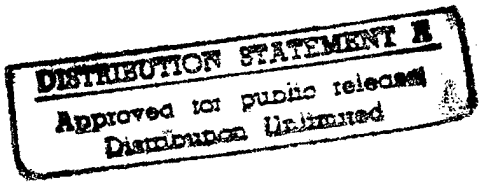
ENERGY SAVINGS OPPORTUNITY SURVEY

AT

WALTER REED ARMY MEDICAL CENTER
WASHINGTON, DC

DEPARTMENT OF THE ARMY
803 FRONT STREET
NORFOLK, VA 23510



SUBMITTED BY

ENERGY ENGINEERING, INC.
SUITE 603
400 GORDON DRIVE
LIONVILLE, PA 19353

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DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

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Marie Wakefield,
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I. Executive Summary

1. Introduction

This Energy Savings Opportunity Survey (ESOS) was performed for sixteen (16) buildings at Walter Reed Army Medical Center (WRAMC) in Washington, D.C. This survey was intended to reevaluate and update projects from a previous Energy Engineering Analysis Program (EEAP) survey performed at WRAMC. However, the previous EEAP survey was determined by the contracting officer to be incomplete and not worthy of further consideration. Therefore, this survey involved the complete reevaluation of the buildings to determine their potential energy cost savings.

Six (6) projects and nine (9) low cost/no cost energy conservation opportunities (ECO's) are recommended for implementation in the buildings. These projects and ECO's are projected to annually save $448,263 at an implementation cost of $891,659. The simple payback (i.e., implementation cost divided by cost savings) for the recommendations in the survey is 1.99 years. The two (2) projects with the greatest cost savings are a stack heat recovery system (Project #5) and HVAC modifications (Project #1). These two (2) projects will provide 67% of the projected total savings for the survey.

The sixteen (16) buildings in this survey represent only 22% of the total floor area of the Walter Reed Army Medical Center complex. It is believed that significant potential energy cost savings amounting to two (2) million dollars may be achieved in the remaining buildings in the complex not included in this survey. Specifically it is believed the main hospital building contains many opportunities for substantial cost savings.

2. BUILDING DATA

Building #7

Building 7 is a three-story, partially-insulated brick structure containing 50,635 square feet of floor area. The building contains administrative offices and a research laboratory. Heat is distributed in the building by air handling units and cabinet unit heaters which utilize steam from the central boiler plant. Chilled water is obtained from the central cooling plant for the air handling units to provide cooling for the building. Domestic hot water is provided by a steam-to-hot-water heat exchanger in the basement. A majority of the lighting in the building is provided by fluorescent fixtures which have individual room switches.

Building #11

Building 11 is a three-story brick structure containing 130,083 square feet of floor area. The building contains administrative offices and a guest house. Heat is distributed in the building by air handling units, fan coil units and cast-iron radiators which utilize steam or hot water converted from steam, supplied by the central boiler plant. Chilled water is obtained from the central cooling plant to the building. Domestic hot water is provided by steam-to-hot water tank heat exchangers in the basement. A majority of the lighting in the building is provided by fluorescent fixtures having individual room light switches.

Building #14

Building 14 is a four-story well insulated structure containing 300,000 square feet of floor area. The building contains personnel housing and a parking garage. Heat is supplied by air handling units which utilize steam from the central boiler plant. Cooling is provided by chilled water obtained from a chiller located in a small building next to building 14. Domestic hot water is provided by a steam heat exchanger located in the mechanical room. A majority of the room lighting is provided by incandescent fixtures supplied by the personnel.

Building #15

Building 15 is a two-story brick uninsulated structure containing 19,890 square feet of floor area. The building is the central boiler plant, but additionally contains the air conditioning and electric shops. A majority of the heat provided to the building is waste heat caused by thermal losses from the boiler equipment. Supplemental heat is provided by a few small air handling units which additionally provide cooling for the shops. Lighting in the building is provided by fluorescent fixtures in the shops and by high pressure sodium fixtures in the boiler room.

Building #17

Building 17 is a two-story brick-faced poorly insulated structure containing 20,530 square feet of floor area. The building is used continuously throughout the year as a guest house for patients and relatives at the hospital. Heat is distributed in the uninsulated building by cast-iron radiators which utilize steam from the central boiler plant. Cooling is provided by window air conditioning units. Domestic hot water is provided by a steam-to-hot water heat exchanger in the basement. A majority of the lighting in the building is provided by incandescent fixtures with individual room switches.

Building #38

Building 38 is a two-story brick satisfactorily insulated administration building containing 9,933 square feet of floor area. Heating and cooling are provided by a dual duct air handling unit located in the basement. Domestic hot water is provided by an electric tank heater located in the basement. A majority of the lighting in the building is provided by fluorescent fixtures which have individual room light switches.

Building #40

Building 40 is a four-story brick satisfactorily insulated building containing 276,182 square feet of floor area. The building contains research laboratories, administrative offices, and an auditorium. Heat is distributed in the building by cast-iron radiators, unit heaters, and air handling units. Steam supplied from the central boiler plant is utilized by the heating equipment. Cooling is provided by the air handling units from chilled water supplied from the central cooling plant and from small split systems. Domestic hot water is provided by steam heat exchangers located in the basement and penthouse. A large majority of the lighting in the building is provided by fluorescent fixtures having individual room light switches.

Building #41

Building 41 is a three-story brick building containing 43,574 square feet of floor area. The building is utilized as a recreation facility and supply distribution center. Heat is distributed to the building by cast-iron radiators, unit heaters and air handling units. Steam from the central boiler plant is utilized by the heating equipment. Cooling is provided by the air handling units which utilize chilled water from the central cooling plant. Domestic hot water in the building is provided by a steam heat exchanger in the basement. A majority of the lighting is provided by fluorescent fixtures having individual room light switches.

Building #83

Building 83 is a two-story brick partially-insulated structure containing 16,674 square feet of floor area. The first floor of the building contains a computer processing area while the second floor is used as office space. Heat is distributed in the building by air handling units and unit heaters which utilize steam from the central boiler plant. Cooling is provided by the air handling units which utilize chilled water from the packaged cooling units located next to the building. Domestic hot water is provided by a steam heat exchanger located in the basement mechanical space. A majority of the lighting in the building is provided by fluorescent fixtures having individual room light switches.

Building #85

Building 85 is a one-story uninsulated brick structure containing 6,323 square feet of floor area. The building contains a child care facility, a dry cleaning shop, a janitorial service and a mini-market. Steam from the central boiler plant is distributed by cast-iron radiators, unit heaters and a small air handling unit to provide heat for the building. Cooling is provided by two split cooling units. Domestic hot water is provided by an electric tank water heater. Lighting is provided by fluorescent fixtures which have the circuitry to obtain partial building lighting.

Building #90

Building 90 is a two-story brick uninsulated structure containing 5,963 square feet of floor area. The building is used continuously throughout the year as a firehouse. Heat is distributed in the building by unit heaters and cast-iron radiators which utilize steam from the central boiler plant. Cooling is provided by a few window air conditioning units. Domestic hot water is provided by a 4.5 kW electric tank water heater. A majority of the lighting in the building is provided by fluorescent fixtures having individual room light switches.

Building #91

Building 91 is a two-story brick insulated structure containing 9,591 square feet of floor area. The building is used as a dental research laboratory. Heating and cooling is provided to the building by three air handling units located in the basement and on the roof. Steam is supplied to the air handling units from the central boiler plant. Chilled water is provided by air cooled package units located on the exterior of the building. Domestic hot water is provided by a steam heat exchanger located in the basement. A majority of the lighting in the building is provided by fluorescent fixtures having individual room light switches.

Building #93

Building 93 is a two-story brick-faced structure containing 14,320 square feet of floor area. The building contains administrative offices. Heat is distributed in the well-insulated building by air handling units located in the basement which utilize steam from a temporary boiler located in a trailer outside the building. Cooling is additionally provided by split system air conditioning units. Domestic hot water is provided by a steam heat exchanger located in the basement. A majority of the lighting is provided by fluorescent fixtures having individual room light switches.

Building #G-76

Building G-76 is a one-story insulated structure containing 25,106 square feet of floor area. The building contains the officers club and kitchen. Heating and cooling are distributed in the building by air handling units located in the basement and building exterior. Steam, supplied by the central boiler plant is provided to the air handling units for heat. Chilled water is supplied by a small basement chiller, package cooling units, and split cooling units. Domestic hot water in the building is provided by a steam heat exchanger in the basement. A majority of the lighting in the building is provided by incandescent fixtures.

Building #T-2

Building T-2 is a two-story insulated metal structure containing 44,450 square feet of floor area. The building is used for research laboratories and equipment storage. Heat is provided by air handling units located in the basement and second floor mechanical rooms, which utilize steam from the central boiler plant. Cooling is additionally provided by the air handling units which utilize chilled water from the central cooling plant. Domestic hot water is provided by a steam tank heat exchanger located in the basement. A majority of the lighting in the building is provided by fluorescent fixtures having individual room light switches.

