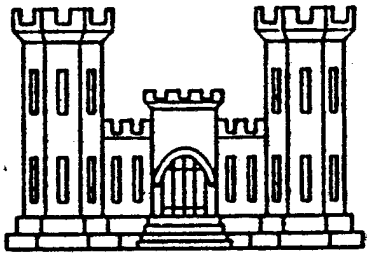
SUBMITTAL NO.15 (FINAL)

ENERGY ENGINEERING ANALYSIS PROGRAM
ARLINGTON HALL STATION , VIRGINIA



VOLUME I

EXECUTIVE SUMMARY

PREPARED FOR:
NORFOLK DISTRICT CORPS OF ENGINEERS
NORFOLK , VIRGINIA
CONTRACT NO. DACA 65-79-C-0075

AUG., 1982

PREPARED BY:
H.D. NOTTINGHAM & ASSOCIATES,INC.
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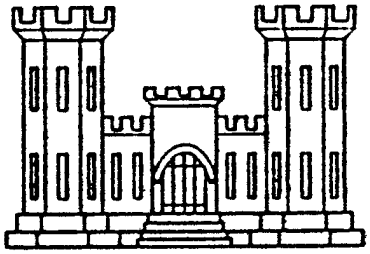

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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

1. PURPOSE

The overall purpose of this report is to provide a systematic plan of improvement projects that will reduce the energy consumption by 1985 in compliance with the Army Facilities Energy Plan (AFEP) without decreasing the present standard of living. The AFEP energy goals from FY 75 base year are as follows:

- Reduce facility energy consumption by 50 percent by the year 2000.
- Reduce facility energy consumption by 25 percent by FY 85.
- Reduce dependence on critical fuels by the year 2000.
- Eliminate use of natural gas.
- Reduce use of petroleum fuels in facilities by 75 percent.
- Reduce annual energy consumption per gross square foot by 20 percent in existing facilities by FY 85.
- Reduce annual energy consumption per square foot by 45 percent in new buildings by FY 85.
- Obtain at least 10 percent of total Army installation energy from coal, coal gasification, solid waste, refuse derived fuel and biomass.
- Obtain one percent of total Army installation energy by solar system.

2. CURRENT ENERGY USAGE (1975-1979)

2.1 Current energy usage (1975-1979) is depicted in Figure 2.1.A. The average annual energy consumption by the installation during the above period was 262,412 MBTU. The maximum energy consumption was 276,468 MBTU in FY 78, which was a 5.45 percent increase from FY 75. Minimum consumption was 250,720 MBTU in FY 79, which was a 4.34 percent reduction from FY 75. Generally, electrical energy consumption has increased since FY 75 whereas thermal energy consumption has shown a slight decrease. Average energy usage per unit area has been 202,387 Btu/ft^2 during this time. Energy consumption trends are shown on Figure 2.1.B.

2.2 Figure 2.2 illustrates the "Energy End Use" for the overall system. Major portions of the energy are consumed by space heating (34.9%), air conditioning and ventilation (24.0%) and indoor lighting (21.1%).

2.3 Nine (9) buildings were selected for analysis to enable establishing the energy consumption for a typical building. Unit area energy use and total energy use for these buildings are shown on Figures 2.3.A and 2.3.B respectively. The unit area energy use varies from 247,489 to 456,437 Btu per square foot, which is mainly due to the type of building construction and the building usage.

3. ENERGY CONSERVATION MEASURES DEVELOPED

3.1 ECM's Investigated

Thirty-eight (38) energy conservation measures requiring capital investment were investigated. These are tabulated in Appendix A. These ECM's were carefully analyzed and Energy Conservation projects developed, to be discussed later.

