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ENERGY AUDIT PAMPHLET FOR INSTALLATIONS.(U)
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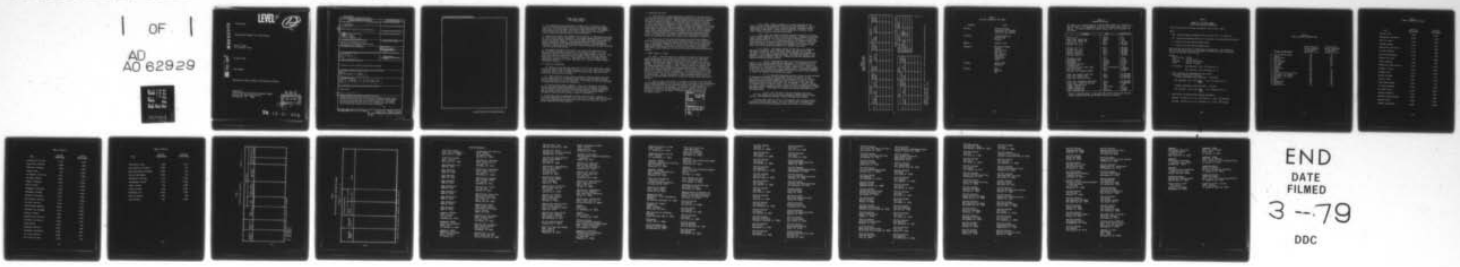

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Energy Audit Pamphlet For Installations

Peter E. Baum
Dr. Harold D. Hollis

26 April 1978

Final Report

Approved for Public Release; Distribution Unlimited

Prepared by:
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Fort Belvoir, VA 22060

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Energy Audit

This pamphlet

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Pamphlet provides guidelines and data forms to perform an energy audit of an installation and to assist in establishing installation energy usage data for the individual facilities of that installation. The pamphlet also describes how that data can be used to identify and rank possible energy conservation opportunities for the installation.

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ENERGY AUDIT PAMPHLET
FOR INSTALLATIONS

1. This pamphlet provides guidelines and data forms to perform an energy audit of an installation and to assist in establishing installation energy usage data for the individual facilities of that installation. The pamphlet also describes how that data can be used to identify and rank possible energy conservation opportunities for the installation.

2. Forms are provided in this pamphlet for collection of information describing an installation's energy consumption. This energy consumption profile can then be used to identify those facilities and buildings that should be surveyed for energy conservation purposes. Once these buildings have been selected an energy utilization survey should be performed on them. A second pamphlet, "Energy Utilization Survey for Buildings" contains guidelines and data collection forms for the building surveys.

3. The general procedure of the audit is tc look at the installation as a whole and determine where the majority of the energy is going, i.e,, what buildings or groups of buildings are using the largest amounts of energy. Then those facilities are ranked by the total number of BTU's used per year per square foot of gross floor area. Those facilities with the highest energy consumption rates will be the best candidates for a survey to develop energy conservation projects.

4. Sources of Information

4.1 Monthly utility and fuel suppliers' bills for the installation usually contain the annual usage of energy in gallons of oil, cubic feet of gas, pounds of propane, tons of coal or kilowatt-hours of electricity. Most bills also contain the cost per unit of energy.

4.2 Some facilities or post areas, buildings or heating plants have some type of energy output or consumption meters which record the daily, monthly, or yearly quantities of fuel or power used. These should be read and documented for comparisons and statistical information.

4.3 When building energy consumption data is not available, the annual heating and cooling energy consumption for particular categories of buildings can be estimated using building load simulation analysis, energy consumption data from other similar buildings, or by estimating the baseline energy consumption using the formula given in Table 3 of Appendix A.

5. Survey data should be organized using the forms provided in Appendix A. The survey forms provide the field survey team with an orderly means of recording those energy consumption characteristics which should be known for rational energy conservation project analysis.

