ENERGY STUDY OF ARMY INDUSTRIAL FACILITIES

OBER-RAMSTADT
WEST GERMANY

EXECUTIVE SUMMARY

FINAL SUBMITTAL

OCTOBER, 1988

PREPARED FOR

DEPARTMENT OF THE ARMY

EUROPEAN DIVISION, CORPS OF ENGINEERS

CONTRACT NO. DACA 90-86-C-0096

ROBERT & COMPANY/NEWCOMB & BOYD
A JOINT VENTURE

ATLANTA, GEORGIA

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OBER-RAMSTADT DEPOT ENERGY STUDY

EXECUTIVE SUMMARY FINAL SUBMITTAL

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1.0 INTRODUCTION AND SUMMARY

1.1 Introduction:

This document is the Executive Summary of the Energy Study of Army Industrial Facilities for the Ober-Ramstadt Depot in West Germany. The purpose of this document is to briefly outline the existing and historical energy situation, summarize the methodology for the development of energy conservation opportunities (ECO's) specific to the Ober-Ramstadt Depot, and present the specific energy conservation projects developed through the Energy Study.

This project was performed under the direction of the European Division of the U.S. Army Corps of Engineers under Contract No. DACA 90-86-C-0096. The study was performed by Robert & Company/Newcomb & Boyd, a joint venture, with home offices in Atlanta, Georgia. Local engineering support for the project was provided by Lahmeyer International, GmbH.

1.2 Ober-Ramstadt Depot:

The U.S. Army Depot Activity at Ober-Ramstadt was established in 1946. Located on a 20 acre site in Ober-Ramstadt, a village 10 kilometers south of Darmstadt, the Depot includes 32 buildings. (See Area Plan, Figure 1.1, and Site Plan, Figure 1.2). These buildings house a variety of functions including warehouse, administration, maintenance, process and personnel support. Of these buildings, 18 were identified under the Project's Detailed Scope of Work for inclusion in this Study. (See Building List, Figure 1.3). These buildings include the largest and most energy intensive at the site. The remaining buildings are either unheated or unused structures. The Depot is owned by the U.S. Government, administered by an on-site government staff as an element of the Mainz Army

Depot, and operated by the German firm MIP Instandsetzungsbetriebe GmbH.

1.3 Project Scope:

The energy audit and resulting engineering analysis of the Ober-Ramstadt Depot Industrial Facility included 18 buildings and their utility systems. Analysis of a building included not only the building's envelope mechanical and electrical systems, but also occupancy, operating schedules, and usage. Processes conducted in a building were closely scrutinized for potential energy conservation opportunities.

1.4 Objectives:

The objectives of the energy survey of the Ober-Ramstadt Depot Industrial Facility, as stated in the Scope of Work, were:

1. Perform a complete energy audit and analysis of the industrial facility.

2. Use and incorporate applicable data and results of related studies, past and current.

3. Identify all Energy Conservation Opportunities (ECO's) including Low/No cost items.

4. Perform an engineering and economic analysis of each ECO.

5. List and prioritize all ECO's based on Savings to Investment Ratio (SIR).

6. Prepare complete programming documentation for any Energy Conservation Investment Program (ECIP), Energy Conservation and Management Program (ECAM) projects.

7. Prepare implementation documentation for all ECO's identified for Quick Return on Investment Program (QRIP), OSD Productivity Investment Funding (OSD PIF), or Productivity Enhancing Capital Investment Program (PECIP) Funding.

8. Provide supporting information to facilitate the implementation of Low/No Cost ECO's.

9. Prepare a comprehensive report which will document the work accomplished, the results and recommendations.

1.5 Executive Summary Scope:

This report provides a summary of the energy and cost analysis leading to recommendation of the proposed energy conservation projects documented in the Energy Report. The Energy Report's prime objective is to use the data gathered during site visits and field inspections to select, analyze savings, estimate cost and evaluate economic criteria for energy conservation opportunities.

Section 2.0 of this report provides illustration of the existing energy situation at the site based on the available information provided by the Depot. Energy conservation opportunities (ECO's) considered for selection, or reasons for their rejection are documented in Section 3.0. These ECO's were derived from the list provided in the Scope of Work, facility suggestions, and experience on other projects. Section 4.0 provides a summary of calculated energy savings and capital investment costs for each of the ECO projects selected in Section 3.0. Section 4.0 of this Executive Summary briefly describes the energy conservation projects developed as a result of this analysis. Section 5.0 of this Summary addresses the impact on energy consumption of implementing the various energy conservation projects.

1.6 Final Submittal Methodology:

1.6.1 Objectives: The primary end product of the Energy Study of Army Industrial Facilities for the Ober-Ramstadt Depot is a consolidated list of architectural, mechanical, electrical and process modification projects which will result in a reduction of energy consumption.

1.6.2 Methodology: The analysis was accomplished by following these basic steps:

Step 1 - Prepare a master list of energy conservation opportunities (ECO's) for buildings and utility systems based on field survey experience and the list of ECO's included in the Scope of Work.

Step 2 - For each building and utility system, select those ECO's from the master list which are applicable according to the survey data.

Step 3 - Calculate energy savings for each ECO/building/system combination. The calculation process uses a combination of computerized and manual methods. Manual methods are used where the ECO's are simple and are not affected by other ECO's.

Computer analysis is used for building ECO's where many interrelated factors affect the results. The computer analysis consists of a base-line and a modified analysis. The base-line run is based on existing conditions and operations. Subsequent runs simulate performance after the energy conservation project under study is implemented. The difference between these runs are the savings estimated for that ECO.

Step 4 - Calculate the cost to implement each ECO selected for each building. Costs have been developed from manufacturer's quotes, contracting experience, and cost data supplied by our German engineering consultants, Lahmeyer International. All costs in the analysis are based on 1987 prices. In preparing specific project documentation, the cost was escalated as required by the specific program guidance.

Step 5 - Based on the savings and costs identified in Steps 3 and 4, an economic analysis, as defined in ECIP criteria, was performed. Economic parameters include Total Discounted Savings, Simple Payback Period, and SIR.

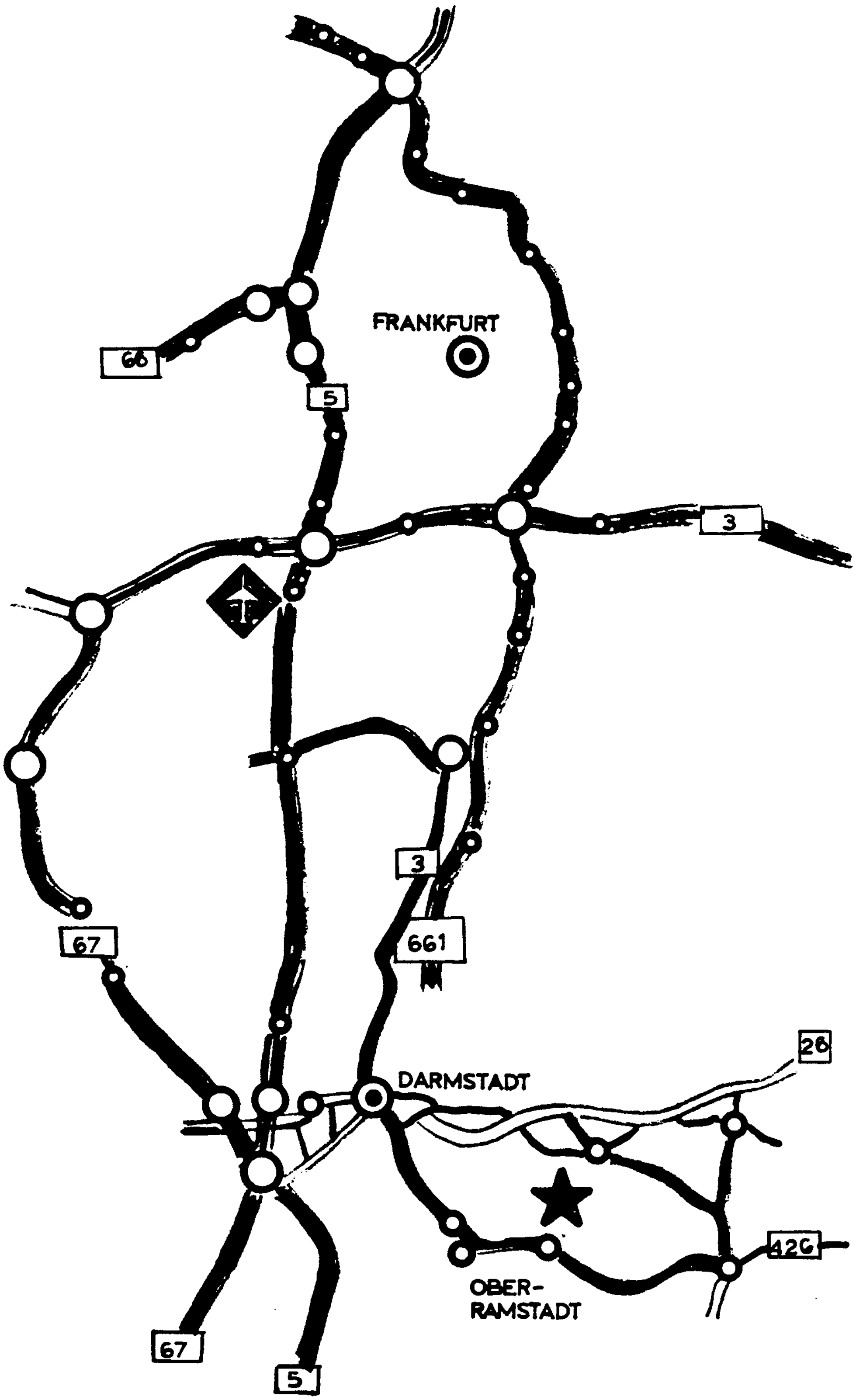
Step 6 - Suggested packaging schemes for combining individual ECO's for individual buildings into projects are discussed with installation personnel following the Interim and Prefinal Submittals.

Step 7 - Using comments received on the Interim and Prefinal Submittals and the list of qualifying ECO's, associated economic calculations are updated.

Step 8 - Programming or implementation documentation for each energy conservation project were prepared. Documents are prepared using criteria furnished at the Energy Study's inception according to the type of funding source (ECIP, QRIP, OSD-PIF, PECIP, or Low/No Cost).

