.4	7.2
50	CAUC-C60	50.8	47.6	12.7	48.3	53.0	10.9	45.7	58.8	9.3	42.9	65.4	7.8
60	CAUC-C60	59.6	59.2	12.0	56.6	65.6	10.3	53.4	72.8	8.8	50.1	80.8	7.4
60	CAUC-C80	60.3	54.2	13.3	57.4	60.4	11.4	54.4	67.2	9.7	51.1	74.6	8.2

30 ton

40 ton

Notes:
1. Evaporator fouling factor is 0.00025 on ARI Standard 590-92.
2. Interpolation between points is permissible. Extrapolation is not permitted.
3. Kw input is for compressors only.
4. EER = Energy Efficiency Ratio, (Btu/watt-hour). Power includes compressors and control power.
5. Rated in accordance with ARI Standard 590-92.
6. Ratings are based on evaporator temperature drop of 10 F.

Proposed Chiller

Performance Data Part Load

Table 15-1 — CGWD 20-60 Ton Part Load Performance

CGWD 20 Unit Compressor Capacity					
	100%	75%	50%	25%	IPLV
Tons	20.6	15.5	10.3	5.2	
Kw	16.4	10.7	5.9	3.1	18.1
EER	15.0	17.2	20.6	18.7	

CGWD 25 Unit Compressor Capacity					
	100%	75%	50%	25%	IPLV
Tons	24.9	18.7	12.5	6.2	
Kw	21.8	14.2	9.0	4.7	15.4
EER	13.6	15.6	16.2	15.2	

CGWD 30 Unit Compressor Capacity					
	100%	75%	50%	25%	IPLV
Tons	29.5	22.1	14.8	7.4	
Kw	25.8	17.3	9.9	5.2	15.8
EER	13.7	15.2	17.5	16.4	

30 ton

CGWD 40 Unit Compressor Capacity					
	100%	75%	50%	25%	IPLV
Tons	41.2	30.9	20.6	10.3	
Kw	33.0	20.6	11.2	5.5	19.0
EER	14.9	17.8	21.7	21.3	

40 ton

CGWD 50 Unit Compressor Capacity					
	100%	75%	50%	25%	IPLV
Tons	48.6	36.5	24.3	12.2	
Kw	42.6	27.3	16.2	8.1	16.3
EER	13.6	15.8	17.8	17.6	

CGWD 60 Unit Compressor Capacity					
	100%	75%	50%	25%	IPLV
Tons	59.3	44.5	29.7	14.8	
Kw	52.2	33.9	19.3	9.4	16.5
EER	13.6	15.7	18.2	18.4	

Notes:
1. Evaporator and condenser flow rates are constant. Flow rates determined at ARI full load standard rating points.
2. Part load is rated in accordance with ARI Standard 590-92.
3. IPLV is a single number part-load efficiency figure of merit calculated per ARI Standard 590-92.
4. KW input is for compressor(s) only.

Performance data (cont) Existing Chiller

PERFORMANCE RATINGS (10 F Chilled Water Rise)

UNIT 30		CAP. (Tons)	SDT (F)	COMPR KW	COOLER FLOW DATA Gpm	PD	CAP. (Tons)	SDT (F)	COMPR KW	COOLER FLOW DATA Gpm	PD	CAP. (Tons)	SDT (F)	COMPR KW	COOLER FLOW DATA Gpm	PD
		105 F Condenser Entering Air Temperature														
		40 F LCWT					42 F LCWT					44 F LCWT				
GA	020	15.4	127.4	20.1	36.8	2.8	16.1	128.3	20.5	38.5	3.0	16.9	129.4	21.0	40.4	3.3
	025	19.5	127.1	25.4	46.6	4.3	20.4	128.1	26.2	48.9	4.7	21.4	129.2	26.9	51.3	5.2
	030	22.8	125.2	28.7	54.6	5.8	23.9	126.1	29.4	57.1	6.4	24.9	127.0	30.1	59.7	6.9
GB	040	30.4	130.3	40.7	72.6	7.5	31.7	131.4	41.7	75.9	8.1	33.1	132.4	42.7	79.2	8.8
	045	37.8	130.0	50.0	90.3	6.5	39.4	131.1	51.3	94.4	7.1	41.2	132.1	52.6	93.6	7.7
	055	44.0	131.5	59.5	105.1	8.8	45.9	132.6	61.0	169.8	9.5	47.8	133.7	62.5	114.5	10.3
	070	57.9	130.1	78.4	138.4	9.8	60.5	131.1	80.3	144.6	10.7	63.1	132.1	82.4	151.0	11.6
GA	085	69.8	131.6	98.0	166.7	8.7	72.8	132.7	100.5	174.1	9.4	75.9	133.8	103.0	181.7	10.2
	105	87.5	132.1	118.4	209.1	7.4	90.9	133.1	121.2	217.5	7.9	94.4	134.1	124.0	226.0	8.5
	110	95.8	135.1	145.4	229.1	8.8	99.5	136.2	149.0	238.0	9.4	103.2	137.3	152.6	247.1	10.1
	120	103.0	138.1	170.7	246.1	10.1	106.8	139.2	175.0	255.4	10.8	110.6	140.4	179.3	264.9	11.6
		45 F LCWT					46 F LCWT					48 F LCWT				
GA	020	17.2	129.9	21.3	41.3	3.4	17.6	130.4	21.5	42.2	3.6	18.4	131.4	22.0	44.1	3.9
	025	21.9	129.7	27.3	52.5	5.4	22.4	130.2	27.6	53.8	5.7	23.5	131.3	28.4	56.3	6.2
	030	25.5	127.4	30.4	61.0	7.2	26.0	127.9	30.8	62.3	7.5	27.1	128.8	31.5	65.0	8.1
GB	040	33.8	132.9	43.1	80.9	9.2	34.5	133.5	43.6	82.6	9.6	35.9	134.6	44.6	86.1	10.3
	045	42.0	132.7	53.2	100.7	8.1	42.9	133.2	53.8	102.8	8.4	44.7	134.3	55.1	107.2	9.1
	055	48.8	134.3	63.3	116.9	10.7	49.8	134.8	64.1	119.4	11.2	51.9	136.0	65.7	124.4	12.1
	070	64.4	132.7	83.4	154.3	12.1	65.8	133.2	84.4	157.5	12.6	68.5	134.3	86.4	164.2	13.6
GA	085	77.5	134.4	104.3	185.6	10.7	79.1	134.9	105.6	189.5	11.1	82.3	136.0	108.1	197.3	12.0
	105	96.2	134.7	125.4	230.4	8.9	98.0	135.2	126.9	234.8	9.2	101.7	136.2	129.7	243.7	9.9
	110	105.1	137.9	154.4	251.7	10.5	107.0	138.4	156.2	256.4	10.9	110.9	139.5	159.9	265.8	11.7
	120	112.6	140.9	181.4	269.6	12.0	114.6	141.5	183.6	274.4	12.4	118.6	142.7	188.0	284.2	13.3

PERFORMANCE RATINGS (10 F Chilled Water Rise)

UNIT 30		CAP. (Tons)	SDT (F)	COMPR KW	COOLER FLOW DATA Gpm	PD	CAP. (Tons)	SDT (F)	COMPR KW	COOLER FLOW DATA Gpm	PD	CAP. (Tons)	SDT (F)	COMPR KW	COOLER FLOW DATA Gpm	PD
		115 F Condenser Entering Air Temperature														
		40 F LCWT					42 F LCWT					44 F LCWT				
GA	020	14.2	136.2	20.8	34.0	2.4	14.9	137.1	21.3	35.6	2.6	15.6	138.1	21.9	37.4	2.9
	025	17.6	135.5	25.7	42.1	3.6	18.6	136.5	26.6	44.4	4.0	19.5	137.5	27.4	46.7	4.4
	030	21.2	134.3	30.0	50.7	5.1	22.2	135.1	30.8	53.1	5.5	23.2	135.9	31.6	55.5	6.0
GB	040	28.1	139.1	42.2	67.1	6.4	29.4	140.0	43.2	70.2	7.0	30.7	141.1	44.3	73.4	7.6
	045	35.0	138.8	52.1	83.6	5.6	36.6	139.8	53.4	87.5	6.2	38.2	140.8	54.8	91.5	6.7
	055	40.8	140.3	61.9	97.6	7.6	42.6	141.3	63.6	102.0	8.3	44.5	142.4	65.3	106.5	9.0
	070	53.7	138.9	81.5	128.5	8.5	56.2	139.9	83.7	134.4	9.3	58.6	140.9	85.8	140.4	10.1
GA	085	64.8	140.4	101.9	155.0	7.5	67.7	141.5	104.5	162.1	8.2	70.7	142.5	107.3	169.3	8.9
	105	81.8	141.1	123.8	195.6	6.5	85.1	142.1	126.8	203.7	7.0	88.5	143.0	129.9	211.9	7.5
	110	89.8	144.1	151.9	214.6	7.7	93.3	145.1	155.7	223.1	8.3	96.9	146.2	159.6	231.8	9.0
	120	96.6	147.0	178.2	230.9	8.9	100.2	148.1	182.7	239.8	9.6	104.0	149.2	187.3	248.9	10.3
		45 F LCWT					46 F LCWT					48 F LCWT				
GA	020	16.0	138.6	22.1	38.2	3.0	16.3	139.1	22.4	39.1	3.1	17.1	140.1	22.9	40.9	3.4
	025	20.0	138.1	27.9	47.9	4.6	20.5	138.6	28.3	49.1	4.8	21.5	139.7	29.1	51.5	5.2
	030	23.7	136.4	31.9	56.8	6.3	24.2	136.8	32.3	58.0	6.6	25.3	137.7	33.1	60.6	7.1
GB	040	31.3	141.6	44.8	75.0	8.0	32.0	142.1	45.3	76.7	8.3	33.4	143.2	46.4	80.0	9.0
	045	39.0	141.3	55.5	93.5	7.0	39.9	141.9	56.1	95.5	7.3	41.6	143.0	57.5	99.7	7.9
	055	45.4	142.9	66.1	108.8	9.4	46.4	143.5	67.0	111.1	9.7	48.3	144.6	68.7	115.8	10.6
	070	59.9	141.4	87.0	143.5	10.5	61.2	141.9	88.1	146.6	11.0	63.8	143.0	90.3	153.0	11.9
GA	085	72.2	143.1	108.6	173.0	9.3	73.8	143.6	110.1	176.7	9.7	76.8	144.7	112.8	184.2	10.5
	105	90.2	143.5	131.4	216.0	7.8	92.0	144.0	133.0	220.3	8.1	95.5	145.1	136.1	228.8	8.7
	110	98.7	146.7	161.5	236.3	9.3	100.5	147.3	163.5	240.7	9.6	104.2	148.4	167.4	249.8	10.4
	120	105.9	149.8	189.6	253.5	10.7	107.8	150.4	191.9	258.1	11.0	111.6	151.6	196.6	267.5	11.8

Cap. — Capacity
Kw — Compressor Motor Power Input at Rated Voltage
LCWT — Leaving Chilled Water Temperature
PD — Pressure Drop (ft water)
SDT — Saturated Discharge Temperature

4.9 ECO 9: RECIRCULATE AIR IN TOWERS

Proposed Modification: Reduce the outside airflow rate in three telescope towers by installing a return air duct system in each tower for recirculation of room air.

Each return air duct system would come through the tower wall next to the existing supply air ductwork. Putting this system in place would involve cutting through the concrete between the tower and its adjacent compressor room and routing a return air duct back into the air handling unit (AHU) in that room. This system will intake only 400 cfm of outside air (OA) (or 20% of supply air) and return 1600 cfm from the tower.

Existing Conditions: Presently, the three telescope towers use 100% OA for cooling. This system consumes significant energy as the cool air is directly vented to the outside and is not reused. According to the building personnel, there is no specific reason why this particular system is in place.

Method of Analysis: Analysis proceeded as follows:

- A baseline computer model of the building was created using DOE2.1d which simulated the building energy consumption over a period of one year.

- The baseline computer model was modified to reflect an 80% reduction of the total outside air. The modified baseline computer model was subtracted from the baseline computer model to determine the energy savings.

Results: The LCCA summarized below represents the results of lowering outside air quantities on the AHUs serving the telescope towers.

Annual Electric Energy Savings (kWh)	74,537
Total Annual Energy Cost Savings	$6,118
Annual Maintenance Cost Savings	$0
Investment Cost	$22,767
Savings-to-Investment Ratio (SIR)	4.05
Simple Payback (Years)	3.7

Recommendations: The reduction of outside airflow in each tower is recommended for implementation.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Jul-95
3. INSTALLATION AND LOCATION GEODSS Site, White Sands Missile Range, NM		
4. PROJECT TITLE Recirculate Tower Air		5. PROJECT NUMBER

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

LOCATION: White Sands Missile Range, NM — REGION: 4 (New Mexico) — PROJECT NO: 1406.008
PROJECT TITLE: Recirculate Tower Air — FISCAL YEAR: 1995
ANALYSIS DATE: 12/01/95 — ECONOMIC LIFE: 20 — PREPARED BY: E.Smith

1. INVESTMENT

A. CONSTRUCTION COST		=	$20,328	
B. SIOH COST	(6.0% of 1A)	=	$1,220	
C. DESIGN COST	(6.0% of 1A)	=	$1,220	
D. TOTAL COST	(1A +1B +1C)	=	$22,767	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		=	$0	
F. PUBLIC UTILITY COMPANY REBATE		=	$0	
G. TOTAL INVESTMENT	(1D -1E -1F)	=	------->	$22,767

2. ENERGY SAVINGS (+) OR COST (-):
DATE OF NISTR-85-3273-9 USED FOR DISCOUNT FACTORS: Jul-95

ENERGY SOURCE	FUEL COST $/KWH (1)	SAVINGS KWH/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. ELECT. (SAV'GS)	$0.0821	74537	$6,119	15.08	$92,282	
B. DIST (GAL.)	$1.10	0	$0	18.57	$0	
C. RESID (GAL.)	$3.00	0	$0	21.02	$0	
D. NAT GAS (MBTU)	$6.18	0	$0	18.58	$0	
E. COAL	$2.00	0	$0	16.83	$0	
G. DEMAND ($/kW)	$0.00	0	$0	15.08	$0	
H. TOTAL		74,537	$6,119		-------->	$92,282

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

A. ANNUAL RECURRING (+/-)

1 ANNUAL MAINTENANCE SAVINGS	$0	14.88	$0
2		14.88	$0
3 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$0		$0

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAV'G/COST(4)
a.	$0	0	0.00	$0
b.	$0	0	0.00	$0
c.	$0	0	0.00	$0
d. TOTAL	$0			$0

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-) (3A3 + 3Bg4) = $0

4. FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bg1/Economic Life))	$6,119
5. SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	3.7
6. TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$92,282
7. DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	4.05

Economic Life (yrs)		20

Energy Information

Energy Type		Unit Energy Cost	UPW Discount Factors (1) Discount Rate = 4%, Region 4		
Economic Life of ECO (yrs)			10	15	20
Electric Energy		0.0821 ($/kWh)	8.58	12.02	15.08

(1) NISTER 4942-1 Energy Prices and Discount Factors for Life-Cycle Cost Analysis 1995

Proposed Supply Airflow Reduction

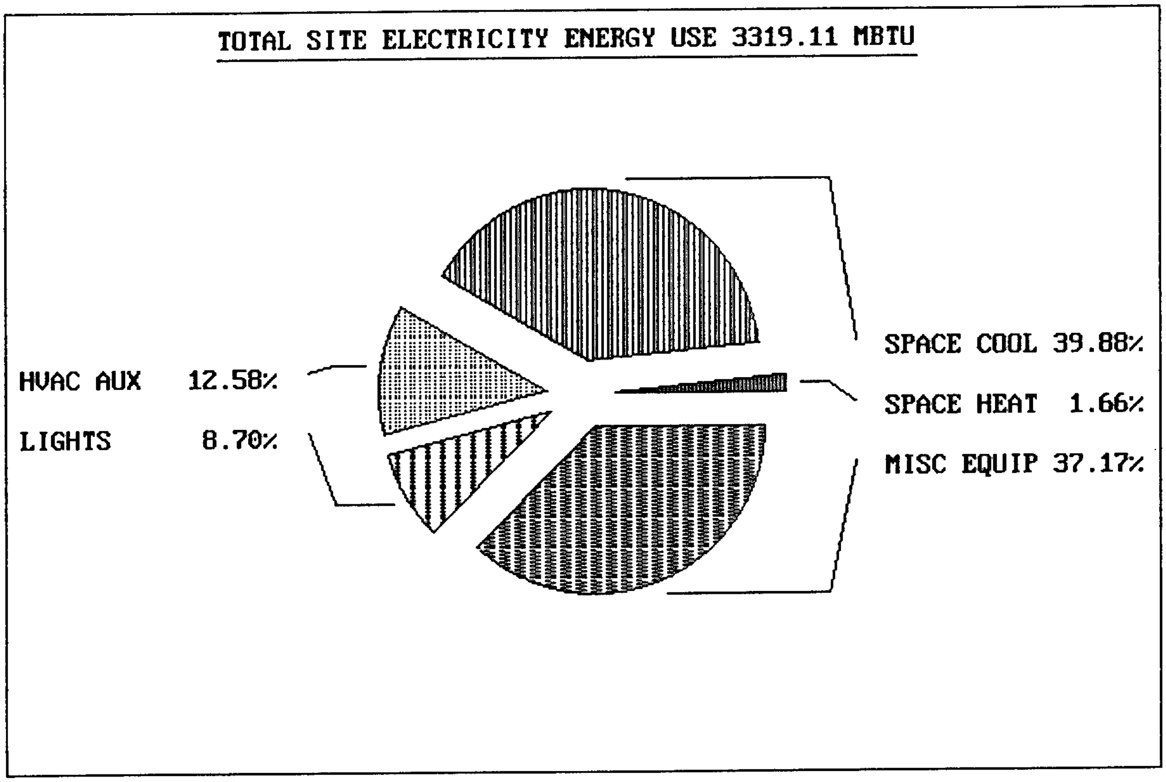
Zone	Floor Area (ft^2)	Existing Supply Airflow (cfm)	Existing Outside Airflow (cfm)	Existing Return Airflow (cfm)	Proposed Supply Airflow (cfm)	Proposed Outside Airflow (cfm)	Proposed Return Airflow (cfm)
Tower 1	576	2000	2000	0	2000	400	1600
Tower 2	576	2000	2000	0	2000	400	1600
Tower 3	576	2000	2000	0	2000	400	1600

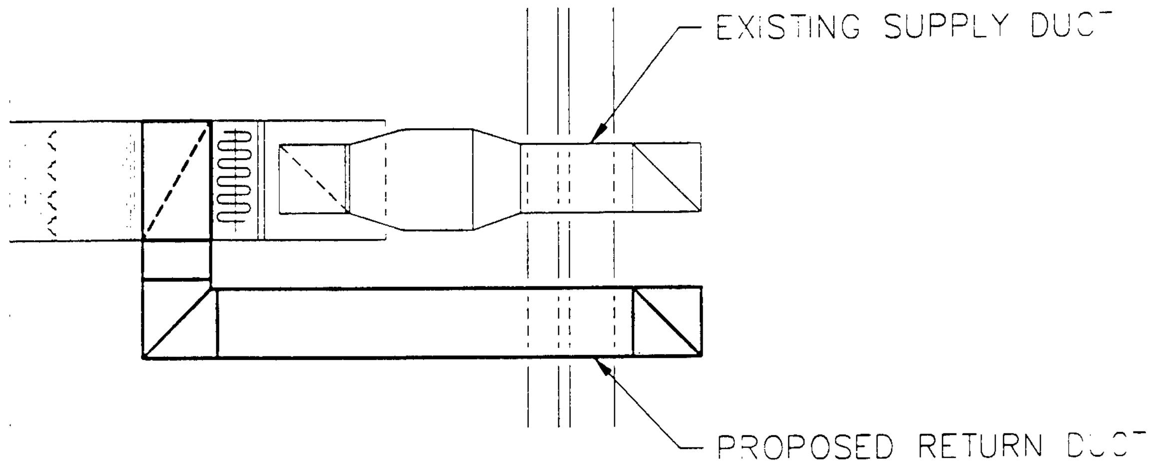
Energy Savings Predicted by DOE 2.1

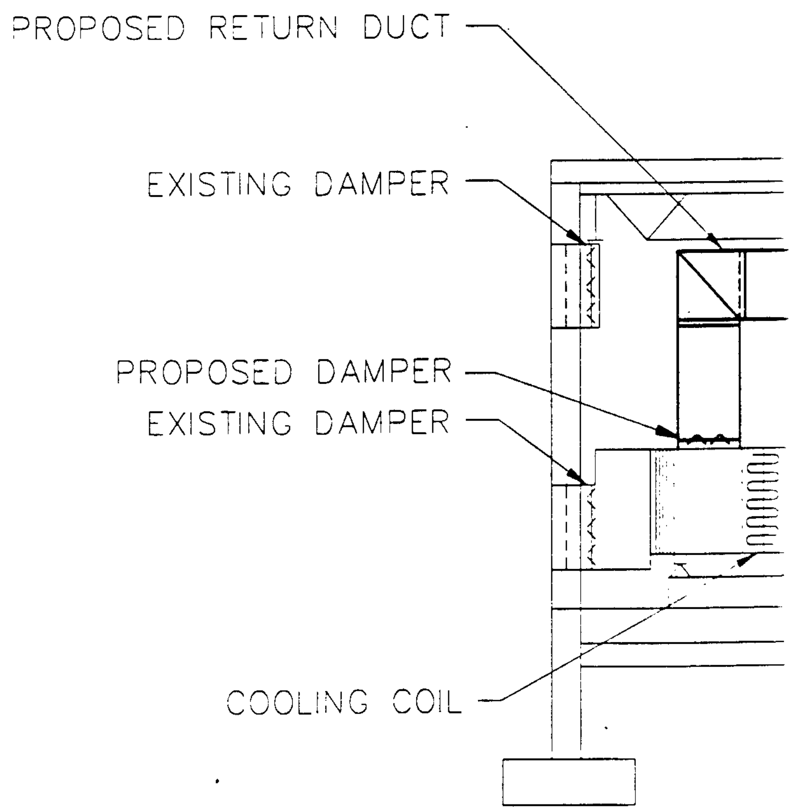
Basesline Energy Consumption (MBTUh)	Energy Consumption With Return Air in Towers (MBTUh)	Predicted Energy Savings (MBTUh)	Annual Savings (kWh)	Unit Energy Cost ($/kWh)	Annual Energy Cost Savings ($)
3573.44	3319.11	254.33	74537	0.0821	$6,119

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	55.12
SPACE COOL	1323.79
HVAC AUX	417.46
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3319.12

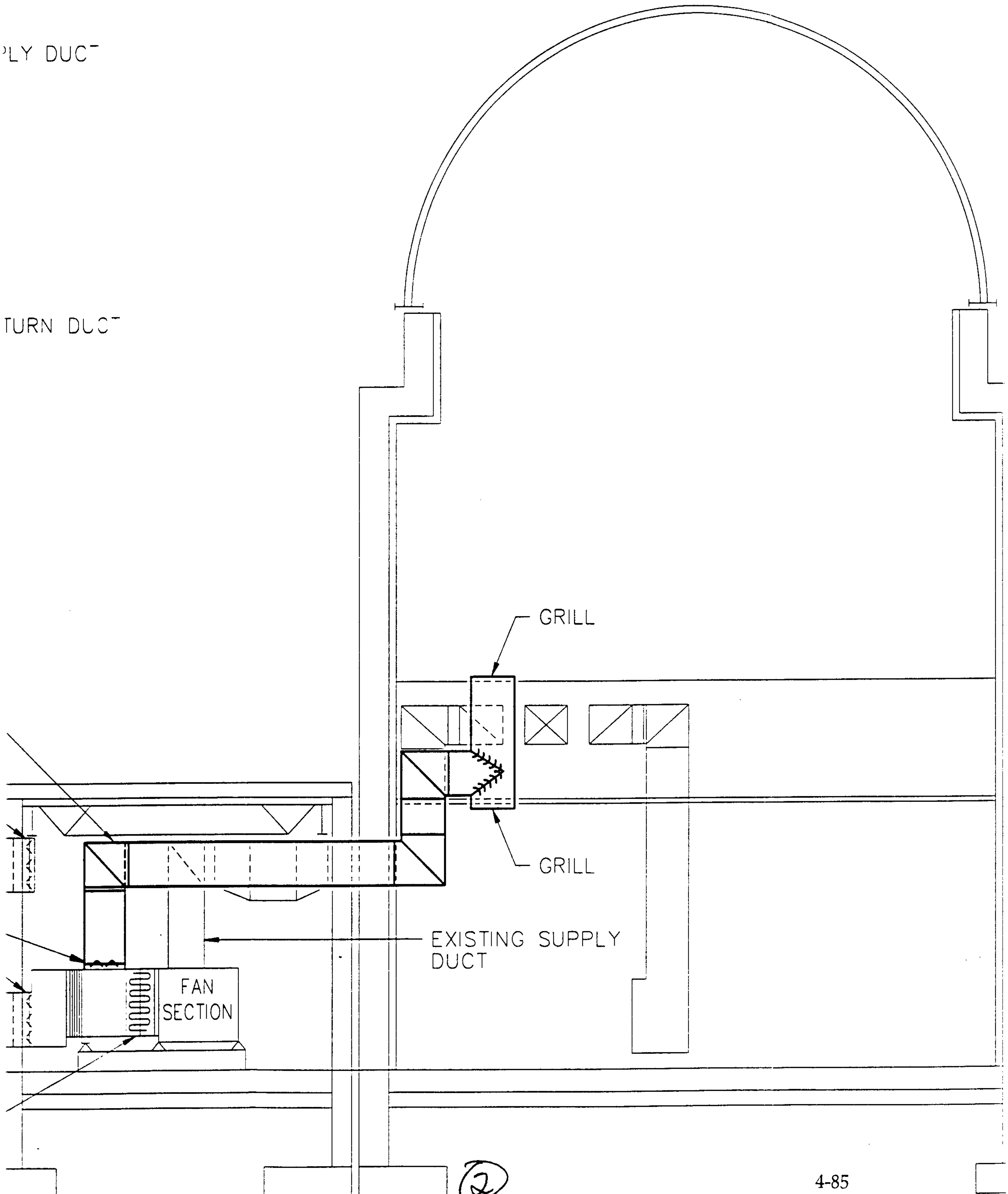
TOTAL SITE ENERGY 3319.12 MBTU 291.2 KBTU/SQFT-YR GROSS-AREA 291.2 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 3319.12 MBTU 291.2 KBTU/SQFT-YR GROSS-AREA 291.2 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED =100.0
NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.




EXISTING SUPPLY DUCT
PROPOSED RETURN DUCT

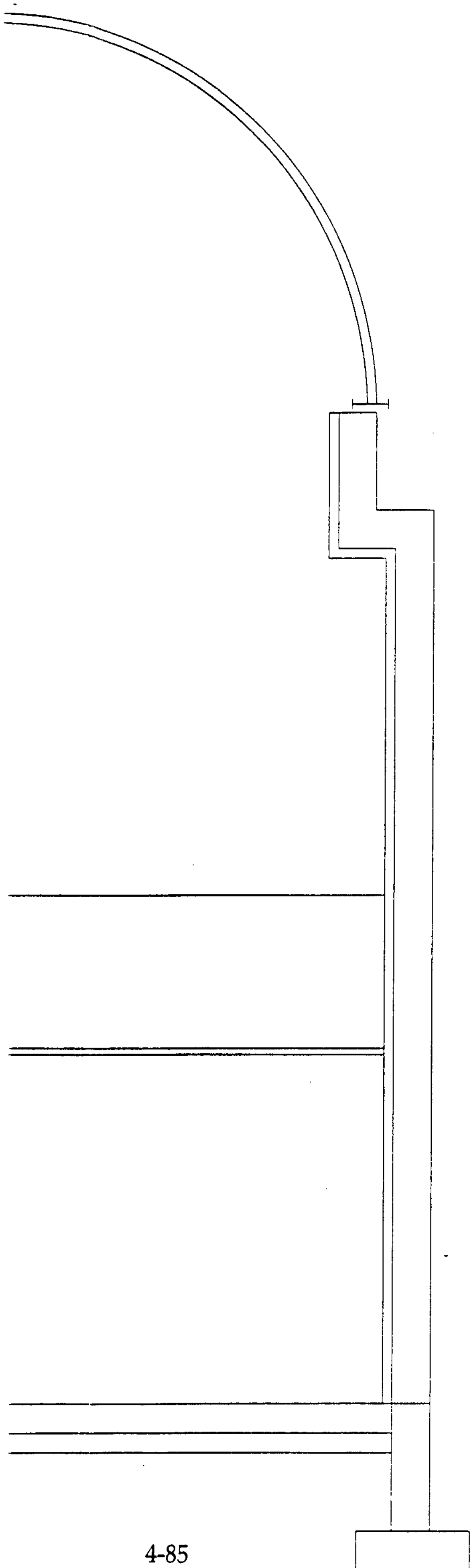

PROPOSED RETURN DUCT
EXISTING DAMPER
PROPOSED DAMPER
EXISTING DAMPER
COOLING COIL

1



PLY DUCT
TURN DUCT
GRILL
GRILL
EXISTING SUPPLY DUCT
FAN SECTION

(2)



3

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		White Sands Missile Range, NM	

PROJECT TITLE	CONTRACT NO.
Recirculate Tower Air GEODSS, Energy Conservation Survey	DACA01-94-D-0033

				MATERIAL COST		LABOR COST				EQUIPMENT COST		TOTAL COST	
Line No.	Item Description	Unit of Measure	No. of Units	Unit Cost	Total	Manhrs/ Unit	Total Manhrs	Labor Cost/ Manhour	Total Labor Cost	Unit Cost	Total	Unit Cost	Total
1	Sawing Concrete	Inch-ft	480	$0.25	$120	0.08	38.40	$22.99	$883	$0.00	$0	$2	$1,003
2	Galvanized Steel Ductwork	Lb	600	$1.00	$600	0.08	48.00	$22.99	$1,104	$0.00	$0	$3	$1,704
3	Ductwork Liner	SF	600	$0.38	$228	0.04	24.00	$22.99	$552	$0.00	$0	$1	$780
4	Damper	ea	3	$70.00	$210	1.00	3.00	$22.99	$69	$0.00	$0	$92.99	$279
5	Pneumatic Operator	ea	3	$153.00	$459	1.00	3.00	$22.99	$69	$0.00	$0	$175.99	$528
6	Pneumatic Econo Control	ea	3	$250.00	$750	1.50	4.50	$22.99	$103	$0.00	$0	$284.49	$853
7	Return Air Grill	ea	6	$39.00	$234	0.53	3.20	$22.99	$74	$0.00	$0	$51.25	$308
8	Balancing	ea	3	$0.00	$0	1.50	4.50	$22.99	$103	$0.00	$0	$34.49	$103
9	Drywall Repair	SF	150	$0.25	$38	0.04	6.00	$22.99	$138	$0.00	$0	$1.17	$175
10	Painting	SF	150	$0.04	$6	0.04	6.00	$22.99	$138	$0.00	$0	$0.96	$144
11	Cleanup (after job completed)	Ls	1		$0	16.00	16.00	$22.99	$368	$0.00	$0	$367.84	$368
12					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
13	Travel to Socorro	hrs	18		$0	1.00	18.00	$22.99	$414	$0.00	$0	$22.99	$414
14	Travel to job site	hrs	15		$0	1.00	15.00	$22.99	$345	$0.00	$0	$22.99	$345
15	Lodging and per diem	days	15		$0		0.00	$22.99	$0	$100.00	$1,500	$100.00	$1,500
16	Milage	miles	800		$0		0.00	$22.99	$0	$0.30	$240	$0.30	$240
17					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
18					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
19					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
20					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
21					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
22					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
23					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
24					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
25					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
26					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
27					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
28					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
29					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
30					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
31					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
32					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
33					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
34					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
35					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
36					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
37					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
38					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
39	SUBCONTRACTOR SUBTOTAL				$2,645		190		$4,359		$1,740		$8,743
40	LABOR BURDEN	%	30		$0				$1,308		$522		$1,830
41	SUBTOTAL				$2,645				$5,667		$2,262		$10,573
42	OVERHEAD	%	12		$317				$680		$271		$1,269
43	SUBTOTAL				$2,962				$6,346		$2,533		$11,842
44	PROFIT	%	12		$355				$762		$304		$1,421
45	SUBCONTRACTOR TOTAL				$3,317				$7,108		$2,837		$13,263
46	OVERHEAD	%	11		$363				$778		$311		$1,452
47	SUBTOTAL				$3,681				$7,886		$3,148		$14,715
48	PROFIT	%	8		$294				$631		$252		$1,177
49	SUBTOTAL				$3,975				$8,517		$3,400		$15,892
50	BOND	%	1		$29				$63		$25		$117
51	SUBTOTAL				$4,004				$8,580		$3,425		$16,009
52	N. M. TAX	%	6		$233				$499		$199		$931
53	SUBTOTAL				$4,237				$9,079		$3,624		$16,940
54	CONTINGENCY	%	20		$847				$1,816		$725		$3,388
55	GRAND TOTAL				$5,084				$10,895		$4,349		$20,328

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
BMS		E M C Engineers, Inc.	11/10/95

157 200 | System Components

157 200 System Components	Crew	Daily Output	Man-Hours	Unit	1995 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P	
30 ton	Q-6	.30	80	Ea.	11,400	2,175		13,575	15,900	230
40 ton		.20	120		15,200	3,275		18,475	21,700	
50 ton		.18	133		18,800	3,650		22,450	26,200	
60 ton		.16	150		22,000	4,100		26,100	30,500	
75 ton		.14	171		37,100	4,675		41,775	48,000	
80 ton		.12	200		38,000	5,450		43,450	50,000	
100 ton	↓	.09	266	↓	51,000	7,275		58,275	67,500	
Water cooled, compressor, heat exchanger, controls										
5 ton	Q-5	.70	22.857	Ea.	3,625	600		4,225	4,925	
15 ton	"	.50	32		6,025	845		6,870	7,925	
20 ton	Q-6	.40	60		8,325	1,650		9,975	11,700	
40 ton		.20	120		15,700	3,275		18,975	22,300	
100 ton	↓	.11	218	↓	33,900	5,950		39,850	46,300	
COOLING TOWERS Packaged units (A8.4-120)										240
Draw thru, single flow										
Belt drive, 60 tons (A8.4-230)	Q-6	90	.267	TonAC	69.50	7.30		76.80	87.50	
95 tons		100	.240		60	6.55		66.55	76	
110 tons		109	.220		59	6		65	74	
125 tons	↓	120	.200	↓	58	5.45		63.45	72.50	
For higher capacities, use multiples										
Induced air, double flow										
Gear drive, 150 ton	Q-6	126	.190	TonAC	76.50	5.20		81.70	92.50	
300 ton		129	.186		52.50	5.10		57.60	66	
600 ton		132	.182		41.50	4.96		46.46	53	
840 ton		142	.169		44	4.61		48.61	55.50	
Up to 1,000 tons	↓	150	.160	↓	43	4.37		47.37	54	
For higher capacities, use multiples										
For pumps and piping, add	Q-6	38	.632	TonAC	35	17.25		52.25	64.50	
For absorption systems, add				"	75%	75%				
For rigging, see division 016-460										
DUCTWORK (R157-050)										250
Fabricated rectangular, includes fittings, joints, supports,										
allowance for flexible connections, no insulation (R157-070)										
NOTE: Fabrication and installation are combined										
as LABOR cost. (R157-100)										
Add to labor for elevated installation										
of fabricated ductwork										
10' to 15' high						6%				
15' to 20' high						12%				
20' to 25' high						15%				
25' to 30' high						21%				
30' to 35' high						24%				
35' to 40' high						30%				
Over 40' high						33%				
For duct insulation and lining see 155-651-3000										
Aluminum, alloy 3003-H14, under 100 lb.	Q-10	75	.320	Lb.	3.49	8.40		11.89	17	
100 to 500 lb.		80	.300		1.81	7.85		9.66	14.30	
500 to 1,000 lb.		95	.253		1.62	6.65		8.27	12.20	
1,000 to 2,000 lb.		120	.200		1.52	5.25		6.77	9.85	
2,000 to 5,000 lb.		130	.185		1.38	4.84		6.22	9.10	
Over 5,000 lb.		145	.166		1.38	4.34		5.72	8.30	
Galvanized steel, under 200 lb.		235	.102		2.47	2.68		5.15	6.90	
200 to 500 lb.		245	.098		1	2.57		3.57	5.10	
500 to 1,000 lb.	↓	255	.094	↓	.62	2.47		3.09	4.55	

MECHANICAL 15

020 700 | Selective Demolition

		020 700 Selective Demolition	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1995 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
724	1320	Double	1 Plum	7	1.143	Ea.		33.50		33.50	53	724
	1400	Water closet, floor mounted		8	1			29.50		29.50	46.50	
	1420	Wall mounted		7	1.143			33.50		33.50	53	
	1500	Urinal, floor mounted		4	2			58.50		58.50	92.50	
	1520	Wall mounted		7	1.143			33.50		33.50	53	
	1600	Water fountains, free standing		8	1			29.50		29.50	46.50	
	1620	Recessed		6	1.333			39		39	61.50	
	2000	Piping, metal, to 2" diameter		200	.040	L.F.		1.17		1.17	1.85	
	2050	To 4" diameter		150	.053			1.56		1.56	2.47	
	2100	To 8" diameter	2 Plum	100	.160			4.69		4.69	7.40	
	2150	To 16" diameter	"	60	.267			7.80		7.80	12.35	
	2240	Toilet partitions, see division 020-732										
	2250	Water heater, 40 gal.	1 Plum	6	1.333	Ea.		39		39	61.50	
	6000	Remove and reset fixtures, minimum		6	1.333			39		39	61.50	
	6100	Maximum		4	2			58.50		58.50	92.50	
726	0010	ROOFING AND SIDING DEMOLITION R020 -610										726
	1000	Deck, roof, concrete plank	B-13	1,680	.033	S.F.		.70	.30	1	1.49	
	1100	Gypsum plank		3,900	.014			.30	.13	.43	.64	
	1150	Metal decking		3,500	.016			.34	.14	.48	.72	
	1200	Wood, boards, tongue and groove, 2" x 6"	2 Clab	960	.017			.32		.32	.55	
	1220	2" x 10"		1,040	.015			.30		.30	.51	
	1280	Standard planks, 1" x 6"		1,080	.015			.29		.29	.49	
	1320	1" x 8"		1,160	.014			.27		.27	.45	
	1340	1" x 12"		1,200	.013			.26		.26	.44	
	2000	Gutters, aluminum or wood, edge hung	1 Clab	240	.033	L.F.		.65		.65	1.10	
	2100	Built-in		100	.080	"		1.55		1.55	2.63	
	2500	Roof accessories, plumbing vent flashing		14	.571	Ea.		11.10		11.10	18.80	
	2600	Adjustable metal chimney flashing		9	.889	"		17.25		17.25	29	
	3000	Roofing, built-up, 5 ply roof, no gravel	B-2	1,600	.025	S.F.		.49		.49	.84	
	3001	Including gravel		890	.045			.89		.89	1.51	
	3100	Gravel removal, minimum		5,000	.008			.16		.16	.27	
	3120	Maximum		2,000	.020			.40		.40	.67	
	3400	Roof insulation board		3,900	.010			.20		.20	.34	
	4000	Shingles, asphalt strip		3,500	.011			.23		.23	.38	
	4100	Slate		2,500	.016			.32		.32	.54	
	4300	Wood		2,200	.018			.36		.36	.61	
	4500	Skylight to 10 S.F.	1 Clab	8	1	Ea.		19.40		19.40	33	
	5000	Siding, metal, horizontal		444	.018	S.F.		.35		.35	.59	
	5020	Vertical		400	.020			.39		.39	.66	
	5200	Wood, boards, vertical		400	.020			.39		.39	.66	
	5220	Clapboards, horizontal		380	.021			.41		.41	.69	
	5240	Shingles		350	.023			.44		.44	.75	
	5260	Textured plywood		725	.011			.21		.21	.36	
728	0010	SAW CUTTING Asphalt over 1000 L.F., 3" deep	B-89	775	.021	L.F.	.21	.46	.36	1.03	1.36	728
	0020	Each additional inch of depth		1,250	.013		.05	.28	.22	.55	.76	
	0400	Concrete slabs, mesh reinforcing, per inch of depth		960	.017		.27	.37	.29	.93	1.21	
	0420	Rod reinforcing, per inch of depth		550	.029		.36	.64	.50	1.50	1.98	
	0800	Concrete walls, plain, per inch of depth	A-1A	100	.080		.25	1.55	.34	2.14	3.27	
	0820	Rod reinforcing, per inch of depth		60	.133		.36	2.59	.57	3.52	5.40	
	1200	Masonry walls, brick, per inch of depth		146	.055		.25	1.06	.23	1.54	2.33	
	1220	Block walls, solid, per inch of depth		122	.066		.25	1.27	.28	1.80	2.74	
	3000	Wood sheathing to 1" thick, on walls	1 Carp	200	.040			.98		.98	1.67	
	3020	On roof	"	250	.032			.79		.79	1.33	
	3050	See also div. 020-125 core drilling										

SITE WORK 2

4-89

155 600 | Heating System Access.

	Line	Description	Crew	Daily Output	Man-Hours	Unit	1995 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P
651	2000	Breeching, 2" calcium silicate with 1/2" cement finish, no lath									
	2020	Rectangular	Q-14	42	.381	S.F.	4.79	9.60		14.39	21
	2040	Round	•	38.70	.413	•	5.30	10.40		15.70	22.50
	2300	Calcium silicate block, + 200° to + 1200°F									
	2310	On irregular surfaces, valves and fittings									
	2340	1" thick	Q-14	30	.533	S.F.	2.71	13.45		16.16	25
	2360	1-1/2" thick		25	.640		2.95	16.15		19.10	29.50
	2380	2" thick		22	.727		3.74	18.35		22.09	33.50
	2400	3" thick	↓	18	.889	↓	5.95	22.50		28.45	43
	2410	On plane surfaces									
	2420	1" thick	Q-14	168	.095	S.F.	2.71	2.40		5.11	6.85
	2430	1-1/2" thick		144	.111		2.95	2.80		5.75	7.80
	2440	2" thick		126	.127		3.74	3.20		6.94	9.30
	2450	3" thick	↓	100	.160	↓	5.95	4.03		9.98	13.05
	2900	Domestic water heater wrap kit									
	2920	1-1/2" with vinyl jacket, 20-60 gal.	1 Plum	8	1	Ea.	30	29.50		59.50	78
	3000	Ductwork									
	3020	Blanket type, fiberglass, flexible									
	3030	Fire resistant liner, black coating one side									
	3050	1/2" thick, 2 lb. density	Q-14	380	.042	S.F.	.38	1.06		1.44	2.14
	3060	1" thick, 1-1/2 lb. density		350	.046		.50	1.15		1.65	2.41
	3070	1-1/2" thick, 1-1/2 lb. density		320	.050		.62	1.26		1.88	2.72
	3080	2" thick, 1-1/2 lb. density	↓	300	.053	↓	.86	1.34		2.20	3.12
	3140	FRK vapor barrier wrap, .75 lb. density									
	3160	1" thick	Q-14	350	.046	S.F.	.28	1.15		1.43	2.17
	3170	1-1/2" thick		320	.050		.37	1.26		1.63	2.45
	3180	2" thick		300	.053		.46	1.34		1.80	2.6[illegible]
	3190	3" thick		260	.062		.53	1.55		2.08	3.[illegible]
	3200	4" thick	↓	242	.066	↓	.71	1.67		2.38	3.48
	3210	Vinyl jacket, same as FRK									
	3280	Unfaced, 1 lb. density									
	3310	1" thick	Q-14	360	.044	S.F.	.29	1.12		1.41	2.13
	3320	1-1/2" thick		330	.048		.39	1.22		1.61	2.41
	3330	2" thick	↓	310	.052	↓	.48	1.30		1.78	2.63
	3490	Board type, fiberglass, 3 lb. density									
	3500	Fire resistant, black pigmented, 1 side									
	3520	1" thick	Q-14	150	.107	S.F.	1.44	2.69		4.13	5.95
	3540	1-1/2" thick		130	.123		1.78	3.10		4.88	6.95
	3560	2" thick	↓	120	.133	↓	2.15	3.36		5.51	7.80
	3600	FRK vapor barrier									
	3620	1" thick	Q-14	150	.107	S.F.	1.10	2.69		3.79	5.55
	3630	1-1/2" thick		130	.123		1.30	3.10		4.40	6.45
	3640	2" thick	↓	120	.133	↓	1.60	3.36		4.96	7.20
	3680	No finish									
	3700	1" thick	Q-14	170	.094	S.F.	.65	2.37		3.02	4.55
	3710	1-1/2" thick		140	.114		.75	2.88		3.63	5.50
	3720	2" thick	↓	130	.123	↓	1	3.10		4.10	6.10
	3730	Sheet insulation									
	3760	Polyethylene foam, closed cell, UV resistant									
	3770	Standard temperature (-90° to +212° F)									
	3771	1/4" thick	Q-14	450	.036	S.F.	.31	.90		1.21	1.79
	3772	3/8" thick		440	.036		.47	.92		1.39	1.99
	3773	1/2" thick		420	.038		.62	.96		1.58	2.2[illegible]
	3774	3/4" thick		400	.040		.99	1.01		2	2[illegible]
	3775	1" thick	↓	380	.042	↓	1.32	1.06		2.38	3.17
	3779	Adhesive (see line 155-651-7878)									

15 MECHANICAL

the Reference Section for reference number information, Crew Listings and City Cost Indexes

092 600 | Gypsum Board Systems

			CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1995 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
608	2000	5/8" thick, on walls, standard, no finish included	2 Carp	2,000	.008	S.F.	.20	.20		.40	.55
	2050	Taped and finished		965	.017		.25	.41		.66	.97
	2100	Fire resistant, no finish included		2,000	.008		.22	.20		.42	.57
	2150	Taped and finished		965	.017		.27	.41		.68	.99
	2200	Water resistant, no finish included		2,000	.008		.29	.20		.49	.65
	2250	Taped and finished		965	.017		.34	.41		.75	1.06
	2300	Prefinished, vinyl, clipped to studs		900	.018		.59	.44		1.03	1.39
	3000	On ceilings, standard, no finish included		1,800	.009		.20	.22		.42	.59
	3050	Taped and finished		765	.021		.25	.51		.76	1.15
	3100	Fire resistant, no finish included		1,800	.009		.22	.22		.44	.61
	3150	Taped and finished		765	.021		.27	.51		.78	1.17
	3200	Water resistant, no finish included		1,800	.009		.29	.22		.51	.69
	3250	Taped and finished		765	.021		.34	.51		.85	1.24
	3500	On beams, columns, or soffits, standard, no finish included		675	.024		.29	.58		.87	1.31
	3550	Taped and finished		475	.034		.35	.83		1.18	1.79
	3600	Fire resistant, no finish included		675	.024		.31	.58		.89	1.33
	3650	Taped and finished		475	.034		.37	.83		1.20	1.81
	3700	Water resistant, no finish included		675	.024		.38	.58		.96	1.41
	3750	Taped and finished		475	.034		.43	.83		1.26	1.87
	4000	Fireproofing, beams or columns, 2 layers, 1/2" thick, incl finish		330	.048		.49	1.19		1.68	2.56
	4050	5/8" thick		300	.053		.55	1.31		1.86	2.83
	4100	3 layers, 1/2" thick		225	.071		.73	1.75		2.48	3.77
	4150	5/8" thick		210	.076		.79	1.87		2.66	4.05
	5050	For 1" thick coreboard on columns		480	.033		.51	.82		1.33	1.95
	5100	For foil-backed board, add					.08			.08	.09
	5200	For high ceilings, over 8' high, add	2 Carp	3,060	.005		.09	.13		.22	.32
	5270	For textured spray, add	2 Lath	1,600	.010		.11	.24		.35	.51
	5300	For over 3 stories high, add per story	2 Carp	6,100	.003		.05	.06		.11	.17
	5350	For finishing corners, inside or outside, add	"	1,100	.015	L.F.	.06	.36		.42	.68
	5500	For acoustical sealant, add per bead	1 Carp	500	.016	"	.03	.39		.42	.70
	5550	Sealant, 1 quart tube				Ea.	4.10			4.10	4.51
	5600	Sound deadening board, 1/4" gypsum	2 Carp	1,800	.009	S.F.	.16	.22		.38	.55
	5650	1/2" wood fiber	"	1,800	.009	"	.22	.22		.44	.61
612	0010	METAL STUDS, DRYWALL Partitions, 10' high, with runners									
	0050	See also Studding, division 051-230									
	2000	Non-load bearing, galvanized, 25 ga. 1-5/8", 16" O.C.	1 Carp	450	.018	S.F.	.24	.44		.68	1
	2100	24" O.C.		520	.015		.19	.38		.57	.85
	2200	2-1/2" wide, 16" O.C.		440	.018		.26	.45		.71	1.05
	2250	24" O.C.		510	.016		.22	.39		.61	.89
	2300	3-5/8" wide, 16" O.C.		430	.019		.30	.46		.76	1.11
	2350	24" O.C.		500	.016		.26	.39		.65	.96
	2400	4" wide, 16" O.C.		420	.019		.35	.47		.82	1.18
	2450	24" O.C.		490	.016		.28	.40		.68	.99
	2500	6" wide, 16" O.C.		410	.020		.45	.48		.93	1.31
	2550	24" O.C.		480	.017		.34	.41		.75	1.07
	2600	20 ga. studs, 1-5/8" wide, 16" O.C.		450	.018		.42	.44		.86	1.20
	2650	24" O.C.		520	.015		.34	.38		.72	1.01
	2700	2-1/2" wide, 16" O.C.		440	.018		.47	.45		.92	1.28
	2750	24" O.C.		510	.016		.38	.39		.77	1.07
	2800	3-5/8" wide, 16" O.C.		430	.019		.56	.46		1.02	1.40
	2850	24" O.C.		500	.016		.45	.39		.84	1.17
	2900	4" wide, 16" O.C.		420	.019		.59	.47		1.06	1.44
	2950	24" O.C.		490	.016		.47	.40		.87	1.20
	3000	6" wide, 16" O.C.		410	.020		.74	.48		1.22	1.62
	3050	24" O.C.		480	.017		.59	.41		1	1.35

For expanded coverage of these items see Means Interior Cost Data 1995

099 200 | Interior Painting

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		CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1995 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
6300	To 16" diameter, primer or sealer coat, brushwork	2 Pord	340	.047	L.F.	.19	1.06		1.25	1.96
6350	Spray		567	.028		.21	.64		.85	1.28
6400	Paint 1 coat, brushwork		325	.049		.20	1.11		1.31	2.05
6450	Spray		567	.028		.23	.64		.87	1.30
6500	Paint 2 coats, brushwork		202	.079		.40	1.79		2.19	3.38
6550	Spray		323	.050		.44	1.12		1.56	2.32
7000	Trim, wood, incl. puttying, under 6" wide									
7200	Primer coat, oil base, brushwork	1 Pord	900	.009	L.F.	.02	.20		.22	.35
7250	Paint, 1 coat, brushwork		875	.009		.02	.21		.23	.36
7400	2 coats		520	.015		.04	.35		.39	.61
7450	3 coats		370	.022		.05	.49		.54	.86
7500	Over 6" wide, primer coat, brushwork		600	.013		.04	.30		.34	.53
7550	Paint, 1 coat, brushwork		450	.018		.04	.40		.44	.70
7600	2 coats		265	.030		.07	.68		.75	1.20
7650	3 coats		190	.042		.09	.95		1.04	1.66
8000	Cornice, simple design, primer coat, oil base, brushwork		550	.015	S.F.	.09	.33		.42	.64
8250	Paint, 1 coat		500	.016		.09	.36		.45	.69
8300	2 coats		300	.027		.18	.60		.78	1.19
8350	Ornate design, primer coat		300	.027		.19	.60		.79	1.20
8400	Paint, 1 coat		280	.029		.19	.65		.84	1.27
8450	2 coats		170	.047		.35	1.06		1.41	2.14
8600	Balustrades, primer coat, oil base, brushwork		598	.013		.05	.30		.35	.56
8650	Paint, 1 coat		544	.015		.05	.33		.38	.61
8700	2 coats		340	.024		.09	.53		.62	.97
8900	Trusses and wood frames, primer coat, oil base, brushwork		800	.010		.05	.23		.28	.43
8950	Spray		1,200	.007		.05	.15		.20	.31
9000	Paint 1 coat, brushwork		750	.011		.05	.24		.29	.46
9200	Spray		1,200	.007		.05	.15		.20	.31
9220	Paint 2 coats, brushwork		500	.016		.09	.36		.45	.69
9240	Spray		600	.013		.09	.30		.39	.59
9260	Stain, brushwork, wipe off		600	.013		.03	.30		.33	.52
9280	Varnish, 3 coats, brushwork		275	.029		.10	.66		.76	1.19
9350	For latex paint, deduct					10%				

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		CREW	DAILY OUTPUT	MAN-HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
0010	WALLS AND CEILINGS									
0020	Labor cost includes protection of adjacent items not painted									
0100	Concrete, dry wall or plaster, oil base, primer or sealer coat									
0200	Smooth finish, brushwork	1 Pord	1,300	.006	S.F.	.04	.14		.18	.27
0240	Roller		2,040	.004		.04	.09		.13	.19
0300	Sand finish, brushwork		1,163	.007		.07	.16		.23	.34
0340	Roller		1,700	.005		.07	.11		.18	.25
0380	Spray		2,720	.003		.05	.07		.12	.17
0400	Paint 1 coat, smooth finish, brushwork		1,200	.007		.05	.15		.20	.31
0440	Roller		2,000	.004		.04	.09		.13	.19
0480	Spray		2,200	.004		.04	.08		.12	.17
0500	Sand finish, brushwork		1,050	.008		.06	.17		.23	.35
0540	Roller		1,600	.005		.06	.11		.17	.26
0580	Spray		2,100	.004		.05	.09		.14	.20
0800	Paint 2 coats, smooth finish, brushwork		680	.012		.08	.27		.35	.53
0840	Roller		1,190	.007		.07	.15		.22	.33
0880	Spray		1,700	.005		.08	.11		.19	.26
0900	Sand finish, brushwork		605	.013		.11	.30		.41	.61
0940	Roller		1,020	.008		.10	.18		.28	.40
0980	Spray		1,700	.005		.09	.11		.20	.27
1200	Paint 3 coats, smooth finish, brushwork		510	.016		.12	.35		.47	.71
1240	Roller		790	.010		.11	.23		.34	.50

For expanded coverage of these items see Means Interior Cost Data 1995

4.10 ECO 10: TURN OFF OFFICE AHU AT NIGHT

Proposed Modifications: Install a time clock to turn off the AHU serving the office areas in the building at night.