6. Conducting the Audit

6.1 Establishing an energy usage and cost profile for the installation will require a search of budget, maintenance and operations records, organizing the data and then recording it. Energy consumption data should be collected for twelve consecutive months for as many past years as possible (maximum 5 years), and should be summarized by yearly totals to establish a profile of Installation energy consumption. Based on weather data (heating and cooling degree days for some areas may be obtained from Table 5 of Appendix A, or from local weather stations and specific consumption conditions (such as leaking steam lines, broken thermostats or heat control valves, etc), an assessment should be made on whether the years investigated may be considered typical or not. All deviations from typical climatic and consumption conditions should be identified and taken into account when survey data are appraised.

6.2 The results of the audit should provide the Facilities Engineer with an overall picture of the energy consumption trends at his installation, i.e., is the energy consumption increasing? Which energy sources have the highest consumption? Higher cost? The audit will also aid in identifying those areas, buildings or facilities that are high energy users/wasters. These will be good candidates for the building survey and energy conservation studies.

7. Audit Forms 1, 2, and 3

7.1 Form 1 - The first task is to determine the amount of each type of energy being used at the installation and what it costs. All else being equal, the potential savings from energy conservation projects will be greatest from those that impact on the energy form consumed in the greatest amounts. The resultant trends in usage and cost can signal a priority area for energy conservation analysis. Form 1 requires data on the amounts and cost of each fuel type consumed over the past several years. Conversion factors for changing the units of different forms of energy into equivalent BTU's are provided in Table 2 of Appendix A. This data collection will help to build a sensitivity to the fuel forms that are driving energy cost up at an installation. The data collected on energy consumption and cost can be used in calculating energy and dollar savings for various energy conservation projects.

7.2 The next step in the audit is to prepare a profile of the individual yearly energy consumption of various facilities or buildings on the installation. Due to limitations of time and available personnel not every building can be audited, and certainly not surveyed. The amount of energy consumed in operating a building is largely dependent on its usage and size, so the following criteria will be helpful in determining which facilities and buildings to audit.

7.2.1 Usage - Energy consumption is usually dependent on the type of and the following building types usually have the highest rates of usage; offices and administration, training, medical, community, storage and housing in that order. Other building types may be included in the audit if they are known to be high energy users.

7.2.2 Size - The amount of energy consumed in operating a building is also largely dependent on the size of the building. Therefore the building types listed in Section 7.2.1 with a floor area of 30,000 sq.ft. or greater should be audited first. If circumstances warrant, all other buildings types with 30,000 sq. ft or greater floor area should also be audited. The next group of buildings to audit are those with 10,000 sq. ft or greater floor area, and finally those with 5,000 sq ft or greater floor area.

7.2.3 Form 2 - The primary purpose of this form is to establish the energy consumption rate in BTU's per square foot per year for each building. In this way similar buildings can be compared to one another on the basis of their energy consumption rates. Buildings that appear to have abnormally high consumption rates will probably be the best candidates for energy conservation project studies.

7.2.3.1 Unfortunately there will be many buildings for which little, if any, energy consumption data available. For instance, very few Army buildings have electrical meters; therefore the electrical load due to lighting or air conditioning will not be known. Another case is when a group of buildings are connected to a central heating plant. The energy consumption of the plant may be known but the amount of energy delivered to each building is usually not metered, and therefore not known.

7.2.3.2 When building energy consumption data are not available an estimate must be made of the building's energy consumption, or more specifically, the building's heating and cooling load in BTU's/sq. ft/year. Estimated baseline energy consumption rates in BTU's/sq ft/year for both heating and cooling are given in Table 4 of the Appendix. The table covers 19 different types of Army buildings. Table 3 provides a formula to calculate the yearly energy consumption using the baseline rates and geographical climatic adjustment factors. Other means of estimating the energy usage maybe used i more appropriate.

7.2.3.3 Fill out Form 2 with the following information.

- Building number from the Building Information Schedule (BIS) or other listing. List buildings served by a Central Heating Plant together.

- Building type, refer to Table 4 of the Appendix and list each building according to one of these types. This will also be used in estimating the heating and cooling energy consumption when actual data is not available.

