

INTERIM REPORT

for the

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP), EUROPE

at the

MANNHEIM MILITARY COMMUNITY

VOLUME I: EXECUTIVE SUMMARY

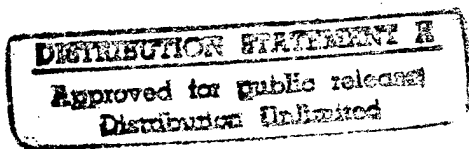
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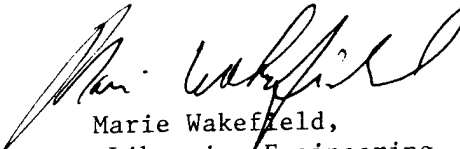

Marie Wakefield,
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SECTION 1

EXECUTIVE SUMMARY

1.1 INTRODUCTION

Contract No. DACA 90-81-C-0072 directs that a basewide energy study be accomplished for the Mannheim and Pirmasens Military Communities, Federal Republic of Germany. The project is identified as Energy Engineering Analysis Program (EEAP) Package No. 5.

The overall objective of the study is to produce a systematic plan of improvement projects that will reduce by 1985 the energy consumption in compliance with the Army Facilities Energy Plan without decreasing the readiness posture of the Army.

The following installations within the Mannheim Community were included in this study:

<u>Installation No.</u>	<u>Designation</u>
GY-074	Benjamin Franklin Village Family Housing
GY-123	Coleman Barracks
GY-295	Funari Barracks
GY-300	Gendamarie Kaserne
GY-314	Hammonds Barracks
GY-506	Friedrichsfeld QM Center
GY-539	Rheinau Coal Point D-1
GY-540	Rheinau Kaserne
GY-568	Turley Barracks
GY-587	Spinelli Barracks
GY-601	Sullivan Barracks
GY-607	Taylor Barracks
GY-778	Rheinau Coal Point D-4
GY-782	Kaefertal LS Cantonment

The study is conducted in three phases, namely:

- Phase I - The gathering of data and inspection of the facilities in the field. This phase included visits to the 14 different installations during which 404 of approximately 950 buildings were examined. The gathering of data involved the taking of notes and making tape recordings of findings, photographing of buildings (where permitted), the collection of available plans and records, and conferences with EUD and Community facility engineering personnel.

The survey revealed that some of the selected buildings had little or no energy use, or were not representative of the buildings in the installation. As a result, certain buildings were deleted. Others were added which were deemed necessary for an accurate energy consumption of each installation to be developed. A final figure of 306 buildings resulted from this process.

The information gathered during the survey was consolidated and included in the Preliminary Submittal made at the completion of this phase. Included in the report were listing of potential energy conservation measures which were developed as a result of the field survey.

- Phase II - The analysis of the collected data permitted the calculation of the existing energy consumption of the selected buildings within each installation; and the calculation of the energy savings due to the application of proposed Energy Conservation Measures (ECM's) to the remainder of the buildings to develop Installation-wide and Community-wide energy consumptions, energy savings, and proposed FY85 energy use.

Each Energy Conservation Measure (ECM) was evaluated in accordance with Energy Conservation Improvements Program (ECIP) criteria to determine its economic feasibility. ECM projects from Increments A & B are divided into ECIP Projects, Increment G Projects, and Increment F projects. This report includes the ECIP Projects, and Increment G Projects. The Increment F Projects are included in a separate report. The ECIP Projects are ranked according to SIR (Savings Investment Ratio) value. Preliminary Programming Documents (PDB's & DD Form 1391's) are developed.

This report summarizes the results of Phase II.

- Phase III - The Prefinal and Final submissions of this report covers the work of this phase.

The Prefinal submission consists of an addendum to the Interim submittal, a revised Executive Summary, and complete 1391's for the seven ECIP projects developed for the Mannheim Community. Following the receipt of comments on the Prefinal submission a complete Final Report will be submitted.

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SECTION 2

EXISTING ENERGY CONSUMPTION

2.1 FY75 BASELINE ENERGY CONSUMPTION

The source energy consumption for the Mannheim Community for baseline FY 75 is:

Electricity	517.25 x 10 ⁹ Btu
No. 2 Fuel Oil	580.42 x 10 ⁹ Btu
No. 6 Fuel Oil	236.35 x 10 ⁹ Btu
Anthracite Coal	475.58 x 10 ⁹ Btu
Bituminous Coal	110.40 x 10 ⁹ Btu

These figures were developed from the FY75 total energy consumption of 1,923,036 x 10⁶ Btu, which are extracted from the Summary Table contained in the Mannheim Facilities Energy Plan. (Refer to Table 2.1). The energy consumption for the installations not included in this table, namely Rheinau Kaserne, Rheinau Coal Points D-1 and D-4, and Kafertal L.S. Cantonment, is minimal and not documented.

2.2 SOURCE ENERGY CONSUMPTION

The source energy consumption and fuel cost by fuel type for the Mannheim Community for FY79, FY80, and FY81, is presented in Table 2.2. These figures were developed using the following conversion factors:

Electricity	11,600 Btu/KWH
Distillate Fuel Oil (No. 2)	138,700 But/Gal
Residual Fuel Oil (No. 6)	149,690 Btu/Gal
Bituminous Coal	27,094,000 Btu/Metric Ton (=2,200 lb)
Anthracite Coal	31,195,000 Btu/Metric Ton (=2,200 lb)
District Hot Water	3,414,000 Btu/MWH

The conversion factors for electricity and No. 2 fuel oil are taken directly from the energy conversion factors in the ECIP Guidance. The values for No. 6 fuel oil and district hot water were obtained from billing data. The anthracite and bituminous coal values were obtained by converting the figures in the ECIP Guidance to metric tons.

The cost figures were developed using the conversion factor of 2.26 D Mark/\$ as directed by EUD.

TABLE 2.1

SUMMARY TABLE

ENERGY CONSUMPTION BY INSTALLATION

	FY75 (Revised)		Reporting Year FY81		Milestone FY82		Goal FY85	
	Floor Area	Btu (10 ⁶) Sq Ft	Floor Area	Btu (10 ⁶) Sq Ft	Btu (10 ⁶) Sq Ft	Btu Sq Ft	Floor Area	Btu, (10 ⁶)
Coleman Barracks	1,912,197	472,824	1,912,277	500,165	261.56	460,270	1,969,456	354,618
BFV	4,433,443	657,570	4,436,691	767,405	172.97	628,389	4,569,792	493,177
Taylor Bks.	800,038	124,332	800,038	88,684	110.85	132,332	800,038	117,776
Funari Bks.	374,878	95,273	369,060	46,867	126.99	91,462	380,132	71,454
Gendarmerie Kas.	117,094	27,311	114,902	19,925	173.41	24,853	118,349	20,483
Hammonds Bks.	414,041	59,736	414,270	39,595	95.58	57,360	426,698	44,802
QM Service Ctr. Friedrichsfeld	193,735	52,145	191,064	29,915	156.57	49,152	196,796	39,109
Turley Bks.	568,874	97,280	564,740	52,788	93.47	93,525	581,682	72,960
Spinelli Bks.	1,700,454	174,273	1,694,302	162,132	95.69	168,534	1,745,131	130,660
Sullivan Bks.	1,082,770	162,292	1,096,018	164,660	150.23	152,686	1,128,899	121,719
TOTALS	11,597,524	1,923,036	11,593,362	1,872,136	161.48	1,858,563	11,916,973	1,466,758

Extracted from Mannheim Facilities Energy Plan.

