Robins Air Force Base Integrated Resource Assessment

Volume 2: Baseline Detail

August 1993

Prepared for the U.S. Department of Energy
Federal Energy Management Program
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
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Abstract

This report documents the assessment of baseline energy use at Robins Air Force Base (AFB), a U.S. Air Force Materiel Command facility located near Macon, Georgia. This is a companion report to Volume 1, *Executive Summary*, and Volume 3, *Integrated Resource Assessment*.

The U.S. Air Force Materiel Command (AFMC) has tasked the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP), supported by the Pacific Northwest Laboratory (PNL),^(a) to identify, evaluate, and assist in acquiring all cost-effective energy projects at Robins AFB. This is part of a model program that PNL is designing to support energy-use decisions in the federal sector. This program 1) identifies and evaluates all cost-effective energy projects; 2) develops a schedule at each installation for project acquisition considering project type, size, timing, and capital requirements, as well as energy and dollar savings; and 3) targets 100% of the financing required to implement energy efficiency projects. PNL applied this model program to Robins AFB.

The analysis examines the characteristics of electric, natural gas, oil, propane, and wood chip use for fiscal year (FY) 1991. The results include energy-use intensities for the facilities at Robins AFB by building type, fuel type, and energy end use. A complete energy consumption reconciliation is presented that accounts for the distribution of all major energy uses and losses among buildings, utilities, and central systems.

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Summary

The U.S. Air Force Materiel Command (AFMC) has tasked the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP), supported by the Pacific Northwest Laboratory (PNL), to identify, evaluate, and assist in acquiring all cost-effective energy projects at Robins Air Force Base (AFB). The FEMP model integrated resource planning (IRP) program is being applied by PNL for federal customers served by the Georgia Power Company.

This volume, *Baseline Detail*, documents the baseline energy use at the Robins AFB, an AFMC base in central Georgia. The analysis characterizes electric, natural gas, #2 fuel oil, and propane for the federal fiscal year (FY) 1991. It provides a breakdown of energy-use for Robins AFB by fuel type, building type and energy end use. A complete energy consumption reconciliation is presented that includes the accounting of all energy use among buildings, utilities, central systems, and applicable losses.

The base's primary mission is to support the Warner Robins Logistics Center (WRLC). Commercial, industrial, and command buildings (hereafter referred to as "commercial buildings") on the base number 646, with a total floor area of 11,634,203 square feet. Table S.1 summarizes the number of buildings and total square feet for each of the areas. In FY 1991, 5,329 military personnel and dependents lived on the 8,790-acre base. There are 1,416 family housing units in 822 buildings with a total area of 1,842,000 square feet. Due to the nature of the activities at Robins AFB, there are many civilian employees. The daytime population on the base averaged 19,920 persons.

Table S.2 summarizes the typical annual energy consumption and cost for all facilities at Robins AFB. For each energy type, the annual total is shown in units appropriate to the energy type and in a common unit as a basis for comparison. The total consumption values represent typical current annual usage, from the best available data during 1990 and 1991. The annual energy consumption was 1,935,629 MBtu, at a cost of \$15,359,000.

Table S.3 breaks down the energy consumption by fuel type and end use for the base's major areas. Propane is not included because it represents only a minute fraction of the base's energy consumption.

This report documents all elements of the energy use baseline analysis conducted for Robins AFB. Site characteristics that affect all forms of energy use, including facility, climate, geography, mission and occupancy characteristics, are also documented.

This report is organized in nine sections. Section 1 describes the mission, geography, climate, utilities, buildings, and occupancy characteristics. Section 2 describes energy sources. Section 3 presents detailed electrical energy consumption, demand, and time-of-use data as compiled from logs, billing records, standard reporting forms, and computer files. Sections 4 through 8 outline the site's non-vehicular consumption of other fuel types. Section 8 presents estimates of end-use energy consumption by building type and utility. The Section 8 estimates are the primary result of the baseline analysis and the most detailed level to which energy use is generally traced in a site-wide conservation potential assessment. Energy use may be traced to a finer level of detail in the process of analyzing certain specific energy conservation or fuel-switching measures (see Volume 3) but such detail is not considered part of the energy use baseline. Section 8 is followed by a reference section, which details the documents used in the baseline analysis.

Table S.1. Robins AFB Building Characterization

Energy Use Sector	Number of Buildings	Total Floorspace (ft ²)	Percent of Total Floorspace
Commercial	646	11,634,203	86.3
Family Housing	822	1,842,000	13.7
Total	1,468	13,476,203	100.0

Table S.2. Typical Annual Energy Consumption and Energy Cost at Robins AFB

Energy Type	Yearly Total (purchase units)	Yearly Total (MBtu) ^(a)	Percent of Total Energy Consumption	Energy Cost (1990 \$ x 10 ³)	Percent of Total Cost
Electricity	269,085 MWh	918,386 ^(b)	47.45	12,200	79.43
Natural Gas	961,873 KCF	982,072 ^(c)	50.74	2,923	19.03
#2 Fuel Oil	249 kgal.	34,603 ^(d)	1.79	230	0.01
Propane	6,220 gal.	568 ^(e)	0.03	6	< 1.50
Totals:		1,935,629	100.00	15,359	100.00
(a) 1 MBtu = 1,000,000 Btu. (b) 3,413 Btu/kWh. (c) 100,000 Btu/therm; 1,050 Btu/ft ³ of natural gas. (d) 0.1388 MBtu/gal of #2 fuel oil. (e) 0.0913 MBtu/gal of propane.					

Table S.3. Energy Consumption by End Use (MBtu/yr)

Fuel Type/End Use	Base Area			
	Commercial	Family Housing	Utility	Total
Electric:				
Heating	1,688	0	0	1,688
Cooling	78,458	39,356	0	117,814
Vent./Fans	103,040	5,326	0	108,366
DHW	3,892	4,109	0	8,001
Cooking	7,092	6,843	0	13,935
Refrigeration	22,983	13,893	0	36,876
Interior Ltg.	205,650	22,085	0	227,736
Exterior Ltg.	10,828	2,454	0	13,281
Other Bldg. End Use	174,661	12,543	0	187,204
Street Ltg.	0	0	35,084	35,084
Trans. & Dist. Loss	0	0	46,064	46,064
Trailer Park	0	3,753	0	3,753
Central Plants	0	0	66,196	66,196
PAVE PAWS	50,841	0	0	50,841
Total	659,134	110,362	147,343	916,839
Percent of Total	71.9 %	12.0 %	16.1 %	100.0 %
Natural Gas:				
Heating	19,414	47,048	0	66,462
DHW	9,024	20,362	0	29,386
Cooking	4,366	0	0	4,366
Other Bldg. End Use	317	0	0	317
Central Plants	0	0	882,038	882,038
Total	33,121	67,410	882,038	982,569
Percent of Total	3.4 %	6.9 %	89.8 %	100.0 %
Fuel Oil				
Heating	13,068	0	0	13,068
DHW	4,657	0	0	4,657
Central Plants	0	0	16,871	16,871
Total	17,725	0	16,871	34,596
Percent of Total	51 %	0 %	49 %	100 %
Total:	709,980	177,772	1,046,252	1,934,004
Percent of Total:	36.7 %	9.2 %	54.1 %	100.0 %

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This report is the result of numerous people working to achieve a common goal of improving energy efficiency at Robins Air Force Base. The authors wish to acknowledge the contribution and valuable assistance provided by all involved Robins Air Force Base staff, particularly those in Civil Engineering. Their positive attitude and up-front answers to many difficult questions provided the PNL team with the information essential to the success of this project.

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Abbreviations and Acronyms

AAFES	Army/Air Force Exchange Service
A/C	air conditioning
AFB	Air Force Base
AFMC	Air Force Materiel Command
AGL	Atlanta Gas Light Company
AHU	air-handling unit
ASD	adjustable speed drive
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
BLCC	Building Life-Cycle Cost Program
Btu	British thermal unit
BX	Base Exchange
CBECs	Commercial Building Energy Consumption Survey
CEP	Central Energy Plant
CF	compact fluorescent
d	day
DEH	Directorate of Engineering and Housing
DEIS	Defense Energy Information System
DFSC	Defense Fuel Supply Center
DHW	domestic hot water
DOE	Department of Energy
DOD	Department of Defense
DOS	disk operating system
DSM	demand-side management
EE	energy efficient
EEF	energy efficient ballast
EEM	energy efficient motor
EIA	Energy Information Administration
ELC	electronic ballast
EMCS	energy management control system
EPA	Environmental Protection Agency
ERO	energy resource opportunity
EUI	energy-use intensity
FEMP	Federal Energy Management Program
FO2	fuel oil No. 2
FORSCOM	Forces Command
g	gram
gal	gallon
GPC	Georgia Power Company
h	hour
hp	horsepower
HPS	high pressure sodium
HTHW	high temperature hot water
HVAC	heating, ventilation, and air conditioning
Hz	Hertz
IES	Illuminating Engineering Society of North America
IRA	Integrated Resource Assessment

kBtu	thousand British thermal unit
kcf	thousand cubic feet
kVA	kilovolt-amperes
KVAR	reactive demand, kilovolt-amperes
kW	kilowatt
kWh	kilowatt hour
lb	pound
LCC	life-cycle cost
LED	light emitting diode
LPS	low pressure sodium
LST	local standard time
LTSM	Lighting Technology Screening Matrix
M	million
mo	month
MBtu	million British thermal unit
MH	metal halide
MW	megawatt
MWh	megawatt hour
NBS	National Bureau of Standards
NG	natural gas or National Guard
NIST	National Institute of Standards and Technology
NPV	net present value
O&M	operations and maintenance
°F	degrees Fahrenheit
PCBs	polychlorinated biphenyls
PCF	permanent compact fluorescent
PNL	Pacific Northwest Laboratory
psi	pounds per square inch
PX	post exchange
RECS	Residential Energy Consumption Survey
REF	parabolic reflector
ROI	return on investment
RPL	real property list
RTU	rooftop unit
rpm	revolutions per minute
SERC	Southeastern Electric Reliability Council
SIR	savings to investment ratio
V	volt
VI	value index
W	watt
WSEO	Washington State Energy Office
yr	year

1.0 Physical Characteristics

This section provides an overview of the site and facilities. The climate and the physical and functional characteristics that influence energy use at Robins AFB are summarized.

1.1 Site Profile

Robins AFB is an 8,790-acre Air Force Materiel Command (AFMC) facility in central Georgia. The base is situated just east of the town of Warner Robins, Georgia, at 32.38°N and 83.36°W and at an elevation (runway) of 294 feet. Regional and area location maps are shown in Figure 1.1.

1.1.1 Occupancy

The daytime population on the base averaged 19,920 in FY 1990. Active military personnel assigned to the site numbered 4,175. The estimated number of military dependents was 5,674. 5,329 military personnel and dependents live on post, with the remainder living in nearby off base towns. Civilians employed full time at the site, but not living in family housing, numbered 15,745 in FY 1990.

The base mission is to support the Warner Robins Air Logistics Center. Tenants include the Air Force Reserve (worldwide) Headquarters (HQ AFRES), 19th Air Refueling Wing (19AREFW), 5th Combat Communications Group (5CCG), 9th Missile Warning Squadron (9MWS), Field Training Detachment 321, Detachment 13, 15th Weather Squadron, and the 4400th Mobility Support Flight. In addition, there are five non-active duty reserve units located at Robins AFB.

Active and retired military personnel not assigned to the site affect energy consumption to some extent by their use of site facilities such as the BX and recreation centers. There are some 23,729 military retirees (and dependents) in middle Georgia who are entitled to use the facilities.

1.1.2 Climate

Robins AFB lies within a climate zone where summers are hot and humid and winters mild. Degree days and design conditions, according to *Engineering Weather Data* (AFM 88-29) are as follows.

Heating degree-days, based on a 65°F balance point, average 2,244 Fahrenheit degree-days/yr, and cooling degree days, also based on a 65°F balance point, average 2,276 Fahrenheit degree-days/yr.

The 97.5% and 99% design temperatures for the Robins AFB/Macon weather station are 25 and 21°F. Dry bulb temperature exceeds 80°F an average of 1,365 hr/yr and exceeds 93°F, 113 hr/yr. Wet bulb temperature exceeds 67°F an average of 2,884 hr/yr and exceeds 73°F an average of 1,213 hr/yr.

Degree days recorded at the Robins AFB weather station for FY 1991 were 1,739 heating degree days and 2,472 cooling degree days.

1.1.3 Facilities Overview

There are 646 commercial, industrial, and command buildings with a total floor area of 11,634,203 ft². The majority of the energy use is electricity and natural gas.

There are 10 permanent on-post family housing areas containing a total of 1,416 family dwelling units with a total floor area of 1,842,000 ft². Family housing areas are located at the southern end of the base and across state highway 247 in the city of Warner Robins. Natural gas is used for space heating and domestic hot water in the majority of the housing areas, with the exception of Chevron Village, which has electric hot water heaters.

Figure 1.1. Robins Air Force Base Map

A mobile home park provides space, electrical service, water and sewer service for 100 units.

1.2 Building and Facility Profile

The site facilities at Robins AFB consist of family housing, commercial and industrial buildings (that will henceforth be referred to simply as "buildings"), and other real property improvements such as utilities (water, sewer, street lighting, gas, steam, and electricity), mission specific facilities (antennas, runways, fuel storage tanks, etc.), outdoor recreation (tennis courts, outdoor pool, etc.), and other surface improvements (streets, culverts, fences and parking lots).

All of the major non-vehicular energy using facilities, family housing, "buildings," and utilities have been classified using 35 primary building types and 5 utility categories as described in the following sections.

1.2.1 Buildings

The building types are based on identifiable function or uniqueness in terms of factors that affect energy use. These factors include occupancy, connected load mix, age, and operation. A building may be treated as two or more buildings, each of a different type, when significant portions of its floor area serve different functions. This may cause some confusion as to the number of buildings or the fuels available to a building. For example, there is a building type labeled "STOR-UH-1." "STOR-UH" is defined as unconditioned storage, yet the "-1" implies that it has central plant heat. This is an anomaly in the process due to the fact that the unconditioned storage is part of a larger building served with central plant heat. There is no energy use attributed to space conditioning for any of the unconditioned storage building types.

The real property list database (RPL) for Robins AFB includes DoD (six digit Air Force version) "category codes" by which to identify building types. Some category codes describe buildings that are very similar in terms of energy use. Groups of codes have therefore been

aggregated into higher level building type categories for the purposes of this assessment. The abbreviations used for each aggregate building type and a brief definitions of each type are listed in Table 1.1.

Building sub-types have been identified where significant differences in style of construction, age, hours of operation, fuel types, or connected load mix result in significant differences in energy use intensity. For example, administration buildings with natural gas heat form one sub-type, those with central plant heat another, and those with central plant heat and cooling a third sub-type.

Table 1.2 lists the important aggregate characteristics of aggregate floor area, fuel type and number of structures for each building type represented at Robins AFB.

Table 1.3 gives the age distribution of buildings by building type.

1.2.2 Family Housing Characterization

Permanent family housing at Robins AFB is located in ten areas that each contain an assortment of duplexes and single family residences. There is also variety in the unit floor plans of the housing stock, with the number of bedrooms ranging from two to four and the floor area ranging from 1,237 to 3,499 square feet.

Table 1.4 details the family housing by floor area, number of bedrooms, buildings, dwelling units, and year of construction, as found in the real property database.