Building #T-20

Building T-20 is a two-story prefabricated insulated metal structure containing 33,440 square feet of floor area. The building is utilized for administrative office space. Heating and cooling are provided to the building by package gas-fired heating/cooling units located on the roof of the building and around the building perimeter. Domestic hot water is provided by a gas-fired tank water heater located in a storage closet. Lighting is provided by fluorescent fixtures having individual room light switches.

3. Analysis of Energy Consumption

A wealth of information can typically be derived by examining monthly energy consumption over an extended period of time. Figure 1 lists monthly electrical consumption in kWh, MBtu's and Btu/SF for fiscal years 1984, 1985 and 1986 for the buildings at the main complex, excluding building 54. Careful review of this data indicates that annual electrical consumption has increased rather than decreased. Consumption rose 4.0% and 0.6% during fiscal years 1985 and 1986, respectively, in comparison to fiscal year 1984. Review of monthly data (Table 1 and Figure 1) does not indicate particular trends in consumption during specific periods of the year, such as, increased consumption during the summer or winter months. The one monthly figure that does stand out is the large increase in consumption in September 1986 in comparison to the previous two years. But with the immense amount of equipment in so many buildings, variations in total electrical consumption can not be accurately explained as to their source.

According to the Army Facilities Energy Plan, FY85, electrical consumption is increasing annually Army-wide and is considered the biggest obstacle to meeting Army Facilities energy goals. It is thus imperative that this continued rise in electrical consumption be addressed at Walter Reed Army Medical Center.

Regarding thermal consumption, a large majority of the buildings at Walter Reed Army Medical Center receive thermal energy from steam lines running from the central heating plant (building 15). The central heating plant has dual-fuel capability (natural gas and #4 heating oil) which is switched in general at the discretion of the boiler plant operator. Thus, for determining thermal consumption, the total consumption for natural gas and heating oil are listed separately (Tables 2 and 3, respectively), but then the combined total of the two fuels (Table 4 and Figure 2) is used in determining total complex thermal consumption.

Upon examination of the total annual thermal consumption data over the period from fiscal years 1983 through 1986, consumption increased 2% during fiscal year 1984. During the following two fiscal years consumption decreased to a level 6% below fiscal year 1983 consumption. Heating degree day data (Table 5) indicates that heating degree days increased between fiscal years 1983 and 1984 from 3,720 to 4,284. Monthly data indicates a particular rise in consumption during December, January, and March of fiscal year 1984 in comparison to 1983. During the same period, heating degree data increased proportionately with consumption; therefore, the rise in consumption during fiscal year 1984 is most likely attributable to a colder winter.

Thermal consumption during fiscal years 1985 and 1986 decreased over 1983 consumption, even though heating degree day data was higher during the past two fiscal years. This decrease in consumption is attributable to the many operational and maintenance practices being implemented at Walter Reed Army Medical Center.

The thermal consumption rate presently is at 132,859 Btu/SF for the main complex. A rate of this magnitude is high in comparison to offices and dormitories previously studied by EEI. Typical rates for these types of buildings is well under 100,000 Btu/SF prior to an energy audit. For hospitals, EEI has found rates in the order of 200,000 Btu/SF to be typical prior to an energy audit. Therefore, considering that the amount of research and hospital area is approximately the same amount of area for offices and dormitories, a rate of 132,859 is not exceptionally high. But the present rate does indicate that many opportunities for energy conservation do exist at Walter Reed Army Medical Center.

Present energy cost and consumption information for the whole WRAMC complex is provided in Table 6. Additionally an estimate of energy cost and consumption data is provided for the sixteen (16) buildings in this survey as well as the remaining consumption for the buildings not in this survey.

TABLE 1 - MONTHLY ELECTRICITY CONSUMPTION

METERED CONSUMPTION INFORMATION FOR: WALTER REED ARMY MEDICAL CENTER
FUEL TYPE : ELECTRICITY (kWh)

MONTH\YEAR	FY1984	FY1985	FY1986
OCTOBER	7033106	7651610	7497875
NOVEMBER	6943241	6851116	6923104
DECEMBER	6823843	6817978	7033573
JANUARY	6680758	6930982	6905039
FEBRUARY	6544061	6866939	6265078
MARCH	6470482	6188071	6301397
APRIL	6266451	7038214	6717323
MAY	6684731	7595227	7973401
JUNE	8468932	8925309	8282275
JULY	9253701	8854082	9087953
AUGUST	8863338	9726171	9329959
SEPTEMBER	8201287	8346196	9997959
TOTALS:	88233931	91791895	92314936

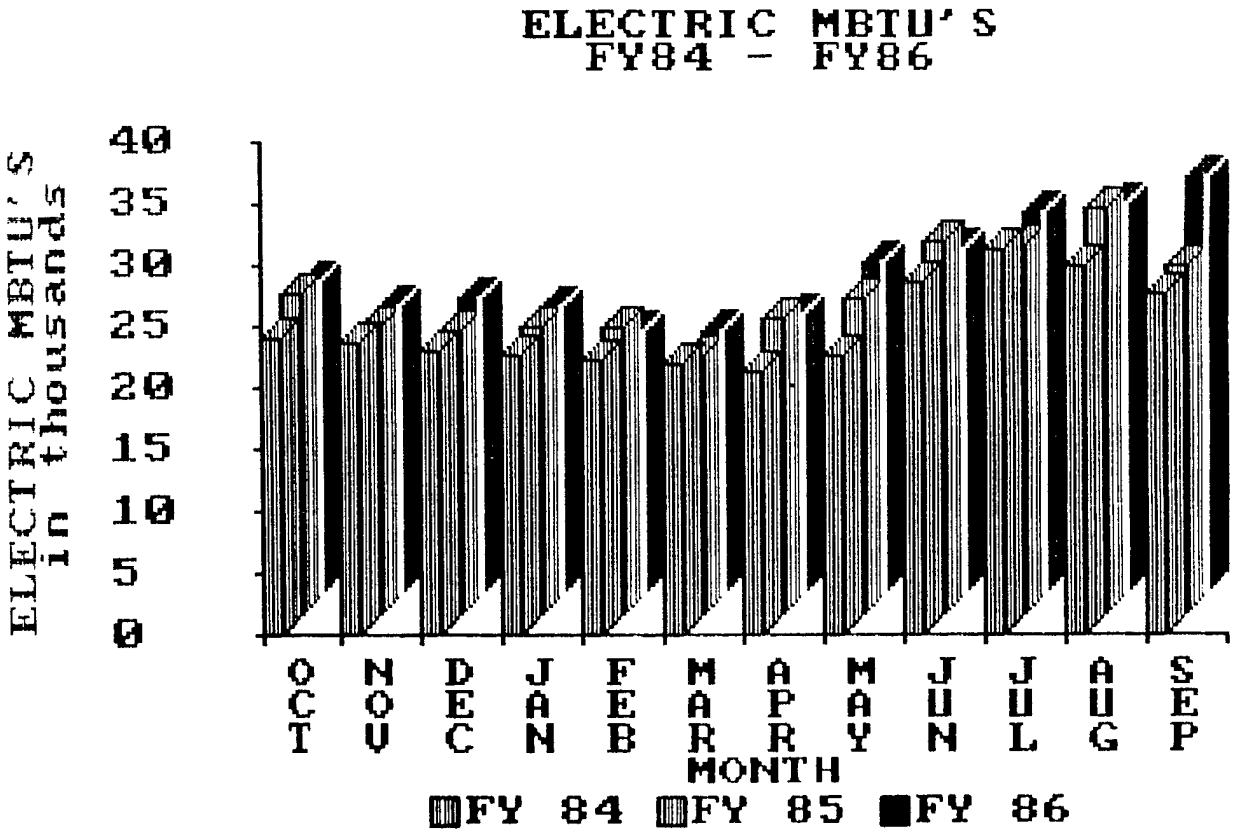
METERED CONSUMPTION INFORMATION FOR: WALTER REED ARMY MEDICAL CENTER
FUEL TYPE : ELECTRICITY (MBtu)

MONTH\YEAR	FY1984	FY1985	FY1986
OCTOBER	24004	26115	25590
NOVEMBER	23697	23383	23629
DECEMBER	23290	23270	24006
JANUARY	22801	23655	23567
FEBRUARY	22335	23437	21383
MARCH	22084	21120	21507
APRIL	21387	24021	22926
MAY	22815	25923	27213
JUNE	28904	30462	28267
JULY	31583	30219	31017
AUGUST	30251	33195	31843
SEPTEMBER	27991	28486	34123
TOTALS:	301142	313286	315071