FORM 1
INSTALLATION ANNUAL
ENERGY USE AND COST

Year	ELECTRICITY				NATURAL GAS			FUEL OIL[1]		
	Maximum Kw-Demand	Kw-Hr Usage	Total Cost ($)	Percent Increase Usage	MCF or Therm Usage	Total Cost ($)	Percent Increase Usage	# of Gallons Usage	Total Cost ($)	Percent Increase Usage

Year	COAL			OTHER:		
	# of Tons Usage	Total Cost ($)	Percent Increase Usage	Quantity & Units	Total Cost ($)	Percent Increase Usage

PRESENT COST OF ENERGY SOURCES ($/unit)

Energy Type	$/Unit[2]	$/MBTU[3]
Electricity	/Kw-Hr	
Nat. or LP Gas	/Therm	
Fuel Oil	/Gal.	
Coal	/Ton	
Other:		

[1] Combine all types and cost, include diesel oil used for heating or producing installation electricty.
[2] Average cost per unit.
[3] Use conversion factors Table 2.

TABLE 1
Building Categories and Types

Category	Type
Offices	Office Buildings
	Laboratory (oil heated)
	Laboratory (gas heated)
Training	Training Building
	Machine Shop
	Library
Medical	Dental Clinic
Community	Recreation Center
	Theater
	Bowling Alley
	NCO Club
	Post Exchange
	Commissary
	Field House
	Chapel
Storage	Boiler Plant
	Warehouse
Housing	Mess
	Barracks
	BOQ

TABLE 2
CONVERSION FACTORS

The common unit of energy measure is the British Thermal Unit (Btu)which is the unit used in this handbook to calculate and compare energy costs and savings. To convert between the common energy units, use the factors in this table.

TO CONVERT	INTO	MULTIPLY BY
Barrels, oil	gallon	42.0
Cubic feet, natural gas	therms	0.01
Cubic feet, natural gas	Btu's	1,031
Gallons, No. 2 oil	Btu's	138,700*
Gallons, No. 4 oil	Btu's	145,000*
Gallons, No. 5 oil	Btu's	148,000*
Gallons, No. 6 oil	Btu's	150,000*
Gallons, kerosine	Btu's	135,000*
Gallons, gasoline	Btu's	125,000*
Gallons, diesel oil	Btu's	138,700*
Horsepower hours	Btu's	2,544
Horsepower hours	kw-hrs	0.7457
Horsepower	Btu/min	42.4176
Horsepower (boiler)	Btu/hr	33,479
Kilowatt hours	Btu's	3,413
Purchased Electric Power (Kwh)	Btu's (at source)	11,600
mCF natural gas	Btu's	1,000,000
Gallons, LPG, Propane, Butane	Btu's	95,500
Short ton, eastern steam coal	Btu's	23,100,000*
Short ton, western coal	Btu's	21,000,000*
Short ton, anthracite coal	Btu's	28,300,000*
Short tons, bitumimous steam coal	Btu's	24,580,000*
Short tons, lignite, brown coal	Btu's	14,000,000*
Steam, saturated (lbs)	Btu's	1,390
Therms, natural gas	cubic feet	100
Therms, natural gas	Btu's	100,000
Tons, refrigeration	Btu's/hr	12,000

*These are average values. Since exact Btu content varies with type and source, contact supplier when extreme accuracy is essential.

TABLE 3

FORMULA TO ESTIMATE YEARLY
HEATING AND COOLING CONSUMPTION

Total Building Baseline Energy Consumption = BEC x Area x CAF/Z

where:

BEC = Baseline Energy Consumption Rate in BTU per ft^2 - yr (Table 4)

CAF = Climatic Adjustment Factor of city closest to installation from Table 5.

Z = 4,258 for heating (heating degree days)

Z = 1,659 for cooling (cooling degree days)

BEC's and CAF can be found in Table 4 and 5 respectively. The values for the BEC's were developed using the ECUBE simulation and actual consumption data on various Army installations.

