Fort Irwin Integrated Resource Assessment

Volume 2: Baseline Detail

January 1994

**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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PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831;
prices available from (615) 576-8401. FTS 626-8401.

Available to the public from the National Technical Information Service,
U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

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January 1994

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Abstract

This report documents the assessment of baseline energy use at Fort Irwin, a U.S. Army Forces Command facility near Barstow, California. It is a companion report to Volume 1, *Executive Summary*, and Volume 3, *Integrated Resource Assessment*.

The U.S. Army Forces Command (FORSCOM) 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 Fort Irwin. This is part of a model program that PNL has designed 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 Fort Irwin.

This analysis examines the characteristics of electric, propane gas, and vehicle fuel use for a typical operating year. It records energy-use intensities for the facilities at Fort Irwin by building type and energy end use. It also breaks down building energy consumption by fuel type, energy end use, and building type. A complete energy consumption reconciliation is presented that accounts for all energy use among buildings, utilities, and applicable losses.

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Summary

The U.S. Army Forces Command (FORSCOM) 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 Fort Irwin. The FEMP model integrated resource planning (IRP) program is being applied by PNL for federal customers served by Southern California Edison Company (SCE).

This volume, *Baseline Detail*, documents the baseline energy use at Fort Irwin, a FORSCOM base near Barstow, California. The analysis characterizes electric, propane, and vehicle fuel use for a sample year. It records energy-use intensities for the facilities at Fort Irwin by building type and energy end use. It also breaks down building energy consumption by fuel type, energy end use, and building type. A complete energy consumption reconciliation is presented that includes the accounting of all energy use among buildings, utilities, and applicable losses.

Fort Irwin is a roughly 1,000-square-mile facility situated in the Mojave desert approximately 37 miles northeast of Barstow, California, and south of Death Valley. The main cantonment is located near the southeastern portion of Fort Irwin. The primary mission at Fort Irwin is the operation of the National Training Center (NTC). For energy consumption and billing purposes, the base is divided into three major sectors: commercial, family housing, and on-post utility (including exterior and streetlighting, pumping, and transmission and distribution losses). Of these three sectors, the first two contain non-utility buildings whose energy use is generally correlated with building function and floor area. Table S.1 summarizes the number of buildings and total square feet for each of the areas. The Fort contains 1,574 buildings with a total area of 6,401,436 ft².

Table S.2 summarizes a sample yearly energy consumption and cost for all facilities at Fort Irwin. For each energy type, the yearly 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 the sample yearly usage, from the last complete year of data available for each fuel type during this analysis (data were collected for 1991 through 1993). The sample yearly energy consumption is 1,328,876 MBtu at a cost of \$11,856,843. Electricity accounts for 18.7% of the usage, propane 16.9%, and transportation fuels (gas, diesel, JP-4, and JP-8) 64.4%. However, electricity accounts for almost 53% of the total energy cost.

Table S.1. Fort Irwin Building Characterization

Energy Use Sector	Number of Buildings	Total Floorspace (ft ²)	Percent of Total Floorspace
Commercial	842	3,439,606	53.7
Family Housing	732	2,961,830	46.3
Total	1,574	6,401,436	100.0

Table S.2. Yearly Energy Consumption and Energy Cost at Fort Irwin

Energy Type	Yearly Total	Yearly Total (MBtu) ^(a)	Percent of Total	Yearly Total (1993 \$)	Percent of Total
Electricity	72,870 MWh	248,705 ^(b)	18.7	6,271,513	52.8
Propane	2,369,487 gal	225,101 ^(c)	16.9	1,120,293	9.5
Gasoline	446,098 gal	55,760 ^(d)	4.2	370,261	3.1
Diesel	3,718,042 gal	516,810 ^(e)	38.9	2,491,088	21.0
JP-4	770,500 gal	97,850 ^(f)	7.4	577,875	4.9
JP-8	1,367,750 gal	184,650 ^(g)	13.9	1,025,813	8.7
Totals		1,328,876	100.0	11,856,843	100.0
<div> <div>(a) 1 MBtu = 1,000,000 Btu.</div> <div>(b) 3,413 Btu/kWh.</div> <div>(c) 0.095 MBtu/gal.</div> <div>(d) 0.125 MBtu/gal.</div> <div>(e) 0.139 MBtu/gal.</div> <div>(f) 0.127 MBtu/gal.</div> <div>(g) 0.135 MBtu/gal.</div> </div>					

Table S.3 presents the energy consumption as derived by the baseline process. Energy use is broken down by energy type and end use - detail that is not available from the total billing data used in Table S.2. The energy in Table S.3 accounts for nearly 100% of the energy billed in Table S.2.

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

Fuel Type/End Use	Commercial	Family Housing	Utility	Total
Electric:				
Heating	1,243	0	0	1,243
Cooling	28,801	29,393	0	58,194
Vent./Fans	13,870	8,087	0	21,957
DHW	565	0	0	565
Cooking	2,557	1,011	0	3,568
Interior Ltg.	40,127	10,109	0	50,236
Exterior Ltg.	7,041	1,011	0	8,052
Refrigeration	13,548	14,152	0	27,700
Office Eqp.	4,866	0	0	4,866
Other Bldg. End Use	13,765	6,065	0	19,830
Water Supply/Sewage Treatment	0	0	26,881	26,881
Trans. & Dist. Losses	0	0	13,657	13,657
Street Lighting	0	0	6,022	6,022
Ft. Irwin School	3,754	0	0	3,754
Trailer Park	0	1,439	0	1,439
General's Qtrs.	0	70	0	70
Total	130,137	71,337	46,560	248,035
Percent of Total	52.5%	28.8%	18.8%	100.0%
Propane:				
Heating	59,454	78,109	0	137,563
DHW	11,838	31,929	0	43,767
Cooking	10,876	15,964	0	26,840
Other Bldg. End Use	5,703	0	0	5,703
Ft. Irwin School	11,582	0	0	11,582
Trailer Park	0	217	0	217
General's Qtrs.	0	107	0	107
Total	99,454	126,326	0	225,779
Percent of Total	44.0%	56.0%	0.0%	100.0%
Transportation Fuels:				
Gasoline	0	0	55,762	55,762
Diesel	0	0	515,692	515,692
JP-4	0	0	97,853	97,853
JP-8	0	0	184,646	184,646
Total	0	0	853,954	853,954
Percent of Total	0.0%	0.0%	100.0%	100.0%
Total Energy	229,591	197,663	900,514	1,327,768
Percent of Total	17.3%	14.9%	67.8%	---

Acknowledgments

The authors gratefully acknowledge the assistance of several people associated with Fort Irwin Operations that provided us with detailed and timely information that increased the value and usefulness of this analysis. While it is not possible to identify all those who provided assistance, we would like to thank the following individuals who provided helpful support: Rene Quinones, Linda Osborne, Greg Williams, Orvy Dahl, Ben Rodarte, LaSandra Miller, and Ed Rojas.

In addition, the authors thank Randy Wahlstrom, Kate McMordie, and Steve Parker, all of PNL, for their assistance in the collection of data used in this document. The efforts of our editor, Dave Payson, are also gratefully acknowledged.

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Abbreviations and Acronyms

AAFES	Army/Air Force Exchange Service
A/C	air conditioning
AHU	air-handling unit
ASD	adjustable speed drive
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc
BGP	Burbank, Glendale, Pasadena.
BLCC	Building Life-Cycle Cost Program
Btu	British thermal unit
CB ECS	Commercial Building Energy Consumption Survey
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
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

LADWP	Los Angeles Department of Water and Power
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
NTC	National Training Center
O&M	operations and maintenance
°F	degrees Fahrenheit
PCBs	polychlorinated biphenyls
PCF	permanent compact fluorescent
PG&E	Pacific Gas and Electric Company
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
SCE	Southern California Edison Company
SIR	savings to investment ratio
V	volt
VI	value index
W	watt
WSCC	Western Systems Coordinating Council
WSEO	Washington State Energy Office
yr	year

1.0 Physical Characteristics

1.1 Site Profile

Fort Irwin is a roughly 1,000-square mile U.S. Army Forces Command (FORSCOM) facility situated in the Mojave desert approximately 37 miles northeast of Barstow, California, and south of Death Valley. The main cantonment is located near the southeastern portion of Fort Irwin. The primary mission at Fort Irwin is the operation of the National Training Center (NTC). The NTC is a support facility for training of troops normally stationed at other posts throughout the United States. A total of twelve, 28-day training rotations are scheduled each year. The Fort mission results in erratic energy consumption because a large portion of the Fort population is transient, moving on and off-site as dictated by the training schedule.

The climate at Fort Irwin is classified as "high desert," with an average rainfall of 2.5 inches annually, most of which falls between December and February. Summer maximum temperatures are around 104°F and winter minimum temperatures are around 29°F. Annual heating and cooling degree days (base 65°F) are generally equivalent to each other at 2,547 and 2,272 respectively.

1.2 Building and Facility Profile

The site facilities at Fort Irwin 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, streetlights, electricity, and LPG), mission-specific facilities (antennas, runways, fuel storage, firing ranges, etc.), outdoor recreation (tennis courts, swimming pools, ballfields, etc.), and other surface improvements (streets, culverts, fences, and parking lots).

1.2.1 Buildings Characterization

Roughly 842 commercial buildings (not including school) with an area of 3,439,606 ft² are reported in the Fort Irwin Real Property Data Base (RPL). There are an additional 732 housing buildings (1636 units - not including General's Quarters) with a reported area of 2,961,830 ft², for a total building area of 6,401,436 ft².

Based on the RPL, the facilities at Fort Irwin may be divided into 36 building types. These building types are created by combining facilities of different facility description codes (as provided in the RPL) into larger categories with similar energy usage. This procedure minimizes the number of building types while preserving any unique or unusual building characteristics that have an effect on energy consumption.

The building type codes in Table 1.1 describe the building types at Fort Irwin.

The assignment of a building to a particular building type is based on the Army Facility Code assigned to the building. Buildings with similar facility codes are assigned to particular building types based on similar energy use intensities. (See Section 3 for more detail on the concept of EUIs.) This categorization of buildings is only as good as the data in the RPL. As buildings are vacated and occupied by new tenants, the numbers of buildings and square footage associated with each category may change. Similarly, the assigned category codes are taken to be correct and representative of actual function. One group of buildings that is not included in the building reconciliation (also not found in the RPL) is that of the public school facilities. The 36 types shown represent the best estimate of Fort Irwin building types at

Table 1.1. Fort Irwin Building Type Descriptions

Bldg Type	Description
ADMIN	Administration Building
ADMIN-MT	Administration Building (manufactured trailer type)
BRK/ADM	Barracks (enlisted & BOQ)
CHAPEL	Chapel
CLINIC	Medical Facility Other Than Hospital
CLUB	Club (NCO, Officers, etc.)
COMCATN	Communications
DET-RR	Detached Restrooms, Latrines, Shower Houses, etc.
DGR	Dry Goods/Retail
DINING	Enlisted Dining Facility
FUELDSP	Fuel Dispensing Bldgs.
GROCERY	Grocery
HANGAR	Hangar
HOSPITL	Hospital
HOTEL	Hotel/Motel/Guesthouse
HSG-FAM	Family Housing
HUT	Misc. Small Bldgs. and Shelters (not security)
LAB-MED	Laboratory/Vet. Facility
MTRPOOL	Maint. Shops for Cars, Trucks, Tanks - Land Vehicles
MWR	Morale, Welfare, & Recreation (Non-Physical Rec)
OTHER	Other (generally low energy use bldgs.)
PLT-BLDG	Heating/Cooling/Power Plant, Elec. Distribution Buildings
POOL-OT	Outdoor Swimming Pools
PUMP	Pump Bldgs. - Sewer, Wells, Wash Platforms, etc.
REC	Physical Recreation (gym, bowling alley, etc.)
RESTRNT	Food Service Facility (non-dining hall)
SECURTY	Security Operations (police, fire)
SHOP	General Maint. Shops, inc. DEH/Base Eng.