In addition to the permanent housing, there is a mobile home park with space for 100 units. All of the mobile homes have electric service, water and sewer service. In addition, some units have propane tanks, but these are the property and responsibility of the residents. The mobile homes are not candidates for energy conservation or fuel-switching measures under this program because they are neither owned by nor permanently situated on the base. The mobile homes are,

Table 1.1. Building Type Abbreviations and Definitions

Building Type	Description
ADMIN	Administration Building
ADMIN-1	Administration Bldg. w/ Central Plant Heat
ADMIN-2	Admin. Bldg. w/ Central Plant Heat & Cool
ADMIN-3	Admin. Bldg. - All Electric
ADMIN-4	Admin. Bldg. - Fuel Oil Heat
BRK/ADM	Barracks (BEQ & BOQ), includes bar. w/ adm & supply, etc.
BRK/ADM-1	Barracks w/ Central Plant Heat
BRK/ADM-2	Barracks w/ Central Plant Heat & Cool
BRK/ADM-4	Barracks w/ Fuel Oil Heat
CHAPEL-1	Chapel w/ Central Plant Heat
CLINIC	Medical/Dental Clinic
CLINIC-1	Medical/Dental Clinic w/ Central Plant Heat
CLUB	Club (NCO, Officers, etc.)
CLUB-4	Club w/ Fuel Oil Heat
COMCATN	Communications
COMCATN-1	Communications w/ Central Plant Heat
COMCATN-3	Communications - All Electric
COMCATN-4	Communications w/ Fuel Oil Heat
DET-RR-3	Detached Restrooms, Latrines, etc. - All Electric
DET-RR-5	DET-RR - No Heat
DGR	Dry Goods/Retail
DGR-1	Dry Goods/Retail w/ Central Plant Heat
DGR-3	Dry Goods/Retail - All Electric
DGR-4	Dry Goods/Retail w/ Fuel Oil Heat
DINING	Enlisted Dining Facility
DINING-1	Same as Dining except w/ Central Plant Heat
FUELDSP-3	Fuel Dispensing Bldgs. - All Electric
FUELDSP-5	Fuel Dispensing Bldgs. - No Heat
GROCERY-1	Grocery w/ Central Plant Heat
HANGAR	Hangar
HANGAR-1	Hangar w/ Central Plant Heat
HANGAR-2	Hangar w/ Central Plant Heat & Cool
HANGAR-3	Hangar - All Electric
HANGAR-4	Hangar w/ Fuel Oil Heat

Table 1.1. (contd)

Building Type	Description
HANGAR-5	Hangar - No Heat
HOSPITL-1	Hospital w/ Central Plant Heat
HOTEL-3	Hotel/Motel - All Electric
HSG-FAM	Family Housing
HSG-FAM-3	Family Housing w/ Electric DHW (Chevron Village)
HUT-2	Misc. Small Bldgs. w/ Central Plant Heat & Cool
HUT-5	HUT - No Heat
LAB-MED	Laboratory/Vet. Facility
LAB-MED-1	Lab. w/ Central Plant Heat
LAB-MED-3	Lab. - All Electric
LAB-MED-4	Lab. w/ Fuel Oil Heat
MTRPOOL	Maint. Shops for Cars, Trucks, Tanks - Land Vehicles
MTRPOOL-1	Maint. Shops w/ Central Plant Heat
MTRPOOL-3	MTRPOOL - All Electric
MTRPOOL-5	MTRPOOL - No Heat
MWR	Morale, Welfare, & Recreation (Non-Physical Rec)
MWR-1	MWR w/ Central Plant Heat
MWR-3	MWR - All Electric
MWR-5	MWR - No Heat
OTHER	Other (non ECO bldgs.)
OTHER-3	OTHER - All Electric
PLT-BLD	Heating/Cooling/Power Plant, Elec. Distribution Buildings
PLT-BLD-1	PLT-BLD w/ Steam/Heat from Another Bldg.
PLT-BLD-3	PLT-BLD - All Electric
PLT-BLD-4	PLT-BLD w/ Fuel Oil
PLT-BLD-5	PLT-BLD - No Heat
PRDCTN-1	Production/Assembly Facilities w/ Central Plant Heat
PRDCTN-4	PRDCTN w/ Fuel Oil Heat
PUMP	Pump Bldgs. - Sewer, Wells, Wash Platforms, etc
PUMP-1	Pump Bldgs. w/ Central Plant Heat
PUMP-3	Pump Bldgs. - All Electric
PUMP-4	Pump Bldgs. w/ Fuel Oil Heat
PUMP-5	Pump Bldgs. - No Heat
REC-1	Phys. Rec. w/ Central Plant Heat

Table 1.1. (contd)

Building Type	Description
RESTRNT-1	Restaurant w/ Central Plant Heat
RESTRNT-2	Restaurant w/ Central Plant Heat & Cool
RESTRNT-3	Restaurant - All Electric
SCHOOL	Dependent Schools
SECURTY	Security Operations (police, fire)
SECURTY-1	Security Operations w/ Central Plant Heat
SECURTY-3	Security Operations - All Electric
SECURTY-4	Security Operations w/ Fuel Oil Heat
SECURTY-5	Security Operations - No Heat
SHOP	General Maint. Shops, inc. DEH/Base Eng.
SHOP-1	SHOP w/ Central Plant Heat
SHOP-2	SHOP w/ Central Plant Heat & Cool
SHOP-3	SHOP - All Electric
SHOP-4	SHOP w/ Fuel Oil Heat
SHOP-5	SHOP - No Heat
SHOP-AIR-1	SHOP-AIR w/ Central Plant Heat
SHOP-AIR-2	SHOP-AIR w/ Central Plant Heat & Cool
SHOP-AIR-3	SHOP-AIR - All Electric
SHOP-AIR-4	SHOP-AIR w/ Fuel Oil Heat
SHOP-AIR-5	SHOP-AIR - No Heat
SHOP-ELC	Maint. Shops for Electronics, Avionics, ECM, etc.
SHOP-ELC-1	SHOP-ELC w/ Central Plant Heat
SHOP-ELC-2	SHOP-ELC w/ Central Plant Heat & Cool
SHOP-ELC-4	SHOP-ELC w/ Fuel Oil Heat
SHOP-ELC-5	SHOP-ELC - No Heat
SHOP-HVY-1	Maint. Shops w/ Heavy Equip. w/ Central Plant Heat
SHOP-WPN-3	Maint. Shops for Weapons - All Electric
STOR-UH	Unheated Storage (vehicles, ammo, residential sheds)
STOR-UH-1	Unheated Storage w/ Central Plant Heat ^(a)
STOR-UH-3	Unheated Storage - All Electric
STOR-UH-5	Unheated Storage - No Heat
TERMINL-1	Airport, Bus, Train Terminal w/ Central Plant Heat
TRAINING	Training/Classrooms (not simulator)
TRAINING-1	Training/Classrooms w/ Central Plant Heat

Table 1.1. (contd)

Building Type	Description
TRAINING-2	Training/Classrooms w/ Central Plant Heat & Cool
TRAINING-3	Training/Classrooms - All Electric
WHS	Warehouse
WHS-1	Warehouse w/ Central Plant Heat
WHS-2	Warehouse w/ Central Plant Heat & Cool
WHS-3	Warehouse - All Electric
WHS-4	Warehouse w/ Fuel Oil Heat
WHS-5	Warehouse - No Heat
WHS-CLD	Cold Storage Warehouse
WHS-CLD-3	Cold Storage Warehouse - All Electric
(a) This area was determined to be unconditioned storage according to its category code, but either all or part of the building has the listed energy type.	

Table 1.2. Building Characteristics by Building Type

Building Type	Description	No.	Total Area ft ²	Percent of Total
ADMIN	Administration Building	16	63,434	0.47
ADMIN-1	Administration Bldg. w/ Central Plant Heat	50	787,189	5.84
ADMIN-2	Admin. Bldg. w/ Central Plant Heat & Cool	15	772,326	5.73
ADMIN-3	Admin. Bldg. - All Electric	24	45,504	0.34
ADMIN-4	Admin. Bldg. - Fuel Oil Heat	9	47,854	0.36
BRK/ADM	Barracks (enlisted & BOQ)	4	64,616	0.48
BRK/ADM-1	Barracks w/ Central Plant Heat	6	150,102	1.11
BRK/ADM-2	Barracks w/ Central Plant Heat & Cool	4	100,950	0.75
BRK/ADM-4	Barracks w/ Fuel Oil Heat	3	23,481	0.17
CHAPEL-1	Chapel w/ Central Plant Heat	1	16,218	0.12
CLINIC	Medical/Dental Clinic	1	2,750	0.02
CLINIC-1	Medical/Dental Clinic w/ Central Plant Heat	8	27,969	0.21
CLUB	Club (NCO, Officers, etc.)	3	51,570	0.38
CLUB-4	Club w/ Fuel Oil Heat	1	7,278	0.05
COMCATN	Communications	2	5,776	0.04
COMCATN-1	Communications w/ Central Plant Heat	2	28,049	0.21
COMCATN-3	Communications - All Electric	3	881	0.01
COMCATN-4	Communications w/ Fuel Oil Heat	5	111,120	0.82
DET-RR-3	Detached Restrooms, Latrines, etc. - All Electric	4	2,255	0.02
DET-RR-5	DET-RR - No Heat	3	1,010	0.01
DGR	Dry Goods/Retail	1	7,500	0.06
DGR-1	Dry Goods/Retail w/ Central Plant Heat	3	45,619	0.34

Table 1.2. (contd)

Building Type	Description	No.	Total Area ft ²	Percent of Total
DGR-3	Dry Goods/Retail - All Electric	2	6,656	0.05
DGR-4	Dry Goods/Retail w/ Fuel Oil Heat	2	5,624	0.04
DINING	Enlisted Dining Facility	2	3,815	0.03
DINING-1	Same as Dining except w/ Central Plant Heat	2	18,038	0.13
FUELDSP-3	Fuel Dispensing Bldgs. - All Electric	1	292	<0.01
FUELDSP-5	Fuel Dispensing Bldgs. - No Heat	3	2,334	0.02
GROCERY-1	Grocery w/ Central Plant Heat	1	81,090	0.60
HANGAR	Hangar	9	413,419	3.07
HANGAR-1	Hangar w/ Central Plant Heat	7	215,831	1.60
HANGAR-2	Hangar w/ Central Plant Heat & Cool	2	571,559	4.24
HANGAR-3	Hangar - All Electric	2	22,110	0.16
HANGAR-4	Hangar w/ Fuel Oil Heat	2	36,924	0.27
HANGAR-5	Hangar - No Heat	1	4,212	0.03
HOSPITL-1	Hospital w/ Central Plant Heat	6	25,325	0.19
HOTEL-3	Hotel/Motel - All Electric	4	17,804	0.13
HSG-FAM	Family Housing	557	1,335,665	9.91
HSG-FAM-3	Family Housing w/ electric DHW	265	506,335	3.76
HUT-2	Misc. Small Bldgs. w/ Central Plant Heat & Cool	1	1,845	0.01
HUT-5	HUT - No Heat	4	8,413	0.06
LAB-MED	Laboratory/Vet. Facility	1	71	<0.01
LAB-MED-1	Lab. w/ Central Plant Heat	2	2,833	0.02
LAB-MED-3	Lab. - All Electric	1	288	<0.01
LAB-MED-4	Lab. w/ Fuel Oil Heat	2	1,328	0.01
MTRPOOL	Maint. Shops for Cars, Trucks, Tanks - Land Vehicles	2	2,248	0.02
MTRPOOL-1	Maint. Shops w/ Central Plant Heat	4	64,350	0.48
MTRPOOL-3	MTRPOOL - All Electric	1	840	0.01
MTRPOOL-5	MTRPOOL - No Heat	1	660	<0.01
MWR	Morale, Welfare, & Recreation (Non-Physical Rec)	6	63,500	0.47
MWR-1	MWR w/ Central Plant Heat	3	45,083	0.33
MWR-3	MWR - All Electric	6	23,690	0.18
MWR-5	MWR - No Heat	5	12,546	0.09
OTHER	Other (non ECO bldgs.)	1	1,606	0.01
OTHER-3	OTHER - All Electric	2	2,488	0.02
PLT-BLD	Heating/Cooling/Power Plant, Elec. Dist. Buildings	22	66,852	0.50
PLT-BLD-1	PLT-BLD w/ Steam/Heat from Another Bldg.	6	14,446	0.11
PLT-BLD-3	PLT-BLD - All Electric	11	12,424	0.09
PLT-BLD-4	PLT-BLD w/ Fuel Oil	5	6,498	0.05
PLT-BLD-5	PLT-BLD - No Heat	2	981	0.01
PRDCTN-1	Production/Assembly Facilities w/ Central Plant Heat	1	13,200	0.10
PRDCTN-4	PRDCTN w/ Fuel Oil Heat	4	42,495	0.32

Table 1.2. (contd)

Building Type	Description	No.	Total Area ft ²	Percent of Total
PUMP	Pump Bldgs. - Sewer, Wells, Wash Platforms, etc	4	950	0.01
PUMP-1	Pump Bldgs. w/ Central Plant Heat	1	906	0.01
PUMP-3	Pump Bldgs. - All Electric	45	16,580	0.12
PUMP-4	Pump Bldgs. w/ Fuel Oil Heat	1	624	<0.01
PUMP-5	Pump Bldgs. - No Heat	11	1,366	0.01
REC-1	Phys. Rec. w/ Central Plant Heat	2	50,860	0.38
RESTRNT-1	Restaurant w/ Central Plant Heat	2	6,587	0.05
RESTRNT-2	Restaurant w/ Central Plant Heat & Cool	2	39,364	0.29
RESTRNT-3	Restaurant - All Electric	1	1,225	0.01
SCHOOL	Dependent Schools	5	122,894	0.91
SECURTY	Security Operations (police, fire)	1	764	0.01
SECURTY-1	Security Operations w/ Central Plant Heat	4	37,216	0.28
SECURTY-3	Security Operations - All Electric	22	6,870	0.05
SECURTY-4	Security Operations w/ Fuel Oil Heat	2	8,483	0.06
SECURTY-5	Security Operations - No Heat	1	240	0.00
SHOP	General Maint. Shops, inc. DEH/Base Eng.	8	41,807	0.31
SHOP-1	SHOP w/ Central Plant Heat	23	252,163	1.87
SHOP-2	SHOP w/ Central Plant Heat & Cool	1	20,290	0.15
SHOP-3	SHOP - All Electric	11	25,960	0.19
SHOP-4	SHOP w/ Fuel Oil Heat	2	3,148	0.02
SHOP-5	SHOP - No Heat	8	10,746	0.08
SHOP-AIR-1	SHOP-AIR w/ Central Plant Heat	12	210,820	1.56
SHOP-AIR-2	SHOP-AIR w/ Central Plant Heat & Cool	7	425,296	3.16
SHOP-AIR-3	SHOP-AIR - All Electric	4	31,708	0.24
SHOP-AIR-4	SHOP-AIR w/ Fuel Oil Heat	5	39,535	0.29
SHOP-AIR-5	SHOP-AIR - No Heat	10	48,188	0.36
SHOP-ELC	Maint. Shops for Electronics, Avionics, ECM, etc.	4	45,696	0.34
SHOP-ELC-1	SHOP-ELC w/ Central Plant Heat	12	406,954	3.02
SHOP-ELC-2	SHOP-ELC w/ Central Plant Heat & Cool	5	646,156	4.79
SHOP-ELC-4	SHOP-ELC w/ Fuel Oil Heat	2	14,109	0.10
SHOP-ELC-5	SHOP-ELC - No Heat	3	5,144	0.04
SHOP-HVY-1	Maint. Shops w/ Heavy Equip. w/ Central Plant Heat	2	7,698	0.06
SHOP-WPN-3	Maint. Shops for Weapons - All Electric	2	2,492	0.02
STOR-UH	Unheated Storage (vehicles, ammo, residential sheds)	4	105,232	0.78
STOR-UH-1	Unheated Storage w/ Central Plant Heat (?)	3	35,900	0.27
STOR-UH-3	Unheated Storage - All Electric	3	5,084	0.04
STOR-UH-5	Unheated Storage - No Heat	33	363,401	2.70
TERMINL-1	Airport, Bus, Train Terminal w/ Central Plant Heat	2	70,316	0.52
TRAINING	Training/Classrooms (not simulator)	6	29,985	0.22
TRAINING-1	Training/Classrooms w/ Central Plant Heat	4	37,875	0.28

Table 1.2. (contd)

Building Type	Description	No.	Total Area ft ²	Percent of Total
TRAINING-2	Training/Classrooms w/ Central Plant Heat & Cool	4	23,795	0.18
TRAINING-3	Training/Classrooms - All Electric	3	13,321	0.10
WHS	Warehouse	5	37,027	0.27
WHS-1	Warehouse w/ Central Plant Heat	23	3,630,756	26.94
WHS-2	Warehouse w/ Central Plant Heat & Cool	4	297,149	2.20
WHS-3	Warehouse - All Electric	3	9,081	0.07
WHS-4	Warehouse w/ Fuel Oil Heat	6	203,395	1.51
WHS-5	Warehouse - No Heat	9	51,984	0.39
WHS-CLD	Cold Storage Warehouse	1	4,400	0.03
WHS-CLD-3	Cold Storage Warehouse - All Electric	1	5,494	0.04
Total:		1,468	13,476,203	100.00
(a) This area was determined to be unconditioned storage according to its category code, but either all or part of the building has the listed energy type.				