NOTE: Totals do not include all installations.

ELECTRICAL ENERGY COSTS

Throughout the report, 11,600 Btu/kWh has been used as the conversion factor from kilowatt hours to Btu. As a result, energy savings (MBtu) are in terms of "source" energy. Unit energy costs (\$/MBtu) also are in terms of source energy.

If a "Load" energy is used as a basis for energy savings - then 3,414 Btu/kWh is the conversion factor. When load energy is considered, the magnitude of energy savings is decreased, but the unit cost (\$/MBtu) is increased proportionally. The result is that the energy cost savings using "source" or "load" energy is the same for both methods. The following example illustrates this point:

Electricity Savings = 5,000 kWh

- Source Energy Method:

$$\text{Energy Savings} = 5,000 \text{ kWh} \times 11,600 \frac{\text{Btu}}{\text{kWh}} \times \frac{1 \text{ MBtu}}{10^6 \text{ Btu}} = 58 \text{ MBtu}$$

$$\text{Energy Cost Savings} = 58 \text{ MBtu} \times 5.02 \text{ \$/source MBtu} = \$291$$

- Load Energy Method:

$$\text{Energy Savings} = 5,000 \text{ kWh} \times 3,413 \frac{\text{Btu}}{\text{kWh}} \times \frac{1 \text{ MBtu}}{10^6 \text{ Btu}} = 17.1 \text{ MBtu}$$

$$\text{Energy Cost Savings} = 17.1 \text{ MBtu} \times 17.06 \text{ \$/load MBtu} = \$291$$

2.3 TOTAL ANNUAL ENERGY CONSUMPTION

From Table 2.2, the annual source energy consumption for the Mannheim Community is:

$$\text{FY79} - 2,192.357 \times 10^9 \text{ Btu}$$

$$\text{FY80} - 2,009.133 \times 10^9 \text{ Btu}$$

$$\text{FY81} - 1,921.591 \times 10^9 \text{ Btu}$$

Relating these values to the FY75 energy consumption of $1,923,036 \times 10^9$ Btu, it is seen that the FY79 energy consumption was 114.0% of the FY75 consumption, FY81 consumption is 99.9% of the FY75 consumption.

2.4 BUILDING GROUP SOURCE ENERGY CONSUMPTION

Table 2.3, presents the energy consumption by building group type for the Community by Installation. These summaries were extracted from the computer printouts contained in Volume 4, Section 3. Rheinau Coal Point D-4 was not included in the summaries since its energy consumption is intermittent. There is no data available concerning energy use by building type. The values contained in Table 2.3 were tabulated using WESTON Energy Software. The values in this table show the relative consumption by building group and Installation. Values are given in MBtu (Millions of Btu) per year = MBtu/yr.

2.5 TYPICAL BUILDING ENERGY CONSUMPTION

Table 2.4 presents values for typical building energy consumption for each of the 13 building group types shown in Table 2.3. Values are given in units of MBtu/yr per square foot (ft^2) of floor area. Values for MBtu/yr were obtained from the Totals column of Table 2.3. The individual buildings included in each building group are listed in the Volume 4 computer printouts. Floor areas are from the building list contained in Section 9 of the main report.

TABLE 2.2
 Source Energy Consumption FY79, FY80 & FY 1
 Mannheim Military Community

Fuel Type	FY79			FY80			FY81		
	Quantity	Cost (\$)	Btu x 10 ⁹	Quantity	Cost (\$)	Btu x 10 ⁹	Quantity	Cost (\$)	Btu x 10 ⁹
Electricity (KWH)	49,176,840	2,758,820	570.451	48,247,400	2,706,679	559.670	49,021,516	2,750,107	568.649
Fuel Oil NO. 2 (Gal.)	4,695,502	4,516,133	651.266	4,466,628	4,296,003	619.517	4,178,674	4,019,049	579.586
Fuel Oil No. 6 (Gal.)	1,889,722	1,579,051	282.869	1,569,812	1,311,812	234.998	1,084,571	906,267	162.349
Anthracite Coal (M Ton)	18,080	1,946,204	564.006	15,299	1,646,845	477.252	12,209	1,314,225	380.860
Bituminous Coal (M Ton)	4,568	442,137	123.765	4,344	420,455	117.696	4,531	438,555	122.763
District Hot Water (MWH)	-	-	-	-	-	-	31,454	774,400	107.384
Totals		11,242,345	2,192.357		10,381,794	2,009.133		10,202,603	1,921.591

TABLE 2.3 (p. 1 of 2)
 Source Energy Consumption By Building Group Type
 (Energy Consumption in MBtu/yr)

Type No.	Building Type	B. Franklin Village	Coleman Barracks	Funari Barracks	Gendarmerie Kaserne	Hammonds Barracks	Friedrichsfeld QM Depot	Rheinau Coal Point D-1
10	Barracks	12,594.97	24,504.16	6,182.79	5,874.18	4,201.10		
20	Chapels	829.78	928.44					
30	Exchanges	10,135.93	1,121.09					
40	Family Housing	92,407.08	2,647.49					
50	Gymnasium	3,286.03				2,123.90		
60	High Bay Shop		20,967.39					
70	Hospital							
80	Hesshall	3,884.43	13,486.11	8,667.72	4,967.73	6,074.98		
90	Office		11,592.53	9,464.14		4,177.40		378.67
100	School	29,701.72	1,065.96	74.47				
110	Shop		12,427.62	3,774.22	1,233.03	328.35	10,009.62	610.56
120	Warehouse		1,244.93		1,786.86	905.65	3,580.80	776.73
130	Others	8,039.15	32,300.01	224.73	600.36	3,525.87		231.56
	TOTAL	160,879.11	122,285.73	28,388.10	14,462.18	21,337.28	13,590.43	1,986.55

TABLE 2.3 (p. 2 of 2)

Source Energy Consumption By Building Group Type
(Energy Consumption in MBtu/yr)

Type No.	Building Type	Rheinau Kaserne	Turley Barracks	Spinnelli Barracks	Sullivan Barracks	Taylor Barracks	Kaeferal LS Cantonment	Total MBtu/yr
10	Barracks	—	29,319.03	26,461.10	53,136.74	21,499.62	1,391.20	185,164.89
20	Chapels	—	138.35	—	228.05	229.85	—	2,354.47
30	Exchanges	—	1,431.03	—	—	—	297.20	12,985.25
40	Family Housing	—	—	—	—	—	—	95,054.57
50	Gymnasium	—	—	968.49	2,951.07	—	—	9,329.49
60	High Bay Shop	—	—	—	—	—	—	20,967.39
70	Hospital	—	—	—	—	—	—	—
80	Messhall	—	5,039.09	—	8,855.32	7,481.65	1,187.06	59,644.09
90	Office	2,020.84	5,392.28	2,643.21	4,465.96	16,236.72	315.05	56,686.81
100	School	—	—	—	—	—	296.83	31,138.98
110	Shop	684.15	8,046.93	20,257.15	8,616.13	19,682.57	—	85,670.33
120	Warehouse	—	—	25,040.57	3,341.58	2,307.89	—	38,985.01
130	Others	—	3,628.39	1,678.21	11,723.89	3,244.23	771.29	65,967.63
TOTAL		2,704.99	52,995.13	77,048.75	93,318.77	70,682.56	4,258.65	663,937.82