Table 1.1. (contd)

Bldg Type	Description
SHOP-AIR	Maint. Shops for Cooling Equipment
SHOP-ELC	Maint. Shops for Electronic Equipment
SHOP-HVY	Maint. Shops with Heavy Eqp.- Plating, Welding, Railroad
SHOP-WPN	Maint. Shops for Weapons, from Pistols to ICBMs
STOR-UH	Unheated Storage (vehicles, ammo, residential sheds)
TRAING	Training/Classrooms (not simulator)
WHS	Warehouse
WHS-CLD	Cold Storage Warehouse

this time. In Table 1.2, the building types are applied to the Fort Irwin RPL to describe each building type in terms of energy type, building count, total floor space, and percent of total floor space. Appendix C contains a list of building numbers in each building type.

There is considerable expansion occurring at Fort Irwin. A new 172-unit housing area is currently under construction, a 220-unit family housing area is planned for FY94, and several new modular office buildings have recently been added. The energy consumption and EUI estimates in this report are only for facilities currently listed in the RPL. While some of the new facilities are similar to existing buildings, changes in building construction codes and equipment efficiency standards may make it difficult to extrapolate the data to new facilities.

Table 1.3 shows the list of building types at Fort Irwin ranked by square footage. Family housing is the single largest category by square footage at Fort Irwin, followed by barracks, administration, motor pools, warehouses, manufactured-trailer administration, and general shops. These building types account for over 80% of the total building stock at Fort Irwin. Because of the different energy use intensities (EUIs) in each building type, building types with greater square footage do not necessarily consume more energy. Section 3 discusses the concept of EUIs in greater detail, and Sections 4 and 5 discuss the total energy usage by the various building types.

Commercial buildings are a mix of older wood frame construction and newer stone/brick construction, with some metal frame and curtain wall construction. Family housing is primarily wood frame construction with varying levels of insulation in the walls or ceilings.

1.2.2 Electrical Utility Service Characterization

Electrical service to Fort Irwin is provided by Southern California Edison (SCE). Distribution on the site consists of five 12-kV transmission lines from the "old" and "new" substations. Line #3 serves barracks facilities, field training areas, and the area out to the sewage treatment plant. Line #4 covers a majority of the family housing areas as well as some barracks and personnel support facilities. Line #5 accounts for the remaining family housing and some support facilities. Line #6/8 serves older barracks,

Table 1.2. Fort Irwin Building Characterization

Building Type	Energy Type	Number of Buildings	Total Floorspace (ft ²)	Average Floorspace (ft ²)	Percent of Base Total Floorspace
ADMIN	E/P	77	362,029	4,702	6
ADMIN-MT	E/P	59	275,376	4,667	4
BRK/ADM	E/P	67	760,148	11,345	12
CHAPEL	E/P	4	23,614	5,904	< 1
CLINIC	E/P	8	25,310	3,164	< 1
CLUB	E/P	9	67,429	7,492	1
COMCATN	E/P	8	5,695	712	< 1
DET-RR	E/P	26	17,644	679	< 1
DGR	E/P	14	114,662	8,190	2
DINING	E/P	3	35,939	11,980	1
FUELDSP	E/P	34	64,715	1,903	1
GROCERY	E/P	1	56,500	56,500	1
HANGAR	E/P	5	82,520	16,504	1
HOSPITL	E/P	1	63,818	63,818	1
HOTEL	E/P	7	11,566	1,652	< 1
HSG-FAM	E/P	732	2,961,830	4,046	46
HUT	-	90	152,478	1,694	2
LAB-MED	E/P	2	9,415	4,708	< 1
MTRPOOL	E/P	30	309,890	10,330	5
MWR	E/P	20	125,854	6,293	2
OTHER	E/P	1	1,536	1,536	< 1
PLT-BLDG	E/P	18	12,366	687	< 1
POOL-OT	E/P	3	7,727	2,576	< 1
PUMP	E	22	10,976	499	< 1
REC	E/P	4	62,016	15,504	1
RESTRNT	E/P	2	4,712	2,356	< 1

Table 1.2. (contd)

Building Type	Energy Type	Number of Buildings	Total Floorspace (ft ²)	Average Floorspace (ft ²)	Percent of Base Total Floorspace
SECURTY	E/P	12	17,498	1,458	< 1
SHOP	E/P	10	189,273	18,927	3
SHOP-AIR	E/P	1	2,000	2,000	< 1
SHOP-ELC	E/P	5	22,684	4,537	< 1
SHOP-HVY	E/P	1	3,200	3,200	< 1
SHOP-WPN	E/P	1	8,022	8,022	< 1
STOR-UH	-	222	157,442	709	2
TRAIING	E/P	29	72,959	2,516	1
WHS	E/P	45	288,093	6,402	5
WHS-CLD	E/P	1	14,500	14,500	< 1
Totals		1,574	6,401,436		100
Notes: E: Electricity, P: Propane					

trailer spaces, support facilities, large maintenance shops, and other industrial areas. Line #7/9 covers the remaining older barracks and support facilities. The "new" substation was built to accommodate the planned expansion of the family housing areas. Accordingly, lines #4 and #5 are fed from the "new" substation; the remaining three lines are fed from the "old" substation. Both the transmission and distribution systems are overhead line systems for most of the commercial areas. A majority of the family housing areas are supplied by underground lines.

There are approximately 610 transformers at Fort Irwin, with a total estimated nameplate capacity of over 35,000 kVA. The losses associated with the operation of these transformers are estimated at an average level of 272 kW, for a total yearly loss of 2,382 MWh. Details of the methodology and Fort Irwin-specific calculations for transmission and distribution system losses can be found in Appendix A of this report.

1.2.3 Water and Sewer Service Characterization

Water is provided to Fort Irwin by eleven operating wells and six booster pumps. Eight of the wells are located in and around the main commercial area. The remaining three wells are to the northeast towards the Bicycle Lake Basin. The aggregate capacity of the well pumps is 4,595 gpm, with an aggregated load of 1,040 horsepower. Booster pumps are also in operation with each of the well systems at a total effective load of approximately 1,050 horsepower.

Table 1.3. Ranked List of Building Types at Fort Irwin

Building Type	Total Area (ft ²)	Percent Area	Cumulative Percent Area
HSG-FAM	2,961,830	46	46
BRK/ADM	760,148	12	58
ADMIN	362,029	6	64
MTRPOOL	309,890	5	69
WHS	288,093	5	74
ADMIN-MT	275,376	4	78
SHOP	189,273	3	81
STOR-UH	157,442	2	83
HUT	152,478	2	85
MWR	125,854	2	87
DGR	114,662	2	89
HANGAR	82,520	1	90
TRAIING	72,959	1	91
CLUB	67,429	1	92
FUELDSP	64,715	1	93
ALL OTHER	416738	< 1 EACH	100

In addition to the well and booster pump system, demineralized water is also produced for use at the Fort. This is supplied to all occupied facilities through a separate distribution system. Demineralization is accomplished at the Reverse Osmosis (RO) Plant. The current major aggregate load of the equipment at the RO plant is approximately 255 horsepower.

Sewage treatment for Fort Irwin is provided by an on-site system. This includes the treatment of sewage for the central Fort Irwin facilities and family housing. The current major aggregate load of the equipment at the sewage treatment plant is approximately 210 horsepower.

Table 1.4 provides an inventory of the various water wells, boosters, RO and sewage treatment equipment at Fort Irwin. The table includes estimated operating hours and consumption (in MWh) for a sample operating year. Consumption data are based on capacity and "run-time" information supplied by Fort Irwin personnel and assumptions of typical operating characteristics.

Table 1.4. Water Well, Booster, RO, and Sewage Treatment Inventory

Bldg. Number	Bldg. Description	Pump Motor Horsepower	Annual Run Hours	Estimated Annual MWh
00042	RO Plant	15	4,000	60
00042	RO Plant	15	4,000	60
00043	RO Plant	75	3,000	225
00044	RO Plant	75	8,760	657
00044	RO Plant	75	8,760	657
00149	Well I-3	60	1,820	109
00319	Well I-5	75	3,028	227
00386	Well I-6	60	3,420	205
00663	Well I-7	200	3,024	605
00700	Sewage Plant	25	4,000	100
00700	Sewage Plant	25	4,000	100
00700	Sewage Ponds	40	8,760	350
00700	Sewage Ponds	40	8,760	350
00700	Sewage Ponds	40	8,760	350
00700	Sewage Ponds	40	8,760	350
05990	Booster #1	200	1,104	221
05990	Booster #2	200	873	175
05990	Booster #3	200	1,544	309
05994	Bicycle Lake Well #2	60	344	21
05996	Bicycle Lake Well #4	100	3,262	326
05997	Bicycle Lake Well #5	125	2,441	305
05998	Bicycle Lake Well #1	60	3,100	186
18000	Langford Booster Stn.	150	2,594	389
18000	Langford Booster Stn.	150	3,052	458
18000	Langford Booster Stn.	150	1,506	226
18003	Langford Well #2	100	3,195	320
18005	Langford Well #1	125	3,590	449
18005	Langford Well #3	75	1,146	86
Totals:		2,555		7,876

1.2.4 Street and Parking Lot Lighting Characterization

Exterior street and parking lot lighting at Fort Irwin is comprised of a variety of lighting types and capacities including High Pressure Sodium (HPS), Mercury Vapor (Mercury), and Metal Halide (MH). Accurate records of quantities and capacities were not available from Fort sources. A manual lighting count was completed that included all street and parking lot lights in and around the main cantonment. Also included in the count were the perimeter lights at the ordinance storage area. This count along with

some lamp procurement information collected at the Fort was used to estimate street and parking lot ighting energy consumption. Table 1.5 provides details on the quantities, estimated types and consumption of street and parking lot lighting at Fort Irwin.

The total streetlighting demand was calculated to be 483 kW. Assuming a conservative 10 hours of operation per day (many will operate longer but some are only used during specific activity), this is equivalent to a total of 1,764 MWh per year. Streetlighting technology consists primarily of High Pressure Sodium (1,041), some Mercury Vapor (79) and a few Metal Halide (9).

Table 1.5. Street and Parking Lot Lighting at Fort Irwin

Lamp Type	Nominal Lamp Wattage	Total Fixture Wattage	Estimated Fixture Quantity	Estimated Annual MWh
HPS	1,000	1,100	72	286
HPS	400	465	505	857
HPS	250	305	459	511
HPS	200	240	5	4
Mercury	750	790	15	42
Mercury	400	460	1	2
Mercury	250	294	25	27
Mercury	175	210	14	11
Mercury	150	170	24	15
MH	1,000	1,080	1	2
MH	250	294	1	1
MH	175	210	7	5
Totals:			1,128	1,764
Lamp Counts:		HPS	1,041	
		Mercury	79	
		MH	9	

2.0 Energy Source Characteristics

Energy sources used by Fort Irwin include electricity, propane, and transportation fuels (gas, diesel, JP-4 and JP-8). Fuel oil is used in small quantities (primarily for backup generator systems) and is not considered in this assessment. Table 2.1 shows a summation of the sample annual energy consumption and cost at Fort Irwin for all facilities including family housing. For each energy type, the yearly total is shown in units appropriate to the energy as well as a common unit as a basis of comparison. The total consumption values are based on the usage values chosen for analysis in this report as typical current yearly usage. This sample year is based on the best available data gathered from 1991 through 1993 consumption levels. These are aggregations of various billing consumption amounts and are considered representative of normal Fort Irwin operational energy consumption.