Since these areas are not occupied at night, the temperature does not need to be maintained or the space ventilated during unoccupied periods. In the summer the temperature may be allowed to rise, while in the winter the temperature may be allowed to drop, in order to save energy.

Existing Conditions: Presently, the thermostat is set to maintain 70°F year-round, even when the offices are unoccupied.

Method of Analysis: The analysis proceeded as follows:

- The AHU operating schedules in the baseline energy model were altered so that the AHU only operates from 6 a.m. to 4 p.m. daily.
- The energy savings were compared to the baseline model and the energy and cost savings were calculated.
- A LCCA was prepared to determine the cost effectiveness of implementing this ECO.
- It was assumed that the GEODSS maintenance staff would install the time clock as part of their normal daily duties. The cost of a time clock is the only expense to implement this ECO.

Results: The LCCA results are presented in the following table.

Annual Electric Energy Savings (kWh)	48,210
Total Annual Energy Cost Savings	$3,958
Annual Maintenance Cost Savings	$0
Investment Cost	$420
Savings-to-Investment Ratio (SIR)	80.86
Simple Payback (Years)	0.10

Recommendations: Turning off the office AHU at night is recommended.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Jul-95
3. INSTALLATION AND LOCATION GEODSS Site, White Sands Missile Range, NM		
4. PROJECT TITLE Recirculate Tower Air		5. PROJECT NUMBER

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

LOCATION: White Sands Missile Range, NM REGION: 4 (New Mexico) PROJECT NO: 1406.008
PROJECT TITLE: Turn Off Office AHU at Night FISCAL YEAR: 1995
ANALYSIS DATE: 11/13/95 ECONOMIC LIFE: 10 PREPARED BY: E.Smith

1. INVESTMENT

A. CONSTRUCTION COST		=	$375	
B. SIOH COST	(6.0% of 1A)	=	$22	
C. DESIGN COST	(6.0% of 1A)	=	$22	
D. TOTAL COST	(1A +1B +1C)	=	$420	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		=	$0	
F. PUBLIC UTILITY COMPANY REBATE		=	$0	
G. TOTAL INVESTMENT	(1D -1E -1F)	=	------->	$420

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

DATE OF NISTR-85-3273-9 USED FOR DISCOUNT FACTORS: Jul-95

ENERGY SOURCE	FUEL COST $/KWH (1)	SAVINGS KWH/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. ELECT. (SAV'GS)	$0.0821	48210	$3,958	8.58	$33,960	
B. DIST (GAL.)	$1.10	0	$0		$0	
C. RESID (GAL.)	$3.00	0	$0		$0	
D. NAT GAS (MBTU)	$6.18	0	$0		$0	
E. COAL	$2.00	0	$0		$0	
G. DEMAND ($/kW)	$0.00	0	$0		$0	
H. TOTAL		48,210	$3,958		-------->	$33,960

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

A. ANNUAL RECURRING (+/-)

1 ANNUAL MAINTENANCE SAVINGS	$0	14.88	$0
2		14.88	$0
3 TOTAL ANNUAL DISC. SAVINGS (+) / COST	$0		$0

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAV'G/COST(4)
a.	$0	0	0.00	$0
b.	$0	0	0.00	$0
c.	$0	0	0.00	$0
d. TOTAL	$0			$0

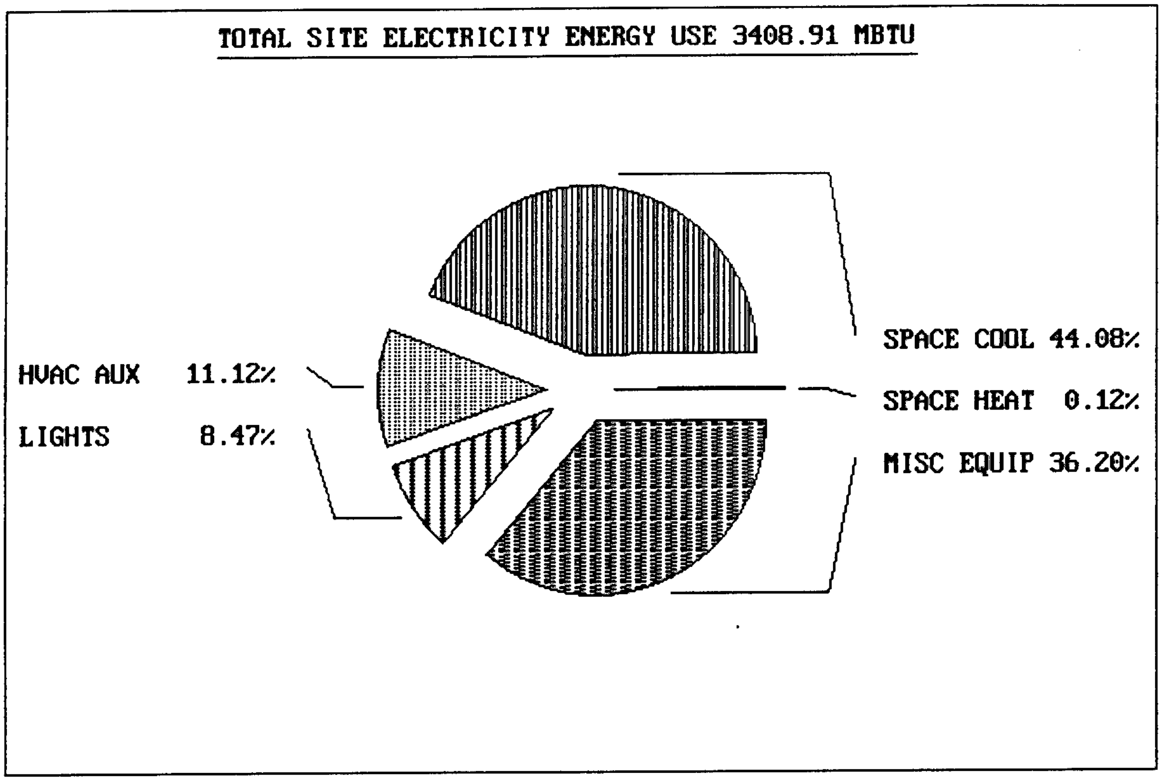
C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-) (3A3 + 3Bg4) = $0

4. FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bg1/Economic Life))	$3,958
5. SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	0.1
6. TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$33,960
7. DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	80.86

Economic Life(Years)	10

Simulation	Energy Consumed (MBTU)	Energy Consumed (kWh)
Baseline Model	3573.45	1,047,011
Night Setback	3408.91	998,802
Savings	164.54	48,210
Cost Savings		$3,958

Annual Electric Energy Savings (kWh)	48,210
Total Annual Energy Cost Savings	$3,958
Construction Cost	$375
SIOH (6.0%)	$22
Design Cost (6.0%)	$22
Investment Cost	$420
Discounted Savings	$33,960
Savings-to-Investment Ratio (SIR)	80.86
Simple Payback (Years)	0.11


TOTAL SITE ELECTRICITY ENERGY USE 3408.91 MBTU
HVAC AUX 11.12%
LIGHTS 8.47%
SPACE COOL 44.08%
SPACE HEAT 0.12%
MISC EQUIP 36.20%

ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		White Sands Missile Range, NM	

PROJECT TITLE Turn Off Office AHU	CONTRACT NO.
GEODSS, Energy Conservation Survey	DACA01-94-D-0033

				MATERIAL COST		LABOR COST				EQUIPMENT COST		TOTAL COST	
Line No.	Item Description	Unit of Measure	No. of Units	Unit Cost	Total	Manhrs/ Unit	Total Manhrs	Labor Cost/ Manhour	Total Labor Cost	Unit Cost	Total	Unit Cost	Total
1	Programmable Timer	ea	1	$249.33	$249	2.00	2.00	$22.99	$46	$0.00	$0	$295	$295
2	(solid state w/battery)				$0		0.00	$22.99	$0	$0.00	$0	$0	$0
3	(Installation by GEODSS staff)				$0		0.00	$22.99	$0	$0.00	$0	$0	$0
4					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
5					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
6					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
7					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
8					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
9					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
10					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
11					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
12					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
13					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
14					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
15					$0		0.00	$22.99	$0	$100.00	$0	$100.00	$0
16					$0		0.00	$22.99	$0	$0.30	$0	$0.30	$0
17					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
18					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
19					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
20					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
21					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
22					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
23					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
24					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
25					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
26					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
27					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
28					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
29					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
30					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
31					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
32					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
33					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
34					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
35					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
36					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
37					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
38					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
39	**SUBCONTRACTOR SUBTOTAL**				$249		2		$46		$0		$295
40	LABOR BURDEN	%	0		$0				$0		$0		$0
41	SUBTOTAL		0		$249				$46		$0		$295
42	OVERHEAD	%	0		$0				$0		$0		$0
43	SUBTOTAL		0		$249				$46		$0		$295
44	PROFIT	%	0		$0				$0		$0		$0
45	**SUBCONTRACTOR TOTAL**		0		$249				$46		$0		$295
46	OVERHEAD	%	0		$0				$0		$0		$0
47	SUBTOTAL		0		$249				$46		$0		$295
48	PROFIT	%	0		$0				$0		$0		$0
49	SUBTOTAL		0		$249				$46		$0		$295
50	BOND	%	0		$0				$0		$0		$0
51	SUBTOTAL		0		$249				$46		$0		$295
52	N. M. TAX	%	5.8125		$14				$3		$0		$17
53	SUBTOTAL		0		$264				$49		$0		$312
54	CONTINGENCY	%	20		$53				$10		$0		$62
55	**GRAND TOTAL**				$317				$58		$0		$375

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
EMS		E M C Engineers, Inc.	11/10/95

157 | Air Conditioning and Ventilation

157 400 | Accessories

		CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1995 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
20 3430	Pneumatic/electric	1 Plum	16	.500	Ea.	135	14.65		149.65	172	420
3440	Pneumatic proportioning		8	1		156	29.50		185.50	217	
3450	Pneumatic switching		12	.667		74.50	19.55		94.05	112	
3460	Selector, 3 point		6	1.333		55.50	39		94.50	121	
3470	Time delay		8	1		206	29.50		235.50	271	
3500	Sensor, air operated										
3520	Humidity	1 Plum	16	.500	Ea.	175	14.65		189.65	216	
3540	Pressure		16	.500		194	14.65		208.65	236	
3560	Temperature		12	.667		138	19.55		157.55	182	
3600	Electric operated										
3620	Humidity	1 Elec	8	1	Ea.	40	28.50		68.50	87	
3650	Pressure		8	1		485	28.50		513.50	580	
3680	Temperature		10	.800		80.50	23		103.50	124	
4000	Thermometers										
4100	Dial type, 3-1/2" diameter, vapor type, union connection	1 Stpi	32	.250	Ea.	95	7.30		102.30	116	
4120	Liquid type, union connection		32	.250		133	7.30		140.30	157	
4130	Remote reading, 15' capillary		32	.250		90	7.30		97.30	110	
4500	Stem type, 6-1/2" case, 2" stem, 1/2" NPT		32	.250		24	7.30		31.30	37.50	
4520	4" stem, 1/2" NPT		32	.250		33	7.30		40.30	47.50	
4600	9" case, 3-1/2" stem, 3/4" NPT		28	.286		40	8.35		48.35	57	
4620	6" stem, 3/4" NPT		28	.286		43	8.35		51.35	60.50	
4640	8" stem, 3/4" NPT		28	.286		49	8.35		57.35	67	
4660	12" stem, 1" NPT		26	.308		55	9		64	74.50	
5000	Thermostats										
5030	Manual	1 Shee	8	1	Ea.	21	28		49	67	
5040	1 set back, electric, timed		8	1		69.50	28		97.50	121	
5050	2 set back, electric, timed		8	1		42.50	28		70.50	90.50	
5100	Locking cover					13.80			13.80	15.15	
5200	24 hour, automatic, clock	1 Shee	8	1		87	28		115	140	
5220	Electric, 2 wire	1 Elec	13	.615		11.60	17.55		29.15	39.50	
5230	3 wire		10	.800		14.05	23		37.05	50	
5240	Pneumatic										
5250	Single temp., single pressure	1 Stpi	8	1	Ea.	102	29.50		131.50	157	
5251	Dual pressure		8	1		141	29.50		170.50	200	
5252	Dual temp., dual pressure		8	1		132	29.50		161.50	190	
5253	Reverse acting w/averaging element		8	1		124	29.50		153.50	181	
5254	Heating-cooling w/deadband		8	1		139	29.50		168.50	198	
5255	Integral w/piston top valve actuator		8	1		129	29.50		158.50	187	
5256	Dual temp., dual pressure		8	1		151	29.50		180.50	211	
5257	Low limit, 8' averaging element		8	1		94	29.50		123.50	149	
5258	Room single temp. proportional		8	1		42	29.50		71.50	91	
5300	Transmitter, pneumatic										
5320	Temperature averaging element	Q-1	8	2	Ea.	80.50	53		133.50	169	
5350	Pressure differential	1 Plum	7	1.143		470	33.50		503.50	565	
5370	Humidity, duct		8	1		158	29.50		187.50	218	
5380	Room		12	.667		143	19.55		162.55	188	
5390	Temperature, with averaging element		6	1.333		90	39		129	159	
5420	Electric operated, humidity	1 Elec	8	1		40	28.50		68.50	87	
5430	DPST		8	1		56	28.50		84.50	105	
6000	Valves, motorized zone										
6100	Sweat connections, 1/2" C x C	1 Stpi	20	.400	Ea.	37	11.70		48.70	59	
6110	3/4" C x C		20	.400		37	11.70		48.70	59	
6120	1" C x C		19	.421		41.50	12.30		53.80	65	
6140	1/2" C x C, with end switch, 2 wire		20	.400		48	11.70		59.70	71	
6150	3/4" C x C, with end switch, 2 wire		20	.400		48	11.70		59.70	71	
6160	1" C x C, with end switch, 2 wire		19	.421		52.50	12.30		64.80	76.50	

MECHANICAL 15

4.11 ECO 11: PROPANE HEAT

Proposed Modification: Replace electric heating coils in ducts with propane-fired duct furnaces which use a less expensive fuel.

This would involve installing propane duct heaters and associated propane lines and a propane storage tank.

Existing Conditions: Only the computer room CRUs and AHU-2 have heating coils, which are placed in the ducts. Propane duct heaters are not practical for the CRUs, therefore they were not evaluated. Since the price of electricity is high at $0.0821/kWh, a way to save money and energy is to convert the existing electric duct heaters over to propane-fired duct furnaces in AHU-2 serving the office.

Method of Analysis: Analysis proceeded as follows:

- A baseline energy consumption model was developed using DOE2.1d.
- A modified baseline energy consumption model was developed using DOE2.1d. ECO 10 (Turn Off Office AHU at Night) significantly reduced the heating energy use. Most heating energy was consumed at night when internal heat gain from lights, office equipment, and people was minimal. The dominant heating load at night was ventilation air heating which was eliminated by ECO 10.
- The baseline models were then modified so that the heating coils for AHU-2 were propane-fired instead of electric.
- The baseline energy consumption model and the modified model were compared and the energy savings were calculated.

Results: The LCCA results are presented in the following table.

	Baseline	Modified Baseline
Annual Electric Energy Savings (kWh)	16,150	1,199
Total Annual Energy Cost Savings	$878	$65
Annual Maintenance Cost Savings	$0	$0
Investment Cost	$11,182	$11,182
Savings-to-Investment Ratio (SIR)	1.04	0.08
Simple Payback (Years)	12.74	171.7

Recommendations: Switching over to propane is not recommended because it is not cost effective when used in conjunction with ECO 10. Furthermore, GEODSS does not desire to use propane in the building due to the risk to the facility.

LIFE CYCLE COST ANALYSIS

PROPANE FIRED DUCT FURNACES

ECONOMIC LIFE (YEARS)	20

Existing Conditions

	Baseline	Baseline with ECO 10
Baseline Electric Heating Energy (MBtu)	55.12	4.09
Conversion Factor (MBtu/kWh)	0.003413	0.003413
Baseline Electric Heating Energy (kWh)	16,150	1,199
Unit Electricity Cost ($/kWh)	$0.0821	$0.0821
Annual Energy Cost ($)	$ 1,326	$ 98

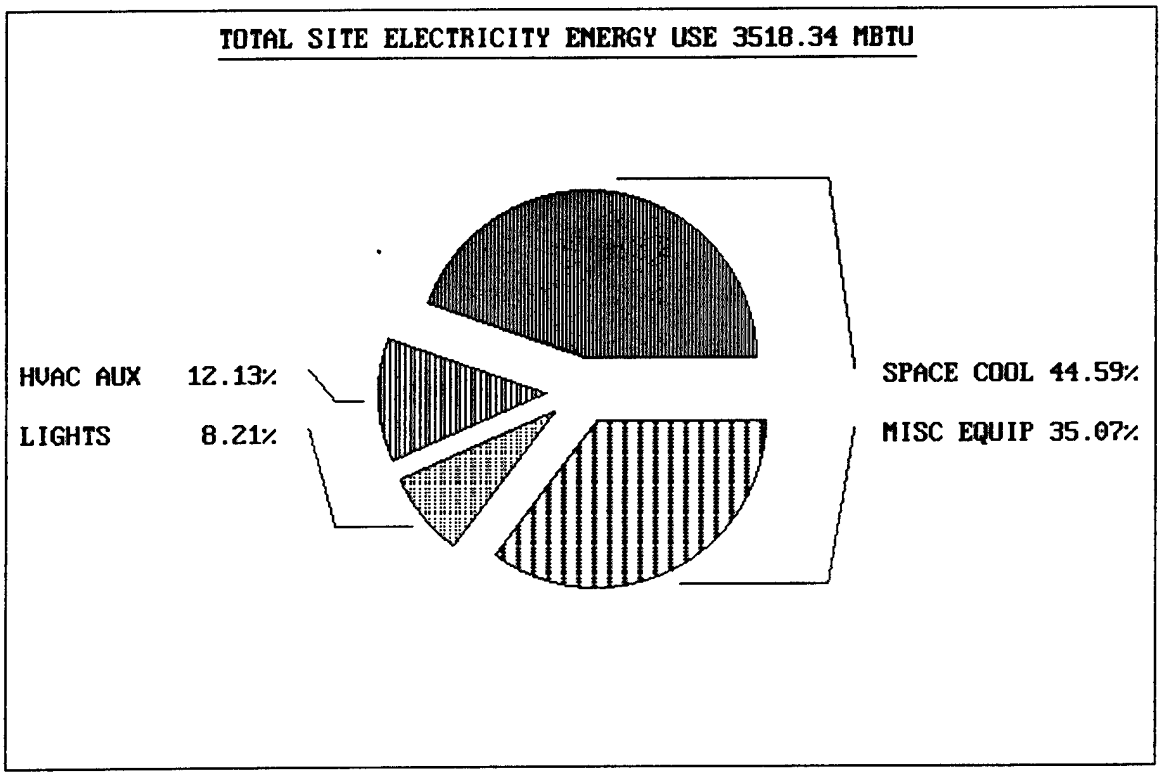
Proposed Modification

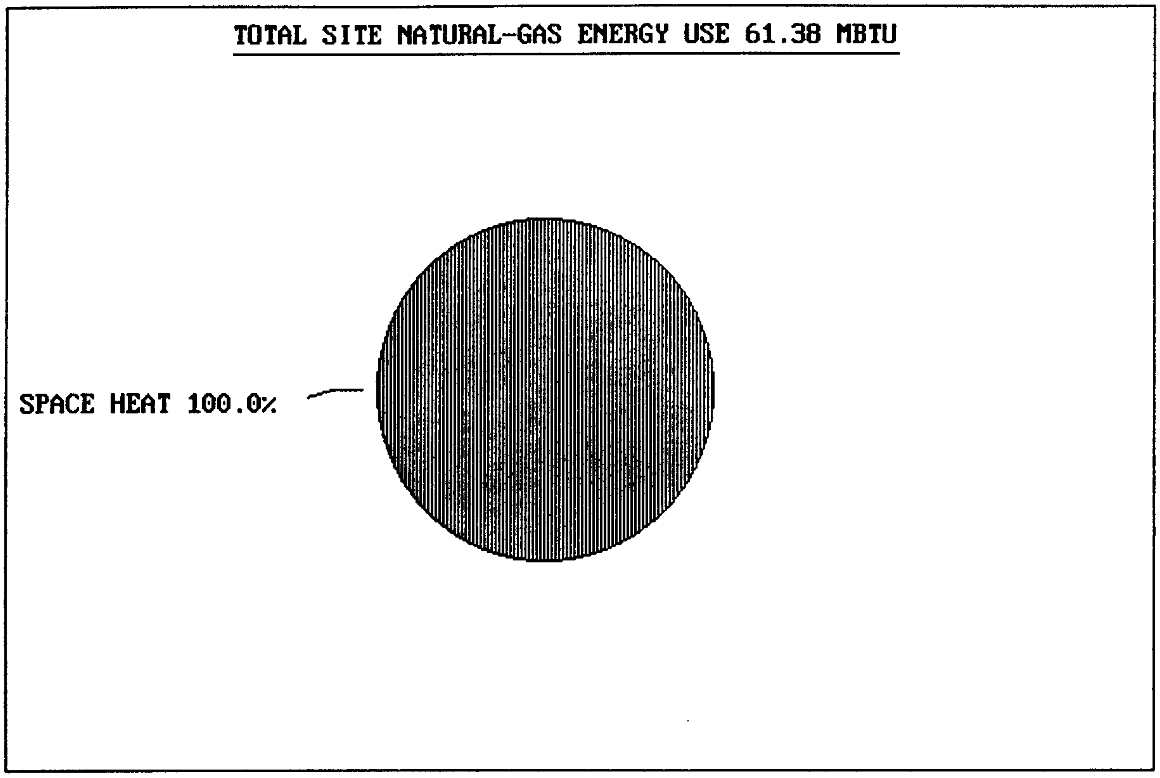
	Baseline	Baseline with ECO 10
Modified Propane Heating Energy (MBtu)	61.38	4.56
Conversion Factor (MBtu/gal)	0.095	0.095
Baseline Propane Required (gal)	646	48
Unit Propane Cost ($/gal)	$0.6940	$0.6940
Annual Energy Cost ($)	$ 448	$ 33

Annual Electric Energy Savings (kWh)	16,150	1,199
Annual Propane Savings (gal)	(646)	(48)
Total Annual Energy Cost Savings	$ 878	$ 65
Annual Maintenance Costs	-	-
Economic Life (yrs)	$ 20	$ 20
UPV Factor - Electricity	15.08	15.08
UPV Factor - LP Gas	18.58	18.58
Life Cycle Cost Savings	$ 11,664	$ 866
Construction Cost	$ 9,984	$ 9,984
SIOH (6.0%)	$ 599	$ 599
Design Cost (6.0%)	$ 599	$ 599
Total Investment	$ 11,182	$ 11,182
Savings-to-Investment Ratio	1.04	0.08
Simple Payback (years)	12.74	171.70

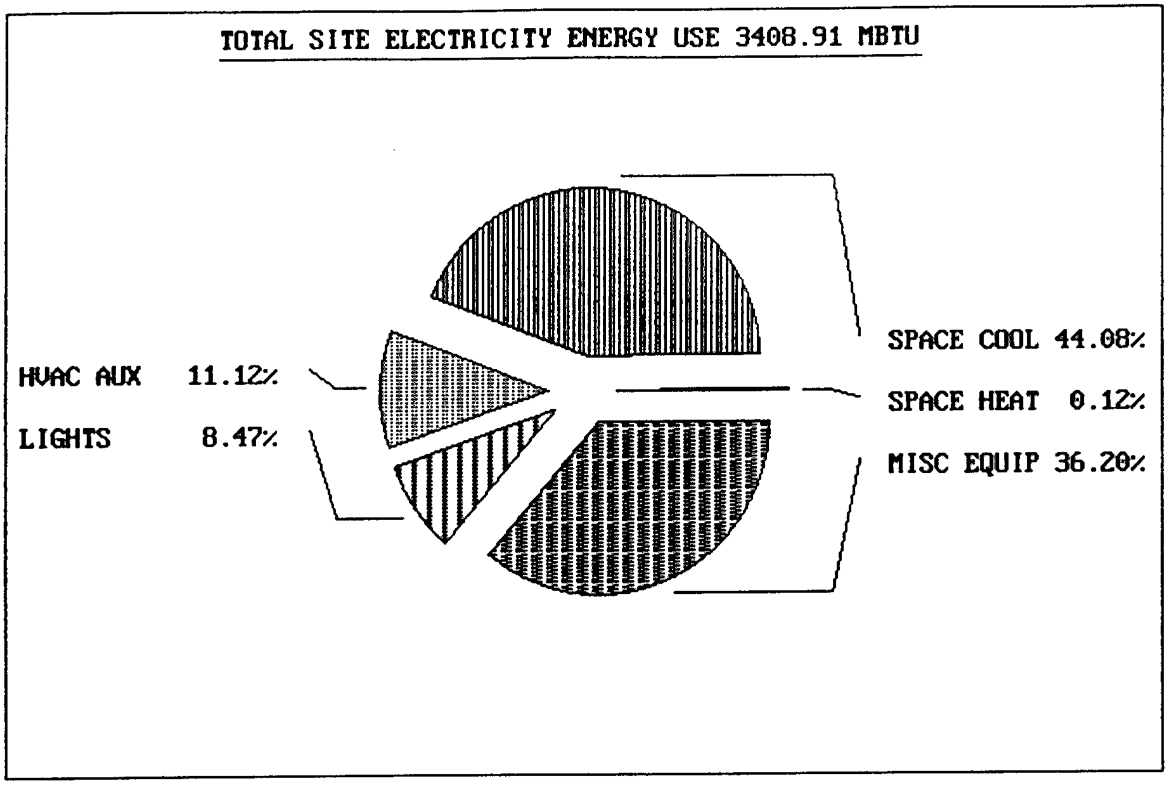
ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY	NATURAL-GAS
SPACE HEAT	0.00	61.38
SPACE COOL	1568.96	0.00
HVAC AUX	426.63	0.00
DOM HOT WTR	0.00	0.00
AUX SOLAR	0.00	0.00
LIGHTS	288.88	0.00
VERT TRANS	0.00	0.00
MISC EQUIP	1233.87	0.00
TOTAL	3518.34	61.38

TOTAL SITE ENERGY 3579.61 MBTU 314.0 KBTU/SQFT-YR GROSS-AREA 314.0 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 3579.61 MBTU 314.0 KBTU/SQFT-YR GROSS-AREA 314.0 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED =100.0
NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.




TOTAL SITE NATURAL-GAS ENERGY USE 61.38 MBTU
SPACE HEAT 100.0%

Baseline with ECO - 10



ENGINEER'S OPINION OF PROBABLE COST

SHEET 1 OF 1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		White Sands Missile Range, NM	

PROJECT TITLE Turn Off Office AHU	CONTRACT NO.
GEODSS, Energy Conservation Survey	DACA01-94-D-0033

				MATERIAL COST		LABOR COST				EQUIPMENT COST		TOTAL COST	
Line No.	Item Description	Unit of Measure	No. of Units	Unit Cost	Total	Manhrs/ Unit	Total Manhrs	Labor Cost/ Manhour	Total Labor Cost	Unit Cost	Total	Unit Cost	Total
1	Propane Tank 305 Gallons	Ea.	1	$2,865	$2,865	8.00	8.00	$22.99	$184	$0.00	$0	$3,049	$3,049
2	Cement Pad	S.F.	18	$0.96	$17	0.00	0.00	$22.99	$0	$0.00	$0	$1	$17
3	Piping	L.F.	44	$2.84	$126	0.11	4.75	$22.99	$109	$0.00	$0	$5	$235
4	Propane Furnace	Ea.	1	$880.00	$880	8.00	8.00	$22.99	$184	$0.00	$0	$1,064	$1,064
5	Excavation	L.F.	20	$0.00	$0	0.10	2.00	$22.99	$46	$0.00	$0	$2.30	$46
6	Pressure Regulator Valve	Ea.	1	$153.00	$153	1.60	1.60	$22.99	$37	$0.00	$0	$189.78	$190
7	Gas Stop	Ea.	1.0	$17.75	$18	0.67	0.67	$22.99	$15	$0.00	$0	$33.08	$33
8					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
9							0.00	$22.99	$0	$0.00	$0	$0.00	$0
10	Travel to job site	hrs	9		$0	1.00	9.00	$22.99	$207	$0.00	$0	$22.99	$207
11	Lodging and per diem				$0		0.00	$22.99	$0	$100.00	$0	$100.00	$0
12	Milage	miles	300		$0		0.00	$22.99	$0	$0.30	$90	$0.30	$90
13					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
14					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
15					$0		0.00	$22.99	$0	$100.00	$0	$100.00	$0
16					$0		0.00	$22.99	$0	$0.30	$0	$0.30	$0
17					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
18					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
19					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
20					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
21					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
22					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
23					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
24					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
25					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
26					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
27					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
28					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
29					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
30					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
31					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
32					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
33					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
34					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
35					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
36					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
37					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
38					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
39	**SUBCONTRACTOR SUBTOTAL**				$4,059		34		$782		$90		$4,931
40	LABOR BURDEN	%	30		$0				$235		$27		$262
41	SUBTOTAL				$4,059				$1,017		$117		$5,193
42	OVERHEAD	%	12		$487				$122		$14		$623
43	SUBTOTAL				$4,546				$1,139		$131		$5,816
44	PROFIT	%	12		$546				$137		$16		$698
45	**SUBCONTRACTOR TOTAL**				$5,092				$1,275		$147		$6,514
46	OVERHEAD	%	11		$558				$140		$16		$713
47	SUBTOTAL				$5,649				$1,415		$163		$7,227
48	PROFIT	%	8		$452				$113		$13		$578
49	SUBTOTAL				$6,101				$1,528		$176		$7,805
50	BOND	%	1		$45				$11		$1		$58
51	SUBTOTAL				$6,146				$1,539		$177		$7,863
52	N. M. TAX	%	6		$357				$89		$10		$457
53	SUBTOTAL				$6,503				$1,629		$187		$8,320
54	CONTINGENCY	%	20		$1,301				$326		$37		$1,664
55	GRAND TOTAL				$7,804				$1,955		$225		$9,984

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
EMS		E M C Engineers, Inc.	11/10/95

026 800 | Fuel Distribution

		CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1995 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
804 0320	Reducers 2"	Q-6	27	.889	Ea.	13.45	24.50		37.95	53.50 804
0330	3" diameter		22	1.091		15.55	30		45.55	64
0340	4" diameter		20	1.200		24	33		57	77.50
1010	Gas station product line for secondary containment (double wall)									
1100	Fiberglass reinforced plastic pipe 25' lengths									
1120	Pipe, plain end 3"	Q-6	375	.064	L.F.	3.62	1.75		5.37	6.75
1130	4" diameter		350	.069		4.66	1.87		6.53	8.05
1140	5" diameter		325	.074		5.20	2.02		7.22	8.90
1150	6" diameter		300	.080		8.80	2.18		10.98	13.15
1200	Fittings									
1230	Elbows, 90° & 45° 3"	Q-6	18	1.333	Ea.	35	36.50		71.50	96
1240	4" diameter		16	1.500		65	41		106	136
1250	5" diameter		14	1.714		134	47		181	221
1260	6" diameter		12	2		139	54.50		193.50	239
1270	Tees 3"		15	1.600		48.50	43.50		92	123
1280	4" diameter		12	2		80.50	54.50		135	175
1290	5" diameter		9	2.667		150	73		223	280
1300	6" diameter		6	4		155	109		264	345
1310	Couplings 3"		18	1.333		23	36.50		59.50	82.50
1320	4" diameter		16	1.500		63	41		104	134
1330	5" diameter		14	1.714		125	47		172	212
1340	6" diameter		12	2		130	54.50		184.50	229
1350	Cross-over nipples, 3"		18	1.333		5.40	36.50		41.90	63.50
1360	4" diameter		16	1.500		6.30	41		47.30	71.50
1370	5" diameter		14	1.714		9.40	47		56.40	84.50
1380	6" diameter		12	2		9.75	54.50		64.25	96.50
1400	Telescoping, reducers, concentric 4" x 3"		18	1.333		18.05	36.50		54.55	77.50
1410	5" x 4"		17	1.412		46.50	38.50		85	112
1420	6" x 5"		16	1.500		114	41		155	190

026 850 | Gas Distribution System

		CREW	DAILY OUTPUT	MAN-HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
854 0010	PIPING, GAS SERVICE & DISTRIBUTION, POLYETHYLENE									854
0020	not including excavation or backfill									
1000	60 psi coils, 1/2" diameter, SDR 9.3	B-20	450	.053	L.F.	.25	1.18		1.43	2.26
1040	1-1/4" diameter, SDR 11		400	.060		.65	1.32		1.97	2.94
1100	2" diameter, SDR 11		360	.067		1.21	1.47		2.68	3.81
1160	3" diameter, SDR 11		300	.080		2.27	1.76		4.03	5.45
1500	40' joints with coupling, 3" diameter, SDR 11	B-21	300	.093		2.47	2.11	.36	4.94	6.65
1540	4" diameter, SDR 11		260	.108		3.91	2.44	.41	6.76	8.85
1600	6" diameter, SDR 11		240	.117		8.95	2.64	.45	12.04	14.75
1640	8" diameter, SDR 11		200	.140		14.90	3.17	.54	18.61	22
856 0010	PIPING, GAS SERVICE & DISTRIBUTION, STEEL									856
0020	not including excavation or backfill, tar coated and wrapped									
4000	Schedule 40, plain end									
4040	1" diameter	Q-4	300	.107	L.F.	2.84	2.98	.17	5.99	8
4080	2" diameter		280	.114		3.21	3.20	.19	6.60	8.80
4120	3" diameter		260	.123		6.45	3.44	.20	10.09	12.75
4160	4" diameter	B-35	255	.188		9.25	4.49	1.96	15.70	19.65
4200	5" diameter		220	.218		13.90	5.20	2.27	21.37	26.50
4240	6" diameter		180	.267		17.05	6.35	2.77	26.17	32
4280	8" diameter		140	.343		27	8.15	3.56	38.71	47
4320	10" diameter		100	.480		37	11.45	4.99	53.44	65.50
4360	12" diameter		80	.600		46.50	14.30	6.25	67.05	81.50
4400	14" diameter		75	.640		52	15.25	6.65	73.90	89.50
4440	16" diameter		70	.686		57	16.35	7.10	80.45	97.50

SITE WORK 2

For expanded coverage of these items see Means Heavy Construction Cost Data

155 200 | Boiler Accessories

	Line	Description	Crew	Daily Output	Man-Hours	Unit	1995 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P	
250	9470	10,400/23,200 GPH	Q-6	.29	82.759	Ea.	26,100	2,250		28,350	32,200	250
260	0010	INDUCED DRAFT FANS										260
	1000	Breeching installation										
	1800	Hot gas, 600°F, variable pitch pulley and motor										
	1840	6" diam. inlet, 1/4 H.P., 1 phase, 400 CFM	Q-9	6	2.667	Ea.	1,000	67.50		1,067.50	1,200	
	1850	7" diam. inlet, 1/4 H.P., 1 phase, 800 CFM		5	3.200		1,075	81		1,156	1,300	
	1860	8" diam. inlet, 1/4 H.P., 1phase, 1120 CFM		4	4		1,575	101		1,676	1,875	
	1870	9" diam. inlet, 3/4 H.P., 1 phase, 1440 CFM		3.60	4.444		1,850	112		1,962	2,200	
	1880	10" diam. inlet, 3/4 H.P., 1 phase, 2000 CFM		3.30	4.848		2,075	123		2,198	2,475	
	1900	12" diam. inlet, 3/4 H.P., 3 phase, 2960 CFM		3	5.333		2,150	135		2,285	2,550	
	1910	14" diam. inlet, 1 H.P., 3 phase, 4160 CFM		2.60	6.154		2,525	156		2,681	3,025	
	1920	16" diam. inlet, 2 H.P., 3 phase, 6720 CFM		2.30	6.957		2,750	176		2,926	3,300	
	1940	18" diam. inlet, 3 H.P., 3 phase, 9120 CFM		2	8		3,325	202		3,527	3,975	
	1950	20" diam. inlet, 3 H.P., 3 phase, 9760 CFM		1.50	10.667		3,625	270		3,895	4,400	
	1960	22" diam. inlet, 5 H.P., 3 phase, 13,360 CFM		1	16		4,225	405		4,630	5,275	
	1980	24" diam. inlet, 7-1/2 H.P., 3 phase, 17,760 CFM		.80	20		5,200	505		5,705	6,525	
	2000	For multi-blade damper at fan inlet, add					20%					
	3600	Chimneytop installation										
	3700	6" size	1 Shee	8	1	Ea.	305	28		333	380	
	3740	8" size		7	1.143		310	32		342	390	
	3780	13" size		6	1.333		420	37.50		457.50	520	
	3880	For speed control switch, add					49.50			49.50	54.50	
	3920	For thermal fan control, add					29			29	32	
	5500	Flue shutter damper for draft control,										
	5520	parallel blades										
	[illegible]	8" size	Q-9	8	2	Ea.	350	50.50		400.50	465	
	[illegible]	9" size		7.50	2.133		380	54		434	505	
	[illegible]	10" size		7	2.286		390	58		448	520	
	[illegible]	12" size		6.50	2.462		430	62.50		492.50	575	
	[illegible]	14" size		6	2.667		490	67.50		557.50	640	
	[illegible]	16" size		5.50	2.909		530	73.50		603.50	700	
	[illegible]	18" size		5	3.200		580	81		661	765	
	[illegible]	20" size		4.50	3.556		645	90		735	850	
	[illegible]	22" size		4	4		710	101		811	940	
	[illegible]	24" size		3.50	4.571		750	116		866	1,000	
	[illegible]	27" size		3	5.333		775	135		910	1,075	
	[illegible]	30" size		2.50	6.400		825	162		987	1,175	
	[illegible]	32" size		2	8		865	202		1,067	1,275	
	[illegible]	36" size		1.50	10.667		930	270		1,200	1,450	

155 400 | Warm Air Systems

	Line	Description	Crew	Daily Output	Man-Hours	Unit	Mat.	Labor	Equip.	Total	Total Incl O&P	
	[illegible]	DUCT FURNACES includes burner, controls, stainless steel										
	[illegible]	heat exchanger. Gas fired, electric ignition										401
	[illegible]	Indoor installation										
	[illegible]	100 MBH output	Q-5	5	3.200	Ea.	880	84.50		964.50	1,100	
	[illegible]	120 MBH output		4	4		1,000	105		1,105	1,250	
	[illegible]	200 MBH output		2.70	5.926		1,375	156		1,531	1,775	
	[illegible]	240 MBH output		2.30	6.957		1,450	183		1,633	1,850	
	[illegible]	280 MBH output		2	8		1,600	211		1,811	2,100	
	[illegible]	320 MBH output		1.60	10		1,750	263		2,013	2,325	
	[illegible]	For powered venter and adapter, add					220			220	242	
	[illegible]	For required flue pipe, see division 155-680										
	[illegible]	Outdoor installation, with vent cap										
	[illegible]	75 MBH output	Q-5	4	4	Ea.	1,325	105		1,430	1,600	
	[illegible]	94 MBH output		4	4		1,475	105		1,580	1,775	

MECHANICAL

022 | Earthwork

		022 200 | Excav./Backfill/Compact.	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1995 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
258	0010	EXCAVATING, UTILITY TRENCH Common earth									
	0050	Trenching with chain trencher, 12 H.P., operator walking									
	0100	4" wide trench, 12" deep	B-53	800	.010	L.F.		.24	.10	.34	.51
	0150	18" deep		750	.011			.26	.11	.37	.53
	0200	24" deep		700	.011			.28	.12	.40	.57
	0300	6" wide trench, 12" deep		650	.012			.30	.13	.43	.62
	0350	18" deep		600	.013			.32	.14	.46	.67
	0400	24" deep		550	.015			.35	.15	.50	.74
	0450	36" deep		450	.018			.43	.19	.62	.89
	0600	8" wide trench, 12" deep		475	.017			.41	.18	.59	.84
	0650	18" deep		400	.020			.48	.21	.69	1.01
	0700	24" deep		350	.023			.55	.24	.79	1.15
	0750	36" deep		300	.027			.64	.28	.92	1.35
	1000	Backfill by hand including compaction, add									
	1050	4" wide trench, 12" deep	A-1	800	.010	L.F.		.19	.08	.27	.41
	1100	18" deep		530	.015			.29	.11	.40	.62
	1150	24" deep		400	.020			.39	.15	.54	.83
	1300	6" wide trench, 12" deep		540	.015			.29	.11	.40	.61
	1350	18" deep		405	.020			.38	.15	.53	.81
	1400	24" deep		270	.030			.57	.22	.79	1.22
	1450	36" deep		180	.044			.86	.33	1.19	1.83
	1600	8" wide trench, 12" deep		400	.020			.39	.15	.54	.83
	1650	18" deep		265	.030			.59	.23	.82	1.24
	1700	24" deep		200	.040			.78	.30	1.08	1.65
	1750	36" deep		135	.059			1.15	.45	1.60	2.44
	2000	Chain trencher, 40 H.P. operator riding									
	2050	6" wide trench and backfill, 12" deep	B-54	1,200	.007	L.F.		.16	.16	.32	[illegible]
	2100	18" deep		1,000	.008			.19	.19	.38	.52
	2150	24" deep		975	.008			.20	.20	.40	.54
	2200	36" deep		900	.009			.21	.21	.42	.59
	2250	48" deep		750	.011			.26	.26	.52	.69
	2300	60" deep		650	.012			.30	.30	.60	.81
	2400	8" wide trench and backfill, 12" deep		1,000	.008			.19	.19	.38	.52
	2450	18" deep		950	.008			.20	.20	.40	.55
	2500	24" deep		900	.009			.21	.21	.42	.59
	2550	36" deep		800	.010			.24	.24	.48	.66
	2600	48" deep		650	.012			.30	.30	.60	.81
	2700	12" wide trench and backfill, 12" deep		975	.008			.20	.20	.40	.54
	2750	18" deep		860	.009			.22	.22	.44	.61
	2800	24" deep		800	.010			.24	.24	.48	.66
	2850	36" deep		725	.011			.27	.27	.54	.72
	3000	16" wide trench and backfill, 12" deep		835	.010			.23	.23	.46	.62
	3050	18" deep		750	.011			.26	.26	.52	.66
	3100	24" deep		700	.011			.28	.28	.56	.74
	3200	Compaction with vibratory plate, add								50%	50%
262	0010	FILL Spread dumped material, by dozer, no compaction	B-10B	1,000	.012	C.Y.		.28	.85	1.13	[illegible]
	0100	By hand	1 Clab	12	.667	"		12.95		12.95	[illegible]
	0150	Spread fill, from stockpile with 2-1/2 C.Y. F.E. loader									
	0170	130 H.P. 300' haul	B-10P	600	.020	C.Y.		.46	1.35	1.81	[illegible]
	0190	With dozer 300 H.P. 300' haul	B-10M	600	.020	"		.46	1.71	2.17	[illegible]
	0500	Gravel fill, compacted, under floor slabs, 4" deep	B-37	10,000	.005	S.F.	.10	.10	.01	.21	[illegible]
	0600	6" deep		8,600	.006		.15	.11	.02	.28	[illegible]
	0700	9" deep		7,200	.007		.25	.14	.02	.41	[illegible]
	0800	12" deep		6,000	.008		.35	.16	.02	.53	[illegible]
	1000	Alternate pricing method, 4" deep		120	.400	C.Y.	7.50	8.20	1.16	16.86	[illegible]

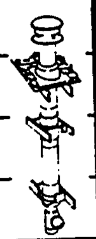
See the Reference Section for reference number information, Crew Listings and City C

55 | Heating

55 600 | Heating System Access.