TABLE 2.4

TYPICAL BUILDING ENERGY CONSUMPTION

<u>Building Group Type</u>		Total Annual Energy Consumption (From Table 2.3) (MBtu/yr)	Total No. of Bldgs.	Total Bldg. Floor Area (ft ²)	Typical Energy Consumption (Btu/yr per ft ²)
Type No.	Description				
10	Barrack	185,164	52	1,600,602	115,684
20	Chapel	2,354	5	35,714	65,913
30	Exchange	12,985	8	73,321	177,098
40	Family Housing	95,055	25	719,899	132,039
50	Gymnasium	9,329	4	66,389	140,520
60	High bay shop	20,967	5	179,807	116,608
70	Hospital	No Bldgs.			
80	Mess Hall	59,644	16	204,134	292,181
90	Office	56,687	45	853,575	66,411
100	School	31,139	10	299,838	103,953
110	Shop	85,670	62	725,236	118,127
120	Warehouse	38,985	37	629,763	61,904
130	Others	65,968	37	551,675	119,578
TOTALS:		663,947	306	5,939,953	111,776

SECTION 3

ENERGY CONSERVATION MEASURES DEVELOPED

3.1 ENERGY CONSERVATION MEASURES INVESTIGATED

A list of Energy Conservation Measures (ECM's) to be investigated is contained in ANNEX A of the EEAP Scope of Work. This list, along with previous energy conservation retrofit experience, and the observations and data obtained from two site visits, provided a basis for a list of ECM's to be quantitatively analyzed.

For Increments A, B, and G, the ECM's involved are:

Building Shell:

- Wall insulation
- Roof & attic insulation
- Storm windows
- Energy efficient windows
- Weatherstrip windows
- Weatherstrip personnel doors
- Weatherstrip vehicular doors
- Skylight modifications
- Insulated dropped ceiling
- Reduce window area
- Translucent insulating panels
- Entrance vestibules
- Replace vehicular door with wall
- Insulate vehicular doors
- Caulking

Heating and Ventilating:

- Destratification
- Ventilating type hoods
- Radiator thermostatic control valves
- Outdoor air HW temperature reset
- Heat recovery
- Pipe Insulation

Domestic Hot Water:

- Flow restrictors
- Summer shutdown of central boiler

Electrical:

- Interior lighting conversion
- Exterior lighting conversion
- Delamping
- Automatic light level controls
- Photocell switches

Central Plant & Distribution Systems (Increment B)

- Hot water vs steam boilers
- Boiler trim controls
- Blowdown controls
- Load shedding
- EMCS
- Boiler economizer

In Chapter 10 of the Main Report (Volume II) a dot matrix is included showing the buildings at each Installation for which the ECM was applicable and was analyzed. The matrix also includes whether the ECM was economically feasible ($SIR > 1$) and was developed into an ECIP Project or was not ($SIR \leq 1$), or was developed into an Increment G project (none were).

Other ECM's analyzed are included under Increment F. Refer to that separate volume. Most of those are analyzed on a unit basis for use by Facilities Engineer (FE) personnel to develop projects. Refer to Tables G-1 and G-2 in Section G for a summary of these projects. ECM's listed in Annex A which were not analyzed, were either not applicable, already implemented, or are scheduled to be implemented. The status of each Annex A ECM is discussed in Section 10 of the Main Report (Vol. II)

The results of the analysis of each ECM are presented in Table 3.1 (2 pages). Results for individual buildings are referenced in Table 10.2 of the Main Report.

TABLE 3.1 (p. 1 of 2)

ECM ANALYSIS SUMMARY
 MANHEJM MILITARY COMMUNITY

ECM PROJECT NAME	ANNUAL ENERGY SAVINGS (MBTU)						TOTAL	ANNUAL ENERGY COST SAVINGS (\$)	TOTAL LIFE CYCLE COST DISCOUNTED SAVINGS (\$)	INVESTMENT COST (\$)	SIMPLE PAYBACK (YRS.)	SIR
	ELECTRICITY	#2 FUEL OIL	#6 FUEL OIL	BITUM. COAL	ANTHRA. COAL	PURCHASED HW						
<u>BUILDING ENVELOPE</u>												
WALL INSULATION		3066.5		89.7		834.6	3990.8	28,800	326,350	73,440	2.6	4.4
ROOF & ATTIC INSULATION		20432.0		9402.0		68488.0	102611.0	755,330	8,606,600	2,272,130	3.0	3.8
STORM WINDOWS		8210.3		4997.9		21855.8	37875.6	268,740	3,112,420	1,624,400	6.0	1.9
ENERGY EFFICIENT WINDOWS							32244.0	143,480	1,661,720	7,096,440	49.5	0.2
WEATHERSTRIP WINDOWS		1591.0		1038.5		3295.3	6658.7	45,510	535,620	136,700	3.0	3.9
WEATHERSTRIP PERSONNEL DOORS		168.8		251.1		317.8	890.2	5,540	68,450	8,950	1.6	7.6
WEATHERSTRIP VEHICULAR DOORS		312.0		323.7		2600.1	3299.5	24,960	282,350	71,920	2.9	3.9
SKYLIGHT MODIFICATIONS				1132.4		41.9	1219.2	5,190	78,250	10,390	2.0	7.5
INSULATED DROPPED CEILING						8420	8420	68,120	750,000	648,400	9.5	1.2
REDUCE WINDOW AREA						10676	10676	86,370	950,940	578,570	6.7	*1.6
TRANSLUCENT INSULATING PANELS						13.0	13.0	105	1,156	1,655	15.8	0.70
ENTRANCE VESTIBULES						4.4	4.4	35	389	2,865	78	0.14
REPLACE VEHICULAR DOOR W/WALL						1116	1116	9,010	99,220	49,392	5.5	2.0
INSULATE VEHICULAR DOORS		119.8		136.2		566.8	864.6	6,235	72,040	208,400	33.4	0.4
CAULKING						327.8	327.8	2,652	29,200	2,120	0.8	13.8
<u>HEATING AND VENTILATING</u>												
DESTRATIFICATION	(-1550.9)	994.3		6310.9		10132.4	17315.3	112,940	1,380,980	148,450	1.3	9.3
VENTILATING TYPE HOODS	(-7995.1)	3117.2		17999.4		14876.1	33496.8	207,900	2,692,250	377,280	1.8	7.1
RADIATOR THERM. CONTROL VALVES		3950		15230			31150	137,225	2,005,350	691,470	5.0	2.9
OUTDOOR AIR HW TEMP. RESET		205					205	1,450	16,500	3,360	2.3	*4.9
HEAT RECOVERY		3190				18580	21770	172,860	1,911,100	270,000	1.6	7.1
<u>DOMESTIC HOT WATER</u>												
FLOW RESTRICTORS		2721.1				23239.1	26417.7	209,060	2,316,310	213,490	1.0	10.8
SUMMER SHUTDOWN OF GEN. BOILER	(- 50.)			192.1			142.1	535	9,340	44,300	82.8	0.2