Table 1.3. Age Distribution by Building Type (Floor Area, ft²)

Bldg. Type	1940-49	1950-59	1960-69	1970-79	1980-91	Total
ADMIN	30,697	200	14,503	5,150	12,884	63,434
ADMIN-1	196,447	304,122	60,620	64,932	161,068	787,189
ADMIN-2	738,913	32,613			800	772,326
ADMIN-3	121		2,654	1,730	40,999	45,504
ADMIN-4	1,750	15,992	30,112			47,854
BRK/ADM			64,616			64,616
BRK/ADM-1		49,922	100,180			150,102
BRK/ADM-2			100,950			100,950
BRK/ADM-4			19,057	4,424		23,481
CHAPEL-1			16,218			16,218
CLINIC	2,750					2,750
CLINIC-1			25,829		2,140	27,969
CLUB	25,463			26,107		51,570
CLUB-4				7,278		7,278
COMCATN			5,776			5,776
COMCATN-1		28,049				28,049
COMCATN-3				487	394	881
COMCATN-4		9,838	1,282		100,000	111,120
DET-RR-3			527		1,728	2,255

Table 1.3. (contd)

Bldg. Type	1940-49	1950-59	1960-69	1970-79	1980-91	Total
DET-RR-5			410		600	1,010
DGR					7,500	7,500
DGR-1	5,128			40,491		45,619
DGR-3				6,656		6,656
DGR-4	5,624					5,624
DINING	3,815					3,815
DINING-1			18,038			18,038
FUELDSP-3					292	292
FUELDSP-5			942		1,392	2,334
GROCERY-1		81,090				81,090
HANGAR		54,724	103,010	42,630	213,055	413,419
HANGAR-1	1,058	30,841	84,372	53,029	46,531	215,831
HANGAR-2	571,559					571,559
HANGAR-3		1,647	20,463			22,110
HANGAR-4			20,463		16,461	36,924
HANGAR-5					4,212	4,212
HOSPITL-1			23,695		1,630	25,325
HOTEL-3				17,804		17,804
HSG-FAM	30,561	388,060	651,676	265,368		1,335,665
HSG-FAM-3		506,335				506,335
HUT-2	1,845					1,845
HUT-5	1,818		2,947		3,648	8,413
LAB-MED				71		71
LAB-MED-1			2,833			2,833
LAB-MED-3				288		288
LAB-MED-4			964		364	1,328
MTRPOOL		248		2,000		2,248
MTRPOOL-1		4,608	3,575	4,927	51,240	64,350
MTRPOOL-3					840	840
MTRPOOL-5				660		660
MWR	3,512		5,923	26,065	28,000	63,500
MWR-1		22,536		12,067	10,480	45,083
MWR-3			4,194		19,496	23,690
MWR-5	1,980				10,566	12,546

Table 1.3. (contd)

Bldg. Type	1940-49	1950-59	1960-69	1970-79	1980-91	Total
OTHER				1,606		1,606
OTHER-3			120		2,368	2,488
PLT-BLD	33,362	20,231	9,378	3,881		66,852
PLT-BLD-1		2,727		6,138	5,581	14,446
PLT-BLD-3		703		5,513	6,208	12,424
PLT-BLD-4		2,046	1,572		2,880	6,498
PLT-BLD-5		827			154	981
PRDCTN-1					13,200	13,200
PRDCTN-4			2,080	8,268	32,147	42,495
PUMP			150	608	192	950
PUMP-1	906					906
PUMP-3	2,364	4,040	6,882	546	2,748	16,580
PUMP-4	624					624
PUMP-5	381	138	827		20	1,366
REC-1			50,860			50,860
RESTRNT-1				2,197	4,390	6,587
RESTRNT-2			564		38,800	39,364
RESTRNT-3					1,225	1,225
SCHOOL	122,894					122,894
SECURTY	764					764
SECURTY-1		10,315	11,337	12,564	3,000	37,216
SECURTY-3			2,207	390	4,273	6,870
SECURTY-4					8,483	8,483
SECURTY-5	240					240
SHOP	37,145	3,694		968		41,807
SHOP-1	163,949	18,656	21,858	1,663	46,037	252,163
SHOP-2				20,290		20,290
SHOP-3	1,728		968		23,264	25,960
SHOP-4	1,810	1,338				3,148
SHOP-5	3,328	1,300		1,752	4,366	10,746
SHOP-AIR-1	100,561	12,548	22,359	66,372	8,980	210,820
SHOP-AIR-2	218,022			203,729	3,545	425,296
SHOP-AIR-3				4,000	27,708	31,708
SHOP-AIR-4			36,925	2,610		39,535

Table 1.3. (contd)

Bldg. Type	1940-49	1950-59	1960-69	1970-79	1980-91	Total
SHOP-AIR-5	504	1,102		5,182	41,400	48,188
SHOP-ELC	41,571	4,125				45,696
SHOP-ELC-1	4,270	79,476	26,131		297,077	406,954
SHOP-ELC-2	105,820	495,518		44,818		646,156
SHOP-ELC-4		1,633	12,476			14,109
SHOP-ELC-5	3,300				1,844	5,144
SHOP-HVY-1				5,658	2,040	7,698
SHOP-WPN-3		330			2,162	2,492
STOR-UH	21,874	5,025			78,333	105,232
STOR-UH-1	1,058	34,842				35,900
STOR-UH-3	596			600	3,888	5,084
STOR-UH-5	1,644	934	12,436	13,148	335,239	363,401
TERMINL-1			1,174	69,142		70,316
TRAING	6,401		7,943	5,297	10,344	29,985
TRAING-1	3,300				34,575	37,875
TRAING-2	23,795					23,795
TRAING-3	539			5,182	7,600	13,321
WHS	33,314			3,713		37,027
WHS-1	939,752	1,994,414	9,380	687,210		3,630,756
WHS-2	297,149					297,149
WHS-3	113			768	8,200	9,081
WHS-4	24,047		34,652		144,696	203,395
WHS-5			43,200	8,400	384	51,984
WHS-CLD			4,400			4,400
WHS-CLD-3				5,494		5,494
Totals:	3,820,166	4,226,787	1,705,708	1,779,871	1,943,671	13,476,203

Table 1.4. Family Housing Characterization

Housing Area	Housing Type	No. of Bedrooms	Year Built	No. of Bldgs.	Total No. of Units	Total Area ft ²	Energy Type	
							Heat	DHW
5th Terrace	Duplex	3	59	2	4	5,904	G	G
	Single	4	59	4	4	6,224	G	G
Chief's Circle	Duplex	3	42	5	10	16,565	G	G
Capehart	Duplex	2	60	10	20	23,268	G	G
	Duplex	3	59	75	150	198,602	G	G
	Duplex	3	60	26	52	68,764	G	G
	Single	4	59	14	14	19,418	G	G
	Single	4	60	6	6	9,276	G	G
Chevron Village/Wherry	Duplex	2	51	160	320	344,572	G	E
	Duplex	2	53	35	70	67,693	G	E
	Single	3	53	30	30	37,110	G	E
	Single	4	51	40	40	56,960	G	E
Crestview	Duplex	2	73	15	30	33,030	G	G
	Duplex	3	73	40	80	101,040	G	G
	Duplex	4	73	20	40	57,920	G	G
Hillside/Fund	Single	3	64	14	14	23,184	G	G
	Single	3	65	19	19	31,464	G	G
	Single	3	66	7	7	11,571	G	G
	Duplex	3	64	30	60	80,736	G	G
	Duplex	3	65	23	46	60,351	G	G
	Duplex	3	66	8	16	22,272	G	G
	Single	4	64	6	6	10,224	G	G
	Single	4	65	5	5	8,520	G	G
	Single	4	66	17	17	32,131	G	G
	Duplex	4	64	10	20	29,010	G	G
	Duplex	4	65	15	30	43,515	G	G
	Duplex	4	66	30	60	88,806	G	G
Lakeside	Duplex	2	73	12	24	26,424	G	G
	Single	3	60	8	8	13,456	G	G
	Duplex	3	59	1	2	2,970	G	G
	Duplex	3	60	12	24	35,442	G	G
	Duplex	3	73	10	20	29,880	G	G
	Single	4	60	12	12	19,814	G	G
	Duplex	4	60	5	10	15,360	G	G
Officer's Circle	Single	3	42	2	2	4,747	G	G
	Single	3	59	27	27	44,901	G	G
	Single	4	42	3	3	9,249	G	G
	Single	4	59	14	14	23,327	G	G
	Single	4	73	6	6	13,050	G	G
Pine Oaks	Single	3	60	4	4	6,728	G	G
	Duplex	3	59	24	48	71,154	G	G
	Duplex	3	60	6	12	17,784	G	G
	Single	4	59	10	10	15,560	G	G
Totals:				822	1,396	1,842,000		
Energy Types: G = Natural Gas E = Electricity								

however, included in the baseline analysis since their energy use must be accounted for to avoid biasing the baseline estimates for other buildings as we attempt to reconcile the data with total energy use.

1.2.3 Central Thermal System Characterization

There are two major and four minor central thermal loops at Robins AFB, as shown in Table 1.5.

There are approximately 9 miles of buried pipeline for steam and 0.74 miles of pipeline for chilled water (taken from the central heating/cooling system distribution maps), as follows: 6 mi. of steam line and 0.74 mi. of chilled water line from Bldg. 177, 2.65 mi. of steam line from Bldg. 644, and 0.35 mi. of steam line from Bldg. 83. The other three minor plant buildings are all located near (adjacent) to the few buildings they serve.

1.2.4 Utility Characterization

Utilities at the site include electricity, natural gas, steam, central chilled water, domestic water and sewer.

Electrical service to most of the base is provided by Georgia Power Company (GPC) to three substations: Ninth Street, D Street, and PAVE PAWS. In addition, Flint Electric Membership Co-op (FEMC) has two substations

located in the Chevron Village and Hillside housing areas across highway 247. The PAVE PAWS substation provides service solely to the PAVE PAWS radar installation at the south end of the base. There is approximately 109,752 kVA of transformer capacity at Robins AFB, of which 25,408 kVA is pole-mounted (usually between 10 - 100 kVA) and 84,344 kVA is pad-mounted (from 25 - 37,000 kVA). A summary of the transformers by number and size by mounting type is shown in Table 1.6.

There are currently 18 feeders serving most of Robins AFB. The general areas served by each feeder are shown in Table 1.7.

The distribution of aggregate building floor area by building type and feeder is given in Table 1.8 for the Ninth Street and both FEMC substations (combined) and in Table 1.9 for the D Street substation. Building types without any service from one or the other substation have been omitted from the respective tables.

According to the exterior electric shop personnel, there are approximately 3,000 street, parking lot and exterior security lights at Robins AFB. Of these, about 90% are between 250 W and 400 W High Pressure Sodium (HPS). The remaining 10% are between 75 W and 250 W HPS. Airfield lighting counts and energy consumption were approximated from data collected for a similar assessment at Patrick AFB, Florida, and are shown in Table 1.10.

Table 1.5. Central Thermal Loop Details

Plant Bldg. No.	No. Bldgs. Served Steam	No. Bldgs. Served Chilled Water	Steam Energy Source
177	83	10	Natural Gas, Fuel Oil
644	41	0	Natural Gas
83	6	0	Fuel Oil
605	1	0	Fuel Oil
642	0	2	Cooling Plt. Only
629	2	0	Fuel Oil

Table 1.6. Transformers Counts and Aggregate Capacity by Size

Size (kVa)	Pad-Mounted		Pole-Mounted	
	Count	Total kVA	Count	Total kVA
3			1	3
5			2	10
7			2	14
10	28	280	52	520
15	43	645	34	510
25	35	875	112	2,800
30			2	60
37	60	2,220	90	3,330
50	53	2,650	65	3,250
75	28	2,100	48	3,600
100	12	1,200	28	2,800
110	3	330		
112	5	560	1	112
125	3	375		
150	17	2,550	3	450
167	2	334	7	1,169
225	13	2,925		
250			3	750
300	21	6,300	4	1,200
330			1	330
500	25	12,500	2	1,000
750	12	9,000		
1,000	7	7,000		
1,500	10	15,000	1	1,500
2,000	5	10,000	1	2,000
2,500	3	7,500		
Totals	385	84,344	459	25,408

Table 1.7. Areas Served by Each Feeder

Substation	Feeder #	Areas/Bldgs. Served
9th Street	#1	Avionics Center and Steam Plant #2 (B/644)
	#2	Crestview Housing, BX, and Mixed Commercial
	#3	Commercial and Industrial
	#4	Barracks, Pine Oaks, Lakeside, and Officer's Circle Housing, and Mixed Commercial
	#5	Warehouses
	#6	Avionics Center
	#7	Commissary, Trailer Park, and Training Areas
	#8	Hospital
D Street	#1	Base Ops, X-Ray Bldg., and Hangar Bldg. 125
	#2	Warehouse, Motorpool, and Admin.
	#3	Hangars
	#4	Labs and Electronic Warfare Complex
	#5	Aircraft Maint. Facilities
	#6	Comptroller
	#7	Aircraft Maint. Facilities
	#8	Steam Plant #1 (B/177)
	#9	Warehouses (B/380 & 385)
	#10	SAC Area, WSA Area, Admin. and Aircraft Maint.
	#11	Ind. Waste Plant, Maint. Facilities
	#12	Administration Bldgs.
	#13	Mixed Commercial And Industrial
	#14	Aircraft Maint. and Commercial
FEMC		Hillside and Chevron Village Housing

Table 1.8. Floor Area (ft²) by Building Type and Electrical Distribution Feed for Ninth Street and FEMC

Bldg. Type	Ninth Street Feeder								FEMC
	#1	#2	#3	#4	#5	#6	#7	#8	
ADMIN		25,703	19,367	7,004			10,048		
ADMIN-1		43,265	51,698	39,329	48,512		9,589		
ADMIN-2						32,613			
ADMIN-3		5,298	2,496	14,705			4,729		
ADMIN-4		6,620	1,595	1,750					
BRK/ADM				64,616					
BRK/ADM-1				150,102					
BRK/ADM-2				100,950					
CHAPEL-1				16,218					
CLINIC				2,750					
CLINIC-1								25,829	
CLUB		26,107		25,463					
CLUB-4				7,278					
COMCATN									360
COMCATN-3			224				170		
COMCATN-4							100,000		
DET-RR-3							528		
DET-RR-5					600				
DGR							7,500		
DGR-1		39,866		5,128	625				
DGR-3							3,376		3,280
DGR-4							5,624		
DINING							3,815		
DINING-1				14,377				3,661	
GROCERY-1							81,090		
HOSPITL-1								23,695	
HOTEL-3							17,804		
HSG-FAM		492,652	6,626	390,579					948,119
HUT-5		1,466		3,299					3,648
LAB-MED-1								2,569	
LAB-MED-3		288							
LAB-MED-4		964							
MTRPOOL							2,000		

Table 1.8. (contd)

	Ninth Street Feeder								
Bldg Type	#1	#2	#3	#4	#5	#6	#7	#8	FEMC
MTRPOOL-1				4,608					
MTRPOOL-3		840							
MWR		35,500					28,000		
MWR-1		22,547		22,536					
MWR-3							23,690		
MWR-5		2,502		444			9,600		
OTHER							1,606		
OTHER-3			120						
PLT-BLD	7,055		296	2,817		4,186		4,162	
PLT-BLD-1	1,972					8,225			
PLT-BLD-3				786					
PLT-BLD-4				1,743		303			
PLT-BLD-5	827								
PUMP							72		800
PUMP-3	332	120	461	2,352			1,034		
PUMP-5		81		345					
REC-1				50,860					
RESTRNT-1				4,390	2,197				
RESTRNT-3		1,225							
SCHOOL		67,168							55,726
SECURTY							764		
SECURTY-1			11,337						
SECURTY-3			1,100				2,946		48
SECURTY-5			240						
SHOP		1,750	27,794	968			9,000		2,295
SHOP-1			33,971	67,716		1,200			
SHOP-3			5,896	6,000			14,064		
SHOP-4							1,810		
SHOP-5			3,508	2,832		286	4,000		
SHOP-AIR-1							37,083		
SHOP-AIR-3				10,332			16,800		
SHOP-AIR-5			21,000	4,800					
SHOP-ELC		1,250	20,257				24,189		

Table 1.8. (contd)

	Ninth Street Feeder								
Bldg. Type	#1	#2	#3	#4	#5	#6	#7	#8	FEMC
SHOP-ELC-1	1,590	78,649	21,409						
SHOP-ELC-2	203,862					291,656			
SHOP-ELC-4			12,476						
SHOP-ELC-5			3,300				1,844		
SHOP-HVY-1				2,040		5,658			
SHOP-WPN-3		2,492							
STOR-UH				5,025	78,333		21,874		
STOR-UH-1			34,842						
STOR-UH-3				3,888			596		
STOR-UH-5		2,904	320,712	3,308			4,000		150
TRAIING		7,943	14,743	6,344			955		
TRAIING-1		33,675	3,300	900					
TRAIING-3				8,139					
WHS		5,640					31,387		
WHS-1			666,944	383,864	675,054		160,045	9,380	
WHS-3				8,313	768				
WHS-4			3,420				165,323		
WHS-5		384	51,600						
WHS-CLD-3		5,494							
Totals:	215,638	912,393	1,340,732	1,448,898	806,089	344,127	801,927	69,296	1,014,426

Table 1.9. Floor Area (ft²) by Building Type and Electrical Distribution Feed for the D Street Substation

D Street Feeder														
Bldg. Type	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14
ADMIN		440			5,700						200			
ADMIN-1	2,516	3,762		96,811		70,610			22,940	60,606	19,361	241,339	44,583	32,268
ADMIN-2	93,438	634,675												11,600
ADMIN-3	121									3,609		2,586	7,610	4,350
ADMIN-4					11,278					23,492	3,119			
BRK/ADM-4										23,481				
CLINIC-1												2,140		
COMCATN					5,416									
COMCATN-1				13,399								14,650		
COMCATN-3					487									
COMCATN-4					8,806					2,314				
DET-RR-3										527		1,200		
DET-RR-5										410				
FUELDSP-3												292		
FUELDSP-5					942					1,392				
HANGER			85,260		54,724					85,905				187,530
HANGER-1							47,589			26,482	30,841			110,919
HANGER-2	571,559													
HANGER-3										20,463				1,647
HANGER-4					16,461					20,463				
HANGER-5											4,212			
HOSPITL-1												1,630		
HUT-2	1,845													
LAB-MED											71			

Table 1.9. (contd)

D Street Feeder														
Bldg. Type	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14
LAB-MED-1		264												
LAB-MED-4										364				
MTRPOOL-1		51,240									3,575		4,927	
MTRPOOL-3														
OTHER-3					2,368									
PLT-BLD		3,881		2,378	620			25,350		2,332		6,671		7,104
PLT-BLD-1							4,249							
PLT-BLD-3	160		703							6,240				4,535
PLT-BLD-4										1,572			2,880	
PLT-BLD-5				154										
PRDCTN-1													13,200	
PRDCTN-4					27,347					15,148				
PUMP-1												906		
PUMP-3	577	1,058		623	398		98	196		6,565	684	225		1,857
PUMP-4											624			
PUMP-5					325					299		20		296
RESTRNT-2		564												38,800
SECURITY-1	10,315												12,564	3,000
SECURITY-3				52					48	2,482	42	100		52
SECURITY-4										7,727		756		
SHOP-1	5,477						76,548			21,858	44,346	1,047		
SHOP-2							20,290							
SHOP-4										1,338				
SHOP-5										120				

Table 1.9. (contd)

D Street Feeder														
Bldg. Type	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14
SHOP-AIR-1				7,300			62,452			20,479	22,755	42,840	11,431	6,480
SHOP-AIR-2	63,962						203,729							157,605
SHOP-AIR-3	4,000				576									
SHOP-AIR-4					2,610					36,925				
SHOP-AIR-5	4,800				504		551			15,982				551
SHOP-ELC-1		77,886		219,327						8,093				
SHOP-ELC-2				80,882										69,756
SHOP-ELC-4					1,633									
STOR-UH-1							1,058							
STOR-UH-3												600		
STOR-UH-5	200						6,576			24,591	384	576		
TERMINL-1	1,174										69,142			
TRAIING-2	23,795													
TRAIING-3										5,182				
WHS-1		21,867							1,202,551				511,051	
WHS-2		297,149												
WHS-4										34,652				
WHS-CLD		4,400												
TOTALS:	783,939	1,097,186	85,963	420,926	140,195	70,610	423,140	25,546	1,225,539	481,093	199,356	317,578	608,906	638,350

Table 1.10. Airfield Lighting

	Count	Watts Each	Total kWh
Runway Edge	630	200	183,960
Taxiway	4,080	45	268,060
VASI	38	500	27,740
Approach	125	200	36,500
Distance Markers	24	200	7,010
Threshold	76	200	22,190
			545,460

From these estimates, the total exterior lighting load including ballasts is approximately 1,470 kW, corresponding to an annual energy use of about 10,282,460 kWh. The lamp circuits (except airfield) are controlled predominantly by photocells, operating an average of 12 hours per day. The airfield lights are assumed to operate an average of 4 hours per day.