2.1 Electric Supply Source Description

Electricity is supplied to Fort Irwin by Southern California Edison (SCE) and delivered to the Tiefert Terminal Station via a 115-kV transmission line. A sub-transmission line rated at 34.5-kV connects this station to the Fort Irwin substations. Fort Irwin is supplied under rate schedule TOU-8, with an additional incremental sales rate agreement covering additional electricity usage above pre-set limits.

The rate structure applicable to Fort Irwin (from the June 1993 bill) is shown in Table 2.2. The existing incremental sales rate (ISR) is very low. However, in 1997, Fort Irwin will no longer be eligible for the ISR and it is assumed that the Fort will revert to the base TOU-8 rate. This will increase the Fort's annual electric bill by approximately \$700,000 (based on May 1992 through June 1993 consumption and the current TOU-8 rate).

Table 2.1. Yearly Energy Consumption and Energy Cost at Fort Irwin

Energy Type	Yearly Total	Yearly Total (MBtu) ^(a)	Percent of Total	Yearly Total (1993 \$)	Percent of Total
Electricity	72,870 MWh	248,705 ^(b)	18.7	6,271,513	52.8
Propane	2,369,487 gal	225,101 ^(c)	16.9	1,120,293	9.5
Gasoline	446,098 gal	55,760 ^(d)	4.2	370,261	3.1
Diesel	3,718,042 gal	516,810 ^(e)	38.9	2,491,088	21.0
JP-4	770,500 gal	97,850 ^(f)	7.4	577,875	4.9
JP-8	1,367,750 gal	184,650 ^(g)	13.9	1,025,813	8.7
Totals		1,328,876	100.0	11,856,843	100.0
(a) 1 MBtu = 1,000,000 Btu. (b) 3,413 Btu/kWh. (c) 0.095 MBtu/gal. (d) 0.125 MBtu/gal. (e) 0.139 MBtu/gal. (f) 0.127 MBtu/gal. (g) 0.135 MBtu/gal.					

Table 2.2. Fort Irwin Electrical Rate Structure (July 1992)

Rate Periods	Summer	Winter
	(first Sunday in June - first Sunday in October)	(first Sunday in October - first Sunday in June)
Peak	12:00 noon to 6:00 PM (M-F)	NA
Mid-Peak	8:00 AM to 12:00 noon (M-F) 6:00 PM to 11:00 PM (M-F)	8:00 AM to 9:00 PM (M-F)
Off-Peak	All other hours not listed plus all day on weekends and holidays	
Super Off-Peak	NA	12:00 midnight to 6:00 PM
Base Rates:		
Charge	Summer	Winter
Demand Charges (per kW)		
Non-Time Related:		
Maximum Peak Demand (not less than 50 % of previous 11 months)	\$3.15	\$3.15
Time Related:		
Maximum Peak Period Demand	\$15.75	NA
Maximum Mid-Peak Period Demand	\$2.35	\$0.00
Maximum Off-Peak Period Demand	\$0.00	\$0.00
Energy Charges (per kWh)		
Peak Period	\$0.13752	NA
Mid-Peak Period	\$0.06517	\$0.07688
Off-Peak Period	\$0.04077	\$0.04335
Power Factor Adjustment (per kVAR)	\$0.25	\$0.25
Peak Period Rate Limiter (per kWh)	\$1.07244	NA
Peak Period Ave. Rate Limiter (per kWh)	\$0.17759	NA
Customer Charge (per meter per month)	\$359.45	\$359.45
Incremental Rates: (applicable to all consumption above base levels)		
Base Levels:		
Demand Levels (ave. monthly base level kW)	Summer	Winter
On-Peak	11,512	NA
Mid-Peak	10,856	8,812
Off-Peak	9,552	7,576
Super Off-Peak	NA	7,576
Non-Time Related	11,512	8,812
Consumption Levels (ave. monthly usage kWh)		
On-Peak	1,208,044	NA
Mid-Peak	1,646,208	1,862,044
Off-Peak	2,710,710	1,745,326
Super Off-Peak	NA	2,296,481
Charge	All Year	
Demand Charges (per kW above base level)	Avoided Cost plus \$1.00 per Summer On-Peak kW (rate varies with each rate period)	
Energy Charges (per kWh)	Avoided Cost plus \$0.02 per kWh (rate varies with each rate period)	
Public Utilities Commission (PUC) and Low Income	As determined	

2.2 Propane Supply Source Description

Propane is supplied to Fort Irwin through a competitive contract and delivered to a central propane storage area consisting of four 30,000-gallon tanks. The propane is distributed through 8-, 6-, 4-, and 2-inch lines throughout the Fort and is used primarily for heating, cooking, and water heating. The current propane rate is 47.3 cents per gallon.

2.3 Transportation Fuel Supply Source Description

Fuels for vehicle use are supplied to Fort Irwin by various contract suppliers and stored at point-of-use locations in commercial areas. The primary fuels are gasoline, diesel, JP-4 (aviation fuel) and JP-8 (combination aviation/ground fuel). Current fuel prices (\$/gal.) are gasoline at \$0.83, diesel at \$0.67, JP-4 at \$0.75, and JP-8 at \$0.75.

3.0 Energy-Use Intensities

Energy-use intensities (EUI) are defined as energy-use per unit floor area, per unit time and are commonly expressed as thousands of Btu per square foot per year (kBtu/ft²-year), or kilowatt hours per square foot per year (kWh/ft²-year). These EUI values are used to help develop baseline consumption for various building types when actual consumption data are not available. This section describes the EUI information that was used in the energy assessment at Fort Irwin.

The specific EUI values used in the Fort Irwin baseline assessment are derived from three primary data sources. The first is regional information collected from local utilities and other energy organizations that have prepared EUI data for their own and public use. The second is the PNL experience gained from analyzing EUI data at other federal sites, including military facilities. The similarity of military facilities from site to site, coupled with appropriate adjustments for climate and operational differences between the sites, provides valuable EUI information. These two sources make up the initial set of EUI values that are used as a starting point for determining appropriate EUI values.

The third and most accurate source of EUI data is actual metered and/or billing information obtained at the site itself. Since this information is usually scarce for a large sample of facilities at the site, the regional and previous site EUI values are relied upon for much of the assessment. Adjusting the data from these three data sources provides the means to derive a specific set of EUI values for the various buildings types and end uses at Fort Irwin.

3.1 Initial Energy-Use Data Values

Initial EUI values are used as a starting point to determine appropriate EUI values in the absence of specific data. The regional and local EUI data make up part of the initial EUI values and were collected from six sources that include Pacific Gas & Electric (PG&E), Southern California Edison (SCE), Los Angeles Department of Water & Power (LADWP), California Energy Commission data for Burbank, Glendale, and Pasadena (BGP), data from the Environmental Protection Agency Western Systems Coordinating Council (EPA/WSCC), and the Energy Information Administration's Commercial Buildings Energy Consumption Survey (CBECS). (Complete references are included in the bibliography.)

Tables B.1–B.24 (located in Appendix B) break out energy use by facility type, building type, fuel type, and fuel end use by data source. The two major building type categories are residential and commercial. Energy use is expressed in kWh/ft²-year for electric EUIs and kBtu/ft²-year for fossil fuel EUIs. Energy-use data are reported for the following end use categories: space heating, cooling, domestic hot water (DHW), cooking, refrigeration, interior and exterior lighting, office equipment, and other. The other category includes miscellaneous end uses like electrical appliances, motors, and water/steam heating for laundry or food preparation.

In the residential category, data were available only as unit energy consumption (UEC) values, given in units of kWh/year per dwelling unit. To convert a UEC to an EUI, an average residential square foot value must be assumed. For this assessment, values of 1,500 ft² for a single family residence and 1,000 ft² for a multi-family residential unit were assumed based on CBECS data. These EUI values were used as a starting point for the analysis of Fort Irwin.

While some of the EUI values correlate well from source to source for a given building type, fuel type, and end use, others do not. There are a number of reasons for discrepancies, including data were derived from different service areas, differences in building size and shape, and poorly defined or ambiguous building types.

The second data source of initial EUI values is that derived from other federal site analysis efforts where similar building types were considered. For this analysis adjustments were made to the regional EUI values where deemed appropriate based on experience at other similar sites. Tables B.25 and B.26 (in Appendix B) contain the fossil and electric EUI values that were used as the initial EUI values for Fort Irwin.

3.2 Site-Specific Energy Use and Consumption

A primary product of the energy baseline analysis for Fort Irwin is the site-specific EUI values for various building types and end uses that make up the energy consumption at Fort Irwin. These EUI values are considered reasonable representations of the magnitude of energy consumption among various end uses, buildings, and areas of Fort Irwin.

The initial step in the development of these values was to assess all available regional and published EUI data that might be applicable to Fort Irwin (Tables B.1–B.26). After reviewing various sources and matching existing data generated from PNL measurements at other facilities, a set of initial EUI values was derived (Tables B.25 and B.26). This set of values provides a reasonable starting EUI value to be used in assigning site-specific EUI values to Fort Irwin facilities.

The next step in EUI development involves the third primary EUI data source (metered data) as well as other site data such as occupancy, fuel availability, and other specific operational characteristics. In this step the initial EUI values are adjusted based on metered data and any available operational characteristics. For Fort Irwin a single adjustment factor was initially applied to initial EUI values that included the effects of building occupancy, fuel availability, and known building function. For example:

- Housing occupancy is known to be around 98%.
- Only 31% of training buildings are known (based on real property data) to have propane fuel available.
- Only 77% of warehouses are known to have any cooling capacity (based on real property data).

These combined factors use available specific Fort Irwin characteristics to adjust the initial EUIs to more closely represent Fort Irwin energy use. In addition, any available actual metered or other billing data are also applied in place of the EUI system wherever appropriate. For example, the electric housing EUI values are derived from the actual Fort Irwin family housing total billing values.

The final step in deriving specific EUIs and allocating energy use among buildings is the reconciliation of the component energy use based on EUIs and other estimated consumption and the billing totals for Fort Irwin. This involves calculating energy use for each building type by multiplying the EUIs by the total square footage. These values are then added to any non-building energy use such as streetlights, water, and sewer. The total of all of these component energy uses should equal the total billed consumption for the Fort. At this point adjustments are made to the EUI values or other consumption values to come to a

balance between the estimated and billed energy amounts. These final adjustments are made based on supplementary knowledge of facility characteristics. Tables 3.1 and 3.2 detail the final adjusted EUI values for the end uses and building types represented at Fort Irwin.