671

Line	Description	Crew	Daily Output	Man-Hours	Unit	1995 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P
70	15 gallon capacity	Q-5	17	.941	Ea.	485	25		510	570
30	24 gallon capacity		14	1.143		520	30		550	620
30	30 gallon capacity		12	1.333		605	35		640	720
00	40 gallon capacity		10	1.600		690	42		732	825
10	60 gallon capacity		8	2		790	52.50		842.50	955
20	80 gallon capacity		7	2.286		905	60		965	1,100
30	100 gallon capacity		6	2.667		1,100	70		1,170	1,325
40	120 gallon capacity		5	3.200		1,275	84.50		1,359.50	1,525
50	135 gallon capacity		4.50	3.556		1,375	93.50		1,468.50	1,650
60	175 gallon capacity		4	4		1,675	105		1,780	2,025
70	220 gallon capacity		3.60	4.444		1,925	117		2,042	2,300
80	240 gallon capacity		3.30	4.848		2,025	128		2,153	2,425
90	305 gallon capacity		3	5.333		2,725	140		2,865	3,225
00	400 gallon capacity		2.80	5.714		3,325	150		3,475	3,900
00	Steel ASME expansion, rubber diaphragm, 19 gal. cap. accept.		12	1.333		1,125	35		1,160	1,300
20	31 gallon capacity		8	2		1,250	52.50		1,302.50	1,450
040	61 gallon capacity		6	2.667		1,750	70		1,820	2,025
060	79 gallon capacity		5	3.200		1,875	84.50		1,959.50	2,175
080	119 gallon capacity		4	4		1,975	105		2,080	2,350
100	158 gallon capacity		3.80	4.211		2,775	111		2,886	3,250
120	211 gallon capacity		3.30	4.848		3,200	128		3,328	3,725
140	317 gallon capacity		2.80	5.714		4,200	150		4,350	4,875
160	422 gallon capacity		2.60	6.154		6,200	162		6,362	7,075
180	528 gallon capacity		2.40	6.667		6,800	176		6,976	7,750
0010	VENT CHIMNEY Prefab metal, U.L. listed									680
0020	Gas, double wall, galvanized steel									
00	3" diameter	Q-9	72	.222	V.L.F.	2.92	5.60		8.52	12.30
010	4" diameter		68	.235		3.57	5.95		9.52	13.55
0120	5" diameter		64	.250		4.20	6.30		10.50	14.80
0140	6" diameter		60	.267		4.93	6.75		11.68	16.30
0160	7" diameter		56	.286		7.25	7.25		14.50	19.70
0180	8" diameter		52	.308		8.10	7.80		15.90	21.50
0200	10" diameter		48	.333		17.05	8.45		25.50	32.50
0220	12" diameter		44	.364		23	9.20		32.20	40
0240	14" diameter		42	.381		38.50	9.65		48.15	57.50
0260	16" diameter		40	.400		52	10.10		62.10	73.50
0280	18" diameter		38	.421		67	10.65		77.65	90.50
0300	20" diameter	Q-10	36	.667		79	17.50		96.50	116
0320	22" diameter		34	.706		100	18.50		118.50	140
0340	24" diameter		32	.750		123	19.65		142.65	168
0360	26" diameter		31	.774		148	20.50		168.50	196
0380	28" diameter		30	.800		156	21		177	206
0400	30" diameter		28	.857		165	22.50		187.50	219
0420	32" diameter		27	.889		192	23.50		215.50	249
0440	34" diameter		26	.923		218	24		242	279
0460	36" diameter		25	.960		231	25		256	295
0480	38" diameter		24	1		252	26		278	320
0500	40" diameter		23	1.043		281	27.50		308.50	355
0520	42" diameter		22	1.091		295	28.50		323.50	370
0540	44" diameter		21	1.143		325	30		355	410
0560	46" diameter		20	1.200		360	31.50		391.50	445
0580	48" diameter		19	1.263		395	33		428	490
	For 4", 5" and 6" oval, add					50%				
	Gas, double wall, galvanized steel, fittings									
0660	Elbow 45°, 3" diameter	Q-9	36	.444	Ea.	7.20	11.25		18.45	26
0670	4" diameter		34	.471		8.50	11.90		20.40	28.50



MECHANICAL 15

For expanded coverage of these items see Means Mechanical or Plumbing Cost Data 1995

033 | Cast-In-Place Concrete

033 100 | Structural Concrete

	Line	Description	Crew	Daily Output	Man-Hours	Unit	1995 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P
130	4050	Over 20 C.Y.	C-15	35.77	2.013	C.Y.	88	46.50	1.65	136.15	178
	4200	Grade walls, 8" thick, 8' high	↓	14.76	4.878		85	113	4	202	[illegible]
	4250	14' high	C-14	21.98	6.551		113	157	51.50	321.50	[illegible]
	4260	12" thick, 8' high	C-15	20.70	3.478		77	80.50	2.85	160.35	225
	4270	14' high	C-14	32.20	4.472		88.50	107	35	230.50	320
	4300	15" thick, 8' high	C-15	25.76	2.795		73	65	2.29	140.29	193
	4350	12' high	C-14	41.24	3.492		78	83.50	27.50	189	259
	4500	18' high		39.32	3.662	↓	87.50	87.50	28.50	203.50	278
	4520	Handicap access ramp, railing both sides, 3' wide		47.37	3.040	L.F.	91.50	75.50	7.10	174.10	241
	4525	5' wide		47	3.053		94	76	7.15	177.15	245
	4530	With cheek walls and rails both sides, 3' wide		26.22	5.491		148	137	3.85	288.85	410
	4535	5' wide	↓	24.32	5.920	↓	180	154	6.80	340.80	480
	4650	Slab on grade, not including finish, 4" thick	C-15	52.36	1.375	C.Y.	62	32	1.13	95.13	123
	4700	6" thick	•	78.79	.914	•	59	21	.75	80.75	102
	4751	Slab on grade, incl. troweled finish, not incl. forms									
	4760	or reinforcing, over 10,000 S.F., 4" thick slab	C-8A	1,982	.024	S.F.	.66	.51		1.17	1.5
	4820	6" thick slab		2,000	.024		.96	.51		1.47	1.9
	4840	8" thick slab		1,840	.026		1.32	.55		1.87	2.3
	4900	12" thick slab		1,594	.030		1.98	.64		2.62	3.2
	4950	15" thick slab	↓	1,458	.033	↓	2.49	.70		3.19	3.9
	5000	Slab on grade, incl. textured finish, not incl. forms									
	5001	For reinforcing, 4" thick slab	C-8A	2,200	.022	S.F.	.64	.46		1.10	1.4
	5010	6" thick		2,000	.024		.96	.51		1.47	1.9
	5020	8" thick	↓	1,800	.027	↓	1.28	.57		1.85	2.3
	5200	Lift slab in place above the foundation, incl. forms,									
	5210	reinforcing, concrete and columns, minimum	C-14	1,665	.086	S.F.	3.38	2.07	.68	6.13	8
	5250	Average		1,240	.116		3.63	2.78	.91	7.32	9.
	5300	Maximum	↓	1,200	.120	↓	3.92	2.87	.94	7.73	10.
	5500	Lightweight, ready mix, including screed finish only,									
	5510	not including forms or reinforcing									
	5550	1:4 for structural roof decks	C-8	80	.700	C.Y.	79.50	15.25	7.15	101.90	120
	5600	1:6 for ground slab with radiant heat		90	.622		75	13.55	6.35	94.90	113
	5650	1:3:2 with sand aggregate, roof deck		80	.700		79.50	15.25	7.15	101.90	120
	5700	Ground slab	↓	105	.533		79.50	11.60	5.45	96.55	113
	5900	Pile caps, incl. forms and reinf., sq. or rect., under 5 C.Y.	C-15	34.34	2.097		74	48.50	1.72	124.22	166
	5950	Over 10 C.Y.		47.34	1.521		71.50	35.50	1.25	108.25	140
	6000	Triangular or hexagonal, under 5 C.Y.		33.66	2.139		66.50	49.50	1.75	117.75	159
	6050	Over 10 C.Y.		53.88	1.336		71	31	1.10	103.10	13
	6200	Retaining walls, gravity, 4' high see division 022-708		21.35	3.372		68	78.50	2.77	149.27	21
	6250	10' high		40.17	1.792		59.50	41.50	1.47	102.47	13
	6300	Cantilever, level backfill loading, 8' high		22.59	3.187		75.50	74	2.61	152.11	21
	6350	16' high		29.29	2.458	↓	73.50	57	2.02	132.52	18
	6800	Stairs, not including safety treads, free standing		120	.600	LF Nose	5	13.95	.49	19.44	2
	6850	Cast on ground		180	.400	•	3.51	9.30	.33	13.14	1
	7000	Stair landings, free standing		285	.253	S.F.	2	5.85	.21	8.06	1
	7050	Cast on ground	↓	685	.105	•	1.13	2.44	.09	3.66	
134	0010	CURING With burlap, 4 uses assumed, 7.5 oz.	2 Clab	55	.291	C.S.F.	2.78	5.65		8.43	1
	0100	12 oz.		55	.291		4	5.65		9.65	1
	0200	With waterproof curing paper, 2 ply, reinforced		70	.229		5.30	4.43		9.73	1
	0300	With sprayed membrane curing compound	↓	95	.168	↓	2.07	3.27		5.34	
	0400	Curing blankets, 1" to 2" thick, buy, minimum				S.F.	.81			.81	
	0450	Maximum					2.53			2.53	
	0500	Electrically heated pads, 110 volts, 15 watts per S.F., buy					4.24			4.24	
	0600	20 watts per S.F., buy					5.65			5.65	
	0710	Electrically, heated pads, 15 watts/sf, 20 uses, minimum					.15			[illegible]	
	0800	Maximum				↓	.25			.25	

See the Reference Section for reference number information, Crew Listings and City C

4.12 ECO 12: ECONOMIZERS

Proposed Modifications: Install an economizer on AHU-2, which serves the hall and office areas.

An economizer uses outside air to cool the building when the outdoor temperature drops below a preset temperature. With the outside air cooling the building instead of the chillers, less energy is used in maintaining the indoor temperature.

Existing Conditions: Only the office AHU is eligible for an economizer as this is the only AHU using outside air as a percentage of their supply air. The restricted environment of the computer room makes an economizer on the CRUs an impractical option.

Method of Analysis: Analysis proceeded as follows:

- The baseline energy consumption model was modified so that the office AHUs included economizers controlled by dry-bulb temperature.

Results: The results are presented in the table below.

Annual Electric Energy Savings (kWh)	967
Total Annual Energy Cost Savings	$79
Annual Maintenance Cost Savings	$0
Investment Cost	$4,096
Savings-to-Investment Ratio (SIR)	0.29
Simple Payback (Years)	51.6

Recommendations: An economizer on AHU-2 is not recommended.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Jul-95
3. INSTALLATION AND LOCATION GEODSS Site, White Sands Missile Range, NM		
4. PROJECT TITLE Install Economizer		5. PROJECT NUMBER

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

LOCATION: White Sands Missile Range, NM   REGION: 4 (New Mexico)   PROJECT NO: 1406.008
PROJECT TITLE: Recirculate Tower Air   FISCAL YEAR: 1995
ANALYSIS DATE: 12/01/95   ECONOMIC LIFE: 20   PREPARED BY: E.Smith

1. INVESTMENT

A. CONSTRUCTION COST		=	$3,657	
B. SIOH COST	(6.0% of 1A) =		$219	
C. DESIGN COST	(6.0% of 1A) =		$219	
D. TOTAL COST	(1A +1B +1C) =		$4,096	
E. SALVAGE VALUE OF EXISTING EQUIPMENT =			$0	
F. PUBLIC UTILITY COMPANY REBATE =			$0	
G. TOTAL INVESTMENT	(1D -1E -1F) =		------->	$4,096

2. ENERGY SAVINGS (+) OR COST (-):
DATE OF NISTR-85-3273-9 USED FOR DISCOUNT FACTORS: Jul-95

ENERGY SOURCE	FUEL COST $/KWH (1)	SAVINGS KWH/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. ELECT. (SAV'GS)	$0.0821	967	$79	15.08	$1,197	
B. DIST (GAL.)	$1.10	0	$0	18.57	$0	
C. RESID (GAL.)	$3.00	0	$0	21.02	$0	
D. NAT GAS (MBTU)	$6.18	0	$0	18.58	$0	
E. COAL	$2.00	0	$0	16.83	$0	
G. DEMAND ($/kW)	$0.00	0	$0	15.08	$0	
H. TOTAL		967	$79		-------->	$1,197

3. NON-ENERGY SAVINGS (+) OR COST (-)
A. ANNUAL RECURRING (+/-)

1 ANNUAL MAINTENANCE SAVINGS	$0	14.88	$0	
2		14.88	$0	
3 TOTAL ANNUAL DISC. SAVINGS (+) / COST (-)	$0		$0	

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE A-2)	DISCOUNTED SAV'G/COST(4)	
a.	$0	0	0.00	$0	
b.	$0	0	0.00	$0	
c.	$0	0	0.00	$0	
d. TOTAL	$0			$0	
C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-)			(3A3 + 3Bg4) =		$0

4.	FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3+3A+(3Bg1/Economic Life))	$79
5.	SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	51.6
6.	TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$1,197
7.	DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	0.29

LIFE CYCLE COST ANALYSIS
ECONOMIZERS

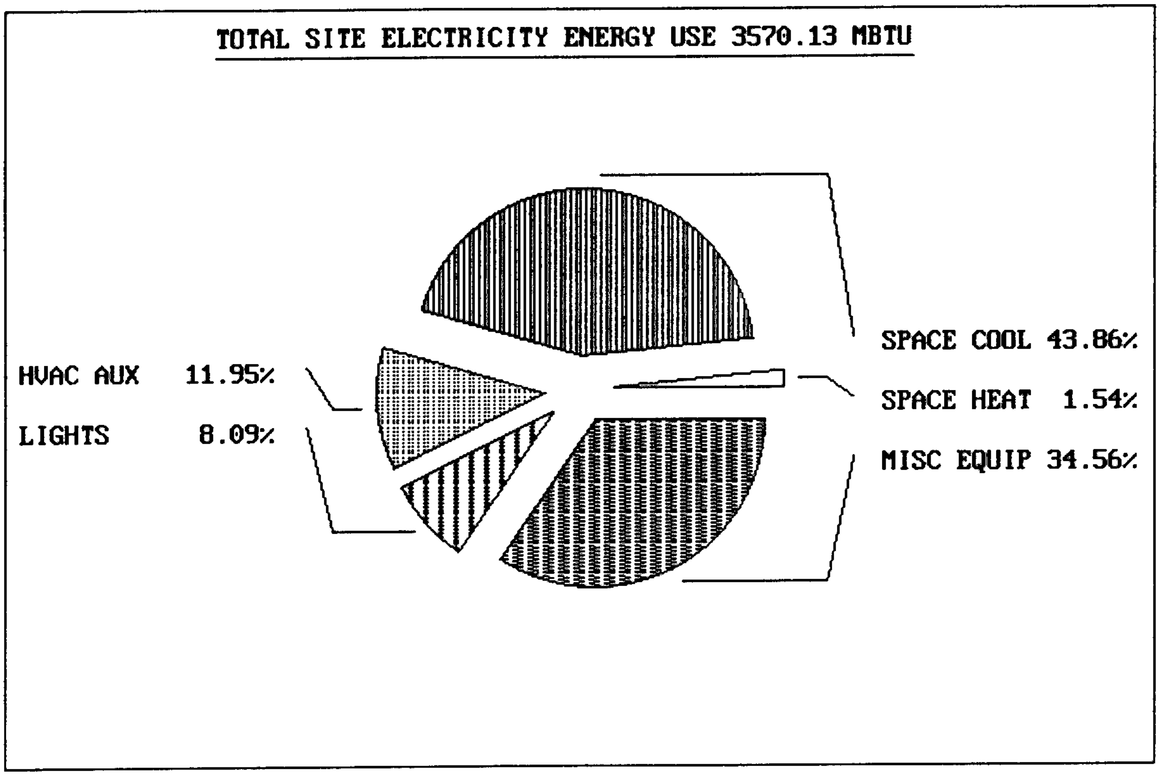
Economic Life(Years)	20

Simulation	Energy Consumed (MBTU)	Energy Consumed (kWh)
Baseline Model	3573.44	1,047,008
Economizer Model	3570.14	1,046,042
Savings	3.30	967
Cost Savings		$79

Annual Electric Energy Savings (kWh)		967
Total Annual Energy Cost Savings		$79
Construction Cost	$	3,657
SIOH (6.0%)	$	219
Design Cost (6.0%)	$	219
Total Investment	$	4,096
Discounted Savings		$1,197
Savings-to-Investment Ratio (SIR)		0.29
Simple Payback (Years)		51.60

ENERGY TYPE IN SITE MBTU - CATEGORY OF USE	ELECTRICITY
SPACE HEAT	55.08
SPACE COOL	1565.69
HVAC AUX	426.63
DOM HOT WTR	0.00
AUX SOLAR	0.00
LIGHTS	288.88
VERT TRANS	0.00
MISC EQUIP	1233.86
TOTAL	3570.14

TOTAL SITE ENERGY 3570.04 MBTU 313.2 KBTU/SQFT-YR GROSS-AREA 313.2 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 3570.04 MBTU 313.2 KBTU/SQFT-YR GROSS-AREA 313.2 KBTU/SQFT-YR NET-AREA
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED =100.0
NOTE ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED ON THE YEARLY DEMAND. ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.



ENGINEER'S OPINION OF PROBABLE COST

SHEET	1	OF	1

AREA	ACTIVITY	LOCATION	AMENDMENT NO.
		White Sands Missile Range, NM	

PROJECT TITLE Install Economizer	CONTRACT NO.
GEODSS, Energy Conservation Survey	DACA01-94-D-0033

Line No.	Item Description	Unit of Measure	No. of Units	MATERIAL COST Unit Cost	MATERIAL COST Total	LABOR COST Manhrs/ Unit	LABOR COST Total Manhrs	LABOR COST Labor Cost/ Manhour	LABOR COST Total Labor Cost	EQUIPMENT COST Unit Cost	EQUIPMENT COST Total	TOTAL COST Unit Cost	TOTAL COST Total
1	Damper Motor	Ea.	3	$153.00	$459	0.50	1.50	$22.99	$34	$0.00	$0	$164	$493
2	Outside Air Temp Sensor	Ea.	1	$69.20	$69	0.80	0.80	$22.99	$18	$0.00	$0	$88	$88
3	Controller	Ea.	1	$250.00	$250	1.14	1.14	$22.99	$26	$0.00	$0	$276	$276
4	Dampers	Ea.	3	$132.00	$396	1.00	3.00	$22.99	$69	$0.00	$0	$155	$465
5	Ductwork Modification	Ls.	1	$0.00	$0	8.00	8.00	$22.99	$184	$0.00	$0	$183.92	$184
6					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
7					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
8					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
9							0.00	$22.99	$0	$0.00	$0	$0.00	$0
10	Travel to job site	hrs	6		$0	1.00	6.00	$22.99	$138	$0.00	$0	$22.99	$138
11	Lodging and per diem				$0		0.00	$22.99	$0	$100.00	$0	$100.00	$0
12	Milage	miles	300		$0		0.00	$22.99	$0	$0.30	$90	$0.30	$90
13					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
14					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
15					$0		0.00	$22.99	$0	$100.00	$0	$100.00	$0
16					$0		0.00	$22.99	$0	$0.30	$0	$0.30	$0
17					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
18					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
19					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
20					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
21					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
22					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
23					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
24					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
25					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
26					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
27					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
28					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
29					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
30					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
31					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
32					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
33					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
34					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
35					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
36					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
37					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
38					$0		0.00	$22.99	$0	$0.00	$0	$0.00	$0
39	**SUBCONTRACTOR SUBTOTAL**				$1,174		20		$470		$90		$1,734
40	LABOR BURDEN	%	30		$0				$141		$27		$168
41	SUBTOTAL				$1,174				$611		$117		$1,902
42	OVERHEAD	%	12		$141				$73		$14		$228
43	SUBTOTAL				$1,315				$684		$131		$2,130
44	PROFIT	%	12		$158				$82		$16		$256
45	**SUBCONTRACTOR TOTAL**				$1,473				$766		$147		$2,386
46	OVERHEAD	%	11		$161				$84		$16		$261
47	SUBTOTAL				$1,634				$850		$163		$2,647
48	PROFIT	%	8		$131				$68		$13		$212
49	SUBTOTAL				$1,765				$918		$176		$2,859
50	BOND	%	1		$13				$7		$1		$21
51	SUBTOTAL				$1,778				$925		$177		$2,880
52	N. M. TAX	%	6		$103				$54		$10		$167
53	SUBTOTAL				$1,881				$979		$187		$3,048
54	CONTINGENCY	%	20		$376				$196		$37		$610
55	**GRAND TOTAL**				$2,258				$1,175		$225		$3,657

PREPARED BY	APPROVED BY	TITLE OR ORGANIZATION	DATE
EMS		E M C Engineers, Inc.	11/10/95

157 400 | Accessories

		157 400 | Accessories	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	1995 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL
401	1850	Double pack to 30,000 CFM, add					5%				
	1860	Double pack to 60,000 CFM, add					6%				
	1870	Inlet or outlet transition, vertical									
	1880	Single pack to 5000 CFM, add					2%				
	1890	Single pack to 24,000 CFM, add					3%				
	1900	Double pack to 24,000 CFM, add					2%				
	2000	Electronic air cleaner, duct mounted									
	2150	400 - 1000 CFM	1 Shee	2.30	3.478	Ea.	380	97.50		477.50	575
	2200	1000 - 1400 CFM		2.20	3.636		485	102		587	695
	2250	1400 - 2000 CFM		2.10	3.810		545	107		652	770
	2950	Mechanical media filtration units									
	3000	High efficiency type, with frame, non-supported				MCFM	35			35	38.50
	3100	Supported type					50			50	55
	4000	Medium efficiency, extended surface					5.50			5.50	6.05
	4500	Permanent washable					45			45	49.50
	5000	Renewable disposable roll					165			165	182
	5500	Throwaway glass or paper media type				Ea.	4.10			4.10	4.51
410	0010	ANTI-FREEZE inhibited									
	0900	Ethylene glycol concentrated									
	1000	55 gallon drums, small quantities				Gal.	6.15			6.15	6.80
	1200	Large quantities					5.70			5.70	6.30
	2000	Propylene glycol, for solar heat, small quantities					7.25			7.25	8
	2100	Large quantities					7.15			7.15	7.85
420	0010	CONTROL COMPONENTS									
	0700	Controller, receiver									
	0730	Pneumatic, panel mount, single input	1 Plum	8	1	Ea.	175	29.50		204.50	[illegible]
	0740	With conversion mounting bracket		8	1		182	29.50		211.50	245
	0750	Dual input, with control point adjustment		7	1.143		250	33.50		283.50	325
	0850	Electric, single snap switch	1 Elec	4	2		244	57		301	355
	0860	Dual snap switches		3	2.667		325	76		401	470
	0870	Humidity controller		8	1		156	28.50		184.50	215
	0880	Load limiting controller		8	1		315	28.50		343.50	390
	0890	Temperature controller		8	1		149	28.50		177.50	207
	1000	Enthalpy control, boiler water temperature control									
	1010	governed by outdoor temperature, with timer	1 Elec	3	2.667	Ea.	142	76		218	271
	2000	Gauges, pressure or vacuum									
	2100	2" diameter dial	1 Stpi	32	.250	Ea.	8	7.30		15.30	20
	2200	2-1/2" diameter dial		32	.250		9.40	7.30		16.70	21.50
	2300	3-1/2" diameter dial		32	.250		12	7.30		19.30	24.50
	2400	4-1/2" diameter dial		32	.250		16.50	7.30		23.80	29.50
	2700	Flanged iron case, black ring									
	2800	3-1/2" diameter dial	1 Stpi	32	.250	Ea.	43	7.30		50.30	58
	2900	4-1/2" diameter dial		32	.250		52	7.30		59.30	68
	3000	6" diameter dial		32	.250		70.50	7.30		77.80	88.50
	3300	For compound pressure-vacuum,add					18%				
	3350	Humidistat									
	3360	Pneumatic operation									
	3361	Room humidistat, direct acting	1 Stpi	12	.667	Ea.	133	19.50		152.50	176
	3362	Room humidistat, reverse acting		12	.667		133	19.50		152.50	176
	3363	Room humidity transmitter		17	.471		143	13.75		156.75	179
	3364	Duct mounted controller		12	.667		175	19.50		194.50	223
	3365	Duct mounted transmitter		12	.667		158	19.50		177.50	[illegible]
	3366	Humidity indicator, 3-1/2"		28	.286		63.50	8.35		71.85	[illegible]
	3390	Electric operated	1 Shee	8	1		40	28		68	[illegible]
	3400	Relays									

15 MECHANICAL

5. RESULTS AND RECOMMENDATIONS

5.1 RESULTS OF ECO ANALYSIS

Table 5-1 presents the results of the analysis for each ECO.

Table 5-1. Summary of Results

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
1	Albedo Modification	1,532	126	0	N/A	N/A	N/A
2	Roof Insulation 6"	1,939	159	0	N/A	N/A	N/A
3	Low-Emissivity Roof Coating	900	74	0	N/A	N/A	N/A
4	T-8 Fluorescent Lamps	29,455	2,418	47	12,429	2.38	5.0
5	Vortex Tube Cooling	38,441	3,156	0	N/A	N/A	N/A
6	High-Efficiency Motors	2,197	180	0	1,753	1.55	9.7
7	UPS System	89,454	7,344	0	22,874	4.85	3.1
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.3
9	Recirculation of Tower Air	74,518	6,118	0	22,767	4.05	3.7
10	Turn Off AHU at Night	48,210	3,958	0	420	80.86	0.1
11	Propane Heat	1,199	65	0	11,182	0.08	171.7
12	Economizers	967	79	0	4,096	0.29	51.6

5.2 RECOMMENDATIONS

The following ECOs are recommended for implementation.

Table 5-2. Summary of Recommended ECOs

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
10	Turn Off AHU at Night	48,210	3,958	0	420	80.86	0.09
7	UPS System	89,454	7,344	0	22,874	4.85	3.11
9	Recirculation of Tower Air	74,518	6,118	47	22,767	4.05	3.72
4	T-8 Fluorescent Lamps	29,455	2,418	0	12,429	2.38	5.04
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.30
6	High Efficiency Motors	2,197	180	0	1,753	1.55	9.72
	Overall Savings	**280,029**	**22,990**	**47**	**101,292**	**N/A**	**4.41**

$$\frac{280{,}029 \text{ KWh}}{1{,}000{,}000} \times \frac{3{,}413 \text{ BTU}}{\text{kwhr}} \times \frac{\text{MBTU}}{\text{BTU}} = 956 \text{ MBTU}$$

The overall savings takes into account the synergistic effects of multiple ECOs. The total annual energy cost savings for combined ECOs is $22,990 per year with a resulting simple payback of 4.4 years. The combined ECOs annual energy savings is 280,029 kWh per year, 27% of the present annual energy use.

To qualify for FEMP funding, ECOs must have an SIR greater than 1.25 and a simple economic payback less than 10 years. The following ECOs are recommended for funding as a Federal Energy Management Program (FEMP) project.

Table 5-3. Summary of ECOs Recommended for FEMP Funding

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
7	UPS System	89,454	7,344	0	22,874	4.85	3.11
9	Recirculation of Tower Air	74,518	6,118	0	22,767	4.05	3.72
4	T-8 Fluorescent Lamps	29,455	2,418	47	12,429	2.38	5.04
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.30
	Combined Savings	252,877	20,761	47	157,609	2.74	5.7

The combined savings of these ECOs with synergistic effects taken into accout is $20,761 per year with a resulting SIR of 2.74 and a simple payback of 5.7 years.

The following ECOs are recommended for in-house implementation by the GEODSS maintenance staff.

Table 5-4. Summary of ECOs Recommended for In-House Implementation

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
10	Turn Off AHU at Night	48,210	3,958	0	420	80.86	0.09
6	High-Efficiency Motors	2,197	180	0	1,753	1.55	9.72

The following ECOs are recommended for implementation with the installation of the new computer system, in about two years.

Table 5-5. Recommended ECO Upgrades with Computer Renovation

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
5	Vortex Tube Cooling	38,441	3,156	0	N/A	N/A	N/A

The following ECOs were not found to be cost effective:

Table 5-6. ECOs Not Recommended

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
1	Albedo Modification	1,532	126	0	N/A	N/A	N/A
2	Roof Insulation 6"	1,939	159	0	N/A	N/A	N/A
3	Low-Emissivity Roof Coating	900	74	0	N/A	N/A	N/A
11	Propane Heat	1,199	65	0	11,182	0.08	171.70
12	Economizers	967	79	0	4,096	0.29	51.60

APPENDIX A

SCOPE OF WORK AND CORRESPONDENCE

YDW

ORDER FOR SUPPLIES OR SERVICES
(Contractor must submit four copies of invoice)

Form Approved
OMB No. 0704-0187
Expires Aug 31, 1992

1. CONTRACT / PURCH ORDER NO	2. DELIVERY ORDER NO.	3. DATE OF ORDER	4. REQUISITION / PURCH REQUEST NO.	5. CERTIFIED FOR NATIONAL DEFENSE UNDER DMS REG 1
D[illegible]A01-94-D-0033	0008	08 MAY 95		DO

6. ISSUED BY CODE
US ARMY ENGINEER DISTRICT, MOBILE
P.O. BOX 2288
MOBILE, ALABAMA 36628-0001

7. ADMINISTERED BY (If other than 6) CODE

8. DELIVERY FOB
[X] DEST
[ ] OTHER
(See Schedule if other)

9. CONTRACTOR CODE FACILITY CODE

NAME AND ADDRESS
EMC ENGINEERS, INC.
2750 SO. WADSWORTH BLVD, SUITE C-200
DENVER, COLORADO 80227-3400

10. DELIVER TO FOB POINT BY (Date)
SEE APPENDIX "A"

11. MARK IF BUSINESS
[ ] SMALL
[X] SMALL DISADVANTAGED
[X] WOMEN-OWNED

12. DISCOUNT TERMS
N/A

13. MAIL INVOICES TO
CESAM-EN-MN

14. SHIP TO CODE
US ARMY ENGINEER DISTRICT, MOBILE
P.O. BOX 2288
MOBILE, ALABAMA 36628-0001

15. PAYMENT WILL BE MADE BY CODE
FINANCE AND ACCOUNTING OFFICER
US ARMY ENGINEER DISTRICT, MOBILE
P.O. BOX 2288
MOBILE, ALABAMA 36628-0001

MARK ALL PACKAGES AND PAPERS WITH CONTRACT OR ORDER NUMBER

16. TYPE OF ORDER

DELIVERY [X] This delivery order is issued on another Government agency or in accordance with and subject to terms and conditions of above numbered contract.

PURCHASE [ ] Reference your furnish the following on terms specified herein.

ACCEPTANCE. THE CONTRACTOR HEREBY ACCEPTS THE OFFER REPRESENTED BY THE NUMBERED PURCHASE ORDER AS IT MAY PREVIOUSLY HAVE BEEN OR IS NOW MODIFIED, SUBJECT TO ALL OF THE TERMS AND CONDITIONS SET FORTH, AND AGREES TO PERFORM THE SAME.

NAME OF CONTRACTOR — SIGNATURE — TYPED NAME AND TITLE — DATE SIGNED

[ ] If this box is marked, supplier must sign Acceptance and return the following number of copies:

17. [illegible]COUNTING AND APPROPRIATION DATA / LOCAL USE
[illegible]020 508-8028 P437018.75-25CZ S01076 QE50215B231B400 (R08956335) TOTAL: $44,069.00

18. ITEM NO.	19. SCHEDULE OF SUPPLIES / SERVICE	20. QUANTITY ORDERED/ ACCEPTED*	21. UNIT	22. UNIT PRICE	23. AMOUNT
	DELIVERY ORDER FOR LIMITED ENERGY STUDY, GEODDS FACILITY, WHITE SANDS MISSILE RANGE NEW MEXICO				$44,069.00

*If quantity accepted by the Government is same as quantity ordered, indicate by X. If different, enter actual quantity accepted below quantity ordered and encircle.

24. UNITED STATES OF AMERICA
Edward M. Slana 8 MAY 95
BY: EDWARD M. SLANA
CONTRACTING ~~ORDERING~~ OFFICER

25. TOTAL $44.069.00

29. DIFFERENCE

26. QUANTITY IN COLUMN 20 HAS BEEN
[ ] INSPECTED [ ] RECEIVED [ ] ACCEPTED, AND CONFORMS TO THE CONTRACT EXCEPT AS NOTED

DATE — SIGNATURE OF AUTHORIZED GOVERNMENT REPRESENTATIVE

27. SHIP NO.
[ ] PARTIAL
[ ] FINAL

28. D.O. VOUCHER NO.

30. INITIALS

32. PAID BY

33. AMOUNT VERIFIED CORRECT FOR

34. CHECK NUMBER

[illegible]rtify this account is correct and proper for payment

DATE — SIGNATURE AND TITLE OF CERTIFYING OFFICER

31. PAYMENT
[ ] COMPLETE
[ ] PARTIAL
[ ] FINAL

35. BILL OF LADING NO.

37. RECEIVED AT	38. RECEIVED BY	39. DATE RECEIVED	40. TOTAL CONTAINERS	41. S/R ACCOUNT NUMBER	42. S/R VOUCHER NUMBER

CESAM-EN-DM

February 1995
Revised 22 March 1995

APPENDIX "A"

SCOPE OF WORK

LIMITED ENERGY STUDY

GEODDS FACILITY, BUILDING 34568

STALLION SITE

WHITE SANDS MISSILE RANGE, NM

Performed as part of the

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

WSMRLS1.doc

SCOPE OF WORK
FOR A
LIMITED ENERGY STUDY
GEODDS FACILITY
WHITE SANDS MISSILE RANGE, NM

TABLE OF CONTENTS

1. <u>BRIEF DESCRIPTION OF WORK</u>: The Architect-Engineer (AE) shall:

1.1 Perform a site survey of a specific facility to collect all data required to perform a thorough energy audit of the facility.

1.2 Identify and evaluate Energy Conservation Opportunities (ECOs) to determine their energy savings potential and economic feasibility.

1.3 Provide project documentation for recommended ECOs as detailed herein.

1.4 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. <u>GENERAL</u>

2.1 This study is limited to the evaluation of the specific building listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3 For the building listed in Annex A, all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All ECOs which produce energy or dollar savings shall be documented in this report. Any ECO considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all energy sources applicable to each building, system, or ECO.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from DAIM-FDF-U, dated 10 Jan 1994 establishes criteria for ECIP projects and shall be used for performing the economic analyses of <u>all</u> ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Computer modeling will be used to analyze ECOs which would modify, replace, or significantly alter the load on an existing heating, ventilating, and air-conditioning (HVAC) system. Modeling will be done using a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting and other energy-producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads of the building under study. The program will use established weather data files and may perform calculations on a true hour-by-hour basis or may condense the weather files and the number of calculations into several "typical" days per month. The Detailed Scope of Work, Annex A, lists programs that are acceptable to the Contracting Officer. If the AE desires to use a different program, it must be submitted for approval with a sample run, an explanation of all input and output data, and a summary of program methodology and energy evaluation capabilities.

2.7 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 funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

2.7.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.7.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest 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 delivery order. Upon award of this delivery order, 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 delivery order. 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 delivery order. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this delivery order. This individual will be the installation representative.

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 the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

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 delivery order number, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

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 delivery order number. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), labor, supervision and travel necessary to perform the work and render the data required under this delivery order are included in the lump sum price of the delivery order.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered 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, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio (SIR) greater than 1.25 and a simple payback period of less than ten years. The overall project and each discrete part of the project shall have an SIR greater than 1.25. All projects meeting the above criteria shall be arranged as specified in paragraph 2.7.1 and shall be provided with programming documentation. Programming documentation shall consist of a DD Form 1391 and life cycle cost analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented). A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate or payback period, but which have an SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.7.2 and shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. Federal Energy Management Program (FEMP) Projects. A FEMP (or O&M Energy) project is one that results in needed maintenance or repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings. The criteria are similar to the criteria for ECIP projects, ie, SIR $\geq$ 1.25, and simple payback period of less than ten years. Projects with a construction cost estimate up to $1,000,000 shall be documented as outlined in par 5.2 above; projects over $1,000,000 shall be documented on 1391s. In the FEMP program, a system may be defined as "failed or failing" if it is inefficient or technically obsolete. However, if this strategy is used to justify a proposed project, the equipment to be replaced must have been in use for at least three years.

b. Low Cost/No Cost Projects. These are projects which the Director of Public Works (DPW) can perform using his resources. Documentation shall be as required by the DPW.

5.3 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 Detailed Scope of Work is contained in Annex A.

7. WORK TO BE ACCOMPLISHED.

7.1 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.2 Evaluate Selected ECOs. The AE shall analyze all identified ECOs in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations 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. 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 ECO and included as part of the supporting data.

7.3 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.4.1, the AE will be advised of the DPW's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par 7.4.2.

7.4 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. 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. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the building occupant, the DPW, 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.

7.4.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed 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, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a. All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

b. All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. 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. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the DPW to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit 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 are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.4.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study 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 recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph 7.4.1 shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An 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 B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

ANNEX A

DETAILED SCOPE OF WORK

LIMITED ENERGY STUDY

GEODDS FACILITY, BUILDING 34568

STALLION SITE, WHITE SANDS MISSILE RANGE, NM

1. The General Scope of Work outlines requirements for the study and the report; and the detailed scope of work describes the specific area to be studied. If any conflicts arise between the General and the Detailed scopes of work, the Detailed Scope of Work shall govern.

2. The facility to be investigated in this study is Building 34568, which is located at Stallion Site in the northern part of White Sands Missile Range. It is approximately 30 miles south and east of Socorro, NM and south of US Highway 380. Access to the site is controlled. Temporary passes will be required for both personnel and vehicle access. A one-week notice should be given by the AE prior to any visit. This time will be needed to make the necessary arrangements for the visit.

3. The installation representative for this contract will be Mr. Julian Delgado, Energy Manager, Directorate of Public Works. The occupant representative will be Msgt. Luther Mills, Chief, Detachment 1, 18th SSS.

4. Building 34568 is a windowless, filled-concrete-block, high-bay structure with an area of approximately 10,000 SF. It is a research facility with scientific and computer equipment, and it is occupied 24 hours per day, 365 days per year. Two TRANE 40-ton, air-cooled chillers are used for air conditioning. Some spaces require year-round cooling. Those spaces that require heat are served by electric resistance duct heaters or unit heaters. The building, although owned by the Army, is occupied by an Air Force Detachment. The site is separately metered, and the Air Force reimburses White Sands Missile Range for all power used. Records of electrical consumption are available for the past three years. Building 34568 and a motor-generator set that serves equipment in B/34568 are the major users of electrical energy on the site.

5. Approximately two years ago the electrical consumption for this facility began to rise sharply. The purpose of this study is to find all cost-effective measures which may be employed to reduce energy consumption and cost.

6. The work consists of conducting a thorough energy audit and to identify and evaluate energy conservation opportunities (ECOs) for the GEODDS facility. All energy-related aspects of the facility should be investigated, ie. skin, lighting, HVAC systems, equipment and controls, other equipment, operations and maintenance. Field data taken should include lighting levels and operating

amps of all major equipment. A field calibration of the electrical meter for the site should be a part of the field investigation. Any proposal that would modify or replace the chillers must take into consideration the latest guidance on CFC refrigerants. See suggested ECOs at the end of this annex.

7. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The final report for this study shall be due not later than 90 days after Notice to Proceed.

MILESTONE	PERCENT OF CONTRACT AMOUNT AUTHORIZED FOR PAYMENT
Completion of Field Work	25
Receipt of Interim Submittal	75
Completion of Interim Presentation & Review	85
Receipt of Final Report	100

8. The following computer programs will be acceptable for use in building and HVAC system simulation. If it is desired to use a program other than one of the following, it must be submitted for approval as outlined in par 2.6 of the general scope of work.

a. Building Loads and System Thermodynamics (BLAST)
b. Carrier E20 or Hourly Analysis Program (HAP)
c. DOE 2.1B
d. Trane Air-Conditioning Economics (TRACE)

9. Government-Furnished Information: The following documents will be furnished to the AE:

a. As-built drawings (as available) of Building 34568.

b. Energy consumption records.

c. Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

d. ETL 1110-3-254, Use of Electric Power for Comfort Space Heating

e. ETL 1110-3-282, Energy Conservation

f. TM 5-785, Engineering Weather Data

g. TM 5-800-2, Cost Estimates, Military Construction

h. AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

i. Architectural and Engineering Instructions, Design Criteria, 9 December 1991

j. The latest MCP Index

10. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. The current edition of LCCID is dated October 1994. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

11. Reports and correspondence shall be provided in the quantities shown to the offices listed below:

	REPORT SUBMITTALS	*FIELD NOTES	CORRESPONDENCE
Commander US Army White Sands Missile Range ATTN: STEWS-DPW-PE (Delgado) White Sands Missile Range, NM 88002-5076	2	1	1
Det 1 18th SSS/DC (Msgt Mills) PO Box W Socorro, NM, 87801	2	1	1
Air Force Space Command ATTN: 73 MSS/CE (Soderlund) 400 O'Malley Avenue, Suite 56 Falcon AFB, CO, 80912-4056	1		
Commander US Army Engineer District, Mobile ATTN: CESAM-EN-DM (Mr. Battaglia) PO Box 2288 Mobile, AL 36628-0001	2	1	1
Commander US Army Engineer District, Fort Worth ATTN: CESWF-ED-MP (Mr Champagne) PO Box 17300 Fort Worth, TX, 76102 - 0300	1	-	-

* To be submitted in final form with the interim submittal

SUGGESTED ENERGY CONSERVATION OPPORTUNITIES

ENVELOPE

- o Insulation (wall, roof, etc.)
- o Color of outside walls, doors, and roof
- o Low emissivity roof coating

POWER

- o Improve power factor
- o High efficiency motor replacement

HVAC

- o Reduce outside air
- o Night setback/setup thermostats
- o Economizer cycles (dry bulb)
- o Chiller replacement
- o Chiller controls
- o Revise or repair building HVAC controls

IMPROVE LIGHTING EFFICIENCY

- o Replace standard fluorescent lamps with energy-conserving lamps
- o Replace standard fluorescent ballasts with electronic ballasts
- o Replace existing fluorescent fixtures with new fixtures having efficient reflectors, electronic ballasts, and energy-conserving lamps
- o Use more efficient lighting source, ie, upgrade from incandescent to fluorescent, from fluorescent to HID, from mercury vapor to high pressure sodium, etc

ANNEX B

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   o Total Annual Energy Used.

   o Site Energy Consumption.

Electricity	- MWH, Dollars, MBTU
Fuel Oil	- GALS, Dollars, MBTU & MWH
Natural Gas	- THERMS, Dollars, MBTU & MWH
Propane	- GALS, Dollars, MBTU & MWH
Other	- QTY, Dollars, MBTU & MWH

4. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP Projects Developed. (Provide list)*

   o Non-ECIP Projects Developed. (Provide list)*

   o Operational or Policy Change Recommendations.

5. Energy and Cost Savings.

   o Total Potential Energy and Cost Savings resulting from recommended projects in MBTU/yr, MWH/yr, and $K/yr.

   o Percentage of Energy Conserved.

   o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

* 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, the simple payback period and the analysis date.

EMC ENGINEERS, INC.

2750 South Wadsworth Blvd. • Suite C-200
Denver, Colorado 80227-3400
303/988-2951 • Fax: 303/985-2527

CONFIRMATION NOTICE

Confirmation Notice No. 1 EMC #1406-008

DATE: 22 September 1995

PROJECT: Limited Energy Study - GEODSS Facility
CONTRACT NO.: DACA01-94-D-0033
DELIVERY ORDER: 0008

NOTES PREPARED BY: E M C Engineers, Inc.

DATE OF MEETING: 19 September 1995

PLACE OF MEETING: WSMR, New Mexico

SUBJECT: Review of Preliminary Report

ATTENDEES:	Anthony W. Battaglia	Mobile COE	(334) 690-2613
	Capt. Ray Marsh	21 CES/CECR	(719) 556-8935
	Sgt. Charles E. Rodgers	Det 1 18SPSS/DC	(505) 835-4546
	Jim Finley	PRC Sitel	DSN 349-4134
	Mike Barrett	PRC Sitel	DSN 349-4134
	Julian T. Delgado	DPW-PE	(505) 678-8762
	Dennis Jones	EMC	(303) 988-2951

The following is a summary of the items discussed, the comments made, and the decisions made during the meeting.

EMC verbally presented the findings of the Preliminary Report.

The following review comments were offered by Mobile COE:

1. Overall, this is a good report, well-presented, and well documented.

   Thank you

2. Pg ES-6 Table ES-3, Summary Of Recommended ECOs: See Comment 15 below.

   Concur. An additional DOE simulation containing all recommended ECOs will be performed.

3. Page 1-2 Section 1.5: A UPV value for LP Gas should also be included.

   Concur.

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   Concur.

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   Will clarify. ECO is retrofit.

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    Copy of quote will be included.

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    Heading will be more clearly identified.

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    Concur.

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    These ECOs will be re-evaluated as per comments discussed later in the Confirmation Notice. It is likely that the resulting payback periods will be less than 10 years.

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    Concur. An additional DOE simulation containing all recommended ECOs will be performed.

16. Be sure to update the distribution list, as some of the names and addresses have changed.

    Concur.

The following additional items were discussed:

GEODSS does not want to use propane in the building due to risk to the facility. EMC will evaluate use of a double-bundle chiller for heating as an alternative.

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Capt. Marsh will fax EMC the 1391 format the Air Force likes to use.

Programming documentation should be prepared for ECOs 4, 7, 8, and 9. GEODSS will implement ECOs 6 and 10 in-house with O&M funds.

This meeting was adjourned.

Dennis E.Jones

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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 list of buildings, zones, or areas including building numbers, square foot floor area, designated temporary or permanent, and usage (administration, patient treatment, etc.).

d. List references, and 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 must 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 a 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 Jan 1994 and any revisions thereto. Note that unescalated costs/savings are to be used in the economic analyses.

m. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

EMC ENGINEERS, INC.

2750 South Wadsworth Blvd. • Suite C-200
Denver, Colorado 80227-3400
303/988-2951 • Fax: 303/985-2527

CONFIRMATION NOTICE

Confirmation Notice No. 1 EMC #1406-008

DATE: 22 September 1995

PROJECT: Limited Energy Study - GEODSS Facility
CONTRACT NO.: DACA01-94-D-0033
DELIVERY ORDER: 0008

NOTES PREPARED BY: E M C Engineers, Inc.

DATE OF MEETING: 19 September 1995

PLACE OF MEETING: WSMR, New Mexico

SUBJECT: Review of Preliminary Report

ATTENDEES:	Anthony W. Battaglia	Mobile COE	(334) 690-2613
	Capt. Ray Marsh	21 CES/CECR	(719) 556-8935
	Sgt. Charles E. Rodgers	Det 1 18SPSS/DC	(505) 835-4546
	Jim Finley	PRC Sitel	DSN 349-4134
	Mike Barrett	PRC Sitel	DSN 349-4134
	Julian T. Delgado	DPW-PE	(505) 678-8762
	Dennis Jones	EMC	(303) 988-2951

The following is a summary of the items discussed, the comments made, and the decisions made during the meeting.

EMC verbally presented the findings of the Preliminary Report.

The following review comments were offered by Mobile COE:

1. Overall, this is a good report, well-presented, and well documented.

   Thank you

2. Pg ES-6 Table ES-3, Summary Of Recommended ECOs: See Comment 15 below.

   Concur. An additional DOE simulation containing all recommended ECOs will be performed.

3. Page 1-2 Section 1.5: A UPV value for LP Gas should also be included.

   Concur.