METERED CONSUMPTION INFORMATION FOR: WALTER REED ARMY MEDICAL CENTER
FUEL TYPE : ELECTRICITY (Btu/SF)

MONTH\YEAR	FY1984	FY1985	FY1986
OCTOBER	5815	6327	6200
NOVEMBER	5741	5665	5725
DECEMBER	5642	5638	5816
JANUARY	5524	5731	5710
FEBRUARY	5411	5678	5180
MARCH	5350	5117	5210
APRIL	5182	5820	5554
MAY	5527	6280	6593
JUNE	7003	7380	6848
JULY	7652	7321	7515
AUGUST	7329	8042	7715
SEPTEMBER	6781	6901	8267
TOTALS:	72958	75900	76332

FIGURE 1 - MONTHLY ELECTRICITY CONSUMPTION IN MBtu's
WALTER REED ARMY MEDICAL CENTER



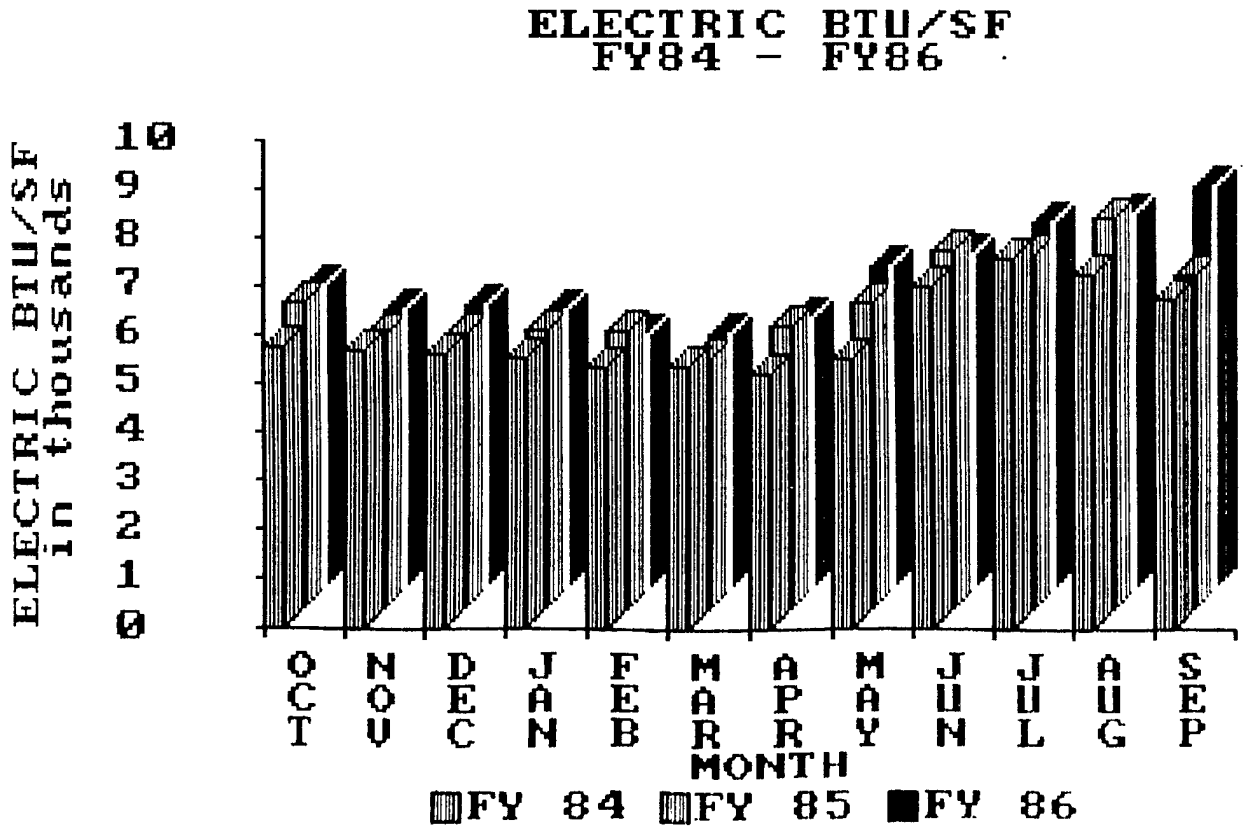


TABLE 2 - MONTHLY NATURAL GAS CONSUMPTION

METERED CONSUMPTION INFORMATION FOR: WALTER REED ARMY MEDICAL CENTER
FUEL TYPE : NATURAL GAS (CCF)

MONTH\YEAR	FY1983	FY1984	FY1985	FY1986
OCTOBER	6926	8310	328046	327440
NOVEMBER	9358	11222	361355	470867
DECEMBER	28135	16337	308529	477365
JANUARY	26979	34500	319421	269197
FEBRUARY	27519	29273	249722	25488
MARCH	12837	25278	290085	111893
APRIL	18278	16409	399668	277152
MAY	8367	377248	349831	72734
JUNE	8453	196104	291000	5388
JULY	6633	260581	247923	110929
AUGUST	5284	234137	151320	259366
SEPTEMBER	5627	312475	283013	314780
TOTALS:	164396	1521874	3579913	2722599

METERED CONSUMPTION INFORMATION FOR: WALTER REED ARMY MEDICAL CENTER
FUEL TYPE : NATURAL GAS (MBtu)

MONTH\YEAR	FY1983	FY1984	FY1985	FY1986
OCTOBER	713	856	33789	33726
NOVEMBER	964	1156	37220	48499
DECEMBER	2898	1683	31778	49169
JANUARY	2779	3554	32900	27727
FEBRUARY	2834	3015	25721	2625
MARCH	1322	2604	29879	11525
APRIL	1883	1690	41166	28547
MAY	862	38857	36033	7492
JUNE	871	20199	29973	555
JULY	683	26840	25536	11426
AUGUST	544	24116	15586	26715
SEPTEMBER	580	32185	29150	32422
TOTALS:	16933	156753	368731	280428

TABLE 3 - MONTHLY FUEL OIL CONSUMPTION

METERED CONSUMPTION INFORMATION FOR: WALTER REED ARMY MEDICAL CENTER
FUEL TYPE : #4 AND #6 FUEL OIL (Gals)

MONTH\YEAR	FY1983	FY1984	FY1985	FY1986
OCTOBER	279280	276445	0	0
NOVEMBER	414103	383611	118230	31795
DECEMBER	463449	548081	259615	236041
JANUARY	592640	640321	440128	428424
FEBRUARY	469672	450361	357129	457809
MARCH	454940	489293	227962	396280
APRIL	395966	380316	67601	179830
MAY	286141	13647	0	195882
JUNE	214464	75050	0	151110
JULY	188267	0	69898	103508
AUGUST	166152	0	78050	0
SEPTEMBER	178140	0	0	730
TOTALS:	4103214	3257125	1618613	2181409

METERED CONSUMPTION INFORMATION FOR: WALTER REED ARMY MEDICAL CENTER
FUEL TYPE : #4 AND #6 FUEL OIL (MBtu)

MONTH\YEAR	FY1983	FY1984	FY1985	FY1986
OCTOBER	41805	41381	0	0
NOVEMBER	61987	57423	17698	4594
DECEMBER	69374	82042	38862	34109
JANUARY	88712	95850	65883	61909
FEBRUARY	70305	67415	53459	66155
MARCH	68100	73242	34124	57264
APRIL	59272	56930	10119	25986
MAY	42832	2043	0	28306
JUNE	32103	11234	0	21836
JULY	28182	0	10463	14957
AUGUST	24871	0	11683	0
SEPTEMBER	26666	0	0	105
TOTALS:	614210	487559	242290	315220