TABLE 3.1 (p.2 of 2)
 ECM ANALYSIS SUMMARY
 MANNHEIM MILITARY COMMUNITY

ECM PROJECT NAME	ANNUAL ENERGY SAVINGS (MBTU)					TOTAL LIFE CYCLE COST DISCOUNTED SAVINGS (\$)	INVESTMENT COST (\$)	SIMPLE PAYBACK (YRS.)	SIR
	ELECTRICITY	#2 FUEL OIL	#6 FUEL OIL	BITUM. COAL	ANTHRA. COAL				
<u>ELECTRICAL</u>									
INTERIOR LIGHTING CONVERSION	24646.0						771,000	6.2	1.8
EXTERIOR LIGHTING CONVERSION	1396.3						37,760	5.4	2.0
DELAMPING	2612						795	0.1	181.6
AUTOMATIC LIGHT LEVEL CONTROL	4400						161,600	7.3	1.5
PHOTOCELL SWITCHES	611						49,720	16.2	0.7
<u>CENTRAL PLANT & DISTRIBUTION</u>									
HOT WATER Vs. STEAM BOILERS				324	1620		1,325,500	132	0.1
BOILER TRIM CONTROLS		324		8508	1012		72,500	1.9	8.2
BLOWDOWN HEAT RECOVERY				239			11,710	12.0	1.3
LOAD SHEDDING MESS HALLS	153 KW						59,220	5.4	2.0
LOAD SHEDDING BFV FAMILY HSG UNITS	525 KW						692,100	18.8	0.8
EMCS	474 (8678KW)	2710	1130	1840	1230	13390	4,149,000		0.5
BOILER ECONOMIZER		113.4		1098.8			580,000	103	0.1

NOTE: ECM'S FOR WHICH SOME OF THE BUILDING ANALYZED WERE ECONOMICALLY FEASIBLE (SIR ≥ 1) ARE INDICATED BY "**". FOR THESE ECM'S THE VALUES REPORTED INCLUDE ONLY THE BUILDINGS WITH SIR ≥ 1.

3.2 ECIP PROJECTS DEVELOPED

Table 3.2 presents a summary of all the ECIP Projects. These 7 projects are comprised of discrete ECM's all of which have SIR > 1. The grouping of ECM's to produce ECIP Projects as shown is tentative, and is presented for review and modification as desired by the Facilities Engineer.

3.3 OTHER ENERGY CONSERVATION PROJECTS

Increment G Projects are formed from ECM's which do not meet ECIP criteria, namely, ESIR value less than 1 and are above the FE funding limits of \$500,000 for new and alteration type work, and \$200,000 for O & M type work. None of the projects investigated fell into this category i.e., there are no Increment G Projects. Refer to Section 10 of Part B of the Main Report (Volume II) for a complete discussion of the differences between Increments A, B, G, F, and ECIP Projects.

Increment F Projects (refer to Section 6) were analyzed mostly on a unit basis, for development into desired projects by the Facilities Engineer.

TABLE 3-2

ECIP PROJECT SUMMARY
MANNHEIM MILITARY COMMUNITY

ECIP PROJECT NAME	ANNUAL ENERGY SAVINGS (MBTU/YR)						PURCHASED HOT WATER	TOTAL	ANNUAL ENERGY COST SAVINGS (\$)	LIFE CYCLE COST PW DISCOUNTED SAVINGS (\$)	INVESTMENT COST (\$)	SIR (BASED ON MID FY 81 COSTS)
	ELECTRICITY	#2 FUEL OIL	#6 FUEL OIL	BIT. COAL	ANTH. COAL	TOTAL						
• <u>ROOF INSULATION (FH)</u>							22,494	22,494	181,980	2,003,580	1,376,260	1.5
• <u>ROOF INSULATION AND WEATHERSTRIPPING</u>		18,277	594	6,127	1,951		32,402	59,351	427,740	4,907,410	2,584,670	1.9
- ROOF INSULATION	(16,275)	(217)	(4,516)	(1,376)			(26,258)	(48,642)	(352,760)	(4,031,930)	(2,369,540)	(1.7)
- WINDOW W/STRIP	(1,521)	(242)	(1,037)	(494)			(3,273)	(6,567)	(44,860)	(528,850)	(134,710)	(3.9)
- PER-Door W/STRIP	(169)	(76)	(251)	(77)			(271)	(844)	(5,160)	(64,280)	(8,500)	(7.6)
- VEH-Door W/STRIP	(312)	(59)	(323)	(4)			(2,600)	(3,298)	(24,960)	(282,350)	(71,920)	(3.9)
• <u>ELECTRICAL MODIFICATIONS</u>	30,442							30,442	163,530	1,800,470	681,000	2.6
- AUTO-LIGHT LEVEL	(4,400)							(4,400)	(22,090)	(243,210)	(161,000)	(1.5)
- LOAD SHEDDING	(153KW)							(153KW)	(10,710)	(117,920)	(59,000)	(2.0)
- INTERIOR LIGHT	(24,646)							(24,646)	(123,720)	(1,362,160)	(434,000)	(3.1)
- EXTERIOR LIGHT	(1,396)							(1,396)	(7,010)	(77,180)	(27,000)	(2.0)
• <u>STORM WINDOWS</u>		3,940	23	612	1,356		12,649	18,580	138,140	1,565,030	836,510	1.9
• <u>MISC. PROJECTS I</u>		4,111	5,499	24,310	1,429		27,958	53,761	344,700	4,335,930	594,640	7.3
- VENTILATING HOODS	(-7,995)	(3,117)	(5,499)	(17,999)			(14,876)	(33,496)	(207,900)	(2,692,250)	(377,280)	(7.1)
- HEAT RECOVERY		(994)		(6,311)	(1,429)		(2,949)	(2,949)	(23,860)	(262,700)	(68,900)	(3.8)
- DESTRATIFICATION FANS	(-1,551)						(10,133)	(17,316)	(112,940)	(1,380,980)	(148,460)	(9.3)
• <u>FLOW RESTRICTORS</u>		2,721			457		23,239	26,417	209,030	2,316,110	212,630	10.9
• <u>BUILDING SHELL MODIFICATIONS</u>		896		522			9,208	10,626	82,960	924,950	613,350	1.5
- SKYLIGHT MOD.				(457)			(34)	(491)	(2,150)	(31,840)	(6,430)	(5.0)
- REDUCE WINDOW AREA							(3,438)	(3,438)	(27,810)	(306,220)	(185,860)	(1.6)
- WALL INSULATION		(880)		(65)			(414)	(1,359)	(9,830)	(111,630)	(45,510)	(2.5)
- REPLACE VEHICULAR DOORS WITH WALLS		(16)					(1,085)	(1,101)	(8,890)	(97,880)	(48,610)	(2.0)
- INSULATED DROPPED CEILING							(4,237)	(4,237)	(34,280)	(377,380)	(326,940)	(1.2)
TOTALS FOR ALL ECIP PROJECTS	20,896	29,945	6,116	31,571	5,193		127,950	221,671	1,548,080	17,853,480	6,899,060	2.6

NOTE 1: TOTAL DOES NOT INCLUDE THE 153 KW DEMAND SAVINGS IN THE LOAD SHEDDING ECM, AS THEY ARE NOT ENERGY SAVINGS.

NOTE 2: VALUES IN PARENTHESES ARE FOR INDIVIDUAL ECM'S WITHIN ECIP PROJECT.

NOTE 3: NEGATIVE VALUES FOR ENERGY SAVINGS DENOTES ADDITIONAL ENERGY REQUIREMENT.