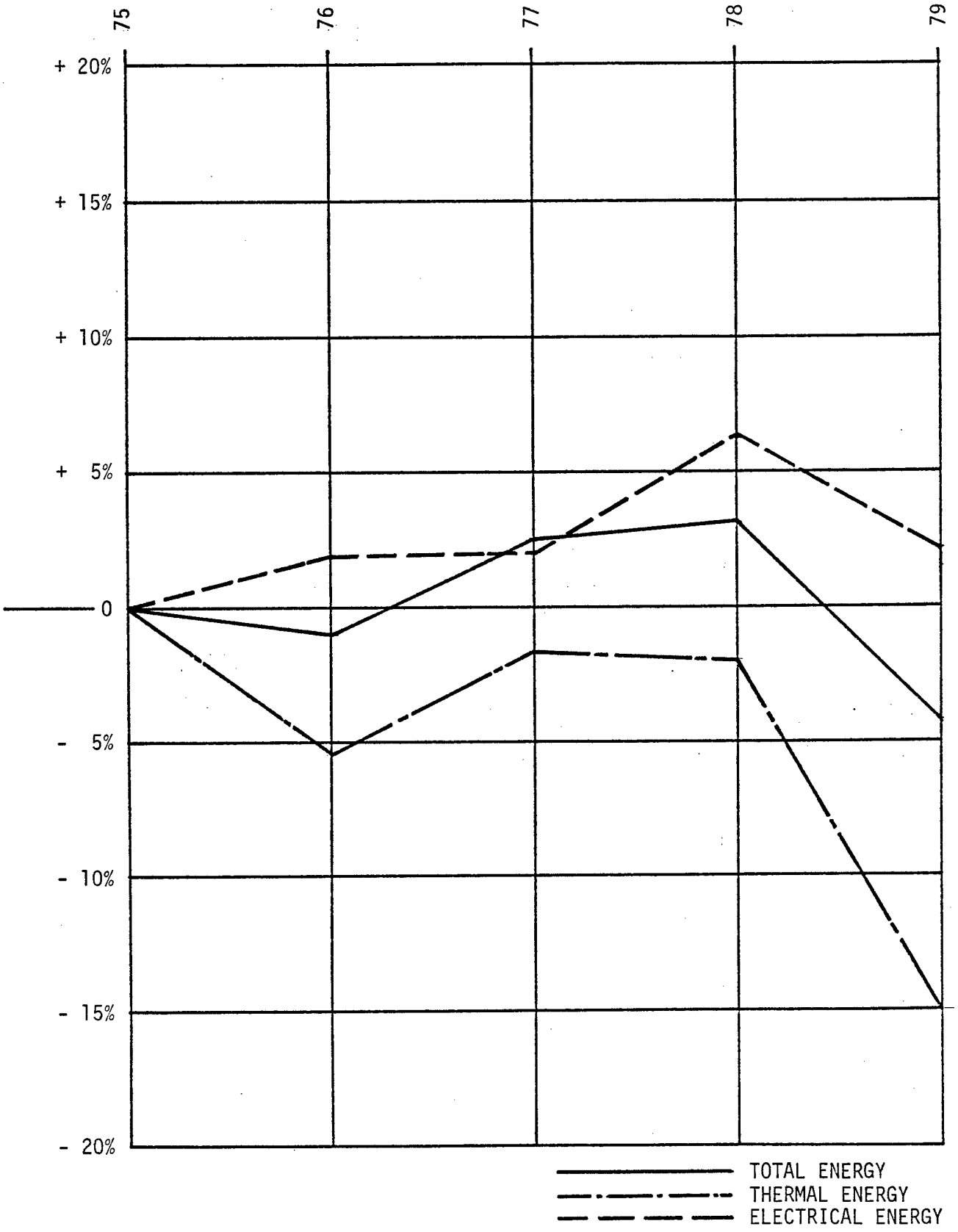
CURRENT ENERGY USAGE (1975-1979)

YEAR	ELECTRICITY MBTU	NO. 2 OIL MBTU	NO. 5 OIL MBTU	NATURAL GAS MBTU	TOTAL MBTU	BTU/S.F.
FY 75 BASE YEAR	161,929	2,521	87,641	10,027	262,119	302,050
FY 76 & P.D.	164,768 + 1.75%	1,847 - 26.74%	82,916 - 5.4%	10,042 + 0.15%	259,574 - 0.97%	299,117
FY 77 & P.D.	165,040 + 1.92%	3,008 + 19.31%	85,228 - 2.76%	9,903 - 1.24%	263,180 + 0.40%	303,272
FY 78 & P.D.	172,051 + 6.25%	1,387 - 44.98%	87,596 - 0.06%	9,433 - 5.93%	276,468 + 5.47%	318,584
FY 79 & P.D.	165,265 + 2.06%	1,351 - 46.42%	74,769 - 4.69%	9,333 - 6.92%	250,720 - 4.34%	288,914
TOTAL 5 YRS.	829,053	10,114	418,150	48,738	1,312,061	1,511,937
AVERAGE	165,810	2,022	83,630	9,747	262,412	302,387