Example:
Building Type - Office
Area - 36,109 sq ft
Equipment - Heating and Cooling
Place - Denver, Colorado

1. From Table 4 - BEC (Heating) = 85×10^3 BTU/sq ft- Yr

   BEC (Cooling) = 36×10^3 BTU/sq ft- Yr

2. BEC's corrected for geographical area (CAF/Z)
   From Table 5 for Denver, Colorado
   Climatic Adjustment Factor (Heating) - 5,673 HDD

   BEC (Heating) $= (85 \times 10^3)\left(\frac{5673}{4258}\right) = 113 \times 10^3$ BTU/sq ft-Yr.

   Climatic Adjustment Factor (Cooling) - 615 CDD

   BEC (Cooling) $= (36 \times 10^3)\left(\frac{615}{1659}\right) - 13 \times 10^3$ BTU/sq ft- Yr.

3. Total Yearly Building Baseline Energy Consumption

   Heating = 36,109 sq ft x 113×10^3 BTU/sq ft = 4.08×10^9 BTU/year

   Cooling = 36,109 sq ft x 13×10^3 BTU/sq ft = 4.69×10^8 BTU/year

TABLE 4
BASELINE ENERGY CONSUMPTION RATE

Military Building Type	Heating Baseline Energy Consumption In Thousands of BTU per ft^2 - Yr	Cooling Baseline Energy Consumption In Thousands of BTU per ft^2 - Yr
1. E.M. Recreation Center	99	58
2. Theatre	213	39
3. Bowling Alley	36	107
4. NCO Club	92	123
5. Post Exchange	106	120
6. Commissary	41	24
7. E.M. Mess	101	139
8. Laundry	117	--
9. Field House	169	--
10. Chapel	156	36
11. Library	117	27
12. Office and Training Building	85	36
13. Laboratory (oil heated)	100	66
14. Laboratory (gas heated)	42	19
15. Barracks	136	22
16. BOQ	102	35
17. Machine Shop	176	54
18. Warehouse	92	41
19. Dental Clinic	76	43

TABLE 5
CLIMATIC ADJUSTMENT FACTORS

City	Heating Degree Days	Cooling Degree Days
Abilene, Texas	2,657	2,394
Albuquerque, New Mexico	4,389	1,038
Amarillo, Texas	4,345	1,401
Atlanta, Georgia	2,811	2,152
Bakersfield, California	2,115	1,706
Billings, Montana	7,106	634
Boston, Massachusetts	5,791	997
Brownsville, Texas	617	4,369
Casper, Wyoming	7,638	465
Charleston, South Carolina	1,769	2,578
Chicago, Illinois	6,310	1,292
Columbus, Ohio	5,277	1,324
Denver, Colorado	5,673	615
El Paso, Texas	2,641	1,741
Fargo, North Dakota	9,274	793
Ft. Smith, Arkansas	3,188	2,326
Ft. Worth, Texas	2,361	2,814
Fresno, California	2,532	1,375
Hatteras, North Carolina	2,392	2,435
Houston, Texas	1,276	3,383
Jackson, Mississippi	2,202	2,656

TABLE 5 (Cont'd)

City	Heating Degree Days	Cooling Degree Days
Jacksonville, Florida	1,113	3,245
Kansas City, Missouri	4,888	1,946
Knoxville, Tennessee	3,590	1,947
Laredo, Texas	781	4,044
Los Angeles, California	1,451	1,026
Las Vegas, Nevada	2,425	1,771
Memphis, Tennessee	3,006	2,393
Miami, Florida	173	4,603
Minneapolis, Minnesota	7,853	1,012
Montgomery, Alabama	1,954	2,694
Nashville, Tennessee	3,513	2,093
New Orleans, Louisiana	1,175	3,365
New York, New York	5,050	1,234
North Platte, Nebraska	6,546	1,073
Oklahoma City, Oklahoma	3,519	2,092
Phoenix, Arizona	1,492	2,691
Raleigh, North Carolina	3,075	1,927
Red Bluff, California	2,546	1,418
Reno, Nevada	6,036	282
Rochester, New York	6,843	868
Sacramento, California	2,600	1,021
St. Louis, Missouri	4,469	1,851
Salt Lake City, Utah	5,463	764