Table 3.1. Fort Irwin-Specific Propane Fuel Energy-Use Intensities (kBtu/ft²/year)

Bldg Type	Total	Heating	DHW	Cooking	Other
ADMIN	35.56	34.30	1.26	0.00	0.00
ADMIN-MT	0.00	0.00	0.00	0.00	0.00
BRK/ADM	36.37	28.97	7.40	0.00	0.00
CHAPEL	28.03	26.14	1.33	0.56	0.00
CLINIC	88.13	45.31	15.00	0.00	27.82
CLUB	145.91	9.18	14.84	106.04	15.85
COMCATN	30.86	30.32	0.53	0.00	0.00
DET-RR	3.04	0.00	3.04	0.00	0.00
DGR	10.84	10.40	0.44	0.00	0.00
DINING	129.02	9.18	14.84	89.15	15.85
FUELDSP	26.14	26.14	0.00	0.00	0.00
GROCERY	21.20	8.25	3.77	2.85	6.34
HANGAR	26.60	26.14	0.47	0.00	0.00
HOSPITL	104.79	45.31	30.14	1.52	27.82
HOTEL	0.00	0.00	0.00	0.00	0.00
HSG-FAM	42.54	26.37	10.78	5.39	0.00
HUT	0.00	0.00	0.00	0.00	0.00
LAB-MED	68.82	26.00	15.00	0.00	27.82
MTRPOOL	20.87	19.86	1.01	0.00	0.00
MWR	24.17	23.00	1.17	0.00	0.00
OTHER	27.46	26.14	1.33	0.00	0.00
PLT-BLDG	56.06	8.26	1.20	0.00	46.60
POOL-OT	50.91	0.00	5.35	0.00	45.56
PUMP	0.00	0.00	0.00	0.00	0.00
REC	34.32	25.35	8.97	0.00	0.00
RESTRNT	72.96	4.59	7.42	53.02	7.92
SECURTY	26.64	25.35	1.29	0.00	0.00
SHOP	1.47	1.29	0.19	0.00	0.00
SHOP-AIR	10.51	9.18	1.33	0.00	0.00
SHOP-ELC	3.99	3.49	0.50	0.00	0.00
SHOP-HVY	10.51	9.18	1.33	0.00	0.00
SHOP-WPN	0.00	0.00	0.00	0.00	0.00
STOR-UH	0.00	0.00	0.00	0.00	0.00
TRAIING	4.09	3.40	0.69	0.00	0.00
WHS	6.24	5.69	0.54	0.00	0.00
WHS-CLD	0.00	0.00	0.00	0.00	0.0

Table 3.2. Fort Irwin-Specific Electric Energy-Use Intensities (kWh/ft²/year)

Bldg. Type	Area (ft ²)	Total	Heat	Cool	Vent	DHW	Cook	Int. Ligs.	Ext. Ligs.	Refrig.	Off. Equip.	Other
ADMIN	362,029	11.11	0.00	2.00	0.98	0.00	0.05	5.00	1.00	0.12	1.46	0.50
ADMIN-MT	275,376	12.05	0.96	3.86	0.36	0.09	0.04	4.82	0.41	0.10	1.20	0.21
BRK/ADM	760,148	12.04	0.05	4.63	1.05	0.00	0.10	2.85	0.38	0.96	0.02	2.00
CHAPEL	23,614	7.44	0.00	1.50	1.38	0.00	0.05	3.00	0.80	0.06	0.15	0.50
CLINIC	25,310	27.96	0.00	4.72	1.86	0.00	0.10	9.59	1.00	0.57	3.28	6.85
CLUB	67,429	35.72	0.00	5.97	6.32	0.00	4.60	3.00	1.00	10.54	0.04	4.26
COMCATN	5,695	8.08	0.03	1.38	1.13	0.08	0.05	1.50	0.50	0.00	2.92	0.50
DET-RR	17,644	4.91	0.00	0.00	1.73	0.78	0.00	2.00	0.40	0.00	0.00	0.00
DGR	114,662	10.20	0.01	0.75	1.22	0.00	0.05	5.62	1.00	0.41	0.18	0.95
DINING	35,939	41.62	0.10	5.97	6.32	0.00	4.60	7.14	2.67	10.54	0.04	4.26
FUELDSP	64,715	1.18	0.00	0.02	0.02	0.00	0.00	0.75	0.40	0.00	0.00	0.00
GROCERY	56,500	41.09	0.00	3.00	2.01	0.00	0.77	10.69	1.52	20.90	0.42	1.78
HANGAR	82,520	3.30	0.00	0.00	0.00	0.00	0.10	1.50	0.80	0.10	0.30	0.50
HOSPITL	63,818	37.34	0.00	9.44	6.32	0.00	0.30	9.59	1.00	0.57	3.28	6.85
HOTEL	11,566	14.88	4.04	2.44	0.88	2.50	0.05	3.80	0.40	0.25	0.02	0.50
HSG-FAM	2,961,830	6.91	0.00	2.91	0.80	0.00	0.10	1.00	0.10	1.40	0.00	0.60
HUT	152,478	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LAB-MED	9,415	32.40	0.00	9.44	2.33	0.00	0.10	9.59	0.25	0.57	3.28	6.85
MTRPOOL	309,890	7.77	0.00	1.28	1.47	0.00	0.10	3.00	0.80	0.10	0.10	0.93
MWR	125,854	11.66	0.00	1.86	1.60	0.08	0.05	6.00	0.80	0.05	0.30	0.93
OTHER	1,536	6.86	0.00	0.75	1.38	0.00	0.00	3.00	0.80	0.00	0.00	0.93
PLT-BLDG	12,366	3.25	0.01	0.18	0.21	0.00	0.05	2.00	0.80	0.00	0.00	0.00
POOL-OT	7,727	1.42	0.00	0.00	0.52	0.00	0.00	0.50	0.40	0.00	0.00	0.00
PUMP	10,976	0.65	0.00	0.00	0.00	0.00	0.25	0.40	0.00	0.00	0.00	0.00
REC	62,016	15.29	0.00	1.50	1.86	0.00	0.05	10.00	0.80	0.05	0.10	0.93
RESTRNT	4,712	44.55	0.00	9.00	6.32	0.00	4.60	7.14	2.67	10.54	0.04	4.26
SECURTY	17,498	13.45	0.00	0.75	1.21	0.00	0.10	6.00	1.43	0.24	1.00	2.72
SHOP	189,273	6.55	0.00	0.75	1.38	0.39	0.10	2.00	0.80	0.10	0.10	0.93
SHOP-AIR	2,000	6.16	0.00	0.75	1.38	0.00	0.10	2.00	0.80	0.10	0.10	0.93
SHOP-ELC	22,684	6.58	0.03	0.99	1.14	0.39	0.10	2.00	0.80	0.10	0.10	0.93
SHOP-HVY	3,200	5.41	0.00	0.00	1.38	0.00	0.10	2.00	0.80	0.10	0.10	0.93
SHOP-WPN	8,022	7.04	0.10	0.75	1.38	0.78	0.10	2.00	0.80	0.10	0.10	0.93
STOR-UH	157,442	0.12	0.00	0.00	0.00	0.00	0.00	0.10	0.02	0.00	0.00	0.00
TRAIING	72,959	7.22	0.06	2.79	0.77	0.00	0.00	2.85	0.70	0.00	0.05	0.00
WHS	288,093	2.95	0.01	0.73	0.53	0.00	0.00	1.00	0.09	0.05	0.05	0.50
WHS-CLD	14,500	48.85	0.10	0.47	0.55	0.00	0.00	2.00	0.19	45.00	0.05	0.50

4.0 Electrical Consumption

4.1 Metering and Data Summary

The three sources of metered electricity consumption data at Fort Irwin are utility meter readings, on-base metering, and PNL substation metering.

Utility meter readings for June 1992 through May 1993 are detailed in Table 4.1. These represent the utility billing records used as the sample year baseline consumption. To provide appropriate billing data to various Army and private organizations, the total Fort Irwin bill is apportioned using on-base metering and engineering judgment into bills for family and General's housing, trailer court spaces, and other reimbursable facilities. Many of the on-base meter records were unusable due to meter errors or missing data. The billing values prepared by Fort Irwin for the family and General's housing, trailer court area, and school were directly usable in determining appropriate EUI values. Metering of the five feeders at the "old" substation was completed by PNL during 1990. The resulting data covered two-week periods in three summer months. These data were useful as a general check of other consumption levels but not as a primary data point for EUI development. See Section 4.3 for analysis of the PNL-collected demand level data.

Table 4.1. Fort Irwin Electric Demand and Consumption - 5/92 to 4/93

Month	Total kWh Consumed	Peak Demand (kW)	Cost	Fiscal Year
JUN	7,258,800	38,645	\$651,872	1992
JUL	7,362,000	45,735	\$763,039	
AUG	8,436,000	47,558	\$821,562	
SEP	7,872,000	43,257	\$784,696	
OCT	6,632,400	42,048	\$559,348	
NOV	4,926,000	24,480	\$388,815	
DEC	5,020,800	24,613	\$432,916	
JAN	5,221,200	26,893	\$352,226	1993
FEB	4,760,400	23,347	\$358,907	
MAR	4,465,200	23,501	\$358,542	
APR	5,076,000	26,035	\$377,793	
MAY	5,839,200	33,139	\$421,796	
TOTALS	72,870,000		\$6,271,513	

4.2 Energy-Use Breakdown

The electrical consumption for buildings at Fort Irwin is shown in Table 4.2. Consumption is apportioned by building type and by primary end use in each building type. Table 4.3 shows the total electrical usage for buildings (from Table 4.2) along with an accounting of all electrical usage not directly associated with buildings such as transmission and distribution losses, water supply and sewage treatment. The electrical consumption shown in Table 4.3 accounts for nearly 100% of the total use for the sample base year at Fort Irwin.

Table 4.2. Sample Fort Irwin Buildings Electrical Usage (kWh/year)

Bldg. Type	Area (ft ²)	Total	Heat	Cool	Vent	DHW	Cook	Int. Ligs.	Ext. Ligs.	Refrig.	Off. Eqp.	Other
ADMIN	362,029	4,021,672	0	724,058	354,499	0	18,101	1,810,145	362,029	44,168	527,657	181,015
ADMIN-MT	275,376	3,318,832	265,462	1,062,951	99,135	23,682	11,290	1,327,312	113,455	27,262	331,553	56,727
BRK/ADM	760,148	9,151,680	37,430	3,522,602	797,243	0	76,015	2,166,422	287,051	727,842	16,248	1,520,828
CHAPEL	23,614	175,688	0	35,421	32,587	0	1,181	70,842	18,950	1,417	3,483	11,807
CLINIC	25,310	707,722	0	119,495	47,137	0	2,531	242,660	25,310	14,325	83,017	173,247
CLUB	67,429	2,408,564	0	402,551	425,983	0	309,836	202,287	67,429	710,702	2,866	286,910
COMCATN	5,695	46,008	146	7,859	6,413	467	285	8,543	2,848	0	16,601	2,848
DET-RR	17,644	86,566	0	0	30,436	13,762	0	35,288	7,080	0	0	0
DGR	114,662	1,169,828	1,364	85,997	140,346	0	5,733	644,400	114,662	47,470	20,926	108,929
DINING	35,939	1,495,880	3,603	214,556	227,045	0	165,140	256,515	95,777	378,797	1,527	152,920
FUELDSP	64,715	76,590	0	971	1,116	0	0	48,536	25,967	0	0	0
GROCERY	56,500	2,321,416	0	169,500	113,565	0	43,364	603,985	85,598	1,181,076	23,871	100,457
HANGAR	82,520	272,110	0	0	0	0	8,252	123,780	66,222	8,252	24,343	41,260
HOSPITL	63,818	2,382,868	0	602,601	403,330	0	18,986	611,855	63,818	36,121	209,323	436,834
HOTEL	11,566	172,101	46,700	28,209	10,215	28,944	578	43,922	4,597	2,892	260	5,783
HSG-FAM	2,961,830	20,459,433	0	8,612,113	2,369,464	0	296,183	2,961,830	296,183	4,146,562	0	1,777,098
HUT	152,478	0	0	0	0	0	0	0	0	0	0	0
LAB-MED	9,415	305,060	0	88,901	21,918	0	942	90,266	2,377	5,329	30,881	64,446
MTRPOOL	309,890	2,407,458	0	395,110	454,376	0	30,989	929,670	248,687	30,989	30,989	286,648
MWR	125,854	1,468,055	0	234,088	201,901	9,817	6,293	755,124	100,998	6,293	37,127	116,415
OTHER	1,536	10,533	0	1,152	2,120	0	0	4,608	1,233	0	0	1,421
PLT-BLDG	12,366	40,208	148	2,226	2,560	0	618	24,732	9,924	0	0	0
POOL-OT	7,727	10,963	0	0	3,999	0	0	3,864	3,100	0	0	0
PUMP	10,976	7,148	0	0	0	0	0	2,744	4,404	0	0	0
REC	62,016	948,318	0	93,024	115,598	0	3,101	620,160	49,768	3,101	6,202	57,365
RESTRNT	4,712	209,931	0	42,408	29,768	0	21,652	33,632	12,557	49,664	200	20,050
SECURTY	17,498	235,396	17	13,124	21,203	0	1,750	104,988	25,022	4,270	17,498	47,525
SHOP	189,273	1,239,833	568	141,955	261,197	73,816	18,927	378,546	151,892	18,927	18,927	175,078
SHOP-AIR	2,000	12,320	0	1,500	2,760	0	200	4,000	1,600	200	200	1,860
SHOP-ELC	22,684	149,170	681	22,457	25,826	8,847	2,268	45,368	18,204	2,268	2,268	20,983
SHOP-HVY	3,200	17,312	0	0	4,416	0	320	6,400	2,560	320	320	2,976
SHOP-WPN	8,022	56,455	802	6,017	11,070	6,257	802	16,044	6,438	802	802	7,420
STOR-UH	157,442	18,657	0	0	0	0	0	15,744	2,913	0	0	0
TRAIING	72,959	526,819	4,523	203,556	56,453	0	0	207,568	51,071	0	3,648	0
WHS	288,093	850,180	1,440	209,409	151,733	0	0	288,093	26,649	14,405	14,405	144,047
WHS-CLD	14,500	708,386	1,450	6,844	7,934	0	0	29,000	2,683	652,500	725	7,250
Totals	6,401,436	57,489,159	364,336	17,050,654	6,433,347	165,593	1,045,337	14,718,873	2,359,054	8,115,953	1,425,868	5,810,145
% of Total	—	100.0%	0.6%	29.7%	11.2%	0.3%	1.8%	25.6%	4.1%	14.1%	2.5%	10.1%