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APPENDIX B

FIELD SURVEY NOTES

BLDG NO.	34568

FLOOR AREA	10,671 ft2

INTERIOR LIGHTS

DESCRIPTION	LAMP TYPE	NO. LAMPS	LAMP WATTS	FIXTURE WATTS	FIXTURE COUNT	TOTAL WATTS
4' RECESSED FLUORESCENT	FLUOR	2	40	89	131	11659
EXIT LIGHT	INC	2	20	40	10	400
EXPOSED INCANDESCENT	INC	1	150	150	12	1800
RECESSED INCANDESCENT	INC	1	60	60	9	540
			TOTAL WATTS			14,399
			WATTS PER SQUARE FOOT			1.35

EXTERIOR LIGHTS

DESCRIPTION	LAMP TYPE	NO. LAMPS	LAMP WATTS	FIXTURE WATTS	FIXTURE COUNT	TOTAL WATTS
INCANDESCENT	INC	1	7.5	7.5	18	135
INCANDESCENT (PARKING LOT)	INC	1	12.5	12.5	33	412.5
			TOTAL WATTS			548

EQUIPMENT OUTSIDE CONDITIONED SPACE

DESCRIPTION	PEAK WATTS	USE FACTOR	USE WATTS
COMPRESSOR #1	4244	0.5	2122
COMPRESSOR #2	4244	0.5	2122
COMPRESSOR #3	4244	0.5	2122
TOTAL WATTS			6,366

EQUIPMENT INSIDE CONDITIONED SPACE

ASHRAE 1989 FUNDAMENTALS page 26.8 & 28.4

DESCRIPTION	PEAK WATTS	USE FACTOR	USE WATTS	COUNT	TOTAL WATTS
COFFEE MAKER	1500	0.75	1125	1	1125
REFRIGERATOR	225	1.00	225	1	225
MICROWAVE	400	0.15	60	1	60
PERSONAL COMPUTER	160	0.5	80	9	720
LASER PRINTER	60	0.5	30	9	270
MEDIUM COPIER	1750	1.00	1750	1	1750
VENDING MACHINE	500	1.00	500	1	500
COKE MACHINE	700	1.00	700	1	700
		TOTAL WATTS			5,350
		WATTS PER SQUARE FOOT			0.50

PEOPLE HEAT GAIN

ASHRAE 1993 FUNDAMENTALS p 26.8

BUILDING TYPE	SENSE BTUh	LATENT BTUh	COUNT
OFFICE	225	125	14
TOTAL PEOPLE			14
SQUARE FOOT PER PERSON			762

HVAC SYSTEMS

ZONE DATA

DESIGNATION	AHU-2	AHU-3,4,5	AHU-6,7,8	AHU-9
AREA SERVED	OFFICES	TOWERS	COMPUTER	CONFERENCE
SUPPLY AIRFLOW (CFM)	4770	2000	12,000	800
VENTILATION	1257	2000	0	0
EXHAUST	1257	2000	0	0
RETURN	3513	0	12,000	800
OUTSIDE AIR (%)	26.40%	100%	0%	0%

AHU DATA

SYSTEM TYPE	SZ	SZ	CRU	SZ
MANUFACTURER	TRANE	TRANE	AIRFLOW CO.	WILLIAMS
MODEL NUMBER	CLIMATE CHANGER #8	CLIMATE CHANGER #6	CCT-41C4	AH-800-W2-B40
COOLING CAPACITY (MBH)	113	62	326	10
HEATING CAPACITY (MBH)	131	N/A	115	N/A
SUPPLY FAN HORSEPOWER	5	3	7.5	0.33
SUPPLY FAN STATIC PRESSURE ("H2O)	3.0	2.5	0.5	-
SUPPLY FAN LOAD (kW)	3.14	1.9	4.72	0.246
RETURN FAN HORSEPOWER	N/A	N/A	N/A	N/A
RETURN FAN STATIC PRESSURE	N/A	N/A	N/A	N/A
RETURN FAN LOAD	N/A	N/A	N/A	N/A

CONTROLS

OPERATING SEASON	ALWAYS	APRIL - NOVEMBER	ALWAYS	ALWAYS
HEATING SEASON	ALWAYS	N/A	ALWAYS	N/A
COOLING SEASON	ALWAYS	APRIL - NOVEMBER	ALWAYS	ALWAYS
TIMECLOCK	NONE	NONE	NONE	NONE
WEEKDAY SCHEDULE	24 HOURS	24 HOURS	24 HOURS	24 HOURS
WEEKEND SCHEDULE	THERMOSTAT	THERMOSTAT	THERMOSTAT	THERMOSTAT
SUPPLY AIR TEMPERATURE CONTROL	THERMOSTAT	THERMOSTAT	N/A	THERMOSTAT
SUPPLY AIR SETPOINT (°F)	N/A	N/A	N/A	N/A
MIXED AIR TEMPERATURE CONTROL	NONE	NONE	NONE	NONE
MIXED AIR SETPOINT (°F)	N/A	N/A	N/A	N/A
COOLING THERMOSTAT	72	40	72	72
HEATING THERMOSTAT	70	N/A	70	N/A
ECONOMIZER TYPE	NONE	N/A	N/A	N/A

TOWER WALL AND ROOF U-VALUES

TOWER WALL

Layer	R-value
Outside air film	0.17
1' Concrete Wall	1.23
4" Insulation (on 2 1/2" metal studs)	13.00
5/8" Gypsum	0.56
Inside air Film	0.68
Total R-value	15.64
Total U-value (Btu/hr-ft2-°F)	0.064

R-values taken from ASHRAE Table 22.4, pg. 22.6-22.9

TOWER ROOF

Layer	R-value
Outside air film	0.17
4" Rigid Insulation	25.00
Inside air Film	0.68
Total R-value	25.85
Total U-value (Btu/hr-ft2-°F)	0.039

COMPUTER WALL, FACILITY WALL, AND ROOF U-VALUES

COMPUTER WALL

Layer	R-value
Outside air film	0.68
8" Concrete masonry unit (Assume medium aggregate w/perlite filled cores at reinforced areas)	2.50
3/4" Plywood	0.93
Air Space	0.91
1 3/8" Plywood removeable doors	1.05
5/8" Gypsum	0.56
Inside air Film	0.68
Total R-value	7.31
Total U-value (Btu/hr-ft2-°F)	0.137

R-values taken from ASHRAE Table 22.4, pg. 22.6-22.9

COMPUTER AND FACILITY ROOF

Layer	R-value
Outside air film	0.17
Built-up roof on underlayment on steel deck on steel joists	0.33
4" Rigid insulation	20.00
Inside air Film	0.68
Total R-value	21.18
Total U-value (Btu/hr-ft2-°F)	0.047

FACILITY EXTERIOR WALLS

Layer	R-value
Outside air film	0.17
8" Concrete masonry unit (Assume medium aggregate w/perlite filled cores at reinforced areas)	2.50
4" Fiberglass Batt Insulation	13.00
5/8" Gypsum (on metal studs)	0.56
Inside air Film	0.68
Total R-value	16.91
Total U-value (Btu/hr-ft2-°F)	0.059

CONDENSER

Manufacturer	Trane
Model No.	CRHR400C-3RAT
Tons	35.73

COMPRESSOR

Manufacturer	Tri volt
Model No.	3N659A
HP	5.00
RPM	1750

B-5

PUMPS

Description	Motor Size (hp)	Full Load (kW)	Flow Rate (gpm)	Speed (rpm)	Operating Schedule
Chilled Water Loop	1	0.63	72	1725	AVAIL
Chilled Water Loop	1	0.63	72	1725	AVAIL
Chilled Water Loop	1	0.63	72	1725	AVAIL
Chilled Water Loop	1	0.63	72	1725	AVAIL

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey Notes

EMC No. 1406.008
Date: 6/22/95
Prepared by: ES

CHILLER PLANT DATA

Chiller No.: 1

Manufacturer:	TRANE	Location:	CHILLER ROOM
Model No.:	CRHR400C - 3RAT		
Serial No.:	N884062288	Serves AHUs:	2,3,4,5,6,7,8,9

TYPE OF CHILLER:		TYPE OF REFRIGERANT:	FREON	MULTIPLE CHILLERS:	
Absorption:		DX:		Series Piping:	
Centrifugal:		Water:		Parallel Piping:	
Reciprocating:		Other:		**SIZE OF PIPING:**	
Rotary Screw:		Air-Cooled:		Supply (in.):	
Other:		Water-Cooled:		Return (in.):	

COMPRESSOR DATA:		CONDENSING FANS:	TRANE	EVAPORATOR DATA:	
No. of Compressors:	1	No. of Fans:	4	Serial No.:	
RLA:	LR: 315	HP:	1.5	No. of Passes:	
Volts:	460	FLA:	3	Miscellaneous:	
kW:		Volts:			
Capacity (tons):	38.23	Phase/Hz:	3 / 60		

OPERATING TIMES:			
Present Start Time:		Required Start Time:	
Present Stop Time:		Required Stop Time:	
Months Operating:		Timeclock (Y/N):	

CONTROLS:		CONTROL VALVES:	
Pneumatic:		Location:	
Electric:		2-Way:	
DDC:		3-Way:	
Setpoints:	CHW: CNW:	Size:	

Comments: MAX FUSE SIZE TIME DELAY: 15, MIN CIR AMPACITY: 13,
CONDENSOR MODEL #: CAUA - 4004 - OB, CONDENSOR TYPE: 621 - 0340 - 3A,
CONDENSOR SERIAL #: J79E - 20224

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey Notes

EMC No.1406.008
Date: 6/22/95
Prepared by: ES

CHILLER PLANT DATA

Chiller No.: 2

Manufacturer: TRANE	Location: CHILLER ROOM
Model No.: CRHR400C - 3FAT	
Serial No.: GOD40J4178	Serves AHUs: 2,3,4,5,6,7,8,9

TYPE OF CHILLER:	**TYPE OF REFRIGERANT:** FREON	**MULTIPLE CHILLERS:**
Absorption:	DX:	Series Piping:
Centrifugal:	Water:	Parallel Piping:
Reciprocating:	Other:	**SIZE OF PIPING:**
Rotary Screw:	Air-Cooled:	Supply (in.):
Other:	Water-Cooled:	Return (in.):

COMPRESSOR DATA:		**CONDENSING FANS:**	TRANE	**EVAPORATOR DATA:**
No. of Compressors:	1	No. of Fans:	4	Serial No.:
RLA: LR: 315		HP:	1.5	No. of Passes:
Volts:	460	FLA:	3	Miscellaneous:
kW:		Volts:		
Capacity (tons):	38.23	Phase/Hz:	3 / 60	

OPERATING TIMES:	
Present Start Time:	Required Start Time:
Present Stop Time:	Required Stop Time:
Months Operating:	Timeclock (Y/N):

CONTROLS:	**CONTROL VALVES:**
Pneumatic:	Location:
Electric:	2-Way:
DDC:	3-Way:
Setpoints: CHW: CNW:	Size:

Comments: MAX FUSE SIZE TIME DELAY: 15, MIN CIR AMPACITY: 13,
CONDENSOR MODEL #: CAUA - 4004 - OB, CONDENSOR TYPE: 621 - 0340 - 3A,
CONDENSOR SERIAL #: J79E - 20224
USED ONLY WHEN NEEDED, OTHERWISE IT IS SHUT DOWN

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM.

EMC No. 1406.008
Date: 6/22/95
Prepared by: ES

MOTORS

Location: Compressor Room #2 **Application:**

Pump Motor: Tri volt				Manufacturer:
Manufacturer Dayton				Model No.:
Model No.: 3N659A				Serial No.:
Serial No.: GO34A1F9OTO81RO43F				Frame No.:
HP: 5		RPM: 1750		Pump Type: D
Volts: 200-236/460		FLA:		GPM: Head (ft.):
Ph/Hz: 3 / 60		LRA:		
Measured RPM:				
Operating Hours:		Months Operating:		
Comments: Type: D, SF: 1.15,	Insul Class: B,	Frame : 184T,	Nema Design: B,	
KVARmax: 2.0,	Amps: 15.4 - 14.6 / 7.3,	SFA: 18.0 - 15.8 / 7.9,	Shaft End BRG: 6206,	
Opp End BRG: 6204,	Nema Nom Eff: 85.5,	Power Factor: 79.5,	Duty: Continuous	

Location: 34566 Building **Application:** Powers Generator

Pump Motor:				Manufacturer:
Manufacturer Toshiba				Model No.:
Model No.: B2504VLF4B3				Serial No.:
Serial No.: 10123512				Frame No.: 447TZ
HP: 250		RPM: 1770		Pump Type:
Volts:		FLA:		GPM: Head (ft.):
Ph/Hz: 4 / 60		LRA:		
Measured RPM: 1796.6				
Operating Hours:		Months Operating: All		
Comments: Type: TIKK, Form: VBKI, Code: E,		Amps: 28.5, Class: F,	Nema Design: B,	4 Poles,
BRG No: LS-NU318 OS-6318,		SF: 1.15, MAX ANB: 40		

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

PUMPS

Location: Chiller Room

Pump Motor: GE Motor				Pump No.: 1,2,3,4	Type:
Manufacturer:				Manufacturer:	
Model No.:				Model No.: 5K43MG8163A	
Serial No.:				Serial No.:	
HP:	1	RPM:	1725	Frame No.:	
Volts:	208	FLA:	3.3	GPM:	Head (ft.):
Fluid: Water				Comments: Typical of all four pumps	
				Chilled Water	

CONTROL SCHEMATIC/PIPING SCHEMATIC

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

AIR HANDLING UNIT DATA

AHU No.: 2

Manufacturer	Trane	Location:	Chiller Room
Model No.:	Climate Changer Size 8	Served by:	
Serial No.:	V80E15027	Serves Area:	Office areas

AHU TYPE: Single-zone:	√	2 Pipe FC:		4 Pipe FC:		Unit Heater:	
H&V Unit:		Multizone:		Double Duct:		Induction Unit:	
VAV:		Reheat:		Comp. Room:		Other:	
Number of Zones:							

SUPPLY FAN:		Blow-thru:		Draw-thru:	√	In-line:		
X Centrifugal:		B.I.:		F.C:		Airfoil:		Radial:
Axial:		Vaneaxial:		Tubeaxial:		Propeller:		
Manufacturer:		Motor Dayton						
Model No.:		3N659						
HP:	5	Volts:	460	FLA:	7.3	RPM:	1730	Phase/Hz: 3 / 60

RETURN FAN:		Axial:		Centrifugal:				
Manufacturer:								
Model No.:		**N/A**						
HP:		Volts:		FLA:		RPM:		Phase/Hz:

COILS:	CHW	HW	Steam	Electric
Preheat:				
Heating:				√
Cooling:	√			
Humidity:				
Reheat:				

CNTRL VLV	CW	HW
Location:		
2-Way:		
3-Way:	√	
Size:		
Pneu/Elec.:	Pneu	

CONTROLS:	
Pneumatic:	√
Electric:	
DDC:	
Damper Control (OA):	√
Damper Control (RA):	
Damper Control (EA):	
Economizer (Y/N):	N small OA duct

SETPOINTS:	
Space:	
Occupied Heating:	
Unoccupied Heating:	
Occupied Cooling:	
Unoccupied Cooling:	
Setback (Y/N):	
Setback Setpoint:	

Comments: RA: 75 °F, PF = 81%
SA: 69 °F,
Motor: 1727.6 rpm measured
Fan: 1727.6 rpm measured
η= 82.5%

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

AIR HANDLING UNIT DATA

AHU No.: 3

Manufacturer:	Trane	Location:	Compressor Room # 1
Model No.:	CC SIZE 6	Served by:	
Serial No.:	V8OE15028	Serves Area:	Tower 1

AHU TYPE:	Single-zone: √	2 Pipe FC:	4 Pipe FC:	Unit Heater:
	H&V Unit:	Multizone:	Double Duct:	Induction Unit:
	VAV:	Reheat:	Comp. Room:	Other:
	Number of Zones:			

SUPPLY FAN:	Blow-thru:	Draw-thru: √	In-line:	
X Centrifugal:	B.I.:	F.C:	Airfoil:	Radial:
Axial:	Vaneaxial:	Tubeaxial:	Propeller:	
Manufacturer:	Motor Economite			
Model No.: 51-385-215	R6-6P			
HP: 3	Volts: 230	FLA: 8.36	RPM: 1760	Phase/Hz: 3 / 60

RETURN FAN:	Axial:	Centrifugal:		
Manufacturer:	**NONE**			
Model No.:				
HP:	Volts:	FLA:	RPM:	Phase/Hz:

COILS:	CHW	HW	Steam	Electric	**CNTRL VLV**	**CW**	**HW**
Preheat:					Location:		
Heating:					2-Way:		
Cooling:	√				3-Way:	√	
Humidity:					Size:		
Reheat:					Pneu/Elec.:		

CONTROLS:		**SETPOINTS:**	
Pneumatic:	√	Space:	
Electric:		Occupied Heating:	
DDC:		Unoccupied Heating:	
Damper Control (OA):	√	Occupied Cooling:	
Damper Control (RA):		Unoccupied Cooling:	
Damper Control (EA):		Setback (Y/N):	
Economizer (Y/N):		Setback Setpoint:	

Comments:	No heating coils	Measured rpm	Motor: 1781.7
	100% outside air		Fan: 1393
	SA: 68 °F		

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

AIR HANDLING UNIT DATA

AHU No.: 4

Manufacturer:	Trane	Location:	Compressor Room # 2
Model No.:	CC SIZE 6	Served by:	
Serial No.:	V8OE15028	Serves Area:	Tower 2

AHU TYPE:	Single-zone: √	2 Pipe FC:	4 Pipe FC:	Unit Heater:
	H&V Unit:	Multizone:	Double Duct:	Induction Unit:
	VAV:	Reheat:	Comp. Room:	Other:
	Number of Zones:			

SUPPLY FAN:	Blow-thru:	Draw-thru:	In-line:	
X Centrifugal:	B.I.:	F.C:	Airfoil:	Radial:
Axial:	Vaneaxial:	Tubeaxial:	Propeller:	
Manufacturer:	Fan Doerr			
Model No.:	3N228			
HP: 3	Volts: 230	FLA: 9.8	RPM: 1740	Phase/Hz: 3 / 60

RETURN FAN:	Axial:	Centrifugal:		
Manufacturer:				
Model No.:	**NONE**			
HP:	Volts:	FLA:	RPM:	Phase/Hz:

COILS:	CHW	HW	Steam	Electric
Preheat:				
Heating:				
Cooling:	√			
Humidity:				
Reheat:				

CNTRL VLV	CW	HW
Location:		
2-Way:		
3-Way:	√	
Size:		
Pneu/Elec.:		

CONTROLS:	
Pneumatic:	√
Electric:	
DDC:	
Damper Control (OA):	√
Damper Control (RA):	
Damper Control (EA):	
Economizer (Y/N):	

SETPOINTS:	
Space:	
Occupied Heating:	
Unoccupied Heating:	
Occupied Cooling:	
Unoccupied Cooling:	
Setback (Y/N):	
Setback Setpoint:	

Comments: Measured rpm Motor: 1768.9
Fan: 1255.7
Identical to AHU # 3

SAT: 70 °F
CWT: 53 °F
LWT: 66 °F

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

AIR HANDLING UNIT DATA

AHU No.: 5

Manufacturer:	Trane	Location:	Compressor Room # 3
Model No.:	CC SIZE 6	Served by:	
Serial No.:	V8OE15028	Serves Area:	Tower 3

AHU TYPE:	Single-zone: √	2 Pipe FC:		4 Pipe FC:		Unit Heater:	
	H&V Unit:	Multizone:		Double Duct:		Induction Unit:	
	VAV:	Reheat:		Comp. Room:		Other:	
	Number of Zones:						

SUPPLY FAN:		Blow-thru:		Draw-thru:		In-line:			
	X Centrifugal:	B.I.:		F.C:		Airfoil:		Radial:	
	Axial:	Vaneaxial:		Tubeaxial:		Propeller:			
Manufacturer:		Motor U.S. Electric							
Model No.:	G137D/N07N1270436F								
HP:	3	Volts:	230	FLA:	9	RPM:	1740	Phase/Hz:	3 / 60

RETURN FAN:		Axial:		Centrifugal:					
Manufacturer:									
Model No.:		**NONE**							
HP:		Volts:		FLA:		RPM:		Phase/Hz:	

COILS:	CHW	HW	Steam	Electric	**CNTRL VLV**	**CW**	**HW**
Preheat:					Location:		
Heating:					2-Way:		
Cooling:	√				3-Way:	√	
Humidity:					Size:		
Reheat:					Pneu/Elec.:		

CONTROLS:		**SETPOINTS:**	
Pneumatic:	√	Space:	
Electric:		Occupied Heating:	
DDC:		Unoccupied Heating:	
Damper Control (OA):	√	Occupied Cooling:	
Damper Control (RA):		Unoccupied Cooling:	
Damper Control (EA):		Setback (Y/N):	
Economizer (Y/N):		Setback Setpoint:	

Comments:	Measured rpm Motor: 1766.2	SAT:	72 °F
	Fan: 1370	CWT:	56 °F
	Identical to AHU # 3	LWT:	62 °F
	Damper on supply air		
	$\eta = 81.5\%$		

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

AIR HANDLING UNIT DATA

AHU No.: 6,7,8

Manufacturer:	Airflow Co.	Location:	Computer Room
Model No.:	CCT-41C4	Served by:	
Serial No.:	M11MD228	Serves Area:	Computer Room

AHU TYPE:	Single-zone:	√	2 Pipe FC:		4 Pipe FC:		Unit Heater:	
	H&V Unit:		Multizone:		Double Duct:		Induction Unit:	
	VAV:		Reheat:		Comp. Room:		Other:	
	Number of Zones:							

SUPPLY FAN:		Blow-thru:		Draw-thru:		In-line:			
X Centrifugal:		B.I.:		F.C:		Airfoil:		Radial:	
Axial:		Vaneaxial:		Tubeaxial:		Propeller:			
Manufacturer:		Marathon Electric							
Model No.:	UVA213TTDR7026GPL								
HP:	7.5	Volts:	480	FLA:	11	RPM:	1750	Phase/Hz:	3 / 60

RETURN FAN:		Axial:		Centrifugal:					
Manufacturer:									
Model No.:									
HP:		Volts:		FLA:		RPM:		Phase/Hz:	

COILS:	CHW	HW	Steam	Electric	**CNTRL VLV**	**CW**	**HW**
Preheat:					Location:		
Heating:				√	2-Way:		
Cooling:	√				3-Way:	√	
Humidity:					Size:		
Reheat:					Pneu/Elec.:	Pneu	

CONTROLS:		**SETPOINTS:**	
Pneumatic:	√	Space:	
Electric:		Occupied Heating:	
DDC:		Unoccupied Heating:	
Damper Control (OA):	√	Occupied Cooling:	
Damper Control (RA):		Unoccupied Cooling:	
Damper Control (EA):		Setback (Y/N):	N
Economizer (Y/N):	N	Setback Setpoint:	

Comments: Nema nom eff: 84.0, Nom PF: 76.6, Maxc CAP KVAR: 5.3, SF: 1.15,
Continuous duty

E M C Engineers, Inc. Field Survey EMC No. 1406.008
Energy Conservation Survey Date: 6/22/95
White Sands Missile Range, NM Prepared By: ES

R HANDLING UNIT DATA

AHU No.: 9

Manufacturer:	Williams	Location:	Conference Room Plenum
Model No.:	AH-800-W2-B40	Served by:	
Serial No.:		Serves Area:	Conference Room

AHU TYPE:	Single-zone:		2 Pipe FC:		4 Pipe FC:		Unit Heater:	
	H&V Unit:		Multizone:		Double Duct:		Induction Unit:	
	VAV:		Reheat:		Comp. Room:		Other:	Fan Coil
	Number of Zones:							

SUPPLY FAN:		Blow-thru:		Draw-thru:		In-line:			
	Centrifugal:	B.I.:		F.C:		Airfoil:		Radial:	
	Axial:	Vaneaxial:		Tubeaxial:		Propeller:			
Manufacturer:									
Model No.:									
HP:	0.33	Volts:	230	FLA:	2.9	RPM:		Phase/Hz:	

RETURN FAN:		Axial:		Centrifugal:				
Manufacturer:								
Model No.:		**NONE**						
HP:		Volts:		FLA:		RPM:		Phase/Hz:

COILS:	CHW	HW	Steam	Electric	**CNTRL VLV**	**CW**	**HW**
Preheat:					Location:		
Heating:					2-Way:	√	
Cooling:	√				3-Way:		
Humidity:					Size:		
Reheat:					Pneu/Elec.:		

CONTROLS:		**SETPOINTS:**	
Pneumatic:	√	Space:	
Electric:		Occupied Heating:	
DDC:		Unoccupied Heating:	
Damper Control (OA):		Occupied Cooling:	
Damper Control (RA):		Unoccupied Cooling:	
Damper Control (EA):		Setback (Y/N):	
Economizer (Y/N):		Setback Setpoint:	

Comments: No outside air

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

INTERNAL LOADS DATA

Equipment Description: Lighting
Equipment Location: Conference Room
Manufacturer:
Model No.:
Serial No.:
Motor Data: HP: RPM: Volts: Amps:

Comments: Ballast- Dimmer Ballast Magnetek 502-ATO-P, Four foot lamps - F-40D
Thermostat- 70 °F, 40 Watts
Wall- 70 °F

Equipment Description:
Equipment Location: Conference Room
Manufacturer:
Model No.:
Serial No.:
Motor Data: HP: RPM: Volts: Amps:

Comments: Temperature Plenum= 75 °F
Roof Bottom 71 °F
Room= 70 °F

Equipment Description:
Equipment Location: Halls
Manufacturer:
Model No.:
Serial No.:
Motor Data: HP: RPM: Volts: Amps:

Comments: Ballast- Universal Rapid Start
Lamps- F-40D 2 Lamp 40 Watts

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

LDING MANAGER INTERVIEW

BUILDING INFORMATION:										
Building No:	34568	Building Name:	GEODSS							
Surveyed by:		Date:	6/2/95		Building Use:					
Building Contact:	Jim Mills				Phone No:	835 - 4546				
Building Contact:					Phone No:					
OCCUPANCY:		Day	Night		Day			Night		
Number of Employees:	Mon.-Fri.:	12 - 14	3 - 4	Schedule:	7am	To	4pm	5pm	To	7am
	Saturday:	2	3 - 4		7am	To	4pm	5pm	To	7am
	Sun./Hol.:	2	3 - 4		7am	To	4pm	5pm	To	7am
Visitors Per Day:	Mon.-Fri.:			Schedule:		To			To	
	Saturday:					To			To	
	Sun./Hol.:					To			To	
Meals Served Per Day:	Breakfast:			Schedule:		To			To	
	Lunch:					To			To	
	Dinner:					To			To	
Comments:										
LIGHTING SCHEDULE:										
Normal Occupancy:	Mon.-Fri.:			Schedule:		To			To	
	Sat./Sun.:					To			To	
Cleaning Crew/2nd Shift:	Mon.-Fri.:			Schedule:		To			To	
	Sat./Sun.:					To			To	
EQUIPMENT SCHEDULE:										
Fan/AHU Schedule:	Mon.-Fri.:			Schedule:		To			To	
	Sat./Sun.:					To			To	
Chiller Schedule:	Mon.-Fri.:			Schedule:		To			To	
	Sat./Sun.:					To			To	
Boiler Schedule:	Mon.-Fri.:			Schedule:		To			To	
	Sat./Sun.:					To			To	
Aux. Equipment Schedule:										
	Mon.-Fri.:			Schedule:		To			To	
	Sat./Sun.:					To			To	
	Mon.-Fri.:			Schedule:		To			To	
	Sat./Sun.:					To			To	
Comments:										

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

LIGHTING

SPACE	# OCCUPANCY SENSORS	# FIXTURES W/ O.S.	# DELAMPED	# FIXTURES IN SPACE	TOTAL OPERATING FIXTURES IN SPACE
HALLS	0	0	0	17	17
OFFICES	7	23	19	82	56
COMPUTER ROOM	3	13	27	77	47
CONFERENCE ROOM	0	0	0	6	6
TOWER 1	0	0	0	7	7
TOWER 2	0	0	0	7	7
TOWER 3	0	0	0	7	7

ENERGY CONSUMPTION

SPACE	TOTAL OPERATING FIXTURES IN SPACE	WATTS PER FIXTURE		TOTAL kW CONSUMED	
		PRESENT	T-8	PRESENT	T-8
HALLS	17	89	58	1.513	0.986
OFFICES	56	89	58	4.984	3.248
COMPUTER ROOM	47	89	58	4.183	2.726
CONFERENCE ROOM	6	89	58	0.534	0.348
TOWER 1	7	89	58	0.623	0.406
TOWER 2	7	89	58	0.623	0.406
TOWER 3	7	89	58	0.623	0.406

TOTAL ENERGY CONSUMED BY LIGHTING

SPACE	TOTAL kW CONSUMED		OTHER LIGHTS	WATTAGE OF OTHER LIGHTS	TOTAL kW CONSUMED	
	PRESENT	T-8			PRESENT	T-8
HALLS	1.513	0.986	0	0	1.513	0.99
OFFICES	4.984	3.248	0	0	4.984	3.25
COMPUTER ROOM	4.183	2.726	7	60	4.603	3.15
CONFERENCE ROOM	0.534	0.348	0	0	0.534	0.35
TOWER 1	0.623	0.406	4	150	1.223	1.01
TOWER 2	0.623	0.406	4	150	1.223	1.01
TOWER 3	0.623	0.406	4	150	1.223	1.01

E M C Engineers, Inc.
Energy Conservation Survey
White Sands Missile Range, NM

Field Survey

EMC No. 1406.008
Date: 6/22/95
Prepared By: ES

MOTORS

Location: Compressor Room # 1 **Application:** Compressed Air for Camera in Tower # 1

Pump Motor:	A.C. TEFC			Manufacturer:			
Manufacturer:	Lincoln			Model No.:			
Model No.:	T-3482 (Lincoln Code)			Serial No.:			
Serial No.:	2278302			Frame No.:			
HP:	5	RPM:	1740	Pump Type:			
Volts:	200/400	FLA:		GPM:		Head (ft.):	
Ph/Hz:	3 / 60	LRA:					
Measured RPM:							
Operating Hours:				Months Operating:			

Comments: INS: B, SF: 1.15, Max Amb: 40, EEF index: K, Nema Design: B,
Nema Code: J, Amps: 15.6 / 7.8,

MOTORS

Location: Compressor Room # 2 **Application:** Compressed Air for Camera in Tower # 2

Pump Motor:	A.C. TEFC			Manufacturer:			
Manufacturer:	Acurate Air ENGR, INC.			Model No.:			
Model No.:	325-14			Serial No.:			
Serial No.:	119526LS			Frame No.:			
HP:	5	RPM:	1740	Pump Type:			
Volts:	200/400	FLA:		GPM:	900	Head (ft.):	
Ph/Hz:	3 / 60	LRA:					
Measured RPM:							
Operating Hours:				Months Operating:			

Comments: INS: B, SF: 1.15, Max Amb: 40, EEF index: K, Nema Design: B,
Nema Code: J, Amps: 15.6 / 7.8,
Vessel Service #: 292700

MOTORS

Location: Compressor Room # 3 **Application:** Compressed Air for Camera in Tower # 3

Pump Motor:	A.C. TEFC			Manufacturer:			
Manufacturer:	Lincoln			Model No.:			
Model No.:	T - 3482 (Lincoln Code)			Serial No.:			
Serial No.:	2580235			Frame No.:			
HP:	5	RPM:	1740	Pump Type:			
Volts:	200/400	FLA:		GPM:		Head (ft.):	
Ph/Hz:	3 / 60	LRA:					
Measured RPM:							
Operating Hours:				Months Operating:			

Comments: INS: B, SF: 1.15, Max Amb: 40, EEF index: K, Nema Design: B,
Nema Code: J, Amps: 15.6 / 7.8,

APPENDIX C

UTILITY DATA

White Sands Utility Rates

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE

PAGE 1 OF PAGES 1

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
P00006	1 Jan 95		

6. ISSUED BY CODE

ilities Sales Officer
EWS-DPW-PE, Bldg 1748
White Sands Missile Range, NM
88002-5076

7. ADMINISTERED BY (If other than Item 6) CODE

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)

Detachment 1, 1st Space Wing (AFSPACECOM)
ATTN: SMSGT Luther Mills
P.O. Box W
Socorro, New Mexico 87801-5000

CODE | FACILITY CODE

(✓) 9A. AMENDMENT OF SOLICITATION NO.

9B. DATED (SEE ITEM 11)

10A. MODIFICATION OF CONTRACT/ORDER NO.

~~DAAD07-89-S-0034~~

10B. DATED (SEE ITEM 13)

01 Jan 89

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a) By completing Items 8 and 15, and returning ______ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/~~ORDERS~~, IT MODIFIES THE CONTRACT/~~ORDER~~ NO. AS DESCRIBED IN ITEM 14.

A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

X Per paragraph 4 of cited contract, CHANGE OF RATE CLAUSE

B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

D. OTHER (Specify type of modification and authority)

E. IMPORTANT: PURCHASER ☒ is not, ☐ is required to sign this document and return ______ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

CHANGE OF RATES as follows:

SPECIAL PROVISIONS A (Electric Service): RATE A - $0.0821/KWH
SPECIAL PROVISIONS B-1 (Propane Gas Service): RATE A - $0.6940/GAL
SPECIAL PROVISIONS C (Water Service): RATE A - $1.3593/KGAL
SPECIAL PROVISIONS F (Refuse Disposal Service): RATE A - $1.4513/CY

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)

16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)
JULIAN T. DELGADO
Utilities Sales Officer

15B. PURCHASER
(Signature of person authorized to sign)

15C. DATE SIGNED

16B. UNITED STATES OF AMERICA
BY Julian T. Delgado
(Signature of Contracting Officer)

16C. DATE SIGNED
21 Feb 95

CONTRACT NO. DAAD07-89-S-0034
MODIFICATION P00006

DETACHMENT 1, 1st SPACE WING (AF)

RATE A - CY 95

Electricity:

Bldg 34568 - Metered

Bldg 34226 - Metered

Propane Gas: Charge is made from metered consumption.

Water: FLAT RATE

6.5 KGAL/yr/employee x 26 employees = 169 KGAL/yr
169 Kgal/yr x $1.3593/Kgal = $229.72 per yr
$ 19.14 per month

Refuse: FLAT RATE

Bldg 34568:

14.27 CY/yr/person x 24 people = 342.48 CY/yr
342.48 CY/yr x $1.4513 = $497.04 per yr
$ 41.42 per month

Bldg 34226:

14.27 CY/yr/person x 2 people = 28.54 CY/yr
28.54 CY/yr x $1.4513 = $41.42 per yr
$ 3.45 per month

PRC Inc.
GEODSS Site 1
P.O. Box 1159
Socorro, NM 87801

PRC

March 27, 1995

Attn: Dennis Jones;

The electric meter installed at the GEODSS site on WSMR New Mexico is labeled as follows.

Manufacturer	Westinghouse
Class	20
Volts	120
	4wY
Type	D458M
Form	6S
Style	280C021G60
TA	2.5
Kh	1.8
Two stator Watt Hour meter	
60 Hz	
PTR	2.4/1
PKh	691.2
CTR	800/5

The meter has a secondary plate with the following information.
Ser 3947514
Mark Io Demand Register
120V 60Hz
F.5 KW 13.824/27.648
Reg Ratio 14 101/216
t-15
Direct reading for Kh 6912

If you need any more information please feel free to contact me.

Mike Barrett

Mike Barrett
GEODSS Site One
Maintenance Supervisor

Meter

ZIA ELECTRICAL PRODUCTS

Customer #:

Serial #: 6808432

Reading: 0565

Meter Brand: Westinghouse

Tested by: WJJ

Comments: meter is OK

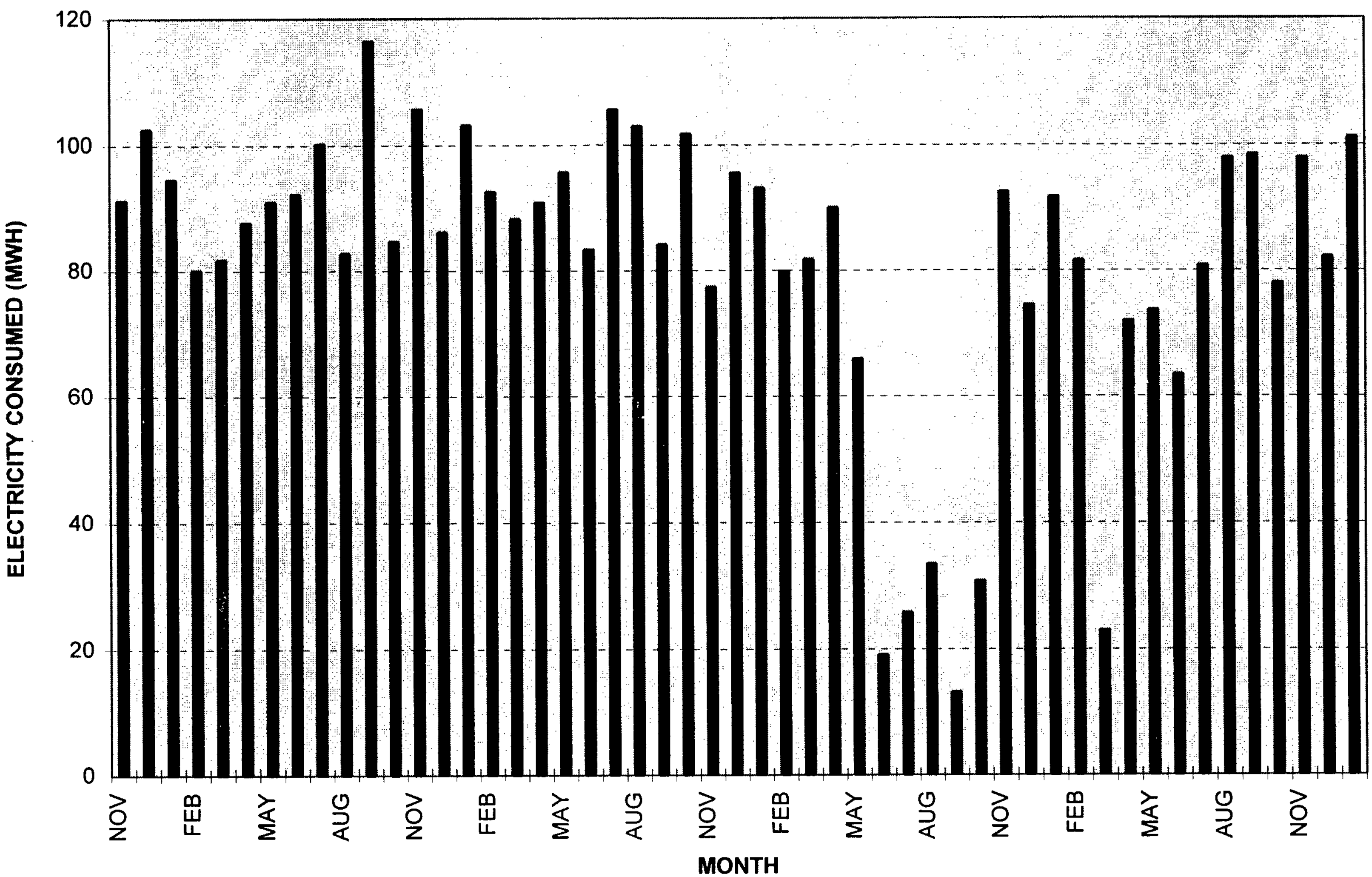
```
THU  JUN  1, 1995   9:51:29 AM
TEST STATUS: AS FOUND

 FORM: 6S 120 VOLTS 2.50 AMPS Kh=  1.80
 REV:FL=  5 PF=  5 LL=  1  N=  0 Nt=  0
            SERIES  LEFT  COMMON  RIGHT
         FL 100.31  99.34 100.18 100.43
 % REG.  PF  99.76 100.41 100.36 100.36
         LL  99.58
```

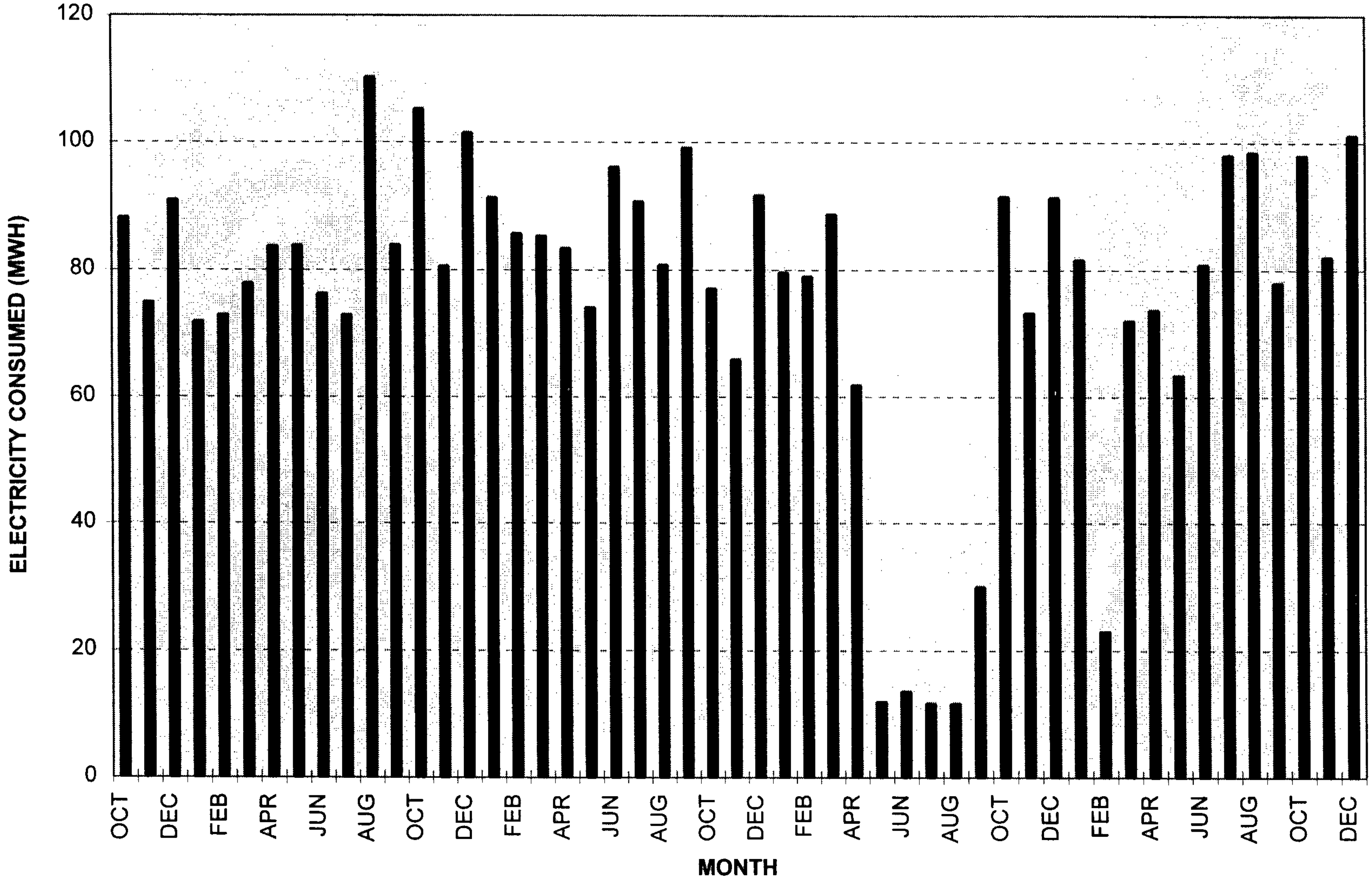
```
THU  JUN  1, 1995  10:48:34 AM
TEST STATUS: AS LEFT

 FORM: 6S 120 VOLTS 2.50 AMPS Kh=  1.80
 REV:FL=  5 PF=  5 LL=  1  N=  0 Nt=  0
            SERIES  LEFT  COMMON  RIGHT
         FL 100.79 100.08 100.93 100.33
 % REG.  PF 100.26 100.79 101.05 100.50
         LL 100.14
```

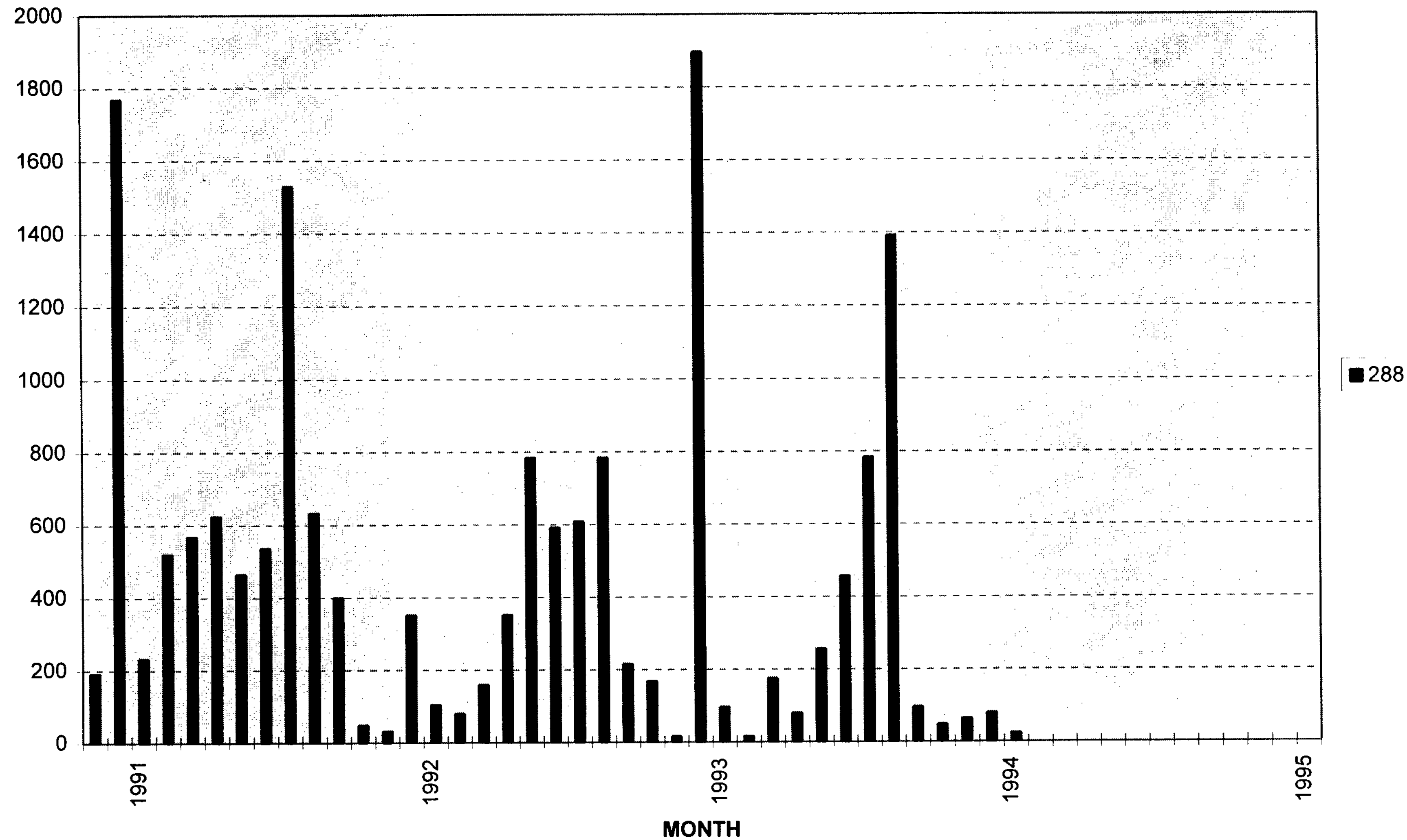
ELECTRICITY PURCHASED & GENERATED OCT 1991- JAN 1995



ELECTRIC CONSUMPTION OCT 1991- JAN 1995



DIESEL CONSUMPTION



YEARLY TOTALS

		ELECTRIC CONSUMED(MWH)	MONTHLY COST	DIESEL FUEL ONSUMED (GAL	MONTHLY COST
	OCT	109.3	8033.55	288	296.64
	NOV	88.2	6482.70	192	197.76
	DEC	74.9	5505.15	1768	1821.04
1991	JAN	90.9	6681.15	232	238.96
	FEB	71.9	5284.65	520	535.6
	MAR	72.9	5358.15	568	585.04
	APR	77.9	5725.65	624	642.72
	MAY	83.7	6151.95	464	477.92
	JUN	83.8	6159.30	536	552.08
	JUL	76.3	5608.05	1528	1573.84
	AUG	72.9	5358.15	632	650.96
	SEP	110.2	8099.70	400	412
	TOTAL	1012.9	74448.15	7752	7984.56
	OCT	83.9	6166.65	48	49.44
	NOV	105.2	7732.2	32	32.96
	DEC	80.6	5924.1	352	362.56
1992	JAN	101.5	7460.25	104	107.12
	FEB	91.3	6710.55	80	82.4
	MAR	85.7	6298.95	160	164.8
	APR	85.3	6269.55	352	362.56
	MAY	83.4	6129.9	784	807.52
	JUN	74.1	5446.35	592	609.76
	JUL	96.1	7063.35	608	626.24
	AUG	90.7	6666.45	784	807.52
	SEP	80.8	5938.8	216	222.48
	TOTAL	1058.6	77807.1	4112	4235.36
	OCT	99.1	7283.85	168	173.04
	NOV	77.1	5666.85	16	16.48
	DEC	65.9	4843.65	1896	1952.88
1993	JAN	91.6	6732.6	96	98.88
	FEB	79.6	5850.6	16	16.48
	MAR	79	5806.5	176	181.28
	APR	88.7	6519.45	80	82.4
	MAY	61.9	4549.65	256	263.68
	JUN	12	882	457	470.71
	JUL	13.6	999.6	784	807.52
	AUG	11.7	859.95	1392	1433.76
	SEP	11.7	859.95	96	98.88
	TOTAL	691.9	50854.65	5433	5595.99

YEARLY

	OCT	30	2205	48	49.44
	NOV	91.5	6725.25	64	65.92
	DEC	73.25	5383.875	80	82.4
1994	JAN	91.33	6712.755	24	24.72
	[redacted]		6179.6181		0
	MAR	23	1741.1		0
	APR	72	5450.4		0
	MAY	73.7	5579.09		0
	JUN	63.4	4799.38		0
	JUL	80.78	6115.046		0
	AUG	97.96	7415.572		0
	SEP	98.4	7448.88		0
	TOTAL	876.953	65755.966	216	222.48

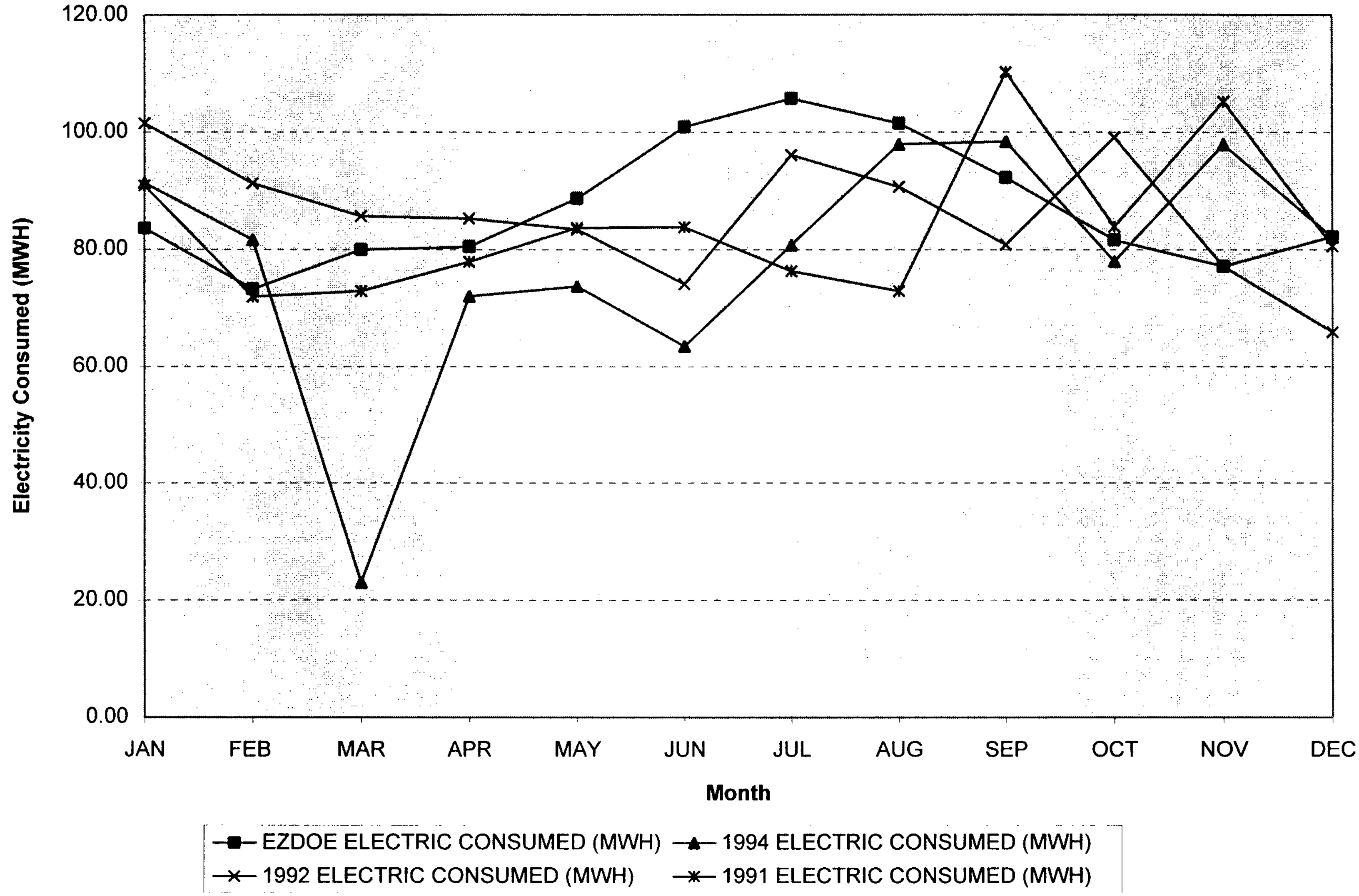
	OCT	77.98	5903.086
	NOV	97.92	7412.544
	DEC	82.06	6211.942
1995	[redacted]		8305.236
	TOTAL	359.12	27832.808