FIGURE 1.1 OBER – RAMSTADT DEPOT

AREA LOCATION MAP



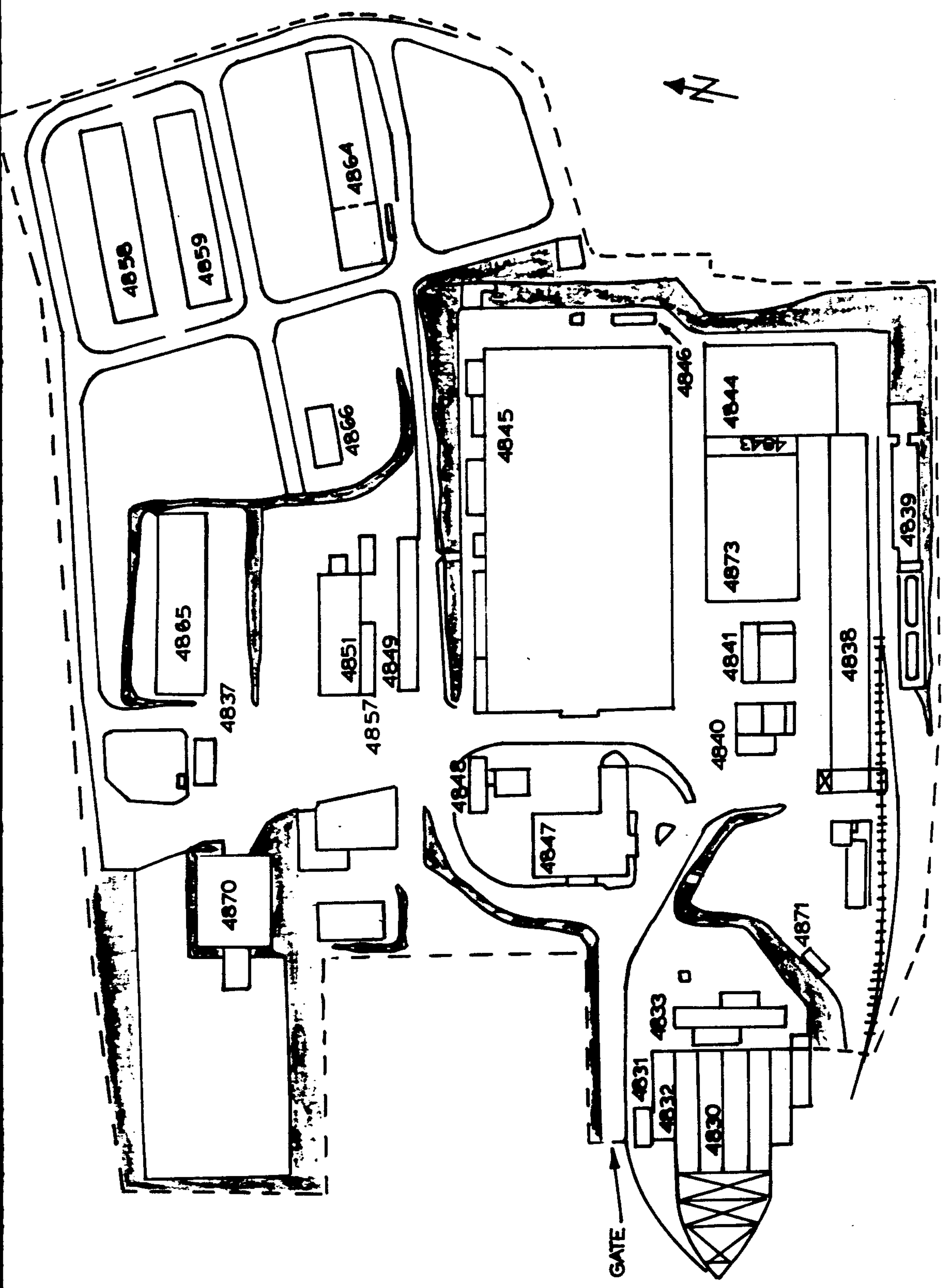


FIGURE 1.2 OBER – RAMSTADT DEPOT

SITE PLAN

FIGURE 1.3

FACILITIES TO BE SURVEYED
OBER-RAMSTADT INDUSTRIAL FACILITY

Bldg. No.	Use	Area (SF)
4831	Sentry Station	771
4832	Classroom	2,744
4833	Canteen	4,170
4838	Maintenance Shop General Purpose	16,917
4839	Heating Plant Building	5,081
4840	Maintenance Shop General Purpose	2,395
4841	Maintenance Shop General Purpose	1,346
4844	Storage Shed General Purpose	15,902
4845	Maintenance Shop General Purpose	78,088
4846	Maintenance Shop General Purpose	533
4847	Administration Bldg. General Purpose	8,709
4848	Ordance Administration Bldg.	2,633
4849	Change House	4,034
4851	Vehicle Maintenance Shop Organi-zational	6,658
4857	Vehicle Maintenance Shop Organi-zational	1,209
4864	Open Warehouse Facility/Maintenance Shop General Purpose	12,616
4872	Maintenance Shop General Purpose	530
4873	Maintenance Shop General Purpose	12,062

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2.0 EXISTING ENERGY SITUATION

2.1 Background:

As part of the energy study for the Ober-Ramstadt Depot, past and present energy consumption was examined.

An examination of the existing energy situation can provide an indication of the relative importance of each type or component of the total energy consumption. By comparing how much energy is used for heating vs. the consumption for domestic water heating, for example, the study may establish priorities for those items having the greatest potential for energy savings. One difficulty which arises in performing this type of analysis is the general lack of sub-metering data of a particular installation's energy consumption. Since most Army facilities were constructed during a time when energy costs were relatively unimportant, very little emphasis in the past has been placed on actual metering of energy usage for a particular function. For example, it's impossible in most cases to examine actual metered data of an individual building's energy consumption within a facility or the usage of energy for different activities within a building. Since this metered data is not available, engineering estimates had to be made to determine the data.

2.2 General Description:

The buildings of the depot facility utilize electricity purchased from the local electric utility. Electricity is utilized for a variety of tasks including lighting, operation of heating system distribution equipment, and office equipment. Many processes performed in refurbishing the tires, trackshoes and road wheels also consume electricity.

Fossil fuels, including No. 2 oil and No. 6 oil, are consumed by the boiler plants to produce steam. This steam is distributed to the various buildings and utilized for space heating, domestic hot water heating and direct process applications.

No detailed sub-metering data is available for the site to provide a break down of energy consumption by component. Computer modeling and engineering estimating techniques have been used to assess constituent energy consumption.

2.3 Distribution Systems Analysis:

2.3.1 Steam System:

Steam is produced in the central boiler plant, Building 4839, by two 3500 kw capacity, No. 6 fuel oil burning boilers, operating at 8 bar pressure and distributed throughout the facility. (See Figure 2.1). The boilers and accessories in the boiler plant are in good condition and well maintained. From steam production records for FY86 25,529 metric tons of steam were produced. During the same period, the boiler plant consumed 1,963,249 liters of Number 6 fuel oil. Using this data and energy equivalencies provided in the ECIP guidance, an average steam production efficiency of 85.8% was calculated. Boiler combustion efficiency measurements made during the field survey produced an 87% efficiency at full load and 80% efficiency at part load. These high efficiencies are attributable to good maintenance, modern boiler design, and high system utilization. German regulations on boiler stack emissions will require the conversion of the plant to No. 2 fuel oil.

During full production and during sever winter weather, both boilers are required to meet steam consumption demand. Existing production schedules call for operation of the main boiler plant 24 hours per day, five days per week. In moderate weather, the main boiler plant remains idle on weekends. Space heating demands during these periods can be met by backfeeding the distribution system with 0.3 bar steam from the boiler plant in Building 4847. When weekend temperatures fall below 0°C, the main boiler plant must operate to meet demand.

The steam distribution system heat loss was calculated. Using field data on insulation thickness, pipe sizes, lengths and system operating temperatures for all exterior high and low pressure steam, condensate, and hot water distribution systems, a total annual heat loss of 810.14×10^6 BTU/year was calculated. This value represents less than a 2% distribution system loss. High efficiency is due in part to proper system design and maintenance, and in part to the high steam distribution system utilization.

2.3.2 Electrical System:

The main electrical service to the site is provided by a 20 kv underground primary. This primary serves 5-630 KVA transformers located in three buildings. The 220/380V secondary is then distributed within those buildings and throughout the site.

The site lighting consists primarily of 80 watt high pressure sodium and 55 watt low pressure sodium fixtures. These fixtures are mounted on 30 foot poles and run the perimeter of the site. They are served through one contactor panel which is controlled by one photo electric device.

2.4 Utility Metering:

2.4.1 Electricity:

The electric metering for the site is accomplished by metering the primary input. No separate metering of individual buildings exists.

The total cost for electrical energy is based on a fixed cost for a peak demand and on a kilowatt hour consumption cost. Consumption costs are divided into two rate schedules, one for day and one for night consumption, with an additional cost for each kilowatt hour for environmental taxes. These electrical rate schedules are shown in Figure 2.2.

Records of monthly electrical consumption were obtained for the past 3 years for the site. This data is tabulated in Figure 2.3. These records are for the entire site and are not divided into individual areas or buildings.

2.4.2 Fuels:

Fuel prices were supplied by the Contractor and are shown in Figure 2.4.

No metering of actual fuel consumption installation wide or at a specific building is used. Records of monthly fossil fuel consumption for the Depot were obtained from the Contractor for the past 3 fiscal years from fuel purchase receipts for No. 6, No. 2 and gasoline fuels. These figures represent fuel purchased and are not necessarily the actual fuel consumed.

2.5 Fossil Fuels:

The central boiler plant in Building 4839 burns No. 6 fuel oil. Records of fuel oil purchases for the past 3 years were obtained and are presented in Figure 2.5 in tabular form. Steam production data for the same period is included for comparison as Figure 2.6.

The small boiler plant in Building 4847 burns No. 2 fuel oil. Partial records of fuel purchases over the past 3 years were obtained and are presented in tabular form as Figure 2.7.

Diesel fuel purchases for trucks, fork lifts, and maintenance equipment are tabulated in Figure 2.8.

Records of gasoline consumption are presented in tabulated form as Figure 2.9. The consumption and utilization of gasoline was not specifically addressed in this study because it is used to fuel transportation of products beyond the boundaries of the Depot.