Natural gas service is provided by Atlanta Gas Light Company (AGL), Access Energy Company (Access), and the City of Warner Robins (CWR). Access gas is available to both the AGL and CWR gas lines through transportation agreements.

The AGL pipeline enters on the east side of the base near the intersection of Second St. and Hannah Rd. The line then runs almost directly to building 177. A branch line has recently been completed from the intersection of 2nd and Hannah to building 52 in the SAC area on the northeast part of the base.

The CWR gas pipeline transverses the housing areas across Highway 147, then enters the base north of building 610. It then branches out across most of the base. An additional pipeline enters west of building 54 for service to buildings in that general area.

The distribution temperature and pressure for steam heating is 340°F and 120 psig. Each

building on the loop has a heat exchanger for space heating and a heat exchanger for domestic water heating. Modulating valves control the flow of steam to control temperature on the load side.

The distribution temperature and pressure for central chilled water is 42-44°F and 60-70 psig.

According to the RPL, domestic water is supplied by 13 wells scattered across the Base. Operating logs indicate that only six of these wells are in regular use. There are 26 domestic water pumping stations and 2 fire protection pumping stations. Water storage is provided by 5 potable tanks (1,800 kgal. total capacity) and 2 fire protection tanks (600 kgal. total cap.). Well number, capacities, pump motor size and operating hours (CY 1992) for the six operating wells are shown in Table 1.11. Water well pumps used approximately 1,524,500 kWh in 1992 based on these capacities and operating hours.

Table 1.11. Water Well Pumps

Well No.	Capacity, gpm	Pump Motor Size, hp	Annual Run Hours, 1992
1	1,200	100	8,760
4	960	60	3,491
5	870	100	3,307
7	800	100	2,148
8	725	75	1,859
15	1,300	100	117

There are two sanitary and two industrial waste treatment plants on base. The base treats all but a small part of their waste which is discharged to the city system. The sewage collection network at Robins AFB consists of 43 lift stations. There are an additional 10 industrial waste lift stations. Based on lift pump motor inventories and estimated operating hours provided by RAFB personnel, it is estimated that the sewage collection system used 2,655,000 kWh in 1991. The four waste treatment plants used an estimated 4,550,000 kWh. Table 1.12 summarizes the sewage and industrial waste lift pump characteristics.

Table 1.12. Sewer Lift Pump Inventory

Sewage Lift Pumps:					
Station No.	No.	Pump hp	Station No.	No.	Pump hp
1	2	40	21	2	3
2	1	5	22	2	8
2	1	10	23	3	10
2	1	20	24	2	16
3	2	2.6	25	2	3.4
4	2	3	26	2	2.6
5	2	24	27	2	3.4
6	2	24	28	2	3.4
7	2	12.1	29	3	31
8	2	3	30	2	3.4
9	2	2.6	31	2	3.5
10	2	2.6	32	2	3
11	2	2.6	33	2	2
12	2	10	34	2	5
13	2	4	35	2	10
14	2	3.4	36	2	3
15	2	2.6	37	2	3
16	2	3	38	3	200
17	2	10	39	2	3
18	2	3	40	2	2
19	2	24	41	2	2
20	2	12.1	42	2	2
			43	2	3
Industrial Waste:					
2	2	2.6	7	2	4
3	2	5.4	8	2	12.1
4	2	12.1	11	2	0.5
5	2	20	12	2	2
6	2	4	13	2	2

2.0 Energy Source Characteristics

This section describes the sources of energy at Robins AFB, how energy is delivered to the base, and what it costs for fiscal year 1991.

Table 2.1 summarizes typical yearly consumption for each form of energy. The total consumption values are based on the usage values chosen for analysis in this report as typical current yearly usage. In some cases the numbers are aggregations of yearly or billing consumption amounts and do not exactly match current or past consumption values or values used in Robins AFB energy reporting. The numbers presented are considered representative of normal base operational energy consumption.

2.1 Electric Supply Source Description

The main electrical service is provided to the substations by GPC on 115 kV lines. Billing records for a typical year (FY 1991) indicate on-post use of 269,085 MWh at a blended cost of 4.53 cents/kWh (calculated by dividing the total cost by the consumption) for a total annual cost of \$12,201,149. Electricity is billed under several different rate structures: D Street is covered under GPC rate structure designated Schedule G-10, with riders SE-7 (Supplemental Energy) and IS-Std-1 (Standard Interruptible Service). The 9th

Table 2.1. Typical Yearly Energy Consumption for FY 1991 (from DEIS report)

Energy Source	Yearly Total	Yearly Total (MBtu)	Percent of Total
Electricity	269,085 MWh	918,386	47.45
Natural Gas	961,873 kcf	982,072	50.74
Fuel Oil #2	249.3 kgallons	34,603	1.79
Propane	6,220 gallons	568	0.03
Totals		1,935,629	100.00
Energy Conversions: General: 1,000,000 Btu/MBtu Electricity: 3,413 Btu/kWh Natural Gas: 1.021 Btu/kcf #2 Fuel Oil: 0.1388 MBtu/gal. Propane: 0.0913 MBtu/gal.			

Street substation is covered by Schedule TOU-4 (time-of-use), and the PAVE PAWS substation is covered by schedule PLL-2, with riders SE-7 and IS-Std-1. FEMC also has two rate schedules, one for housing, and one for general service, FGH-9 and FGS-9, respectively. The current rate structures are as follows:

GPC Schedule G-10: Full Use Service to Governmental Institutions

Monthly Rate:
Base Charge: \$55.00

All consumption (kWh) not greater than 300 hours times the billing demand:

First	50,000 kWh @	\$0.0600/kWh
Next	150,000 kWh @	\$0.0582/kWh
Next	800,000 kWh @	\$0.0442/kWh
Over	1,000,000 kWh @	\$0.0410/kWh

All consumption in excess of 300 hours times the billing demand @ \$0.0115/kWh.

Fuel Cost Recovery: The amount calculated at the above rate is increased by a fuel cost recovery factor as specified by the effective Fuel Cost Recovery Schedule. For 1992, this charge was an additional \$0.01347/kWh

The billing demand is based on the highest 30 minute kW measurement during the current month and the preceding eleven months.

For the billing months of June through September, the billing demand is the greater of:

1. The current actual demand, or,
2. Ninety five percent of the highest actual demand occurring in any previous summer month (June through September), or,
3. Sixty percent (60%) of the highest demand occurring in any previous winter month (October through May).

For the billing months of October through May, the billing demand is the greater of:

1. Ninety five percent (95%) of the highest summer month (June through September), or,
2. Sixty percent (60%) of the highest winter month (October through May), including the current month.

GPC Schedule SE-7: Supplemental Energy Rider

Monthly Rate:
Administrative Charge: \$155.00
On Peak Energy Charge: \$0.0197/kWh
Off Peak Energy Charge: \$0.0127/kWh
Demand Charge (On-Peak, June to Sept.): \$0.80/kW

Schedule SE-7 is a rider which provides for lower demand charges in exchange for load shedding. The base is billed for demand at a set value (21,272 kW for the D St. substation), no matter how many kW are used; however, when required, the base must activate generators to cut their total demand to the set value. The Supplemental Energy (SE) billed is the product of the current month load factor (maximum actual demand in previous 12 month period times total hours/kWh used), the number of hours SE is used, and the additional demand used. The additional demand is the difference between the maximum kW measured during an on-peak period of SE use and the greater of:

- the maximum kW used on-peak during a curtailment period, or
- the established billing demand.

The inability to meet the SE contract results in \$30.00/kW per occurrence as liquidated damages for exceeding the demand threshold. According to Robins staff, this has happened once before, resulting in an upward adjustment of the demand

threshold (the billing demand), and accordingly higher monthly demand charges.

GPC Schedule IS Standard-1: Standard Interruptible Service Rider

This rider applies to the PAVE PAWS facility and the D Street substation (Rate G-10), in conjunction with the SE-7 rider. The interruptible load is defined as the difference between the supplemental energy (SE) threshold and the interruptible rate threshold. If an interruption is called during an SE off-peak period, the interruption threshold is defined as the off-peak SE threshold minus the amount of load defined above. Credit is given based on the number of hours use of demand (HUD), the number of interruptions allowed (per day or week), and the amount of load interrupted.

GPC Schedule TOU-4: Time of Use

Monthly Rate:

Base Charge: \$475.00

Demand Charges:

June through September:

Maximum actual demand between 12 noon and 8 p.m.

Monday - Friday:

First 2,000 kW \$15.48/kW

Next 3,000 kW \$13.18/kW

Over 5,000 kW \$11.30/kW

Economy actual demand between 8 p.m. and 12 Noon,

Monday - Friday, all day weekends and specified holidays:

All kW \$ 3.45/kW

October through May:

Maximum actual demand between 12 noon and 8 p.m.

Monday - Friday:

First 2,000 kW \$10.72/kW

Next 3,000 kW \$ 9.00/kW

Over 5,000 kW \$ 7.36/kW

Economy actual demand between 8 p.m. and 12 Noon,

Monday - Friday, all day weekends and specified holidays:

All kW \$ 3.45/kW

Energy Charges:

June through September:

All energy consumed between 7 a.m. and 1 p.m.

Monday - Friday

All kWh \$0.01455/kWh

All energy consumed between 1 p.m. and 10 p.m.

Monday - Friday

All kWh \$0.03275/kWh

All energy consumed between 10 p.m. and 7 a.m.

Monday - Friday

All kWh \$0.00502/kWh

All energy consumed between 7 a.m. and 10 p.m.

Saturday - Sunday

All kWh \$0.00665/kWh

All energy consumed between 10 p.m. and 7 a.m.

Saturday - Sunday

All kWh \$0.00502/kWh

October through May:

All energy consumed between 7 a.m. and 10 p.m.

Monday - Friday

All kWh \$0.01211/kWh

All energy consumed between 10 p.m. and 7 a.m.

Monday - Friday

All kWh \$0.00502/kWh

All energy consumed between 7 a.m. and 10 p.m.

Saturday - Sunday

All kWh \$0.00665/kWh

All energy consumed between 10 p.m. and 7 a.m.

Saturday - Sunday

All kWh \$0.00502/kWh

Fuel Cost Recovery: The amount calculated at the above rate is increased by a fuel cost recovery factor as specified by the the effective Fuel Cost Recovery Schedule. For 1992, this charge was an additional \$0.01347/kWh

GPC Schedule PLL-2: Large

Monthly Rate:

Base Charge: \$16.75

All consumption (kWh) not greater than 200 hours times the billing demand:

First 3,000 kWh \$0.11050/kWh

Next 7,000 kWh \$0.10050/kWh

Next 190,000 kWh \$0.08600/kWh

Over 200,000 kWh \$0.06670/kWh

All consumption in excess of 200 hours and not greater than 400 hours times the billing demand: \$0.01138/kWh

All consumption in excess of 400 hours and not greater than 600 hours times the billing demand: \$0.00900/kWh

All consumption in excess of 600 hours times the billing demand: \$0.00650/kWh

Fuel Cost Recovery: The amount calculated at the above rate is increased by a fuel cost recovery factor as specified by the the effective Fuel Cost Recovery Schedule. For 1992, this charge was an additional \$0.01347/kWh.

Billing demand for schedule PLL-2 is determined based on the highest 30-minute kW measurement during the current month and the preceding eleven months. For the billing months of June through September, the billing demand is the greatest of:

- The current actual demand, or
- Ninety-five percent of the highest actual demand occurring in any previous applicable summer month (June through September), or
- Sixty percent of the highest actual demand occurring in any previous applicable winter month (October through May).

For the billing months October through May, the billing demand is the greater of:

- Ninety-five percent of the highest summer month, or
- Sixty percent of the highest winter month.

In no case will the billing demand be less than the greater of:

- The contract minimum, or

- Fifty percent of the total contract capacity, or
- 500 kW.

FEMC Schedule FGH-9: Government-Owned Housing

Monthly Rate:

Customer Charge: \$125.00/month

Demand Charge: \$ 10.00/kW

Energy Charge: \$ 0.02973/kWh

Street Lighting: \$4.35 per 175 W Mercury Vapor Light
\$7.10 per 175 W Mercury Vapor Light, where separate pole is required.
\$7.20 per 400 W Mercury Vapor Light
\$9.90 per 400 W Mercury Vapor Light, where separate pole is required.

Facilities Charge: Annual charge for electric plant serving Robins AFB housing: \$10,440, billed at \$870/month.

Fuel Adjustment: The rate calculated above is adjusted by an amount per kWh equal to the difference between the average wholesale energy cost per kWh charged to FEMC by its wholesaler and 21.23 mills/kWh. In 1992, this adjustment was an average decrease of about \$0.00133/kWh.

The monthly billing demand is based on the customers sixty minute demand measured coincident with the Highest Georgia Territorial Demands Year-to-Date, beginning June 1 of each year.

For the billing months of September through the following August, the billing demand will be the average of the customer's demand coincident with the forty-four (44) highest Georgia Territorial Demands Year-to-Date.

FEMC Schedule FGS-9: General Service Rate

Monthly Rate:

Service Charge: \$12.50/month

All kW of Billing Demand: \$ 3.90/kW

First 200 kWh per kW of Billing Demand: \$0.05823/kWh

Over 200 kWh per kW of Billing Demand: \$ 0.04983/kWh

Fuel Adjustment: The rate calculated above is adjusted by an amount per kWh equal to the difference between the average wholesale energy cost per kWh charged to FEMC by its wholesaler and 21.23 mills/kWh. In 1992, this adjustment was an average decrease of about \$0.00133/kWh.

The monthly billing demand is based on the highest 15-minute demand measured during the current month and the previous eleven months and is the greater of:

- 100% of the current month, or
- 85% of the peak demand measured in the billing months June through September, inclusive.

In addition to the utility electric supply, RAFB has a number of diesel generators for back-up/emergency power for critical loads. According to the RPL and recurring work program (RWP) list, there are 57 diesel generators at the site with 50 kVA or greater capacity with total capacity of 22,580 kW. The generators of 250 kVA or greater capacity have an aggregate capacity of 19,395 kW. Generators are currently used to provide emergency power for critical buildings and for sewage lift stations and other critical utility functions. In addition, five of the larger generators (10.5 MW, according to Robins staff) are used for demand curtailment as discussed above in rate schedule SE-7. The generators (sorted by size) are listed in Table 2.2, along with their building type and description.