YEAR	ELECTRIC CONSUMPTION	COST $	DIESEL FUEL ONSUMED (GAL	MONTHLY COST
1991	1012.9	74448.15	7752	7984.56
1992	1058.6	77807.1	4112	4235.36
1993	691.9	50854.65	5433	5595.99
1994	876.953	65755.966	216	222.48
1995	359.12	27832.808		

APPENDIX D

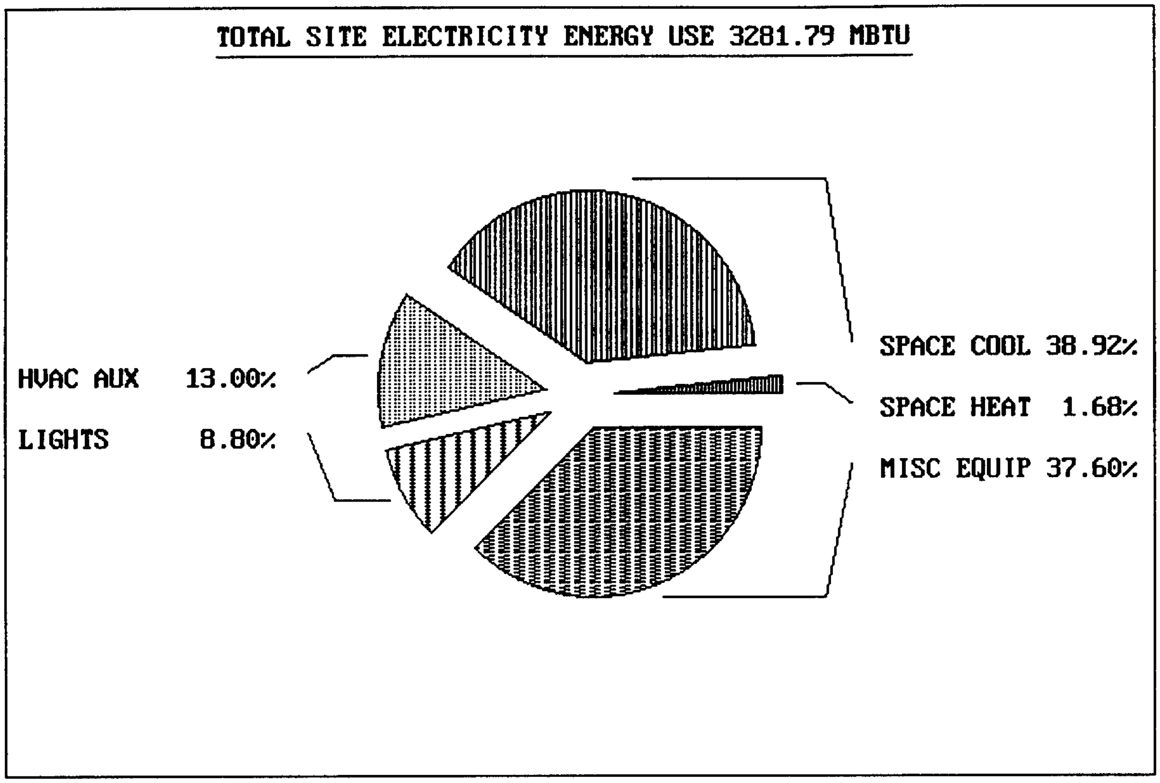
COMPUTER SIMULATIONS

DOE2.1d Model vs. Historical Data

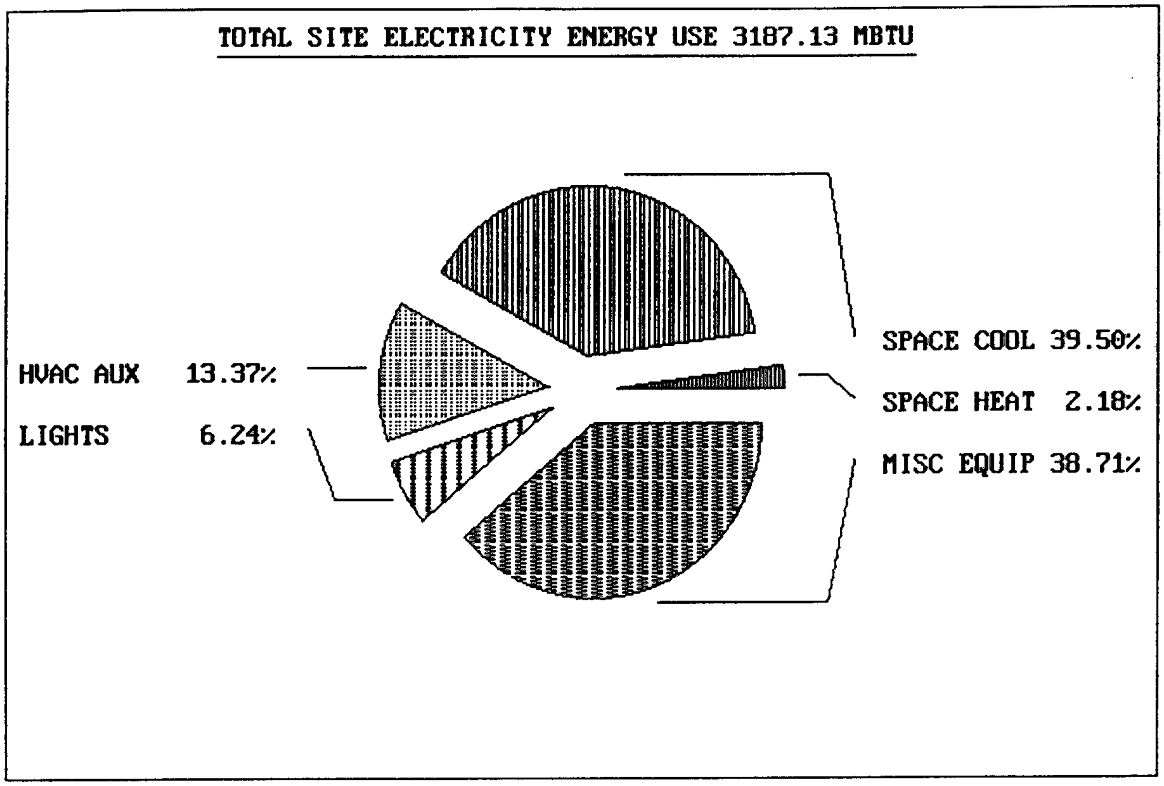


EZDOE Model Data **ELECTRICAL DATA FROM SITE**

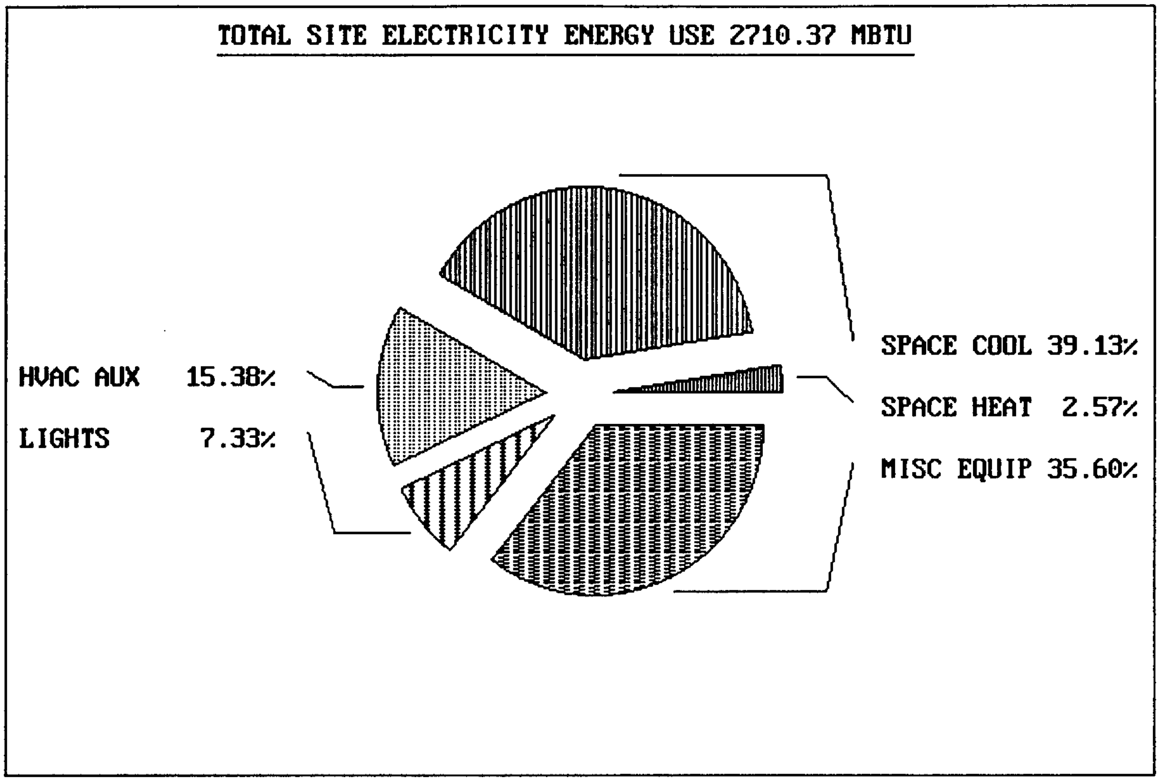
		ELECTRIC CONSUMED (MBTU)	EZDOE ELECTRIC CONSUMED (MWH)	1994 ELECTRIC CONSUMED (MWH)	1992 ELECTRIC CONSUMED (MWH)	1991 ELECTRIC CONSUMED (MWH)
1994	JAN	285.20	83.58	91.33	101.50	90.90
	FEB	249.90	73.24	[redacted]	91.30	71.90
	MAR	272.83	79.96	23.00	85.70	72.90
	APR	274.47	80.44	72.00	85.30	77.90
	MAY	302.69	88.71	73.70	83.40	83.70
	JUN	344.08	100.84	63.40	74.10	83.80
	JUL	360.70	105.71	80.78	96.10	76.30
	AUG	346.30	101.49	97.96	90.70	72.90
	SEP	314.83	92.27	98.40	80.80	110.20
	OCT	278.59	81.65	77.98	99.10	83.90
	NOV	263.28	77.16	97.92	77.10	105.20
	DEC	280.48	82.20	82.06	65.90	80.60
TOTAL		3573.35	1047.25	940.16	1031.00	1010.20



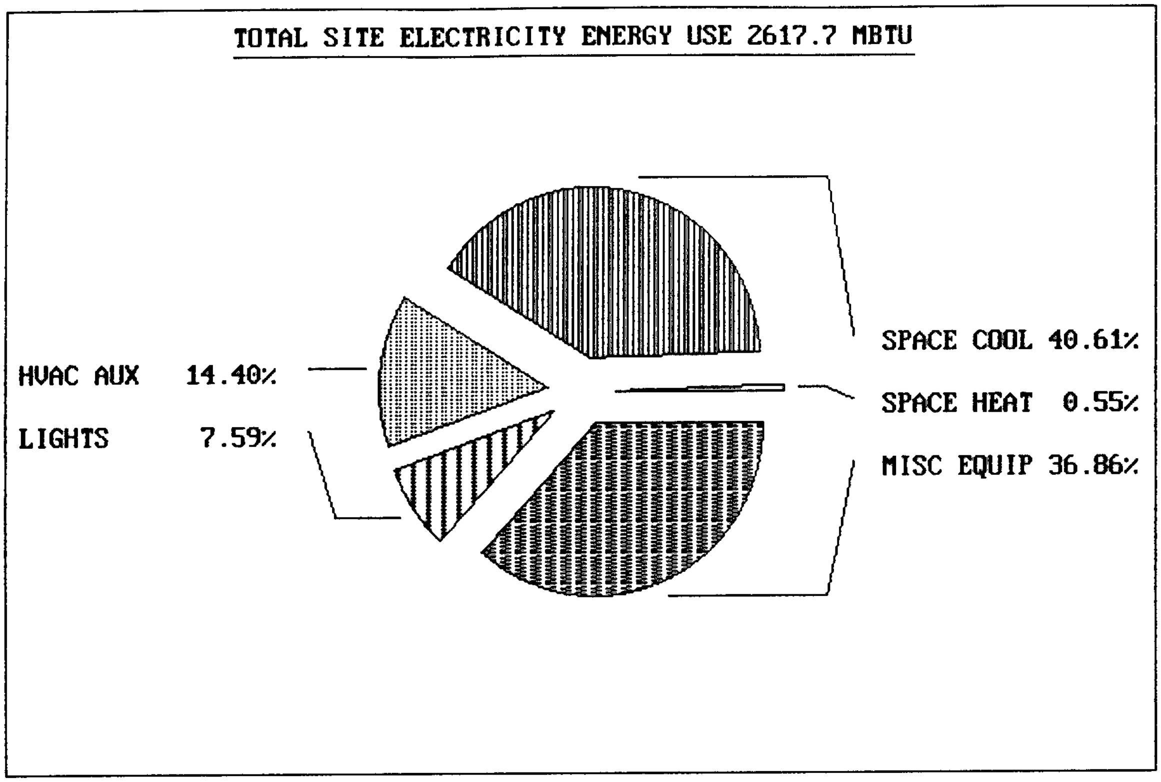
ECO-8 Chiller Replacement



ECO – 8 Chiller Replacement
+
ECO – 4 T-8 Lighting



ECO-8 Chiller Replacement
+
ECO-4 T-8 Lighting
+
ECO-9 Recirculation
+
ECO-7 UPS Modification



ECO's 4, 6, 7, 8, 9, 10

```
INPUT LOADS  ..

                    $---------------------------------$
                    $ E Z - D O E   L O A D S  I N P U T $
                    $---------------------------------$

                       $ GENERAL PROJECT DATA

TITLE  LINE-1 *     EMC      ENGINEERS      INC.      *
       LINE-2 *EZDOE - ELITE SOFTWARE DEVELOPMENT INC*
       LINE-3 *     DENVER,       CO       80227      *

       LINE-4 *GEODSS SITE DOE EVALUATION              * ..

ABORT               ERRORS  ..
DIAGNOSTIC          WARNINGS ..
LOADS-REPORT        VERIFICATION=(LV-B,LV-D,LV-F,LV-G,LV-I)
                    SUMMARY=(LS-A,LS-B,LS-C,LS-D)
                    HOURLY-DATA-SAVE = YES  ..
BUILDING-LOCATION   ALTITUDE = 4998.
                    SHIELDING-COEF = 0.31
                    X-REF = 0.0
                    Y-REF = 0.0  ..
RUN-PERIOD          JAN 1 1994 THRU DEC 31 1994  ..


                       $ SCHEDULES

D_LIGHTS    =DAY-SCHEDULE  (1,6) (0.75)
                           (7,16) (1.)
                           (17,24) (0.75) ..

SSH_LIGHTS =DAY-SCHEDULE  (1,6) (0.4)
                           (7,16) (0.16)
                           (17,24) (0.4) ..

DAYOCCUP    =DAY-SCHEDULE  (1,5) (0.25)
                           (6) (0.5)
                           (7,10) (1.)
                           (11,13) (0.75)
                           (14,16) (1.)
                           (17) (0.5)
                           (18,24) (0.25) ..

SSH_OCCUP   =DAY-SCHEDULE  (1,6) (0.25)
                           (7,16) (0.14)
                           (17,24) (0.25) ..

OFFICEQUIP =DAY-SCHEDULE  (1,5) (0.5)
                           (6) (0.75)
                           (7,16) (1.)
                           (17) (0.75)
                           (18,24) (0.5) ..

D_ON        =DAY-SCHEDULE  (1,24) (1.) ..

SSHOFFEQUP =DAY-SCHEDULE  (1,6) (0.6)
                           (7,16) (0.25)
```

```
                              (17,24) (0.6) ..

CONFOCCUP   =DAY-SCHEDULE    (1,9) (0.)
                              (10,12) (1.,0.,1.)
                              (13,24) (0.) ..

TOWERLIGHT =DAY-SCHEDULE     (1,5) (0.)
                              (6) (1.)
                              (7,11) (0.)
                              (12) (1.)
                              (13,16) (0.)
                              (17) (1.)
                              (18,24) (0.) ..

TOWEQUIP    =DAY-SCHEDULE    (1,6) (1.)
                              (7,14) (0.)
                              (15,24) (1.) ..

ld_off      =DAY-SCHEDULE    (1,24) (0.) ..

infiltow    =DAY-SCHEDULE    (1,6) (5.)
                              (7,17) (1.)
                              (18,24) (5.) ..

SUMINFIL    =DAY-SCHEDULE    (1,6) (1.)
                              (7,18) (0.)
                              (19,24) (1.) ..


WEEKLIGHTS =WEEK-SCHEDULE    (WD)  D_LIGHTS
                              (WEH) SSH_LIGHTS  ..

WEEKLYPEOP =WEEK-SCHEDULE    (WD)  DAYOCCUP
                              (WEH) SSH_OCCUP  ..

W_EQUIP     =WEEK-SCHEDULE   (WD)  OFFICEQUIP
                              (WEH) SSHOFFEQUP  ..

W_CONFOCCU =WEEK-SCHEDULE    (ALL) CONFOCCUP  ..

LITETOWER   =WEEK-SCHEDULE   (ALL) TOWERLIGHT  ..

T_EQUIP     =WEEK-SCHEDULE   (ALL) TOWEQUIP  ..

compequip   =WEEK-SCHEDULE   (ALL) D_ON  ..

lw_off      =WEEK-SCHEDULE   (ALL) ld_off  ..

towinfil    =WEEK-SCHEDULE   (ALL) infiltow  ..

INFILSUM    =WEEK-SCHEDULE   (ALL) SUMINFIL  ..


$ YEAR SCHEDULE
y_lights    =SCHEDULE THRU DEC 31 WEEKLIGHTS  ..

$ YEARLYOCCUP
A_OCCUP     =SCHEDULE THRU DEC 31 WEEKLYPEOP  ..

$ YEARLY EQUIPMENT
```

```
Y_EQUIP    =SCHEDULE THRU DEC 31 W_EQUIP  ..

$ OCUUPANCYOFCONFERENCERM
OCCUCONFRM =SCHEDULE THRU DEC 31 W_CONFOCCU  ..

$ TOWER LIGHTS
T_LIGHTS   =SCHEDULE THRU DEC 31 LITETOWER  ..

$ EQIPMENT IN TOWER
TOWEREQUIP =SCHEDULE THRU DEC 31 T_EQUIP  ..

$ computer room equip
equipcomp  =SCHEDULE THRU DEC 31 compequip  ..

L-hrly_rps =SCHEDULE THRU MAR 12 lw_off
                     THRU MAR 13 compequip
                     THRU SEP  7 lw_off
                     THRU SEP  8 compequip
                     THRU DEC 31 lw_off  ..

$ infiltration into tower
towerinfil =SCHEDULE THRU APR  1 towinfil
                     THRU NOV  1 INFILSUM
                     THRU DEC 31 towinfil  ..


                    $ CONSTRUCTION TYPES



 $ ROOF OVER MAIN BUILDING
TOP_ROOF =LAYERS          MATERIAL=(RG01,BR01,IN37,AL23)
                          THICKNESS=(0.042,0.031,0.333,0.000)  ..
REGROOF  =CONSTRUCTION    LAYERS = TOP_ROOF
                           ABSORPTANCE = 0.600  ..

 $ WALL AROUND TOWERS
T_WALL   =LAYERS          MATERIAL=(CC07,IN02,GP02)
                          THICKNESS=(1.000,0.296,0.052)  ..
TOWERWAL =CONSTRUCTION    LAYERS = T_WALL
                           ABSORPTANCE = 0.650  ..

 $ FLOOR OF BLDG(NOT COMP ROOM)
FLOOR    =CONSTRUCTION    U-VALUE =  0.800  ..

 $ DOME ON TOWER
TOWEROOF =CONSTRUCTION    U-VALUE =  0.048
                           ABSORPTANCE = 0.400  ..

 $ CEILING WITH 4.5 FT PLENUM
REGCEIL  =LAYERS          MATERIAL=(HF-E4,AC03)
                          THICKNESS=(0.000,0.063)  ..
CEILING  =CONSTRUCTION    LAYERS = REGCEIL  ..

 $ CEILING WITH 4.5 FT PLENUM
T_CEILIG =LAYERS          MATERIAL=(HF-E4,IN03,HF-E1)
                          THICKNESS=(0.000,0.511,0.063)  ..
TOWCEIL  =CONSTRUCTION    LAYERS = T_CEILIG  ..
```

```
 $ REGULAR WALL AROUND BUILDING
WALL      =LAYERS           MATERIAL=(CB14,IN02,PW05,GP02)
                            THICKNESS=(0.667,0.296,0.063,0.052)  ..
REGWALL   =CONSTRUCTION     LAYERS = WALL
                             ABSORPTANCE = 0.650  ..

 $ INT WAL IN COMPUTER ROOM
C_WALL    =LAYERS           MATERIAL=(CB14,IN02,PW05,GP02)
                            THICKNESS=(0.667,0.296,0.063,0.052)  ..
COMPWAL   =CONSTRUCTION     LAYERS = C_WALL     ..

 $ FLOOR OF COMPUTER ROOM
FLOORCOM  =CONSTRUCTION     U-VALUE =  0.800  ..

 $ INT WAL IN COMPUTER ROOM
I_WALL    =LAYERS           MATERIAL=(CB12,PW05,GP02)
                            THICKNESS=(0.667,0.063,0.052)  ..
INTWALL   =CONSTRUCTION     LAYERS = I_WALL     ..

GEODSS    =GLASS-TYPE       GLASS-TYPE-CODE =  1
                            INSIDE-EMISS = 0
                            VIS-TRANS = 0.00  ..



                    $ SPACE DESCRIPTION

CONFERENCE =SPACE       AREA = 348.0  VOLUME = 2786.0
                        ZONE-TYPE = CONDITIONED  PEOPLE-SCHEDULE = OCCUCONFRM
                        NUMBER-OF-PEOPLE = 1.0  PEOPLE-HEAT-GAIN = 350.0
                        PEOPLE-HG-LAT = 125.0  PEOPLE-HG-SENS = 250.0
                        LIGHTING-TYPE = REC-FLUOR-NV  LIGHTING-KW = 0.53
                        LIGHT-TO-SPACE = 0.8  LIGHT-TO-OTHER = 0.2
                        LIGHT-HEAT-TO = CONFPLENUM
                        LIGHTING-SCHEDULE = OCCUCONFRM
                        EQUIP-SCHEDULE = OCCUCONFRM  EQUIPMENT-KW = 0.5
                        FURNITURE-TYPE = HEAVY  FURN-WEIGHT = 4.
                        INF-METHOD = CRACK  NEUTRAL-ZONE-HT = 6.0   ..

              I-W        HEIGHT = 8.0  WIDTH = 18.4  CONS = INTWALL
                         NEXT-TO = HALLS   ..

              I-W        HEIGHT = 8.0  WIDTH = 19.0  CONS = INTWALL
                         NEXT-TO = HALLS   ..

              I-W        HEIGHT = 8.0  WIDTH = 18.4  CONS = INTWALL
                         NEXT-TO = COMPUTERRM   ..

              I-W        HEIGHT = 8.0  WIDTH = 19.0  CONS = INTWALL
                         NEXT-TO = COMPUTERRM   ..


HALLS      =SPACE       AREA = 5285.5  VOLUME = 42284.0
                        ZONE-TYPE = CONDITIONED  PEOPLE-SCHEDULE = A_OCCUP
                        NUMBER-OF-PEOPLE = 4.0  PEOPLE-HEAT-GAIN = 350.0
                        PEOPLE-HG-LAT = 125.0  PEOPLE-HG-SENS = 250.0
                        LIGHTING-TYPE = REC-FLUOR-NV  LIGHTING-KW = 6.5
                        LIGHT-TO-SPACE = 0.8  LIGHT-TO-OTHER = 0.2
```

```
                LIGHT-HEAT-TO = HALLPLENUM
                LIGHTING-SCHEDULE = y_lights
                EQUIP-SCHEDULE = Y_EQUIP  EQUIPMENT-KW = 5.35
                FURNITURE-TYPE = LIGHT  INF-METHOD = CRACK
                NEUTRAL-ZONE-HT = 0.0   ..

         E-W     HEIGHT = 8.0  WIDTH = 80.0  CONS = REGWALL
                 AZIMUTH = 315   ..

         E-W     HEIGHT = 8.0  WIDTH = 117.6  CONS = REGWALL
                 AZIMUTH = 45   ..

         E-W     HEIGHT = 8.0  WIDTH = 80.0  CONS = REGWALL
                 AZIMUTH = 135   ..

        U-W     HEIGHT = 1.0  WIDTH = 80.0  CONS = FLOOR ..

        U-W     HEIGHT = 117.6  WIDTH = 1.0  CONS = FLOOR ..

        U-W     HEIGHT = 1.0  WIDTH = 80.0  CONS = FLOOR ..


TOWER_1    =SPACE     AREA = 576.0  VOLUME = 14976.0
                ZONE-TYPE = CONDITIONED  PEOPLE-SCHEDULE = T_LIGHTS
                NUMBER-OF-PEOPLE = 2.0  LIGHTING-TYPE = INCAND
                LIGHTING-KW = 1.23  LIGHTING-SCHEDULE = T_LIGHTS
                EQUIP-SCHEDULE = TOWEREQUIP  EQUIPMENT-KW = 4.39
                EQUIP-SENSIBLE = 0.3  INF-METHOD = AIR-CHANGE
                AIR-CHANGES/HR = 0.75  INF-SCHEDULE = towerinfil   ..

         ROOF    HEIGHT = 24.0  WIDTH = 24.0  CONS = TOWEROOF
                 TILT = 0   ..

         E-W     HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
                 AZIMUTH = 45   ..

         E-W     HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
                 AZIMUTH = 135   ..

         E-W     HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
                 AZIMUTH = 225   ..

        U-W     HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..

         E-W     HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
                 AZIMUTH = 315   ..

        U-W     HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..

        U-W     HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..

        U-W     HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..


TOWER_3    =SPACE     AREA = 576.0  VOLUME = 14976.0
                ZONE-TYPE = CONDITIONED  PEOPLE-SCHEDULE = T_LIGHTS
                NUMBER-OF-PEOPLE = 2.0  LIGHTING-TYPE = INCAND
                LIGHTING-KW = 1.23  LIGHTING-SCHEDULE = T_LIGHTS
                EQUIP-SCHEDULE = TOWEREQUIP  EQUIPMENT-KW = 4.39
                EQUIP-SENSIBLE = 0.3  INF-METHOD = AIR-CHANGE
```

```
            AIR-CHANGES/HR = 0.75  INF-SCHEDULE = towerinfil   ..

     ROOF     HEIGHT = 24.0  WIDTH = 24.0  CONS = TOWEROOF
              TILT = 0   ..

     E-W      HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
              AZIMUTH = 45   ..

     E-W      HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
              AZIMUTH = 135   ..

     E-W      HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
              AZIMUTH = 225   ..

     U-W      HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..

     E-W      HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
              AZIMUTH = 315   ..

     U-W      HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..

     U-W      HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..

     U-W      HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..


COMPUTERRM =SPACE   AREA = 4037.4  VOLUME = 36337.0
            ZONE-TYPE = CONDITIONED  PEOPLE-SCHEDULE = equipcomp
            NUMBER-OF-PEOPLE = 4.0  PEOPLE-HEAT-GAIN = 350.0
            PEOPLE-HG-LAT = 125.0  PEOPLE-HG-SENS = 250.0
            LIGHTING-TYPE = REC-FLUOR-NV  LIGHTING-KW = 4.72
            LIGHT-TO-SPACE = 0.8  LIGHT-TO-OTHER = 0.2
            LIGHT-HEAT-TO = COMPRMPLN
            LIGHTING-SCHEDULE = equipcomp
            EQUIP-SCHEDULE = equipcomp  EQUIPMENT-KW = 29.0
            EQUIP-SENSIBLE = 0.67  INF-METHOD = CRACK
            NEUTRAL-ZONE-HT = 0.0   ..

     I-W      HEIGHT = 9.0  WIDTH = 59.6  CONS = INTWALL
              NEXT-TO = HALLS   ..

     I-W      HEIGHT = 9.0  WIDTH = 40.6  CONS = INTWALL
              NEXT-TO = HALLS   ..

     I-W      HEIGHT = 9.0  WIDTH = 49.3  CONS = INTWALL
              NEXT-TO = HALLS   ..

     I-W      HEIGHT = 9.0  WIDTH = 18.3  CONS = INTWALL
              NEXT-TO = CONFERENCE   ..

     I-W      HEIGHT = 9.0  WIDTH = 19.0  CONS = INTWALL
              NEXT-TO = CONFERENCE   ..

     E-W      HEIGHT = 9.0  WIDTH = 67.6  CONS = COMPWAL
              AZIMUTH = 225   ..

     U-W      HEIGHT = 67.6  WIDTH = 1.0  CONS = FLOORCOM ..


CONFPLENUM =SPACE   AREA = 348.0  VOLUME = 1879.2
```

```
        ZONE-TYPE = UNCONDITIONED   ..

    I-W      HEIGHT = 5.4   WIDTH = 18.4   CONS = INTWALL
             NEXT-TO = COMPRMPLN    ..

    I-W      HEIGHT = 5.4   WIDTH = 19.0   CONS = INTWALL
             NEXT-TO = COMPRMPLN    ..

    I-W      HEIGHT = 5.4   WIDTH = 18.4   CONS = INTWALL
             NEXT-TO = HALLPLENUM    ..

    I-W      HEIGHT = 5.4   WIDTH = 19.0   CONS = INTWALL
             NEXT-TO = HALLPLENUM    ..

    I-W      HEIGHT = 18.4   WIDTH = 19.0   CONS = CEILING
             NEXT-TO = CONFERENCE    ..

    ROOF     HEIGHT = 17.4   WIDTH = 19.0   CONS = REGROOF
             TILT = 0   ..

    ROOF     HEIGHT = 1.0   WIDTH = 19.0   CONS = REGROOF
             TILT = 0   ..


COMPRMPLN   =SPACE    AREA = 4037.4   VOLUME = 17764.6
                      ZONE-TYPE = UNCONDITIONED   INF-METHOD = CRACK
                      NEUTRAL-ZONE-HT = 0.0    ..

    I-W      HEIGHT = 4.4   WIDTH = 59.6   CONS = INTWALL
             NEXT-TO = HALLPLENUM    ..

    I-W      HEIGHT = 4.4   WIDTH = 40.6   CONS = INTWALL
             NEXT-TO = HALLPLENUM    ..

    I-W      HEIGHT = 4.4   WIDTH = 49.3   CONS = INTWALL
             NEXT-TO = HALLPLENUM    ..

    I-W      HEIGHT = 4.4   WIDTH = 18.3   CONS = INTWALL
             NEXT-TO = CONFPLENUM    ..

    I-W      HEIGHT = 4.4   WIDTH = 19.0   CONS = INTWALL
             NEXT-TO = CONFPLENUM    ..

    I-W      HEIGHT = 49.3   WIDTH = 59.6   CONS = CEILING
             NEXT-TO = COMPUTERRM    ..

    I-W      HEIGHT = 18.3   WIDTH = 40.6   CONS = CEILING
             NEXT-TO = COMPUTERRM    ..

    E-W      HEIGHT = 4.4   WIDTH = 67.6   CONS = COMPWAL
             AZIMUTH = 225    ..

    ROOF     HEIGHT = 49.3   WIDTH = 59.6   CONS = REGROOF
             TILT = 0   ..

    ROOF     HEIGHT = 18.3   WIDTH = 40.6   CONS = REGROOF
             TILT = 0   ..


HALLPLENUM =SPACE    AREA = 5285.5   VOLUME = 28541.7
```

```
            ZONE-TYPE = UNCONDITIONED  INF-METHOD = CRACK
            NEUTRAL-ZONE-HT = 0.0   ..

    E-W       HEIGHT = 5.4  WIDTH = 80.0  CONS = REGWALL
              AZIMUTH = 315   ..

    E-W       HEIGHT = 5.4  WIDTH = 117.6  CONS = REGWALL
              AZIMUTH = 45   ..

    E-W       HEIGHT = 5.4  WIDTH = 80.0  CONS = REGWALL
              AZIMUTH = 135   ..

    I-W       HEIGHT = 25.0  WIDTH = 80.0  CONS = CEILING
              NEXT-TO = HALLS   ..

    I-W       HEIGHT = 67.6  WIDTH = 19.0  CONS = CEILING
              NEXT-TO = HALLS   ..

    I-W       HEIGHT = 25.0  WIDTH = 80.0  CONS = CEILING
              NEXT-TO = HALLS   ..

    ROOF      HEIGHT = 25.0  WIDTH = 80.0  CONS = REGROOF
              TILT = 0   ..

    ROOF      HEIGHT = 67.6  WIDTH = 19.0  CONS = REGROOF
              TILT = 0   ..

    ROOF      HEIGHT = 25.0  WIDTH = 80.0  CONS = REGROOF
              TILT = 0   ..


TOWER_2   =SPACE    AREA = 576.0  VOLUME = 14976.0
            ZONE-TYPE = CONDITIONED  PEOPLE-SCHEDULE = T_LIGHTS
            NUMBER-OF-PEOPLE = 2.0  LIGHTING-TYPE = INCAND
            LIGHTING-KW = 1.23  LIGHTING-SCHEDULE = T_LIGHTS
            EQUIP-SCHEDULE = TOWEREQUIP  EQUIPMENT-KW = 4.39
            EQUIP-SENSIBLE = 0.3  INF-METHOD = AIR-CHANGE
            AIR-CHANGES/HR = 0.75  INF-SCHEDULE = towerinfil   ..

    ROOF      HEIGHT = 24.0  WIDTH = 24.0  CONS = TOWEROOF
              TILT = 0   ..

    E-W       HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
              AZIMUTH = 45   ..

    E-W       HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
              AZIMUTH = 135   ..

    E-W       HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
              AZIMUTH = 225   ..

    U-W      HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..

    E-W       HEIGHT = 26.0  WIDTH = 24.0  CONS = TOWERWAL
              AZIMUTH = 315   ..

    U-W      HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..

    U-W      HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..
```

```
            U-W      HEIGHT = 24.0  WIDTH = 1.0  CONS = FLOOR ..


                    $ HOURLY REPORT DESCRIPTION

GLOBAL_BLK =REPORT-BLOCK VARIABLE-TYPE = GLOBAL
                         VARIABLE-LIST = (24,17) ..
glob_hrly  = HOURLY-REPORT  REPORT-SCHEDULE = L-hrly_rps
                         REPORT-BLOCK = (GLOBAL_BLK)
 ..
dup_glob_b = HOURLY-REPORT  REPORT-SCHEDULE = L-hrly_rps
                         REPORT-BLOCK = (GLOBAL_BLK)
 ..
END  ..
COMPUTE LOADS  ..

INPUT SYSTEMS  ..


                $-------------------------------------$
                $ E Z - D O E   S Y S T E M S   I N P U T $
                $-------------------------------------$

                    $ GENERAL PROJECT DATA

TITLE  LINE-1 *      EMC      ENGINEERS      INC.      *
       LINE-2 *EZDOE - ELITE SOFTWARE DEVELOPMENT INC*
       LINE-3 *      DENVER,       CO       80227      *

       LINE-4 *GEODSS SITE DOE EVALUATION               * ..
ABORT                ERRORS  ..
DIAGNOSTIC           WARNINGS ..
SYSTEMS-REPORT       VERIFICATION=(SV-A)
                     SUMMARY=(SS-A,SS-C,SS-K,SS-O)  ..

                    $ SCHEDULES

DAILYTEMP  =DAY-SCHEDULE  (1,24) (68.) ..
TOWER_AHU  =DAY-SCHEDULE  (1,24) (1.) ..
S_GEODSSYS =DAY-SCHEDULE  (1,7) (100.)
                          (8,15) (50.)
                          (16,24) (100.) ..
CAMCOMPRES =DAY-SCHEDULE  (1,7) (100.)
                          (8,15) (0.)
                          (16,24) (100.) ..
CRU        =DAY-SCHEDULE  (1,24) (72.) ..
WINTOWER   =DAY-SCHEDULE  (1,24) (0.) ..
COOLCOMP   =DAY-SCHEDULE  (1,24) (72.) ..
ahu2       =DAY-SCHEDULE  (1,24) (0.26) ..

INSIDE     =WEEK-SCHEDULE  (ALL) DAILYTEMP  ..

W_GEODSS   =WEEK-SCHEDULE  (ALL) TOWER_AHU  ..

WINGEODSS  =WEEK-SCHEDULE  (ALL) WINTOWER  ..

W_CAMERA   =WEEK-SCHEDULE  (ALL) CAMCOMPRES  ..

COMPHEAT   =WEEK-SCHEDULE  (ALL) CRU  ..
```

```
CONF_AHU    =WEEK-SCHEDULE  (ALL) TOWER_AHU  ..

BIGAHU      =WEEK-SCHEDULE  (ALL) TOWER_AHU  ..

COMPCOOL    =WEEK-SCHEDULE  (ALL) COOLCOMP  ..

w_ahu2      =WEEK-SCHEDULE  (ALL) ahu2  ..


$ FULL TIME RUNNUNG AHU
FULL_ON     =SCHEDULE THRU DEC 31 CONF_AHU  ..

$ YEARLY SYSTEMS TOWERS
TOWERYEAR   =SCHEDULE THRU APR  1 WINGEODSS
                      THRU NOV  1 W_GEODSS
                      THRU DEC 31 WINGEODSS  ..

$ YEARLY CAMERA COMPRESSO
Y_CAMERA    =SCHEDULE THRU DEC 31 W_CAMERA  ..

$ TEMPERATURE IN BLDG
BLDGTEMP    =SCHEDULE THRU DEC 31 INSIDE  ..

$ TEMPERATUREOFCOMPRM
COMPUTER    =SCHEDULE THRU DEC 31 COMPHEAT  ..

s_off       =SCHEDULE THRU DEC 31 WINGEODSS  ..

hrly-sched =SCHEDULE THRU MAR 12 WINGEODSS
                     THRU MAR 13 CONF_AHU
                     THRU SEP  7 WINGEODSS
                     THRU SEP  8 CONF_AHU
                     THRU DEC 31 WINGEODSS  ..

$ HEATER FOR AHU #1
HEATER      =SCHEDULE THRU APR  1 CONF_AHU
                      THRU NOV  1 WINGEODSS
                      THRU DEC 31 CONF_AHU  ..

$ TEMP TO COOL IN COMP RM
COOL_COMP   =SCHEDULE THRU DEC 31 COMPCOOL  ..

$ outside air to ahu2
oaahu2      =SCHEDULE THRU DEC 31 w_ahu2  ..


                    $ ZONE DESCRIPTION

CONFERENCE =ZONE    DESIGN-HEAT-T = 68.0  DESIGN-COOL-T = 72.0
                    HEAT-TEMP-SCH = BLDGTEMP  COOL-TEMP-SCH = COMPUTER
                    ZONE-TYPE = CONDITIONED  MAX-HEAT-RATE = -1.0
                    THERMOSTAT-TYPE = PROPORTIONAL  ASSIGNED-CFM = 800.
                    SIZING-OPTION = FROM-LOADS  COOLING-CAPACITY = 10000.0
                    COOL-SH-CAP = 8000.0   ..

HALLS      =ZONE    DESIGN-HEAT-T = 68.0  DESIGN-COOL-T = 72.0
                    HEAT-TEMP-SCH = BLDGTEMP  COOL-TEMP-SCH = COMPUTER
                    ZONE-TYPE = CONDITIONED
```

```
                THERMOSTAT-TYPE = PROPORTIONAL  ASSIGNED-CFM = 4770.
                OUTSIDE-AIR-CFM = 1247.  SIZING-OPTION = FROM-LOADS
                EXHAUST-CFM = 1247.0  HEATING-CAPACITY = -76817.0
                COOLING-CAPACITY = 113658.0  COOL-SH-CAP = 102183.0   ..

TOWER_1    =ZONE    DESIGN-HEAT-T = 68.0  DESIGN-COOL-T = 72.0
                    HEAT-TEMP-SCH = BLDGTEMP  COOL-TEMP-SCH = COMPUTER
                    ZONE-TYPE = CONDITIONED  MAX-HEAT-RATE = -1.0
                    THERMOSTAT-TYPE = PROPORTIONAL  ASSIGNED-CFM = 2000.
                    SIZING-OPTION = FROM-LOADS  EXHAUST-CFM = 2000.0
                    COOLING-CAPACITY = 62702.0  COOL-SH-CAP = 62702.0   ..

TOWER_3    =ZONE    DESIGN-HEAT-T = 68.0  DESIGN-COOL-T = 72.0
                    HEAT-TEMP-SCH = BLDGTEMP  COOL-TEMP-SCH = COMPUTER
                    ZONE-TYPE = CONDITIONED  MAX-HEAT-RATE = -1.0
                    THERMOSTAT-TYPE = PROPORTIONAL  ASSIGNED-CFM = 2000.
                    SIZING-OPTION = FROM-LOADS  EXHAUST-CFM = 2000.0
                    COOLING-CAPACITY = 62866.0  COOL-SH-CAP = 62866.0   ..

COMPUTERRM =ZONE    DESIGN-HEAT-T = 68.0  DESIGN-COOL-T = 72.0
                    HEAT-TEMP-SCH = BLDGTEMP  COOL-TEMP-SCH = COOL_COMP
                    ZONE-TYPE = CONDITIONED
                    THERMOSTAT-TYPE = PROPORTIONAL  ASSIGNED-CFM = 36000.
                    SIZING-OPTION = FROM-LOADS  RATED-CFM = 36000.0
                    HEATING-CAPACITY = -345300.0
                    COOLING-CAPACITY = 978600.0  COOL-SH-CAP = 838200.0   ..

CONFPLENUM =ZONE    DESIGN-HEAT-T = 68.0  DESIGN-COOL-T = 72.0
                    ZONE-TYPE = UNCONDITIONED  SIZING-OPTION = FROM-LOADS   ..

COMPRMPLN  =ZONE    DESIGN-HEAT-T = 68.0  DESIGN-COOL-T = 72.0
                    ZONE-TYPE = UNCONDITIONED  SIZING-OPTION = FROM-LOADS   ..

HALLPLENUM =ZONE    DESIGN-HEAT-T = 68.0  DESIGN-COOL-T = 72.0
                    ZONE-TYPE = UNCONDITIONED  SIZING-OPTION = FROM-LOADS   ..

TOWER_2    =ZONE    DESIGN-HEAT-T = 68.0  DESIGN-COOL-T = 72.0
                    HEAT-TEMP-SCH = BLDGTEMP  COOL-TEMP-SCH = COMPUTER
                    ZONE-TYPE = CONDITIONED  MAX-HEAT-RATE = -1.0
                    THERMOSTAT-TYPE = PROPORTIONAL  ASSIGNED-CFM = 2000.
                    SIZING-OPTION = FROM-LOADS  EXHAUST-CFM = 2000.0
                    COOLING-CAPACITY = 62702.0  COOL-SH-CAP = 62702.0   ..


                    $ SYSTEM DESCRIPTION

1TOWER     =SYSTEM   SYSTEM-TYPE = SZRH
                     MAX-SUPPLY-T = 120.0  MIN-SUPPLY-T = 55.0
                     HEATING-SCHEDULE = s_off
                     COOLING-SCHEDULE = TOWERYEAR  MAX-HUMIDITY = 90.0
                     OA-CONTROL = FIXED  SUPPLY-CFM = 2000.
                     MIN-OUTSIDE-AIR = 1.0  FAN-SCHEDULE = TOWERYEAR
                     SUPPLY-STATIC = 2.5  SUPPLY-EFF = 0.72
                     NIGHT-CYCLE-CTRL = STAY-OFF  NIGHT-VENT-DT = 0.0
                     MIN-CFM-RATIO = 1.0  REHEAT-DELTA-T = 65.
                     COOLING-CAPACITY = 40000.  COOL-SH-CAP = 40000.
                     COOL-FT-MIN = 0.  FURNACE-AUX = 0.
                     FURNACE-HIR = 1.0
                     ZONE-NAMES = (TOWER_1)  ..
```

```
CRUINT     =SYSTEM     SYSTEM-TYPE = SZRH
                       MAX-SUPPLY-T = 72.0  MIN-SUPPLY-T = 62.0
                       HEATING-SCHEDULE = FULL_ON
                       COOLING-SCHEDULE = FULL_ON  MAX-HUMIDITY = 55.0
                       MIN-HUMIDITY = 30.0  OA-CONTROL = FIXED
                       SUPPLY-CFM = 36000.  RETURN-CFM = 36000.
                       MAX-OA-FRACTION = 0.0  FAN-SCHEDULE = FULL_ON
                       SUPPLY-STATIC = 1.5  SUPPLY-EFF = 0.72
                       NIGHT-CYCLE-CTRL = STAY-OFF  NIGHT-VENT-DT = 0.0
                       MIN-CFM-RATIO = 1.0  REHEAT-DELTA-T = 65.
                       COOLING-CAPACITY = 978600.  COOL-SH-CAP = 838200.
                       COOL-FT-MIN = 0.  HEATING-CAPACITY = -345300.
                       FURNACE-AUX = 0.  HEAT-SOURCE = ELECTRIC
                       RETURN-AIR-PATH = DUCT
                       ZONE-NAMES = (COMPUTERRM, COMPRMPLN)  ..

2TOWER     =SYSTEM     SYSTEM-TYPE = SZRH
                       MAX-SUPPLY-T = 120.0  MIN-SUPPLY-T = 55.0
                       HEATING-SCHEDULE = s_off
                       COOLING-SCHEDULE = TOWERYEAR  MAX-HUMIDITY = 90.0
                       OA-CONTROL = FIXED  SUPPLY-CFM = 2000.
                       MIN-OUTSIDE-AIR = 1.0  FAN-SCHEDULE = TOWERYEAR
                       SUPPLY-STATIC = 2.5  SUPPLY-EFF = 0.72
                       NIGHT-CYCLE-CTRL = STAY-OFF  NIGHT-VENT-DT = 0.0
                       MIN-CFM-RATIO = 1.0  REHEAT-DELTA-T = 65.
                       COOLING-CAPACITY = 40000.  COOL-SH-CAP = 40000.
                       COOL-FT-MIN = 0.  FURNACE-AUX = 0.
                       FURNACE-HIR = 1.0
                       ZONE-NAMES = (TOWER_2)  ..

3TOWER     =SYSTEM     SYSTEM-TYPE = SZRH
                       MAX-SUPPLY-T = 120.0  MIN-SUPPLY-T = 55.0
                       HEATING-SCHEDULE = s_off
                       COOLING-SCHEDULE = TOWERYEAR  MAX-HUMIDITY = 90.0
                       OA-CONTROL = FIXED  SUPPLY-CFM = 2000.
                       MIN-OUTSIDE-AIR = 1.0  FAN-SCHEDULE = TOWERYEAR
                       SUPPLY-STATIC = 2.5  SUPPLY-EFF = 0.72
                       NIGHT-CYCLE-CTRL = STAY-OFF  NIGHT-VENT-DT = 0.0
                       MIN-CFM-RATIO = 1.0  REHEAT-DELTA-T = 65.
                       COOLING-CAPACITY = 40000.  COOL-SH-CAP = 40000.
                       COOL-FT-MIN = 0.  FURNACE-AUX = 0.
                       FURNACE-HIR = 1.0
                       ZONE-NAMES = (TOWER_3)  ..

REGAHU     =SYSTEM     SYSTEM-TYPE = SZRH
                       MAX-SUPPLY-T = 120.0  MIN-SUPPLY-T = 58.0
                       HEATING-SCHEDULE = FULL_ON
                       COOLING-SCHEDULE = FULL_ON  HEAT-SET-T = 120.0
                       MAX-HUMIDITY = 80.0  OA-CONTROL = FIXED
                       SUPPLY-CFM = 4770.  RETURN-CFM = 3523.
                       MIN-OUTSIDE-AIR = 0.26  MAX-OA-FRACTION = 0.26
                       FAN-SCHEDULE = FULL_ON  SUPPLY-STATIC = 3.0
                       SUPPLY-EFF = 0.72  NIGHT-CYCLE-CTRL = STAY-OFF
                       NIGHT-VENT-DT = 0.0  MIN-CFM-RATIO = 1.0
                       REHEAT-DELTA-T = 65.  COOLING-CAPACITY = 113658.
                       COOL-SH-CAP = 102183.  COOL-FT-MIN = 0.
                       HEATING-CAPACITY = -76817.  FURNACE-AUX = 0.
                       FURNACE-HIR = 1.0  HEAT-SOURCE = ELECTRIC
                       RETURN-AIR-PATH = DUCT
                       ZONE-NAMES = (HALLS, HALLPLENUM)  ..
```

```
CONFRMAHU  =SYSTEM    SYSTEM-TYPE = SZRH
                      MAX-SUPPLY-T = 70.0  MIN-SUPPLY-T = 62.0
                      HEATING-SCHEDULE = s_off  COOLING-SCHEDULE = FULL_ON
                      MAX-HUMIDITY = 50.0  OA-CONTROL = FIXED
                      SUPPLY-CFM = 800.  RETURN-CFM = 800.
                      MAX-OA-FRACTION = 0.0  FAN-SCHEDULE = FULL_ON
                      SUPPLY-DELTA-T = 2.42  SUPPLY-KW = 0.00031
                      NIGHT-CYCLE-CTRL = STAY-OFF  NIGHT-VENT-DT = 0.0
                      MIN-CFM-RATIO = 1.0  REHEAT-DELTA-T = 65.
                      COOLING-CAPACITY = 10000.  COOL-SH-CAP = 8000.
                      COOL-FT-MIN = 0.  FURNACE-AUX = 0.
                      FURNACE-HIR = 1.0  RETURN-AIR-PATH = DUCT
                      ZONE-NAMES = (CONFERENCE, CONFPLENUM)  ..


                    $ HOURLY REPORT DESCRIPTION

zone-blk    =REPORT-BLOCK VARIABLE-TYPE = TOWER_1
                          VARIABLE-LIST = (6,7,17,18) ..
ahu-blk     =REPORT-BLOCK VARIABLE-TYPE = 1TOWER
                          VARIABLE-LIST = (5,6,8,1,2,17) ..
hrly-0zone = HOURLY-REPORT  REPORT-SCHEDULE = hrly-sched
                          REPORT-BLOCK = (zone-blk)
 ..
hrly-sys1  = HOURLY-REPORT  REPORT-SCHEDULE = hrly-sched
                          REPORT-BLOCK = (ahu-blk)
 ..
END  ..
COMPUTE SYSTEMS  ..

INPUT PLANT  ..


                 $------------------------------------$
                 $ E Z - D O E   P L A N T S   I N P U T $
                 $------------------------------------$

                    $ GENERAL PROJECT DATA

TITLE  LINE-1 *     EMC      ENGINEERS      INC.     *
       LINE-2 *EZDOE - ELITE SOFTWARE DEVELOPMENT INC*
       LINE-3 *     DENVER,       CO       80227     *

       LINE-4 *GEODSS SITE DOE EVALUATION              * ..

ABORT              ERRORS  ..
DIAGNOSTIC         WARNINGS ..
PLANT-REPORT       SUMMARY=(PS-A,PS-B,PS-C,BEPS)
  ..

                    $ SCHEDULES

PD_ON      =DAY-SCHEDULE  (1,24) (1.) ..


PW_ON      =WEEK-SCHEDULE  (ALL) PD_ON  ..


$ GEODSSP_ON
```

```
P_ON        =SCHEDULE THRU DEC 31 PW_ON  ..


                    $ EQUIPMENT DESCRIPTION


                    $ CURVE-FIT


CHILLER1    = CURVE-FIT  TYPE = QUADRATIC
                         OUTPUT-MIN =         1.00
                         COEF = (       0.088,       1.138,      -0.226)  ..

CHILLERS    =PLANT-EQUIPMENT   TYPE = HERM-REC-CHLR
                       SIZE = 0.4  INSTALLED-NUMBER = 2
                       MAX-NUMBER-AVAIL = 2  ..

PLANT-PARAMETERS       HERM-REC-COND-TYPE = AIR  HERM-REC-UNL-RAT = 1.0
                       CHILL-WTR-T = 45.  CCIRC-MOTOR-EFF = 0.85
                       CCIRC-HEAD = 45.0  HCIRC-MOTOR-EFF = 0.83
                       HCIRC-HEAD = 0.0     ..


PART-LOAD-RATIO  TYPE = HERM-REC-CHLR
                 MIN-RATIO          =  0.2500  MAX-RATIO        =  1.0000
                 OPERATING-RATIO  =  1.0000  ELEC-INPUT-RATIO =  0.4071  ..

ENERGY-RESOURCE        RESOURCE = ELECTRICITY  SOURCE-SITE-EFF = 1.000  ..
ENERGY-RESOURCE        RESOURCE = NATURAL-GAS  ..


EQUIPMENT-QUAD    HERM-REC-EIR-FPLR = CHILLER1     ..

END  ..
COMPUTE PLANT ..
STOP ..
```

```
*****  *****   ****   ***   *****         ***     *   ****
*          *    *   *  *   *  *             *   *  **   *   *
*****     *     *   *  *   *  *****  ***      *     *   *   *
*         *     *   *  *   *  *              **     *   *   *
*****  *****   ****   ***   *****       *****  *  ***  ****
```

B U I L D I N G   E N E R G Y   A N A L Y S I S   P R O G R A M

DEVELOPED BY
LAWRENCE BERKELEY LABORATORY/UNIVERSITY OF CALIFORNIA
AND
James J. Hirsch/HIRSCH & ASSOCIATES/(805) 482-5515

WITH MAJOR SUPPORT FROM
UNITED STATES DEPARTMENT OF ENERGY
ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
OFFICE OF BUILDINGS AND COMMUNITY SYSTEMS
BUILDING SYSTEMS DIVISION

LBL RELEASE DEC 1990 version : JJHirsch PC 2.1D-017
Elite Software PC DOE-2.1D released in April 1993.