Table 4.3. Overall Fort Irwin Electric Consumption (MWh/year)

Sector	Consumption (MWh/year)	Percent of Consumption
Buildings	58,106	81.1 %
Water Supply/Sewage Treatment	7,876	11.0 %
Transformer Losses	2,392	3.3 %
Street/Lot Lighting	1,764	2.5 %
Fort Irwin School	1,100	1.5 %
Trailer Sites	422	0.6 %
General's Quarters	21	<0.1 %
Total	71,681	100.0 %

4.3 Electrical Demand Summary

Time-of-use data were collected through PNL metering equipment as part of a separate study sponsored by FORSCOM. The metering was completed for all five main feeders and produced good usable data for two-week periods in April, June and August of 1990. The study results indicate that the overall Fort Irwin demand profile is generally flat - indicating little easy opportunity for any peak shaving options that do not involve general load reduction. Figure 4.1 presents the average weekday load profiles for the available metered data in April, June and August. Figure 4.2 presents the corresponding profiles for weekends. Figures 4.3 through 4.8 present the demand profiles for each month, by feeder.

Additional detail on Fort Irwin feeder demand can be found in the Mobile Energy Laboratory (MEL) report for the Federal Energy Management Program (FEMP) titled *Test Report for Fort Irwin: Electric Substation Monitoring* (unpublished).

Figure 4.1. Weekday Average Electric Load Profiles

Figure 4.2. Weekend Average Electric Load Profiles

Figure 4.3. April Weekday Average Electric Demand by Feeder

Figure 4.4. April Weekend Average Electric Demand by Feeder

Figure 4.5. June Weekday Average Electric Demand by Feeder

Figure 4.6. June Weekend Average Electric Demand by Feeder

Figure 4.7. August Weekday Average Electric Demand by Feeder

Figure 4.8. August Weekend Average Electric Demand by Feeder

5.0 Propane Consumption

5.1 Metering and Data Summary

Propane delivery data were provided by Fort Irwin as monthly delivery totals to the distribution storage tanks. Some on-base metering exists for gas distribution. Unfortunately, most was unusable due to inoperable meters, questionable, or missing data. Metered values for the General's housing, dining and commissary facilities were used in the calculation of EUI values. The consumption for March 1991 through February 1992 was chosen as a sample yearly use.

5.2 Energy-Use Breakdown

Propane consumption for Fort Irwin buildings is shown in Table 5.1. The consumption is apportioned within each building type, for each of its primary end uses. All of the propane use at Fort Irwin is accounted for in Table 5.2. The consumption of propane by the four central systems is represented by the consumption of each of the buildings (in Table 5.1) that are on the systems. A relatively small amount of loss due to plant inefficiencies is expected but not considered critical to this baseline assessment.

Table 5.1. Sample Fort Irwin Propane Consumption (MBtu/year)

Bldg. Type	Area (ft ²)	Total	Heating	DHW	Cooking	Other
ADMIN	362,029	12,872	12,416	457	0	0
ADMIN-MT	275,376	0	0	0	0	0
BRK/ADM	760,148	27,644	22,021	5,622	0	0
CHAPEL	23,614	662	617	31	13	0
CLINIC	25,310	2,231	1,147	380	0	704
CLUB	67,429	9,839	619	1,001	7,150	1,069
COMCATN	5,695	176	173	3	0	0
DET-RR	17,644	54	0	54	0	0
DGR	114,662	1,243	1,193	51	0	0
DINING	35,939	5,244	330	533	3,811	570
FUELDSP	64,715	1,691	1,691	0	0	0
GROCERY	56,500	1,198	466	213	161	358
HANGAR	82,520	2,195	2,157	38	0	0
HOSPITL	63,818	6,687	2,892	1,923	97	1,776
HOTEL	11,566	0	0	0	0	0
HSG-FAM	2,961,830	126,002	78,109	31,929	15,964	0
HUT	152,478	0	0	0	0	0
LAB-MED	9,415	648	245	141	0	262
MTRPOOL	309,890	6,468	6,155	313	0	0
MWR	125,854	3,042	2,894	147	0	0
OTHER	1,536	42	40	2	0	0
PLT-BLDG	12,366	693	102	15	0	576
POOL-OT	7,727	393	0	41	0	352
PUMP	10,976	0	0	0	0	0
REC	62,016	2,128	1,572	556	0	0
RESTRNT	4,712	344	22	35	250	37
SECURTY	17,498	466	444	23	0	0
SHOP	189,273	279	243	35	0	0
SHOP-AIR	2,000	21	18	3	0	0
SHOP-ELC	22,684	91	79	11	0	0
SHOP-HVY	3,200	34	29	4	0	0
SHOP-WPN	8,022	0	0	0	0	0
STOR-UH	157,442	0	0	0	0	0
TRAIING	72,959	299	248	50	0	0
WHS	288,093	1,797	1,640	156	0	0
WHS-CLD	14,500	0	0	0	0	0
TOTAL	6,401,436	213,874	137,563	43,767	26,840	5,703
% OF TOTAL	--	100.0	64.3	20.5	12.5	2.7

Table 5.2. Overall Fort Irwin Propane Consumption (MBtu/year)

Sector	Consumption (MBtu/year)	Percent of Consumption
Buildings	213,874	94.7%
Fort Irwin School	11,582	5.1%
Trailer Sites	217	<0.1%
General's Quarters	107	<0.1%
Total	225,780	100.0%

6.0 Transportation Fuel Consumption

6.1 Metering and Data Summary

Transportation fuel quantities were provided by Fort Irwin as yearly total values for gasoline, diesel, JP-4, and JP-8 fuels. JP-4 is used almost exclusively by helicopters. JP-8 is used by both helicopters and as a replacement fuel for diesel. According to site personnel, there is an effort underway to completely eliminate the use of diesel fuel, replacing it with JP-8. Portions of each of the fuels are used for field operations by the rotational units that train at Fort Irwin. Basic vehicle records were available for Fort Irwin and on-site General Services Administration (GSA) ground vehicles. Table 6.1 shows type, fuel, and quantities of ground vehicles. No information was collected for tactical vehicles or aircraft that would consume the JP-4 and/or JP-8 fuels.

Table 6.1. Current On-Site Fort Irwin Vehicle Inventory

Vehicle Type	Fuel Type	Quantity
Sedan	Gasoline	72
Ambulance	Gasoline	3
Truck	Gasoline	116
Truck	Diesel	12
Truck w/Trailer	Diesel	5
Pickup Truck	Gasoline	82
Passenger Van	Gasoline	91
Passenger Van	Diesel	3
Bus	Diesel	12
Forklift	Diesel	16
Misc. (backhoe, grader, etc.)	Diesel	11
Total		423

6.2 Energy-Use Breakdown

Table 6.2 provides details on sample yearly consumption as well as estimates of field use quantities provided by Fort Irwin.

Table 6.2. Sample Fort Irwin Vehicle Fuel Consumption (MBtu/year)

Fuel Type	Yearly Consumption (Gal)	Percent Used For Rotational Training
Gasoline	446,098	30 % ^(a)
Diesel	3,718,042	74 % ^(a)
JP-4	770,500	63 % ^(a)
JP-8	1,367,750	69 % ^(a)
(a) The balance of consumption is used for standard operations not associated with specific rotational unit use.		

7.0 References

Earley, M. W., et al. 1989. *The National Electrical Code Handbook: Based on the 1990 Edition of the National Electrical Code*. National Fire Protection Association, Quincy, Massachusetts.

Gönen, T. 1986. *Electric Power Distribution System Engineering*. Mc-Graw-Hill Book Company, New York, New York.

7.1 Regional EUI Sources

Commercial Sector Energy Use Simulation for Planning Area: BGP (Burbank, Glendale, Pasadena). 1989. California Energy Commission.

Commercial Sector Energy Use Simulation for Planning Area: LADWP (Los Angeles Department of Water and Power). 1989. California Energy Commission.

Commercial Sector Energy Use Simulation for Planning Area: PG&E (Pacific Gas and Electric). 1989. California Energy Commission.

Commercial Sector Energy Use Simulation for Planning Area: SCED (Southern California Edison). 1989. California Energy Commission.

Household Energy Consumption and Expenditure 1987 (RECS). 1987. Energy Information Administration.

Nonresidential Building Energy Consumption Survey: Commercial Buildings Consumption and Expenditure 1986 (CBECS). 1986. Energy Information Administration.

EPA Regional Commercial and Residential End-Use Data: WSCC (Western Systems Coordinating Council). 1986. Environmental Protection Agency.

Appendix A

Transmission and Distribution System

Appendix A

Transmission and Distribution System

Most of the transmission and distribution system energy losses at Fort Irwin are due to transformer losses. Transformers are necessary to convert high voltage distribution power to low voltage utilization power. The total combined losses for the approximately 610 Fort Irwin distribution transformers account for about 2.4 million kWh of annual energy losses, contributing approximately 273 kW to the peak demand. The methodology for calculating this consumption is given in this appendix. Transformer loss calculations were done using incomplete data. In some cases, the number of phases, primary or secondary voltages were unavailable. In these cases, the losses were extrapolated from the average losses calculated for the known data. Unavailable data in the tables are denoted by a "-".

A.1 Transformer Loss Methodology

Transformer energy loss consists of no-load and load power losses. No-load loss is the energy consumed by the transformer's magnetic field during periods when the transformer is energized. It is dependent on the configuration and design of the device, materials used, and the voltage and frequency of the power. These characteristics remain constant during the loading cycle and, therefore, do not change with transformer load (typically measured in kVA).

Load losses, on the other hand, are produced from resistance in the conductor windings. These losses are a function of the total transformer current, and vary as a function of the square of the transformer load.

A.2 Transformer Loss Characteristics

Table A.1 lists typical no-load and load losses for transformer sizes at Fort Irwin. These data were extrapolated from data contained in Gönen (1986), with interpolation and extrapolation for those sizes not included in Gönen. The load loss given in the table represents operation at full nameplate capacity, as measured in kVA. Loss values for transformers where phase or voltage information was missing were estimated by assuming similar characteristics to other transformers of the same or similar sizes.