2.6 Energy Utilization Analysis

Investigation of the Ober-Ramstadt Facility showed that two sources, steam and electricity, played the major roles in providing the energy required to operate the facility. Steam is very important to the rubber curing process as it is used to heat the vulcanizing presses. Steam is also used for space heating and many other process applications. Electricity is used in practically every facet of the facility including equipment motors, welding, lighting and HVAC. The task of dividing these energy sources according to process and area involved data gathering and calculation of many types. The results of these findings are described below.

2.7 Steam:

The total steam consumption for 1986 was not available at the time this analysis was performed and, therefore, the annual consumption for 1985 was used. Steam consumption was calculated for each major piece of equipment and for the heating loads of the various facilities. Using these values and the steam consumption data, yearly steam consumption for each process was calculated giving 23.15 x 10^9 btu/yr for the tires, 9.26 x 10^9 btu/yr for the roadwheels, 6.19 x 10^9 btu/yr for the single pin track shoes, 7.54 x 10^9 BTU/yr for double pin track shoes, and 2.09 x 10^9 btu/yr for special products, giving a total consumption of 48.23 x 10^9 btu/yr of steam for the process. Based on the consumptions calculated, a usage of about 69.61 x 10^9 btu/yr of steam is expected for 1986. The values for process consumption are summarized in Figure 2.10.

2.8 Electricity

The total electrical consumption for 1986 was 4,236,300 kwh taken from data supplied by the plant. Through field investigation and calculation, sources of electrical usage were identified and their consumption approximated. By field data taken from auxiliary HVAC equipment, an annual value of 300,597 kwh was calculated. Lighting arrangements and usages were observed and a lighting consumption of 394,520 kwh was calculated for the facility.

Process electrical consumption was evaluated in several ways. A recording ammeter was used to find current loads at individual pieces of equipment or for entire process areas. Then, based on observed process procedures and times, an annual energy consumption was calculated. Where no amp readings were taken, equipment nameplate data was used to approximate yearly consumption. A large consumer of energy was found to be the air compressor whose amp reading was taken and annual energy usage was calculated to be 821,300 kwh. This value was distributed evenly among the tire, roadwheel, single and double pin track shoe processes since they are primary users of compressed air. The boiler plant was treated in a similar manner, assuming about 90% of the electricity used to run the boiler is for the processes. Lighting values were also broken out by process and applied to each process total. Combining this number with those for the boiler, compressor and lights yields a consumption of 620,334 kwh/yr for the double pin process. Electrical energy consumption for the other processes was calculated yielding 717,831 kwh/yr for tires; 754,761 kwh/yr for roadwheels; 1,052,635 kwh/yr for single pin track; and 56,060 kwh/yr for special products. This gives a total annual consumption of 3,201,621 kwh/yr for all processes. These numbers are compiled and shown in a summary of values on Figure 2.11.

2.9 Energy Consumption Per End Product

Energy consumption for each process was calculated and combined with production records, enabled calculation of btu's per end product. Data on scrap for each process was included. Scrap comes from three inspection points - receiving, pre-shop inspection and during production and escalates the energy consumption per end product since some energy is consumed by waste products. The more scrap that can be identified early in the process, such as during receiving and pre-shop inspection rather than during production, the greater the contribution to energy savings per end product. Figure 2.12 shows consumption per product by energy type.

2.9.1 Tires

Based on 1985 production records and the use of electricity, steam and gasoline, the energy consumption rate is calculated to be 477,693 btu/tire. Most of the energy used for tires is from the steam used at various points in the process but mainly for vulcanizing. Much of the scrap from this process is found in preshop inspection and receiving preventing process energy for being wasted on useless items.

2.9.2 Roadwheels

Based on 1985 production recorded for steel and aluminum roadwheels, the energy consumption per end product is calculated to be 289,087 btu/wheel. The main energy source for roadwheels is steam although it uses roughly one half the steam that the tires do. Roadwheels, however, use more gasoline since much more forklift traffic is required than for tires. Large percentages of scrap wheels are found during preliminary receiving inspections helping to reduce wasted process energy.

2.9.3 Single Pin Track Shoes

Also based on 1985 production, an energy consumption of 42,847 btu per shoe was calculated. This consumption is the lowest of all processes, due in part to the small size of the track shoe, and to higher process efficiencies made possible through high volume output. Steam again is the primary energy source with electricity close behind. All of the scrap items are found during production since preliminary inspection is difficult when these track shoes are still assembled and have rubber on them. This energy consumption, therefore, is quite good considering that a large amount of process energy is wasted on scrap.

2.9.4 Double Pin Track Shoes

Production data from 1986 was used as a basis to calculate energy consumption of 193,759 btu/shoe for double pin track shoes. Although this is lower than that for the tires and roadwheels, it is significantly higher than that for the single pin track shoes, due mainly to the inefficiency of breaking in a new system. Many machines are left on while waiting for parts from other process stages. Steam consumption is again the main energy source and is about 4.7 times higher per shoe than that for the single pins. Electricity consumption is significantly lower but is still about 2.7 times greater than that for single pins. High steam usage may be accounted for in the adhesive dryer system which is rather large but not always worked at capacity. Gasoline consumption is low since the process is contained in one building, keeping forklift time to a minimum. Also, similar to the single pin process, 100% of all scrap is found at some point during production, wasting some process energy on scrap items.

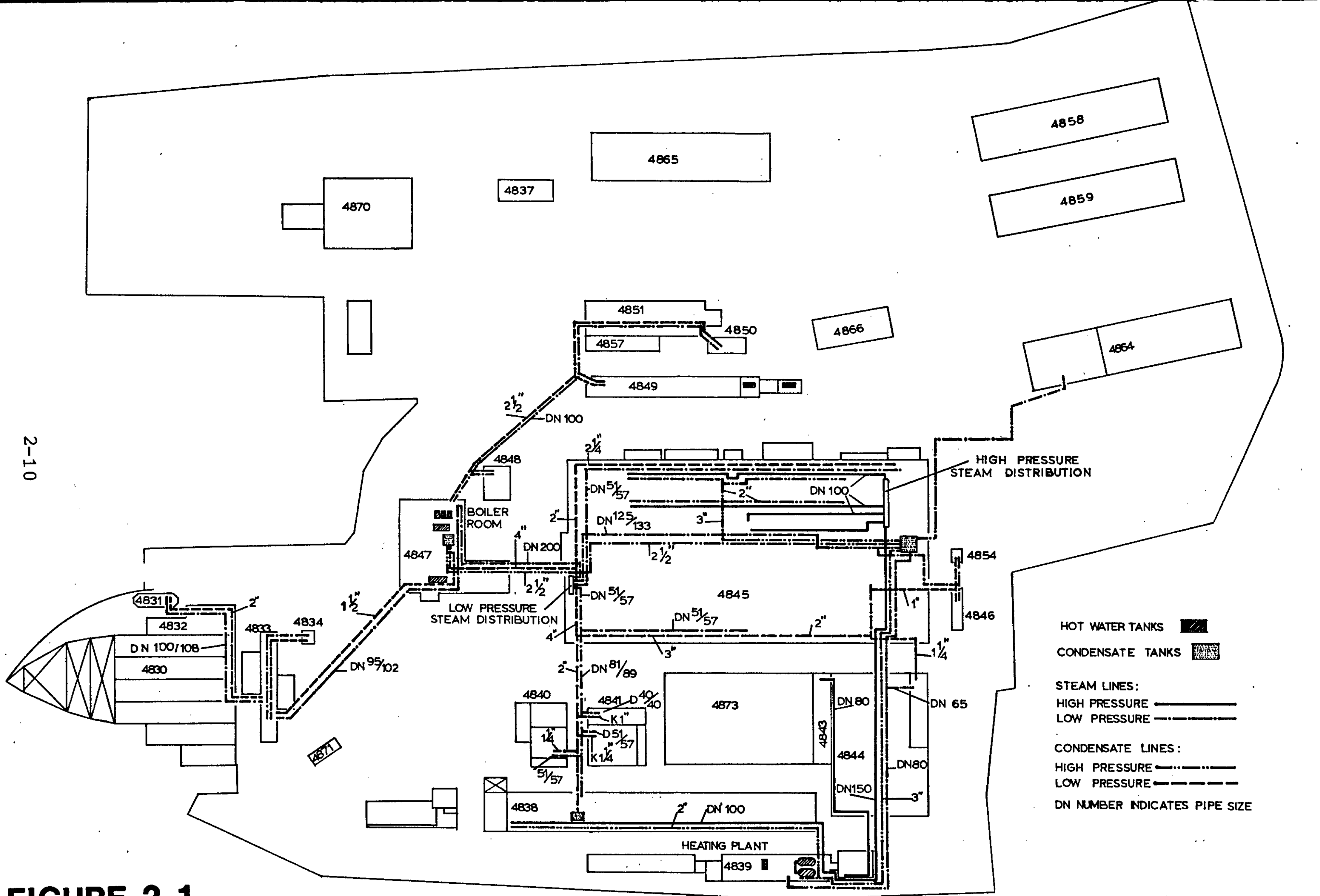

FIGURE 2.1
STEAM DISTRIBUTION SYSTEM

FIGURE 2. 2

ELECTRIC UTILITY RATE SCHEDULE

FIXED COST FOR PEAK DEMAND

0-250 KILOWATTS	-	23.1625	DM/KW
250-500 KILOWATTS	-	20.5892	DM/KW
OVER 500 KILOWATTS	-	18.015	DM/KW

CONSUMPTION COSTS

DAY RATE 0.1079 DM/KWH

APR - SEP: 0700-2000

OCT - MAR: 0600-2100

NIGHT RATE .0809 DM/KWH

APR - SEP: 2000-0700

OCT - MAR: 2100-0600

(PLUS)

ENVIRONMENTAL TAXES- 0.011 DM/KWH

FIGURE 2.3 ELECTRIC ENERGY CONSUMPTION (KILOWATT HOURS)

	FY 1984	FY 1985	FY 1986
OCT	259,900	283,900	267,900
NOV	247,800	307,900	373,100
DEC	284,300	286,100	365,500
JAN	228,500	233,500	281,200
FEB	415,000	318,500	426,800
MAR	392,046	273,900	433,800
APR	324,800	265,900	315,000
MAY	209,200	244,600	350,400
JUN	237,300	201,700	363,300
JUL	229,600	238,000	335,800
AUG	228,900	233,300	372,000
SEP	257,900	283,400	351,500
TOTAL	3,315,246	3,170,700	4,236,300

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NOTE: DOUBLE PIN TRACK SHOE PRODUCTION START 1 OCT. 1985

FIGURE 2.4

Energy Costs

	Purchase Price[1]	Equivalent Cost[2]
Electricity	0.1189 DM/KWH	$14.16/MBTU
No. 2 Fuel Oil	$0.21673/liter	$ 5.91/MBTU
No. 6 Fuel Oil	$0.19725/kg	$ 4.85/MBTU
Liquid Nitrogen	0.167 DM/liter	$ 0.04/MBTU

1) Fuel and electricity purchase prices are based on current Energy Costs at Ober-Ramstadt Depot at the time of this study.