2.2 Natural Gas Supply Source Description

The site has three natural gas suppliers: The City of Warner Robins (CWR), Atlanta Gas Light (AGL), and Access Gas (Access). Of the three suppliers, only AGL has a fixed price structure, CWR and Access rates vary depending on the spot

Table 2.2. Diesel Generators of 50 kVA or Greater Capacity

Bldg. No.	Bldg. Type	Description	Size, kVA
177	SECURTY-1	FR STN	50
2	COMCATN	RAPCON CEN	60
263	SECURTY-1	SP OPERATIONS	60
286	STOR-UH-1	BE STOR CV FCLTY	60
286	STOR-UH-1	BE STOR CV FCLTY	60
286	STOR-UH-1	BE STOR CV FCLTY	60
286	STOR-UH-1	BE STOR CV FCLTY	60
286	STOR-UH-1	BE STOR CV FCLTY	60
50	HANGAR	ACFT COR CON	75
54	HANGAR-1	ACFT COR CON	100
107	SECURTY-3	TRAFFIC CHK HSE	100
107	SECURTY-3	TRAFFIC CHK HSE	100
265	ADMIN-3	DPI	100
272	ADMIN-1	BSE ENGR ADMIN	100
286	STOR-UH-1	BE STOR CV FCLTY	100
286	STOR-UH-1	BE STOR CV FCLTY	100
286	STOR-UH-1	BE STOR CV FCLTY	100
286	STOR-UH-1	BE STOR CV FCLTY	100
701	WHS-3	MATERIAL SERVICES	100
2	COMCATN	RAPCON CEN	125
78	ADMIN-1	HQ WG	125
700	HOSPITL-1	COMPOSITE MED	125
700	HOSPITL-1	COMPOSITE MED	125
39	PUMP-3	PMP STN, LF	150
70	PUMP-3	PMP STN, LF	150
72	PUMP-3	PMP STN, LF	150
110	HANGAR-2	HG, MAINT DEP	150
644	PLT-BLD	STEAM FCLTY BLDG	150
100	PRDCTN-4	SHIP MSL ASM8	160
210	ADMIN-1	HQ MAJOR COMD	175
214	COMCATN-1	COMM FCLTY	175
340	STOR-UH	HAZARD STOR, BSE	200
812	PUMP-3	SAN SEWAGE PMP STN	230
225	COMCATN-1	COMM FCLTY	250
350	WHS-1	WHSE SUP EQUIP DEP	275
177	PLT-BLD	STEAM FCLTY BLDG	300
187	PLT-BLD-5	ELEC PWR STN BLDG	300
371	PLT-BLD-4	WST TRMT BLDG	300
142	SHOP-AIR-1	SHIP ACFT GEN PURP	400
1	PLT-BLD-3	ELEC PWR STN BLDG	450
74	PLT-BLD-3	ELEC PWR STN BLDG	450
177	PLT-BLD	STEAM FCLTY BLDG	450
227	SHOP-ELC-1	INTEGR SPT FCLTY	500
36	OTHER-3	UTIL VAULT	520
127	TERMINL-1	TRML, AIR FRT	550
127	TERMINL-1	TRML, AIR FRT	550
231	SHOP-ELC-1	TECH LAB	600
228	ADMIN-1	DPI	750
228	ADMIN-1	DPI	750
181	SHOP-1	SHIP ACFT GEN PURP	800
181	SHOP-1	SHIP ACFT GEN PURP	800
181	SHOP-1	SHIP ACFT GEN PURP	800
226	SHOP-ELC-1	INTEGR SPT FCLTY	1,000
226	SHOP-ELC-1	INTEGR SPT FCLTY	1,000
300	ADMIN-2	LOG FCLTY DEP OPS	1,000
1400	COMCATN-4	RDR TMTR COMP BLDG	3,300
1400	COMCATN-4	RDR TMTR COMP BLDG	3,300

gas market. The rate structures for each of these suppliers are as follows:

Atlanta Gas Light Schedule I-24: Large Commercial General Service

Customer Charge:	\$250/month
Firm Service Charge:	\$1.30/therm/month
Commodity Charge:	
First 100,000 therms/month	\$0.073/therm
Next 200,000 therms/month	\$0.063/therm
Over 300,000 therms/month	\$0.052/therm
Base Take or Pay:	\$0.096/therm

Access Energy Corporation:

Fixed Charges:	
Transportation Rate:	\$0.262/MBtu
Cost Adjustment Factor:	\$0.0023/MBtu
Take or Pay Surcharge:	\$0.08187/MBtu
Gas Research Institute:	\$0.0142/MBtu

Gas sales rate varies monthly with the spot gas market, according to *Inside FERC Gas Market Report* (McGraw Hill Inc.).

City of Warner Robins:

Non-interruptible:	\$0.401964/therm
Interruptible:	varies with spot market.

The City of Warner Robins has 13 gas meters: six in the Chevron Village and Hillside housing areas, 3 in the Capehart housing areas, 2 at Linwood School, one at bldg. 644, and one each at the Radome facility, Nosedock facility and the depaint/corrosion building. The family housing areas, schools and Radome facility use gas for both heat and hot water. Building 644 is the main steam plant at the south end of the base. The Nosedock facilities use gas for heat, and the depaint/corrosion building uses gas for process loads.

Atlanta Gas Light has four meters that all feed into the main steam plant, bldg 177. Access gas is available to all four of the AGL meters and three of the city meters, at bldgs. 644, 54, and 62. There is a 500-therm daily firm contract with AGL, all other gas delivered through the AGL meters to the site is from Access and is interruptible.

Natural gas consumption in FY 1990 was 961,873 kcf (982,072 MBtu) at an average cost of \$3.04/kcf, for a total cost of \$2,923,101. Natural gas represents 50.5% of the non-transport energy use on the base.

For the purposes of the energy resource opportunities (see Volume 3 of this report), the following natural gas rates are assumed.

City of Warner Robins - Firm:	\$0.40200/therm
City of Warner Robins - Interruptible	\$0.28576/therm
Atlanta Gas Light - Firm	\$0.41896/therm
Atlanta Gas Light - Interruptible	\$0.27887/therm

These rates take all of the various parts of the CWR and AGL schedules into account, as well as the gas delivered from Access through the CWR and AGL lines.

2.3 Oil Supply Source Description

Fuel oil is primarily used at the central energy plants to produce steam for both heating and cooling. There are also a number of buildings not connected to the central system which use #2 oil for heat and hot water.

In FY 1991, 249,312 gallons of #2 fuel oil (34,580 MBtu) was used at Robins AFB at an average price of \$0.92/gallon (\$6.65/MBtu), for an annual cost of \$230,078. Fuel oil use represents 1.78% of the non-transport energy on the base. Fuel oil is purchased through the Air Force Supply System and is delivered to a single location on base. It is then distributed by base personnel as required.

2.4 Propane Supply Source Description

In FY 1991, 6,220 gallons of propane (590.9 MBtu) was used at Robins AFB at an average price of \$0.89/gallon (\$9.41/MBtu), for an

annual cost of \$5,558. Propane represents 0.03 % of non-transport energy used on base. Propane is supplied and delivered by Greene's Propane Gas Corp.

3.0 Electrical Consumption

Metered electrical use data form the primary basis for baseline energy-use intensity estimates. The data from existing meters, utility bills and the base's electrical system monitoring equipment are summarized and discussed in this section.

3.1 Metering and Data Summary

There are three sources of electric metering and consumption data at Robins AFB: utility company meter readings, the base System Control and Data Acquisition (SCADA) system, and meter readings from buildings housing reimbursable and tenant activities.

Most buildings owned or occupied by agencies that are required to pay their utilities (e.g., AAFES facilities such as the Commissary and BX, and tenants, such as the dependent schools) have meters that are read monthly.

Monthly GPC electric billing data for service provided at each GPC substation October 1990 through September 1991 (FY 1991) are shown below in Table 3.1. Also included are the monthly demand peaks and monthly excess reactive demand numbers. These data were used to reconcile the initial estimates of energy use by building type with the actual electric consumption. The "SE" portion of the D Street Bills represents the charges when the supplemental energy schedule was in effect.

Individual building meter readings are limited to buildings housing reimbursable and tenant activities and large blocks of family housing. Since there are many different activities at Robins AFB, this comprises a large number of buildings. The readings were used to refine energy use intensity estimates for building types that share feeders with one or more individually metered buildings. The FEMC utility bills offer some metered data since many of the buildings are separately billed. FEMC electrical utility accounts for FY 1991 are listed in Table 3.2. Kilowatt-months (kW-mo) are the sum of the demand readings for each month

per account. Due to the FEMC billing structure, kWh is not recorded for street/security lighting.

In many of the tenant buildings, electric meters are not installed. In these cases, the Robins AFB staff have made estimates of the annual electric energy consumption for billing purposes. While these data are not as accurate as meter readings, they were assumed to be the best estimate available for those buildings and was used in this analysis. The metered and estimated data were compiled into a single table with columns for estimates and actual meter readings for FY 1990 and FY 1991. Where both estimates and meter readings for the same building were available, an average was calculated for use in determining building level energy use intensities. The average was calculated based on studying the data and conversations with Robins AFB personnel concerning the accuracy of both the meter readings and estimates. It was decided that there were errors in both data sets and that an average would provide the best final estimate of the buildings electric consumption. These data are listed in Table 3.3. The most complete set of data is shown in all cases, which may result in data from different time periods, as detailed in the tables.

3.2 Electrical Demand Summary

Time-of-use data is needed to assess peak-shaving and demand-limiting measures as well as the demand consequences of other measures. The base SCADA system monitors the two main GPC substations (D Street and Ninth Street), and records demand every thirty minutes. These two substations represent the majority of the electric energy consumption on the base and the other loads are assumed to follow a similar profile.

3.2.1 Time-of-Use Characterization

The average winter and summer weekday time-of-use profiles are plotted for both D Street and

Table 3.1. Georgia Power Company Electric Meter Readings

D Street:

Day	Month	kWh ^(a)	SE kWh	SE kW	Actual On Peak Demand	Billing Demand	Reactive Demand, RKVA		Billing Amount
							Actual	Excess	
66	Oct	9,846,000	0	0	19,800	21,272	11,003	4,403	\$462,626
27	Nov	10,620,000	0	0	20,304	21,272	11,016	6,805	\$484,413
27	Dec	10,566,000	0	0	21,197	21,272	11,501	7,104	\$474,014
25	Jan '91	10,332,000	0	0	21,197	21,272	11,501	7,104	\$467,677
25	Feb	11,232,000	0	0	22,073	21,272	11,421	3,861	\$491,611
25	Mar	9,414,000	0	0	20,430	21,272	11,286	5,380	\$442,741
25	Apr	10,512,000	0	0	22,212	21,272	11,691	4,287	\$472,209
24	May	11,412,000	0	0	24,048	21,272	13,209	6,336	\$497,754
24	Jun	12,308,719	471,281	4,342	25,614	21,272	13,094	4,556	\$541,331
25	Jul	12,881,314	618,686	4,792	26,064	21,272	13,832	5,144	\$534,565
27	Aug	13,432,820	499,180	4,018	25,290	21,272	13,032	4,602	\$543,732
25	Sep '91	11,545,326	370,674	3,982	25,254	21,272	13,157	4,739	\$492,219
FY 1991		136,062,000							\$5,904,890

(a) kWh refers to all consumption except that during supplemental energy sales periods. The FY 1991 total is the sum of both kWh columns.

Ninth Street:

Day	Month	kWh	On Peak KW	Off Peak Kw	Economy kW	Act. RKVA	Excess RKVA	Billing Amount
26	Oct	10,273,341	20,578	19,930	0	10,093	3,234	\$420,692
27	Nov	7,036,647	16,243	16,157	0	8,089	2,675	\$305,785
27	Dec	6,885,410	13,651	13,334	0	7,981	3,431	\$278,185
25	Jan '91	7,222,054	12,773	12,888	115	7,366	3,070	\$279,243
25	Feb	6,819,667	13,536	13,507	0	7,707	3,195	\$275,348
25	Mar	6,459,052	13,608	14,436	828	8,189	3,377	\$271,186
25	Apr	8,192,250	15,588	14,724	0	8,958	3,762	\$324,844
24	May	7,922,880	17,892	16,992	0	9,769	3,805	\$335,604
24	Jun	9,478,512	18,684	18,216	0	10,351	4,123	\$510,350
25	Jul	10,103,148	21,528	20,484	0	11,494	4,318	\$544,807
27	Aug	11,888,173	21,240	20,484	0	11,390	4,310	\$589,029
25	Sep '91	10,113,462	20,664	19,584	0	11,369	4,481	\$534,393
FY 1991		102,394,596						\$4,669,465

PAVE PAWS:

Day	Month	kWh	Actual kW	Billing kW	Billing Amount
26	Oct	1,318,400	1,997	1,872	\$58,918
27	Nov	1,353,600	1,939	1,872	\$59,718
27	Dec	1,264,000	2,013	1,872	\$56,455
25	Jan '91	1,110,400	1,978	1,872	\$52,830
25	Feb	1,296,000	1,936	1,872	\$57,270
25	Mar	1,129,600	1,926	1,872	\$53,345
25	Apr	1,360,000	1,981	1,872	\$58,770
24	May	1,174,400	2,074	1,872	\$54,457
24	Jun	1,244,800	2,262	1,872	\$57,108
25	Jul	1,225,600	2,147	1,872	\$53,913
27	Aug	1,238,400	2,195	1,872	\$54,054
25	Sep '91	1,222,400	2,000	1,872	\$52,869
FY 1991		14,937,600			\$669,708

Table 3.2. FEMC Electric Utility Accounts, FY 1991

Building/Area	kWh	Actual kW-mo	Billing kW-mo	Cost, \$
UHF-VHF Transmitter	25,020	76	99	1901
BAK-9 Arresting Barrier	8,439	24	26	706
Gate 12 Guard House	6,006	N/A	N/A	521
Fund Housing	5,119,673	14,112	18,565	316,602
Wherry Housing	8,499,651	20,631	25,965	486,319
Wherry Housing Street Lights	N/A	N/A	N/A	5,234
Linwood School	622,560	2,091	2,437	43,592
Linwood School Classroom Bldg.	16,324	N/A	N/A	1,212
Linwood School Office Bldg.	25,600	N/A	N/A	1,882
Shopette	286,200	632	649	17,400
Water Well #6	112,640	620	911	9,907
Linwood Dr. Street Lights	N/A	N/A	N/A	150
Hillside Swimming Pool	104,111	357	361	7,166
Hillside Park Tennis Court Lights	900	N/A	N/A	106
Maintenance Shop	49,202	299	300	4,001
Water Booster Pumps, B/1689	119,880	518	562	8,937
Museum of Aviation	303,240	835	851	19,404
Museum of Aviation - Hangar 1	229,800	715	715	15,782
Museum of Aviation - Display Shop	31,946	155	159	2,508
Museum of Aviation - Hangar	54,720	366	379	4,710
Museum of Aviation - Office Bldg.	20,431	173	176	1,986
Museum of Aviation - Security Lights	N/A	N/A	N/A	851
Museum of Aviation - B/1505 Warehouse	378	N/A	N/A	93
Base Employment Office	53,002	262	262	4,106
Flint General Total:	2,070,399	7,122	7,887	152,155
Flint Housing Total:	13,619,324	34,743	44,530	802,921
Flint Total:	15,689,723	41,865	52,417	955,075
N/A: Consumption/demand data is either not available or not recorded for these accounts.				

Ninth Street substations in Figures 3.1 and 3.2. The corresponding weekend profiles are plotted in Figures 3.3 and 3.4. These data are based on an average of Georgia Power Company 30 minute kW readings for 1992.

The weekday profiles have the classic "hat-shape" that is characteristic of commercial buildings; consumption increasing from about 0600 to 0800, a slight dip around noon, and then a steady decrease from about 1500 to 1700. What is not seen here, but is often the case at other military facilities, is an evening increase from about 1800

to 2200 corresponding to barracks and family housing electricity use. One possible explanation is that a large part of the family housing is not served by either the D Street or Ninth Street substations. The weekend profiles show that there is little commercial activity on the base during "non-business" hours, as the load profiles for both substations are fairly flat.

Also seen on the figures is a large continuous load: 20 MW winter, 25 MW summer (both substations combined). This is made up mostly of

Table 3.3. Electric Meter Readings and Estimates

Bldg. No.	Estimated FY90 kWh	Actual FY90 kWh	Estimated FY91 kWh	Actual FY91 kWh	Average kWh
2		2,006		7,956	4,981
8		2,485,800			2,485,800
10 & 11				5,409	5,409
12				2,654	2,654
18		7,754		1,431	4,593
24			23,076		23,076
27	106,992		106,992		106,992
28		8,760		11,880	10,320
29		1,960		5,200	3,580
31		9,885		15,104	12,495
33	23,698	35,680	23,698		27,692
35		980		1,070	1,025
36		2,120		5,280	3,700
40	48,390		48,390		48,390
44	3,173,112		2,674,740		2,923,926
45	154,459		154,459		154,459
47	305,485		318,000		311,743
48	1,230,829	870,900	1,140,368		1,080,699
49	933,984	181,520	933,984		683,163
50				230,787	230,787
51				2,879	2,879
52				3,492	3,492
54	2,503,588	2,110,824		1,665,432	2,093,281
55	624,204	93,000	531,330	103,020	337,889
56				6,336	6,336
63				340	340
72				566	566
73				9,205	9,205
75				66	66
78				7,477	7,477
79				906	906
83				5,794	5,794
89	3,590,572		3,457,409		3,523,991
91			170,880	70,560	120,720
93	16,532		16,532		16,532
104	18,336		18,336		18,336
110	2,398,412	1,531,530	1,758,560		1,896,167
120	16,978		17,455	35,683	23,372
125	9,912,660		7,010,291	4,484,610	7,135,854
127				84,960	84,960
128	206,309		175,891		191,100
130	4,282,318	3,433,060	3,434,180	3,434,180	3,645,935
131	292,640	161,400	273,600	273,600	250,310
132	4,480				4,480
137	362,536		362,536		362,536

Table 3.3. (contd)