A.2.1 Peak Power Loss

Transformer loss calculations include both the peak power demand and the annual energy consumption. This distinction is particularly important to assess the impact to the overall electrical consumption, since both demand and energy are billed separately.

The peak transformer demand includes the no-load and load losses. Since transformer loss is a function of load, the maximum transformer loss is coincident with the peak load consumed by Fort Irwin.

Table A.1. Individual Transformer Losses by Size

			Loss (Watts)	
No. of Phases	Voltage Prim/Sec	Capacity (kVA)	No-Load	Load
1	120/240	5	41	103
1	120/240	10	68	136
1	120/240	15	84	198
1	120/240	25	118	304
1	120/240	37.5	166	404
1	120/240	50	185	535
1	120/240	75	285	700
1	120/240	100	355	920
1	120/240	167	500	1600
1	-/480	10	68	141
3	34.5k/12k	7500	11600	50600
3	120/208	10	88	247
3	120/208	15	106	280
3	120/208	25	149	430
3	120/208	37.5	198	585
3	120/208	45	223	683
3	120/208	50	246	734
3	120/208	75	360	990
3	120/208	100	445	1130
3	120/208	112.5	530	1270
3	120/208	150	560	1690
3	120/208	225	880	2420
3	120/208	300	1050	3250
3	120/208	500	1600	5200
3	120/240	10	68	136
3	120/240	15	84	198

Table A.1. (contd)

			Loss (Watts)	
No. of Phases	Voltage Prim/Sec	Capacity (kVA)	No-Load	Load
3	120/240	25	118	304
3	120/240	37.5	166	404
3	120/240	50	185	535
3	120/240	100	355	920
3	120/240	167	500	1600
3	120/240	300	749	3202
3	-/240	10	68	136
3	-/240	25	118	304
3	2400/4160	100	416	798
3	277/480	15	87	242
3	277/480	25	144	403
3	277/480	37.5	370	600
3	277/480	112.5	530	1270
3	277/480	300	1050	3050
3	277/480	500	1600	4900
3	277/480	750	1800	7600
3	-/480	10	68	141
3	-/480	15	84	203
3	-/480	25	118	309
3	-/480	37.5	166	409
3	-/480	50	234	748
3	-/480	75	360	990
3	-/480	100	473	177
3	-/480	112.5	530	1270
3	-/480	167	633	3212
3	-/480	225	880	2420

Table A.1. (contd)

			Loss (Watts)	
No. of Phases	Voltage Prim/Sec	Capacity (kVA)	No-Load	Load
3	-/480	500	1600	4900
3	-/-	15	106	280
3	-/-	25	149	430
3	-/-	37.5	166	404
3	-/-	50	185	535
3	-/-	75	360	990
3	-/-	150	560	1690
3	-/-	500	1600	5200
-	-/-	10	68	136
-	-/-	25	149	430
-	-/-	37.5	166	404

The transformer load loss given in Table A.1 represents the loss at nameplate capacity. Since the peak load is normally quite different than the transformer capacity, the actual loss must be adjusted accordingly. Equation (A.1) gives the formula for calculating the demand loss factor (F_{DLS}), used to adjust the transformer loss during peak loading as opposed to nameplate capacity operation. Since the load loss is primarily resistive losses in the windings, this equation is based on the I^2R nature of resistive loss.

$$F_{DLS} = \left(\frac{\text{Peak Load (kVA)} \times \text{div. factor}}{\text{Nameplate Capacity (kVA)}} \right)^2 \quad (A.1)$$

A.2.2 Annual Energy Loss

To calculate the total annual energy loss of the transformers, both the no-load and load contributions must be properly accounted for. The no-load energy consumption is the no-load loss multiplied by the number of hours in the year. The load loss contribution must include the variations in the load. Variations in electrical consumption at Fort Irwin exist both seasonally (primarily summer/winter) and hourly (within 24 hour day). An equation based on empirical data, developed in Gönen (1986), correlates the average transformer loss with the average and peak loads of the system. This formula takes into consideration the I^2R nature of the resistive loss and typical characteristics of daily load variations (within 24

hour day). The equation is then modified to account for the difference between peak load and nameplate capacity. The energy loss factor (F_{ELS}) is now given by Equation (A.2).

$$F_{ELS} = F_{DLS} (0.3 F_{LD} + 0.7 F_{LD}^2) \quad (A.2)$$

where $F_{LD} = \text{Load Factor} = \frac{\text{Average Load (kW)}}{\text{Peak Load (kW)}}$

A.3 Fort Irwin Transformer Losses

For the transformers at Fort Irwin, average and peak loads for summer and winter were derived based on peak billed kW and total transformer nameplate capacity. Power factors were calculated for each season based on the reported kVAR values from utility billing records. These were found to be 0.8965 for summer and 0.9071 for winter. The load factors were based on the calculated average load for the season divided by the billed peak load. The demand and energy loss factors are given in Table A.2.

A diversity (ratio between the individual maximum demands and the coincident maximum demand) factor of 2.0 was applied to all transformers based on the National Electric Code diversity factor allowances (Earley et al. 1989). The equations for calculating the overall contribution of transformer losses on the Fort Irwin peak power demand and annual energy consumption are given below in Equations (A.3) and (A.4).

$$\text{Peak Power Loss} = \text{NLL} + F_{DLS} \text{ LL} \quad \text{Watts} \quad (A.3)$$

$$\text{Annual Energy Loss} = 8.76 (\text{NLL} + F_{ELS} \text{ LL}) \quad \text{kWh/year} \quad (A.4)$$

where NLL = Transformer no-load loss (watts)
LL = Transformer load loss (watts)

Table A.2. Loss Factors for Fort Irwin Transformers

Season	Peak Load (MW)	Power Factor	Demand Loss Factor	Load Factor	Energy Loss Factor
Summer	16.838	0.8965	1.140	0.135	0.0605
Winter	10.714	0.9071	0.451	0.157	0.0290

The total transformer power and energy consumption for Fort Irwin, aggregated by transformer size, is given in Table A.3.

Table A.3. Fort Irwin Transformer Power Consumption by Size

No. Phase	Voltage Prim/Sec	Capacity (kVA)	No. Units	Energy		Demand	
				Summer (kWh)	Winter (kWh)	Summer (kW)	Winter (kW)
1	120/240	5	2	494	426	0.3	0.2
1	120/240	10	25	9,680	8,542	5.6	3.2
1	120/240	15	36	17,928	15,543	11.2	6.2
1	120/240	25	14	10,032	8,608	6.5	3.6
1	120/240	37.5	35	34,737	30,005	21.9	12.2
1	120/240	50	54	62,735	53,068	42.9	23.0
1	120/240	75	52	88,824	76,644	56.3	31.2
1	120/240	100	29	62,619	53,692	40.7	22.3
1	120/240	167	8	25,929	21,646	18.6	9.8
1	-/480	10	2	781	687	0.5	0.3
1	-/-	59	1	1,162	983	0.8	0.4
3	34.5k/12k	7500	5	420,247	335,588	346.5	172.1
3	120/208	10	30	16,431	13,952	11.1	6.0
3	120/208	15	24	15,557	13,309	10.2	5.6
3	120/208	25	51	47,690	40,352	32.6	17.5
3	120/208	37.5	12	15,019	12,670	10.4	5.5
3	120/208	45	1	1,425	1,197	1.0	0.5
3	120/208	50	15	23,395	19,711	16.2	8.7
3	120/208	75	10	22,272	18,959	14.9	8.1
3	120/208	100	9	24,223	20,820	15.6	8.6
3	120/208	112.5	2	6,311	5,462	4.0	2.2
3	120/208	150	2	7,126	5,995	5.0	2.6
3	120/208	225	3	16,333	13,903	10.9	5.9
3	120/208	300	4	26,936	22,586	19.0	10.1
3	120/208	500	1	10,424	8,684	7.5	3.9
3	120/240	10	6	2,323	2,050	1.3	0.8
3	120/240	15	11	5,478	4,749	3.4	1.9
3	120/240	25	9	6,449	5,533	4.2	2.3
3	120/240	37.5	1	992	857	0.6	0.3
3	120/240	50	2	2,324	1,965	1.6	0.9
3	120/240	100	2	4,319	3,703	2.8	1.5
3	120/240	167	1	3,241	2,706	2.3	1.2
3	120/240	300	1	5,384	4,313	4.4	2.2
3	-/240	10	6	2,323	2,050	1.3	0.8
3	-/240	25	3	2,150	1,844	1.4	0.8
3	2400/4160	100	3	7,039	6,238	4.0	2.3
3	277/480	15	12	6,480	5,509	4.4	2.4
3	277/480	25	3	2,686	2,282	1.8	1.0
3	277/480	37.5	3	6,044	5,442	3.2	1.9
3	277/480	112.5	1	3,156	2,731	2.0	1.1
3	277/480	300	3	19,808	16,746	13.6	7.3
3	277/480	500	6	61,362	51,524	43.1	22.9
3	277/480	750	2	25,754	20,667	20.9	10.5
3	-/480	10	3	1,171	1,030	0.7	0.4

Table A.3. (contd)

No. Phase	Voltage Prim/Sec	Capacity (kVA)	No. Units	Energy		Demand	
				Summer (kWh)	Winter (kWh)	Summer (kW)	Winter (kW)
3	-/480	15	6	3,008	2,600	1.9	1.1
3	-/480	25	21	15,117	12,945	9.9	5.4
3	-/480	37.5	9	8,962	7,730	5.7	3.2
3	-/480	50	16	24,261	20,256	17.4	9.1
3	-/480	75	3	6,682	5,688	4.5	2.4
3	-/480	100	3	6,564	6,386	2.0	1.7
3	-/480	112.5	1	3,156	2,731	2.0	1.1
3	-/480	167	3	14,648	11,424	12.9	6.2
3	-/480	225	1	5,444	4,634	3.6	2.0
3	-/480	500	1	10,227	8,587	7.2	3.8
3	-/-	15	3	1,945	1,664	1.3	0.7
3	-/-	25	3	2,805	2,374	1.9	1.0
3	-/-	37.5	3	2,977	2,572	1.9	1.0
3	-/-	50	3	3,485	2,948	2.4	1.3
3	-/-	59	12	17,105	14,363	12.0	6.4
3	-/-	75	3	6,682	5,688	4.5	2.4
3	-/-	150	1	3,563	2,998	2.5	1.3
3	-/-	500	2	20,848	17,368	15.1	7.9
-	-/-	10	2	774	683	0.4	0.3
-	-/-	25	1	935	791	0.6	0.3
-	-/-	37.5	1	992	857	0.6	0.3
-	-/-	59	7	8,132	6,879	5.6	3.0
Totals:	-	14,638	610	1,305,107	1,087,136	942.9	493.9

Appendix B

EUI Data Sources

Appendix B

EUI Data Sources

Tables B.1 through B.24 show the various EUI values obtained from a number of sources. Tables B.25 and B.26 show the initial EUI values applied to the Fort Irwin analysis (see Section 3.2 for final site-specific EUI values).