TABLE 5 (Cont'd)

City	Heating Degree Days	Cooling Degree Days
San Antonio, Texas	1,579	3,137
San Francisco, California	3,069	210
Sault Sante Marie, Michigan	9,475	400
Seattle, Washington	4,438	197
Shreveport, Louisiana	2,117	2,900
Tallahassee, Florida	1,519	2,909
Tampa, Florida	674	3,669
Tucson, Arizona	1,776	2,085
Washington, DC	4,258	1,659
Winslow, Arizona	4,702	863
Yuma, Arizona	851	3,004

FORM 2

Building Energy Consumption Year(s)_____

Building [1] Number	Building [2] Type	Total Floor Area	Energy Data				
			Fuel Type	Total Yearly Usage (Average)	Equivalent [3] BTU's/Year	BTU's per sq. ft	
						Actual	Estimated[4]

1. List buildings served by central plant together.
2. See Table 3.
3. See Table 2.
4. See Table 3.

FORM 3

PLAN FOR BUILDING ENERGY CONSERVATION SURVEY

Category [1] _____

BUILDING NUMBER	FLOOR AREA sq. ft.	Energy Consumption		NOTES
		RATE BTU's/ sq. ft.-yr	BTU's/ Year	

1. Offices, Training, Medical, Community, Storage, Housing.

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Facility Engineer
Fort Bragg
Fort Bragg, NC 28308

Facility Engineer
Fort Campbell
Fort Campbell, KY 42223

Facility Engineer
Fort Carson
Fort Carson, CO 80913

Facility Engineer
Fort Drum
Watertown, NY 13601

Facility Engineer
Fort Hood
Fort Hood, TX 76544

Facility Engineer
Fort Indiantown Gap
Annville, PA 17003

Facility Engineer
Fort Lewis
Fort Lewis, WA 98433

Facility Engineer
Fort MacArthur
Fort MacArthur, CA 90731

Facility Engineer
Fort McCoy
Sparta, WI 54656

Facility Engineer
Fort McPherson
Fort McPherson, GA 30330

Facility Engineer
Fort George G. Meade
Fort George G. Meade, MD 20755

Facility Engineer
Fort Polk
Fort Polk, LA 71459

Facility Engineer
Fort Riely
Fort Riley, KX 66442

Facility Engineer
Fort Stewart
Fort Stewart, GA 31313

Facility Engineer
Indiana Army Ammunition Plant
Charlestown, IN 47111

Facility Engineer
Joliet Army Ammunition Plant
Joliet, IL 60436

Facility Engineer
Anniston Army Depot
Anniston, AL 36201

Facility Engineer
Corpus Christi Army Depot
Corpus Christi, TX 78419

Facility Engineer
New Cumberland Army Depot
New Cumberland, PA 17070

Facility Enginer
Red River Army Depot
Texarkana, TX 75501

Facility Engineer
Sacramento Army Depot
Sacreamento, CA 95813

Facility Engineer
Sharpe Army Depot
Lathrop, CA 95330

Facility Engineer
Seneca Army Depot
Romulus, NY 14541

Facility Engineer
Fort Ord
Fort Ord, CA 93941

Facility Engineer
Presidio of San Francisco
Presidio of San Francisco, CA 94129

Facility Engineer
Fort Sheridan
Fort Sheridan, IL 60037

Facility Engineer
Holston Army Ammunition Plant
Kingsport, TN 37662

Facility Engineer
Iowa Army Ammunition Plant
Burlington, IA 52600

Facility Engineer
Baltimore Output
Baltimore, MD 21222

Facility Engineer
Bay Area Military Ocean Terminal
Oakland, CA 94626

Facility Engineer
Bayonne Military Ocean Terminal
Bayonne, NJ 07002

Facility Engineer
Cape Canaveral Outport
Patrick, AFB, FL 32925

Facility Engineer
Gulf Output
New Orleans, LA 70146

Facility Engineer
Fort Huachuca
Fort Huachuca, AZ 86513

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Letterkenny Army Depot
Chambersburg, PA 17201

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Warren, MI 48089

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