TABLE 4 - TOTAL MONTHLY THERMAL CONSUMPTION

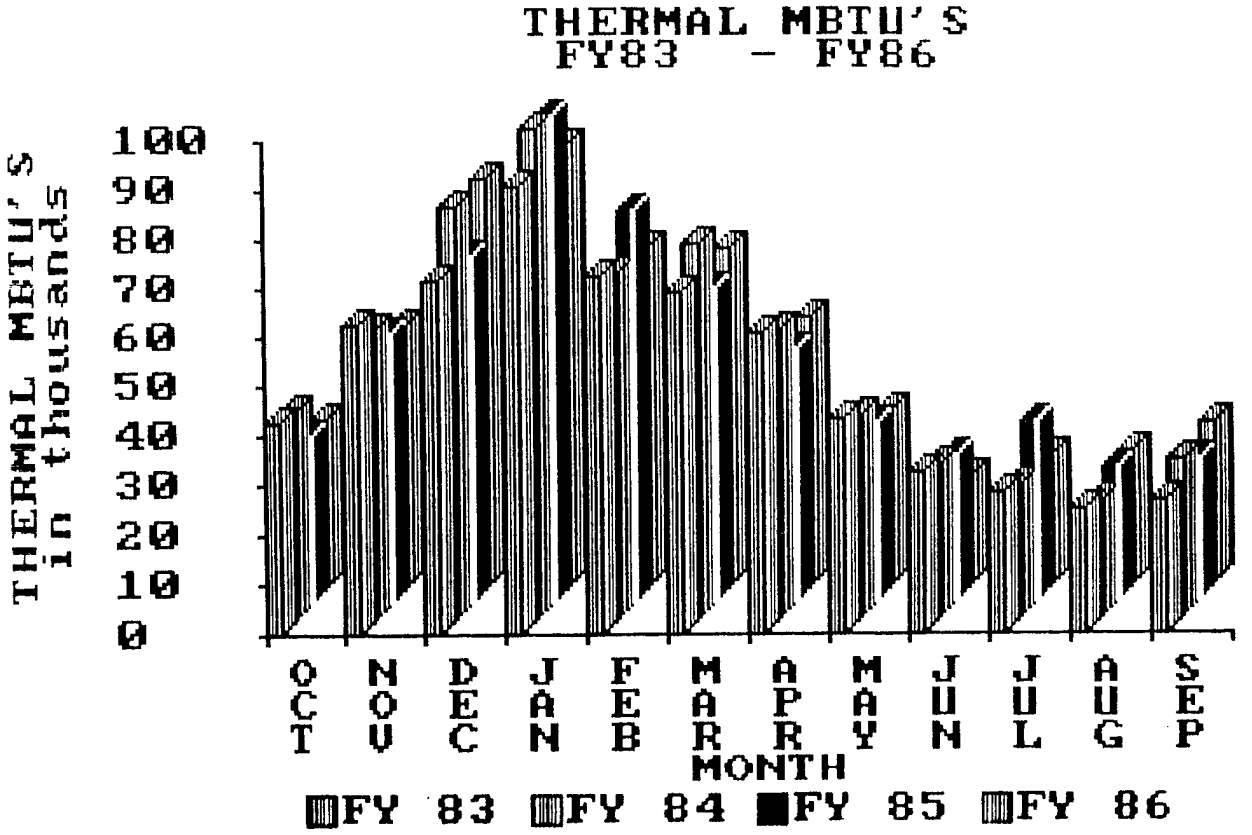
METERED CONSUMPTION INFORMATION FOR: WALTER REED ARMY MEDICAL CENTER
FUEL TYPE : OIL AND GAS (MBtu)

MONTH\YEAR	FY1983	FY1984	FY1985	FY1986
OCTOBER	42519	42237	33789	33726
NOVEMBER	62951	58579	54917	53094
DECEMBER	72272	83725	70640	83277
JANUARY	91491	99403	98783	89636
FEBRUARY	73140	70430	79180	68780
MARCH	69422	75846	64002	68789
APRIL	61155	58620	51285	54533
MAY	43694	40899	36033	35797
JUNE	32974	31433	29973	22391
JULY	28865	26840	35999	26383
AUGUST	25416	24116	27269	26715
SEPTEMBER	27245	32185	29150	32528
TOTALS:	631143	644312	611021	595648

METERED CONSUMPTION INFORMATION FOR: WALTER REED ARMY MEDICAL CENTER
FUEL TYPE : OIL AND GAS (Btu/SF)

MONTH\YEAR	FY1983	FY1984	FY1985	FY1986
OCTOBER	9484	9421	7537	7523
NOVEMBER	14041	13066	12249	11843
DECEMBER	16120	18675	15756	18575
JANUARY	20407	22172	22033	19993
FEBRUARY	16314	15709	17661	15341
MARCH	15485	16917	14276	15343
APRIL	13641	13075	11439	12163
MAY	9746	9123	8037	7985
JUNE	7355	7011	6685	4994
JULY	6438	5987	8030	5885
AUGUST	5669	5379	6082	5959
SEPTEMBER	6077	7179	6502	7255
TOTALS:	140776	143713	136288	132859

FIGURE 2 - MONTHLY FUEL OIL & NATURAL GAS CONSUMPTION IN MBtu'S
WALTER REED ARMY MEDICAL CENTER



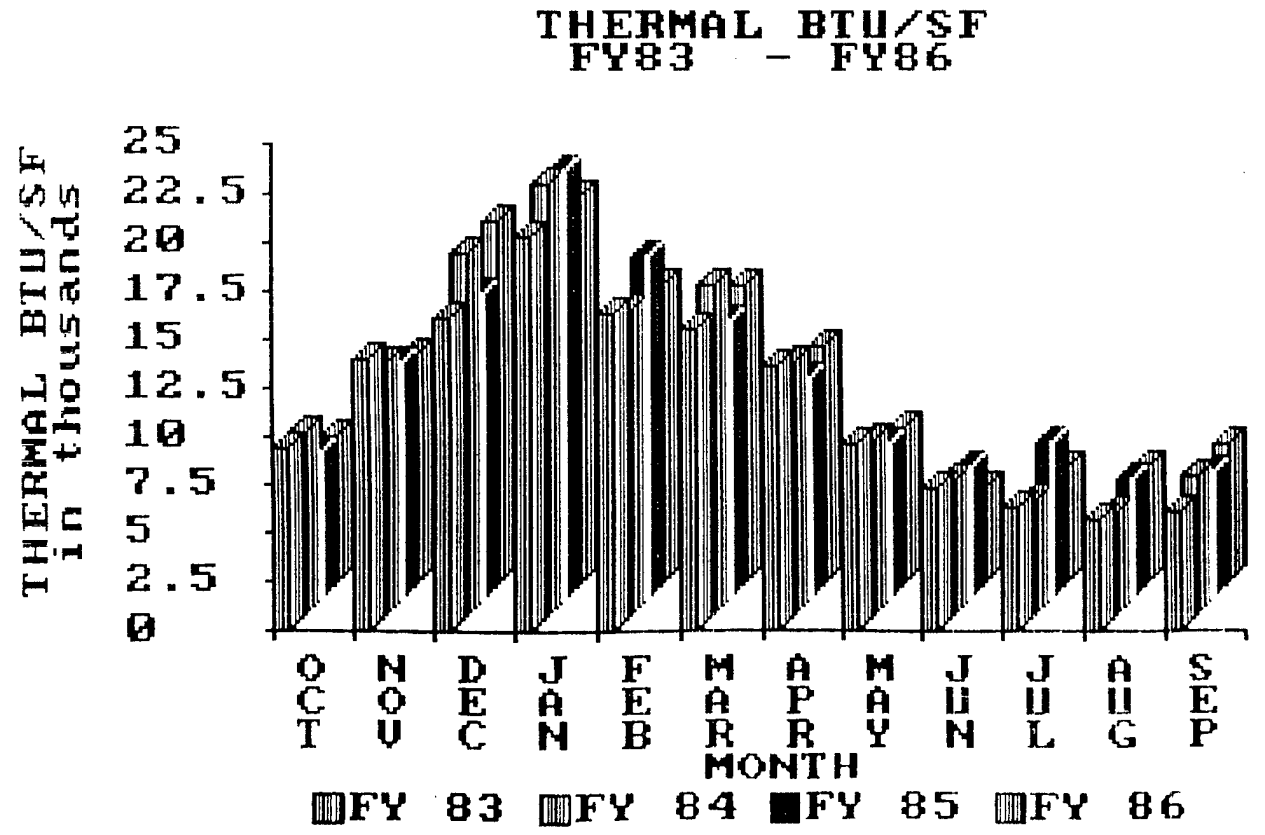


TABLE 5 - HEATING DEGREE DAY DATA

HEATING DEGREE DAY DATA FOR: WASHINGTON
SOURCE : NATIONAL WEATHER SERVICE

MONTH\YEAR	FY1983	FY1984	FY1985	FY1986
OCTOBER	193	177	59	147
NOVEMBER	402	433	561	320
DECEMBER	597	890	594	879
JANUARY	827	1009	1053	931
FEBRUARY	730	610	757	824
MARCH	497	710	533	542
APRIL	365	302	166	267
MAY	77	95	30	61
JUNE	0	4	6	3
JULY	0	0	0	0
AUGUST	0	0	0	13
SEPTEMBER	32	54	14	18
TOTALS:	3720	4284	3773	4005