REMARKS: P.D.: PERCENT DEVIATION FROM BASE YEAR FY 75

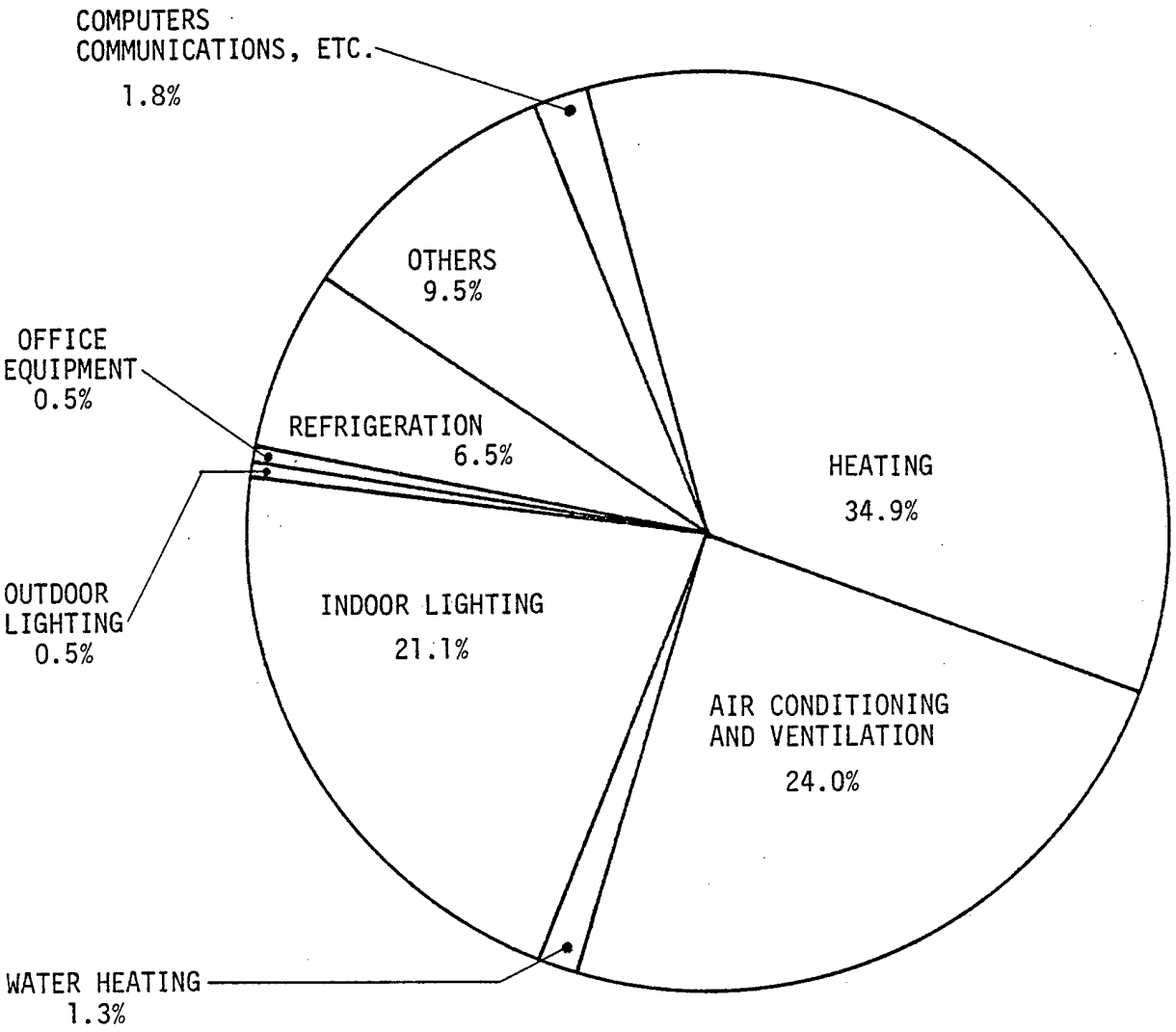
FIG. 2.1.A.

FIGURE 2.1.B



ENERGY CONSUMPTION TRENDS

FIGURE 2.2



ENERGY END USE

ENERGY USE/FT^2 BY SELECTED BUILDINGS

	ENERGY USE/FT^2						
	ELECT.		OIL		NATURAL GAS		
	KWH	BTU	GAL.	BTU	THERM.	BTU	TOTAL
BUILDING 100	16.902	196,070	.51	73,160			269,230
BUILDING 111	9.220	106,963	1.49	215,280			322,243
BUILDING 115	18.610	215,887			1.43	143,550	359,437
BUILDING 125	26.920	312,271	.36	53,180			456,437
BUILDING 301	17.940	208,114			1.61	161,780	369,894
BUILDING 302/3/4	11.770	136,538	.28	41,660	1.88	188,570	366,768
BUILDING 316	17.608	204,263			2.14	214,470	418,733
BUILDING 401	14.023	162,669	.58	84,820			247,489
BUILDING 504	11.995	139,146	1.14	164.290			303,436

FIG. 2.3.A

TOTAL ENERGY CONSUMPTION BY SELECTED BUILDINGS

	TOTAL ENERGY USE						
	ELECT.		OIL		NATURAL GAS		
	MWH	MBTU	GAL.	MBTU	THERM	MBTU	TOTAL
BUILDING 100	200	2,320.1	6,012	865.8			3,185.9
BUILDING 111	85.3	989.2	13,826	1,991			2,980.2
BUILDING 115	91.1	1,057.2			7,030	703	1,760.2
BUILDING 125	382.2	4,433.8	5,243	755			5,188.8
BUILDING 301	50.2	582.7			4,530	453	1,035.7
BUILDING 302/3/4	98.9	1,146.9	2,430	350	15,840	1,584	3,080.9
BUILDING 316	53.3	618.1			6,490	649	1,267.1
BUILDING 401	3,734.3	43,318	156,868	22,589			65,907
BUILDING 504	66.6	772.4	6,333	912			1,684.4

FIG. 2.3.B

3.2 Energy Conservation Projects Developed.

3.2.1 Increment "A"

- Building Weatherization
  - The installation of exterior synthetic insulation board, storm window and ceiling and crawl space insulation, replacement of windows, providing weather stripping and blocking up non-essential windows.