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- LV-B SUMMARY OF SPACES OCCURRING IN THE PROJECT TRUTH OR CONSEQU, N

NUMBER OF SPACES 9 EXTERIOR 8 INTERIOR 1

SPACE	SPACE MULT	SPACE TYPE	AZIMUTH	LIGHTING (WATT / SQFT)	PEOPLE	EQUIP (WATT / SQFT)	INFILTRATION METHOD	AIR CHANGES PER HOUR	AREA (SQFT)	VOLUME (CUFT)
CONFERENCE	1.0	INT	0.0	1.52	1.0	1.44	CRACK	0.00	348.00	2786.00
HALLS	1.0	EXT	0.0	1.23	4.0	1.01	CRACK	0.00	5285.50	42284.00
TOWER_1	1.0	EXT	0.0	2.14	2.0	7.62	AIR-CHANGE	0.75	576.00	14976.00
TOWER_3	1.0	EXT	0.0	2.14	2.0	7.62	AIR-CHANGE	0.75	576.00	14976.00
COMPUTERRM	1.0	EXT	0.0	1.17	4.0	7.18	CRACK	0.00	4037.40	36337.00
CONFPLENUM	1.0	EXT	0.0	0.00	0.0	0.00	NO-INFILT.	0.00	348.00	1879.20
COMPRMPLN	1.0	EXT	0.0	0.00	0.0	0.00	CRACK	0.00	4037.40	17764.60
HALLPLENUM	1.0	EXT	0.0	0.00	0.0	0.00	CRACK	0.00	5285.50	28541.70
TOWER_2	1.0	EXT	0.0	2.14	2.0	7.62	AIR-CHANGE	0.75	576.00	14976.00
BUILDING TOTALS					15.0				21069.80	174520.50

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- LV-D DETAILS OF EXTERIOR SURFACES IN THE PROJECT TRUTH OR CONSEQU, N

NUMBER OF EXTERIOR SURFACES 30 RECTANGULAR 30 OTHER 0
(U-VALUE INCLUDES INSIDE AIR FILM PLUS OUTSIDE AIR FILM AT 7.5 MPH WINDSPEED)

SURFACE	SPACE	- - - - G L A S S - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- W A L L + G L A S S - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	AZIMUTH
	HALLS	0.000	0.00	0.066	940.80	0.066	940.80	NORTH-EAST
	TOWER_1	0.000	0.00	0.068	624.00	0.068	624.00	NORTH-EAST
	TOWER_3	0.000	0.00	0.068	624.00	0.068	624.00	NORTH-EAST
	HALLPLENUM	0.000	0.00	0.066	635.04	0.066	635.04	NORTH-EAST
	TOWER_2	0.000	0.00	0.068	624.00	0.068	624.00	NORTH-EAST
	TOWER_3	0.000	0.00	0.068	624.00	0.068	624.00	SOUTH-EAST
	TOWER_1	0.000	0.00	0.068	624.00	0.068	624.00	SOUTH-EAST
	HALLPLENUM	0.000	0.00	0.066	432.00	0.066	432.00	SOUTH-EAST
	HALLS	0.000	0.00	0.066	640.00	0.066	640.00	SOUTH-EAST
	TOWER_2	0.000	0.00	0.068	624.00	0.068	624.00	SOUTH-EAST
	TOWER_1	0.000	0.00	0.068	624.00	0.068	624.00	SOUTH-WEST
	TOWER_3	0.000	0.00	0.068	624.00	0.068	624.00	SOUTH-WEST
	COMPUTERRM	0.000	0.00	0.066	608.40	0.066	608.40	SOUTH-WEST
	COMPRMPLN	0.000	0.00	0.066	297.44	0.066	297.44	SOUTH-WEST
	TOWER_2	0.000	0.00	0.068	624.00	0.068	624.00	SOUTH-WEST
	TOWER_1	0.000	0.00	0.068	624.00	0.068	624.00	NORTH-WEST
	HALLS	0.000	0.00	0.066	640.00	0.066	640.00	NORTH-WEST
	HALLPLENUM	0.000	0.00	0.066	432.00	0.066	432.00	NORTH-WEST
	TOWER_3	0.000	0.00	0.068	624.00	0.068	624.00	NORTH-WEST
	TOWER_2	0.000	0.00	0.068	624.00	0.068	624.00	NORTH-WEST
	CONFPLENUM	0.000	0.00	0.053	330.60	0.053	330.60	ROOF
	CONFPLENUM	0.000	0.00	0.053	19.00	0.053	19.00	ROOF

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION TRUTH OR CONSEQU, N
REPORT- LV-D DETAILS OF EXTERIOR SURFACES IN THE PROJECT

HALLPLENUM	0.000	0.00	0.053	2000.00	0.053	2000.00	ROOF
HALLPLENUM	0.000	0.00	0.053	1284.40	0.053	1284.40	ROOF
HALLPLENUM	0.000	0.00	0.053	2000.00	0.053	2000.00	ROOF
TOWER_2	0.000	0.00	0.047	576.00	0.047	576.00	ROOF
TOWER_3	0.000	0.00	0.047	576.00	0.047	576.00	ROOF
COMPRMPLN	0.000	0.00	0.053	2938.28	0.053	2938.28	ROOF
COMPRMPLN	0.000	0.00	0.053	742.98	0.053	742.98	ROOF
TOWER_1	0.000	0.00	0.047	576.00	0.047	576.00	ROOF
HALLS	0.000	0.00	0.800	80.00	0.800	80.00	UNDERGRND
HALLS	0.000	0.00	0.800	117.60	0.800	117.60	UNDERGRND
HALLS	0.000	0.00	0.800	80.00	0.800	80.00	UNDERGRND
TOWER_1	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_1	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_1	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_1	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_3	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_3	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_3	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_3	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
COMPUTERRM	0.000	0.00	0.800	67.60	0.800	67.60	UNDERGRND
TOWER_2	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_2	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_2	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND
TOWER_2	0.000	0.00	0.800	24.00	0.800	24.00	UNDERGRND

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION TRUTH OR CONSEQU, N
REPORT- LV-D DETAILS OF EXTERIOR SURFACES IN THE PROJECT

	AVERAGE U-VALUE/GLASS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+GLASS (BTU/HR-SQFT-F)	GLASS AREA (SQFT)	OPAQUE AREA (SQFT)	GLASS+OPAQUE AREA (SQFT)
NORTH-EAST	0.000	0.067	0.067	0.00	3447.84	3447.84
SOUTH-EAST	0.000	0.067	0.067	0.00	2944.00	2944.00
SOUTH-WEST	0.000	0.067	0.067	0.00	2777.84	2777.84
NORTH-WEST	0.000	0.067	0.067	0.00	2944.00	2944.00
ROOF	0.000	0.052	0.052	0.00	11043.26	11043.26
ALL WALLS	0.000	0.067	0.067	0.00	12113.68	12113.68
WALLS+ROOFS	0.000	0.060	0.060	0.00	23156.94	23156.94
UNDERGRND	0.000	0.800	0.800	0.00	633.20	633.20
BUILDING	0.000	0.080	0.080	0.00	23790.14	23790.14

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION TRUTH OR CONSEQU, N
REPORT- LV-F DETAILS OF INTERIOR SURFACES IN THE PROJECT

NUMBER OF INTERIOR SURFACES 24
(U-VALUE INCLUDES BOTH AIR FILMS)

SURFACE NAME	AREA (SQFT)	CONSTRUCTION NAME	SURFACE TYPE	U-VALUE (BTU/HR-SQFT-F)	ADJACENT SPACES SPACE-1	SPACE-2
	147.20	INTWALL	DELAYED STANDARD	0.326	CONFERENCE	HALLS
	152.00	INTWALL	DELAYED STANDARD	0.326	CONFERENCE	HALLS
	147.20	INTWALL	DELAYED STANDARD	0.326	CONFERENCE	COMPUTERRM
	152.00	INTWALL	DELAYED STANDARD	0.326	CONFERENCE	COMPUTERRM
	536.40	INTWALL	DELAYED STANDARD	0.326	COMPUTERRM	HALLS
	365.40	INTWALL	DELAYED STANDARD	0.326	COMPUTERRM	HALLS
	443.70	INTWALL	DELAYED STANDARD	0.326	COMPUTERRM	HALLS
	164.70	INTWALL	DELAYED STANDARD	0.326	COMPUTERRM	CONFERENCE
	171.00	INTWALL	DELAYED STANDARD	0.326	COMPUTERRM	CONFERENCE
	99.36	INTWALL	DELAYED STANDARD	0.326	CONFPLENUM	COMPRMPLN
	102.60	INTWALL	DELAYED STANDARD	0.326	CONFPLENUM	COMPRMPLN
	99.36	INTWALL	DELAYED STANDARD	0.326	CONFPLENUM	HALLPLENUM
	102.60	INTWALL	DELAYED STANDARD	0.326	CONFPLENUM	HALLPLENUM
	349.60	CEILING	DELAYED STANDARD	0.279	CONFPLENUM	CONFERENCE
	262.24	INTWALL	DELAYED STANDARD	0.326	COMPRMPLN	HALLPLENUM
	178.64	INTWALL	DELAYED STANDARD	0.326	COMPRMPLN	HALLPLENUM
	216.92	INTWALL	DELAYED STANDARD	0.326	COMPRMPLN	HALLPLENUM
	80.52	INTWALL	DELAYED STANDARD	0.326	COMPRMPLN	CONFPLENUM
	83.60	INTWALL	DELAYED STANDARD	0.326	COMPRMPLN	CONFPLENUM
	2938.28	CEILING	DELAYED STANDARD	0.279	COMPRMPLN	COMPUTERRM
	742.98	CEILING	DELAYED STANDARD	0.279	COMPRMPLN	COMPUTERRM
	2000.00	CEILING	DELAYED STANDARD	0.279	HALLPLENUM	HALLS
	1284.40	CEILING	DELAYED STANDARD	0.279	HALLPLENUM	HALLS
	2000.00	CEILING	DELAYED STANDARD	0.279	HALLPLENUM	HALLS

NUMBER OF SCHEDULES 9 (NON DIMENSIONLESS SCHEDULES ARE GIVEN IN ENGLISH UNITS)

SCHEDULE y_lights

THROUGH 31 12

FOR DAYS SUN SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.40	0.40	0.40	0.40	0.40	0.40	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40

FOR DAYS MON TUE WED THU FRI

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.75	0.75	0.75	0.75	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75

SCHEDULE A_OCCUP

THROUGH 31 12

FOR DAYS SUN SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.25	0.25	0.25	0.25	0.25	0.25	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

FOR DAYS MON TUE WED THU FRI

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.25	0.25	0.25	0.25	0.25	0.50	1.00	1.00	1.00	1.00	0.75	0.75	0.75	1.00	1.00	1.00	0.50	0.25	0.25	0.25	0.25	0.25	0.25	0.25

SCHEDULE Y_EQUIP

THROUGH 31 12

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- LV-G DETAILS OF SCHEDULES OCCURRING IN THE PROJECT TRUTH OR CONSEQU, N

FOR DAYS SUN SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.60	0.60	0.60	0.60	0.60	0.60	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60

FOR DAYS MON TUE WED THU FRI

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.50	0.50	0.50	0.50	0.50	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.50	0.50	0.50	0.50	0.50	0.50	0.50

SCHEDULE OCCUCONFRM

THROUGH 31 12

FOR DAYS SUN MON TUE WED THU FRI SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SCHEDULE T_LIGHTS

THROUGH 31 12

FOR DAYS SUN MON TUE WED THU FRI SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SCHEDULE TOWEREQUIP

THROUGH 31 12

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- LV-G DETAILS OF SCHEDULES OCCURRING IN THE PROJECT TRUTH OR CONSEQU, N

FOR DAYS SUN MON TUE WED THU FRI SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

SCHEDULE equipcomp

THROUGH 31 12

FOR DAYS SUN MON TUE WED THU FRI SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

SCHEDULE L-hrly_rps

THROUGH 12 3

FOR DAYS SUN MON TUE WED THU FRI SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

THROUGH 13 3

FOR DAYS SUN MON TUE WED THU FRI SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

THROUGH 7 9

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EMC      ENGINEERS      INC.       EZDOE - ELITE SOFTWARE DEVELOPMENT INC       DOE-2.1D   8/ 7/1995    15: 8:11  LDL RUN 1
DENVER,     CO          80227      GEODSS SITE DOE EVALUATION
REPORT- LV-G  DETAILS OF SCHEDULES OCCURRING IN THE PROJECT                     TRUTH OR CONSEQU, N

         FOR DAYS  SUN MON TUE WED THU FRI SAT HOL
      HOUR  1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24
          0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00

      THROUGH  8  9

         FOR DAYS  SUN MON TUE WED THU FRI SAT HOL
      HOUR  1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24
          1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00

      THROUGH 31 12

         FOR DAYS  SUN MON TUE WED THU FRI SAT HOL
      HOUR  1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24
          0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00

   SCHEDULE  towerinfil

      THROUGH  1  4

         FOR DAYS  SUN MON TUE WED THU FRI SAT HOL
      HOUR  1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24
          5.00 5.00 5.00 5.00 5.00 5.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 5.00 5.00 5.00 5.00 5.00 5.00 5.00

      THROUGH  1 11

         FOR DAYS  SUN MON TUE WED THU FRI SAT HOL
      HOUR  1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24
          1.00 1.00 1.00 1.00 1.00 1.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 1.00 1.00 1.00 1.00 1.00 1.00

      THROUGH 31 12
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EMC      ENGINEERS      INC.       EZDOE - ELITE SOFTWARE DEVELOPMENT INC       DOE-2.1D   8/ 7/1995    15: 8:11  LDL RUN 1
DENVER,     CO          80227      GEODSS SITE DOE EVALUATION
REPORT- LV-G  DETAILS OF SCHEDULES OCCURRING IN THE PROJECT                     TRUTH OR CONSEQU, N

         FOR DAYS  SUN MON TUE WED THU FRI SAT HOL
      HOUR  1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24
          5.00 5.00 5.00 5.00 5.00 5.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 5.00 5.00 5.00 5.00 5.00 5.00 5.00
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EMC      ENGINEERS      INC.       EZDOE - ELITE SOFTWARE DEVELOPMENT INC       DOE-2.1D   8/ 7/1995    15: 8:11  LDL RUN 1
DENVER,     CO          80227      GEODSS SITE DOE EVALUATION
REPORT- LV-I  DETAILS OF CONSTRUCTIONS OCCURRING IN THE PROJECT                 TRUTH OR CONSEQU, N
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NUMBER OF CONSTRUCTIONS 10 DELAYED 7 QUICK 3

CONSTRUCTION NAME	U-VALUE (BTU/HR-SQFT-F)	SURFACE ABSORPTANCE	SURFACE ROUGHNESS INDEX	SURFACE TYPE	NUMBER OF RESPONSE FACTORS
REGROOF	0.054	0.60	3	DELAYED	5
TOWERWAL	0.069	0.65	3	DELAYED	15
FLOOR	0.800	0.70	3	QUICK	0
TOWEROOF	0.048	0.40	3	QUICK	0
CEILING	0.279	0.70	3	DELAYED	4
TOWCEIL	0.045	0.70	3	DELAYED	5
REGWALL	0.067	0.65	3	DELAYED	19
COMPWAL	0.067	0.70	3	DELAYED	19
FLOORCOM	0.800	0.70	3	QUICK	0
INTWALL	0.326	0.70	3	DELAYED	9

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EMC      ENGINEERS      INC.       EZDOE - ELITE SOFTWARE DEVELOPMENT INC       DOE-2.1D   8/ 7/1995    15: 8:11  LDL RUN 1
DENVER,     CO          80227      GEODSS SITE DOE EVALUATION
REPORT- LS-A SPACE PEAK LOADS SUMMARY                                           TRUTH OR CONSEQU, N
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SPACE NAME	MULTIPLIER SPACE	MULTIPLIER FLOOR	COOLING LOAD (KBTU/HR)	TIME OF PEAK	DRY-BULB	WET-BULB	HEATING LOAD (KBTU/HR)	TIME OF PEAK	DRY-BULB	WET-BULB
CONFERENCE	1.	1.	2.252	APR 3 12 NOON	60.F	45.F	0.000		0.F	0.F
HALLS	1.	1.	37.671	AUG 1 4 PM	97.F	65.F	-1.752	JAN 16 2 PM	43.F	31.F
TOWER_1	1.	1.	14.370	JUL 31 7 PM	96.F	60.F	-116.665	JAN 10 9 PM	4.F	2.F
TOWER_3	1.	1.	14.370	JUL 31 7 PM	96.F	60.F	-116.665	JAN 10 9 PM	4.F	2.F
COMPUTERRM	1.	1.	81.185	AUG 1 11 PM	83.F	64.F	0.000		0.F	0.F
CONFPLENUM	1.	1.	1.359	JUL 13 3 PM	86.F	61.F	-1.518	JAN 11 8 AM	-3.F	-4.F
COMPRMPLN	1.	1.	17.198	JUL 13 3 PM	86.F	61.F	-14.123	JAN 11 8 AM	-3.F	-4.F
HALLPLENUM	1.	1.	25.015	JUL 13 4 PM	87.F	61.F	-25.730	JAN 11 8 AM	-3.F	-4.F
TOWER_2	1.	1.	14.370	JUL 31 7 PM	96.F	60.F	-116.665	JAN 10 9 PM	4.F	2.F
			---------				---------			
SUM			207.788				-393.119			
BUILDING PEAK			147.375	AUG 1 7 PM	94.F	65.F	-349.994	JAN 10 9 PM	4.F	2.F

SPACE CONFERENCE

MULTIPLIER 1.0 FLOOR MULTIPLIER 1.0
FLOOR AREA 348 SQFT 32 M2
VOLUME 2786 CUFT 79 M3

COOLING LOAD / HEATING LOAD

TIME APR 3 12NOON
DRY-BULB TEMP 60F 16C
WET-BULB TEMP 45F 7C

	COOLING SENSIBLE (KBTU/H)	COOLING SENSIBLE (KW)	COOLING LATENT (KBTU/H)	COOLING LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)	
WALLS	0.000	0.000	0.000	0.000	0.000	0.000	
ROOFS	0.000	0.000	0.000	0.000	0.000	0.000	
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000	
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000	
DOOR	0.000	0.000	0.000	0.000	0.000	0.000	
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000	
UNDERGROUND SURFACES	0.000	0.000	0.000	0.000	0.000	0.000	
OCCUPANTS TO SPACE	0.170	0.050	0.082	0.024	0.000	0.000	
LIGHT TO SPACE	0.851	0.249	0.000	0.000	0.000	0.000	
EQUIPMENT TO SPACE	1.230	0.360	0.000	0.000	0.000	0.000	
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000	
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000	
TOTAL	2.252	0.659	0.082	0.024	0.000	0.000	
TOTAL LOAD	2.334 KBTU/H		0.683	KW	0.000 KBTU/H	0.000	KW
TOTAL LOAD / AREA	6.71BTU/H.SQFT		21.139	W / M2	0.000BTU/H.SQFT	0.000	W / M2

NOTE 1) THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
2) TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION

SPACE HALLS

MULTIPLIER 1.0 FLOOR MULTIPLIER 1.0
FLOOR AREA 5286 SQFT 491 M2
VOLUME 42284 CUFT 1197 M3

COOLING LOAD / HEATING LOAD

TIME AUG 1 4PM / JAN 16 2PM
DRY-BULB TEMP 97F 36C / 43F 6C
WET-BULB TEMP 65F 18C / 31F -1C

	COOLING SENSIBLE (KBTU/H)	COOLING SENSIBLE (KW)	COOLING LATENT (KBTU/H)	COOLING LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)	
WALLS	2.680	0.785	0.000	0.000	-6.538	-1.915	
ROOFS	0.000	0.000	0.000	0.000	0.000	0.000	
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000	
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000	
DOOR	0.000	0.000	0.000	0.000	0.000	0.000	
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000	
UNDERGROUND SURFACES	-0.048	-0.014	0.000	0.000	-4.146	-1.214	
OCCUPANTS TO SPACE	0.864	0.253	0.328	0.096	0.144	0.042	
LIGHT TO SPACE	16.674	4.883	0.000	0.000	3.534	1.035	
EQUIPMENT TO SPACE	17.500	5.125	0.000	0.000	5.253	1.539	
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000	
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000	
TOTAL	37.671	11.033	0.328	0.096	-1.752	-0.513	
TOTAL LOAD	37.998 KBTU/H		11.129	KW	-1.752 KBTU/H	-0.513	KW
TOTAL LOAD / AREA	7.19BTU/H.SQFT		22.664	W / M2	0.332BTU/H.SQFT	1.045	W / M2

NOTE 1) THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
2) TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- LS-B SPACE PEAK LOAD COMPONENTS TOWER_1 TRUTH OR CONSEQU, N

SPACE TOWER_1

MULTIPLIER	1.0		FLOOR MULTIPLIER	1.0	
FLOOR AREA	576	SQFT	54	M2	
VOLUME	14976	CUFT	424	M3	

	COOLING LOAD		HEATING LOAD	
TIME	JUL 31	7PM	JAN 10	9PM
DRY-BULB TEMP	96F	36C	4F	-16C
WET-BULB TEMP	60F	16C	2F	-17C

	COOLING SENSIBLE (KBTU/H)	COOLING SENSIBLE (KW)	COOLING LATENT (KBTU/H)	COOLING LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)
WALLS	2.592	0.759	0.000	0.000	-8.386	-2.456
ROOFS	0.733	0.215	0.000	0.000	-1.845	-0.540
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	-0.258	-0.076	0.000	0.000	-1.434	-0.420
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.422	0.124	0.000	0.000	0.319	0.094
EQUIPMENT TO SPACE	3.923	1.149	0.000	0.000	4.062	1.190
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	6.958	2.038	0.000	0.000	-109.381	-32.035
TOTAL	14.370	4.208	0.000	0.000	-116.665	-34.168
TOTAL LOAD	14.370 KBTU/H	4.208 KW			-116.665 KBTU/H	-34.168 KW
TOTAL LOAD / AREA	24.95BTU/H.SQFT	78.645 W / M2			202.543BTU/H.SQFT	638.513 W / M2

NOTE 1) THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
---- 2) TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- LS-B SPACE PEAK LOAD COMPONENTS TOWER_3 TRUTH OR CONSEQU, N

SPACE TOWER_3

MULTIPLIER	1.0		FLOOR MULTIPLIER	1.0	
FLOOR AREA	576	SQFT	54	M2	
VOLUME	14976	CUFT	424	M3	

	COOLING LOAD		HEATING LOAD	
TIME	JUL 31	7PM	JAN 10	9PM
DRY-BULB TEMP	96F	36C	4F	-16C
WET-BULB TEMP	60F	16C	2F	-17C

	COOLING SENSIBLE (KBTU/H)	COOLING SENSIBLE (KW)	COOLING LATENT (KBTU/H)	COOLING LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)
WALLS	2.592	0.759	0.000	0.000	-8.386	-2.456
ROOFS	0.733	0.215	0.000	0.000	-1.845	-0.540
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	-0.258	-0.076	0.000	0.000	-1.434	-0.420
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.422	0.124	0.000	0.000	0.319	0.094
EQUIPMENT TO SPACE	3.923	1.149	0.000	0.000	4.062	1.190
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	6.958	2.038	0.000	0.000	-109.381	-32.035
TOTAL	14.370	4.208	0.000	0.000	-116.665	-34.168
TOTAL LOAD	14.370 KBTU/H	4.208 KW			-116.665 KBTU/H	-34.168 KW
TOTAL LOAD / AREA	24.95BTU/H.SQFT	78.645 W / M2			202.543BTU/H.SQFT	638.513 W / M2

NOTE 1) THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
---- 2) TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION

SPACE COMPUTERRM

MULTIPLIER 1.0 FLOOR MULTIPLIER 1.0
FLOOR AREA 4037 SQFT 375 M2
VOLUME 36337 CUFT 1029 M3

	COOLING LOAD				HEATING LOAD	
TIME	AUG 1 11PM					
DRY-BULB TEMP	83F	28C				
WET-BULB TEMP	64F	18C				
	SENSIBLE		LATENT		SENSIBLE	
	(KBTU/H)	(KW)	(KBTU/H)	(KW)	(KBTU/H)	(KW)
WALLS	1.043	0.306	0.000	0.000	0.000	0.000
ROOFS	0.000	0.000	0.000	0.000	0.000	0.000
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	-0.007	-0.002	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.946	0.277	0.328	0.096	0.000	0.000
LIGHT TO SPACE	12.887	3.774	0.000	0.000	0.000	0.000
EQUIPMENT TO SPACE	66.315	19.422	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	81.185	23.777	0.328	0.096	0.000	0.000
TOTAL LOAD	81.513 KBTU/H		23.873	KW	0.000 KBTU/H	0.000 KW
TOTAL LOAD / AREA	20.19BTU/H.SQFT		63.647	W / M2	0.000BTU/H.SQFT	0.000 W / M2

NOTE 1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR
---- LOADS
2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION
IN CONSIDERATION

SPACE CONFPLENUM

MULTIPLIER 1.0 FLOOR MULTIPLIER 1.0
FLOOR AREA 348 SQFT 32 M2
VOLUME 1879 CUFT 53 M3

	COOLING LOAD				HEATING LOAD	
TIME	JUL 13 3PM				JAN 11 8AM	
DRY-BULB TEMP	86F	30C			-3F	-19C
WET-BULB TEMP	61F	16C			-4F	-20C
	SENSIBLE		LATENT		SENSIBLE	
	(KBTU/H)	(KW)	(KBTU/H)	(KW)	(KBTU/H)	(KW)
WALLS	0.000	0.000	0.000	0.000	0.000	0.000
ROOFS	1.328	0.389	0.000	0.000	-1.521	-0.445
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.030	0.009	0.000	0.000	0.003	0.001
EQUIPMENT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	1.359	0.398	0.000	0.000	-1.518	-0.445
TOTAL LOAD	1.359 KBTU/H		0.398	KW	-1.518 KBTU/H	-0.445 KW
TOTAL LOAD / AREA	3.90BTU/H.SQFT		12.309	W / M2	4.363BTU/H.SQFT	13.754 W / M2

NOTE 1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR
---- LOADS
2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION
IN CONSIDERATION

SPACE COMPRMPLN

MULTIPLIER	1.0		FLOOR MULTIPLIER	1.0
FLOOR AREA	4037 SQFT	375 M2		
VOLUME	17765 CUFT	503 M3		

	COOLING LOAD		HEATING LOAD	
TIME	JUL 13 3PM		JAN 11 8AM	
DRY-BULB TEMP	86F	30C	-3F	-19C
WET-BULB TEMP	61F	16C	-4F	-20C

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)
WALLS	-0.011	-0.003	0.000	0.000	-1.328	-0.389
ROOFS	13.987	4.096	0.000	0.000	-16.017	-4.691
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	3.222	0.944	0.000	0.000	3.222	0.944
EQUIPMENT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	17.198	5.037	0.000	0.000	-14.123	-4.136
TOTAL LOAD	17.198 KBTU/H		5.037 KW		-14.123 KBTU/H	-4.136 KW
TOTAL LOAD / AREA	4.26BTU/H.SQFT		13.429 W / M2		3.498BTU/H.SQFT	11.028 W / M2

NOTE 1) THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
---- 2) TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION

SPACE HALLPLENUM

MULTIPLIER	1.0		FLOOR MULTIPLIER	1.0
FLOOR AREA	5286 SQFT	491 M2		
VOLUME	28542 CUFT	808 M3		

	COOLING LOAD		HEATING LOAD	
TIME	JUL 13 4PM		JAN 11 8AM	
DRY-BULB TEMP	87F	31C	-3F	-19C
WET-BULB TEMP	61F	16C	-4F	-20C

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)
WALLS	0.759	0.222	0.000	0.000	-6.758	-1.979
ROOFS	19.951	5.843	0.000	0.000	-22.992	-6.734
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	4.304	1.261	0.000	0.000	4.020	1.177
EQUIPMENT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	25.015	7.326	0.000	0.000	-25.730	-7.536
TOTAL LOAD	25.015 KBTU/H		7.326 KW		-25.730 KBTU/H	-7.536 KW
TOTAL LOAD / AREA	4.73BTU/H.SQFT		14.920 W / M2		4.868BTU/H.SQFT	15.347 W / M2

NOTE 1) THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
---- 2) TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION

SPACE TOWER_2

MULTIPLIER 1.0 FLOOR MULTIPLIER 1.0
FLOOR AREA 576 SQFT 54 M2
VOLUME 14976 CUFT 424 M3

	COOLING LOAD				HEATING LOAD	
TIME	JUL 31 7PM				JAN 10 9PM	
DRY-BULB TEMP	96F	36C			4F	-16C
WET-BULB TEMP	60F	16C			2F	-17C
	SENSIBLE		LATENT		SENSIBLE	
	(KBTU/H)	(KW)	(KBTU/H)	(KW)	(KBTU/H)	(KW)
WALLS	2.592	0.759	0.000	0.000	-8.386	-2.456
ROOFS	0.733	0.215	0.000	0.000	-1.845	-0.540
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	-0.258	-0.076	0.000	0.000	-1.434	-0.420
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.422	0.124	0.000	0.000	0.319	0.094
EQUIPMENT TO SPACE	3.923	1.149	0.000	0.000	4.062	1.190
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	6.958	2.038	0.000	0.000	-109.381	-32.035
TOTAL	14.370	4.208	0.000	0.000	-116.665	-34.168
TOTAL LOAD	14.370 KBTU/H		4.208 KW		-116.665 KBTU/H	-34.168 KW
TOTAL LOAD / AREA	24.95BTU/H.SQFT		78.645 W / M2		202.543BTU/H.SQFT	638.513 W / M2

NOTE 1) THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
---- 2) TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION

*** BUILDING ***

FLOOR AREA 11399 SQFT 1059 SQMT
VOLUME 126335 CUFT 3578 CUMT

	COOLING LOAD				HEATING LOAD	
TIME	AUG 1 7PM				JAN 10 9PM	
DRY-BULB TEMP	94F	34C			4F	-16C
WET-BULB TEMP	65F	18C			2F	-17C
	SENSIBLE		LATENT		SENSIBLE	
	(KBTU/H)	(KW)	(KBTU/H)	(KW)	(KBTU/H)	(KW)
WALLS	12.638	3.701	0.000	0.000	-25.157	-7.368
ROOFS	2.142	0.627	0.000	0.000	-5.536	-1.621
GLASS CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACES	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURFACES	-0.083	-0.024	0.000	0.000	-4.301	-1.260
OCCUPANTS TO SPACE	1.316	0.385	0.410	0.120	0.000	0.000
LIGHT TO SPACE	28.405	8.319	0.000	0.000	0.958	0.281
EQUIPMENT TO SPACE	89.138	26.106	0.000	0.000	12.186	3.569
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	13.819	4.047	0.000	0.000	-328.143	-96.105
TOTAL	147.375	43.163	0.410	0.120	-349.994	-102.505
TOTAL LOAD	147.785 KBTU/H		43.282 KW		-349.994 KBTU/H	-102.505 KW
TOTAL LOAD / AREA	12.96BTU/H.SQFT		40.871 W /SQMT		30.704BTU/H.SQFT	96.795 W /SQMT

NOTE 1) THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
---- 2) TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- LS-D BUILDING MONTHLY LOADS SUMMARY TRUTH OR CONSEQU, N

	- - - - - - - - - C O O L I N G - - - - - - - - -						- - - - - - - - - H E A T I N G - - - - - - - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	69.37014	21	12	56.F	38.F	107.628	-35.625	10	21	4.F	2.F	-349.994	37827.	59.443
FEB	63.04140	18	12	62.F	45.F	107.796	-36.330	3	22	31.F	25.F	-292.306	34170.	59.443
MAR	71.42878	9	15	78.F	56.F	116.264	-34.220	2	5	30.F	26.F	-255.733	38070.	59.443
APR	71.72991	22	16	89.F	53.F	122.174	-3.298	1	23	60.F	43.F	-25.152	36689.	59.443
MAY	78.91193	9	18	86.F	52.F	130.740	-0.771	2	3	37.F	24.F	-18.115	37827.	59.443
JUN	86.18958	23	18	84.F	58.F	147.152	-0.002	1	10	83.F	52.F	-0.540	36811.	59.443
JUL	90.58653	28	18	91.F	65.F	143.785	0.000					0.000	37705.	59.443
AUG	91.05647	1	18	94.F	65.F	147.375	0.000					0.000	38070.	59.443
SEP	85.07023	1	18	85.F	61.F	137.977	0.000					0.000	36689.	59.443
OCT	77.88515	6	16	80.F	51.F	126.112	-2.154	15	24	43.F	39.F	-36.774	37705.	59.443
NOV	70.93912	10	15	68.F	47.F	114.183	-15.763	19	5	34.F	28.F	-127.152	36567.	59.443
DEC	70.90217	9	12	52.F	40.F	108.745	-29.420	30	23	29.F	24.F	-197.853	37827.	59.443
TOTAL	927.111						-157.582						445954.	
MAX						147.375						-349.994		59.443

HOURLY DATA FILE 1FROM PROG 1

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
glob_hrly = HOURLY-REPORT TRUTH OR CONSEQU, N

MMDDHH	GLOBAL DRY BULB ABS TEMP R ----(24)	GLOBAL WIND SPEED KNOTS ----(17)
313 1	487.0	10.0
313 2	487.0	9.0
313 3	485.0	10.0
313 4	484.0	9.0
313 5	484.0	13.0
313 6	486.0	13.0
313 7	487.0	7.0
313 8	490.0	9.0
313 9	493.0	12.0
31310	497.0	9.0
31311	502.0	9.0
31312	503.0	7.0
31313	506.0	9.0
31314	507.0	9.0
31315	507.0	9.0
31316	507.0	9.0
31317	506.0	4.0
31318	502.0	4.0
31319	499.0	3.0
31320	497.0	9.0
31321	495.0	4.0
31322	493.0	3.0
31323	492.0	5.0
31324	490.0	0.0
DAILY SUMMARY (MAR 13)		
MN	484.0	0.0
MX	507.0	13.0
SM	11886.0	185.0
AV	495.3	7.7
MONTHLY SUMMARY (MAR)		
MN	484.0	0.0
MX	507.0	13.0
SM	11886.0	185.0
AV	495.3	7.7

EMC ENGINEERS INC. DENVER, CO 80227	EZDOE - ELITE SOFTWARE DEVELOPMENT INC GEODSS SITE DOE EVALUATION	DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1 TRUTH OR CONSEQU, N
glob_hrly - HOURLY-REPORT		

	GLOBAL DRY BULB ABS TEMP R ----(24)	GLOBAL WIND SPEED KNOTS ----(17)
9 8 1	531.0	8.0
9 8 2	530.0	8.0
9 8 3	529.0	5.0
9 8 4	526.0	0.0
9 8 5	524.0	5.0
9 8 6	524.0	0.0
9 8 7	528.0	0.0
9 8 8	533.0	4.0
9 8 9	537.0	0.0
9 810	541.0	0.0
9 811	542.0	0.0
9 812	547.0	0.0
9 813	546.0	8.0
9 814	549.0	6.0
9 815	547.0	6.0
9 816	547.0	0.0
9 817	542.0	18.0
9 818	537.0	10.0
9 819	537.0	10.0
9 820	536.0	5.0
9 821	534.0	5.0
9 822	532.0	4.0
9 823	531.0	4.0
9 824	530.0	4.0
DAILY SUMMARY (SEP 8)		
MN	524.0	0.0
MX	549.0	18.0
SM	12860.0	110.0
AV	535.8	4.6
MONTHLY SUMMARY (SEP)		
MN	524.0	0.0
MX	549.0	18.0
SM	12860.0	110.0
AV	535.8	4.6
YEARLY SUMMARY		
MN	484.0	0.0
MX	549.0	18.0
SM	24746.0	295.0
AV	515.5	6.1

EMC ENGINEERS INC. DENVER, CO 80227	EZDOE - ELITE SOFTWARE DEVELOPMENT INC GEODSS SITE DOE EVALUATION	DOE-2.1D 8/ 7/1995 15: 8:11 LDL RUN 1 TRUTH OR CONSEQU, N
dup_glob_b - HOURLY-REPORT		

MMDDHH	GLOBAL DRY BULB ABS TEMP R ----(24)	GLOBAL WIND SPEED KNOTS ----(17)
313 1	487.0	10.0
313 2	487.0	9.0
313 3	485.0	10.0
313 4	484.0	9.0
313 5	484.0	13.0
313 6	486.0	13.0
313 7	487.0	7.0
313 8	490.0	9.0
313 9	493.0	12.0
31310	497.0	9.0
31311	502.0	9.0
31312	503.0	7.0
31313	506.0	9.0
31314	507.0	9.0
31315	507.0	9.0
31316	507.0	9.0
31317	506.0	4.0
31318	502.0	4.0
31319	499.0	3.0
31320	497.0	9.0
31321	495.0	4.0
31322	493.0	3.0
31323	492.0	5.0
31324	490.0	0.0
DAILY SUMMARY (MAR 13)		
MN	484.0	0.0
MX	507.0	13.0
SM	11886.0	185.0
AV	495.3	7.7
MONTHLY SUMMARY (MAR)		
MN	484.0	0.0
MX	507.0	13.0
SM	11886.0	185.0
AV	495.3	7.7

	GLOBAL DRY BULB ABS TEMP R ----(24)	GLOBAL WIND SPEED KNOTS ----(17)
9 8 1	531.0	8.0
9 8 2	530.0	8.0
9 8 3	529.0	5.0
9 8 4	526.0	0.0
9 8 5	524.0	5.0
9 8 6	524.0	0.0
9 8 7	528.0	0.0
9 8 8	533.0	4.0
9 8 9	537.0	0.0
9 810	541.0	0.0
9 811	542.0	0.0
9 812	547.0	0.0
9 813	546.0	8.0
9 814	549.0	6.0
9 815	547.0	6.0
9 816	547.0	0.0
9 817	542.0	18.0
9 818	537.0	10.0
9 819	537.0	10.0
9 820	536.0	5.0
9 821	534.0	5.0
9 822	532.0	4.0
9 823	531.0	4.0
9 824	530.0	4.0
DAILY SUMMARY (SEP 8)		
MN	524.0	0.0
MX	549.0	18.0
SM	12860.0	110.0
AV	535.8	4.6
MONTHLY SUMMARY (SEP)		
MN	524.0	0.0
MX	549.0	18.0
SM	12860.0	110.0
AV	535.8	4.6
YEARLY SUMMARY		
MN	484.0	0.0
MX	549.0	18.0
SM	24746.0	295.0
AV	515.5	6.1

MESSAGE LIST FROM SYSTEMS PROGRAM

```
**WARNING***************************************************************
     IN 1TOWER          THE RETURN HUMIDITY FOR A COIL EXIT T =  53.7 IS 0.0090
      BUT YOUR SETPOINT IS 0.0009 WHICH MAY NOT BE HELD.
**WARNING***************************************************************
       SYSTEM 1TOWER           MAY HAVE INADEQUATE COOLING CAPABILITY
       (CHECK COOLING-CAPACITY AND MIN-SUPPLY-T FOR CONSISTENCY)
**WARNING***************************************************************
     SYSTEM CRUINT          HAS ZERO OUTSIDE AIR FOR DESIGN CALCULATION
**WARNING***************************************************************
     IN 2TOWER          THE RETURN HUMIDITY FOR A COIL EXIT T =  53.7 IS 0.0090
      BUT YOUR SETPOINT IS 0.0009 WHICH MAY NOT BE HELD.
**WARNING***************************************************************
       SYSTEM 2TOWER           MAY HAVE INADEQUATE COOLING CAPABILITY
       (CHECK COOLING-CAPACITY AND MIN-SUPPLY-T FOR CONSISTENCY)
**WARNING***************************************************************
     IN 3TOWER          THE RETURN HUMIDITY FOR A COIL EXIT T =  53.7 IS 0.0090
      BUT YOUR SETPOINT IS 0.0009 WHICH MAY NOT BE HELD.
**WARNING***************************************************************
       SYSTEM 3TOWER           MAY HAVE INADEQUATE COOLING CAPABILITY
       (CHECK COOLING-CAPACITY AND MIN-SUPPLY-T FOR CONSISTENCY)
**WARNING***************************************************************
       SYSTEM REGAHU           MAY HAVE INADEQUATE COOLING CAPABILITY
       (CHECK COOLING-CAPACITY AND MIN-SUPPLY-T FOR CONSISTENCY)
**WARNING***************************************************************
     SYSTEM CONFRMAHU       HAS ZERO OUTSIDE AIR FOR DESIGN CALCULATION
**WARNING***************************************************************
       SYSTEM CONFRMAHU        MAY HAVE INADEQUATE COOLING CAPABILITY
       (CHECK COOLING-CAPACITY AND MIN-SUPPLY-T FOR CONSISTENCY)
```


SYSTEM NAME	ALTITUDE MULTIPLIER
1TOWER	1.200

SUPPLY FAN (CFM)	ELEC (KW)	DELTA-T (F)	RETURN FAN (CFM)	ELEC (KW)	DELTA-T (F)	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)
2400.	0.815	1.3	0.	0.000	0.0	1.000	40.000	1.000	-166.707	0.00	0.00

ZONE NAME	SUPPLY FLOW	EXHAUST FLOW	FAN (KW)	MINIMUM FLOW RATIO	OUTSIDE AIR FLOW	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	EXTRACTION RATE (KBTU/HR)	HEATING CAPACITY (KBTU/HR)	ADDITION RATE (KBTU/HR)	MULTIPLIER
TOWER_1	2400.	2400.	0.000	1.000	2400.	0.00	0.00	-0.33	-168.48	-134.78	1.0

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SV-A SYSTEM DESIGN PARAMETERS CRUINT TRUTH OR CONSEQU, N

SYSTEM NAME	ALTITUDE MULTIPLIER
CRUINT	1.200

SUPPLY FAN (CFM)	ELEC (KW)	DELTA-T (F)	RETURN FAN (CFM)	ELEC (KW)	DELTA-T (F)	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)
43200.	8.803	0.8	43200.	0.000	0.0	0.000	978.600	0.857	-345.300	0.00	0.00

ZONE NAME	SUPPLY FLOW	EXHAUST FLOW	FAN (KW)	MINIMUM FLOW RATIO	OUTSIDE AIR FLOW	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	EXTRACTION RATE (KBTU/HR)	HEATING CAPACITY (KBTU/HR)	ADDITION RATE (KBTU/HR)	MULTIPLIER
COMPUTERRM	43200.	0.	0.000	1.000	0.	0.00	0.00	387.05	-2529.79	-155.68	1.0
COMPRMPLN	0.	0.	0.000	0.000	0.	0.00	0.00	0.00	0.00	0.00	1.0

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SV-A SYSTEM DESIGN PARAMETERS 2TOWER TRUTH OR CONSEQU, N

SYSTEM NAME	ALTITUDE MULTIPLIER
2TOWER	1.200

SUPPLY FAN (CFM)	ELEC (KW)	DELTA-T (F)	RETURN FAN (CFM)	ELEC (KW)	DELTA-T (F)	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)
2400.	0.815	1.3	0.	0.000	0.0	1.000	40.000	1.000	-166.707	0.00	0.00

ZONE NAME	SUPPLY FLOW	EXHAUST FLOW	FAN (KW)	MINIMUM FLOW RATIO	OUTSIDE AIR FLOW	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	EXTRACTION RATE (KBTU/HR)	HEATING CAPACITY (KBTU/HR)	ADDITION RATE (KBTU/HR)	MULTIPLIER
TOWER_2	2400.	2400.	0.000	1.000	2400.	0.00	0.00	-0.33	-168.48	-134.78	1.0

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SV-A SYSTEM DESIGN PARAMETERS 3TOWER TRUTH OR CONSEQU, N

SYSTEM NAME	ALTITUDE MULTIPLIER
3TOWER	1.200

SUPPLY FAN (CFM)	ELEC (KW)	DELTA-T (F)	RETURN FAN (CFM)	ELEC (KW)	DELTA-T (F)	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)
2400.	0.815	1.3	0.	0.000	0.0	1.000	40.000	1.000	-166.707	0.00	0.00

ZONE NAME	SUPPLY FLOW	EXHAUST FLOW	FAN (KW)	MINIMUM FLOW RATIO	OUTSIDE AIR FLOW	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	EXTRACTION RATE (KBTU/HR)	HEATING CAPACITY (KBTU/HR)	ADDITION RATE (KBTU/HR)	MULTIPLIER
TOWER_3	2400.	2400.	0.000	1.000	2400.	0.00	0.00	-0.33	-168.48	-134.78	1.0

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SV-A SYSTEM DESIGN PARAMETERS REGAHU TRUTH OR CONSEQU, N

SYSTEM NAME	ALTITUDE MULTIPLIER
REGAHU	1.200

SUPPLY FAN (CFM)	ELEC (KW)	DELTA-T (F)	RETURN FAN (CFM)	ELEC (KW)	DELTA-T (F)	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)
5724.	2.333	1.5	4228.	0.000	0.0	0.261	113.658	0.899	-76.817	0.00	0.00

ZONE NAME	SUPPLY FLOW	EXHAUST FLOW	FAN (KW)	MINIMUM FLOW RATIO	OUTSIDE AIR FLOW	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	EXTRACTION RATE (KBTU/HR)	HEATING CAPACITY (KBTU/HR)	ADDITION RATE (KBTU/HR)	MULTIPLIER
HALLS	5724.	1496.	0.000	1.000	1496.	0.00	0.00	49.21	-346.17	-276.94	1.0
HALLPLENUM	0.	0.	0.000	0.000	0.	0.00	0.00	0.00	0.00	0.00	1.0

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SV-A SYSTEM DESIGN PARAMETERS CONFRMAHU TRUTH OR CONSEQU, N

SYSTEM NAME	ALTITUDE MULTIPLIER
CONFRMAHU	1.200

SUPPLY FAN (CFM)	ELEC (KW)	DELTA-T (F)	RETURN FAN (CFM)	ELEC (KW)	DELTA-T (F)	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)
960.	0.248	2.0	960.	0.000	0.0	0.000	10.000	0.800	0.000	0.00	0.00