TABLE 6: PRESENT ENERGY COST AND CONSUMPTION

October, 1985 - September, 1986

BUILDING	GSF	ELECTRICITY			THERMAL			TOTAL		
		KWH	BTU/SF	$	MBTU	BTU/SF	$	MBTU	BTU/SF	$
TOTAL COMPLEX	4483321	92314936	76332	5232382	595648	132859	3139065	910719	209191	8371447
7	50635	423015	28513	23976	3784	74731	19994	5228	103244	43920
11	130083	1422559	37324	80631	12171	93564	64150	17026	130888	144781
14	300000	2001787	22774	113860	20965	69883	110502	27797	92657	224362
15	19890	1179581	202409	66859	1040	52284	5482	5066	254693	72341
17	20530	109503	18204	6207	2519	122708	13278	2893	140912	19485
38	9933	187180	64316	10647	1044	105131	5505	1683	169447	16152
40	276182	5927081	73246	335947	31177	112937	164331	51407	186183	500278
41	43574	339641	26603	19250	3576	82065	18849	4735	108668	38099
83	16674	986141	201855	55894	996	59758	5252	4362	261613	61146
85	6323	159965	86346	9066	1048	165793	5525	1594	252139	14591
90	5963	18669	10685	1058	507	85003	2672	571	95688	3730
91	9591	446682	158953	25408	2605	271564	13728	4129	430517	39136
93	14320	154336	36783	8748	1416	98904	7466	1943	135687	16214
T-2	44450	1037892	79692	59036	9086	204400	47889	12628	284093	106924
T-20	33440	635219	64833	36005	4211	125938	22198	6379	190771	58203
G-76	25106	668378	90862	37884	3049	121441	16070	5330	212303	53954
TOTAL FOR BLDGS IN REPORT	1006694	15697629	53220	890476	99195	98536	522891	152771	151755	1413315
REMAINING CONSUMPTION	3476627	76617307	75215	4341906	496453	142797	2616174	757948	218012	6958132

4. Description of Recommended Projects and ECO's

A great many Energy Conservation Opportunities (ECOs) were investigated during the field survey (see table 7) for possible application in the sixteen (16) buildings at WRAMC surveyed in this report. A majority of the ECOs investigated were either previously implemented, were not applicable to the building equipment or structure, or were not economically justifiable (SIR <1) for inclusion in this report (see table 8).

Six (6) projects and nine (9) low cost/not cost ECOs have been recommended in this report for implementation at WRAMC. All of the six (6) projects recommended are planned for funding under the Productivity Capital Investment Program (PCIP), while the low cost/no cost ECOs will be financed by existing WRAMC funds. The documentation prepared for the six (6) PCIP projects was completed as directed by Walter Reed Army Medical Center personnel. The following is a listing of the recommended projects and ECOs:

Project/ECO Number	Title
Project #1	HVAC Modifications
Project #2	Lighting Conversions
Project #3	Air System Modification
Project #4	Building Weatherization
Project #5	Stack Heat Recovery
Project #6	Lighting Power Reducers
ECO #1	Delamp Overlit Areas
ECO #2	Install Insulating Panel
ECO #3	Install Showerhead Flow Restrictors
ECO #4	Pipe Insulation
ECO #5	Reduce DHW Temperature
ECO #6	Reduce Lighting Hours of Operation
ECO #7	Repair Steam System
ECO #8	Replace Louvers on HVAC Equipment
ECO #9	Turn Off Unnecessary Lighting.

Two (2) of the six (6) projects recommended involve modifications to lighting systems in the surveyed buildings. Project #2 concerns converting existing interior and exterior lighting fixtures and lamps to more efficient lighting sources. Project #6 concerns installing lighting power reducers on existing fluorescent fixtures. Lighting power reducers lower the current to the ballasts in the fixtures which thus reduces electrical consumption.

Project #1 involves modifications to the heating, ventilating and air conditioning (HVAC) equipment and controls in the surveyed buildings. Specifically, the project includes installing timeclocks on exhaust fans, installing new energy-efficient motors and installing and modifying HVAC controls. The timeclocks on the exhaust fans will eliminate ventilation during unoccupied hours to reduce thermal and electrical consumption. The new energy-efficient motors will reduce electrical consumption by lowering the amount of energy input required by the motors. The modifications to the HVAC controls will provide savings by lowering occupied and unoccupied building space temperatures and by reducing equipment operation time.

Project #3 involves the installation of variable speed drives on two (2) air handling units and central exhaust fans in building 40. Ventilation levels will be significantly lowered during unoccupied hours to provide large electrical and thermal energy savings. Additionally, the fume hoods in the building will be placed on a separate exhaust system from the two (2) central building exhaust fans.

Project #4 involves the installation of roof insulation and exterior door weatherstripping to reduce thermal losses due to conduction and infiltration of heat.

Project #5 involves the installation of economizers on boilers #3 and #4 in the boiler plant (building 15). The economizers will recover waste heat, which normally is lost to the atmosphere, to be utilized in heating boiler feedwater.

Of the nine (9) low cost/no cost ECOs recommended, three (3) of the ECOs concern modifications to the lighting systems in the buildings. ECO #1 involves the delamping of fixtures in overlit areas to reduce electrical consumption by lowering light output of the lighting fixtures to meet DoD recommended illumination guidelines. ECO #6 involves installing photocells on building lighting to reduce lighting hours of operation during daylight hours. Finally, ECO #9 involves the turning off of unnecessary lighting fixtures in specific areas in which lighting fixtures are left on while the space is unoccupied.

Two (2) of the remaining ECOs involve reducing thermal losses through the building structures. ECO #2 concerns installing insulating panels over windows in building 85 to reduce conductive losses. ECO #8 concerns installing or repairing louvers on HVAC equipment to reduce infiltration losses through the louvers when the equipment is not in operation.

The final ECOs recommended include installing showerhead flow restrictors (ECO #3); installing pipe insulation on pipes and valves presently uninsulated (ECO #4); reducing the domestic hot water temperature to recommended levels (ECO #5); and repairing steam and condensate leaks in the buildings (ECO #7).

TABLE 7 - ENERGY CONSERVATION OPPORTUNITIES INVESTIGATED

ECO's To Be Investigated From Scope of Work

1. Insulation (wall, roof, pipe, duct, etc.)
2. Insulated glass or double glazed windows
3. Weatherstripping and caulking
4. Insulated panels
5. Solar films
6. Vestibules
7. Load dock seals
8. Reduction of glass area
9. Replace kitchen light fixtures
10. Shutdown energy to hot water heaters or modify controls
11. Energy conserving fluorescent lamps and ballasts
12. Reduce lighting levels
13. Replace incandescent lighting
14. Use more efficient lighting source
15. Improve power factor
16. High efficiency motor replacement
17. Night setback/setup thermostats
18. Infrared heaters
19. Economizer cycles (dry bulb)
20. Control hot water circulation pump
21. FM radio controls
22. Radiator controls
23. Decentralize domestic hot water heaters
24. Install shower flow restrictors or limited flow showerheads
25. Heat reclaim from hot refrigerant gas
26. Reduce air flow
27. Prevent air stratification
28. Install timeclocks
29. Boiler oxygen trim controls
30. Revise boiler controls
31. Chiller replacement
32. Replace absorption chiller
33. Reduce street lights
34. Insulate steam lines
35. Return condensate
36. Heat reclaim from condenser units for preheating DHW
37. Domestic hot water heat pumps
38. Transformer overvoltage
39. Transformer loading
40. Revise or repair building HVAC controls
41. Waste heat recovery
42. Thermal storage
43. Steam trap inspection
44. Instantaneous hot water heater
45. Air curtains

Additional ECO's Investigated

46. Cogeneration
47. EMCS
48. Reduce DHW temperature
49. Two speed fan motors
50. Install photocells on exterior lighting

TABLE 8: ECO's REJECTED

The following is a summary of those ECO's which were rejected in which preliminary calculations were performed to determine their economic feasibility. The calculations are provided in Section VI "Energy Conservation Opportunities Not Recommended".

Building #	ECO Title	SIR
7	Double Glazing for Windows	0.69
7	Reduce Glass Area	0.85
11	Double Glazing for Windows	0.91
14	Double Glazing for Windows	0.82
17	Double Glazing for Windows	0.51
38	Double Glazing for Windows	0.27
38	Reduce Glass Area	0.82
40	Double Glazing for Windows	0.88
41	Double Glazing for Windows	0.90
41	Reduce Glass Area	0.97
41	Insulate Ceiling	0.98
83	Double Glazing for Windows	0.42
85	Insulate Ceiling	0.79
90	Double Glazing for Windows	0.79
T-2	Double Glazing for Windows	0.73
G-76	Double Glazing for Windows	0.67

5. Summary of Building and Project Savings

A 23% reduction in energy costs amounting to $319,490 can be realized in the sixteen (16) buildings in this survey following the implementation of the recommended projects and ECO's. Energy consumption will additionally drop 43,491 MBtu annually for a 28% reduction in energy consumption (see Table 13).

The sixteen (16) buildings in this survey represent 22% of the total gross floor area of the WRAMC complex. Energy consumption and costs will decrease 7% and 5%, respectively, each year for the WRAMC complex following the implementation of the projects and ECO's in this survey (see Table 12). The total implementation cost (i.e., construction cost + SIOH + Design) for the recommended projects and ECO's is $891,659 with a cost savings of $448,263.