- Automatic Temperature Control Improvements, etc.
  - The installation of self-contained radiator valves and shower restrictors
  - Modifications to condenser water piping
  - The installation of piping insulation
  - The replacement of electric heaters with steam or hot water heaters

3.2.2 Increment "B"

- Replacement of Incinerators
  - The replacement of the existing incinerators with a heat recovery type incinerator
- The installation of oxygen trim packages to the boilers
- The use of a computer controlled radio control system (CCRCS)

3.2.3 Increment "F"

- Reset Condenser Water Temperature
- Reduce Ventilation Rate
- Reset Chilled Water Temperature
- Install Flow Restrictors to Lavatories

3.2.4 Increment "G"

- The replacement of 40 watt fluorescent lamps with the 35 watt lamps
- The installation of Exterior Synthetic Wall Finish (ESWF)
- The replacement of existing air conditioning equipment

3.2.5 ECM's Requiring Policy Changes

Thirty-four (34) of potential energy conservation measures are listed in Appendix B which requires management action at the installtion level with no cost or little cost. Implementation of these measures will further reduce energy consumption at the installation.

4. ENERGY AND COST SAVINGS

4.1 Basewide Consumption Following Implementation of Energy Conservation Projects

Upon completion of the energy consumption projects depicted in Figure 3-1, the installation will reduce its energy consumption by 101,880 MBTU annually, which is a 38.9 percent reduction from FY 75. Also, with the installation of a new heat recovery incinerator, 24,120 MBTU of thermal energy (equivalent to 167,500 gallons of No. 5 oil) will be supplied annually, thus reducing the purchased energy consumption by 9.2 percent from FY 75. Overview of energy conservation and total energy savings profile is as indicated on Figure 4.1.A and 4.1.B. The completion of the Energy Conservation projects meets or exceeds items B, D and F of the AFEP energy goals as follows:

- Reduce facility energy by 38.9 percent.
- Reduce annual energy consumption per gross square feet by 38.9 percent in existing facilities.
- Obtain 13.7 percent of future total installation energy from solid waste and refuse by a heat recovery type incinerator.

ENERGY CONSERVATION PROJECTS SUMMARY

ECIP PROJECTS	CONST. COST $	SAVINGS/YEAR		B/C	E/C	PAYBACK YEARS
		MBTU	DOLLARS			
Building Weatherization (Increment A)	3,902,600	56,044	565,281	3.43	14.36	6.90
Automatic Temp. Control Improvements, etc. (Increment A)	421,100	8,795	89,228	2.99	20.9	4.72
Installation of Oxygen Trim Package to Boilers (Increment B)	101,410	3,151	33,747	4.74	31.07	3.01
Replacement of Incinerators (Increment B)	999,570	24,120	258,325	3.68	24.12	3.87
Computer Controlled Radio Control System (Increment B)	643,150	13,208	221,634	4.69	20.54	2.90
Subtotal Increments A & B	6,067,830	105,318	1,168,215	--	--	--
Reset Condenser Water Temp. (Increment F)	2,826	2,260	18,510	87.4	797.7	.2
Reduce Ventilation Rate (Increment F)	26,555	3,205	31,054	16.3	120.7	.9
Reset Chilled Water Temp. (Increment F)	9,826	510	4,178	5.7	51.9	2.4
Install Flow Restrictors to Lavatories (Increment F)	105,918	1,145	25,706	3.9	10.8	4.1
Replacement of 40 Watt Fluorescent Lamps (Increment G)	216,650	4,570	34,457	2.51	21.08	4.7
Installation of ESWF (Increment G)	1,345,210	6,911	82,276	1.40	5.14	16.3
Replacement of existing A/C equipment in Bldg. P-1 (Increment G)	802,360	2,081	63,599	1.02	2.59	12.61
TOTALS	8,568,175	126,000	1,427,995	--	--	--

FIGURE 3.1

4.2 Allocation of Energy Conservation Project Savings

Completion of the energy conservation projects, as indicated on Figure 3.1, would result in the annual saving of 1,427,995 in energy and maintenance costs.