ZONE NAME	SUPPLY FLOW	EXHAUST FLOW	FAN (KW)	MINIMUM FLOW RATIO	OUTSIDE AIR FLOW	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	EXTRACTION RATE (KBTU/HR)	HEATING CAPACITY (KBTU/HR)	ADDITION RATE (KBTU/HR)	MULTIPLIER
CONFERENCE	960.	0.	0.000	1.000	0.	0.00	0.00	4.69	-67.39	-2.07	1.0
CONFPLENUM	0.	0.	0.000	0.000	0.	0.00	0.00	0.00	0.00	0.00	1.0

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-A SYSTEM MONTHLY LOADS SUMMARY FOR 1TOWER TRUTH OR CONSEQU, N

MONTH	COOLING: COOLING ENERGY (MBTU)	COOLING: TIME OF MAX DY	COOLING: TIME OF MAX HR	COOLING: DRY-BULB TEMP	COOLING: WET-BULB TEMP	COOLING: MAXIMUM COOLING LOAD (KBTU/HR)	HEATING: HEATING ENERGY (MBTU)	HEATING: TIME OF MAX DY	HEATING: TIME OF MAX HR	HEATING: DRY-BULB TEMP	HEATING: WET-BULB TEMP	HEATING: MAXIMUM HEATING LOAD (KBTU/HR)	ELEC: ELEC-TRICAL ENERGY (KWH)	ELEC: MAXIMUM ELEC LOAD (KW)
JAN	0.00000					0.000	0.000					0.000	2291.	5.618
FEB	0.00000					0.000	0.000					0.000	2069.	5.618
MAR	0.00000					0.000	0.000					0.000	2291.	5.618
APR	8.67692	22	15	91.F	54.F	46.677	0.000					0.000	2784.	6.433
MAY	14.27732	9	18	90.F	53.F	45.304	0.000					0.000	2897.	6.433
JUN	22.71675	23	15	98.F	63.F	57.992	0.000					0.000	2804.	6.433
JUL	24.99347	1	18	100.F	60.F	62.778	0.000					0.000	2897.	6.433
AUG	23.42665	22	18	73.F	67.F	53.562	0.000					0.000	2897.	6.433
SEP	18.79902	13	16	90.F	60.F	45.225	0.000					0.000	2804.	6.433
OCT	8.20284	7	16	85.F	57.F	38.099	0.000					0.000	2897.	6.433
NOV	0.23611	1	15	73.F	48.F	26.300	0.000					0.000	2237.	6.433
DEC	0.00000					0.000	0.000					0.000	2291.	5.618
TOTAL	121.329						0.000						31159.	
MAX						62.778						0.000		6.433

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-C SYSTEM MONTHLY LOAD HOURS FOR 1TOWER TRUTH OR CONSEQU, N

MONTH	HOURS COOLING LOAD	HOURS HEATING LOAD	HOURS COINCIDENT COOL-HEAT LOAD	HOURS FLOATING	HOURS HEATING AVAIL.	HOURS COOLING AVAIL.	HOURS FANS ON	HOURS FANS CYCLE ON	HOURS NIGHT VENTING	HOURS FLOATING WHEN FANS ON	HEATING LOAD AT COOLING PEAK (KBTU/HR)	ELECTRIC LOAD AT COOLING PEAK (KW)
JAN	0	0	0	744	0	0	0	0	0	0	0.000	4.388
FEB	0	0	0	672	0	0	0	0	0	0	0.000	4.388
MAR	0	0	0	744	0	0	0	0	0	0	0.000	4.388
APR	498	0	0	222	0	686	696	0	0	198	0.000	5.203
MAY	621	0	0	123	0	667	744	0	0	123	0.000	5.203
JUN	713	0	0	7	0	715	720	0	0	7	0.000	5.203
JUL	744	0	0	0	0	744	744	0	0	0	0.000	5.203
AUG	744	0	0	0	0	744	744	0	0	0	0.000	5.203
SEP	714	0	0	6	0	720	720	0	0	6	0.000	5.203
OCT	507	0	0	237	0	744	744	0	0	237	0.000	5.203
NOV	14	0	0	706	0	24	24	0	0	10	0.000	5.203
DEC	0	0	0	744	0	0	0	0	0	0	0.000	4.388
ANNUAL	4555	0	0	4205	0	5044	5136	0	0	581		

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-K SPACE TEMPERATURE SUMMARY 1TOWER TRUTH OR CONSEQU, N

MONTH	AVERAGE SPACE TEMP: ALL HOURS (F)	COOLING HOURS (F)	HEATING HOURS (F)	FAN ON HOURS (F)	FAN OFF HOURS (F)	AVERAGE TEMPERATURE DIFFERENCE BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN ON HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN OFF HOURS (F)	SUMMED TEMP DIFFERENCE BETWEEN OUTDOOR& ROOM AIR HEATING HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	HUMIDITY RATIO DIFFERENCE BETWEEN OUTDOOR AND ROOM AIR (FRAC.OR MULT.)
JAN	44.72			0.00	44.72	-7.83	0.00	-7.83			-0.00508
FEB	48.66			0.00	48.66	-4.68	0.00	-4.68			-0.00527
MAR	53.36			0.00	53.36	-3.10	0.00	-3.10			-0.00470
APR	57.66	59.77		57.48	62.90	2.48	2.58	-0.45		173.37	-0.00015
MAY	61.91	62.91		61.91	0.00	5.30	5.30	0.00		228.91	0.00000
JUN	67.28	67.30		67.28	0.00	10.48	10.48	0.00		321.24	0.00001
JUL	67.53	67.53		67.53	0.00	10.72	10.72	0.00		332.66	0.00011
AUG	66.03	66.03		66.03	0.00	9.02	9.02	0.00		280.38	0.00022
SEP	64.79	64.84		64.79	0.00	7.62	7.62	0.00		242.87	0.00004
OCT	57.34	59.89		57.34	0.00	1.41	1.41	0.00		159.87	0.00000
NOV	57.00	57.83		54.98	57.07	-8.88	1.85	-9.25		314.89	0.00017
DEC	49.21			0.00	49.21	-9.65	0.00	-9.65			0.00021
ANNUAL	57.99	64.47	0.00	63.18	50.64	1.10	6.73	-6.87	0.00	3086.05	-0.00118

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-O TEMPERATURE SCATTER PLOT 1TOWER FOR TOWER_1 TRUTH OR CONSEQU, N

TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

HOUR	1AM	2	3	4	5	6	7	8	9	10	11	12	1PM	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ABOVE 85	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
81-85	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
76-80	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	3	0	0	0	0	0	0	7
71-75	4	3	0	0	0	0	0	1	3	7	31	21	40	85	62	83	63	68	45	32	20	14	12	8	602
66-70	43	39	27	23	21	10	33	45	74	93	96	100	101	72	90	78	86	78	79	75	77	71	58	52	1521
61-65	106	105	114	110	115	76	88	77	67	56	45	49	39	30	32	29	35	31	46	62	68	78	88	95	1641
BELOW 60	61	67	73	81	78	128	93	91	70	58	42	44	34	26	29	23	29	34	44	45	49	51	56	59	1365

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-A SYSTEM MONTHLY LOADS SUMMARY FOR CRUINT TRUTH OR CONSEQU, N

MONTH	- - - COOLING - - - COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	- - - HEATING - - - HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	- - ELEC - - ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	217.58914	29	10	42.F	35.F	295.765	-134.871	11	11	12.F	10.F	-187.717	31626.	42.509
FEB	196.18980	14	20	40.F	29.F	294.231	-120.258	14	11	45.F	35.F	-182.704	28566.	42.509
MAR	217.12257	27	7	39.F	34.F	294.359	-131.741	6	11	53.F	38.F	-182.082	31626.	42.509
APR	210.48479	29	8	51.F	43.F	295.580	-125.645	29	8	51.F	43.F	-178.922	30606.	42.509
MAY	217.77766	22	7	60.F	45.F	295.134	-128.496	2	9	48.F	31.F	-176.955	31626.	42.509
JUN	211.18484	16	3	60.F	57.F	295.847	-122.632	1	8	61.F	44.F	-173.556	30606.	42.509
JUL	218.16196	5	20	77.F	61.F	296.336	-125.922	24	11	78.F	63.F	-173.166	31626.	42.509
AUG	217.55618	23	23	70.F	60.F	296.612	-125.627	25	11	71.F	61.F	-174.459	31626.	42.509
SEP	211.65114	10	2	63.F	57.F	297.234	-123.521	27	10	69.F	53.F	-175.570	30606.	42.509
OCT	217.99722	6	8	55.F	42.F	295.079	-129.675	20	9	46.F	42.F	-179.452	31626.	42.509
NOV	210.65187	22	10	39.F	33.F	295.759	-127.831	22	10	39.F	33.F	-183.868	30606.	42.509
DEC	217.30580	15	8	25.F	21.F	295.569	-133.730	16	11	33.F	30.F	-185.580	31626.	42.509
TOTAL	2563.674						-1529.949						372373.	
MAX						297.234						-187.717		42.509

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-C SYSTEM MONTHLY LOAD HOURS FOR CRUINT TRUTH OR CONSEQU, N

MONTH	HOURS COOLING LOAD	HOURS HEATING LOAD	HOURS COINCIDENT COOL-HEAT LOAD	HOURS FLOATING	HOURS HEATING AVAIL.	HOURS COOLING AVAIL.	HOURS FANS ON	HOURS FANS CYCLE ON	HOURS NIGHT VENTING	HOURS FLOATING WHEN FANS ON	--COINCIDENT LOADS-- HEATING LOAD AT COOLING PEAK (KBTU/HR)	ELECTRIC LOAD AT COOLING PEAK (KW)
JAN	744	744	744	0	744	744	744	0	0	0	-183.958	42.509
FEB	672	672	672	0	672	672	672	0	0	0	-180.864	42.509
MAR	744	744	744	0	744	744	744	0	0	0	-181.009	42.509
APR	720	720	720	0	720	720	720	0	0	0	-178.922	42.509
MAY	744	744	744	0	744	744	744	0	0	0	-174.995	42.509
JUN	720	720	720	0	720	720	720	0	0	0	-173.326	42.509
JUL	744	744	744	0	744	744	744	0	0	0	-171.898	42.509
AUG	744	744	744	0	744	744	744	0	0	0	-173.186	42.509
SEP	720	720	720	0	720	720	720	0	0	0	-174.287	42.509
OCT	744	744	744	0	744	744	744	0	0	0	-175.213	42.509
NOV	720	720	720	0	720	720	720	0	0	0	-183.868	42.509
DEC	744	744	744	0	744	744	744	0	0	0	-184.895	42.509
ANNUAL	8760	8760	8760	0	8760	8760	8760	0	0	0		

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-K SPACE TEMPERATURE SUMMARY CRUINT TRUTH OR CONSEQU, N

MONTH	AVERAGE SPACE TEMP: ALL HOURS (F)	COOLING HOURS (F)	HEATING HOURS (F)	FAN ON HOURS (F)	FAN OFF HOURS (F)	AVERAGE TEMPERATURE DIFFERENCE: BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN ON HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN OFF HOURS (F)	SUMMED TEMP DIFFERENCE: BETWEEN OUTDOOR& ROOM AIR HEATING HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	HUMIDITY RATIO DIFFERENCE BETWEEN OUTDOOR AND ROOM AIR (FRAC.OR MULT.)
JAN	67.31	67.31	67.31	67.31	0.00	-30.42	-30.42	0.00	942.93	942.93	0.00000
FEB	67.90	67.90	67.90	67.90	0.00	-23.92	-23.92	0.00	670.83	670.83	0.00000
MAR	68.38	68.38	68.38	68.38	0.00	-18.12	-18.12	0.00	572.24	572.24	0.00000
APR	69.21	69.21	69.21	69.21	0.00	-9.07	-9.07	0.00	360.75	360.75	0.00000
MAY	69.75	69.75	69.75	69.75	0.00	-2.53	-2.53	0.00	282.73	282.73	0.00000
JUN	70.53	70.53	70.53	70.53	0.00	7.23	7.23	0.00	305.93	305.93	0.00000
JUL	70.77	70.77	70.77	70.77	0.00	7.48	7.48	0.00	278.23	278.23	0.00001
AUG	70.57	70.57	70.57	70.57	0.00	4.48	4.48	0.00	221.80	221.80	0.00002
SEP	70.19	70.19	70.19	70.19	0.00	2.21	2.21	0.00	231.14	231.14	0.00000
OCT	69.16	69.16	69.16	69.16	0.00	-10.41	-10.41	0.00	380.02	380.02	0.00000
NOV	68.20	68.20	68.20	68.20	0.00	-20.07	-20.07	0.00	604.96	604.96	0.00000
DEC	67.55	67.55	67.55	67.55	0.00	-27.99	-27.99	0.00	867.60	867.60	0.00000
ANNUAL	69.13	69.13	69.13	69.13	0.00	-10.04	-10.04	0.00	5719.16	5719.16	0.00000

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-O TEMPERATURE SCATTER PLOT CRUINT FOR COMPUTERRM TRUTH OR CONSEQU, N

TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

HOUR	1AM	2	3	4	5	6	7	8	9	10	11	12	1PM	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ABOVE 85	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
81-85	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
76-80	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
71-75	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
66-70	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	8760
61-65	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
BELOW 60	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

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION TRUTH OR CONSEQU, N
REPORT- SS-O TEMPERATURE SCATTER PLOT CRUINT FOR COMPRMPLN

TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

HOUR	1AM	2	3	4	5	6	7	8	9	10	11	12	1PM	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ABOVE 85	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
81-85	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
76-80	29	24	21	19	16	12	9	13	20	27	36	46	57	64	65	66	63	59	52	46	38	34	33	31	880
71-75	153	156	157	156	159	162	165	162	157	153	150	144	137	131	134	133	135	138	140	146	153	154	154	155	3584
66-70	154	156	157	160	157	156	156	155	153	152	148	149	147	150	146	150	150	147	150	150	151	150	150	150	3644
61-65	29	29	30	30	33	35	35	35	35	33	31	26	24	20	20	16	17	21	23	23	23	27	28	29	652
BELOW 60	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

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION TRUTH OR CONSEQU, N
REPORT- SS-A SYSTEM MONTHLY LOADS SUMMARY FOR 2TOWER

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.00000					0.000	0.000					0.000	2291.	5.618
FEB	0.00000					0.000	0.000					0.000	2069.	5.618
MAR	0.00000					0.000	0.000					0.000	2291.	5.618
APR	8.67692	22	15	91.F	54.F	46.677	0.000					0.000	2784.	6.433
MAY	14.27732	9	18	90.F	53.F	45.304	0.000					0.000	2897.	6.433
JUN	22.71675	23	15	98.F	63.F	57.992	0.000					0.000	2804.	6.433
JUL	24.99347	1	18	100.F	60.F	62.778	0.000					0.000	2897.	6.433
AUG	23.42665	22	18	73.F	67.F	53.562	0.000					0.000	2897.	6.433
SEP	18.79902	13	16	90.F	60.F	45.225	0.000					0.000	2804.	6.433
OCT	8.20284	7	16	85.F	57.F	38.099	0.000					0.000	2897.	6.433
NOV	0.23611	1	15	73.F	48.F	26.300	0.000					0.000	2237.	6.433
DEC	0.00000					0.000	0.000					0.000	2291.	5.618
TOTAL	121.329						0.000						31159.	
MAX						62.778						0.000		6.433

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION TRUTH OR CONSEQU, N
REPORT- SS-C SYSTEM MONTHLY LOAD HOURS FOR 2TOWER

	NUMBER OF HOURS										--COINCIDENT LOADS--	
MONTH	HOURS COOLING LOAD	HOURS HEATING LOAD	HOURS COINCIDENT COOL-HEAT LOAD	HOURS FLOATING	HOURS HEATING AVAIL.	HOURS COOLING AVAIL.	HOURS FANS ON	HOURS FANS CYCLE ON	HOURS NIGHT VENTING	HOURS FLOATING WHEN FANS ON	HEATING LOAD AT COOLING PEAK (KBTU/HR)	ELECTRIC LOAD AT COOLING PEAK (KW)
JAN	0	0	0	744	0	0	0	0	0	0	0.000	4.388
FEB	0	0	0	672	0	0	0	0	0	0	0.000	4.388
MAR	0	0	0	744	0	0	0	0	0	0	0.000	4.388
APR	498	0	0	222	0	686	696	0	0	198	0.000	5.203
MAY	621	0	0	123	0	667	744	0	0	123	0.000	5.203
JUN	713	0	0	7	0	715	720	0	0	7	0.000	5.203
JUL	744	0	0	0	0	744	744	0	0	0	0.000	5.203
AUG	744	0	0	0	0	744	744	0	0	0	0.000	5.203
SEP	714	0	0	6	0	720	720	0	0	6	0.000	5.203
OCT	507	0	0	237	0	744	744	0	0	237	0.000	5.203
NOV	14	0	0	706	0	24	24	0	0	10	0.000	5.203
DEC	0	0	0	744	0	0	0	0	0	0	0.000	4.388
ANNUAL	4555	0	0	4205	0	5044	5136	0	0	581		

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION TRUTH OR CONSEQU, N
REPORT- SS-K SPACE TEMPERATURE SUMMARY 2TOWER

	AVERAGE SPACE TEMP					AVERAGE TEMPERATURE DIFFERENCE			SUMMED TEMP DIFFERENCE		
MONTH	ALL HOURS (F)	COOLING HOURS (F)	HEATING HOURS (F)	FAN ON HOURS (F)	FAN OFF HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN ON HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN OFF HOURS (F)	BETWEEN OUTDOOR& ROOM AIR HEATING HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	HUMIDITY RATIO DIFFERENCE BETWEEN OUTDOOR AND ROOM AIR (FRAC.OR MULT.)
JAN	44.72			0.00	44.72	-7.83	0.00	-7.83			-0.00508
FEB	48.66			0.00	48.66	-4.68	0.00	-4.68			-0.00527
MAR	53.36			0.00	53.36	-3.10	0.00	-3.10			-0.00470
APR	57.66	59.77		57.48	62.90	2.48	2.58	-0.45		173.37	-0.00015
MAY	61.91	62.91		61.91	0.00	5.30	5.30	0.00		228.91	0.00000
JUN	67.28	67.30		67.28	0.00	10.48	10.48	0.00		321.24	0.00001
JUL	67.53	67.53		67.53	0.00	10.72	10.72	0.00		332.66	0.00011
AUG	66.03	66.03		66.03	0.00	9.02	9.02	0.00		280.38	0.00022
SEP	64.79	64.84		64.79	0.00	7.62	7.62	0.00		242.87	0.00004
OCT	57.34	59.89		57.34	0.00	1.41	1.41	0.00		159.87	0.00000
NOV	57.00	57.83		54.98	57.07	-8.88	1.85	-9.25		314.89	0.00017
DEC	49.21			0.00	49.21	-9.65	0.00	-9.65			0.00021
ANNUAL	57.99	64.47	0.00	63.18	50.64	1.10	6.73	-6.87	0.00	3086.05	-0.00118

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-O TEMPERATURE SCATTER PLOT 2TOWER FOR TOWER_2 TRUTH OR CONSEQU, N

TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

HOUR	1AM	2	3	4	5	6	7	8	9	10	11	12	1PM	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ABOVE 85	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
81-85	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
76-80	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	3	0	0	0	0	0	0	7
71-75	4	3	0	0	0	0	0	1	3	7	31	21	40	85	62	83	63	68	45	32	20	14	12	8	602
66-70	43	39	27	23	21	10	33	45	74	93	96	100	101	72	90	78	86	78	79	75	77	71	58	52	1521
61-65	106	105	114	110	115	76	88	77	67	56	45	49	39	30	32	29	35	31	46	62	68	78	88	95	1641
BELOW 60	61	67	73	81	78	128	93	91	70	58	42	44	34	26	29	23	29	34	44	45	49	51	56	59	1365

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-A SYSTEM MONTHLY LOADS SUMMARY FOR 3TOWER TRUTH OR CONSEQU, N

	C O O L I N G						H E A T I N G						E L E C	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.00000					0.000	0.000					0.000	2291.	5.618
FEB	0.00000					0.000	0.000					0.000	2069.	5.618
MAR	0.00000					0.000	0.000					0.000	2291.	5.618
APR	8.67692	22	15	91.F	54.F	46.677	0.000					0.000	2784.	6.433
MAY	14.27732	9	18	90.F	53.F	45.304	0.000					0.000	2897.	6.433
JUN	22.71675	23	15	98.F	63.F	57.992	0.000					0.000	2804.	6.433
JUL	24.99347	1	18	100.F	60.F	62.778	0.000					0.000	2897.	6.433
AUG	23.42665	22	18	73.F	67.F	53.562	0.000					0.000	2897.	6.433
SEP	18.79902	13	16	90.F	60.F	45.225	0.000					0.000	2804.	6.433
OCT	8.20284	7	16	85.F	57.F	38.099	0.000					0.000	2897.	6.433
NOV	0.23611	1	15	73.F	48.F	26.300	0.000					0.000	2237.	6.433
DEC	0.00000					0.000	0.000					0.000	2291.	5.618
TOTAL	121.329						0.000						31159.	
MAX						62.778						0.000		6.433

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-C SYSTEM MONTHLY LOAD HOURS FOR 3TOWER TRUTH OR CONSEQU, N

	N U M B E R O F H O U R S										--COINCIDENT LOADS--	
MONTH	HOURS COOLING LOAD	HOURS HEATING LOAD	HOURS COINCIDENT COOL-HEAT LOAD	HOURS FLOATING	HOURS HEATING AVAIL.	HOURS COOLING AVAIL.	HOURS FANS ON	HOURS FANS CYCLE ON	HOURS NIGHT VENTING	HOURS FLOATING WHEN FANS ON	HEATING LOAD AT COOLING PEAK (KBTU/HR)	ELECTRIC LOAD AT COOLING PEAK (KW)
JAN	0	0	0	744	0	0	0	0	0	0	0.000	4.388
FEB	0	0	0	672	0	0	0	0	0	0	0.000	4.388
MAR	0	0	0	744	0	0	0	0	0	0	0.000	4.388
APR	498	0	0	222	0	686	696	0	0	198	0.000	5.203
MAY	621	0	0	123	0	667	744	0	0	123	0.000	5.203
JUN	713	0	0	7	0	715	720	0	0	7	0.000	5.203
JUL	744	0	0	0	0	744	744	0	0	0	0.000	5.203
AUG	744	0	0	0	0	744	744	0	0	0	0.000	5.203
SEP	714	0	0	6	0	720	720	0	0	6	0.000	5.203
OCT	507	0	0	237	0	744	744	0	0	237	0.000	5.203
NOV	14	0	0	706	0	24	24	0	0	10	0.000	5.203
DEC	0	0	0	744	0	0	0	0	0	0	0.000	4.388
ANNUAL	4555	0	0	4205	0	5044	5136	0	0	581		

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-K SPACE TEMPERATURE SUMMARY 3TOWER TRUTH OR CONSEQU, N

	A V E R A G E S P A C E T E M P					AVERAGE TEMPERATURE DIFFERENCE			SUMMED TEMP DIFFERENCE		
MONTH	ALL HOURS (F)	COOLING HOURS (F)	HEATING HOURS (F)	FAN ON HOURS (F)	FAN OFF HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN ON HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN OFF HOURS (F)	BETWEEN OUTDOOR& ROOM AIR HEATING HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	HUMIDITY RATIO DIFFERENCE BETWEEN OUTDOOR AND ROOM AIR (FRAC.OR MULT.)
JAN	44.72			0.00	44.72	-7.83	0.00	-7.83			-0.00508
FEB	48.66			0.00	48.66	-4.68	0.00	-4.68			-0.00527
MAR	53.36			0.00	53.36	-3.10	0.00	-3.10			-0.00470
APR	57.66	59.77		57.48	62.90	2.48	2.58	-0.45		173.37	-0.00015
MAY	61.91	62.91		61.91	0.00	5.30	5.30	0.00		228.91	0.00000
JUN	67.28	67.30		67.28	0.00	10.48	10.48	0.00		321.24	0.00001
JUL	67.53	67.53		67.53	0.00	10.72	10.72	0.00		332.66	0.00011
AUG	66.03	66.03		66.03	0.00	9.02	9.02	0.00		280.38	0.00022
SEP	64.79	64.84		64.79	0.00	7.62	7.62	0.00		242.87	0.00004
OCT	57.34	59.89		57.34	0.00	1.41	1.41	0.00		159.87	0.00000
NOV	57.00	57.83		54.98	57.07	-8.88	1.85	-9.25		314.89	0.00017
DEC	49.21			0.00	49.21	-9.65	0.00	-9.65			0.00021
ANNUAL	57.99	64.47	0.00	63.18	50.64	1.10	6.73	-6.87	0.00	3086.05	-0.00118

EMC ENGINEERS INC. DENVER, CO 80227 — EZDOE - ELITE SOFTWARE DEVELOPMENT INC — GEODSS SITE DOE EVALUATION — DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1 — TRUTH OR CONSEQU, N

REPORT- SS-O TEMPERATURE SCATTER PLOT 3TOWER FOR TOWER_3

TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

HOUR	1AM	2	3	4	5	6	7	8	9	10	11	12	1PM	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ABOVE 85	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
81-85	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
76-80	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	3	0	0	0	0	0	0	7
71-75	4	3	0	0	0	0	0	1	3	7	31	21	40	85	62	83	63	68	45	32	20	14	12	8	602
66-70	43	39	27	23	21	10	33	45	74	93	96	100	101	72	90	78	86	78	79	75	77	71	58	52	1521
61-65	106	105	114	110	115	76	88	77	67	56	45	49	39	30	32	29	35	31	46	62	68	78	88	95	1641
BELOW 60	61	67	73	81	78	128	93	91	70	58	42	44	34	26	29	23	29	34	44	45	49	51	56	59	1365

EMC ENGINEERS INC. DENVER, CO 80227 — EZDOE - ELITE SOFTWARE DEVELOPMENT INC — GEODSS SITE DOE EVALUATION — DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1 — TRUTH OR CONSEQU, N

REPORT- SS-A SYSTEM MONTHLY LOADS SUMMARY FOR REGAHU

MONTH	COOLING: COOLING ENERGY (MBTU)	COOLING: TIME OF MAX DY	COOLING: TIME OF MAX HR	COOLING: DRY-BULB TEMP	COOLING: WET-BULB TEMP	COOLING: MAXIMUM COOLING LOAD (KBTU/HR)	HEATING: HEATING ENERGY (MBTU)	HEATING: TIME OF MAX DY	HEATING: TIME OF MAX HR	HEATING: DRY-BULB TEMP	HEATING: WET-BULB TEMP	HEATING: MAXIMUM HEATING LOAD (KBTU/HR)	ELEC: ELEC-TRICAL ENERGY (KWH)	ELEC: MAXIMUM ELEC LOAD (KW)
JAN	0.01148	7	15	65.F	46.F	5.829	-19.195	11	5	-4.F	-5.F	-77.525	13170.	36.616
FEB	0.31244	18	16	66.F	46.F	21.342	-9.587	6	7	25.F	21.F	-48.643	9630.	24.639
MAR	2.84964	9	15	78.F	56.F	35.172	-5.523	13	7	27.F	20.F	-44.647	9410.	23.701
APR	8.60703	22	15	91.F	54.F	61.833	-0.162	3	7	41.F	35.F	-13.919	7435.	14.841
MAY	17.97717	9	16	90.F	53.F	61.215	-0.117	2	6	34.F	22.F	-15.906	7583.	16.018
JUN	31.52359	23	15	98.F	63.F	79.282	0.000					0.000	7509.	14.178
JUL	34.38252	1	16	97.F	58.F	79.666	0.000					0.000	7427.	14.178
AUG	32.51204	1	16	97.F	65.F	81.035	0.000					0.000	7792.	14.178
SEP	26.14456	1	16	91.F	63.F	68.950	0.000					0.000	7388.	14.178
OCT	9.68971	7	16	85.F	57.F	55.715	-0.466	31	6	33.F	26.F	-15.993	7563.	17.664
NOV	1.87308	10	14	69.F	48.F	29.858	-5.596	20	7	25.F	21.F	-46.931	8905.	24.470
DEC	0.00421	8	15	57.F	39.F	1.669	-14.478	17	8	21.F	18.F	-55.820	11789.	24.852
TOTAL	165.887						-55.124						105607.	
MAX						81.035						-77.525		36.616

EMC ENGINEERS INC. DENVER, CO 80227 — EZDOE - ELITE SOFTWARE DEVELOPMENT INC — GEODSS SITE DOE EVALUATION — DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1 — TRUTH OR CONSEQU, N

REPORT- SS-C SYSTEM MONTHLY LOAD HOURS FOR REGAHU

MONTH	HOURS COOLING LOAD	HOURS HEATING LOAD	HOURS COINCIDENT COOL-HEAT LOAD	HOURS FLOATING	HOURS HEATING AVAIL.	HOURS COOLING AVAIL.	HOURS FANS ON	HOURS FANS CYCLE ON	HOURS NIGHT VENTING	HOURS FLOATING WHEN FANS ON	COINCIDENT LOADS: HEATING LOAD AT COOLING PEAK (KBTU/HR)	COINCIDENT LOADS: ELECTRIC LOAD AT COOLING PEAK (KW)
JAN	6	642	0	96	744	648	744	0	0	96	0.000	14.178
FEB	34	500	0	138	672	534	672	0	0	138	0.000	14.178
MAR	232	316	0	196	744	548	744	0	0	196	0.000	14.178
APR	478	37	0	205	720	515	720	0	0	205	0.000	14.178
MAY	669	16	0	59	744	685	744	0	0	59	0.000	14.178
JUN	720	0	0	0	720	720	720	0	0	0	0.000	14.178
JUL	744	0	0	0	744	744	744	0	0	0	0.000	14.178
AUG	744	0	0	0	744	744	744	0	0	0	0.000	14.178
SEP	718	0	0	2	720	718	720	0	0	2	0.000	14.178
OCT	529	71	0	144	744	600	744	0	0	144	0.000	14.178
NOV	163	332	0	225	720	495	720	0	0	225	0.000	14.178
DEC	7	609	0	128	744	616	744	0	0	128	0.000	14.178
ANNUAL	5044	2523	0	1193	8760	7567	8760	0	0	1193		

EMC ENGINEERS INC. DENVER, CO 80227 — EZDOE - ELITE SOFTWARE DEVELOPMENT INC — GEODSS SITE DOE EVALUATION — DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1 — TRUTH OR CONSEQU, N

REPORT- SS-K SPACE TEMPERATURE SUMMARY REGAHU

MONTH	AVERAGE SPACE TEMP: ALL HOURS (F)	AVERAGE SPACE TEMP: COOLING HOURS (F)	AVERAGE SPACE TEMP: HEATING HOURS (F)	AVERAGE SPACE TEMP: FAN ON HOURS (F)	AVERAGE SPACE TEMP: FAN OFF HOURS (F)	AVERAGE TEMPERATURE DIFFERENCE BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN ON HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN OFF HOURS (F)	SUMMED TEMP DIFFERENCE BETWEEN OUTDOOR& ROOM AIR HEATING HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	HUMIDITY RATIO DIFFERENCE BETWEEN OUTDOOR AND ROOM AIR (FRAC.OR MULT.)
JAN	66.18	67.66	65.94	66.18	0.00	-29.29	-29.29	0.00	849.78	907.89	-0.00002
FEB	67.42	69.73	67.03	67.42	0.00	-23.45	-23.45	0.00	560.53	657.03	-0.00002
MAR	68.81	70.42	67.56	68.81	0.00	-18.55	-18.55	0.00	354.10	580.69	-0.00003
APR	70.96	71.55	69.14	70.96	0.00	-10.82	-10.82	0.00	37.88	386.52	-0.00002
MAY	72.15	72.38	69.22	72.15	0.00	-4.93	-4.93	0.00	17.73	288.74	-0.00002
JUN	73.71	73.71		73.71	0.00	4.05	4.05	0.00		268.15	-0.00002
JUL	74.03	74.03		74.03	0.00	4.22	4.22	0.00		231.46	0.00011
AUG	73.72	73.72		73.72	0.00	1.33	1.33	0.00		199.22	0.00023
SEP	73.08	73.09		73.08	0.00	-0.68	-0.68	0.00		223.88	0.00001
OCT	70.87	71.50	68.79	70.87	0.00	-12.12	-12.12	0.00	72.17	407.36	-0.00002
NOV	68.38	70.19	67.25	68.38	0.00	-20.25	-20.25	0.00	372.26	608.44	-0.00002
DEC	66.71	68.13	66.46	66.71	0.00	-27.15	-27.15	0.00	751.85	841.76	-0.00002
ANNUAL	70.52	72.75	66.80	70.52	0.00	-11.42	-11.42	0.00	3016.30	5601.12	0.00001

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-O TEMPERATURE SCATTER PLOT REGAHU FOR HALLS TRUTH OR CONSEQU, N

TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

HOUR	1AM	2	3	4	5	6	7	8	9	10	11	12	1PM	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ABOVE 85	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
81-85	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
76-80	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
71-75	217	211	208	204	201	204	210	212	222	229	245	251	255	263	275	278	271	254	244	237	236	233	228	219	5607
66-70	148	154	157	161	164	161	155	153	143	136	120	114	110	102	90	87	94	111	121	128	129	132	137	146	3153
61-65	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
BELOW 60	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

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-O TEMPERATURE SCATTER PLOT REGAHU FOR HALLPLENUM TRUTH OR CONSEQU, N

TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

HOUR	1AM	2	3	4	5	6	7	8	9	10	11	12	1PM	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ABOVE 85	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
81-85	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
76-80	95	91	90	82	76	72	71	73	78	92	96	99	99	107	109	107	108	104	102	100	98	98	97	96	2240
71-75	94	98	97	103	106	108	108	106	106	96	96	96	100	94	93	96	94	97	98	98	99	97	96	96	2372
66-70	96	96	96	95	94	94	93	94	91	90	93	94	101	103	106	106	107	105	103	97	96	95	95	93	2333
61-65	76	74	76	78	82	84	86	85	84	81	75	72	62	58	54	54	53	56	59	67	69	72	74	76	1707
BELOW 60	4	6	6	7	7	7	7	7	6	6	5	4	3	3	3	2	3	3	3	3	3	3	3	4	108

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-A SYSTEM MONTHLY LOADS SUMMARY FOR CONFRMAHU TRUTH OR CONSEQU, N

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.84872	21	12	56.F	38.F	5.406	0.000					0.000	248.	1.278
FEB	0.87625	18	12	62.F	45.F	5.500	0.000					0.000	224.	1.278
MAR	1.08429	30	12	73.F	53.F	5.558	0.000					0.000	248.	1.278
APR	1.23204	22	12	84.F	50.F	5.648	0.000					0.000	240.	1.278
MAY	1.38165	10	12	82.F	51.F	5.659	0.000					0.000	248.	1.278
JUN	1.47795	29	12	87.F	63.F	5.728	0.000					0.000	240.	1.278
JUL	1.56652	27	12	88.F	65.F	5.764	0.000					0.000	248.	1.278
AUG	1.54302	1	12	92.F	67.F	5.811	0.000					0.000	248.	1.278
SEP	1.42242	8	12	82.F	63.F	5.694	0.000					0.000	240.	1.278
OCT	1.26640	7	12	75.F	53.F	5.611	0.000					0.000	248.	1.278
NOV	1.01403	10	12	67.F	48.F	5.540	0.000					0.000	240.	1.278
DEC	0.90256	9	12	52.F	40.F	5.432	0.000					0.000	248.	1.278
TOTAL	14.616						0.000						2924.	
MAX						5.811						0.000		1.278

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-C SYSTEM MONTHLY LOAD HOURS FOR CONFRMAHU TRUTH OR CONSEQU, N

	NUMBER OF HOURS										COINCIDENT LOADS	
MONTH	HOURS COOLING LOAD	HOURS HEATING LOAD	HOURS COINCIDENT COOL-HEAT LOAD	HOURS FLOATING	HOURS HEATING AVAIL.	HOURS COOLING AVAIL.	HOURS FANS ON	HOURS FANS CYCLE ON	HOURS NIGHT VENTING	HOURS FLOATING WHEN FANS ON	HEATING LOAD AT COOLING PEAK (KBTU/HR)	ELECTRIC LOAD AT COOLING PEAK (KW)
JAN	675	0	0	69	0	675	744	0	0	69	0.000	1.278
FEB	616	0	0	56	0	616	672	0	0	56	0.000	1.278
MAR	682	0	0	62	0	682	744	0	0	62	0.000	1.278
APR	660	0	0	60	0	660	720	0	0	60	0.000	1.278
MAY	682	0	0	62	0	682	744	0	0	62	0.000	1.278
JUN	660	0	0	60	0	660	720	0	0	60	0.000	1.278
JUL	684	0	0	60	0	684	744	0	0	60	0.000	1.278
AUG	690	0	0	54	0	690	744	0	0	54	0.000	1.278
SEP	661	0	0	59	0	661	720	0	0	59	0.000	1.278
OCT	682	0	0	62	0	682	744	0	0	62	0.000	1.278
NOV	660	0	0	60	0	660	720	0	0	60	0.000	1.278
DEC	682	0	0	62	0	682	744	0	0	62	0.000	1.278
ANNUAL	8034	0	0	726	0	8034	8760	0	0	726		

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-K SPACE TEMPERATURE SUMMARY CONFRMAHU TRUTH OR CONSEQU, N

	AVERAGE SPACE TEMP					AVERAGE TEMPERATURE DIFFERENCE			SUMMED TEMP DIFFERENCE		
MONTH	ALL HOURS (F)	COOLING HOURS (F)	HEATING HOURS (F)	FAN ON HOURS (F)	FAN OFF HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN ON HOURS (F)	BETWEEN OUTDOOR& ROOM AIR FAN OFF HOURS (F)	BETWEEN OUTDOOR& ROOM AIR HEATING HOURS (F)	BETWEEN OUTDOOR& ROOM AIR ALL HOURS (F)	HUMIDITY RATIO DIFFERENCE BETWEEN OUTDOOR AND ROOM AIR (FRAC.OR MULT.)
JAN	68.35	68.37		68.35	0.00	-31.46	-31.46	0.00		975.13	0.00000
FEB	69.15	69.16		69.15	0.00	-25.17	-25.17	0.00		705.36	0.00000
MAR	69.82	69.82		69.82	0.00	-19.56	-19.56	0.00		612.61	0.00000
APR	70.96	70.97		70.96	0.00	-10.82	-10.82	0.00		393.06	0.00000
MAY	71.68	71.68		71.68	0.00	-4.46	-4.46	0.00		293.31	0.00000
JUN	72.71	72.71		72.71	0.00	5.05	5.05	0.00		281.93	0.00000
JUL	73.03	73.04		73.03	0.00	5.22	5.22	0.00		246.84	0.00000
AUG	72.78	72.79		72.78	0.00	2.27	2.27	0.00		207.02	0.00000
SEP	72.26	72.26		72.26	0.00	0.15	0.15	0.00		228.54	0.00000
OCT	70.88	70.89		70.88	0.00	-12.13	-12.13	0.00		413.25	0.00000
NOV	69.55	69.56		69.55	0.00	-21.43	-21.43	0.00		643.74	0.00000
DEC	68.67	68.68		68.67	0.00	-29.11	-29.11	0.00		902.45	0.00000
ANNUAL	70.83	70.84	0.00	70.83	0.00	-11.73	-11.73	0.00	0.00	5903.25	0.00000

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-O TEMPERATURE SCATTER PLOT CONFRMAHU FOR CONFERENCE TRUTH OR CONSEQU, N

TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

HOUR	1AM	2	3	4	5	6	7	8	9	10	11	12	1PM	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ABOVE 85	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
81-85	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
76-80	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
71-75	365	365	365	365	365	365	365	365	181	210	170	210	365	365	365	365	365	365	365	365	365	365	365	365	8071
66-70	0	0	0	0	0	0	0	0	184	155	195	155	0	0	0	0	0	0	0	0	0	0	0	0	689
61-65	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
BELOW 60	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

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- SS-O TEMPERATURE SCATTER PLOT CONFRMAHU FOR CONFPLENUM TRUTH OR CONSEQU, N

TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

HOUR	1AM	2	3	4	5	6	7	8	9	10	11	12	1PM	2	3	4	5	6	7	8	9	10	11	12	TOTAL
ABOVE 85	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
81-85	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
76-80	29	25	22	19	17	12	11	14	27	24	46	43	62	67	70	71	70	65	56	47	43	36	33	32	941
71-75	149	152	153	156	157	162	162	159	150	150	142	142	128	126	125	125	125	127	136	143	145	150	150	148	3462
66-70	150	150	152	147	145	142	143	141	137	156	134	149	141	145	145	144	145	145	144	143	144	144	145	148	3479
61-65	37	38	38	43	46	49	49	51	51	35	43	31	34	27	25	25	25	28	29	32	33	35	37	37	878
BELOW 60	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

MMDDHH	TOWER_1 ZONE TEMP F ----(6)	TOWER_1 THERMOST SETPOINT F ----(7)	TOWER_1 HTG SET POINT F ----(17)	TOWER_1 CLG SET POINT F ----(18)
313 1	39.9	-999.0	-999.0	999.0
313 2	39.9	-999.0	-999.0	999.0
313 3	38.3	-999.0	-999.0	999.0
313 4	38.0	-999.0	-999.0	999.0
313 5	35.9	-999.0	-999.0	999.0
313 6	37.2	-999.0	-999.0	999.0
313 7	40.9	-999.0	-999.0	999.0
313 8	40.9	-999.0	-999.0	999.0
313 9	40.9	-999.0	-999.0	999.0
31310	41.5	-999.0	-999.0	999.0
31311	42.1	-999.0	-999.0	999.0
31312	43.7	-999.0	-999.0	999.0
31313	43.0	-999.0	-999.0	999.0
31314	43.2	-999.0	-999.0	999.0
31315	45.3	-999.0	-999.0	999.0
31316	45.7	-999.0	-999.0	999.0
31317	47.3	-999.0	-999.0	999.0
31318	45.6	-999.0	-999.0	999.0
31319	45.3	-999.0	-999.0	999.0
31320	43.4	-999.0	-999.0	999.0
31321	44.3	-999.0	-999.0	999.0
31322	44.4	-999.0	-999.0	999.0
31323	43.2	-999.0	-999.0	999.0
31324	46.6	-999.0	-999.0	999.0
DAILY SUMMARY (MAR 13)				
MN	35.9	-999.0	-999.0	999.0
MX	47.3	-999.0	-999.0	999.0
SM	1016.3	-23976.0	-23976.0	23976.0
AV	42.3	-999.0	-999.0	999.0
MONTHLY SUMMARY (MAR)				
MN	35.9	-999.0	-999.0	999.0
MX	47.3	-999.0	-999.0	999.0
SM	1016.3	-23976.0	-23976.0	23976.0
AV	42.3	-999.0	-999.0	999.0

EMC ENGINEERS INC. DENVER, CO 80227 hrly-0zone = HOURLY-REPORT
EZDOE - ELITE SOFTWARE DEVELOPMENT INC GEODSS SITE DOE EVALUATION
DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
TRUTH OR CONSEQU, N

	TOWER_1 ZONE TEMP F ----(6)	TOWER_1 THERMOST SETPOINT F ----(7)	TOWER_1 HTG SET POINT F ----(17)	TOWER_1 CLG SET POINT F ----(18)
9 8 1	65.1	68.0	68.0	72.0
9 8 2	64.9	68.0	68.0	72.0
9 8 3	63.7	68.0	68.0	72.0
9 8 4	62.0	68.0	68.0	72.0
9 8 5	63.1	68.0	68.0	72.0
9 8 6	60.3	68.0	68.0	72.0
9 8 7	62.9	68.0	68.0	72.0
9 8 8	65.0	68.0	68.0	72.0
9 8 9	66.0	68.0	68.0	72.0
9 810	67.9	68.0	68.0	72.0
9 811	68.4	68.0	68.0	72.0
9 812	70.1	68.0	68.0	72.0
9 813	68.4	68.0	68.0	72.0
9 814	72.1	72.0	68.0	72.0
9 815	69.7	68.0	68.0	72.0
9 816	72.1	72.0	68.0	72.0
9 817	68.2	68.0	68.0	72.0
9 818	67.3	68.0	68.0	72.0
9 819	67.6	68.0	68.0	72.0
9 820	67.4	68.0	68.0	72.0
9 821	66.8	68.0	68.0	72.0
9 822	65.7	68.0	68.0	72.0
9 823	65.4	68.0	68.0	72.0
9 824	64.7	68.0	68.0	72.0
DAILY SUMMARY (SEP 8)				
MN	60.3	68.0	68.0	72.0
MX	72.1	72.0	68.0	72.0
SM	1594.5	1640.0	1632.0	1728.0
AV	66.4	68.3	68.0	72.0
MONTHLY SUMMARY (SEP)				
MN	60.3	68.0	68.0	72.0
MX	72.1	72.0	68.0	72.0
SM	1594.5	1640.0	1632.0	1728.0
AV	66.4	68.3	68.0	72.0
YEARLY SUMMARY				
MN	35.9	-999.0	-999.0	72.0
MX	72.1	72.0	68.0	999.0
SM	2610.8	-22336.0	-22344.0	25704.0
AV	54.4	-465.3	-465.5	535.5

EMC ENGINEERS INC. DENVER, CO 80227 EZDOE - ELITE SOFTWARE DEVELOPMENT INC GEODSS SITE DOE EVALUATION DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
hrly-sys1 = HOURLY-REPORT TRUTH OR CONSEQU, N

MMDDHH	1TOWER TOT HTG COIL PWR BTU/HR ----(5)	1TOWER TOT CLG COIL PWR BTU/HR ----(6)	1TOWER TOT ZONE CLG PWR BTU/HR ----(8)	1TOWER HTG COIL AIR TEMP F ----(1)	1TOWER CLG COIL AIR TEMP F ----(2)	1TOWER TOT SYST FLOWRATE CUFT/MIN ----(17)
313 1	0.	0.	0.	0.0	0.0	0.
313 2	0.	0.	0.	0.0	0.0	0.
313 3	0.	0.	0.	0.0	0.0	0.
313 4	0.	0.	0.	0.0	0.0	0.
313 5	0.	0.	0.	0.0	0.0	0.
313 6	0.	0.	0.	0.0	0.0	0.
313 7	0.	0.	0.	0.0	0.0	0.
313 8	0.	0.	0.	0.0	0.0	0.
313 9	0.	0.	0.	0.0	0.0	0.
31310	0.	0.	0.	0.0	0.0	0.
31311	0.	0.	0.	0.0	0.0	0.
31312	0.	0.	0.	0.0	0.0	0.
31313	0.	0.	0.	0.0	0.0	0.
31314	0.	0.	0.	0.0	0.0	0.
31315	0.	0.	0.	0.0	0.0	0.
31316	0.	0.	0.	0.0	0.0	0.
31317	0.	0.	0.	0.0	0.0	0.
31318	0.	0.	0.	0.0	0.0	0.
31319	0.	0.	0.	0.0	0.0	0.
31320	0.	0.	0.	0.0	0.0	0.
31321	0.	0.	0.	0.0	0.0	0.
31322	0.	0.	0.	0.0	0.0	0.
31323	0.	0.	0.	0.0	0.0	0.
31324	0.	0.	0.	0.0	0.0	0.
DAILY SUMMARY (MAR 13)						
MN	0.	0.	0.	0.0	0.0	0.
MX	0.	0.	0.	0.0	0.0	0.
SM	0.	0.	0.	0.0	0.0	0.
AV	0.	0.	0.	0.0	0.0	0.
MONTHLY SUMMARY (MAR)						
MN	0.	0.	0.	0.0	0.0	0.
MX	0.	0.	0.	0.0	0.0	0.
SM	0.	0.	0.	0.0	0.0	0.
AV	0.	0.	0.	0.0	0.0	0.

EMC ENGINEERS INC. DENVER, CO 80227 EZDOE - ELITE SOFTWARE DEVELOPMENT INC GEODSS SITE DOE EVALUATION DOE-2.1D 8/ 7/1995 15: 8:11 SDL RUN 1
hrly-sys1 = HOURLY-REPORT TRUTH OR CONSEQU, N

	1TOWER TOT HTG COIL PWR BTU/HR ----(5)	1TOWER TOT CLG COIL PWR BTU/HR ----(6)	1TOWER TOT ZONE CLG PWR BTU/HR ----(8)	1TOWER HTG COIL AIR TEMP F ----(1)	1TOWER CLG COIL AIR TEMP F ----(2)	1TOWER TOT SYST FLOWRATE CUFT/MIN ----(17)
9 8 1	0.	25182.	0.	61.0	59.5	2400.
9 8 2	0.	24549.	0.	60.3	58.8	2400.
9 8 3	0.	24879.	0.	59.2	57.6	2400.
9 8 4	0.	27853.	0.	57.3	55.8	2400.
9 8 5	0.	18722.	0.	57.0	55.5	2400.
9 8 6	0.	18901.	0.	57.0	55.5	2400.
9 8 7	0.	23298.	0.	58.9	57.4	2400.
9 8 8	0.	26155.	0.	62.5	61.0	2400.
9 8 9	0.	30408.	0.	64.4	62.9	2400.
9 810	0.	33518.	0.	66.9	65.3	2400.
9 811	0.	35078.	0.	67.1	65.6	2400.
9 812	0.	39546.	0.	69.9	68.3	2400.
9 813	0.	39698.	0.	68.9	67.3	2400.
9 814	0.	42071.	0.	70.6	69.1	2400.
9 815	0.	40639.	0.	69.3	67.7	2400.
9 816	0.	40033.	0.	69.6	68.0	2400.
9 817	0.	35375.	0.	67.0	65.4	2400.
9 818	0.	33007.	0.	63.3	61.7	2400.
9 819	0.	32973.	0.	63.3	61.7	2400.
9 820	0.	30008.	0.	63.7	62.1	2400.
9 821	0.	27233.	0.	63.0	61.4	2400.
9 822	0.	25818.	0.	61.7	60.1	2400.
9 823	0.	25135.	0.	61.0	59.5	2400.
9 824	0.	24549.	0.	60.3	58.8	2400.
DAILY SUMMARY (SEP 8)						
MN	0.	18722.	0.	57.0	55.5	2400.
MX	0.	42071.	0.	70.6	69.1	2400.
SM	0.	724629.	0.	1523.1	1486.1	57600.
AV	0.	30193.	0.	63.5	61.9	2400.
MONTHLY SUMMARY (SEP)						
MN	0.	18722.	0.	57.0	55.5	2400.
MX	0.	42071.	0.	70.6	69.1	2400.
SM	0.	724629.	0.	1523.1	1486.1	57600.
AV	0.	30193.	0.	63.5	61.9	2400.
YEARLY SUMMARY						
MN	0.	0.	0.	0.0	0.0	0.
MX	0.	42071.	0.	70.6	69.1	2400.
SM	0.	724629.	0.	1523.1	1486.1	57600.
AV	0.	15096.	0.	31.7	31.0	1200.