Bldg. No.	Estimated FY90 kWh	Actual FY90 kWh	Estimated FY91 kWh	Actual FY91 kWh	Average kWh
140	8,285,832	8,246,256	6,993,120	10,493,520	8,504,682
142	6,154,256	6,153,600	7,775,360	9,176,000	7,314,804
144	99,600		99,600		99,600
148	528,055	530,640	538,456	521,280	529,608
149	283,990		283,990		283,990
150	261,613	122,958	247,616	223,200	213,847
154	48		48		48
155		263,000	361,559	110,000	244,853
158		2,373,440	2,862,894	2,796,431	2,677,588
162			1,070,240		1,070,240
163	20,951		20,951		20,951
165	1,133,922	1,021,200	1,397,400	1,029,000	1,145,381
166		1,332,800	1,343,465	1,348,640	1,341,635
169	3,072,000		1,653,600	2,836,800	2,520,800
171	6,000		6,000		6,000
173	953,378		953,378		953,378
177		10,594,960	8,913,360		9,754,160
180	4,094,000	4,488,000	1,664,000	1,664,000	2,977,500
181	872,400	821,000	952,000		881,800
182	7,359		7,359		7,359
183		289,920	451,700	314,400	352,007
184	31,100		16,023	10,380	19,168
185	101,500	104,520	88,980	88,980	95,995
189	18,064		18,064		18,064
190				185	185
196		505		1,352	929
203	2,964		41,484		22,224
204	2,280		2,280		2,280
207			473,640		473,640
210			26,400		26,400
215		27,078	21,864	25,259	24,734
220	593,907	1,184,322	524,821	1,093,576	849,157
226		9,764,400		16,671,680	13,218,040
227		1,192,704		7,948,032	4,570,368
228		8,856,600		9,124,400	8,990,500
231		3,739,935	1,683,170	3,903,452	3,108,852
300		303,363	283,559		293,461
301			20,400		20,400
309		628,000		660,900	644,450
310	96,000	1,602,816		1,574,400	1,091,072
311			6,911		6,911
319		298,560		66,240	182,400
327		74,343		75,866	75,105
333		1,760			1,760
348		16,400			16,400

Table 3.3. (contd)

Bldg. No.	Estimated FY90 kWh	Actual FY90 kWh	Estimated FY91 kWh	Actual FY91 kWh	Average kWh
350		1,173,120		2,386,560	1,779,840
361			45,600		45,600
362			6,000		6,000
364		826,800		661,680	744,240
365		499,200		492,960	496,080
366		283,600		414,300	348,950
367		386,640		721,440	554,040
371		841,053			841,053
376		3,962,880		6,079,616	5,021,248
377		2,980		3,002	2,991
425			9,600		9,600
429			7,200		7,200
430			67,200		67,200
431	7,200		7,200		7,200
432			8,400		8,400
448			140,400		140,400
541			34,872		34,872
542	1,479,396	1,861,100	1,187,872	1,255,600	1,445,992
545		92,460	68,280	68,280	76,340
595		234,560		261,040	247,800
596			22,760		22,760
603		195,220	306,680	226,680	242,860
605		74,201	29,346	29,346	44,298
622			1,885		1,885
628		5,246,040		2,200,080	3,723,060
630		50,746			50,746
632		128,832		168,768	148,800
634			84		84
635			263,288		263,288
640		11,293,940	23,065,181	30,404,342	21,587,821
641		131,400		154,600	143,000
642		398,880			398,880
644		600,360		1,086,120	843,240
645		11,845,148	15,896,361	19,313,690	15,685,066
647			4,859		4,859
650	5,509		5,509		5,509
652			5,189		5,189
660	2,153,664	2,260,080	1,902,339		2,105,361
664				14,680	14,680
670		1,532,000	2,039,554	1,348,000	1,639,851
675		22,560		24,640	23,600
680		67,762	55,398	22,595	48,585
700		1,165,920	1,176,400	1,148,160	1,163,493
701	89,440	135,840	156,400	140,400	130,520
755		19,520			19,520

Table 3.3. (contd)

Bldg. No.	Estimated FY90 kWh	Actual FY90 kWh	Estimated FY91 kWh	Actual FY91 kWh	Average kWh
756		344,000			344,000
758		1,813,120		201,920	1,007,520
759		359,680		341,760	350,720
767			435,565		435,565
782	49,200		49,200		49,200
795		426,560		562,560	494,560
812		8,640			8,640
827		421,740	455,340		438,540
901		100,720	99,265		99,993
904			22,343		22,343
905			188,640	1,426,240	807,440
908	429,520	467,040	415,280	415,280	431,780
910			6,000		6,000
913	49,788		49,788		49,788
914	2,753,601	1,461,120	1,499,840		1,904,854
917			5,392		5,392
922	80,800	80,800	93,080	93,080	86,940
946		187,920	339,696	291,168	272,928
949		9,797,119		2,951,409	6,374,264
951		37,360		55,200	46,280
956	1,337,120	1,359,720	1,116,168		1,271,003
963		591,360		617,600	604,480
978	91,964	114,048	82,336		96,116
980	96,060		100,560		98,310
984		119,520		234,240	176,880
985	117,480	112,080	115,640	105,040	112,560
986		20,640	31,500	56,640	36,260
1021			195,736		195,736
1117			28,656		28,656
1172		916		871	894
1174		28,000	20,400	22,240	23,547
1330			67,600	65,040	66,320
1400		1,745			1,745
1401				12,515	12,515
1403				19,039	19,039
1404				16,100	16,100
1602			322,680		
1603			9,240		180,200,376
2100			360	160	260

Figure 3.1. Average Winter Weekday Electric Load Profiles

Figure 3.2. Average Summer Weekday Electric Load Profiles

Figure 3.3. Average Winter Weekend Electric Load Profiles

Figure 3.4. Average Summer Weekend Electric Load Profiles

specific night-time loads like street, airfield and security lighting, continuous loads like space conditioning equipment, process equipment, and large computer systems, and the remainder is interior lights and other miscellaneous equipment left on continuously.

3.2.2 Consumption, Peak Demand and Reactive Demand Growth

Figure 3.5 shows the variation in electrical consumption from October 1989, through September 1992 (FY 1990-92) for the three GPC substations and the two Flint schedules. Flint housing covers the Hillside and Chevron village housing areas, while Flint general is all other FEMC supplied buildings. Billing data are plotted

by billing month. A billing month ends on the meter reading day of the month indicated on the horizontal axis of Figure 3.5. Meter reading days fall between the 21st and 27th of the month and are always a weekday.

A statistical study of the data in Figure 3.5 shows that all of the loads are increasing, except for PAVE PAWS. D Street and Ninth Street are increasing the most rapidly (approximately 800 MWh/yr and 600 MWh/yr, respectively), followed by Flint housing and Flint general. Seasonal variation due to summer cooling loads are seen in Ninth Street and Flint housing, and to a lesser degree in D Street. PAVE PAWS and Flint generally remain fairly constant year-round.

Figure 3.5. GA Power and Flint EMC Electric Billing Data

4.0 Natural Gas Consumption

4.1 Metering and Data Summary

Natural gas metering is carried out in the same manner as electrical metering; for reimbursable accounts, family housing, and boiler plant operating logs. The only recorded natural gas meter readings were for groups of buildings as reported through the Defense Energy Information System (DEIS) Reports, and the thermal energy plant operating logs.

4.2 Energy Use Breakdown

Natural gas is consumed at Robins AFB for central plant steam, heat and domestic hot water in

1,416 family housing units, by commercial kitchens and dining facilities, and other buildings not connected to the district thermal loops. FY 1990 is the most recent year for which a complete set of data is available. Table 4.1 lists the natural gas consumption reported via the DEIS reports and Table 4.2 lists the two central plants (Bldg. 177 & Bldg. 644) with recorded natural gas consumption (both tables are in DEIS report units of thousands of cubic feet of gas). The consumption for Capehart housing includes about 1,862 kcf/month (1,900 MBtu/month) of non-housing load fed through this meter.

Table 4.1. DEIS Report Natural Gas Consumption, FY 1990

Month	Fund Housing (kcf)	Hel. Wel. & Ed. (kcf)	Capehart Housing (kcf)	Radome (kcf)	Wherry Housing (kcf)	Steam Plt. T-30 (kcf)	Bldg. 54 (kcf)	AGL (kcf)
Oct	1,580.1	118.0	3,799.6	23.4	1,048.6	13,650.0	0.0	35,997.4
Nov	2,481.0	459.1	5,780.4	606.5	2,375.1	17,169.0	0.0	56,523.3
Dec	5,478.9	2,102.6	13,203.1	1,968.0	6,697.7	20,795.0	0.0	86,625.4
Jan	3,685.6	1,119.8	8,834.8	1,421.5	3,992.1	23,519.0	0.0	95,823.4
Feb	2,656.6	879.3	6,216.3	1,154.3	2,574.8	19,215.0	10.0	75,495.9
Mar	2,331.4	357.2	5,248.7	768.0	1,791.5	18,450.0	1.0	50,504.7
Apr	1,641.0	77.7	3,729.1	41.8	1,066.2	17,074.0	1.0	34,786.2
May	1,019.2	57.0	2,729.9	4.8	173.6	17,533.0	0.0	30,027.6
Jun	923.7	16.0	2,668.0	5.0	94.9	15,923.0	1.0	30,805.3
Jul	842.5	3.2	2,484.4	2.1	85.5	15,891.0	8.0	3,731.0
Aug	865.7	27.3	2,542.6	1.6	69.6	15,412.0	604.0	31,141.3
Sep	880.8	35.8	2,659.3	0.9	84.9	16,215.0	0.0	31,925.7
Total	24,387	5,253	59,896	6,001	20,055	210,846	625	563,387
MBtu	24,899	5,363	61,154	6,127	20,476	215,274	638	574,655
Base Total	908,585	MBtu ^(a)						
Percent of Total	2.74%	0.59%	6.73%	0.67%	2.25%	23.7%	0.01%	63.2%

(a) This total is for FY90, and is therefore different from the total shown in Table 2.1.

Table 4.2. Natural Gas Consumption at the Central Thermal Plants, FY 1991

Date	Bldg. 177 (kcf)	Bldg. 644 (kcf)
Oct.	635,179	16,045
Nov.	67,894	17,372
Dec.	101,265	20,913
Jan.	114,490	23,814
Feb.	93,022	18,155
Mar.	74,637	20,125
Apr.	35,517	15,681
May.	32,652	13,183
Jun.	33,481	12,866
Jul.	31,369	12,165
Aug.	25,826	13,300
Sep.	21,533	11,723
FY91 Totals	666,865	195,342

5.0 Oil Consumption

5.1 Metering and Data Summary

Heating oil consumption information is available from two sources: the energy plant boiler operating logs and delivery records to other buildings. The only buildings where deliveries take place and the building number is regularly recorded are the central plant buildings.

5.2 Energy Use Breakdown

Fuel oil, like natural gas, is used for heating and domestic water heating in many of the

buildings not connected to the central thermal systems. This includes many of the buildings in the SAC area and aircraft maintenance shops at the north end of the base. However, as stated above, the available delivery records are not accurate enough to separate the consumption among these buildings. Delivery records to the central thermal plants are shown in Table 5.1, along with a total for deliveries to other buildings. Central energy plant consumption from the boiler plant operating logs (Bldgs. 177 & 644) is shown in Table 5.2.

Table 5.1. Fuel Oil Delivery Records, Jan. - Dec. 1990

Date	B/177 (gal.)	B/644 (gal.)	B/52 (gal.)	B/83 (gal.)	Misc. Bldgs (gal.)
Jan.	0	0	0	0	0
Feb.	0	0	0	12,000	0
Mar.	0	0	6,255	6,190	0
Apr.	0	0	0	0	0
May	0	0	0	0	0
June	0	0	0	0	0
July	187,586	0	0	0	0
Aug.	23,842	0	0	0	0
Sep.	0	0	0	0	803
Oct.	1,654	0	0	0	3,101
Nov.	0	1,830	873	3,813	0
Dec.	20,193	8,620	1,310	9,076	0
CY90 gal.	233,275	10,450	8,438	31,079	3,904
CY90 MBtu	32,379	1,450	1,171	4,314	542

Table 5.2. Fuel Oil Consumption from the Boiler
Operating Logs, FY 1991

Month	Bldg 177 (gal)	Bldg. 644 (gal)
Oct.	1,654	0
Nov.	0	1,830
Dec.	20,193	8,620
Jan.	850	0
Feb.	30,662	13,031
Mar.	0	0
Apr.	0	0
May.	0	0
Jun.	0	0
Jul.	0	0
Aug.	0	0
Sep.	990	390
FY91 gal.	54,349	23,871
FY91 MBtu	7,544	3,313

6.0 Propane Consumption

6.1 Metering and Data Summary

Propane data is available as monthly delivery records to individual buildings. These data are not accurate as far as amount delivered to each

building. Initial investigations show propane consumption being a small part of the total energy use on the base and no further attempt was made to quantify its consumption.

7.0 Thermal Capacity Consumption

All thermal capacity is produced on base from other fuels already covered in the above sections. From the boiler plant operating logs, total fuel input and steam output (in MBtu on a monthly

basis) is useful in estimating the plant efficiency. This data is shown in Table 7.1 for Bldgs. 177 and 644.

Table 7.1. Fuel Input and Steam Output from the Boiler Plant Logs, FY 1991

	Bldg. 177		Bldg. 644	
Date	MBtu Input	MBtu Output	MBtu Input	MBtu Output
Oct.	36,219	27,733	16,414	10,113
Nov.	69,456	54,482	18,028	13,236
Dec.	106,421	86,896	22,601	18,155
Jan.	117,242	95,992	24,362	19,624
Feb.	99,454	79,374	20,397	16,475
Mar.	76,353	59,822	20,587	16,472
Apr.	36,333	29,040	16,042	12,704
May	33,403	27,050	13,486	10,657
Jun.	34,251	28,279	13,162	10,257
Jul.	32,090	24,212	12,445	9,676
Aug.	13,268	10,498	5,121	3,987
Sep.	22,167	16,360	12,047	9,365
FY91 Totals	676,657	539,738	288,499	155,459

8.0 Energy-Use Intensities

This section presents estimates of site-specific energy-use intensity (EUI) by building type and end use and describes their development. Section 8.1 is a survey of regional end-use studies that reports EUIs by building type. These data serve as a starting point for the site-specific analysis in Section 8.2. Section 8.3 presents the results of the site-specific disaggregation of whole-building EUI estimates into estimates of EUI by end use.

A primary product of the energy consumption analysis for Robins AFB is a set of site-specific EUI values for the building types and end uses at the base. The EUIs have been determined from aggregate, rather than directly measured, energy deliveries. Some error is inevitable in the disaggregation process. However, these EUI estimates are consistent with all available energy use records and are consistent with regional estimates of energy use by building type. The estimates are therefore considered to be sufficiently accurate for identification and ranking of energy projects. More detailed connected load inventories of targeted end-use equipment should be obtained in many cases prior to implementation of the conservation and efficiency measures recommended in Volume 3 of this report.

The initial step in estimating site-specific EUIs was to assess all available regional and published EUI data that might be applicable to Robins AFB. After reviewing all sources and matching existing data building types with Robins AFB building types, a set of initial EUI values was created. This set of values provides a range of reasonable EUI values within which the site-specific values are expected to fall.

8.1 Initial Energy-Use Intensity Values

Energy-use intensities are defined as energy use per unit area per unit time. EUIs are commonly expressed as thousands of British thermal units per

square foot per year (kBtu/ft²-yr), or kilowatt-hours per square foot per year (kWh/ft²-yr).

Tables 8.1 through 8.3 summarize the results of several regional end-use EUI surveys. EUIs are estimated by building type, fuel type, and fuel end use. Energy use is expressed in kWh/ft²-year for electric EUIs and kBtu/ft²-year for fossil fuel EUIs. End-use data are for the following end-use categories: space heating, cooling, ventilation, domestic hot water (DHW), cooking, lighting (includes interior and exterior), refrigeration, and other. The "other" category was found to cover miscellaneous end uses made up of a variety of electrical appliances and motors as well as water/steam heating for laundry or food preparation. Significant differences in how the surveys defined the "other" category are noted in the tables.

Tables 8.1 through 8.3 present the survey and analysis results reported by the Environmental Protection Agency/Southeastern Electric Reliability Council (EPA/SERC), Georgia Power Company, Gulf Power Company, and the DOE-EIA RECS (Residential Energy Consumption Survey) and CBECS (Commercial Building Energy Consumption Survey). The electric end-use results appear in Table 8.1, the natural gas end-use results in Table 8.2, and the fuel oil end-use results appear in Table 8.3.

While some of the EUI values correlate very well among the surveys for a given building type, fuel type, and end use, other values do not. The largest discrepancy is between the CBECS survey and the other two surveys. In most cases, the CBECS values are lower than the values from the other two surveys, in some cases by a factor of 1/2 to 1/3. There are a number of contributors to these discrepancies.