2) Equivalent energy costs were calculated using purchase price and energy conversion factors below from ECIP Guidance dated 4 March 1985 furnished by DAEN-ZCF-U and updated by letter dated 10 January 1986 from DAEN-ZCF-U.

Conversions

1 KWH Electricity	=	3,413 BTU
1 Gal. No. 2 Oil	=	138,700 BTU
1 Gal No. 6 Oil	=	150,000 BTU
1 Lb Liquid Nitrogen	=	85.8 BTU

FIGURE 2.5 NUMBER 6 FUEL OIL (LITERS)

	FY 1984	FY 1985	FY 1986
OCT	———	113,814	85,242
NOV	———	183,969	187,303
DEC	———	140,067	175,773
JAN	229,600	231,273	184,878
FEB	219,379	230,459	234,807
MAR	160,000	208,877	234.260
APR	168,100	185,136	184,688
MAY	87,959	145,009	126,690
JUN	136,900	128,489	121,212
JUL	177,200	124,243	119,595
AUG	111,340	138,116	128,041
SEP	197,137	177,674	180,760
TOTAL	———	2,007,126	1,963,249

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FIGURE 2.6 STEAM PRODUCTION

(METRIC TONS)

	FY 1984	FY 1985	FY 1986
OCT	2088	2323	2098
NOV	2491	2263	2467
DEC	2501	1829	1461
JAN	2396	3078	2856
FEB	2691	2630	3259
MAR	2784	2467	2530
APR	1979	1902	2289
MAY	1908	1478	1307
JUN	1587	1256	1809
JUL	2199	1529	2000
AUG	1880	1755	1685
SEP	1594	1713	1768
TOTAL	26,098	24,223	25,529

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FIGURE 2.7 NUMBER 2 FUEL OIL (LITERS)

	FY 1984	FY 1985	FY 1986
OCT	-	-	1100
NOV	8100	600	2800
DEC	-	5220	3600
JAN	6400	7600	11,200
FEB	4200	4200	3400
MAR	600	1200	1200
APR	382	5900	4100
MAY	6900	1300	6650
JUN	4200	1400	-
JUL	800	-	-
AUG	1200	-	-
SEP	-	-	-
TOTAL			

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FIGURE 2.8 NUMBER 2 FUEL OIL (DIESEL) (LITERS)

	FY 1984	FY 1985	FY 1986
OCT	-	700	1677
NOV	-	553	2241
DEC	-	329	1586
JAN	-	1287	2055
FEB	-	1953	3489
MAR	-	1763	2687
APR	-	1434	2649
MAY	-	1366	2660
JUN	-	632	2744
JUL	1041	1302	3345
AUG	700	1147	3266
SEP	1680	2903	3535
TOTAL	-	15,368	31,934

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FIGURE 2.9 GASOLINE CONSUMPTION (LITERS)

	FY 1984	FY 1985	FY 1986
OCT	2899	5434	4099
NOV	5972	9029	7453
DEC	6100	4912	4277
JAN	4988	5465	4621
FEB	6611	7096	6127
MAR	6108	5926	6090
APR	7580	5661	5129
MAY	5601	5722	4920
JUN	6070	5143	4784
JUL	6626	6910	6252
AUG	5211	5775	5704
SEP	9820	8643	7505
TOTAL	73,586	75,716	66,961

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FIGURE 2.10

ESTIMATED PROCESS STEAM USAGE

1. TIRES:

Presses	11.20	Million Lbs./Yr.	=	13.31	Billion BTU/Yr.
Tire Wash	1.55	Million Lbs./Yr.	=	1.84	Billion BTU/Yr.
Section Molds	1.37	Million Lbs./Yr.	=	1.63	Billion BTU/Yr.
Leaks	5.36	Million Lbs./Yr.	=	6.37	Billion BTU/Yr.
Total	19.48	Million Lbs./Yr.	=	23.15	Billion BTU/Yr.

2. ROADWHEELS:

Presses	3.17	Million Lbs./Yr.	=	3.77	Billion BTU/Yr.
Paint Dryer	1.34	Million Lbs./Yr.	=	1.59	Billion BTU/Yr.
Adhes. Dryer	1.15	Million Lbs./Yr.	=	1.37	Billion BTU/Yr.
Degreaser	0.80	Million Lbs./Yr.	=	0.95	Billion BTU/Yr.
Leaks	1.33	Million Lbs./Yr.	=	1.58	Billion BTU/Yr.
Total	7.79	Million Lbs./Yr.	=	9.26	Billion BTU/Yr.

3. SINGLE PIN TRACK SHOES

Presses	1.80	Million Lbs./Yr.	=	2.14	Billion BTU/Yr.
Dryer	1.73	Million Lbs./Yr.	=	2.06	Billion BTU/Yr.
Degreaser	0.22	Million Lbs./Yr.	=	0.26	Billion BTU/Yr.
Leaks	1.46	Million Lbs./Yr.	=	1.73	Billion BTU/Yr.
Total	5.21	Million Lbs./Yr.	=	6.19	Billion BTU/Yr.

4. DOUBLE PIN TRACK SHOES

Presses	1.48	Million Lbs./Yr.	=	1.76	Billion BTU/Yr.
Dryer	3.67	Million Lbs./Yr.	=	4.36	Billion BTU/Yr.
Degreaser	0.13	Million Lbs./Yr.	=	0.15	Billion BTU/Yr.
Leaks	1.07	Million Lbs./Yr.	=	1.27	Billion BTU/Yr.
Total	6.35	Million Lbs./Yr.	=	7.54	Billion BTU/Yr.

5. SPECIAL PRODUCTS

Total	1.76	Million Lbs./Yr.	=	2.09	Billion BTU/Yr.

6. TOTAL PROCESS

	40.59	Million Lbs./Yr.	=	48.23	Billion BTU/Yr.

Note: 1 Pound Steam = 1188 BTU

FIGURE 2.11

ESTIMATED PROCESS ELECTRICITY USAGE

1. TIRES:

Molds	52,592	KWH/Yr.
Buffing Skiving	177,212	KWH/Yr.
Tire Drying *	5,000	KWH/Yr.
Tire Wash	20,000	KWH/Yr.
Inspection Area	10,000	KWH/Yr.
Strip Application	110,000	KWH/Yr.
Boiler Plant	56,270	KWH/Yr.
Compressor	205,325	KWH/Yr.
Lights	81,432	KWH/Yr.
Total	717,831	KWH/Yr.

2. ROADWHEELS:

1/2 Building 4838	315,552	KWH/Yr.
Welding	102,544	KWH/Yr.
Induct. Furnace/N2 4840	40,000	KWH/Yr.
Boiler	56,720	KWH/Yr.
Compressor	205,325	KWH/Yr.
Lights	35,070	KWH/Yr.
Total	754,761	KWH/Yr.

3. SINGLE PIN TRACK SHOES

1/2 Building 4838	315,552	KWH/Yr.
Induct. Furnace 4840	70,000	KWH/Yr.
Bushing Presses 4845	236,664	KWH/Yr.
Auto. Welder 4845	18,664	KWH/Yr.
Weld/Grind 4845	33,527	KWH/Yr.
Hyd. Pumps 4845	19,722	KWH/Yr.
Hyd. Pumps 4841	20,000	KWH/Yr.
Boiler	56,270	KWH/Yr.
Compressor	205,325	KWH/Yr.
Lights	56,270	KWH/Yr.
Total	1,052,635	KWH/Yr.

4. DOUBLE PIN TRACK SHOES

Building 4873 Main	289,913	KWH/Yr.
Compressor	205,325	KWH/Yr.
Boiler	6,270	KWH/Yr.
Lights	68,826	KWH/Yr.
Total	620,334	KWH/Yr.

FIGURE 2.11 (Continued)

ESTIMATED PROCESS ELECTRICITY USAGE

5. SPECIAL PRODUCTS

Equipment	50,000	KWH/Yr.
Lights	6,060	KWH/Yr.
Total	56,060	KWH/Yr.

6. TOTAL 3,201,621 KWH/Yr.

Notes: All KWH values measured with recording ammeter except those marked (*) which are estimates based on name plate data.

"Boiler" load includes total estimated HVAC auxiliary load.

Compressor and boiler plant load distributed evenly among processes. Assume 90% of boiler load is process load.

GURE 2.12

ARLY CONSUMPTION PER END PRODUCT

ODUCT	STEAM	ELECTRICITY	GASOLINE	TOTAL BTU/ PRODUCT	# PRODUCED
res	431,147 BTU	45,628 BTU	918 BTU	477,692	53,694
adwheels	223,380 BTU	62,141 BTU	3,566 BTU	269,087	41,454
ngle Pin	26,708 BTU	15,501 BTU	638 BTU	42,847	231,766
uble Pin	163,366 BTU (149,752 BTU)*	45,873 BTU (42,050 BTU)	2,135 BTU (1,957 BTU)*	211,374 (193,759)*	46,154 (50,350)*

tes: All values in BTU/END PRODUCT

Produced bases on 1986 production for double pin track shoes and 1985 production for all others.

(*) Production data for 1986 had one month missing. Corrected for 1986 using 11 month year.

3.0 ENERGY CONSERVATION OPPORTUNITY (ECO) SELECTION

3.1 Introduction

The objective of this study was to develop ECO's which will reduce energy consumption at the Ober-Ramstadt Depot. Energy conservation opportunities are the individual elements of work which can be performed to save energy. For example, replacing single glazed windows with double glazed windows is an energy conservation opportunity. Adding insulation to an existing roof is another example of an energy conservation opportunity. Using this list of ECO's, military construction, renovation and maintenance related projects were created. These construction projects consist of several energy conservation opportunities logically combined to form a single project.

3.2 Creation of Master ECO List

The first step was to identify those energy conservation opportunities which will be analyzed as a part of the study. Once those items are identified, their applicability to a particular building must be determined through judgement based on the field survey data. The Scope of Work provides a list of ECO's which have been successful at similar facilities. This list of ECO's is reproduced in Figure 3.1.