The six projects recommended represent 95% of the total cost savings expected in this report. The greatest cost savings of all the projects are from Projects #1 and #5 (see Tables 9 and 10) which are projected to annually save $146,915 and $147,602, respectively. The greatest amount of energy savings is from Project #5 which is expected to annually save 28,008 MBtu. The project with the highest SIR is Project #1 with an SIR of 13.57, while the highest SIR of an ECO is #5 with an SIR of 129.94 (see Table 11).

A project summary is provided which details the expected energy cost and consumption savings for each ECO implemented for each building (see Tables 14 through 29). Additionally, the cost and consumption data before and after implementing the ECO's is provided. The numbers on these tables have a letter followed by an ECO number. The letter, either an E or a P, stands for an ECO or a project, respectively. The number represents which project or ECO from Table 9.

TABLE 9: SUMMARY OF RECOMMENDED PROJECTS AND ECO'S

Project/ECO Number	Title	SIR	Simple Amortization Period	Construction Cost ($)	Annual Savings ($)**	Annual Savings (MBTU)
Project #1	HVAC Modifications	13.57	0.84 years	$123,962	$146,915	23,899
Project #2	Lighting Conversions	4.95	3.05 years	$ 52,890	$ 21,991	1,033
Project #3	Air System Modification	3.85	2.60 years	$159,837	$ 64,228	6,681
Project #4	Building Weatherization	3.09	5.77 years	$ 41,569	$ 7,138	1,354
Project #5	Stack Heat Recovery	9.60	1.86 years	$276,836	$147,602	28,008
Project #6	Lighting Power Reducers	3.38	3.50 years	$133,167	$ 35,956	2,165
ECO #1	Delamp Overlit Areas	32.44	0.43 years	$ 1,200	$ 3,291	168
ECO #2	Install Insulating Panel	22.33	0.80 years	$ 505	$ 627	119
ECO #3	Install Showerhead Flow Restrictors	55.81	0.32 years	$ 1,377	$ 4,270	810
ECO #4	Pipe Insulation	13.57	1.31 years	$ 12,369	$ 9,331	1,770
ECO #5	Reduce DHW Temperature	129.94	0.14 years	$ 300	$ 1,969	374
ECO #6	Reduce Lighting Hours of Operation	11.55	1.03 years	$ 592	$ 630	35
ECO #7	Repair Steam System	18.45	0.97 years	$ 947	$ 970	184
ECO #8	Replace Louvers on HVAC Equipment	18.18	0.66 years	$ 235	$ 355	68
ECO #9	Turn Off Unnecessary Lighting	17.10	0.80 years	$ 1,977	$ 2,990	154
	TOTAL			$807,763	$448,263	66,822

*Construction Cost plus SIOH.
**Includes Energy and Non-Energy Savings.

TABLE 10: BREAKDOWN OF PROJECT AND ECO ENERGY AND ENERGY COST SAVINGS

Project/ECO Number	Title	Electric		Natural Gas		Total	
		$	MBtu	$	MBtu	$	MBtu
Project #1	HVAC Modifications	30,681	1,847	116,234	22,052	146,915	23,899
Project #2	Lighting Conversions	17,157	1,033			17,157	1,033
Project #3	Air System Modification	42,503	2,559	21,726	4,122	64,228	6,681
Project #4	Building Weatherization			7,138	1,354	7,138	1,354
Project #5	Stack Heat Recovery			147,602	28,008	147,602	28,008
Project #6	Lighting Power Reducers	35,956	2,165			35,956	2,165
ECO #1	Delamp Overlit Areas	2,788	168			2,788	168
ECO #2	Install Insulating Panel	627	119			627	119
ECO #3	Install Showerhead Flow Restrictors			4,270	810	4,270	810
ECO #4	Pipe Insulation			9,331	1,770	9,331	1,770
ECO #5	Reduce DHW Temperature			1,969	374	1,969	374
ECO #6	Reduce Lighting Hours of Operation	571	35			571	35
ECO #7	Repair Steam System			970	184	970	184
ECO #8	Replace Louvers on HVAC Equipment			355	68	355	68
ECO #9	Turn Off Unnecessary Lighting	2,566	154			2,566	154
	TOTAL	132,849	8,080	309,595	58,742	442,443	66,822

TABLE 11: SUMMARY OF RECOMMENDED PROJECTS AND ECO's BY GREATEST SIR

Project/ECO Number	Title	SIR
ECO #5	Reduce DHW Temperature	129.94
ECO #3	Install Showerhead Flow Restrictors	55.81
ECO #1	Delamp Overlit Areas	32.44
ECO #2	Install Insulating Panel	22.33
ECO #7	Repair Steam System	18.45
ECO #8	Replace Louvers on HVAC Equipment	18.18
ECO #9	Turn Off Unnecessary Lighting	17.10
Project #1	HVAC Modifications	13.57
ECO #4	Pipe Insulation	13.57
ECO #6	Reduce Lighting Hours of Operation	11.55
Project #5	Stack Heat Recovery	9.60
Project #2	Lighting Conversions	4.95
Project #3	Air System Modifications	3.85
Project #6	Lighting Power Reducers	3.38
Project #4	Building Weatherization	3.09

Table 12: TOTAL COMPLEX CONSUMPTION AND COST SAVINGS

	Electricity		Natural Gas		Total	
	$	MBtu	$	MBtu	$	MBtu
Present	$5,232,382	315,071	$3,139,065	595,648	$8,371,447	910,719
Project/ ECO Totals	$ 132,849	8,080	$ 309,594	58,742	$ 442,443	66,822
After Projects/ ECO's	$5,099,533	306,991	$2,829,471	536,906	$7,929,004	843,897
Percent Reduction	3%	3%	10%	10%	5%	7%

TABLE 13: SURVEYED BUILDINGS CONSUMPTION AND COST SAVINGS

	Electricity		Natural Gas		Total	
	$	MBtu	$	MBtu	$	MBtu
Present	$890,476	53,576	$522,891	99,195	$1,413,315	152,771
Project/ ECO Totals	$132,849	8,080	$186,641	35,411	$ 319,490*	43,491*
After Projects/ ECO's	$757,627	45,496	$336,250	63,784	$1,093,825	109,280
Percent Reduction	15%	15%	36%	36%	23%	28%

* Project #5, Stack Heat Recovery, will reduce consumption in all the buildings at the WRAMC complex. Therefore, the total amount of thermal consumption for the sixteen (16) buildings in this survey (99,195 MBtu) was divided by the complex thermal consumption (595,648 MBtu) to obtain the percent savings for Project #5 attributable to the buildings in this survey.

TABLE 14:

PROJECT SUMMARY: WRAMC - BUILDING # 7

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	23976	1444	28513	19994	3784	74731	43920	5228	103244

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. P1/timeclocks on exhaust fans	40.78	693	266	16	316	1929	366	7219	2195	382	7535
2. E4/Pipe insulation	20.26	388	0	0	0	397	75	1481	397	75	1481
3. P1/HVAC Modifications	8.38	12190	4087	246	4860	4608	874	17267	8695	1120	22127
4. P2/Interior light. conversions	5.92	1231	464	28	552	0	0	0	464	28	552
5. P4/Weatherstrip	2.79	381	0	0	0	54	10	201	54	10	201
6. P6/Lighting power reducers	2.63	11697	2343	141	2787	0	0	0	2343	141	2787
7. P4/Insulate roof	1.96	23176	0	0	0	2291	435	8583	2291	435	8583
8. P2/Exterior light. conversions	1.34	806	86	5	102	0	0	0	86	5	102
TOTALS		50562	7246	436	8617	9279	1760	34751	16525	2196	43368

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	16730	1008	19896	10715	2024	39980	27395	3032	59876

TABLE 15:

PROJECT SUMMARY: WRAMC - BUILDING # 11

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	80631	4855	37324	64150	12171	93564	144781	17026	130888

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. E5/Reduce DHW temperature	86.64	100	0	0	0	438	83	638	438	64	638
2. E3/Install shower flow restrictors	66.40	1102	0	0	0	3696	701	5391	3696	701	5391
3. P1/HVAC Modifications	15.69	7805	3656	220	1692	6540	1241	9540	10195	1461	11232
4. P2/Interior light. conversions	12.96	3161	1234	74	571	0	0	0	1234	74	571
5. P4/Weatherstrip	5.99	1969	0	0	0	596	113	869	596	113	869
6. P6/Lighting power reducers	3.56	19240	5213	314	2413	0	0	0	5213	314	2413
7. P1/Install energy efficient motors	2.94	3819	853	51	395	0	0	0	853	51	395
8. E6/Reduce lighting hours of operation	2.28	284	46	3	21	0	0	0	46	3	21
9. P2/Exterior light. conversions	2.07	6225	1069	64	495	0	0	0	1069	64	495
TOTALS		43705	12071	726	5587	11270	2138	16439	23340	2845	22026