One factor in the discrepancies is that the CBECS data are not specific to one particular

Table 8.1. Regional EUI Survey Results (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Light	Ref.	Other	Total
Single-Family Residence									
EPA/SERC ^(c)	5.2	2.15	-	2.55	0.6	-	-	2.6 ^(a)	13.11
GA Power	3.7	1.6	-	2.2	0.54	-	-	3 ^(a)	11.04
RECS ^(b)	-	-	-	-	-	-	-	-	10.92
Lodging									
EPA/SERC ^(c)	3.0	4.9	1.4	5.8	6.2	5.3	1.1	2.4	30.1
Gulf Power ^(c)	3.35	5.82	1.15	0.75	0.68	5.17	0.75	4.45	22.12
GA Power ^(d)	2.22	4.02	0.95	0.5	0.34	3.49	1.34	2.72	15.58
CBECS	-	-	-	-	-	-	-	-	15.91
Office									
EPA/SERC	2.2	5.5	2.5	0.8	0.6	6.7	0.3	3.6	22.2
Gulf Power	0.66	3.51	0.7	0.38	0.81	2.98	0.11	1.51	10.66
GA Power	1.64	4.3	3.0	0.7	0.23	8.12	0.24	3.3	21.53
CBECS	-	-	-	-	-	-	-	-	20.07
Grocery									
EPA/SERC	3.7	4.7	3.8	0.8	2.1	15.3	28.7	2.3	61.4
Gulf Power	0.75	10.8	2.49	0.49	0.14	10.73	16.35	2.99	44.74
GA Power	0.32	8.23	2.23	0.69	0.77	13.23	24	2.71	52.18
CBECS	-	-	-	-	-	-	-	-	45.62
Restaurant									
EPA/SERC	2.3	4.3	1.9	3.9	7.2	5.2	5.5	2.1	32.4
Gulf Power	0.83	13.97	3.98	3.55	0.75	5.83	9.63	3.91	42.45
GA Power	0.99	22.52	3.33	2.27	10.82	10.6	17.96	4.6	73.09
CBECS	-	-	-	-	-	-	-	-	28.24
Health									
EPA/SERC	2.7	6.5	2.4	2.5	0.4	5.9	0.6	2.4	23.4
Gulf Power	1.2	8.79	1.97	0.5	1.06	6.28	0.95	4.4	25.15
GA Power	0.97	6.01	2.58	0.42	0.96	7.49	1.54	4.23	24.2
CBECS	-	-	-	-	-	-	-	-	18.99
Retail									
EPA/SERC	2.3	3.1	1.4	0.6	0.9	6.1	0.7	1.4	16.5
Gulf Power	.96	3.95	0.99	0.46	0.01	4.26	1.41	3.51	15.55
GA Power	1.62	4.75	1.8	0.89	0.19	6.75	0.56	2.79	19.35
CBECS	-	-	-	-	-	-	-	-	14.36
Warehouse									
EPA/SERC	1.9	1.8	1.3	0.6	-	3.8	8.6	1.2	19.2
Gulf Power	-	-	-	-	-	-	-	-	-
GA Power	0.03	1.23	0.73	0.23	0.05	1.95	0.46	0.9	5.58
CBECS	-	-	-	-	-	-	-	-	11.69
School									
EPA/SERC	4.2	1.3	0.6	1.1	2.1	4.2	0.4	0.6	14.5
Gulf Power	0.26	2.99	0.69	0.39	0.26	2.63	0.45	0.71	8.38
GA Power	0.49	1.79	0.76	0.26	0.27	2.79	0.7	1.44	8.5
CBECS	-	-	-	-	-	-	-	-	7.62
College									
EPA/SERC	2.7	1.4	1.1	1.2	2.4	3.3	0.4	1	13.5
Gulf Power	0.1	4.94	1.18	0.53	0.12	5.24	0.73	3.26	16.1
GA Power	0.43	3.7	2.61	0.4	0.54	7.32	0.66	3.93	19.59

Table 8.1. (contd)

	Heat	Cool	Vent	DHW	Cook	Light	Ref.	Other	Total
CBECS	-	-	-	-	-	-	-	-	-
Misc. Bldgs.									
EPA/SERC	4.5	2.7	1.3	0.4	0.7	3.1	0.9	1.3	14.9
Gulf Power	2	12.0	6.92	0.63	0.15	12.2	1.15	11.6	46.66
GA Power	0.23	3.3	1.18	0.28	0.25	3.62	1.07	2.39	12.32
CBECS	-	-	-	-	-	-	-	-	18.4
Assembly									
Gulf Power	0.51	2.27	0.23	0.61	-	2.18	0.02	0.45	6.27
CBECS	-	-	-	-	-	-	-	-	6.47
(a) Defined as miscellaneous EUI, includes lighting, refrigeration, and residual appliances.									
(b) RECS data is for the South Atlantic region. EUI calculated assumes 1500 ft ² per single family residence.									
(c) EPA/SERC and Gulf Power data for lodging category.									
(d) GA Power Data for hotel/motel category.									

utility service territory, rather the data are for four states that make up the South Atlantic region of the United States.

A second factor contributing to lower CBECS values is the CBECS EUI reporting convention. CBECS reports EUIs by building type and fuel but does not report the proportions of the different fuels used for each end use. The resulting EUIs represent an average of some, but not all, end uses for a given building and fuel type. The CBECS EUIs are therefore expected to be lower than the EUIs which represent all end uses, as is the case for the EUIs reported by EPA and GPC.

Other factors that can contribute to the discrepancies are building age, construction type, occupant density and schedules, and implemented energy conservation measures. All these factors can lead to significant variation in average EUI for a given building type category.

8.2 Energy Use by Building Type

A large number of the buildings at Robins AFB have electric meters that are read consistently, or have assumed accurate estimates of their electric consumption. To determine the conservation potential of measures relating to specific end-use

equipment we begin by estimating energy use by building type. This is straightforward in cases where actual building metering data or building type area metering exist. In other cases EUI values are derived by an energy balance method. This procedure accounts for all energy use at the base while apportioning it as accurately as possible to the various buildings and other uses.

Estimates of annual energy consumption by building type (based on the EUIs) are presented in Table 8.4. The consumption numbers that are not tied to a specific building type (streetlights, etc.) are shown with totals only. The last line item (in the electric column) is the total of loss in the electrical distribution system. Distribution losses are associated with individual buildings roughly in proportion to their energy use. The three restaurant building types use natural gas for cooking only.

8.3 Energy-Use Intensities by End Use

The energy consumption is allocated within each building type to several primary end uses. This allocation is based on three types of information: 1) the regional EUI estimates, 2) similar reports by PNL for other DoD sites, and 3) site-specific data on equipment characteristics,

Table 8.2. Regional Natural Gas EUI Survey Results (kBtu/ft²-yr)

	Heating	DHW	Cooking	Cooling	Other	Total
Single Family Residence						
EPA/SERC	22.6	13.5	5.5	-	-	41.6
RECS	-	-	-	-	-	70.3
Lodging						
EPA/SERC	108.1	24.8	15.2	9.6	3.8	161.5
Gulf Power	5.09	14.52	3.87	0.68	10.27	34.43
GA Power	16.55	16.46	8.36	4.88	14.81	61.06
CBECS	-	-	-	-	-	45.7
Office						
EPA/SERC	46.5	14.6	0.9	277.8	0.6	340.4
Gulf Power	14.92	1.02	-	-	0.38	16.32
GA Power	26.86	5.84	0.31	1.44	3.3	37.75
CBECS	-	-	-	-	-	36.5
Grocery						
EPA/SERC	214.1	57.8	107	147.2	-	526.1
Gulf Power	22.29	0.52	0.31	-	0.55	23.67
GA Power	10.65	2.97	3.27	-	-	16.89
CBECS						
Restaurant						
EPA/SERC	61	35.9	43.4	41.1	-	181.4
Gulf Power	23.44	47.65	0.85	-	0.39	72.33
GA Power	37.94	80.97	90.88	5.1	2.03	216.92
CBECS	-	-	-	-	-	73.4
Health						
EPA/SERC	198.6	40.7	4.2	65.7	8.1	317.3
Gulf Power	30.92	16.43	5.54	0.99	9.68	63.56
GA Power	38.8	17.61	10.99	7.65	9.97	85.02
CBECS	-	-	-	-	-	102.9
Retail						
EPA/SERC	43.8	18.6	2.2	67.2	-	131.8
Gulf Power	0.41	0.13	-	-	1.15	1.69
GA Power	20.32	4.13	0.24	0.99	2.02	27.7
CBECS	-	-	-	-	-	41.9
Warehouse						
EPA/SERC	31.3	8.6	-	11.7	1.3	52.9

Table 8.2. (contd)

	Heating	DHW	Cooking	Cooling	Other	Total
Gulf Power	-	-	-	-	-	-
GA Power	9.66	3.63	0.34	4.39	-	18.02
CBECS	-	-	-	-	-	-
School						
EPA/SERC	37.3	18.1	4.5	8.4	1.8	70.1
Gulf Power	14.32	3.52	0.09	-	0.24	18.17
GA Power	25.98	10.35	5.78	0.19	2.89	45.19
CBECS	-	-	-	-	-	35.2
College						
EPA/SERC	35.4	14.1	5.1	12.7	2.9	70.2
Gulf Power	33.85	3.43	0.4	-	9.65	47.33
GA Power	22.71	30.08	19.6	0.43	4.2	77.02
CBECS	-	-	-	-	-	-
Misc. Bldgs.						
EPA/SERC	39.6	7.6	2.9	29.7	3.1	82.9
Gulf Power	0.48	0.7	-	-	3.56	4.42
GA Power	9.87	14.2	7.36	0.91	7.63	39.97
CBECS	-	-	-	-	-	-
Assembly						
Gulf Power	11.84	1.4	0.01	-	0.72	13.97
CBECS	-	-	-	-	-	23.9

including hours of operation. The available equipment characteristics data for Robins AFB included lamp replacement data and fan, pump and chiller inventory abstracted from the Real Property List and Recurring Work Program List.

Tables 8.5 through 8.7 present the results of the end-use EUI analysis. Energy-use intensity estimates are given for all of the major end uses and building types that exist at Robins AFB.

Appearance of zero (0) in the table for a minor end use indicates that the building type in question has too small a component of that end use to be apportioned separately. In such cases the end-use component appears as part of "other." The absence of energy consumption in major end uses such as heating and dining hall cooking indicates that the end use is not electric. The data provided only indicate rough percentages of penetration of equipment in these housing areas.

Table 8.3. Regional Fuel Oil EUI Survey Results (KBtu/ft²-yr)

	Heating	DHW	Total
Single Family Residence			
EPA/SERC	22.4	13.4	35.8
RECS	-	-	67.4
Lodging			
EPA/SERC	43.9	29	72.9
Gulf Power	0.01	0.01	0.02
GA Power	0.65	1.73	2.38
Office			
EPA/SERC	37.7	14.7	52.4
Gulf Power	3.65	-	3.65
GA Power	1.18	0.34	1.52
Grocery			
EPA/SERC	47.8	37.6	85.4
Gulf Power	1.94	0.02	1.96
GA Power	0.41	0.5	0.91
Restaurant			
EPA/SERC	5.8	30.6	36.4
Gulf Power	0.05	0.84	0.89
GA Power	-	1.06	1.06
Health			
EPA/SERC	53.2	39.8	93
Gulf Power	0.11	0.03	0.14
GA Power	0.83	0.69	1.52
Retail			
EPA/SERC	41.1	99.4	140.5
Gulf Power	0.1	-	0.1
GA Power	0.92	-	0.92
CBECS	-	-	37.7
Warehouse			
EPA/SERC	89.2	108.4	197.6
GA Power	0.17	-	0.17
School			
EPA/SERC	78.5	32	110.5
Gulf Power	0.01	-	0.01
GA Power	1.18	0.12	1.3

Table 8.3. (contd)

	Heating	DHW	Total
College			
EPA/SERC	19.2	9.3	28.5
Gulf Power	0.36	-	0.36
GA Power	2	1.58	3.58
Misc. Bldgs.			
EPA/SERC	56.3	6.8	63.1
GA Power	1.11	0.1	1.21
Assembly			
CB ECS	-	-	15.2

Table 8.4. Estimated Energy Consumption by Building Type

Building Type	Electricity kWh/yr	Natural Gas MBtu/yr	#2 Fuel Oil MBtu/yr
ADMIN	1,295,675	1,882	
ADMIN-1	13,223,901		
ADMIN-2	9,135,758		
ADMIN-3	1,088,708		
ADMIN-4	1,025,299		925
BRK/ADM	1,081,643	1,901	
BRK/ADM-1	2,497,625		
BRK/ADM-2	1,084,159		
BRK/ADM-4	463,505		447
CHAPEL-1	168,667		
CLINIC	77,059	161	
CLINIC-1	539,625		
CLUB	2,830,561	8,899	
CLUB-4	354,314		169
COMCATN	171,517	165	
COMCATN-1	760,324		
COMCATN-3	25,858		
COMCATN-4	2,796,927		2,680
DET-RR-3	7,335		
DET-RR-5	3,198		
DGR	218,536	214	
DGR-1	1,340,634		
DGR-3	180,395		
DGR-4	165,278		78
DINING	140,417	402	
DINING-1	966,236		
FUELDSP-3	22,223		
FUELDSP-5	133,063		
GROCERY-1	2,761,582		
HANGAR	8,659,527	9,359	
HANGAR-1	5,352,608		
HANGAR-2	12,145,118		
HANGAR-3	485,527		
HANGAR-4	809,949		1,609

Table 8.4. (contd)

Building Type	Electricity kWh/yr	Natural Gas MBtu/yr	#2 Fuel Oil MBtu/yr
HANGAR-5	94,499		
HOSPITL-1	955,717		
HOTEL-3	391,336		
HSG-FAM	21,394,682	54,449	
HSG-FAM-3	9,849,317	12,961	
HUT-2	26,802		
HUT-5	111,913		
LAB-MED	1,396	3	
LAB-MED-1	53,940		
LAB-MED-3	9,102		
LAB-MED-4	39,219		20
MTRPOOL	45,593	40	
MTRPOOL-1	1,267,431		
MTRPOOL-3	21,034		
MTRPOOL-5	10,789		
MWR	1,126,862	341	
MWR-1	744,660		
MWR-3	463,828		
MWR-5	144,490		
OTHER	5,087	29	
OTHER-3	8,052		
PLT-BLD	1,286,009		
PLT-BLD-1	247,412		
PLT-BLD-3	212,782		
PLT-BLD-4	111,289		
PLT-BLD-5	16,556		
PRDCTN-1	275,176		
PRDCTN-4	968,178		1,161
PUMP	20,282	5	
PUMP-1	23,566		
PUMP-3	394,853		
PUMP-4	13,111		9
PUMP-5	28,701		
REC-1	955,403		

Table 8.4. (contd)

Building Type	Electricity kWh/yr	Natural Gas MBtu/yr	#2 Fuel Oil MBtu/yr
RESTRNT-1	227,691	198	
RESTRNT-2	1,481,976	1,181	
RESTRNT-3	71,690	37	
SCHOOL	2,828,474	3,583	
SECURTY	13,775	14	
SECURTY-1	445,305		
SECURTY-3	124,877		
SECURTY-4	120,761		218
SECURTY-5	1,783		
SHOP	643,280	1,192	
SHOP-1	3,966,612		
SHOP-2	296,744		
SHOP-3	444,131		
SHOP-4	49,529		86
SHOP-5	117,586		
SHOP-AIR-1	6,714,352		
SHOP-AIR-2	13,566,164		
SHOP-AIR-3	1,169,415		
SHOP-AIR-4	1,476,350		1,017
SHOP-AIR-5	1,442,593		
SHOP-ELC	1,317,275	1,517	
SHOP-ELC-1	16,395,943		
SHOP-ELC-2	17,974,347		
SHOP-ELC-4	544,476		386
SHOP-ELC-5	188,991		
SHOP-HVY-1	147,166		
SHOP-WPN-3	64,299		
STOR-UH	527,644		
STOR-UH-1	116,955		
STOR-UH-3	16,309		
STOR-UH-5	1,202,062		
TERMINL-1	969,658		
TRAING	656,536	931	
TRAING-1	611,163		

Table 8.4. (contd)

Building Type	Electricity kWh/yr	Natural Gas MBtu/yr	#2 Fuel Oil MBtu/yr
TRAINING-2	228,531		
TRAINING-3	198,871		
WHS	150,831	569	
WHS-1	17,518,932		
WHS-2	1,037,165		
WHS-3	69,868		
WHS-4	694,027		9,461
WHS-5	211,113		
WHS-CLD-3	<u>139,986</u>	<u> </u>	<u> </u>
Sub-Total:	209,517,053	100,531	17,726
Line Items:			
Trailer Park	1,100,000		
Pave Paws	14,900,000		
Central Plants	19,400,000	882,038	16,871
Exterior Lighting	10,282,000		
Dist. Loss	<u>13,500,000</u>	<u> </u>	<u> </u>
Sub-Total:	59,182,000	882,038	16,871
TOTAL:	268,699,053	982,569	<u>34,596</u>

Table 8.5. Electrical EUIs by Building Type and End Use (kWh/ft²/yr)