TABLE 3.2 (p. 2 of 2)

ECIP PROJECT SUMMARY
MANNHEIM MILITARY COMMUNITY

ECIP PROJECT NUMBER	ECIP PROJECT NAME	ANNUAL ENERGY SAVINGS (MBTU/YR)						PURCHASED HOT WATER	TOTAL	ANNUAL ENERGY COST SAVINGS (\$)	LIFE CYCLE COST PW DISCOUNTED SAVINGS (\$)	INVESTMENT COST (\$)	SIR
		ELECTRICITY	#2 FUEL OIL	#6 FUEL OIL	BIT. COAL	ANTH. COAL							
#9	HEATING & VENTILATING PROJECTS		7382	15455	12030	21964	56,831	340,735	4,255,150	1,067,030	4.0		
	• RADIATOR THERM. CONTROL VALVES		(3950)	(15230)	(11970)		(31,150)	(137,625)	(2,005,350)	(691,470)	(2.9)		
	• REMOTE THERM. SENSORS		(37)	(225)	(60)	(3384)	(3,706)	(28,800)	(322,200)	(102,200)	(3.1)		
	• OUTDOOR AIR HW TEMP. RESET		(205)				(205)	(1,450)	(16,500)	(3,360)	(4.9)		
	• HEAT RECOVERY		(3190)			(18580)	(21,770)	(172,860)	(1,911,100)	(270,000)	(7.1)		
#10	MISC. PROJECTS - III:	7012 ¹		8747	1012		16,771 ¹	85,887	1,119,816	305,825	3.8		
	• DELAMPING	(2612)					(2,612)	(13,114)	(144,380)	(795)	(181.6)		
	• AUTOMATIC LIGHT LEVEL CONTROL	(4400)					(4,400)	(22,100)	(243,200)	(161,600)	(1.5)		
	• BOILER TRIM CONTROLS			(8508)	(1012)		(9,520)	(38,806)	(597,300)	(72,500)	(8.2)		
	• BLOWDOWN HEAT RECOVERY			(239)			(239)	(977)	(15,036)	(11,710)	(1.3)		
	• LOAD SHEDDING MESS HALL	(153 KW)					(153 KW)	(10,890)	(119,900)	(59,220)	(2.0)		
TOTALS FOR ALL ECIP PROJECTS		23508.3 ¹	47995.3	7869.5	20653.3	188184.9	353,958.9	2,387,554	28,044,036	\$,397,247	3.3		

NOTE 1: TOTAL DOES NOT INCLUDE THE 153 KW DEMAND SAVINGS IN THE LOAD SHEDDING ECM, AS THEY ARE NOT ENERGY SAVINGS.

NOTE 2: VALUES IN PARENTHESES ARE FOR INDIVIDUAL ECM'S WITHIN ECIP PROJECT.

NOTE 3: NEGATIVE VALUES FOR ENERGY SAVINGS DENOTES ADDITIONAL ENERGY REQUIREMENT.

SECTION 4

ENERGY AND COST SAVINGS

4.1 BASE-WIDE CONSUMPTION AFTER ENERGY CONSERVATION PROJECTS

The annual source energy consumption for the Mannheim Community in FY81, as indicated in Table 2.2, was $1,921.6 \times 10^9$ Btu. The annual energy savings resulting from implementation of the 7 ECIP Projects is 221.7×10^9 Btu/yr. This would result in an energy consumption, after ECIP projects implementation of $1,699.9 \times 10^9$ Btu. This represents a reduction of 11.5% in energy use.

The energy cost for the Mannheim Community in FY81, as indicated in Table 2.2, was \$10,202,600. The annual energy cost savings (in FY81 dollars) for the 7 ECIP projects is \$1,548,080. The energy cost after implementation of the ECIP projects would be \$8,654,520. This represents a reduction of 15.2% in energy cost.

4.2 ALLOCATION OF ENERGY CONSERVATION PROJECT SAVINGS

Table 3.2, the ECIP Project Summary, presents a breakdown in energy savings by ECIP project.

4.3 PROJECTED ENERGY CONSUMPTION

As stated above, an 11.5% reduction in energy consumption will result from the implementation of the 7 ECIP projects. Base-wide consumption will decrease by 221.7×10^9 Btu/yr from $1,921.6 \times 10^9$ Btu to $1,699.9 \times 10^9$ Btu. Future population changes, building demolition, and construction would modify these values. Complete data on such changes is not available, but in any case, contemplated changes would not produce significant changes.

4.4 PROJECTED ENERGY COSTS

As stated above, a 15.2% reduction in energy costs will result from the implementation of the 7 ECIP Projects. Base-wide energy cost will decrease \$1,548,080/yr from \$10,202,600 to \$8,654,520. These values are in terms of 1981 dollars, as required by SIR analysis, and does not include inflation of fuel costs to 1985.

SECTION 5

INCREMENT "E" - CENTRAL BOILER PLANTS - MANNHEIM

5.1 SCOPE

This contract does not include Increment "E", however, during the meeting at EUD on 24 March 1982, Mr. Gunzel of EUD requested that the study should include a brief feasibility summary of the opportunity for centralization at the communities studied.

5.2 RESULTS AND RECOMMENDATIONS

At present, the Mannheim District hot water system serves Taylor, Sullivan, Funari, and Turley Barracks and Benjamin Franklin Village. In addition, Spinelli Barracks is slated to be connected in FY 83-84. Coleman Barracks and Gendarmerie Kaserne are being considered for future connection, but in the meantime, these installations, with Hammonds Barracks, Rheinau Kaserne and Coal Points and Friedrichsfeld QM Depot remain to be considered for boiler centralization.

Heating plants and central heating plants in the Mannheim Community are necessarily considered in the context of how they fit into the ultimate goal of providing for heating from the Mannheim District Heating System.

Thus, improvements to low pressure steam heating systems and their further centralization should take the form of conversions to and expansion of hot water heating systems and their eventual consolidation with the municipal system.

For the few high pressure steam systems, the improvements to the heating portion may thus take the form of local or central conversions to hot water heating using exchangers.

Examples of centralization are:

- Coleman Barracks: The LP Steam heated area served by Boiler Houses No. 10, 84 and 51 in winter and by Boiler House No. 10 in summer, while interconnected is not truly centralized except under low summer loads. The problem has to do with the nature of the loop steam heating systems which are limited as to their operating

pressure. Alternates making possible operation as a centralized system would be to convert to a higher pressure trapped steam system or, better, to a circulating hot water distribution system designed for eventual tie in to the district heating system.

- Hammond Barracks: While mostly served from the boiler room in Building 968 using low pressure steam, its conversion to a hot water central heating plant should allow the inclusion of areas heated by Building 977 boiler room.
- Gendarmerie Kaserne: Currently heated by boiler rooms in Building 137, 143 and 145, a consolidation and conversion to hot water heating would include all areas, possibly using Building 145 as the central plant, as a step toward eventual district heating conversion.

5.3 CONCLUSIONS

Since the advent of hot water systems for most Mannheim installations, it was not necessary to consider boiler centralization at Mannheim.

SECTION 6

INCREMENT F - FACILITIES ENGINEER CONSERVATION MEASURES

6.1 INTRODUCTION

Increment F requires the A/E to identify projects involving the modifications and changes in systems operation which are within the Facilities Engineer funding authority and management control. Included are low cost O & M (Operations and Maintenance) type projects and projects selected from Increments A, B, and G to be financed from OMA funding. It should be noted that Increment F was not a part of the initial contract, but was later added. An additional site visit was conducted in summer of 1982 to gather data for each Increment.