Table B.1. Small Office - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	.07	3.67	1.39	.19	.2	.21	4.47	1.0	3.14	3.19	17.53
SCE	.03	3.52	.87	.2	.26	.26	4.83	.93	2.82	2.48	16.20
LADWP	.05	3.72	.94	.21	.27	.28	5.06	1.04	3.24	3.61	18.42
BGP	.1	4.64	1.12	.22	.27	.27	4.93	2.75	2.46	1.2	17.96
EPA/WSCC	9.3	6.7	1.8	1.3	.6	.2	8.6 ^(b)	--	--	3.1	31.6
CBECS	--	--	--	--	--	--	--	--	--	--	--
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.2. Large Office - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	3.41	3.7	3.74	.31	.09	.1	7.79	1.21	3.2	2.66	26.21
SCE	3.14	5.5	3.01	.33	.1	.11	8.08	.93	2.25	1.82	25.27
LADWP	2.88	5.77	3.22	.33	.11	.11	8.25	1.91	3.44	3.0	28.3
BGP	3.14	5.32	3.19	.34	.1	.11	8.21	1.57	1.97	2.48	26.43
EPA/WSCC	5.2	6.8	2.8	1.4	.5	.3	7.5 ^(b)	--	--	4.1	28.6
CBECS	--	--	--	--	--	--	--	--	--	22.7	--
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.3. Restaurant - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	3.02	4.32	7.66	1.0	4.24	9.94	6.95	2.56	0.5	4.45	44.19
SCE	1.63	6.2	5.7	.41	4.58	10.7	6.94	2.1	.05	3.3	41.61
LADWP	1.7	6.84	5.94	.88	4.67	10.93	7.34	1.91	.06	4.14	44.14
BGP	1.67	6.39	5.97	1.72	4.89	10.59	7.32	4.09	.01	5.13	47.78
EPA/WSCC	10.3	6.1	2.2	12.8	21.7	6.4	6.1 ^(b)	--	--	2.4	68.0
CBECs	--	--	--	--	--	--	--	--	--	--	30.2
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.4. Retail - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	.28	1.77	1.86	.07	.12	.78	5.29	.92	.33	.89	12.31
SCE	.17	2.75	1.46	.1	.16	.88	5.78	.91	.21	.75	13.17
LADWP	.11	2.38	1.49	.09	.16	.9	5.57	.82	.32	.94	12.78
BGP	.12	2.94	1.54	.11	.16	.88	5.84	1.24	.6	.87	14.3
EPA/WSCC	4.1	1.0	1.3	.7	1.2	.7	5.4 ^(b)	--	--	1.3	15.7
CBECs	--	--	--	--	--	--	--	--	--	--	12.2
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.5. Food Store - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	1.29	1.11	2.31	.14	.62	17.49	9.91	1.44	.36	1.79	36.46
SCE	.79	1.06	1.92	.18	.8	21.12	10.88	1.43	.33	1.51	40.02
LADWP	.74	1.08	1.94	.19	.81	21.8	11.11	1.27	.35	1.91	41.2
BGP	.62	1.7	1.87	.2	.84	20.41	10.86	1.92	.65	1.78	40.85
EPA/WSCC	13.3	3.8	3.2	2.9	12.1	23.7	12.6 ^(b)	--	--	1.9	73.5
CBECS	--	--	--	--	--	--	--	--	--	--	--
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.6. Warehouse - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	.25	.7	.69	.05	--	1.43	3.07	.17	.26	1.46	8.08
SCE	.19	.83	.56	.06	--	1.55	3.2	.16	.14	1.16	7.85
LADWP	.19	.84	.57	.06	--	1.44	3.25	.2	.24	1.78	8.57
BGP	.12	.95	.6	.06	--	1.57	3.24	.21	.46	1.3	8.51
EPA/WSCC	1.5	1.4	1.0	.7	--	6.1	2.7 ^(b)	--	--	.9	14.3
CBECS	--	--	--	--	--	--	--	--	--	--	7.7
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.7. Elementary School - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	1.21	2.15	1.13	.58	.3	.17	2.88	.75	.48	.41	10.06
SCE	1.27	2.0	.75	.57	.29	.18	2.77	.41	.4	.21	8.85
LADWP	1.0	2.26	.81	.55	.32	.19	2.87	.52	.65	.36	9.53
BGP	.98	2.03	.87	.42	.32	.18	2.86	1.12	.28	.44	9.5
EPA/WSCC	7.2	1.7	.6	2.9	1.9	.4	4.3 ^(b)	--	--	.6	19.6
CBECs	--	--	--	--	--	--	--	--	--	--	8.23
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.8. University/College - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	8.94	3.28	2.38	2.19	.28	93	2.93	.17	1.36	1.68	24.14
SCE	4.14	4.3	1.75	2.41	.3	1.04	2.89	.1	1.68	.9	19.51
LADWP	1.31	3.99	1.85	2.07	.32	1.06	2.65	.11	1.92	1.32	16.6
BGP	3.11	3.81	1.84	1.84	.32	.97	2.96	.24	.26	1.73	17.08
EPA/WSCC	4.6	1.9	1.1	3.3	2.1	.4	3.4 ^(b)	--	--	1.0	17.8
CBECs	--	--	--	--	--	--	--	--	--	--	--
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.9. Hospital - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	4.56	7.07	2.78	7.05	.26	.54	9.13	.26	3.79	7.74	43.18
SCE	3.46	9.55	2.3	7.94	.31	.6	9.94	.26	2.88	6.63	43.87
LADWP	1.33	11.25	2.31	8.23	.31	.61	9.45	.16	4.73	5.8	44.18
BGP	3.24	9.9	2.35	8.06	.31	.58	9.83	.33	1.72	7.21	43.53
EPA/WSCC	6.6	4.3	1.9	4.4	7.1	.5	4.5 ^(b)	—	—	1.9	31.2
CBECS	—	—	—	—	—	—	—	—	—	—	13.24
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.10. Hotel/Motel - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	7.15	3.75	1.33	2.24	.5	1.82	3.73	.05	.02	2.34	22.93
SCE	5.49	4.9	.98	2.56	.53	1.95	3.84	.46	.02	1.82	22.55
LADWP	5.01	4.91	1.03	2.59	.55	1.97	3.75	.44	.02	2.43	22.70
BGP	4.27	5.43	1.08	2.62	.56	1.92	3.87	.64	.03	2.14	22.56
EPA/WSCC	2.7	5.4	1.1	5.2	16	.9	4.0 ^(b)	—	—	1.8	37.1
CBECS	—	—	—	—	—	—	—	—	—	—	13.54
(a) Defined as miscellaneous/other EUI.											
(b) Number includes interior and exterior lighting.											

Table B.11. Miscellaneous - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
PG&E	4.51	4.76	2.02	.73	.09	.11	3.69	.79	.37	.98	18.05
SCE	3.29	5.1	1.56	.79	.1	.12	3.68	.61	.15	.68	16.08
LADWP	3.27	5.59	1.62	.8	.1	.12	3.75	.69	.45	1.04	17.43
BGP	3.0	6.66	1.7	.8	.11	.13	3.79	1.12	.21	1.0	18.52
EPA/WSCC	8.4	4.3	1.4	.7	1.0	1.0	3.3 ^(b)	--	--	1.4	21.5
CBECS	--	--	--	--	--	--	--	--	--	--	15.67

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

Table B.12. Single Family Residence - Electric (kWh/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other ^(a)	Total
EPA/WSCC	4.18	.67	--	2.44	.58	--	--	--	--	2.63	10.5
RECS ^(b)	--	--	--	--	--	--	--	--	--	--	9.36

(a) Other category includes refrigeration, lighting, and residual appliances.
(b) RECS data are for the West Region.

Table B.13. Small Office - Propane (kWh/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	.5	82.58	1.67	5.98	--	13.55	104.28
SCE	.18	82.66	1.18	5.19	--	12.66	101.87
LADWP	.27	75.33	.73	4.94	--	12.83	94.1
BGP	.72	106.07	1.73	5.91	.52	13.36	128.31
EPA/WSCC	48.9	13	5.9	1.3	--	.5	69.6
CBECS	--	--	--	--	--	--	--
(a) Defined as miscellaneous/other EUI.							

Table B.14. Large Office - Propane (kWh/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	38.12	98.3	6.4	.52	--	10.74	154.08
SCE	20.36	140.55	5.72	.47	1.47	9.78	178.35
LADWP	18.35	152.2	5.93	.48	1.45	10.16	188.57
BGP	23.84	142.56	6.35	.52	1.46	10.67	185.4
EPA/WSCC	36.1	59.1	8.9	2.0	--	.7	106.8
CBECS	--	--	--	--	--	--	33.3
(a) Defined as miscellaneous/other EUI.							

Table B.15. Restaurant - Propane (kWh/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	15.87	95.55	15.79	110.58	--	16.44	254.23
SCE	7.61	145.8	13.97	98.43	33.14	14.99	313.94
LADWP	3.36	153.84	12.96	102.61	33.29	15.27	321.33
BGP	9.89	152.57	16.64	112.55	33.33	16.69	341.67
EPA/WSCC	101.7	60.0	92.0	141.8	--	--	395.5
CBECS	--	--	--	--	--	--	189.4
(a) Defined as miscellaneous/other EUI.							

Table B.16. Retail - Propane (kWh/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	1.59	33.64	.51	.22	--	8.54	44.5
SCE	1.01	61.85	.43	.17	7.39	7.97	78.82
LADWP	.54	59.93	.4	.14	7.39	7.94	76.34
BGP	.86	67.08	.52	.22	7.43	8.48	84.59
EPA/WSCC	33.5	100.8	9.7	4.5	--	--	148.5
CBECS	--	--	--	--	--	--	26.2
(a) Defined as miscellaneous/other EUI.							

Table B.17. Food Store - Propane (kWh/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	14.89	22.22	1.05	6.25	105.65	27.25	177.31
SCE	7.54	23.2	.88	5.48	--	25.65	62.75
LADWP	5.88	21.89	.55	4.81	--	25.81	58.94
BGP	8.34	33.89	1.05	6.29	--	27.03	76.6
EPA/WSCC	60.7	100.8	8.4	3.4	--	--	72.5
CBECS	--	--	--	--	--	--	--
(a) Defined as miscellaneous/other EUI.							

Table B.18. Warehouse - Propane (kWh/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	1.35	12.36	1.01	.09	--	38.06	52.87
SCE	16.16	15.19	.9	.08	4.7	35.94	72.97
LADWP	15.34	17.72	.61	.09	4.7	37.14	75.6
BGP	.72	18.67	.98	.09	4.73	37.14	62.93
EPA/WSCC	19.5	2.8	2.1	--	--	1.4	25.8
CBECS	--	--	--	--	--	--	13.2
(a) Defined as miscellaneous/other EUI.							

Table B.19. Elementary School - Propane (kWh/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	16.2	25.61	2.27	.17	--	19.64	63.89
SCE	10.03	23.45	2.05	.13	--	17.57	53.23
LADWP	7.62	25.37	2.12	.13	--	18.09	53.33
BGP	10.06	32.34	2.45	.17	1.6	19.59	66.21
EPA/WSCC	58	29.7	17.2	11.1	--	3.0	119
CBECS	--	--	--	--	--	--	46.7
(a) Defined as miscellaneous/other EUI.							

Table B.20. University/College - Propane (kWh/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	92.32	81.35	10.23	.16	--	14.45	198.51
SCE	46.44	121.48	9.02	.12	--	12.39	189.45
LADWP	46.8	161.5	8.62	.08	--	11.27	228.27
BGP	57.0	138.46	10.91	.18	1.67	15.06	223.28
EPA/WSCC	51.3	50.6	15.1	14.3	--	5.4	136.7
CBECS	--	--	--	--	--	--	--
(a) Defined as miscellaneous/other EUI.							

Table B.21. Hospital - Propane (kWh/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	23.34	92.91	30.26	1.31	--	33.97	181.79
SCE	16.56	151.74	29.31	1.24	--	33.32	232.17
LADWP	5.62	109.11	26.41	1.08	--	26.61	168.83
BGP	14.93	183.47	29.6	1.28	7.47	33.31	270.06
EPA/WSCC	166.1	21.8	35.1	2.7	--	11.9	237.6
CBECS	--	--	--	--	--	--	133.6
(a) Defined as miscellaneous/other EUI.							