EMC ENGINEERS INC. DENVER, CO 80227 EZDOE - ELITE SOFTWARE DEVELOPMENT INC GEODSS SITE DOE EVALUATION DOE-2.1D 8/ 7/1995 15: 8:11 PDL RUN 1
REPORT- PV-A EQUIPMENT SIZES TRUTH OR CONSEQU, N

E Q U I P M E N T	SIZE (MBTU/H)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/H)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/H)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/H)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/H)	NUMBER INSTD	NUMBER AVAIL	SIZE (MBTU/H)	NUMBER INSTD	NUMBER AVAIL
HERM-REC-CHLR	0.400	2	2															

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 PDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- PS-A PLANT ENERGY UTILIZATION SUMMARY TRUTH OR CONSEQU, N

	SITE ENERGY												SOURCE
	2	3	4	5	6	7	8	9	10	11	12	13	14
MONTH	TOTAL HEAT LOAD	TOTAL COOLING LOAD	TOTAL ELECTR LOAD	RCVRED ENERGY	WASTED RCVRABL ENERGY	FUEL INPUT COOLING	ELEC INPUT COOLING	FUEL INPUT HEATING	ELEC INPUT HEATING	FUEL INPUT ELECT	TOTAL FUEL INPUT	TOTAL SITE ENERGY	TOTAL SOURCE ENERGY
JAN	136.3	225.7	285.2 83.5E	0.0	0.0	0.0	107.9 31.6E	0.0	0.0 0.0E	0.0	0.0	285.2	285.2
FEB	121.5	204.0	249.9 73.2E	0.0	0.0	0.0	97.5 28.6E	0.0	0.0 0.0E	0.0	0.0	249.9	249.9
MAR	133.1	228.3	272.8 79.9E	0.0	0.0	0.0	108.4 31.7E	0.0	0.0 0.0E	0.0	0.0	272.8	272.8
APR	127.0	253.4	274.5 80.4E	0.0	0.0	0.0	115.2 33.8E	0.0	0.0 0.0E	0.0	0.0	274.5	274.5
MAY	129.9	287.3	302.7 88.7E	0.0	0.0	0.0	138.3 40.5E	0.0	0.0 0.0E	0.0	0.0	302.7	302.7
JUN	124.0	319.4	344.1 100.8E	0.0	0.0	0.0	184.4 54.0E	0.0	0.0 0.0E	0.0	0.0	344.1	344.1
JUL	127.3	336.4	360.7 105.6E	0.0	0.0	0.0	196.8 57.6E	0.0	0.0 0.0E	0.0	0.0	360.7	360.7
AUG	127.0	329.2	346.3 101.4E	0.0	0.0	0.0	181.2 53.1E	0.0	0.0 0.0E	0.0	0.0	346.3	346.3
SEP	124.9	302.7	314.8 92.2E	0.0	0.0	0.0	155.6 45.6E	0.0	0.0 0.0E	0.0	0.0	314.8	314.8
OCT	131.1	260.8	278.6 81.6E	0.0	0.0	0.0	114.3 33.5E	0.0	0.0 0.0E	0.0	0.0	278.6	278.6
NOV	129.2	221.3	263.3 77.1E	0.0	0.0	0.0	104.6 30.6E	0.0	0.0 0.0E	0.0	0.0	263.3	263.3
DEC	135.1	225.5	280.5 82.1E	0.0	0.0	0.0	107.9 31.6E	0.0	0.0 0.0E	0.0	0.0	280.5	280.5
	1546.4	3193.9	3573.4 1046.5E	0.0	0.0	0.0	1612.2 472.2E	0.0	0.0 0.0E	0.0	0.0	3573.4	3573.4

NOTE-- ALL ENTRIES ARE IN MBTU EXCEPT
ENTRIES FOLLOWED BY E ARE IN MWH (THOUSANDS OF KWH)

EMC ENGINEERS INC. EZDOE - ELITE SOFTWARE DEVELOPMENT INC DOE-2.1D 8/ 7/1995 15: 8:11 PDL RUN 1
DENVER, CO 80227 GEODSS SITE DOE EVALUATION
REPORT- PS-B MONTHLY PEAK AND TOTAL ENERGY USE TRUTH OR CONSEQU, N

MO	UTILITY-	ELECTRICITY
JAN	TOTAL (MBTU)	285.200
	PEAK (KBTU)	463.528
	DY/HR	11/ 6
FEB	TOTAL (MBTU)	249.904
	PEAK (KBTU)	425.794
	DY/HR	3/ 6
MAR	TOTAL (MBTU)	272.826
	PEAK (KBTU)	429.078
	DY/HR	14/ 6
APR	TOTAL (MBTU)	274.472
	PEAK (KBTU)	612.297
	DY/HR	22/15
MAY	TOTAL (MBTU)	302.693
	PEAK (KBTU)	611.021
	DY/HR	9/17
JUN	TOTAL (MBTU)	344.078
	PEAK (KBTU)	643.065
	DY/HR	22/17
JUL	TOTAL (MBTU)	360.698
	PEAK (KBTU)	647.350
	DY/HR	1/17
AUG	TOTAL (MBTU)	346.303
	PEAK (KBTU)	639.052
	DY/HR	1/17
SEP	TOTAL (MBTU)	314.834
	PEAK (KBTU)	612.207
	DY/HR	1/16
OCT	TOTAL (MBTU)	278.588
	PEAK (KBTU)	590.171
	DY/HR	7/16
NOV	TOTAL (MBTU)	263.279
	PEAK (KBTU)	424.847
	DY/HR	22/ 6
DEC	TOTAL (MBTU)	280.481
	PEAK (KBTU)	428.507
	DY/HR	16/ 6
	ONE YEAR USE/PEAK	3573.357 647.350

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    EMC      ENGINEERS      INC.          EZDOE - ELITE SOFTWARE DEVELOPMENT INC          DOE-2.1D   8/ 7/1995    15: 8:11  PDL RUN 1
    DENVER,      CO        80227          GEODSS SITE DOE EVALUATION
REPORT- PS-C  EQUIPMENT PART LOAD OPERATION                                               TRUTH OR CONSEQU, N
---------------------------------------------------------------------------------------------------------------------------------

                                                                                          TOTAL   ANNUAL    FALSE     ELEC     THERMAL
                                   HOURS AT PERCENT PART LOAD RATIO                       HOURS    LOAD     LOAD      USED     USED
EQUIPMENT                                                                                         (MBTU)   (MBTU)    (MBTU)   (MBTU)
            0 -- 10 -- 20 -- 30 -- 40 -- 50 -- 60 -- 70 -- 80 -- 90 -- 100 - 110+ -----   ------   ------    ------   ------
HERM-REC-CHLR    0     0     0     0     0  1396  4394   790   904  1276     0      8760    3193.9   1010.4    1568.9      0.0
                 0     0     0  4899  2180  1396   270    15     0     0     0

       HOT  LOOP CIRCULATION PUMP ELECTRICAL USE =       0.0 MBTU
       COLD LOOP CIRCULATION PUMP ELECTRICAL USE =      43.3 MBTU

       NOTES TO TABLE
         1) THE FIRST PART LOAD ENTRY FOR EACH PIECE OF EQUIPMENT IS
            THE HOURLY LOAD DIVIDED BY THE HOURLY OPERATING CAPACITY
         2) THE SECOND PART LOAD ENTRY FOR EACH PIECE OF EQUIPMENT IS
            THE HOURLY LOAD DIVIDED BY THE TOTAL INSTALLED CAPACITY


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    EMC      ENGINEERS      INC.          EZDOE - ELITE SOFTWARE DEVELOPMENT INC          DOE-2.1D   8/ 7/1995    15: 8:11  PDL RUN 1
    DENVER,      CO        80227          GEODSS SITE DOE EVALUATION
REPORT- BEPS  ESTIMATED BUILDING ENERGY PERFORMANCE                                       TRUTH OR CONSEQU, N
---------------------------------------------------------------------------------------------------------------------------------

                        ENERGY TYPE
                        IN SITE MBTU -   ELECTRICITY
                       CATEGORY OF USE
                          SPACE HEAT          55.12
                          SPACE COOL        1568.95
                          HVAC AUX           426.63
                          DOM HOT WTR          0.00
                          AUX SOLAR            0.00
                          LIGHTS             288.88
                          VERT TRANS           0.00
                          MISC EQUIP        1233.86
                                         ----------
                           TOTAL            3573.45

              TOTAL SITE ENERGY        3573.36 MBTU     313.5 KBTU/SQFT-YR GROSS-AREA     313.5 KBTU/SQFT-YR NET-AREA
              TOTAL SOURCE ENERGY      3573.36 MBTU     313.5 KBTU/SQFT-YR GROSS-AREA     313.5 KBTU/SQFT-YR NET-AREA
              PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.4
              PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =100.0
              NOTE  ELECTRICITY AND/OR FUEL USED TO GENERATE ELECTRICITY IS APPORTIONED BASED
                    ON THE YEARLY DEMAND.  ALL OTHER ENERGY TYPES ARE APPORTIONED HOURLY.
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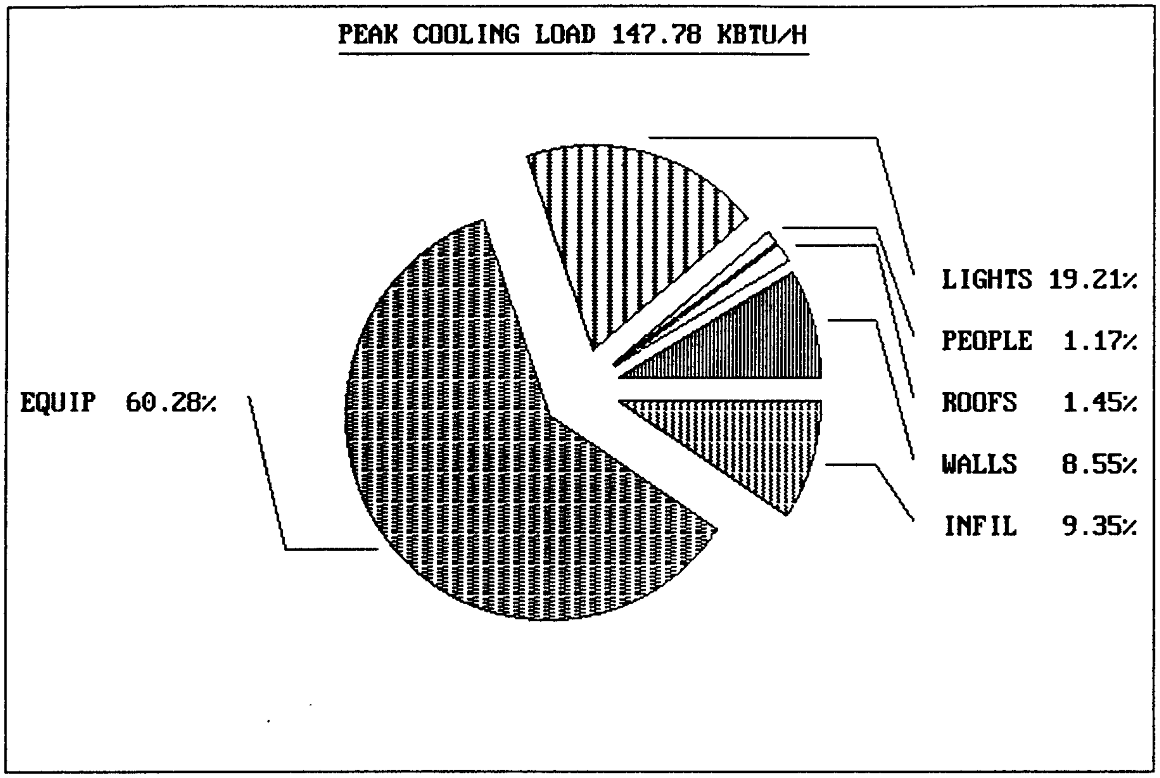
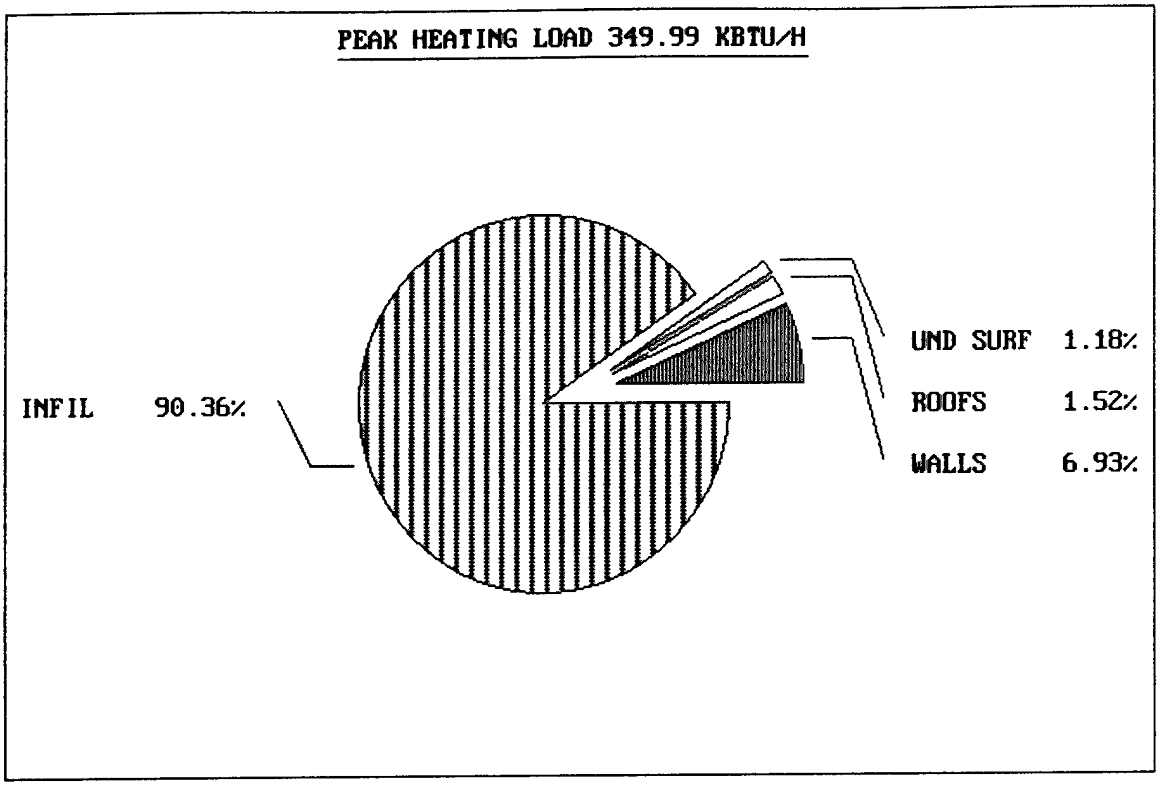
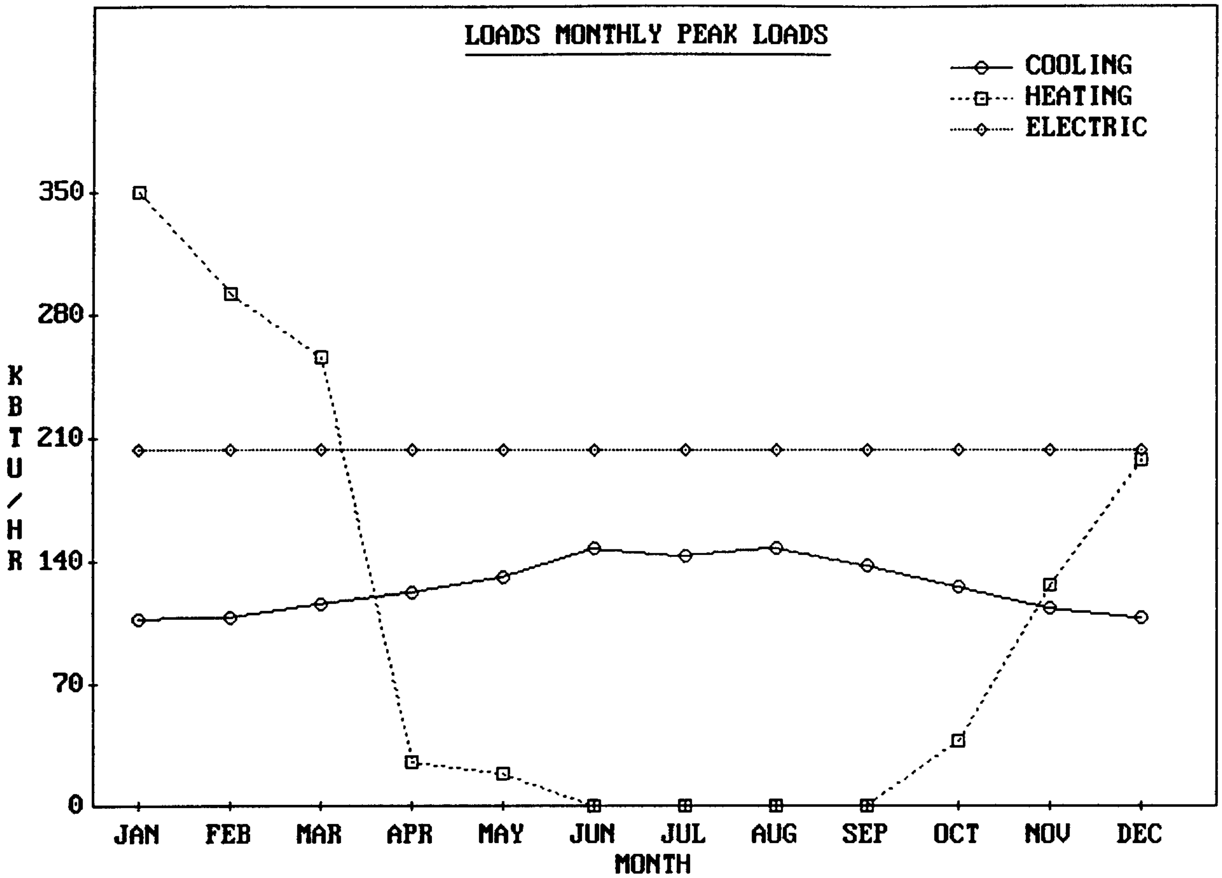
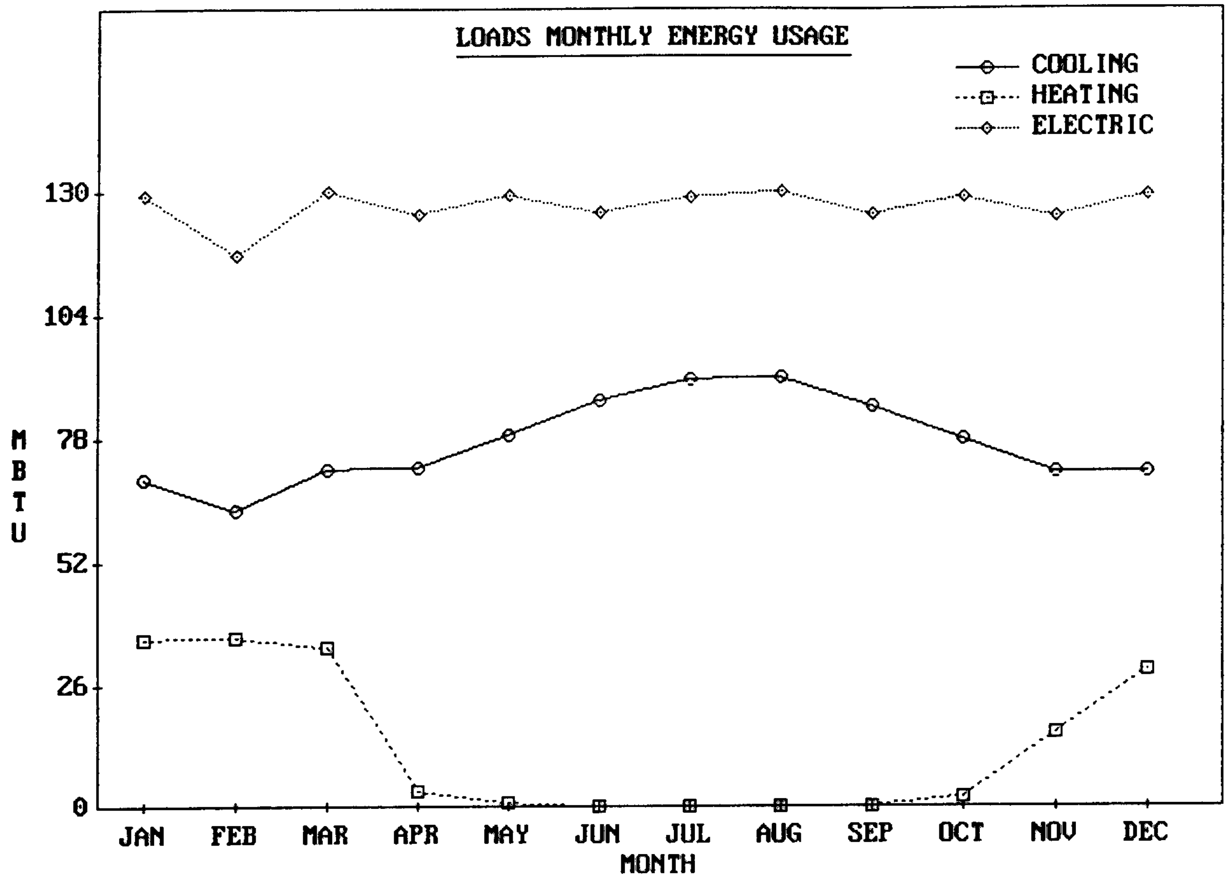

PEAK COOLING LOAD 147.78 KBTU/H
LIGHTS 19.21%
PEOPLE 1.17%
ROOFS 1.45%
WALLS 8.55%
INFIL 9.35%
EQUIP 60.28%

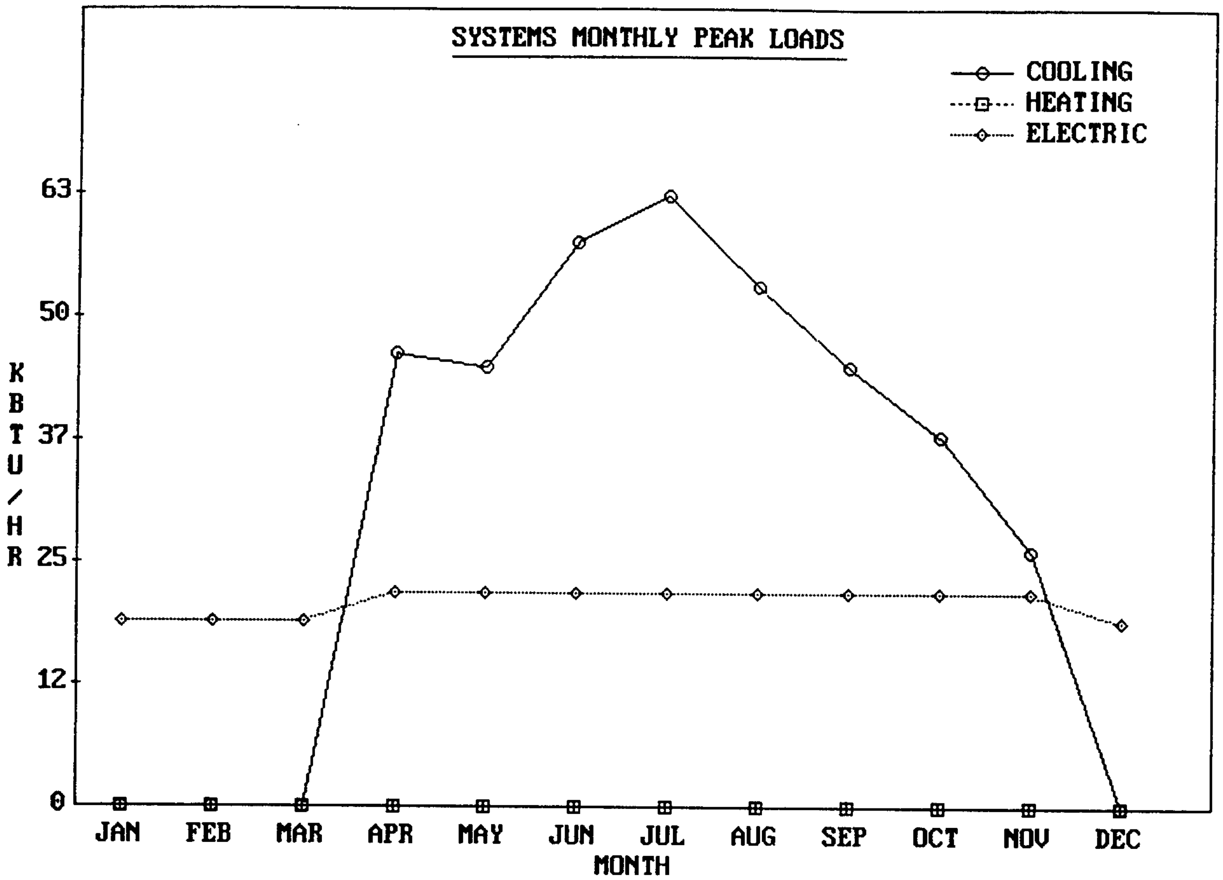

PEAK HEATING LOAD 349.99 KBTU/H
INFIL 90.36%
UND SURF 1.18%
ROOFS 1.52%
WALLS 6.93%

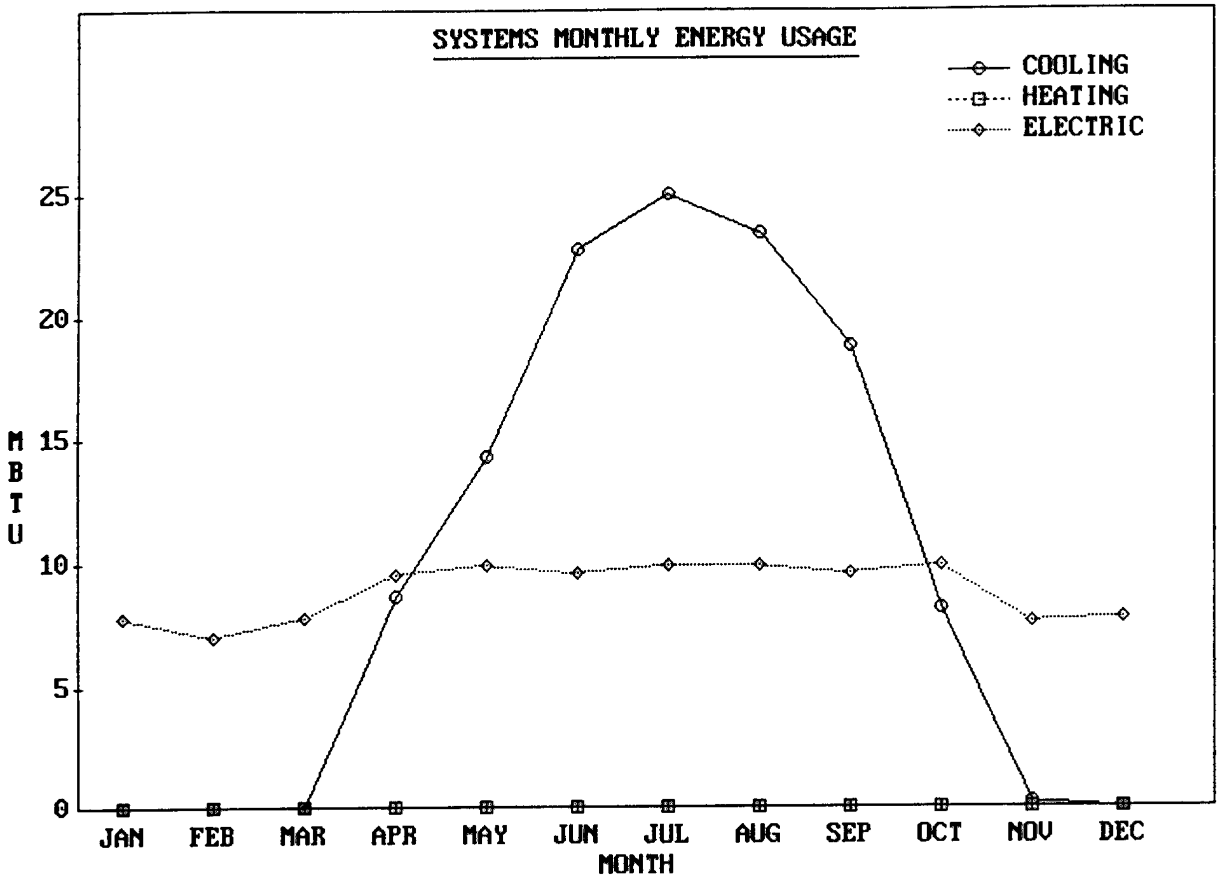


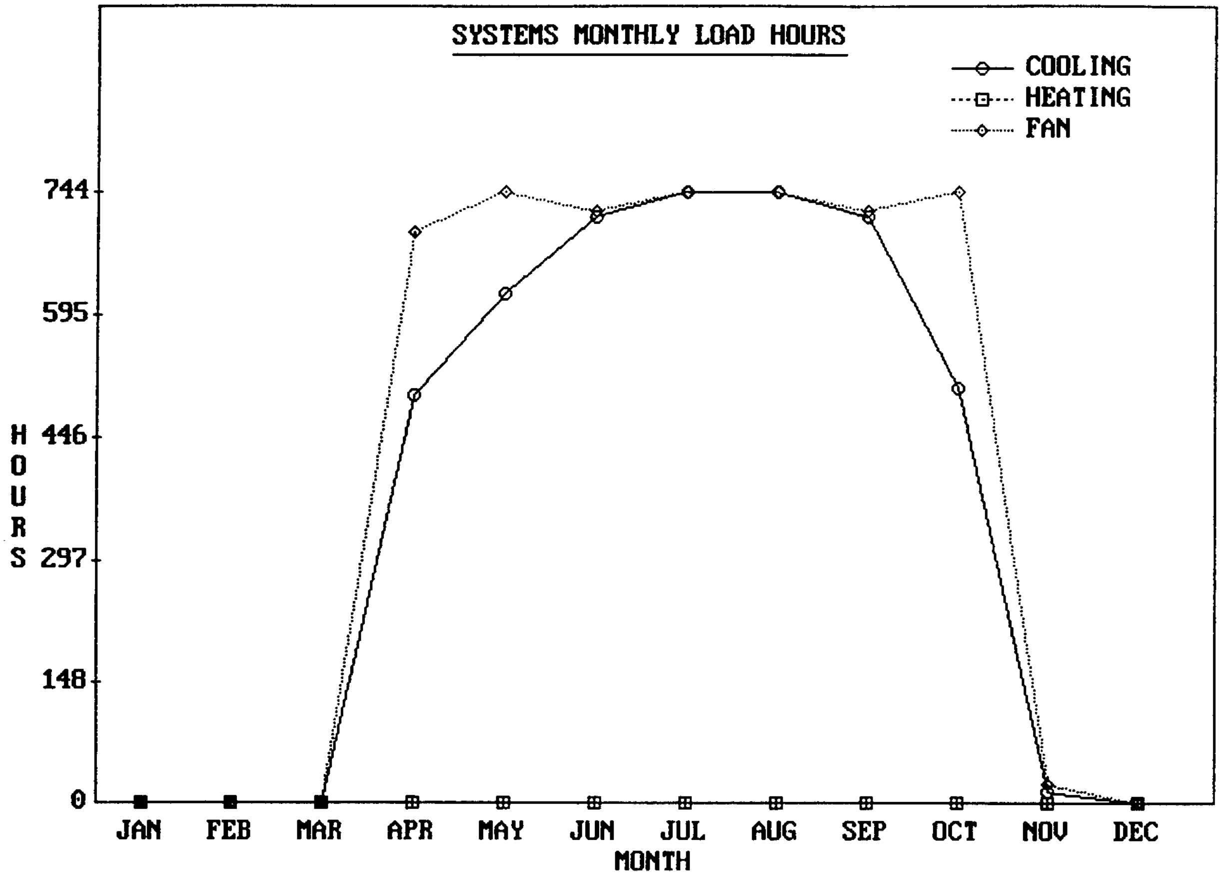
LOADS MONTHLY PEAK LOADS
COOLING
HEATING
ELECTRIC
KBTU/HR
350
280
210
140
70
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH

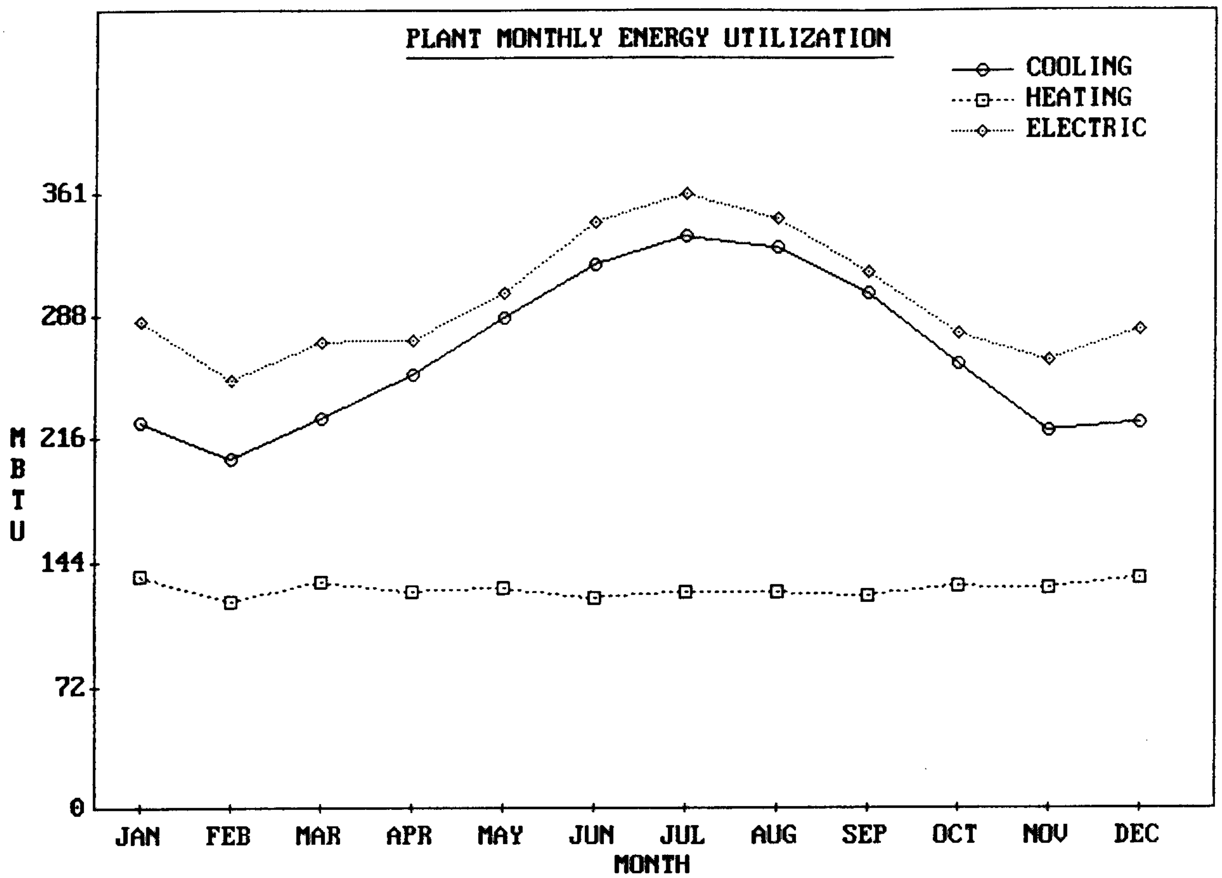


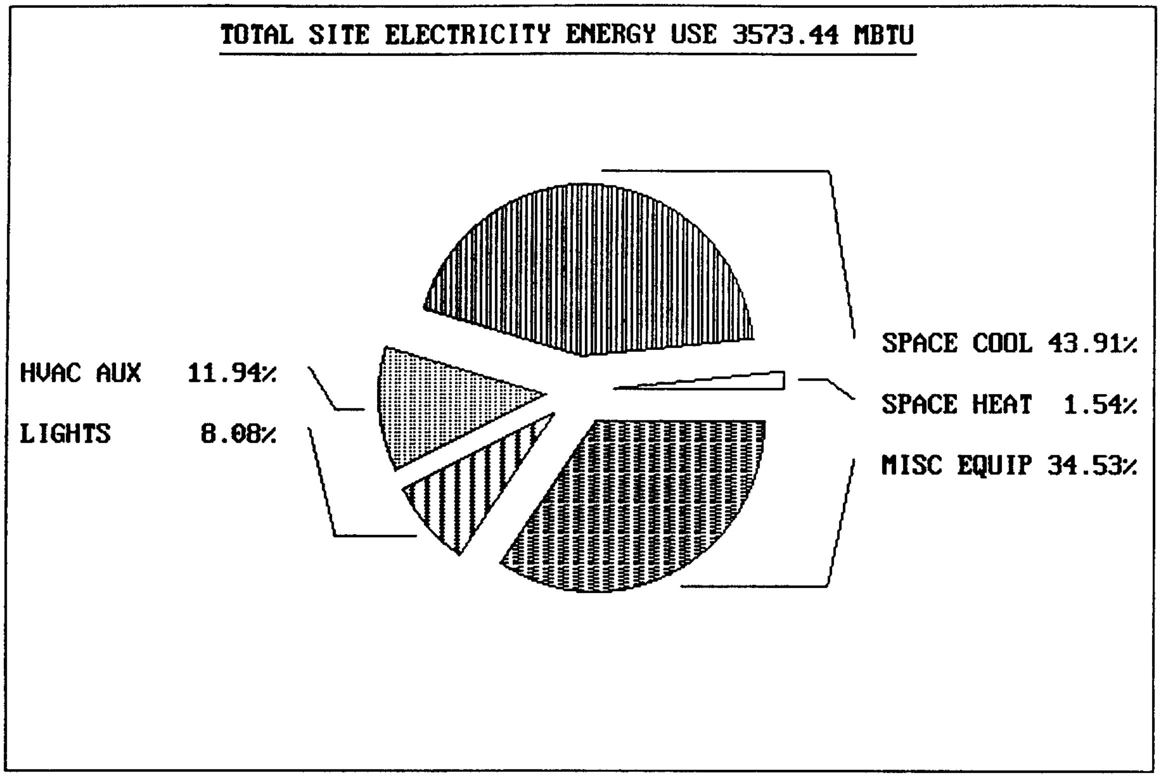
LOADS MONTHLY ENERGY USAGE
COOLING
HEATING
ELECTRIC
130
104
78
52
26
0
MBTU
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH

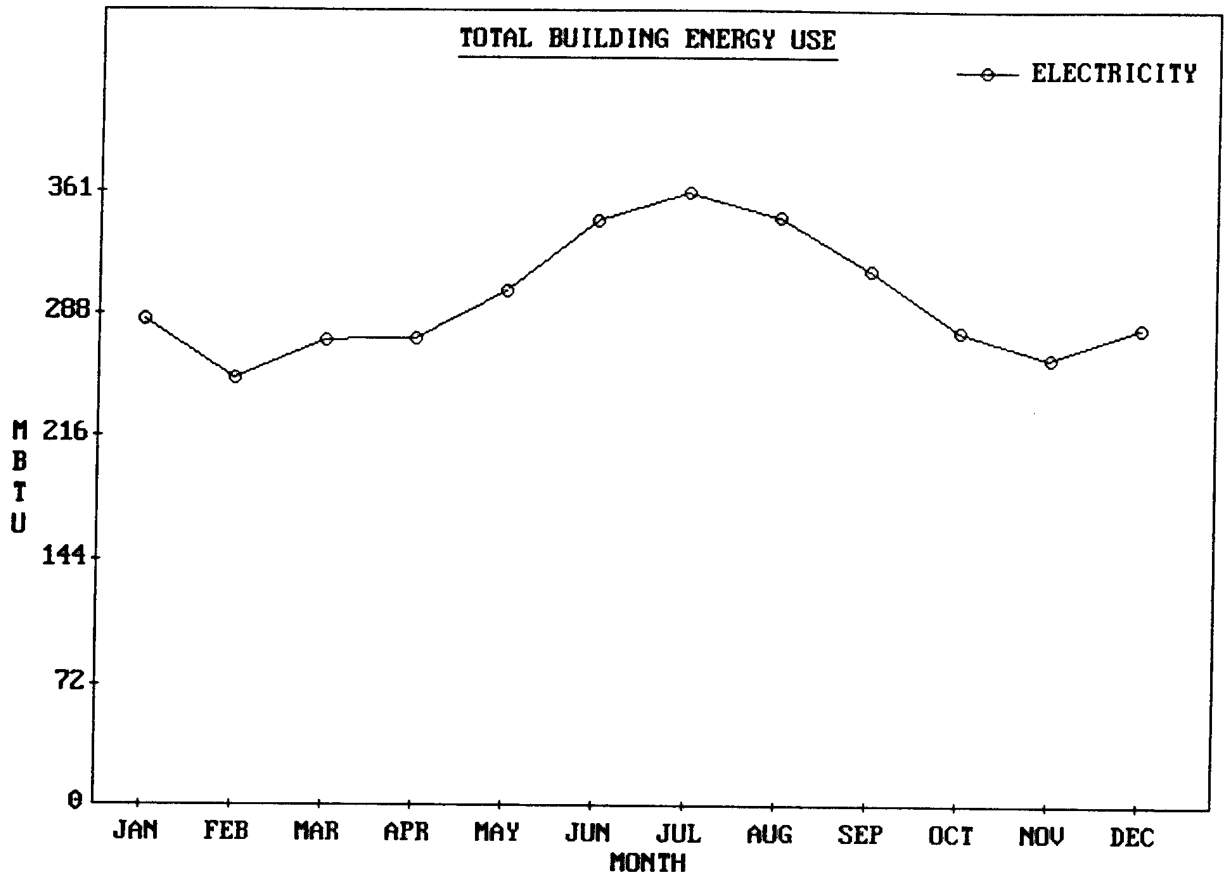

SYSTEMS MONTHLY PEAK LOADS
COOLING
HEATING
ELECTRIC
63
50
37
25
12
0
KBTU/HR
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH


SYSTEMS MONTHLY ENERGY USAGE
COOLING
HEATING
ELECTRIC
MBTU
0
5
10
15
20
25
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH


SYSTEMS MONTHLY LOAD HOURS
COOLING
HEATING
FAN
744
595
446
297
148
0
HOURS
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH


PLANT MONTHLY ENERGY UTILIZATION
COOLING
HEATING
ELECTRIC
361
288
216
144
72
0
MBTU
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH


TOTAL SITE ELECTRICITY ENERGY USE 3573.44 MBTU
HVAC AUX 11.94%
LIGHTS 8.08%
SPACE COOL 43.91%
SPACE HEAT 1.54%
MISC EQUIP 34.53%


TOTAL BUILDING ENERGY USE
ELECTRICITY
361
288
216
144
72
0
MBTU
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH

APPENDIX E

PROJECT DOCUMENTATION

1. COMPONENT AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 15-Nov-95

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
GEODSS Site, White Sands Missile Range, NM	**FEMP Energy Conservation Package**

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NO.	8. PROJECT COST ($000)
			160

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Primary Facilities:				
UPS System Modification	LS			21
Air Recirculation System	LS			21
High Efficiency Lighting	LS			11
Chiller Replacement	LS			89
Supporting Facilities				
Estimated Contract Cost				142
Supervision, Inspection and Overhead (6%)				9
Design (6%)				9
TOTAL REQUEST				160
TOTAL REQUEST (ROUNDED)				160
Installed Equipment-Other Appropriations				

10. DESCRIPTION OF PROPOSED CONSTRUCTION

This project includes four separate subprojects:

Uninterruptible Power Supply
Air Recirculation System
High Efficiency Lighting
Chiller Replacement

11. REQUIREMENT

This project is required for HVAC and lighting systems to operate at peak efficiency and effectiveness. An immediate utility savings would be recognized.

UPS System Modifications - Measurements on the existing 250 hp motor at the time of the field survey indicated that the motor was 11% loaded and was operating with a 65% efficiency and a 45% power factor.

The new 100 hp motor operating at the same conditions would be 28% loaded and operate with a 94% efficiency and a power factor of 68%.

1. COMPONENT AIR FORCE	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 15-NOV-95
3. INSTALLATION AND LOCATION GEODSS Site, White Sands Missile Range, NM		
4. PROJECT TITLE FEMP Energy Conservation Opportunity Package	5. PROJECT NUMBER	

11. REQUIREMENT (continued)

Air Recirculation System - Presently, the three telescopes use 100% outside air cooled with mechanical refrigeration for cooling. This system consumes significant energy as the cool air is directly vented to the outside and is not reused. According to the building personnel, there is no specific reason why this particular system is in place.

The project would provide return air ducting and motorized dampers which would allow recirculation with mechanical cooling or 100% outside air when outside air is cool.

High Efficiency Lighting - Fluorescent lighting fixtures in the building are equipped with standard 40 watt lamps and magnetic ballasts. High-efficiency T-8 fluorescent lamps and electronic ballasts would reduce lighting energy consumption by 32%.

Chiller Replacement - The current chillers are full-load use 1.43 kW/ton. At half-load this ratio increases to 1.72 kW/ton. These chillers also use R-22 refrigerant coolant which has been linked to the destruction of the ozone layer. The proposed chillers at full-load would use 1.51 kW/ton, but at half-load this ratio drops to 1.02 kW/ton.

Impact If Not Provided:

If this project is not funded, the GEODSS Facility will continue to operate with excessive energy requirements and will not realize a $432,000 life cycle energy savings over the next 20 years.

Supporting Documentation:

Supporting data includes the basic engineering calculations which show the energy savings. The supporting data was documented and conducted under an Army contract performed by an A-E firm (E M C Engineers, Inc.) in FY 95.

Verification of Savings:

The energy use for the periods prior to the project can be compared to the energy use for billing periods subsequent to the project upgrade.

Amount of Energy Conserved:

The amount of combined energy conserved is estimated to be 252,877 kWh/yr ($20,761/yr).

Summary of ECOs Recommended for FEMP Funding

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
7	UPS System	89,454	7,344	0	22,874	4.85	3.11
9	Recirculation of Tower Air	74,518	6,118	0	22,767	4.05	3.72
4	T-8 Fluorescent Lamps	29,455	2,418	47	12,429	2.38	5.04
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.30
	Combined Savings	252,877	20,761	47	157,609	2.74	5.7

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE Apr-95
3. INSTALLATION AND LOCATION GEODSS Site, White Sands Missile Range, NM		
4. PROJECT TITLE FEMP - Energy Conservation Opportunity Package		5. PROJECT NUMBER

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

LOCATION:	GEODSS Site, White Sands Missile Range, NM		REGION: 4	PROJECT NO:	
PROJECT TITLE:	FEMP - Energy Conservation Opportunity Package			FISCAL YEAR:	1995
DISCRETE PORTION NAME:	TOTAL				
ANALYSIS DATE:	11/22/95	ECONOMIC LIFE:	20	PREPARED BY:	D Jones

1. INVESTMENT

A. CONSTRUCTION COST =	=		$141,353	
B. SIOH COST	(5.5% of 1A) =		$7,774	
C. DESIGN COST	(6.0% of 1A) =		$8,481	
D. TOTAL COST	(1A +1B +1C) =		$157,609	
E. SALVAGE VALUE OF EXISTING EQUIPMENT =				
F. PUBLIC UTILITY COMPANY REBATE =				
G. TOTAL INVESTMENT	(1D -1E -1F) =		------->	$157,609

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

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

ECO	FUEL COST $/kWh (1)	SAVINGS kWh (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A. UPS System	$0.0821	89,454	$7,344	15.08	$110,750	
B. Recirculation of Tower Air	$0.0821	74,518	$6,118	15.08	$92,258	
C. T-8 Fluorescent Lamps	$0.0821	29,455	$2,418	12.02	$29,067	
D. Chiller Replacement	$0.0821	85,453	$7,016	15.08	$105,796	
E.						
F.						
G.						
H. TOTAL		278,880	$22,896		-------->	$337,872

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

A. ANNUAL RECURRING (+/-)

1 DISCOUNT FACTOR (From Table A) =

2 DISCOUNTED SAVINGS (+) / COST (-) (3A x 3A1) =

B. NON-RECURRING (+/-)

ITEM	SAVINGS (+) COST(-) (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3) (TABLE B)	DISCOUNTED SAVINGS/COST (4)
a. AVOIDED COST OF CHILLER REPLACEMENT	$99,539	2	0.943	$93,865
b. MATERIAL: NONE				
c. MATERIAL: NONE				
d. TOTAL	$99,539			$93,865

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (+) OR COST (-) (3A2 + 3Bd4) = $93,865

4.	FIRST YEAR DOLLAR SAVINGS (+) / COSTS (-)	(2H3 + 3A + (3Bd1/Economic Life))	$27,873
5.	SIMPLE PAYBACK (SPB) IN YEARS (MUST BE < 10 YEARS TO QUALIFY)	(1G/4) =	5.65
6.	TOTAL NET DISCOUNTED SAVINGS	(2H5 + 3C) =	$431,737
7.	DISCOUNTED SAVINGS-TO-INVESTMENT RATIO (SIR) (MUST HAVE SIR > 1.25 TO QUALIFY)	(6/1G) =	2.74