A separate report is submitted to meet the requirements for the Increment F Interim Submittal. Refer to that Report for complete discussion and calculations for the 22 Increment F Projects, and a summary of Increments A, B, and G Projects.

6.2. SUMMARY OF INCREMENT F PROJECTS

All of the Increment F projects are analyzed on a unit basis, i.e., per 100 ft² of ceiling area, per personnel door, per broken or missing window. This will enable Facilities Engineer personnel to develop appropriate projects on an ongoing basis using the methodology and data supplied with each project so analyzed. Some projects are alternatives to others, and others are calculated only for a particular type of building use and particular Installation, but may be expanded to include other situations.

Table 6-1, Increment F Projects Savings, Costs and Economics refers to these unit values, and therefore Installation and Community-wide totals are not appropriate. This is also true of the Increment F projects from Increments A, B, and G which have to be defined by Facilities Engineering.

TABLE 6-1

INCREMENT F PROJECTS SAVINGS, COSTS AND ECONOMICS SUMMARY

Project No.	Project Name	Unit	Material Cost (\$)	Labor Time (hr)	Labor Cost (\$)	Contracted Cost (\$)	Annual Savings (MBtu/yr)	Annual Energy Cost Savings (\$/yr)	STR
F-1	Repair holes in roof	Per opening	27.3	1.0	17	53.2	7.1	57	11.8
F-2	Cover unused flue opening	Per flue	6.3	0.67	11.7	22	4.4	35.6	18.2
F-3	Install double glazing to skylights	Per ft ² area	388	8	136	629	4.9	39.6	0.69
F-4	Install insulated panel beneath skylights	Per ft ² area	253	10	170	508	9.2	74.4	1.6
F-5	Install dropped ceiling	Per 1000 ft ² area	1,740	34	578	2,780	35.1	284	1.12
F-6	Install ceiling insulation	Per 1000 ft ² area	560	28	380	940	20.2	163	1.56
F-7	Repair gaps at wall panel joints	Per repair	27	3.0	51	94	20.9	169	19.4
F-8	Replace glazing with insulated panel	Per 100 ft ² area	421	16	243	666	14.7	119	1.64
F-9	Replace glazing with glass block	Per 100 ft ² area	830	27.9	440	1,524	11.6	93.8	0.73
F-10	Repair broken and missing glazing	Per repair	9.4	7.5	12.7	26.5	8.8	71	29.5
F-11	Seal and insulate unused vehic. doors	Per dbl. doors	127	6.6	112	287	8.7	70	2.7
F-12	Repair openings in vehicular doors	Per repair	35	1.0	17.0	50.4	6.3	51	11.2
F-13	Install storm doors	Per door	88	1.0	17.0	126	1.52	12.3	1.08
F-14	Reduce domestic hot water temperature	Per heaters	0	0.75	14.4	17.3	2.8	22.6	15.9
F-15	Regular cleaning of flour. tubes and fixtures	Per 1000 ft ² office (recessed fixtures)	0	3.9	23.40	23.4	1.46	7.33	1.20
F-16	Caulking	Per 100 ft ² window	7.00	0.6	8.10	18.10	2.8	22.65	13.8
F-17	Disconnect unused ballasts	Per 10 ballasts	0	3	58.20	69.30	1.96	1.84	1.55
F-18	Repair openings in walls	Per 1 ft ² opening	3.56	2	31.50	42.07	12.5	101	26.4
F-19	Air curtains	Per air curtain	5,280	9	160	6,350	126	1,020	1.81
F-20	Loading dock seals	Per dock seal	640	14	240	1,060	65.1	527	5.5
F-21	Loading dock shelters	Per dock shelter	1,110	15	250	1,630	22.7	1.84	1.24
F-22	Pipe insulation	Per 100 ft 1" pipe	209	6.9	129	406	700	566	15.5

SECTION 7

ENERGY PLAN

7.1 MATRIX OF ENERGY SAVINGS

The ECM's investigated were combined to produce 7 ECIP projects. These projects are prioritized in Table 7-1 according to decreasing SIR. The percent energy consumption reduction is also calculated and shown in the last column. Totals for all 7 ECIP projects are included.

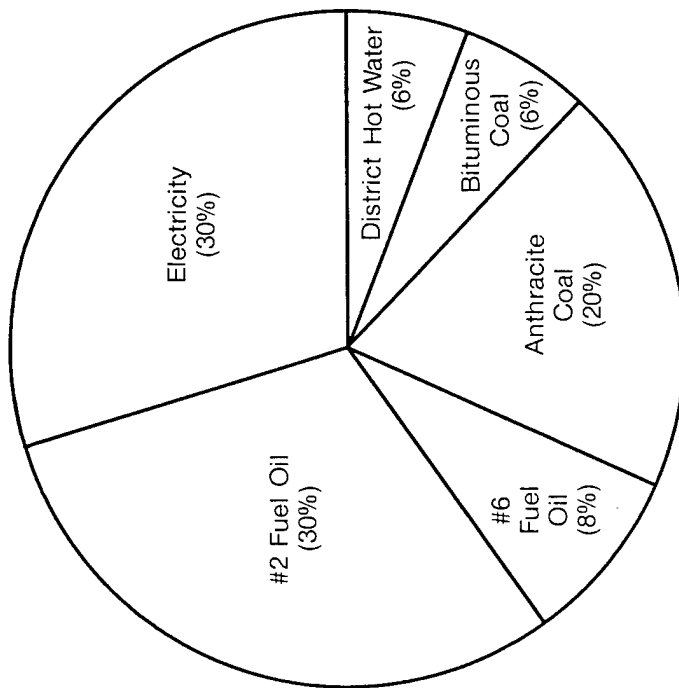
7.2 PREDICTED ENERGY SAVINGS

Figures 7.1, 7.2 and 7.3 graphically represent the energy savings to be realized by the implementation of ECIP projects. Figure 7.1 is a Pie Graph which illustrates the total FY81 energy consumption and costs for the Community. Figures 7.2 and 7.3 show, using both a Pie Graph and a Bar Chart, the energy savings picture by fuel type.