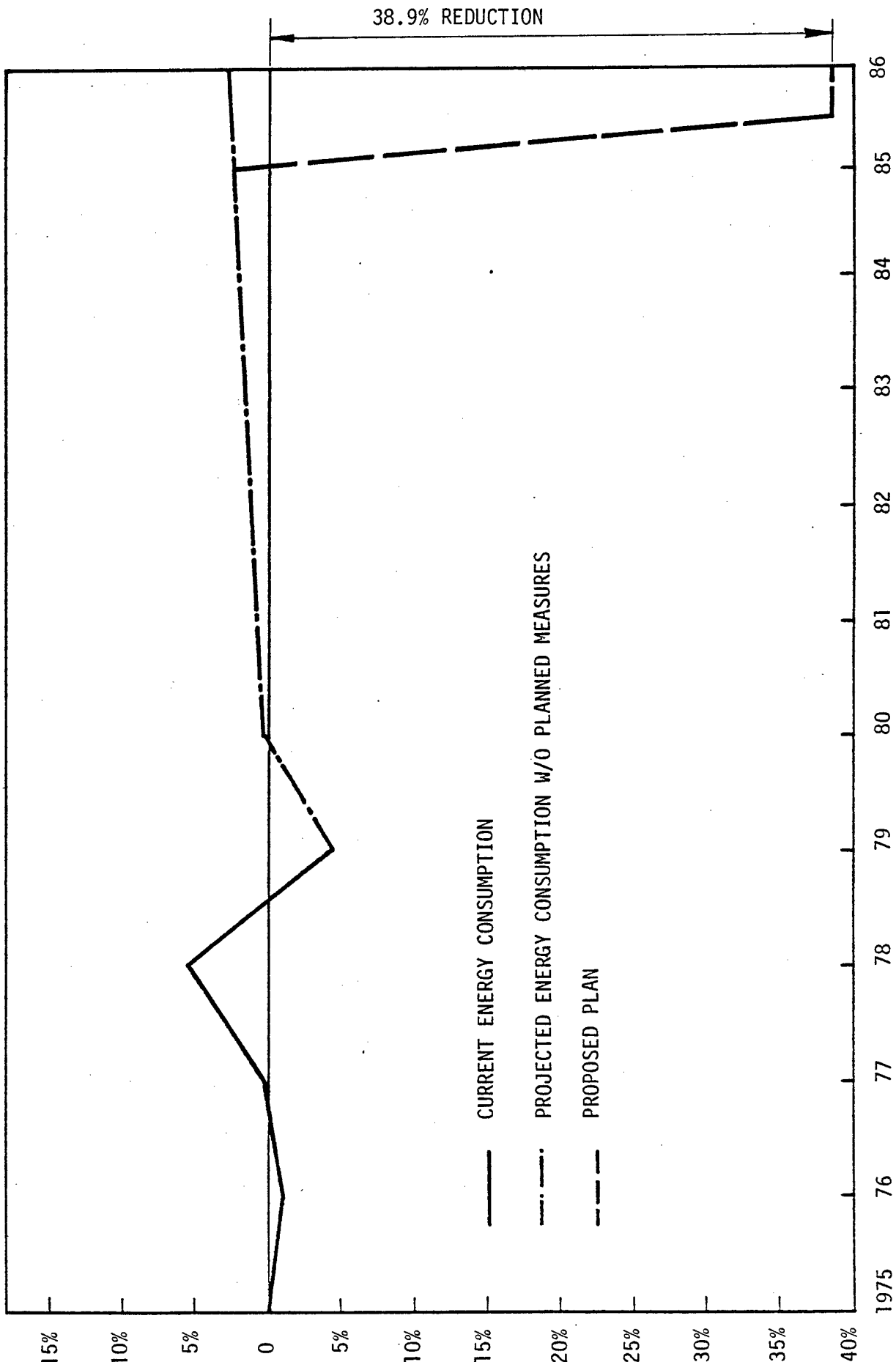
4.3 Projected Energy Consumption

The total energy consumption of the installation does not indicate any significant change during the period FY 75 to FY 80, except for a slight increase in the electrical energy consumption (Figure 4.1.A). The increase in electrical energy demand is mainly due to the continuous addition of air conditioning equipment to meet the requirements of the computer facilities. Since at present no plan exists for changes in the installation's mission, population or new construction and demolition, it is expected that the current level of energy consumption will be maintained until the energy conservation projects are completed. However, as discusses earlier, the energy consumption will be significantly reduced upon completion of the energy conservation projects as indicated hereinbefore.

4.4 Projected Energy Costs

Figure 4.4 indicated the projected increasing energy costs and the anticipated reduction when the energy conservation projects are implemented. The energy costs were escalated using the rates supplied by the Norfolk District, ECIP guidance.

FIGURE 4.1.A



OVERVIEW OF ENERGY CONSERVATION PLAN

Fig. 4.1.B.