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	68560	4129	31737	52880	10033	77125	121441	14181	108862

TABLE 16:

PROJECT SUMMARY: WRAMC - BUILDING # 14

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	110014	6601	22004	109699	20813	69376	219713	27414	91380

ECO # / title	SIR	Cost	Electric Svgs $	Electric Svgs MBtu	Electric Svgs Btu/SF	Thermal Svgs $	Thermal Svgs MBtu	Thermal Svgs Btu/SF	Total Svgs $	Total Svgs MBtu	Total Svgs Btu/SF
1.P1/HVAC Modifications	809.97	191	0	0	0	11661	2212	7376	11661	2212	7376
2.E7/steam system	74.50	144	0	0	0	542	103	343	542	103	343
3.E4/Pipe insulation	11.63	1304	0	0	0	766	145	6464	766	145	6464
4.E6/Reduce light. hours of operation	9.56	77	51	3	10	0	0	0	51	3	10
5.P6/Lighting power reducers	8.96	10650	7256	437	1456	0	0	0	7256	437	1456
6.P2/Interior light. conversions	5.95	13056	4834	291	970	0	0	0	4834	291	970
7.P4/Weatherstrip	5.35	381	0	0	0	103	20	65	103	20	65
8.P1/Install energy efficient motors	4.38	4989	1662	100	334	0	0	0	1662	100	334
9.P2/Exterior light. conversion	1.77	722	101	6	20	0	0	0	101	6	20
TOTALS		31514	13904	837	2791	13072	2480	14248	26976	3317	17038

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	96110	5764	19213	96627	18333	55128	192737	24097	74342

TABLE 17:

PROJECT SUMMARY: WRAMC - BUILDING # 15

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	66859	4026	202409	5482	1040	52284	72341	5066	254693

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. E4/Pipe insulation	28.16	1676	0	0	0	2384	452	30338	2384	452	30338
2. P6/Lighting power reducers	4.05	2336	719	43	2176	0	0	0	719	43	2176
3. P1/Install energy efficient motors	3.26	7799	1927	116	5834	0	0	0	1927	116	5834
4. P1/HVAC Modifications	3.24	3255	0	0	0	794	151	7575	794	151	7575
TOTALS		15066	2646	159	8010	3178	603	37913	5824	762	45923

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	64213	3867	194399	2304	437	14371	66517	4304	208770

TABLE 18:

PROJECT SUMMARY: WRAMC - BUILDING # 17

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	6227	374	18204	9212	1748	85139	15440	2122	103343

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1.E5/Reduce DHW temperature	89.27	50	0	0	0	225	43	2150	225	43	2150
2.E3/Install shower flow restrictors	27.53	413	0	0	0	574	109	5305	574	109	5305
3.E9/Turn off light	22.70	191	304	18	891	0	0	0	304	18	891
4.E4/Pipe insul.	14.47	461	0	0	0	337	64	4150	337	64	4150
5.P4/Insulate roof	8.89	5513	0	0	0	2475	470	22869	2475	470	22869
6.P6/Install power reducers	8.63	43	28	2	82	0	0	0	28	2	82
7.P4/Weatherstrip	7.18	76	0	0	0	28	5	219	28	5	219
8.P2/Exterior light. conversions	2.74	600	110	7	323	0	0	0	110	7	323
9.P2/Interior light. conversions	2.60	8507	1370	83	4018	0	0	0	1370	83	4018
10.P1/HVAC Modifications	1.10	1944	0	0	0	161	31	1488	161	31	1488
TOTALS		17798	1812	110	5314	3800	722	36182	5611	832	41495

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	4415	264	12890	5412	1026	48957	9829	1290	61848

TABLE 19:

PROJECT SUMMARY: WRAMC - BUILDING # 38

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	10647	639	64316	5505	1044	105131	16152	1683	169447

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. E1/Delamp lights	31.01	347	759	46	4599	0	0	0	759	46	4599
2. E4/Pipe insul.	24.39	380	0	0	0	468	89	11926	468	89	11926
3. P1/HVAC Modifications	12.81	5583	3104	187	18813	3042	577	58109	6146	764	76922
4. E6/Reduce light. hours of operation	5.33	77	25	2	152	0	0	0	25	2	152
5. P4/Weatherstrip	4.12	152	0	0	0	32	6	611	32	6	611
6. P6/Lighting power reducers	2.95	1805	405	24	2456	0	0	0	405	24	2456
7. P2/Interior light. conversion	2.90	1983	357	22	2165	0	0	0	357	22	2165
8. P1/Install energy efficient motor	1.66	583	74	4	447	0	0	0	74	4	447
9. P2/Exterior light. conversion	1.48	408	50	3	303	0	0	0	50	3	303
TOTALS		11318	4774	288	28935	3542	672	70646	8316	960	99581

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	5873	351	35381	1963	372	34485	7836	723	69866

TABLE 20:

PROJECT SUMMARY: WRAMC - BUILDING # 40

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	335947	20229	73246	164331	31177	112937	500278	51407	186183

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. E5/Reduce DHW temperature	244.50	100	0	0	0	673	128	519	673	128	519
2. P1/Timeclock on exhaust fans	72.52	738	204	12	44	3880	736	2666	4084	748	2710
3. E9/Turn off light	18.19	1943	1683	101	367	0	0	0	1683	101	367
4. P1/HVAC Modifications	15.52	39502	1500	90	327	45066	8550	30963	46566	8640	31290
5. E4/Pipe insul.	13.50	1658	0	0	0	1074	204	985	1074	204	985
6. P2/Interior light. conversions	8.57	5598	3194	192	696	0	0	0	3194	192	696
7. P3/Air system modification	3.85	185491	42503	2559	9267	21726	4122	14925	64228	6681	24191
8. P1/Install energy efficient motors	3.50	1711	456	27	99	0	0	0	456	27	99
9. P6/Lighting power reducers	2.93	50336	11225	676	2447	0	0	0	11225	676	2447
TOTALS		287077	60764	3657	13248	72419	13740	50057	133182	17397	63305

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	275183	16572	59998	91912	17437	62880	367096	34010	122878

TABLE 21:

PROJECT SUMMARY: WRAMC - BUILDING # 41

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	18185	1095	25131	15437	2929	67213	33622	4024	92344

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. E1/Delamp overlit areas	33.24	386	796	48	1100	0	0	0	796	48	1100
2. E4/Pipe insul.	11.71	835	0	0	0	494	94	2844	494	94	2844
3. P1/HVAC Modifications	5.95	5590	219	13	303	2343	445	10201	2562	458	10504
4. P6/Lighting power reducers	4.86	5916	2189	132	3024	0	0	0	2189	132	3024
5. P2/Exterior light. conversions	4.86	209	61	4	84	0	0	0	61	4	84
6. P2/Interior light. conversions	2.89	2344	432	26	597	0	0	0	432	26	597
7. P4/Weatherstrip	2.17	509	0	0	0	56	11	243	56	11	243
TOTALS		15789	3697	223	5109	2893	550	13288	6589	773	18397

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	14488	872	20022	12544	2379	53925	27033	3251	73947

TABLE 22:

PROJECT SUMMARY: WRAMC - BUILDING # 83

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	48928	2946	176696	3531	670	40199	52460	3616	216895

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. E4/Pipe insul.	12.91	909	0	0	0	592	112	12575	592	112	12575
2. P1/HVAC Modifications	7.02	754	0	0	0	399	76	4540	399	76	4540
3. P1/Timeclock on exhaust fan	6.50	305	70	4	253	97	18	1104	166	23	1357
4. P4/Insulate roof	3.38	1484	0	0	0	253	48	2879	253	48	2879
5. P6/Lighting power reducers	2.56	3372	656	40	2369	0	0	0	656	40	2369
TOTALS		6824	726	44	2621	1341	254	21098	2066	299	23719

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	48202	2902	174075	2190	416	19101	50394	3317	193176

TABLE 23:

PROJECT SUMMARY: WRAMC - BUILDING # 85

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	9066	546	86346	5525	1048	165793	14591	1594	252139

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. E8/Louvers on HVAC equipment	39.71	42	0	0	0	126	24	3772	126	24	3772
2. E6/Reduce light. hours of operation	25.95	77	128	8	1265	0	0	0	128	8	1265
3. E2/Insulating Panels	22.33	556	0	0	0	627	119	18812	627	119	18812
4. E7/Steam system	9.44	897	0	0	0	428	81	12836	428	81	12836
5. P2/Interior light. conversion	8.33	165	25	2	253	0	0	0	25	2	253
6. P1/HVAC Modifications	7.74	3018	213	13	2024	1601	304	48031	1813	317	50055
7. P6/Lighting power reducers	2.09	1997	317	19	3021	0	0	0	317	19	3021
8. P2/Exterior light. conversion	2.07	281	27	2	253	0	0	0	27	2	253
9. P4/Weatherstrip	1.96	1082	0	0	0	107	20	3211	107	20	3211
TOTALS		8115	709	44	6816	2888	548	86661	3598	592	93478