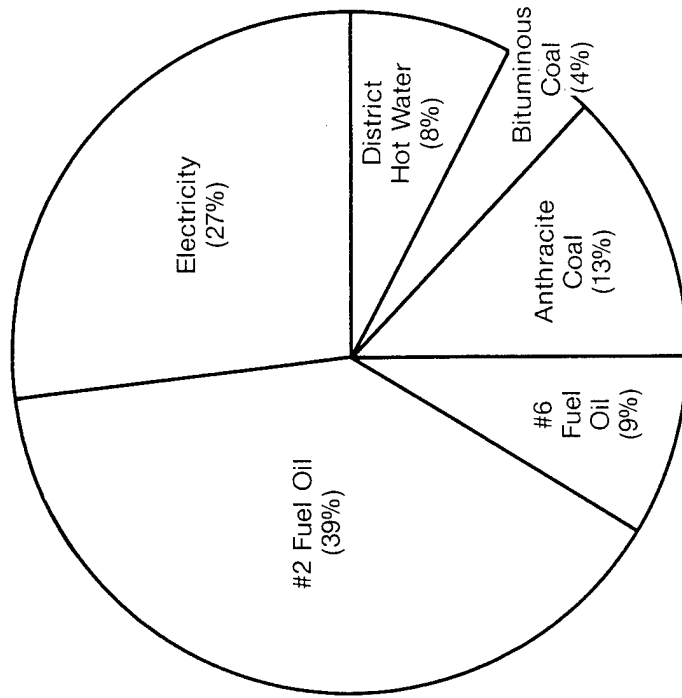
TABLE 7-1

PRIORITIZATION OF ECIP PROJECTS

Priority	ECIP Proj. No.	ECIP Project Name	SIR	Project Cost (\$)	Annual Energy Savings (MBtu/Yr)	Annual Energy Cost Savings (\$/Yr)	Percent Energy Reduction of FY81 Use = 1,921,600 MBtu/Yr
1	#1	Flow Restrictors	10.9	212,630	26,417	209,030	1.37
2	#2	Miscellaneous Projects I	7.3	594,640	53,761	344,700	2.80
3	#3	Electrical Modifications	2.6	681,000	30,442	163,530	1.58
4	#4	Roof Insulation and Weatherstripping	1.9	2,584,670	59,351	427,740	3.09
5	#5	Storm Windows	1.9	836,510	18,580	138,140	0.97
6	#6	Roof Insulation	1.5	1,376,260	22,494	181,980	1.17
7	#7	Building Shell Modifications	1.5	613,350	10,626	82,960	0.55
Total for All ECIP Projects				6,899,060	221,671	1,548,080	11.5



FY 81 Community Energy Use
 (Total = 1921.6×10^9 Btu = 100%)



FY 81 Energy Cost
 (Total = \$10,202,600 = 100%)

FIGURE 7.1 MANNHEIM MILITARY COMMUNITY
 PRESENT FY 81 COMMUNITY ENERGY USE AND
 ENERGY COST BY FUEL TYPE

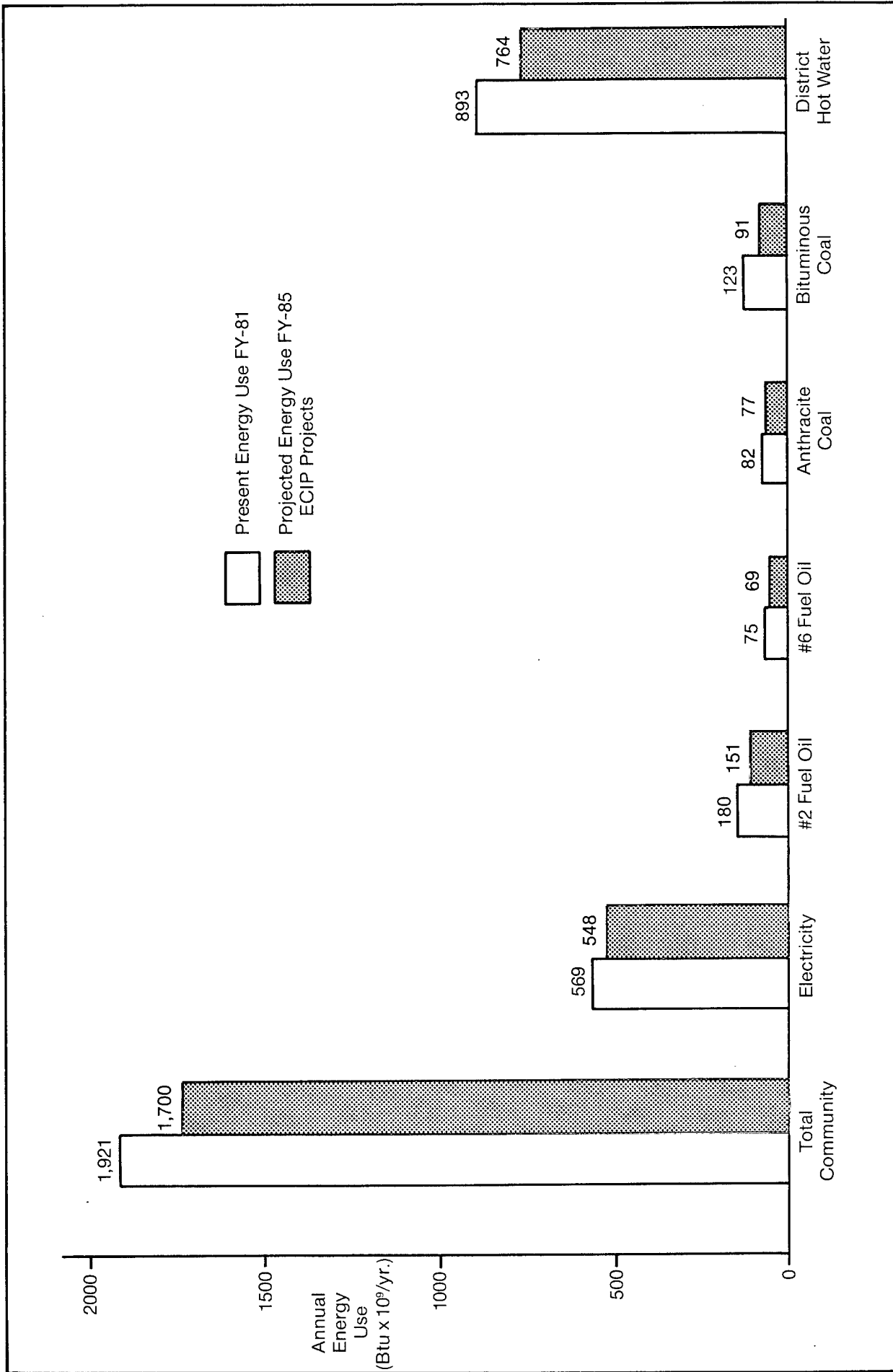
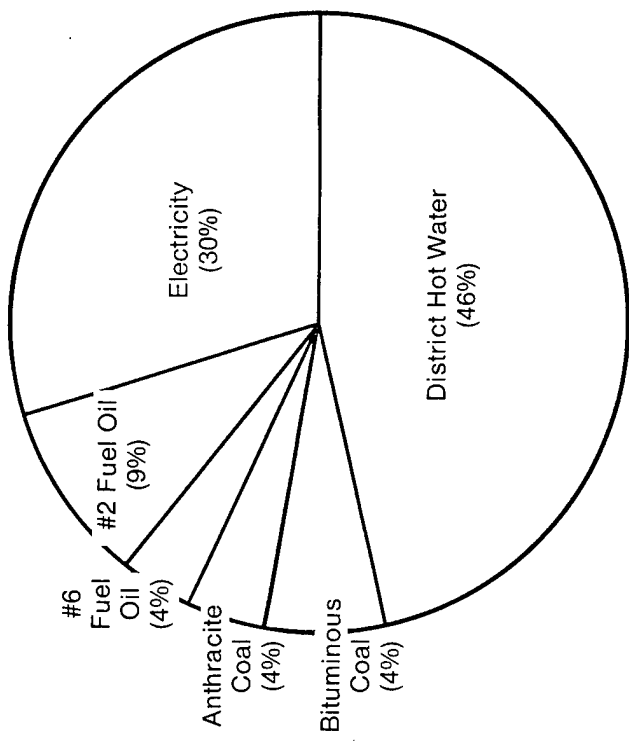
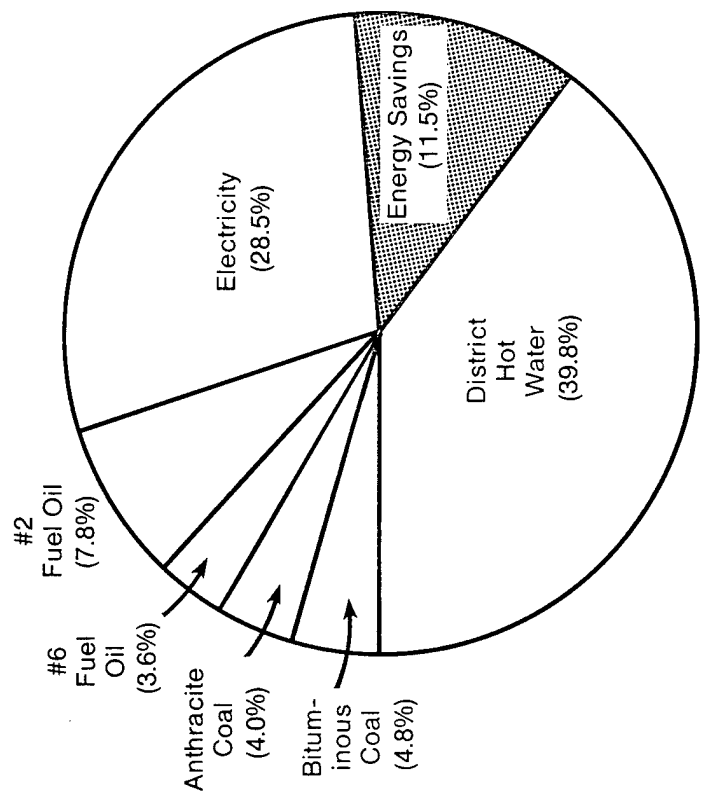