TOTAL ENERGY SAVINGS PROFILE

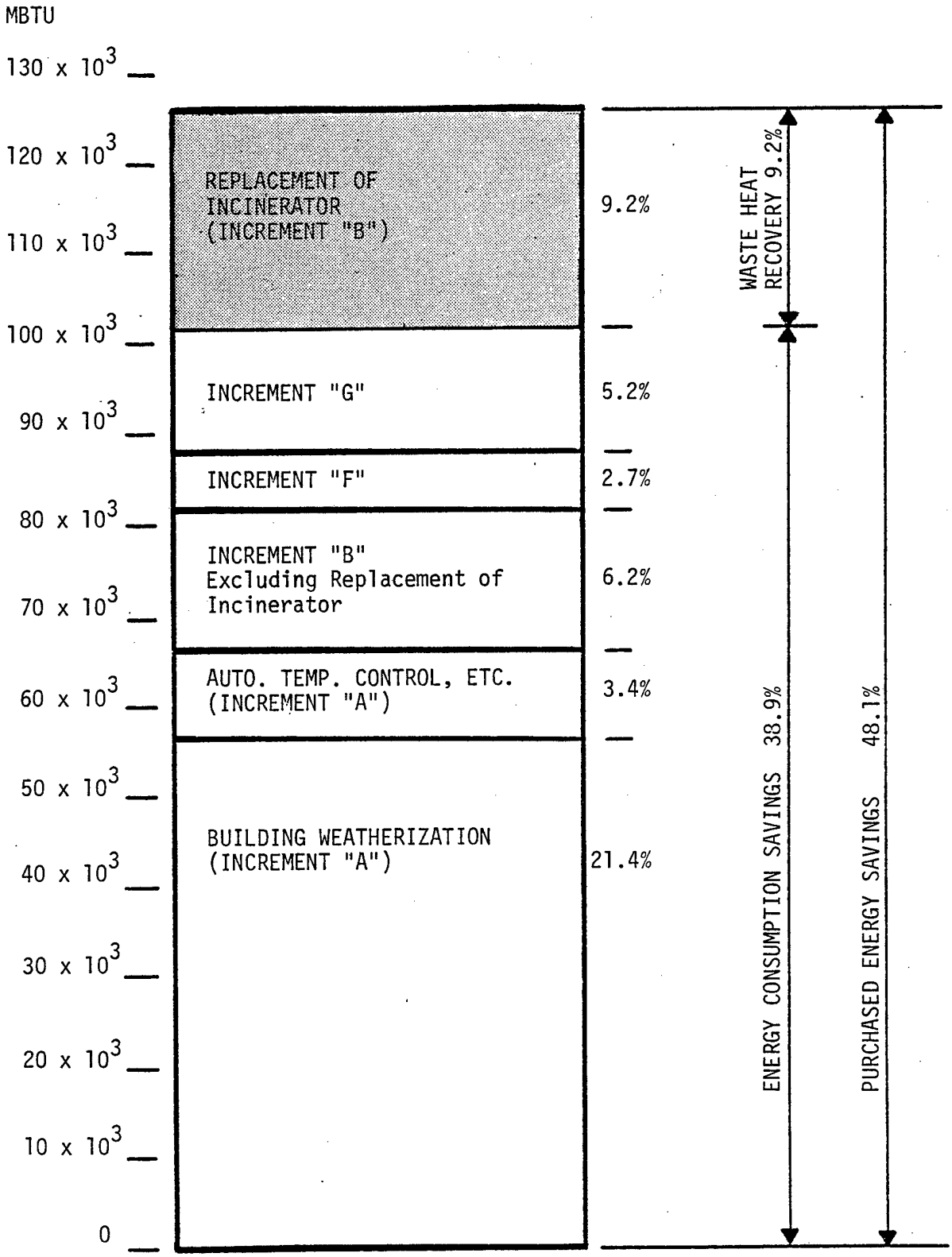
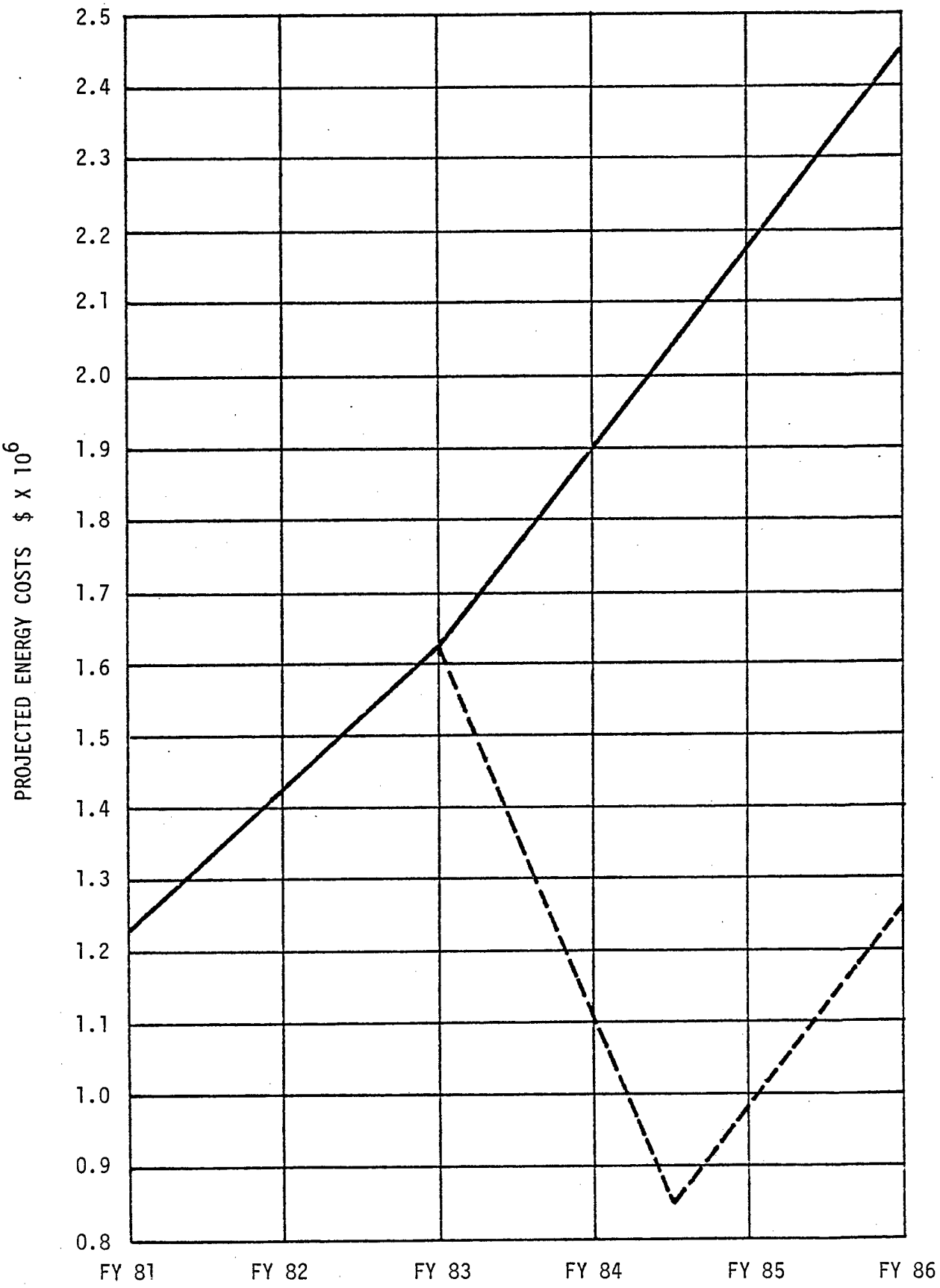