Building Type	Total Electric	Heating	Cooling	Vent/ Fans	DHW	Cooking	Refrigation	Other	Int. Inc.	Ext. Inc.	Fluorescent	Int. HID	Ext. HID
ADMIN	20.43	0.00	8.00	2.10	0.63	0.14	0.22	2.75	0.64	0.00	5.60	0.00	0.34
ADMIN-1	16.80	0.00	5.00	2.10	0.00	0.14	0.22	2.75	0.64	0.00	5.60	0.00	0.34
ADMIN-2	11.83	0.00	0.03	2.10	0.00	0.14	0.22	2.75	0.64	0.00	5.60	0.00	0.34
ADMIN-3	23.93	1.50	10.00	2.10	0.63	0.14	0.22	2.75	0.64	0.00	5.60	0.00	0.34
ADMIN-4	21.43	0.00	9.00	2.10	0.63	0.14	0.22	2.75	0.64	0.00	5.60	0.00	0.34
BRK/ADM	16.74	0.00	6.00	1.40	0.00	0.72	1.28	3.00	0.84	0.00	3.39	0.00	0.11
BRK/ADM-1	16.64	0.00	4.50	1.68	0.00	0.79	1.53	3.00	1.01	0.00	4.07	0.00	0.06
BRK/ADM-2	10.74	0.00	0.00	1.40	0.00	0.72	1.28	3.00	0.84	0.00	3.39	0.00	0.11
BRK/ADM-4	19.74	0.00	9.00	1.40	0.00	0.72	1.28	3.00	0.84	0.00	3.39	0.00	0.11
CHAPEL-1	10.40	0.00	4.54	0.46	0.00	0.00	0.04	1.00	0.65	0.00	3.53	0.00	0.17
CLINIC	28.02	0.00	7.65	2.50	1.30	0.90	1.11	7.50	1.06	0.00	5.72	0.00	0.28
CLINIC-1	19.29	0.00	0.00	2.55	0.00	0.90	1.13	7.50	1.08	0.00	5.84	0.00	0.29
CLUB	54.89	0.00	18.00	2.98	3.14	6.07	10.70	7.00	1.05	0.00	5.67	0.00	0.28
CLUB-4	48.68	0.00	13.00	3.19	0.00	6.51	11.48	7.00	1.13	0.00	6.08	0.00	0.30
COMCATN	29.69	0.00	13.00	3.09	0.00	0.36	1.03	6.00	0.93	0.00	5.04	0.00	0.25
COMCATN-1	27.11	0.00	11.00	3.13	0.44	0.18	0.52	6.00	0.47	0.00	5.11	0.00	0.25
COMCATN-3	29.35	2.24	11.00	3.13	0.44	0.18	0.52	6.00	0.47	0.00	5.11	0.00	0.25
COMCATN-4	25.17	0.00	9.50	3.13	0.00	0.18	0.52	6.00	0.47	0.00	5.11	0.00	0.25
DET-RR-3	3.25	0.28	0.75	0.39	0.05	0.00	0.00	1.00	0.12	0.00	0.63	0.00	0.03
DET-RR-5	3.17	0.00	0.84	0.44	0.00	0.00	0.00	1.00	0.13	0.00	0.72	0.00	0.04
DGR	29.14	0.00	7.34	2.61	1.21	0.68	1.66	5.00	1.60	0.00	8.62	0.00	0.43
DGR-1	29.39	0.00	10.00	2.00	0.00	0.79	1.91	5.00	2.44	0.00	6.60	0.00	0.65
DGR-3	27.10	2.02	6.00	1.73	1.61	0.68	1.65	5.00	2.12	0.00	5.72	0.00	0.57
DGR-4	29.39	0.00	10.00	2.00	0.00	0.79	1.91	5.00	2.44	0.00	6.60	0.00	0.65
DINING	36.81	0.00	0.00	3.07	3.24	6.26	11.03	6.00	1.08	0.00	5.84	0.00	0.29
DINING-1	53.57	0.00	20.00	3.07	0.00	6.26	11.03	6.00	1.08	0.00	5.84	0.00	0.29
FUELDSP-3	76.11	7.35	12.00	10.27	1.43	0.00	0.00	24.38	3.10	0.00	16.74	0.00	0.83
FUELDSP-5	57.01	0.00	0.00	10.47	1.46	0.00	0.00	24.00	3.16	0.00	17.07	0.00	0.84
GROCERY-1	34.06	0.00	5.00	1.71	0.00	0.60	13.86	5.00	1.18	0.00	4.41	1.97	0.32
HANGAR	20.95	0.00	0.50	5.65	0.39	0.00	0.94	7.50	0.85	0.00	3.18	1.71	0.23
HANGAR-1	24.80	0.00	2.00	8.06	0.00	0.00	0.74	7.74	0.68	0.00	2.52	2.70	0.36
HANGAR-2	21.25	0.00	0.00	7.19	0.00	0.00	0.66	7.50	0.90	0.00	2.25	2.41	0.32
HANGAR-3	21.96	2.24	1.00	5.64	0.44	0.00	0.52	7.50	0.71	0.00	1.77	1.89	0.25
HANGAR-4	21.94	0.00	1.50	6.77	0.00	0.00	0.62	7.50	0.85	0.00	2.12	2.27	0.30
HANGAR-5	22.44	0.00	2.00	6.77	0.00	0.00	0.62	7.50	0.85	0.00	2.12	2.27	0.30
HOSPITL-1	37.74	0.00	13.00	3.62	0.00	1.26	1.61	8.00	1.54	0.00	8.30	0.00	0.41
HOTEL-3	21.98	1.77	10.00	0.72	1.46	1.49	0.66	3.00	1.44	0.00	1.33	0.00	0.12
HSG-FAM	16.07	0.00	6.00	0.85	0.00	1.09	2.21	2.00	2.74	0.39	0.78	0.00	0.00

Table 8.5. (contd)

Building Type	Total Electric	Heating	Cooling	Vent/ Fans	DHW	Cooking	Refrigation	Other	Int. Inc.	Ext. Inc.	Fluorescent	Int. HID	Ext. HID
HSG-FAM-3	19.45	0.00	7.00	0.85	2.38	1.09	2.22	2.00	2.74	0.39	0.78	0.00	0.00
HUT-2	14.53	0.00	0.00	3.13	0.00	0.00	0.00	5.09	0.95	0.00	5.11	0.00	0.25
HUT-5	13.30	0.00	0.00	2.63	0.37	0.00	0.00	5.00	0.80	0.00	4.29	0.00	0.21
LAB-MED	19.66	0.00	0.00	1.99	0.98	0.69	0.88	9.50	0.84	0.00	3.15	1.41	0.22
LAB-MED-1	19.04	0.00	0.00	2.05	0.00	0.71	0.91	9.55	0.87	0.00	3.25	1.45	0.23
LAB-MED-3	31.61	1.22	12.00	1.74	0.86	0.61	0.77	9.50	0.74	0.00	2.75	1.23	0.20
LAB-MED-4	29.53	0.00	12.00	1.74	0.00	0.61	0.77	9.50	0.74	0.00	2.75	1.23	0.20
MTRPOOL	22.80	0.00	6.01	3.13	0.44	0.37	1.04	5.50	0.95	0.00	3.53	1.58	0.25
MTRPOOL-1	19.70	0.00	1.00	3.81	0.00	0.45	1.27	5.50	1.15	0.00	4.30	1.92	0.31
MTRPOOL-3	25.04	2.24	6.01	3.13	0.44	0.37	1.04	5.50	0.95	0.00	3.53	1.58	0.25
MTRPOOL-5	16.35	0.00	0.00	3.13	0.00	0.37	1.04	5.50	0.95	0.00	3.53	1.58	0.25
MWR	17.75	0.00	5.08	1.03	2.73	0.00	0.09	3.00	1.46	0.00	3.95	0.00	0.39
MWR-1	16.52	0.00	8.00	0.70	0.00	0.00	0.06	3.00	1.00	0.00	3.50	0.00	0.27
MWR-3	19.58	2.10	5.60	0.95	2.51	0.00	0.08	3.00	1.35	0.00	3.63	0.00	0.36
MWR-5	11.52	0.00	3.00	0.70	0.00	0.00	0.06	3.00	1.00	0.00	3.49	0.00	0.27
OTHER	3.17	0.00	0.90	0.47	0.07	0.00	0.00	0.80	0.14	0.00	0.76	0.00	0.04
OTHER-3	3.24	0.30	0.81	0.42	0.06	0.00	0.00	0.80	0.13	0.00	0.69	0.00	0.03
PLT-BLD	19.24	0.00	0.25	3.80	0.53	0.00	0.00	7.00	1.15	0.00	4.29	1.91	0.31
PLT-BLD-1	17.13	0.00	0.25	3.13	0.44	0.00	0.00	7.00	0.95	0.00	3.53	1.58	0.25
PLT-BLD-3	17.13	0.00	0.25	3.13	0.44	0.00	0.00	7.00	0.95	0.00	3.53	1.58	0.25
PLT-BLD-4	17.13	0.00	0.25	3.13	0.44	0.00	0.00	7.00	0.95	0.00	3.53	1.58	0.25
PLT-BLD-5	16.88	0.00	0.00	3.13	0.44	0.00	0.00	7.00	0.95	0.00	3.53	1.58	0.25
PRDCTN-1	20.85	0.00	0.00	3.13	0.00	0.37	1.04	10.00	0.95	0.00	3.53	1.58	0.25
PRDCTN-4	22.78	0.00	1.50	3.13	0.44	0.37	1.04	10.00	0.95	0.00	3.53	1.58	0.25
PUMP	23.26	0.00	0.00	5.42	0.00	0.00	0.00	14.00	1.64	0.00	1.77	0.00	0.44
PUMP-1	26.01	0.00	5.00	3.92	0.00	0.00	0.00	14.00	1.18	0.00	1.60	0.00	0.32
PUMP-3	23.82	2.80	0.00	3.92	0.00	0.00	0.00	14.00	1.18	0.00	1.60	0.00	0.32
PUMP-4	21.01	0.00	0.00	3.92	0.00	0.00	0.00	14.00	1.18	0.00	1.60	0.00	0.32
PUMP-5	21.01	0.00	0.00	3.92	0.00	0.00	0.00	14.00	1.18	0.00	1.60	0.00	0.32
REC-1	18.78	0.00	6.00	1.50	0.00	0.00	0.09	4.00	1.43	0.00	5.39	0.00	0.38
RESTRNT-1	34.57	0.00	0.00	3.07	0.00	6.26	11.03	7.00	1.08	0.00	5.84	0.00	0.29
RESTRNT-2	37.65	0.00	0.00	3.41	0.00	6.96	12.26	7.00	1.20	0.00	6.49	0.00	0.32
RESTRNT-3	58.52	1.13	25.00	2.53	2.67	5.16	9.09	7.00	0.89	0.00	4.81	0.00	0.24
SCHOOL	23.02	0.00	5.14	1.73	1.48	2.22	1.31	3.00	1.22	0.00	6.59	0.00	0.33
SECURTY	18.03	0.00	10.00	1.63	0.00	0.00	0.00	2.50	0.98	0.00	2.66	0.00	0.26
SECURTY-1	11.97	0.00	3.83	1.66	0.00	0.00	0.00	2.50	1.00	0.00	2.71	0.00	0.27
SECURTY-3	18.18	2.28	8.00	1.59	0.00	0.00	0.00	2.50	0.96	0.00	2.59	0.00	0.26
SECURTY-4	14.24	0.00	6.00	1.69	0.00	0.00	0.00	2.50	1.02	0.00	2.75	0.00	0.27

Table 8.5. (contd)

Building Type	Total Electric	Heating	Cooling	Vent/ Fans	DHW	Cooking	Refrigation	Other	Int. Inc.	Ext. Inc.	Fluorescent	Int. HID	Ext. HID
SECURTY-5	7.43	0.00	0.00	1.45	0.00	0.00	0.00	2.50	0.88	0.00	2.37	0.00	0.23
SHOP	15.39	0.00	3.00	1.77	0.25	0.21	0.59	6.00	0.54	0.00	2.00	0.89	0.14
SHOP-1	15.73	0.00	3.47	1.81	0.00	0.21	0.60	6.00	0.55	0.00	2.04	0.91	0.15
SHOP-2	14.63	0.00	0.00	2.49	0.00	0.29	0.83	6.00	0.75	0.00	2.81	1.25	0.20
SHOP-3	17.11	1.28	3.42	1.78	0.25	0.21	0.59	6.00	0.54	0.00	2.01	0.90	0.14
SHOP-4	15.73	0.00	3.47	1.81	0.00	0.21	0.60	6.00	0.55	0.00	2.04	0.91	0.15
SHOP-5	10.94	0.00	0.00	1.43	0.00	0.17	0.47	6.00	0.43	0.00	1.61	0.72	0.11
SHOP-AIR-1	31.85	0.00	1.50	5.89	0.00	0.00	0.65	14.00	1.38	0.00	3.09	4.60	0.74
SHOP-AIR-2	31.90	0.00	0.00	5.88	0.00	0.00	0.65	14.00	1.60	0.00	3.58	5.33	0.85
SHOP-AIR-3	36.88	4.26	3.00	4.47	0.83	0.00	0.49	14.00	1.38	0.00	3.10	4.61	0.74
SHOP-AIR-4	37.34	0.00	7.39	4.82	0.00	0.00	0.53	14.00	1.49	0.00	3.34	4.97	0.80
SHOP-AIR-5	29.94	0.00	0.00	4.27	0.00	0.00	0.47	15.80	1.32	0.00	2.96	4.41	0.71
SHOP-ELC	28.83	0.00	1.00	3.13	0.87	0.00	0.52	10.00	1.17	0.00	9.58	1.94	0.62
SHOP-ELC-1	40.29	0.00	13.00	4.33	0.00	0.00	0.72	10.00	1.07	0.00	8.81	1.79	0.57
SHOP-ELC-2	27.82	0.00	0.15	5.47	0.00	0.00	0.91	10.00	0.99	0.00	8.12	1.65	0.53
SHOP-ELC-4	38.59	0.00	11.13	2.90	0.00	0.00	0.48	10.00	1.23	0.00	10.13	2.06	0.66
SHOP-ELC-5	36.74	0.00	10.41	2.71	0.00	0.00	0.45	10.00	1.15	0.00	9.47	1.92	0.62
SHOP-HVY-1	19.12	0.00	3.00	3.76	0.00	0.00	0.31	6.71	1.14	0.00	1.06	2.84	0.30
SHOP-WPN-3	25.80	2.69	5.00	3.76	0.52	0.00	0.31	5.00	1.14	0.00	4.24	2.84	0.30
STOR-UH	5.01	0.00	0.05	0.68	0.00	0.00	0.00	0.70	0.29	0.00	1.07	1.92	0.31
STOR-UH-1	3.26	0.00	0.05	0.76	0.00	0.00	0.00	0.70	0.11	0.00	0.81	0.72	0.12
STOR-UH-3	3.21	0.00	0.00	0.76	0.00	0.00	0.00	0.70	0.11	0.00	0.81	0.72	0.12
STOR-UH-5	3.31	0.00	0.10	0.76	0.00	0.00	0.00	0.70	0.11	0.00	0.81	0.72	0.12
TERMINL-1	13.79	0.00	2.00	0.69	0.00	0.00	0.06	4.50	0.98	0.00	5.30	0.00	0.26
TRAIING	21.90	0.00	8.00	1.27	1.08	1.63	0.96	3.00	0.89	0.00	4.82	0.00	0.24
TRAIING-1	16.14	0.00	3.64	1.23	0.00	1.58	0.93	3.00	0.86	0.00	4.67	0.00	0.23
TRAIING-2	9.60	0.00	0.00	0.85	0.00	1.10	0.65	3.00	0.60	0.00	3.25	0.00	0.16
TRAIING-3	14.93	2.06	2.53	0.85	0.73	1.10	0.65	3.00	0.60	0.00	3.25	0.00	0.16
WHS	4.07	0.00	0.77	0.52	0.21	0.00	0.00	1.10	0.22	0.00	0.82	0.37	0.06
WHS-1	4.83	0.00	0.20	0.92	0.00	0.00	0.00	1.10	0.39	0.00	1.46	0.65	0.10
WHS-2	3.49	0.00	0.00	0.62	0.00	0.00	0.00	1.10	0.27	0.00	0.99	0.44	0.07
WHS-3	7.69	0.93	1.50	0.98	0.40	0.00	0.00	1.10	0.42	0.00	1.56	0.69	0.11
WHS-4	3.41	0.00	0.25	0.54	0.00	0.00	0.00	1.10	0.23	0.00	0.85	0.38	0.06
WHS-5	4.06	0.00	0.00	0.77	0.00	0.00	0.00	1.10	0.33	0.00	1.23	0.55	0.09
WHS-CLD-3	25.48	0.00	3.00	1.99	0.00	0.00	8.87	6.00	0.84	0.00	3.15	1.41	0.23

Table 8.6. Natural Gas EUIs by Building Type and End Use (Btu/ft²/yr)

Building Type	Natural Gas Total	Heating	DHW	Cooking	Other
ADMIN	29,673	23,541	6,132	0	0
BRK/ADM	29,413	10,820	18,593	0	0
CLINIC	58,670	29,631	21,176	0	7,863
CLUB	200,000	49,753	66,885	54,442	1,476
COMCATN	28,508	19,788	8,720	0	0
DGR	28,563	22,170	6,393	0	0
DINING	105,389	28,555	38,388	37,598	847
HANGAR	22,639	18,551	4,088	0	0
HSG-FAM	40,888	25,598	15,291	0	0
HSG-FAM-3	25,598	25,598	0	0	0
LAB-MED	41,414	20,916	14,948	0	5,550
MTRPOOL	19,788	19,788	0	0	0
MWR	13,240	11,840	1,400	0	0
OTHER	17,818	12,368	5,450	0	0
PUMP	6,184	6,184	0	0	0
RESTRNT-1 ^(a)	30,000	0	0	30,000	0
RESTRNT-2 ^(a)	30,000	0	0	30,000	0
RESTRNT-3 ^(a)	30,000	0	0	30,000	0
SCHOOL	29,151	19,400	7,993	0	1,759
SECURTY	18,551	18,551	0	0	0
SHOP	28,508	19,788	8,720	0	0

(a) These building types use natural gas for cooking only.

Table 8.7. #2 Fuel Oil EUIs by Building Type and End Use (Btu/ft²/yr)

Building Type	Fuel Oil Total	Heating	DHW
ADMIN-4	19,320	19,320	0
BRK/ADM-4	19,040	5,200	13,840
CLUB-4	23,250	17,550	5,700
COMCATN-4	24,116	21,529	2,588
DGR-4	13,800	13,800	0
HANGAR-4	28,940	25,835	3,105
LAB-MED-4	15,200	8,300	6,900
PRDCTN-4	27,332	24,399	2,933
PUMP-4	14,353	14,353	0
SECURTY-4	25,724	22,964	2,760
SHOP-4	27,332	24,399	2,933
SHOP-AIR-4	25,724	22,964	2,760
SHOP-ELC-4	27,332	24,399	2,933
WHS-4	46,517	28,956	17,561

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