FIGURE 7.2 MANNHEIM MILITARY COMMUNITY
COMMUNITY ENERGY USE BY FUEL TYPE:
PRESENT FY 81 AND PROJECTED FY 85



FY 81 Community Energy Use
 (Total = 1921.6×10^9 Btu = 100%)
 (Adjusted For 1985 District Hot Water Distribution)



FY 85 Projected Energy Use with ECIP Projects
 (Total = 1699.9×10^9 Btu = 88.5% of FY 81)

**FIGURE 7.3 MANNHEIM MILITARY COMMUNITY
 COMMUNITY ENERGY USE BY FUEL TYPE —PRESENT
 FY 81 AND PROJECTED FY 85**

SECTION 8

ORGANIZATION OF REPORT

This section has been prepared to provide a comprehensive summary of the organization of this report. It includes a listing of all valid volumes of the report as well as copies of their Tables of Contents. A complete current copy of WESTON's EEAP Package #5 for the Mannheim Military Community is comprised of the following volumes:

<u>Title</u>	<u>Submittal Date</u>
Preliminary Submittal Volumes I-X	15 February 1982
Volume I - Executive Summary	May 1984
Volume II - Main Report	November 1983
Volume III - Appendix	November 1982
Volume IIIB - Appendix	November 1983
Volume IV - Bundles/1391's	May 1984
Volume V (A-E) ECIP Support Data	November 1982
Increment F	November 1983
Documentation of Computer Analysis	October 1983
Addendum	May 1984

PRELIMINARY SUBMITTAL VOLUMES I - X

The Preliminary Submittal of this report was made in February of 1982 and consisted of 10 volumes. The purpose of this submittal was to present all data gathered during Phase I. Both physical data and operational data on each surveyed building is presented. The organization of the Preliminary Submittal is as follows:

<u>Volume</u>	<u>Installations</u>
Volume I	Ben Franklin Village
Volume II	Ben Franklin Village
Volume III	Coleman Barracks
Volume IV	Coleman Barracks
Volume V	Funari Barracks Gendarmerie Kaserne Hammonds Barracks
Volume VI	Friedrichsfeld Q.M. Depot Rheinau Coal Point D-1

<u>Volume</u>	<u>Installations</u>
Volume VI (Cont'd)	Rheinau Kaserne Turley Barracks
Volume VII	Spinelli Barracks
Volume VIII	Sullivan Barracks
Volume IX	Taylor Barracks
Volume X	Taylor Barracks Rheinau Coal Point D-4 L.S. Cantonment

VOLUME I - EXECUTIVE SUMMARY

The purpose of the Executive Summary is to provide management level information in a concise volume. The most current edition is May 1984. The Table of Contents for this volume can be found on Page i.

VOLUME II - MAIN REPORT

The Main Report (Narrative Report) contains the basis of analysis and the results of the study. It is a comprehensive volume and was last submitted in November of 1983. All modifications to the November 1983 edition can be found in the Addendum, submitted with the Prefinal Submittal. The following spells out the organization of the Main Report.

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VOLUME III - APPENDIX

Volume III - Appendix was submitted in November of 1982 and has never required updating. Its primary purpose is to provide support data and to that end it contains samples of the computer analysis, Table information used in the computer analysis and copies of the Scope of Work and Minutes of the Pre-negotiation Meeting. The Table of Contents for this volume is as follows:

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VOLUME III B - APPENDIX

Volume III B - Appendix, prepared in November of 1983, is a supplement to the original Appendix (11/82). It contains the complete analyses of all conservation opportunities that WESTON evaluated manually. These are primarily specialty opportunities that cannot easily be evaluated by computer. The organization of Volume III B is as follows:

Volume III B

APPENDIX

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VOLUME IV - BUNDLES/1391's

Volume IV - Bundles of this project has been prepared in May of 1984. It contains the complete 1391's for each of the seven ECIP Projects prepared for Mannheim. This Volume has been assembled in a three-ring binder for ease of modification. The organization of Volume IV is as follows:

VOLUME IV - BUNDLES

TABLE OF CONTENTS

TITLE OF SECTION

- Installation of Roof Insulation (Family Housing).
- Installation of Roof Insulation and Weatherstripping.
- Electrical Modifications.
- Storm Windows.
- Miscellaneous Projects I.
- Flow Restrictors.
- Building Shell Projects.

VOLUME V (A-E) ECIP SUPPORT DATA

These volumes were prepared and submitted in November 1982 and contain the results of each opportunity evaluated for each building. These printouts are contained in five black, three-ring binders and require no updating. The following indicates the contents of these binders:

<u>Volume</u>	<u>Contents</u>
A	Wall Insulation Roof Insulation
B	Storm Windows Energy Efficient Windows
C	Weatherstrip Windows Weatherstrip Personnel Doors
D	Replace Personnel Doors Entrance Vestibule Weatherstrip Vehicular Doors Skylight Modifications Flow Restrictors
E	Interior Lighting Conversion Exterior Lighting Conversion

INCREMENT F

The Increment F Submittal of this report was last made in November of 1983. This volume contains data for use by the Facilities Engineer in approaching day-to-day problems. The Table of Contents for Increment F is as follows:

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DOCUMENTATION OF COMPUTER ANALYSIS

This document was prepared at the request of EUD and submitted on a one-time basis. No comments requiring resubmission have been made. The information contained in this volume is as follows:

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ADDENDUM

The Addendum volume has been submitted in May 1984 to update the appropriate pages in the Interim Submittal. It is a one-time submittal. The updated pages will be inserted in their proper locations for the Final Submittal. The Addendum contains inserts for Volume II - Main Report and Volume IIIB - Appendix.