FIGURE 4.4

PROJECTED ENERGY COSTS



5. INCREMENTS "C" AND "D"

5.1 Scope of Work

Increment "C" projects involve new solar energy systems for the major dining facility kitchens and the gymnasium. Increment "D" projects shall consist of the utilization of the solid waste incinerators on the installation. In order to expedite the project, utilization of the solid waste incinerators is included under Increment "B" in lieu of Increment "D" and therefore, Increment "D" projects have been deleted from this report.

5.2 Energy Savings Anticipated

The buildings included in the new solar energy study are P-465, S-125, S-550 and T306/307. The anticipated savings are 1,436 MBTU and $11,876 annually. The E/C ratio of the project is 1.93 with a payback period of 62.64 years.

APPENDIX A

POTENTIAL ENERGY CONSERVATION MEASURES REQUIRING CAPITAL INVESTMENT

Measures Studied	Comments
1. Shut-down ventilation systems during unoccupied periods in noncritical area	Good measure and included in Energy Conservation Project. (ECP)
2. Optimize Ventilation Startup Times	Good measure and included in ECP Project.
3. Reduce Infilatration Through Openings in Building Envelope	Good measure and included in ECP Project.
4. Install Weatherstripping Around Windows and Doors. Caulk Around Window and Door Frames	Good measure and included in ECP Project.
5. Reduce the Quantity of Exhaust Air from Hoods	Not applicable for this installation because all kitchen hoods uses untempered outside air.
6. Recover Heat from Exhaust Air to Precondition Incoming Air	Mostly not applicable for this installation.
7. Lower Indoor Temperature During Heating Season	Good measure and included in ECP Project.
8. Add Automatic Controls to Setback Temperatures During Unoccupied Periods in Noncritical Areas	Good measure and included in ECP Project.
9. Improve Thermal Efficiency of Heat Distribution Systems by Addition of Pipe Insulation	Good measure and included in ECP Project.
10. Install Warm-up Cycle on Air Handling Units with Outside Air Intake as Applicable	Existing AHUs are provided with warm-up cycle.
11. Use Insulating Materials to Block Off & Thermally Seal All Unused Windows	Good measure and included in ECP Project.