These ECO's were examined for their applicability to this specific site. Using ECO's from the supplied list, supplemented by additional ECO's identified during the field survey, a list of potential ECO's to be evaluated was prepared. This master list of ECO's was subdivided into 4 "Trades": Architectural, Mechanical, Electrical and Process.

3.3 ECO Descriptions

3.3.1 Architectural ECO's

A1a	Insulate Roof
A1b	Insulate Walls
A2	Replace single Glazed Windows
A3	Repair Windows
A4	Replace existing single glazed skylights with new double glazed skylights being installed on Building 4845.
A5	Replace Roof Ventilators
A6	Install Skylights
A7	Close and Insulate Skylights
A8	Construct Loading/Transfer Vestibules
A9	Replace Draft Barrier Strips
A10	Seal and Insulate Door

Mechanical ECO's:

M1	Install Thermostat/Timeclock Controls
M2	Install Condensate/Hot Water Heat Exchanger
M3	Interconnect Boiler Plants
M4	Convert from Steam to Hot Water Heat
M5	Install Flow Restrictors
M6	Install Electric Control Valves
M7	Install Automatic Boiler Blowdown
M8	Install Heat Recovery Systems
M9	Insulate Condensate Tanks

M10 Repair Insulation
M11 Insulate Piping
M12 Reduce Domestic Hot Water Temperature
M13 Repair Control Valve
M14 Insulate Tank
M15 Repair Steam Valve
M16 Convert Boilers to No. 2 Oil
M17 Install Exhaust Hood Outside Air Make-Up

Electrical ECO's

E-1 Use Photocell and Timer Control of Fluorescent Lighting In Buildings with Skylights
E-2 Photocell Override
E-3 Personnel to be Trained in Energy Conservation
E-4 Modify Localized Switching of Fluorescent lighting in Buildings with Skylights
E-5 Replace Quartz Fixtures
E-6 Recircuit Feed to 400 HP Air Compressor
E-7 Reconfiguration of the Distribution System in Building 4838
E-8 Paint Removal from Windows

Process ECO's:

P-1 Fix compressed air leaks throughout the plant.
P-2 Fix steam leaks throughout the plant.
P-3 Schedule shutting down machinery when not needed.
P-4 Grade tire by M.I.P. representatives at receiving stations prior to shipment to Ober-Ramstadt.
P-5 Improve field loading so that maximum capacity is obtained for each vehicle.
P-6 Utilize machinery available to increase production, saving time and energy.

P-7 Close doors and windows, especially in areas requiring special conditions.

P-8 Reinsulate nitrogen piping.

P-9 Reinsulate tire wash tank and hot water piping at Building 4864.

P-10 Provide insulation on non-insulated steam and condensate piping at production equipment.

P-11 Insulate vulcanizing, tire, track shoe and roadwheel molds.

P-12 Add material handling system in Building 4838 from extruder to paint booth to facilitate handling of roadwheels at molds for trimming, etc.

P-13 Evaluate four day work week.

P-14 Evaluate building sunscreen over the nitrogen tank.

P-15 Evaluate implementing condensate monitoring system.

P-16 Evaluate automatic welding system versus semiautomatic welding system for single pin track shoes.

P-17 Evaluate hiring of clean up crew to clean process areas so that production personnel may continue work until the end of their shift.

P-18 Evaluate lowering of hot water temperature at the tire wash and inspection.

P-19 Add to and up grade material handling system in Building 4845.

P-20 Evaluate separating heating and process steam to buildings so that steam can be turned off to the molds, etc., while still keeping the buildings warm enough to prevent freezing.

P-21 Relocate tire drying to Building 4864.

P-22 Provide new conveyor system for transporting tires from Building 4864 to Building 4845.

P-23 Relocate the single pin track disassembly from Building 4841 to Building 4845.

P-24 Relocate single pin induction furnace from Building 4840 to Building 4845.

P-25 Relocate single pin bushing removal as a result of ECOs P-21 and P-22.

P-26 Add sandblasting for single pin shoes in Building 4845 to achieve straight line product flow.

3.4 ECO's Evaluated:

A matrix indicating which ECO's were analyzed in each building is presented as Figure 3.2.

3.5 Other Projects Underway:

During the field survey, information on projects relating to energy conservation at the Depot which have either been implemented in the recent past or are planned and funded for installation in the near future was requested. Figure 3.3 contains a list of projects which have been implemented. Figure 3.4 contains a list of planned projects by the Mainz Army Depot.

FIGURE 3.1

RECOMMENDED ECO'S FROM ANNEX A
OF
PROJECT SCOPE OF WORK

ECO	Evaluated by ECO's	Notes
Production equipment replacement, modifications, disposals.	P-6, P-16, P-22, M-9, M-10, M-11	
Energy efficient motors and variable frequency drives.		(a)
Scheduling/loading of production equipment.	P-3, P-13	
Waste heat recovery from industrial processes.	M-2, M-8	
Automated control of production equipment - integrated with existing or proposed EMCS equipment, if appropriate.		(b)
Improve facility layout and space utilization.	P-12	
Solar applications.	P-14, A-6, A-7	(c)
Consolidate processes and equipment requiring special environments.	P-20, P-21, P-23, P-24, P-25, P-26	
Building ventilation, exhaust systems.	M-17	

FIGURE 3.1 (continued)

RECOMMENDED ECO'S FROM ANNEX A
OF
PROJECT SCOPE OF WORK

Production equipment maintenance.	P-8, P-9, P-10 P-11	
Improve methods/controls to reduce scrap, rework, and"gold-plating," which consume energy without contributing to production mission.	P-4, P-5, P-16, P-19	
Steam distribution and condensate return systems.	P-2, P-10	
Compressed air distribution systems.	P-1	
Lighting control (zones, levels, etc.).	E-1, E-2, E-4, E-5	
Electrical distribution.	E-6, E-7	
Radiant heating		(d)
Loading dock seals.	A-8, A-9	
Thermal storage.		(e)

Notes

The preceding list of ECO's were evaluated as applicable at the facility, except those noted.

(a) Energy efficient motors are included as part of the new equipment ECO's. Variable speed drives are not appropriate for the processes studied.

(b) The Detailed Scope of Work indicated that the evaluation of an EMCS was not included in this project. Computer controlled machinery is used at the Depot and replacement of aging manual process machines with automated units was considered.

(c) The Detailed Scope of Work deleted requirements for the evaluation of solar energy utilization. However, the use of skylights for daylighting was considered.

(d) Existing buildings are heated by steam radiators and unit heaters. Natural gas fired radiant heaters cannot be installed as natural gas is not available at the site. Electric radiant heaters are not cost effective with Germany's high electric rates. LP gas fired heaters also are uneconomic at current fuel costs.

(e) Thermal storage is not practical. These processes would not benefit from the storage of energy. Space heating is provided as a by-product of the process energy utilized, and thus cannot derive much benefit from thermal storage either unless energy is stored over prolonged periods of time.

BUILDING	A 1a	A 1b	A 2	A 3	A 4	A 5	A 6	A 7	A 8	A 9	A 10
	ARCHITECHTURAL										
4831	■	■	■								
4832											
4833	■	■	■								
4838				■	■	■			■	■	
4839											
4840											
4841											
4844											
4845				■	■	■		■	■	■	■
4846											
4847	■	■	■								
4848		■									
4849											
4851											
4857											
4864											
4872											
4873									■	■	

BUILDING	M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	M 10	M 11	M 12	M 13	M 14	M 15	M 16	M 17
	MECHANICAL																
4831				■													
4832				■													
4833				■					■						■		
4838	■					■			■								■
4839							■		■							■	
4840	■																
4841																	
4844																	
4845	■					■											■
4846																	
4847				■					■			■					
4848																	
4849				■	■						■	■	■				
4851				■													
4857																	
4864	■																
4872																	
4873																	

BUILDING	E 1	E 2	E 3	E 4	E 5	E 6	E 7	E 8
	ELECTRICAL							
4831								
4832								
4833								
4838	■			■			■	
4839								
4840								
4841								
4844	■							■
4845	■			■		■		
4846								
4847								
4848								
4849								
4851								
4857								
4864								
4872								
4873								

BUILDING	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 11	P 12	P 13	P 14	P 15	P 16	P 17	P 18	P 19	P 20	P 21	P 22	P 23	P 24	P 25	P 26
	PROCESS																									
4831																										
4832																										
4833																										
4838	■	■								■	■				■		■									
4839																										
4840								■																		
4841																										
4844																										
4845	■	■	■				■			■	■				■	■	■					■				
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4849																										
4851																										
4857																										
4864									■						■			■								
4872																										
4873	■	■				■					■				■											

ECO's EVALUATED
FIGURE 3.2

FIGURE 3.3

IMPLEMENTED PROJECTS

Number	Description	Cost	Date
	Replace 2 Boilers	-	1979
	Replace Steam Lines, Insulation to Buildings 4835, 4840, 4841, 4845	-	1980
MA 131-81	Repair Water System	-	1982
MA 149-81	Repair Skylights, Building 4838	-	1982
MA 65-82	Repair Roof, Building 4845	-	1982
	Replace Steam Lines, Building 4851	-	1982
	Replace Lighting System Buildings 4838, 4844, 4845	-	1983
	Install Insulation on Track Shoe, Road Wheel Molds	-	1984
	Replace 18 Tire Molds	-	1985-86
MA 26-82	Repair Roof of Bldgs. 4840, 4941	-	1982
MA 31-82	Modernize Boiler Plant, 4839	-	1982
MA 32-82	Rehabilitate Heating System, Bldg. 4847	-	1982
MA 99-82	Replace 20KV Supply	33,900DM	FY82
MA 105-82	Dismantle Bldg 4844	5,000DM	FY82
MA 243-83	Install Storage Bldg.	487,000DM	FY83
MA 252-83	Repair Flooring in Bldgs. 4838, 4845	350,000DM	FY83
MA 34-82	Rehabilitate Bldg. 4833, Incl. Windows	79,000DM	1983-84
MA 63-82	Rehabilitate Bldg. 4848, Htg. Sys.	340,000DM	1983
MA 67-82	Repair Compressed Air Lines, Bldg. 4845	150,000DM	1983
MA 225-83	Rehabilitate Bldg. 4851	310,000DM	1984
MA 230-83	Repair Sewer System	425,000DM	FY83
MA 238-83	Tire Receiving Inspection, Bldg. 4864	385,000DM	1984

FIGURE 3.3 (cont)