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	8357	502	79530	2637	500	79132	10993	1002	158661

TABLE 24:

PROJECT SUMMARY: WRAMC - BUILDING # 90

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	1058	64	10685	2672	507	85003	3730	571	95688

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. E8/Louvers On HVAC Equipment	14.02	217	0	0	0	229	44	7295	229	44	7295
2. P1/HVAC Modifications	4.51	821	0	0	0	279	53	8905	279	53	8905
3. P4/Insulate Roof	2.37	3101	0	0	0	372	71	11823	372	71	11823
4. P6/Lighting Power Reducers	2.11	384	51	3	520	0	0	0	51	3	520
TOTALS		4523	51	3	520	880	168	28023	931	171	28543

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	1007	61	10165	1792	339	56980	2798	400	67145

TABLE 25:

PROJECT SUMMARY: WRAMC - BUILDING # 91

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	17071	1024	106800	5887	1117	116456	22958	2141	223256

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. P1/Timeclock on exhaust fans	141.33	232	1868	113	11731	1059	201	20940	2927	314	32671
2. P1/HVAC Modifications	28.99	372	0	0	0	813	154	16085	813	154	16085
3. E4/Pipe insul.	23.60	506	0	0	0	603	114	15907	603	114	15907
4. E1/Delamp overlit areas	22.45	487	771	46	4839	0	0	0	771	46	4839
5. P1/Install energy efficient motors	2.54	1612	311	19	1953	0	0	0	311	19	1953
6. P6/Lighting power reducers	2.18	5591	928	56	5825	0	0	0	928	56	5825
7. P2/Interior light. conversions	1.89	1144	135	8	847	0	0	0	135	8	847
8. P4/Weatherstrip	1.86	679	0	0	0	64	12	1262	64	12	1262
TOTALS		10623	4013	242	25196	2538	481	54193	6552	723	79389

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	13058	782	81604	3349	636	62263	16406	1418	143867

TABLE 26:

PROJECT SUMMARY: WRAMC - BUILDING # 93

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	4963	299	20863	3384	642	44828	8345	941	65691

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. P1/HVAC Modifications	103.14	32	0	0	0	249	47	3296	249	47	3296
2. E5/Reduce DHW temperature	28.11	50	0	0	0	59	11	782	59	11	782
3. E9/Turn off light	21.41	351	448	27	1883	0	0	0	448	27	1883
4. P2/Exterior light. conversion	6.24	169	60	4	252	0	0	0	60	4	252
E4/Insulate pipes	5.86	735	0	0	0	217	41	3841	217	41	3841
6. P2/Interior light. conversion	4.16	525	101	6	404	0	0	0	101	6	404
7. P4/Weatherstrip	2.69	233	0	0	0	32	6	424	32	6	424
8. P6/Lighting power reducers	2.64	1140	229	14	963	0	0	0	229	14	963
9. P4/Insulate roof	1.73	5657	0	0	0	495	94	6564	495	94	6564
TOTALS		8892	838	51	3502	1052	199	14907	1890	250	18409

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	4125	248	17361	2331	443	29921	6455	691	47282

TABLE 27:

PROJECT SUMMARY: WRAMC - BUILDING # T-2

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	41701	2511	56490	24106	4573	102889	65806	7084	159379

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. P1/HVAC Modifications	768.04	66	330	20	448	3571	678	15242	3901	697	15690
2. P1/Timeclocks on exhaust fans	29.73	7259	4904	295	6642	12560	2383	53618	17465	2678	60260
3. E4/Pipe insul.	17.44	1218	0	0	0	1073	204	6493	1073	204	6493
4. E9/Turn off light	5.39	351	131	8	184	0	0	0	131	8	184
5. P2/Interior light. conversions	4.28	2533	678	41	918	0	0	0	678	41	918
6. P6/Lighting power reducers	3.07	14998	3499	211	4739	0	0	0	3499	211	4739
7. P1/Install energy efficient motors	1.88	3549	509	31	689	0	0	0	509	31	689
TOTALS		29974	10051	606	13620	17204	3265	75352	27256	3870	88973

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	31650	1905	42870	6902	1308	27537	38550	3214	70406

TABLE 28:

PROJECT SUMMARY: WRAMC - BUILDING # T-20

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	36005	2168	64833	22198	4211	125938	58203	6379	190771

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. E1/Delamp lighting	41.07	210	462	28	832	0	0	0	462	28	832
2. E6/Reduce light. hours of operation	32.84	136	321	19	578	0	0	0	321	19	578
3. P1/HVAC Modifications	12.17	18409	3391	204	6106	14323	2718	81265	17715	2922	87371
P1/Timeclock on exhaust fan	7.85	305	158	9	284	61	12	348	219	21	632
5. P2/Interior light. conversion	2.57	83	13	1	24	0	0	0	13	1	24
6. P4/Weatherstrip	2.56	408	0	0	0	53	10	299	53	10	299
7. P6/Lighting power reducers	2.48	9400	1772	107	3190	0	0	0	1772	107	3190
TOTALS		28951	6117	368	11015	14437	2740	81912	20554	3108	92927

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	29888	1800	53818	7761	1471	44026	37649	3271	97844

TABLE 29:

PROJECT SUMMARY: WRAMC - BUILDING # G-76

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Initial Building Energy Cost & Consumption :	30969	1865	74280	12739	2417	96265	43708	4282	170545

			Electric Svgs			Thermal Svgs			Total Svgs		
ECO # / title	SIR	Cost	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
1. P1/HVAC Modifications	663.13	24	0	0	0	1200	228	9070	1200	228	9070
2. E4/Pipe insul.	5.08	3612	0	0	0	926	176	9334	926	176	9334
3. P6/Lighting power reducers	4.03	920	282	17	676	0	0	0	282	17	676
4. P1/Install energy efficient motors	3.77	3208	919	55	2205	0	0	0	919	55	2205
5. P2/Interior light. conversions	3.50	7970	2616	158	6273	0	0	0	2616	158	6273
6. P4/Weatherstrip	2.90	928	0	0	0	136	26	1028	136	26	1028
7. P2/Exterior light conversion	2.04	459	60	4	144	0	0	0	60	4	144
TOTALS		17121	3877	234	9298	2262	430	19432	6139	664	28730

	Electricity			Thermal			Total Energy		
	$	MBtu	Btu/SF	$	MBtu	Btu/SF	$	MBtu	Btu/SF
Final Building Energy Cost & Consumption :	27092	1631	64982	10476	1987	76833	37569	3618	141815

6. Operation and Maintenance Recommendations

The operating and maintenance (O&M) practices at Walter Reed Army Medical Center were good in comparison to many facilities previously studied by EEI. For example, HVAC equipment is regularly inspected; steam and condensate leaks are steadily being repaired; and steam and condensate pipes and valves in general are insulated. Additionally, many other energy conservation projects have been accomplished at the facility to reduce energy costs.

Many of the steam traps in the buildings it is believed are malfunctioning as indicated by the amount of steam vented from the deaerator stack and other vents at the facility. Presently the facility does not have routine surveys made of the steam traps in the buildings and thus does not determine which traps need replacing. It is recommended that a survey be performed of all the traps in the buildings and those deemed to be malfunctioning be replaced.

Presently only two electricity meters exist at the main complex of the Walter Reed Army Medical Center. One meter serves building 54 while the other meter serves the remaining buildings. Without individual building metering, the determination of how electricity is consumed is at best a rough approximation. Individual building meters provide a record of consumption from which trends can be observed and consumption goals set. Abnormalities in consumption can be observed and necessary actions taken to alleviate problems. It is thus recommended that individual building electricity meters be installed and a program monitoring consumption trends be implemented.

Additionally, steam meters do not exist for individual buildings. Presently steam is produced and is not monitored anywhere in the steam system. The boiler operator each month estimates how much steam is produced by the boilers. The installation of individual building steam meters, in at least the buildings with the large consumption amounts, would provide an important record of thermal consumption trends. Of particular importance is how much steam is utilized during the non-heating season (during which time, consumption may have the possibility of being reduced significantly).

Although utility metering in itself will not save energy, the energy monitoring program established for the tracking of utility consumption will provide the capability for reducing consumption. By understanding consumption trends and levels, additional projects and recommendations can be established to reduce consumption.

It is also recommended that all incandescent lamps in the complex be replaced with a fluorescent PL/TL type lamp on a replacement or burnout basis.

Finally, it is recommended that the boilers in building 15 be routinely checked and tuned to insure their proper operation and maximum thermal efficiency.