Measures Studied	Comments
12. Install Storm Windows & Doors	Good measure and included in ECP Project
13. Add Additional Insulation to Roofs, Ceilings, Walls and Floors Over Unconditioned Areas	Good measure and included in ECP Project
14. Consider Reglazing with Double or Triple Glazing	Good measure but because of its high installation cost, storm windows are considered in this study instead of this measure.
15. Evaluate the Necessity for Humidification; Curtain as Practical	Humidification is provided in Computer Room only; therefore, this measure is not studied.
16. Insulate All Duct Work Carrying Conditioned Air Through Unconditioned Spaces	Not applicable.
17. Vary the Steam Pressure in Accordance with Space Heating Demands	Not applicable since the installation is using low pressure steam.
18. Reset Heating Water Temperature in Accordance with Load	Good measure and included in ECP Project.
19. Reduce Hours of Equipment Operation	Good measure and included in ECP Project.
20. Install Automatic Temperature Control Valves in Radiators and Convectors by Hand Valves	Good measure and included in ECP Project.
21. Provide Additional Thermostats for Better Control of Heating Equipment	Good measure and included in ECP Project.
22. Install Flue Gas Analyzer	Good measure and included in ECP Project.
23. Install Boiler Stack Economizer for Preheating Feed Water	Good measure and included in ECP Project.

Measures Studied	Comments
24. Utilize Heat from Internal Spaces for Heating Perimeter Areas	Good measure but the installation does not have sufficient interior space to apply.
25. Install Solar Panels	Good measure but the installation will be provided with its thermal energy required from solid waste heat recovery, solar project is not recommended.
26. De-energize Hot Water Circulating Pumps When Building is Unoccupied	Good measure and included in ECP Project.
27. Insert Orifices in Hot Water Pipes to Reduce Flow (Shower Flow Restricters - 3 gpm)	Good measure and included in ECP Project.
28. Recover Heat from Incinerators	Good measure and included in ECP Project.
29. Replace Electric Heaters With Water or Steam Heaters	Good measure and included in ECP Project.
30. Provide Automation to Turn Off Cooling System During Unoccupied Hours in Noncritical areas	Good measure and is included in ECP Project.
31. Use Outdoor Air with Enthalpy Controller for Economizer Cooling	Good measure but has limited application for the installation.
32. Convert Constant-Volume Fan System to Variable Air Volume Where Occupancy Permits	Good measure but does not meet the criteria.
33. Replace Inefficient Window Air Conditioners with New High EER Units of Larger, More Efficient Central Systems	Good measure and is included in ECP Project for Bldg. P-1.
34. Modify HVAC Systems to Eliminate the Need for Winter Refrigeration	Good measure but is not applicable to the installation.

Measures Studied	Comments
35. Utilize Automatic Building Demand Limiters	Good measure and is included in ECP Project.
36. Install EMCS System	Good measure but has very limited application for this installation compared to its substantially high first cost. Therefore, computer controlled radio control system (CCRCS) is utilized instead of EMCS systems.
37. Use 35 Watt Lamps & Ballasts in 48-inch Fluorescent Fixtures	Good measure and included in ECP Project.
38. Use Higher Efficiency Lamps	Good measure and included in ECP Project.

APPENDIX B

POTENTIAL ENERGY CONSERVATION MEASURES REQUIRING MANAGEMENT ACTION AT THE INSTALLATION

1. Reduce ventilation rates during occupied hours to a minimum in noncritical areas.
2. Close fireplace dampers when not in use.
3. Adjust outdoor air dampers for tight closure.
4. Rehang misaligned exterior doors.
5. Repair all leaks: Water, steam, air, fuel, etc.
6. Recalibrate all controls & verify sequence.
7. Repair Faulty Equipment: Steam traps, Valves, Dampers, etc., if any.
8. Turn off or eliminate all portable electric heaters.
9. Keep doors and windows closed when heating system is operating.
10. Adjust dampers in mixing boxes so that they shut-off tight to reduce leakage.
11. Check vents in hot water and steam systems for proper performance.
12. Balance water flows to minimally satisfactory levels.
13. Clean strainer screens in pumping systems.
14. Trim pump impeller to match load.
15. Adjust all pumps to control leakage at pump packing glands or replace work mech. seals.
16. Maintain all equipment and auxiliary at peak efficiency.
17. Keep filters and heat transfer surfaces clean.
18. Use proper water treatment to reduce fouling of heat transfer surfaces in boilers, chillers, heat exchangers, etc.
19. Reduce blowdown losses.
20. Replace existing boilers with modular boilers as replacement is required.
21. Reduce illumination to levels consistent with productivity, safety and security considerations.

22. Use daylight for illumination in perimeter areas as practical.

23. Move desks & other work surfaces to a position & orientation that will use installed luminaires to their greatest advantage.

24. Keep lamps, luminaires, and interior surfaces clean.

25. Consider the use of light colors for walls, floors & ceilings to increase reflectance but avoid specular reflections.

26. Eliminate hot water at fixtures where it is not essential.

27. Operate dishwashers & clothes washers with full loads as possible.

28. Maintain lower indoor temperature during heating season and higher during cooling season.

29. Do not cool or heat lobbies, passageways and storage areas to the same degree as work areas.

30. Reduce internal heat gain.

31. Operate condenser water system at lower temperature.

32. Raise chilled water temperature in accordance with load.

33. Close off unused areas and rooms.

34. Replace equipment with high efficiency models as replacement is required.