IMPLEMENTED PROJECTS

Number	Description	Cost	Date
MA 306-84	Repair Concrete Roads	587,000DM	FY85
MA 307-84	Repair Sewer System	876,000DM	FY85
MA 309-84	Repair Roofs, Bldgs. 4845, 4847	1,095,000DM	FY85
MA 315-84	Construct Bituminous Area	495,000DM	FY85
MA 358-84	Alter Bldg. 8443	514,000DM	FY85
MA 159-85	Repair Skylights, Bldg. 4845	51,200	FY85
MA 7-86	Roof Insulation, B.dg 4848	-	1986

FIGURE 3.4

PLANNED PROJECTS

Number	Description	Cost	Date
MA 316-84	Construct New Workshop	$ 92,900	Start 1986
	Extend Warehouse	393,000	1988
	Construct Wash for Rollers	121,000	1988
	Extend Bldg. 4857	37,000	1989
	Alter Bldg. 4863	146,000	1990
MA 529-88	Convert Boiler Plant 4839 to No. 2 Fuel Oil	248,800	1987
MA 41-86	Thermal Insul, Dbl. Glass, 4838	585,000	1987
MA 57-86	Replace Heating System, 4833	300,000	1987
	Thermal Insulation, 4845	110,000	1987
	Install metering-Steam, Electricity	140,000	1988
MA 204-87	Repair 20KV Transformer Station, 4845	145,006	1987
MA 221-87	Repair Heating System	169,000	1988
MA 213-87	Rehabilitate Bldg. 4851	183,000	1988
	Install Central Steam Trap Monitor	124,000	1989
	Install Thermal Insul., 4851	149,000	1990
	Install Thermal Insul., 4865	146,000	1991
	Repair Steam and Condensate Mains	194,000	1991
	Repair Steam and Condensate Mains	134,000	1993
	Construct Storage Shelter @ 4864	203,000	FY88
	Repair Concrete Roads @ 4838	148,000	FY88
	Install Water Purification, 4838	49,000	FY88

FIGURE 3.4 (continued)

PLANNED PROJECTS

Number	Description	Cost	Date
	Rehabilitate/Alter Rms, 4845	360,000	FY88
	Repair Concrete Roads	193,000	FY89
	Repair Roof, 4851	149,000	FY89
	Alter Rubber Dust Hopper	302,000	FY89
	Upgrade Bldg. 4845	10,427,000	FY89
	Replace Elec. Distrib. Sys., 4845	122,500	FY90
	Alter Bldg. 4865	146,000	FY90
	Upgrade Heating Plant 4839	-	FY90
	Repair Concrete Storage Area	250,000	FY90
	Repair Emerg. Light. Sys	34,000	FY90
	Repair Steam and Condensate Mains	242,500	FY90
	Install Central Clock Sys	46,000	FY90
	Repair Supporting Wall, 4839	102,000	FY91
	Upgrade Welding Shop, 4845	292,000	FY91
	Rehabilitate Cellar,4847	26,000	FY91
	Improve Storage Area, 4866	169,000	FY91
	Repair Concrete Roads	187,000	FY91
	Repair Main Water Supply Lines	118,000	FY91
	Mark Roads and Areas	54,000	FY92
	Rehabilitate Wash & Locker Rms	107,000	FY92
	Repair Water Main Lines	54,000	FY92
	Repair Blacktop Roads	70,000	FY92
	Repair Steam and Condensate Main Lines	167,500	FY92
	Repair Electric and Lighting Sys	100,000	FY92
	Replace Boilers, 4847	235,000	FY92
	Upgrade Parking Lot, 4848	80,000	FY92

FIGURE 3.4 (continued)

PLANNED PROJECTS

Number	Description	Cost	Date
	Exterior/Interior Painting	107,000	FY92
	Extend Motorpool, 4857	37,000	FY92
	Rehabilitate 4845, Single Pin Shoes	509,000	FY92
	Construct Track Shoe Wash Rack	169,000	FY92
	Install Metering Devices	167,000	FY93
	Extend Warehouse	393,000	FY93
	Improve Exterior Lighting	93,000	FY93
	Improve Storage Areas	399,000	FY93
	Paint Exterior, Bldgs. 4838, 4845	85,000	FY93
	Renovate Parking, 4830	162,000	FY93
	Repair Railroad Tracks	72,000	FY93
	Repair Blacktop Areas	29,000	FY93
	Exterior/Interior Painting	75,000	FY93

4.0 PROJECT DEVELOPMENT

Once the appropriate ECOs were identified for each building, the next step in the process was the calculation of the savings which would result from and the cost to implement each ECO. The savings were calculated using a combination of manual and computerized analysis techniques.

Estimated costs were calculated based on the extent of work required in each building. Unit prices used in the estimate were obtained from Lahmeyer International, GMBH, a mechanical consulting and contracting firm located in Frankfurt, West Germany. Construction cost estimates are in Deutsch Marks and are for FY88.

The savings and cost data for each ECO was used to compute economic parameters to determine the viability of a particular project. This economic analysis was performed in accordance with ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) GUIDANCE dated 15 February 1985, which was furnished as criteria for this EEAP study. That ECIP guidance requires the computation of a number of economic measures. These include:

1. ECO construction cost (Deutsch Marks).

2. Total annual energy savings.

3. Annual cost savings ($).

4. Total discounted cost savings ($).

5. Discounted savings/investment ratio (SIR).

6. Discounted energy savings/investment ratio (ESIR).

Economic analysis, including computation of these values, was performed using LOTUS 1-2-3, an electronic "spreadsheet" program running on an IBM personal computer, created by Lotus Development Corporation.

The results of this analysis are presented in Tables 4.1 through 4.4. The tables contain data on architectural, mechanical, electrical and process ECO's, respectively. ECO's listed in these tables are numbered according to the system used in the ECO descriptions and list of Section 3.0.

Having performed the economic analysis, ECO's not meeting the minimum economic criteria of savings/investment ratio (SIR) greater than 1.0 were dropped from further consideration. The remaining projects were combined to form projects falling into one of three project categories.

1. Low Cost / No Cost Projects.

2. ECIP Projects.

3. Other funding program projects.

4.1 Low Cost / No Cost Projects:

Many ECO's studied were of little or no cost to implement and produced significant energy savings. These projects, such as fluorescent lamp replacement, reduction of domestic hot water temperature, and weatherstripping, are classified as Low Cost / No Cost projects. Projects identified which fall into this category are presented by trade in Tables 4.5 through 4.8. Most of these projects have already been implemented or programmed by the Depot.

4.2 Project Development:

Remaining ECO's with SIR's and ESIR's greater than 1.0 are normally combined to form projects meeting the minimum project cost requirements of various funding source criteria.

Because of the small number of remaining, qualifying ECO's and their low total cost, it was decided to group all ECO's into one project for funding. If the project has a total cost of more than $3,000 and an amortization period of 4 years or less, it may qualify as a Productivity Enchancing Capital Investment Program (PECIP).

Projects with a cost of less than $100,000 and an amortization period of less than 2 years can be classified as Quick Return on Investment Programs (QRIP).

Projects whose total cost is greater than $100,000 and an amortization period of 4 years or less, may qualify as OSD Productivity Investment Funding (OSD PIF) projects.

Finally, if a project has a total cost greater than $200,000, and both the SIR and the SIR calculated using the project nonenergy qualification test are greater than 1.0, it may be funded as an Energy Conservation Investment Program (ECIP) project.

Table 4.9 summarizes the remaining qualified ECO's for the proposed project. It is obvious that the remaining ECO's either individually or in combination do not meet any of the funding criteria, despite their energy conserving potential. These ECO's, although not exactly low cost, should be considered for implementation as a part of the depot's aggressive ongoing energy conservation efforts.

TABLE 4.1- ECIP ECONOMIC ANALYSIS SUMMARY
ARCHITECTURAL ECO'S

BLDG. NO.	ECO NO.	ECO DESCRIPTION	ECON LIFE	TOTAL COST (DM)	EXCHANGE RATE (DM/$)	TOTAL COST ($)	SIMPLE PAYBACK PERIOD (YEARS)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNT SAVINGS ($)	SIR	COMMENT
4845	A-10	INSULATE EXTERIOR DOOR	25	1366	2.46	555	2.2	254	4249	8.503	COMPLETED
4845	A-3	REPAIR BROKEN WINDOWS	25	9321	2.46	3789	3.1	1231	20588	6.037	PROGRAMMED
4831	A-1a	INSULATE ROOF	25	2431	2.46	988	4.0	248	4152	4.668	PROGRAMMED
4845	A-7	INSULATE SKYLIGHT	25	11206	2.46	4555	5.9	778	13014	3.174	COMPLETED
4833	A-1a	INSULATE ROOF	25	21370	2.46	8687	7.8	1111	18577	2.376	COMPLETED
4845	A-9	REPLACE DRAFT BARRIER	25	28717	2.46	11674	9.2	1266	21171	2.015	COMPLETED
4838	A-9	REPLACE DRAFT BARRIER	25	12410	2.46	5045	13.7	368	6146	1.354	COMPLETED
4838	A-3	REPAIR BROKEN WINDOWS	25	7426	2.46	3019	16.5	183	3065	1.128	PROGRAMMED
**********	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
4873	A-9	REPLACE DRAFT BARRIER	25	10325	2.46	4197	18.8	223	3730	0.987	
4845	A-5	REPLACE ROOF VENTS	25	138806	2.46	56425	24.0	2349	39270	0.773	COMPLETED
4831	A-1b	INSULATE WALLS	25	12920	2.46	5252	30.9	170	2838	0.600	
4833	A-1b	INSULATE WALLS	25	34119	2.46	13870	31.6	439	7338	0.588	
4845	A-8	CONSTRUCT VESTIBULE	25	163013	2.46	66265	35.3	1877	31380	0.526	
4848	A-1b	INSULATE WALLS	25	40080	2.46	16293	37.9	430	7184	0.490	
4833	A-2	REPLACE WINDOWS	25	13209	2.46	5370	53.0	101	1695	0.351	
4847	A-1a	INSULATE ROOF	25	84255	2.46	34250	105.1	326	5449	0.177	
4838	A-5	REPLACE ROOF VENTS	25	70089	2.46	28491	116.6	244	4087	0.159	
4873	A-8	CONSTRUCT VESTIBULE	25	91207	2.46	37076	124.7	297	4971	0.149	
4838	A-8	CONSTRUCT VESTIBULE	25	172647	2.46	70182	142.9	491	8214	0.130	
4847	A-1b	INSULATE WALLS	25	221392	2.46	89997	145.2	620	10363	0.128	
4831	A-2	REPLACE WINDOWS	25	32159	2.46	13073	158.6	82	1378	0.117	
4838	A-4	REPLACE SKYLIGHTS	25	389804	2.46	158457	189.3	837	13995	0.098	
4845	A-4	REPLACE SKYLIGHTS	25	797022	2.46	323993	222.2	1458	24382	0.084	COMPLETED
4847	A-2	REPLACE WINDOWS	25	316392	2.46	128615	337.8	381	6365	0.055	COMPLETED