Table B.22. Hotel/Motel - Propane (kBtu/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	51.42	34.27	9.75	3.15	--	23.53	122.12
SCE	34.43	--	9.23	2.87	--	22.2	68.73
LADWP	28.24	--	7.94	2.84	--	21.57	60.59
BGP	30.76	--	10.06	3.11	--	23.86	67.79
EPA/WSCC	172.8	68.1	28.8	13.4	--	6.0	289.1
CBECS	--	--	--	--	--	--	69.4
(a) Defined as miscellaneous/other EUI.							

Table B.23. Miscellaneous - Propane (kBtu/ft²-yr)

	Heat	Cool	DHW	Cook	Refrig.	Other ^(a)	Total
PG&E	38.37	74.94	6.54	.61	--	53.66	174.12
SCE	22.57	89.81	5.61	.52	1.98	48.92	169.41
LADWP	19.46	96.17	5.44	.51	1.99	50.72	174.29
BGP	24.14	112.4	6.71	.61	1.99	53.8	199.65
EPA/WSCC	45.0	20.8	4.8	1.4	--	3.5	75.5
CBECS	--	--	--	--	--	--	60.7
(a) Defined as miscellaneous/other EUI.							

Table B.24. Single Family Residence - Propane (kBtu/ft²-yr)

	Heat	Cool	Vent	DHW	Cook	Refrig.	Int. Lgt.	Ext. Lgt.	Office Equip.	Other	Total
EPA/WSCC	26.91	--	--	.16	.06	--	--	--	--	--	27.13
RECS ^(a)	--	--	--	--	--	--	--	--	--	--	55.9
NOTE: All data available only as UEC (unit energy consumption). EUI calculated assumes 1500 ft ² /single family residence.											
(a) RECS data are for the West Region.											

Table B.25. Fort Irwin Initial Propane EUIs (kBtu/ft²-yr)

Bldg Type	Total	Heat	DHW	Cooking	Other
ADMIN	35.56	36.10	1.33	0.00	0.00
ADMIN-MT	0.00	33.00	1.33	0.00	0.00
BRK/ADM	36.37	36.21	9.25	0.00	0.00
CHAPEL	28.03	26.14	1.33	0.56	0.00
CLINIC	88.13	45.31	15.00	0.56	27.82
CLUB	145.91	9.18	14.84	106.04	15.85
COMCATN	30.86	36.10	1.33	0.00	0.00
DET-RR	3.04	10.00	6.08	0.00	0.00
DGR	10.84	10.95	0.47	0.00	0.00
DINING	145.91	9.18	14.84	106.04	15.85
FUELDSP	26.14	26.14	0.00	0.00	0.00
GROCERY	28.08	9.16	6.08	5.71	26.44
HANGAR	26.60	26.14	0.47	0.00	0.00
HOSPITL	104.79	45.31	30.14	1.52	27.82
HOTEL	0.00	36.21	9.25	0.00	0.00
HSG-FAM	42.54	26.91	11.00	5.50	0.00
HUT	0.00	0.00	0.00	0.00	0.00
LAB-MED	68.82	26.00	15.00	1.52	27.82
MTRPOOL	20.87	26.14	1.33	0.00	0.00
MWR	24.17	26.14	1.33	0.00	0.00
OTHER	27.46	26.14	1.33	0.00	0.00
PLT-BLDG	56.06	9.18	1.33	0.00	51.78
POOL-OT	50.91	0.00	6.08	0.00	51.78
PUMP	0.00	0.00	0.00	0.00	0.00
REC	34.32	26.14	9.25	0.00	0.00
RESTRNT	72.96	9.18	14.84	106.04	15.85
SECURTY	26.64	26.14	1.33	0.00	0.00

Table B.25. (contd)

Bldg Type	Total	Heat	DHW	Cooking	Other
SHOP	1.47	9.18	1.33	0.00	0.00
SHOP-AIR	10.51	9.18	1.33	0.00	0.00
SHOP-ELC	3.99	9.18	1.33	0.00	0.00
SHOP-HVY	10.51	9.18	1.33	0.00	0.00
SHOP-WPN	0.00	9.18	1.33	0.00	0.00
STOR-UH	0.00	0.00	0.00	0.00	0.00
TRAIING	4.09	10.98	2.22	0.00	0.00
WHS	6.24	9.18	0.88	0.00	0.00
WHS-CLD	0.00	9.18	0.88	0.00	0.00

Table B.26. Fort Irwin Initial Electric EUI (kWh/ft²-year)

Bldg. Type	Total	Heat	Cool	Vent	DHW	Cook	Int. Lgt.	Ext. Lgt.	Refrig.	Office Equip.	Other
ADMIN	9.86	0.60	1.50	1.22	0.21	0.10	5.00	1.00	0.24	2.92	0.50
ADMIN-MT	16.68	0.60	3.89	1.22	0.21	0.10	6.00	1.00	0.24	2.92	0.50
BRK/ADM	12.04	4.92	4.88	1.10	2.50	0.20	3.00	0.40	1.92	0.02	2.11
CHAPEL	6.69	3.52	1.50	1.73	0.78	0.10	3.00	0.80	0.12	0.30	0.50
CLINIC	27.96	3.15	9.44	2.33	7.82	0.10	9.59	1.00	0.57	3.28	6.85
CLUB	35.72	0.30	5.97	6.32	1.00	4.60	3.00	1.00	10.54	0.04	4.26
COMCATN	8.08	0.06	1.50	1.22	0.21	0.10	3.00	1.00	0.10	2.92	0.50
DET-RR	4.91	3.52	1.50	1.73	0.78	0.10	2.00	0.80	0.00	0.00	0.00
DGR	10.20	0.17	1.50	1.53	0.09	0.10	5.62	1.00	0.83	0.37	0.95
DINING	41.62	2.01	5.97	6.32	1.00	4.60	7.14	2.67	10.54	0.04	4.26
FUELDSP	1.18	3.52	1.50	1.73	0.78	0.10	3.00	0.80	0.00	0.00	0.00
GROCERY	39.32	0.86	1.24	2.01	0.18	0.77	10.69	1.52	20.90	0.42	1.78
HANGAR	3.30	3.52	1.50	1.73	0.78	0.10	3.00	0.80	0.10	0.30	0.50
HOSPITL	37.34	3.15	9.44	6.32	7.82	0.30	9.59	1.00	0.57	3.28	6.85
HOTEL	14.88	4.92	4.88	1.10	2.50	0.10	3.80	0.40	0.50	0.02	0.50
HSG-FAM	6.91	4.18	4.88	1.10	2.50	0.58	3.80	0.40	1.92	0.02	2.11
HUT	0.00	3.52	1.50	1.73	0.78	0.10	1.00	0.00	0.00	0.00	0.00
LAB-MED	32.40	3.15	9.44	2.33	7.82	0.10	9.59	0.25	0.57	3.28	6.85
MTRPOOL	7.77	3.52	1.50	1.73	0.78	0.10	3.00	0.80	0.10	0.10	0.93
MWR	11.20	3.52	1.50	1.73	0.78	0.10	6.00	0.80	0.10	0.30	0.93
OTHER	6.86	3.52	1.50	1.73	0.78	0.10	3.00	0.80	0.10	0.30	0.93
PLT-BLDG	3.25	0.10	1.50	1.73	0.78	0.10	2.00	0.80	0.10	0.10	0.00
POOL-OT	1.87	3.52	1.50	1.73	0.78	0.10	1.00	0.80	0.10	0.00	0.00
PUMP	0.65	3.52	1.50	1.73	0.78	0.10	1.00	0.80	0.10	0.00	0.00
REC	14.54	3.52	1.50	2.33	0.78	0.10	10.00	0.80	0.10	0.10	0.93
RESTRNT	44.55	2.01	9.00	6.32	1.00	4.60	7.14	2.67	10.54	0.04	4.26

Table B.26. (contd)

Bldg. Type	Total	Heat	Cool	Vent	DHW	Cook	Int. Lgt.	Ext. Lgt.	Refrig.	Office Equip.	Other
SECURTY	14.19	0.10	1.50	1.22	0.21	0.10	6.00	1.43	0.24	1.00	2.72
SHOP	6.55	0.10	1.50	1.73	0.78	0.10	2.00	0.80	0.10	0.10	0.93
SHOP-AIR	6.16	0.1	1.5	1.73	0.78	0.1	2.00	0.8	0.1	0.1	0.93
SHOP-ELC	6.58	0.10	1.50	1.73	0.78	0.10	2.00	0.80	0.10	0.10	0.93
SHOP-HVY	6.16	0.1	1.5	1.73	0.78	0.1	2.00	0.8	0.1	0.1	0.93
SHOP-WPN	7.04	0.10	1.50	1.73	0.78	0.10	2.00	0.80	0.10	0.10	0.93
STOR-UH	0.12	0.19	0.00	0.68	0.06	0.00	1.00	0.19	0.00	0.00	0.00
TRAIING	7.22	0.10	3.00	0.83	0.53	0.10	2.85	0.70	0.10	0.10	0.00
WHS	2.95	0.10	0.94	0.68	0.06	0.00	2.00	0.19	0.10	0.10	0.50
WHS-CLD	48.85	0.10	0.94	0.68	0.06	0.00	2.00	0.19	1.50	0.10	0.50

Appendix C

Building Numbers by Building Type

Appendix C

Building Numbers by Building Type

Building Type	Building Numbers
ADMIN	00011, 00100, 00101, 00130, 00152, 00154, 00157, 00158, 00236, 00237, 00241, 00243, 00248, 00255, 00256, 00257, 00258, 00279, 00281, 00316, 00320, 00365, 00372, 00383, 00385, 00408, 00411, 00415, 00425, 00426, 00428, 00429, 00433, 00436, 00437, 00439, 00441, 00442, 00443, 00444, 00445, 00451, 00452, 00453, 00454, 00458, 00464, 00466, 00479, 00483, 00488, 00497, 00498, 00499, 00504, 00506, 00508, 00510, 00513, 00520, 00521, 00524, 00526, 00527, 00528, 00529, 00539, 00543, 00544, 00549, 00551, 00554, 00564, 00570, 00578, 00579, 00580, 00583, 00587, 00604, 00615, 00813, 00826, 00828, 00930, 00983, 00985, 00988, 06201, 06252, 07600
ADMIN-MT	00136, 00156, 00182, 00230, 00239, 00402, 00500, 00502, 00503, 00505, 00507, 00546, 00548, 00550, 00561, 00563, 00565, 00566, 00567, 00569, 00571, 00573, 00575, 00577, 00582, 00590, 00591, 00592, 00593, 00594, 00595, 00596, 00597, 00598, 00599, 00653, 00654, 00655, 00656, 00657, 00658, 00662, 00867, 00931, 00932, 00933, 00940
BRK/ADM	00014, 00028, 00098, 00099, 00102, 00103, 00104, 00105, 00106, 00107, 00108, 00110, 00111, 00226, 00249, 00250, 00251, 00252, 00261, 00262, 00264, 00265, 00267, 00273, 00275, 00412, 00413, 00414, 00416, 00417, 00418, 00419, 00420, 00421, 00422, 00423, 00434, 00440, 00448, 00487, 00489, 00491, 00493, 00494, 00511, 00512, 00514, 00516, 00518, 00519, 00523, 00530, 00534, 00540
CHAPEL	00212, 00233, 00315
CLINIC	00171, 00235, 00242, 00245, 00478
CLUB	00021, 00037, 00202, 20018
COMCATN	00013, 05005, 05006, 06202, 06212, 06220, 06230, 06250, 16150
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GROCERY	00920
HANGAR	06203
HOSPITL	00166
HOTEL	00900, 00901, 00902, 00903, 00904, 00906, TS001, TS003, TS004, TS005, TS036, TS046, TS047, TS048, TS049, TS050
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07701, 20001, 20005, 20008

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