TABLE 4.2 - ECIP ECONOMIC ANALYSIS SUMMARY
MECHANICAL ECO'S

BLDG. NO.	ECO NO.	ECO DESCRIPTION	ECON LIFE	TOTAL COST (DM)	EXCHANGE RATE (DM/$)	TOTAL COST ($)	SIMPLE PAYBACK PERIOD (YEARS)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNT SAVINGS ($)	SIR	COMMENT
4838	M-17b	INSTALL OA MAKE-UP UNIT	15	112	2.46	45	0.1	314	3598	88.202	COMPLETED
4833	M-9	INSULATE CONDENSATE TANK	25	772	2.46	314	1.1	293	4896	17.344	PROGRAMMED
4839	M-9	INSULATE CONDENSATE TANK	25	4000	2.46	1626	1.1	1478	24715	16.891	COMPLETED
4838	M-1	INSTALL TIMECLOCK	15	4683	2.46	1904	0.8	2408	27598	16.108	PLANNED
4838	M-9	INSULATE CONDENSATE TANK	25	778	2.46	316	1.2	269	4493	15.779	PROGRAMMED
4845	M-1	INSTALL TIMECLOCK	15	12711	2.46	5167	1.4	3577	40993	8.815	PROGRAMMED
4849	M-13	REPAIR DOM HW CTRL VALVE	15	5218	2.46	2121	1.6	1308	14994	7.854	COMPLETED
4864	M-1	INSTALL TIMECLOCK	15	2342	2.46	952	1.7	571	6541	7.636	PROGRAMMED
4847	M-9	INSULATE CONDENSATE TANK	25	2596	2.46	1055	2.6	413	6904	7.270	PROGRAMMED
4849	M-12	REDUCE DOMESTIC HW TEMP	15	67	2.46	27	2.6	11	121	4.950	COMPLETED
4845	M-6	INSTALL STEAM CTRL VAVLE	25	20237	2.46	8227	4.1	2026	33877	4.576	PROGRAMMED
4833	M-15	REPAIR STEAM CTRL VALVE	25	1673	2.46	680	4.3	160	2671	4.365	PROGRAMMED
4840	M-1	INSTALL TIMECLOCK	15	2342	2.46	952	3.3	285	3268	3.815	PROGRAMMED
4847	M-12	REDUCE DOMESTIC HW TEMP	15	67	2.46	27	4.2	7	75	3.056	COMPLETED
4838	M-17a	INSTALL OA MAKE-UP UNIT	15	3267	2.46	1328	4.2	313	3582	2.997	SAFETY RQMNTS
4849	M-11	INSULATE PIPING	15	3152	2.46	1281	5.4	235	2695	2.337	COMPLETED
4849	M-5	INSTALL FLOW RESTRICTORS	15	10314	2.46	4193	7.7	543	6227	1.650	
4838	M-6	INSTALL STEAM CTRL VAVLE	25	23058	2.46	9373	12.3	765	12792	1.516	PROGRAMMED
********											
4845	M-17	INSTALL OA MAKE-UP UNIT	15	6021	2.46	2448	14.8	166	1900	0.862	PROGRAMMED
MULTI	M-4	CONVERT BLDGS 4849 & 4851 TO HW HEAT	25	144950	2.46	58923	31.2	1891	31623	0.596	
MULTI	M-4	CONVERT BLDGS 4831, 4832 & 4833 TO HW HEAT	25	124724	2.46	50701	40.6	1249	20879	0.458	
4839	M-16	CONVERT TO #2 OIL	25	82510	2.46	33541	45.9	731	12224	0.405	
4839	M-7	INSTALL BLR BLOWDOWN CTRL	25	16725	2.46	6799	51.9	131	2189	0.358	
4838	M-17c	INSTALL OA MAKE-UP UNIT	15	3713	2.46	1509	***	0	0	0.000	

TABLE 4.3 - ECIP ECONOMIC ANALYSIS SUMMARY
ELECTRICAL ECO'S

BLDG. NO.	ECO NO.	ECO DESCRIPTION	ECON LIFE	TOTAL COST (DM)	EXCHANGE RATE (DM/$)	TOTAL COST ($)	SIMPLE PAYBACK PERIOD (YEARS)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNT SAVINGS ($)	SIR	COMMENT
4844	E-2	INSTALL PHOTOCELL & TIMER	25	948	2.46	385	0.9	415	4925	14.203	PROGRAMMED
4838	E-4	SWITCHES FOR SKYLIGHT AREA	25	1499	2.46	609	1.9	313	3722	6.788	PROGRAMMED
4845	E-4	SWITCHES FOR SKYLIGHT AREA	25	7953	2.46	3233	2.1	1535	18240	6.269	PROGRAMMED
4845	E-1	INSTALL PHOTOCELL & TIMER	25	21598	2.46	8779	4.8	1844	21910	2.773	PROGRAMMED
SITE	E-3	REDUCE LIGHT USEAGE	25	9059	2.46	3683	4.9	759	9013	2.719	
SITE	E-5	INSTALL METAL HALIDE LIGHTS	25	5220	2.46	2122	6.3	334	3984	2.086	
4838	E-1	INSTALL PHOTOCELL & TIMER	25	7004	2.46	2847	7.3	391	4650	1.815	PROGRAMMED
4844	E-8	REMOVE PAINT FROM WINDOWS	25	4961	2.46	2017	9.2	219	2599	1.432	NOT ALLOWED
********											
4838	E-7	RECONFIGURE ELECT DIST	25	11323	2.46	4603	***	0	0	0.000	
4845	E-6	RECIRCUIT AIR COMP	25	4457	2.46	1812	***	0	0	0.000	

TABLE 4.4 - ECIP ECONOMIC ANALYSIS SUMMARY
PROCESS ECO'S

BLDG. NO.	ECO NO.	ECO DESCRIPTION	ECONOMIC LIFE	TOTAL COST (DM)	EXCHANGE RATE (DM/$)	TOTAL COST ($)	SIMPLE PAYBACK PERIOD (YEARS)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNT SAVINGS ($)	SIR	COMMENT
4838	P-2	REPAIR STEAM LEAKS	25	83	2.46	34	0.1	387	6463	214.097	COMPLETED
4845	P-2	REPAIR STEAM LEAKS	25	83	2.46	34	0.1	387	6463	214.097	COMPLETED
4873	P-2	REPAIR STEAM LEAKS	25	83	2.46	34	0.1	387	6463	214.097	COMPLETED
4873	P-1	REPAIR AIR LEAKS	25	83	2.46	34	0.2	189	3165	104.834	COMPLETED
4838	P-1	REPAIR AIR LEAKS	25	83	2.46	34	0.2	189	2251	74.576	
4845	P-1	REPAIR AIR LEAKS	25	83	2.46	34	0.2	189	2251	74.576	COMPLETED
4873	P-6	INCREASE EQPT UTILIZATION	25	8296	2.46	3372	0.3	12406	207188	68.267	COMPLETED
4845	P-3	SHUTDOWN UNNECESSARY MACH	25	2230	2.46	907	0.3	2592	30790	37.740	COMPLETED
4838	P-10	INSULATE COND PIPING	25	6405	2.46	2603	0.5	4753	79377	33.876	COMPLETED
4864	P-18	LOWER TIRE WASH TEMP	25	223	2.46	91	0.7	129	2146	26.306	
4873	P-15	INSTALL TRAP MONITORING	25	16023	2.46	6513	1.0	6832	114088	19.463	PROGRAMMED
4864	P-15	INSTALL TRAP MONITORING	25	2680	2.46	1090	1.1	959	16019	16.335	PROGRAMMED
4838	P-15	INSTALL TRAP MONITORING	25	45156	2.46	18356	1.3	14342	239515	14.498	PROGRAMMED
4845	P-15	INSTALL TRAP MONITORING	25	90081	2.46	36618	1.4	26602	444261	13.480	PROGRAMMED
4845	P-10	INSULATE COND PIPING	25	22255	2.46	9047	2.1	4408	73618	9.042	PROGRAMMED
MULTI	P-26	REARRANGE PROCESS FLOW	25	136969	2.46	55678	4.2	13150	177093	3.534	IN DESIGN
4864	P-9	REINSULATE TIRE WASH TANK	25	1111	2.46	451	11.2	40	672	1.654	COMPLETED
4845	P-11	INSULATE MOLDS	25	187320	2.46	76146	17.0	4481	74833	1.092	NOT PRACTICAL
************											
4845	P-7	CLOSE DOORS & WINDOWS	25	2788	2.46	1133	23.4	48	810	0.794	COMPLETED
MULTI	P-17	IMPLEMENT CLEAN UP CREW SINGLE PIN SHOES - BLDGS 4838,4840,4841 & 4845	25	32112	2.46	13054	20.5	636	7555	0.643	
	P-14	SCREEN NITROGEN TANK	25	8474	2.46	3445	20.6	167	1948	0.628	
4838	P-11	INSULATE MOLDS	25	84740	2.46	34447	29.6	1162	19405	0.626	NOT PRACTICAI
MULTI	P-17	IMPLEMENT CLEAN UP CREW ROADWHEELS - BLDGS 4830, 4840 & 4845	25	32112	2.46	13054	28.6	456	5418	0.461	
4845	P-17	IMPLEMENT CLEAN UP CREW	25	32112	2.46	13054	30.1	433	5149	0.438	
4873	P-11	INSULATE MOLDS	25	15610	2.46	6346	46.2	137	2292	0.401	
4873	P-17	IMPLEMENT CLEAN UP CREW	25	32112	2.46	13054	34.8	375	4459	0.380	
4845	P-22	INSTALL CONVEYER	25	485025	2.46	197165	85.5	2305	38492	0.217	PROGRAMMED
4845	P-27	INSTALL NEW SANDBLASTER	25	237201	2.46	96423	93.6	1030	17197	0.198	
4840	P-8	INSULATE NITROGEN PIPING	25	673	2.46	274	188.2	1	24	0.099	COMPLETED
4845	P-16	EVALUATE AUTOMATIC WELDER	25	411547	2.46	167295	382.5	437	5196	0.035	PROGRAMMED

Table 4.5 - LOW COST/NO COST PROJECTS ARCHITECTURAL

BLDG. NO.	ECO NO.	ECO DESCRIPTION	TOTAL COST (DM)	TOTAL COST ($)	ANNUAL ENERGY SAVINGS (MBTU / YEAR)	SIMPLE PAYBACK PERIOD (YEARS)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNT SAVINGS ($)	SIR	COMMENT
4845	A-10	INSULATE EXTERIOR DOOR	1366	555	52.4	2.2	254	4249	8.503	COMPLETED
4831	A-1a	INSULATE ROOF	2431	988	51.2	4.0	248	4152	4.668	PROGRAMMED
		TOTAL	3797	1543	103.6		502	8400		

TABLE 4.6 - LOW COST/NO COST PROJECTS
MECHANICAL

BLDG. NO.	ECO NO.	ECO DESCRIPTION	TOTAL COST (DM)	TOTAL COST ($)	ANNUAL ENERGY SAVINGS (MBTU / YEAR)	SIMPLE PAYBACK PERIOD (YEARS)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNT SAVINGS ($)	SIR	COMMENT
4838	M-17b	INSTALL OA MAKE-UP UNIT	112	45	64.7	0.1	314	3598	88.202	COMPLETED
4833	M-9	INSULATE CONDENSATE TANK	772	314	60.4	1.1	293	4896	17.344	PROGRAMMED
4839	M-9	INSULATE CONDENSATE TANK	4000	1626	304.8	1.1	1478	24715	16.891	
4838	M-1	INSTALL TIMECLOCK	4683	1904	496.6	0.8	2408	27598	16.108	COMPLETED
4838	M-9	INSULATE CONDENSATE TANK	778	316	55.4	1.2	269	4493	15.779	COMPLETED
4849	M-13	REPAIR DOM HW CTRL VALVE	5218	2121	269.8	1.6	1308	14994	7.854	
4864	M-1	INSTALL TIMECLOCK	2342	952	117.7	1.7	571	6541	7.636	PROGRAMMED
4847	M-9	INSULATE CONDENSATE TANK	2596	1055	85.1	2.6	413	6904	7.270	PROGRAMMED
4849	M-12	REDUCE DOMESTIC HW TEMP	67	27	2.2	2.6	11	121	4.950	COMPLETED
4833	M-15	REPAIR STEAM CTRL VALVE	1673	680	32.9	4.3	160	2671	4.365	
4840	M-1	INSTALL TIMECLOCK	2342	952	58.8	3.3	285	3268	3.815	COMPLETED
4847	M-12	REDUCE DOMESTIC HW TEMP	67	27	1.3	4.2	7	75	3.056	PROGRAMMED
4838	M-17a	INSTALL OA MAKE-UP UNIT	3267	1328	64.5	4.2	313	3582	2.997	PROGRAMMED
4849	M-11	INSULATE PIPING	3152	1281	48.5	5.4	235	2695	2.337	PROGRAMMED
		TOTAL	31066	12629	1662.7		8064	106150		

TABLE 4.7 - LOW COST/NO COST PROJECTS
ELECTRICAL

BLDG. NO.	ECO NO.	ECO DESCRIPTION	TOTAL COST (DM)	TOTAL COST ($)	ANNUAL ENERGY SAVINGS (MBTU / YEAR)	SIMPLE PAYBACK PERIOD (YEARS)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNT SAVINGS ($)	SIR	COMMENT
4844	E-2	INSTALL PHOTOCELL & TIMER	948	385	29.3	0.9	415	4925	14.203	PROGRAMMED
4838	E-4	SWITCHES FOR SKYLIGHT AREA	1499	609	22.1	1.9	313	3722	6.788	PROGRAMMED
SITE	E-5	INSTALL METAL HALIDE LIGHTS	5220	2122	27.0	6.3	334	3984	2.086	
4838	E-1	INSTALL PHOTOCELL & TIMER	7004	2847	27.6	7.3	391	4650	1.815	PROGRAMMED
4844	E-8	REMOVE PAINT FROM WINDOWS	4961	2017	15.5	9.2	219	2599	1.432	NOT ALLOWED
4845	E-6	RECIRCUIT AIR COMP	4457	1812	0.0	***	0	0	0.000	
		TOTAL	24088	9792	121.5		1673	19881		

TABLE 4.8- LOW COST/NO COST PROJECTS
PROCESS

BLDG. NO.	ECO NO.	ECO DESCRIPTION	TOTAL COST (DM)	TOTAL COST ($)	ANNUAL ENERGY SAVINGS (MBTU / YEAR)	SIMPLE PAYBACK PERIOD (YEARS)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNT SAVINGS ($)	SIR	COMMENT
4838	P-2	REPAIR STEAM LEAKS	83	34	79.8	0.1	387	6463	214.097	COMPLETED
4845	P-2	REPAIR STEAM LEAKS	83	34	79.8	0.1	387	6463	214.097	COMPLETED
4873	P-2	REPAIR STEAM LEAKS	83	34	79.8	0.1	387	6463	214.097	COMPLETED
4873	P-1	REPAIR AIR LEAKS	83	34	13.4	0.2	189	3165	104.834	COMPLETED
4838	P-1	REPAIR AIR LEAKS	83	34	13.4	0.2	189	2251	74.576	
4845	P-1	REPAIR AIR LEAKS	83	34	13.4	0.2	189	2251	74.576	COMPLETED
4845	P-3	SHUTDOWN UNNECESSARY MACHINES	2230	907	183.0	0.3	2592	30790	37.740	COMPLETED
4838	P-10	INSULATE COND PIPING	6405	2603	980.1	0.5	4753	79377	33.876	COMPLETED
4864	P-18	LOWER TIRE WASH TEMP	223	91	26.5	0.7	129	2146	26.306	
4864	P-15	INSTALL TRAP MONITORING	2680	1090	197.8	1.1	959	16019	16.335	PROGRAMMED
4864	P-9	REINSULATE TIRE WASH TANK	1111	451	8.3	11.2	40	672	1.654	COMPLETED
		TOTAL	13144	5343	1675.2		10202	156060		

TABLE 4.9 - ECIP ECONOMIC ANALYSIS SUMMARY POSSIBLE PROJECT

BLDG. NO.	ECO NO.	ECO DESCRIPTION	TOTAL COST (DM)	TOTAL COST ($)	ANNUAL ENERGY SAVINGS (MBTU / YEAR)	SIMPLE PAYBACK PERIOD (YEARS)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNT SAVINGS ($)	SIR
4849	M-5	INSTALL FLOW RESTRICTOR	10314	4193	112.1	7.7	543	6227	1.650
SITE	E-3	REDUCE LIGHT USEAGE	9059	3683	53.6	4.9	759	9013	2.719
		PROJECT TOTALS	19373	7875	165.6	6.0	1302	15241	2.150

5.0 PROJECT IMPACT

5.1 Introduction:

The ultimate goal of the Energy Study process is to conserve energy and save money. It is easy to lose sight of this goal however and get lost in the reams of paper and millions of calculations that compose the supporting documentation of the study. This section summarizes the energy savings of the investigated ECO's. The results of implementing these projects are compared with present energy consumption.

5.2 Total Energy Consumption:

The total energy consumption of the Depot for Fiscal Year 1986 was estimated for comparison purposes. From the data presented in Section 2.0, the total estimated energy consumption is derived in Table 5.1. This Figure, 96,561.5 MBTU/year, represents the total energy being consumed at the Depot at the time of the Energy Study.

5.3 Projected Energy Savings:

Table 5.2 summarizes the energy savings identified by the Energy Study for each type of energy conservation project. Energy savings are listed in MBTU's using energy equivalency conversion factors supplied in the ECIP criteria. In the interest of being concise, the total energy savings for all projects is listed rather than listing each project separately.

Many of the ECO's identified by this study, particularly the low/no cost projects, have already been accomplished as a part of the Depot's ongoing energy conservation efforts. Through the implementation of all energy savings projects identified by the Energy Study, energy savings of 22,167 MBTU/yr are possible. This represents a potential savings of 23.0%.

TABLE 5.1

ENERGY CONSUMPTION FY-1986

FUEL	CONSUMPTION	CONVERSION	MBTU
ELECTRICITY	4,236,300 KWH	3,413 BTU/KWH	14,458.5
#2 FUEL OIL	51,075 LITERS	36,642 BTU/Liter	1,871.5 *
#6 FUEL OIL	1,963,249 LITERS	39,627 BTU/Liter	77,797.7
GASOLINE	66,961 LITERS	36,347 BTU/Liter	2,433.8
		TOTAL	96,561.5

* Part year data extrapolated to 12 month consumption.

TABLE 5.2

ESTIMATED ANNUAL SAVINGS

PROJECT DESCRIPTION	TOTAL COST ($)	ANNUAL ENERGY SAVINGS (MBTU/ YEAR)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNTED SAVINGS ($)
ARCHITECTURAL LOW / NO COST ECO'S	1,543	103.6	502	8,400
MECHANICAL LOW / NO COST ECO'S	12,629	1,662.7	8,064	106,150
ELECTRICAL LOW / NO COST ECO'S	9,792	121.5	1,673	19,881
PROCESS LOW / NO COST ECO'S	5,343	1,675.2	10,202	156,060
TOTAL LOW / NO COST ECO'S	29,307	3,563.0	20,441	290,491
IMPLEMENTED ARCHITECTURAL ECO'S	38,312	1,121.8	5,440	90,961
IMPLEMENTED MECHANICAL ECO'S	34,067	2,911.5	14,119	190,231
IMPLEMENTED ELECTRICAL ECO'S	17,871	333.1	4,718	56,046

TABLE 5.2 (Continued)
ESTIMATED ANNUAL SAVINGS

PROJECT DESCRIPTION	TOTAL COST ($)	ANNUAL ENERGY SAVINGS (MBTU/ YEAR)	FIRST YEAR SAVINGS ($)	TOTAL DISCOUNTED SAVINGS ($)
IMPLEMENTED PROCESS ECO'S	134,804	14,072.0	87,625	1,407,425
TOTAL IMPLEMENTED ECO'S	225,054	18,438.4	111,902	1,744,663
REMAINING UNIMPLEMENTED ECO'S	7,875	165.6	1,302	15,241
TOTAL OF ALL IDENTIFIED ECO'S	262,236	22,167.0	133,645	2,050.396