ESL-TR-1979-302

ENERGY CONSUMPTION AND DEMAND, NAVAL WEAPONS CENTER

TRW Incorporated
Energy Systems Group
One Space Park
Redondo Beach, CA 90278

Contract No. N68305-79-C-0007

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ENGINEERING & SERVICES LABORATORY
AIR FORCE ENGINEERING & SERVICES CENTER
TYNDALL AIR FORCE BASE, FLORIDA 32403

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14. ABSTRACT

Energy storage has proven to be effective in load leveling for utilities and for making feasible the switch to inconstant energy sources such as solar and wind in applications requiring nearly constant sources of power. To date, energy storage has not been used in large measure on military bases as a technique for improving energy use efficiency. To assess the potential for energy storage at a military base, the U.S. Naval Facilities at Port Hueneme, California was selected as a candidate energy storage study site. This report is the result of the first phase of that study which has three major objectives:

1 - Determining the historical energy use patterns at the study site
2 - Evaluate specific energy storage techniques at the study site
3 - Develop a handbook that will assist personnel at other bases in evaluating energy storage applications at their location.

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INTRODUCTION

The achievement of the goal of energy self sufficiency can be furthered through the use of energy storage techniques presently available. To assess the potential for energy storage at U.S. Navy Facilities, the Civil Engineering Laboratory (CEL) at Pt. Hueneme, California has directed TRW Energy Systems to investigate the benefits at a selected naval facility.

After reviewing available data at several facilities, TRW, with CEL concurrence, has selected the Naval Weapons Center at China Lake, California as the study site. NWC personnel have had an active program of energy conservation at their facility and have previously assessed the energy consumption and demand patterns needed for this study of energy storage applications. With the cooperation of NWC personnel, TRW has endeavored to update energy consumption data previously reported by NWC for calendar year 1976* to include data for the years 1977 and 1978. This report supplies a tabulation of that data.

The raw data has been categorized by type of energy for basewide consumption and where data are available, energy demand is shown regionally within the facility. For example, NWC has installed substation metering for electricity at twenty-five locations on the base permitting a breakdown of electrical energy consumption and demand data to localized areas of the base. This permits an assessment of energy flows to a degree not usually possible in an audit of a non-metered facility.

Data are included for all purchased energy used at NWC, supplemented with additional information expected to be of value in the subsequent study of specific energy storage applications at NWC. Furthermore, it is expected that the types of information contained in this report will serve as a sample of information needed should other facilities be evaluated for energy storage applications.

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*NWC Technical Memorandum, 3295, November 1977.

TOTAL ENERGY CONSUMPTION

Composite energy use figures for calendar years 1977 and 1978 are shown in the tables on pages 3 and 4. The monthly figures represent a monthly composite as reported in utility bills and/or base consumption figures. These composites for the base are broken down into finer detail in subsequent tables.

From the composite tables, the seasonal peaking in demand is evident. Electricity demand rises sharpley in the summer months in response to peak air cooling requirements. Natural gas, fuel oil and propane reflect the demand for facility heating in the cooler months. Gasoline use, primarily for transportation services, exhibits a nearly steady demand through the survey period.

Demand for all energy shows a downward trend over the two year period. Conservation programs at the base are thought to be responsible. Though not shown in the composite tables, it should be noted that energy costs for 1978 were actually higher than those of 1977, in spite of the reduced consumption. Increases in utility rate schedules have been larger than the corresponding reductions in energy use leading to the higher utility bills.

The conversion of the composite totals into Btu's for 1977 indicates that fuel oil supplied a slightly larger proportion of the base energy compared to either electricity or natural gas, the other major energy sources at China Lake. In 1978, oil use was curtailed, with natural gas taking over as the major source of base energy with oil moving into second place.

NWC TOTAL ENERGY CONSUMPTION

Calendar Year 1977

	Electricity (MWH)	Natural Gas (MCF)	Fuel Oil (GAL)	Propane (GAL)	Gasoline (GAL)
Jan	7,884	78,625	256,020	99,563	53,238
Feb	6,660	36,044	330,676	89,431	44,232
Mar	7,632	40,617	305,629	39,842	35,592
Apr	7,200	26,527	277,568	88,839	52,352
May	6,804	35,967	170,594	19,814	43,945
Jun	8,784	10,456	140,333	57,717	43,670
Jul	9,360	14,350	74,598	-	43,515
Aug	9,252	8,207	167,522	-	42,817
Sep	8,280	14,617	126,230	-	52,393
Oct	6,552	12,388	126,381	33,347	51,646
Nov	6,757	34,694	185,923	70,914	43,193
Dec	7,333	45,616	306,666	95,817	26,290
Total	92,498	358,108	2,468,140	595,284	532,883

NWC TOTAL ENERGY CONSUMPTION

Calendar Year 1978

	Electricity (MWH)	Natural Gas (MCF)	Fuel Oil (GAL)	Propane (GAL)	Gasoline (GAL)
Jan	6,754	51,263	202,636	78,594	52,593
Feb	6,455	33,805	217,609	84,340	35,079
Mar	7,312	33,211	152,674	62,239	43,363
Apr	6,307	28,947	189,354	39,913	43,397
May	7,463	20,969	208,309	24,606	43,646
Jun	7,949	14,028	142,427	15,860	43,377
Jul	9,050	14,183	154,839	4,448	34,257
Aug	8,647	15,833	150,057	9,996	43,521
Sep	7,661	12,526	82,404	25,336	52,155
Oct	6,898	25,629	159,157	24,906	41,802
Nov	6,653	34,837	219,463	73,774	34,940
Dec	7,549	51,386	113,503	108,346	61,126
Total	88,698	336,617	1,992,432	552,358	529,256

ELECTRIC DEMAND

Fifteen-minute average electrical demand is recorded by the utility supplying the Naval Weapons Center in order to assess monthly peak demand charges (see rate schedule in the Appendix). On pages 7 to 10, data from the utility demand files have been plotted. The period shown is for the month of October, 1978, the first month in which a recording meter was installed.

LOAD CURVE ANALYSIS

The graphs show a seven day cycle beginning on Monday and ending on Sunday. For the week ending 10/8/78, the first days data are partially missing. This was the first day the recording meter was installed and readings did not begin until around two in the afternoon.

The first five cycles for that week show a recurring pattern typical of weekday energy use at the base. Starting from a low point of approximately 7000 KW, the electrical demand climbs sharply during the morning hours. At the midday lunch break, demand levels out, only to climb to the peak for the day between twelve and three in the afternoon. The combination of peak base activity and the demands of the facility air conditioning equipment during this interval generate this pattern each work day.

In an effort to limit this daily peak, facilities engineers have restricted well water pumping operations to the late afternoon and heavy morning hours. All water for the base is pumped from underground wells and stored for the next days' use. The jump in demand around six P.M. is the result of activation of the well pumps and accounts for a large part of the night time base load.

The last two cycles on the graph of 10/8/78 show the reduced demand of weekend operations at NWC. Peak demand of 10,000 KW or less is typical compared to as much as 16,600 KW during the week.

For the week ending 10/15/78, the first day, Monday October 9 shows a repeat of the weekend pattern. That day was observed as a holiday by base personnel, limiting demand to the weekend levels. The patterns for the four remaining days duplicate the curves of the previous week.

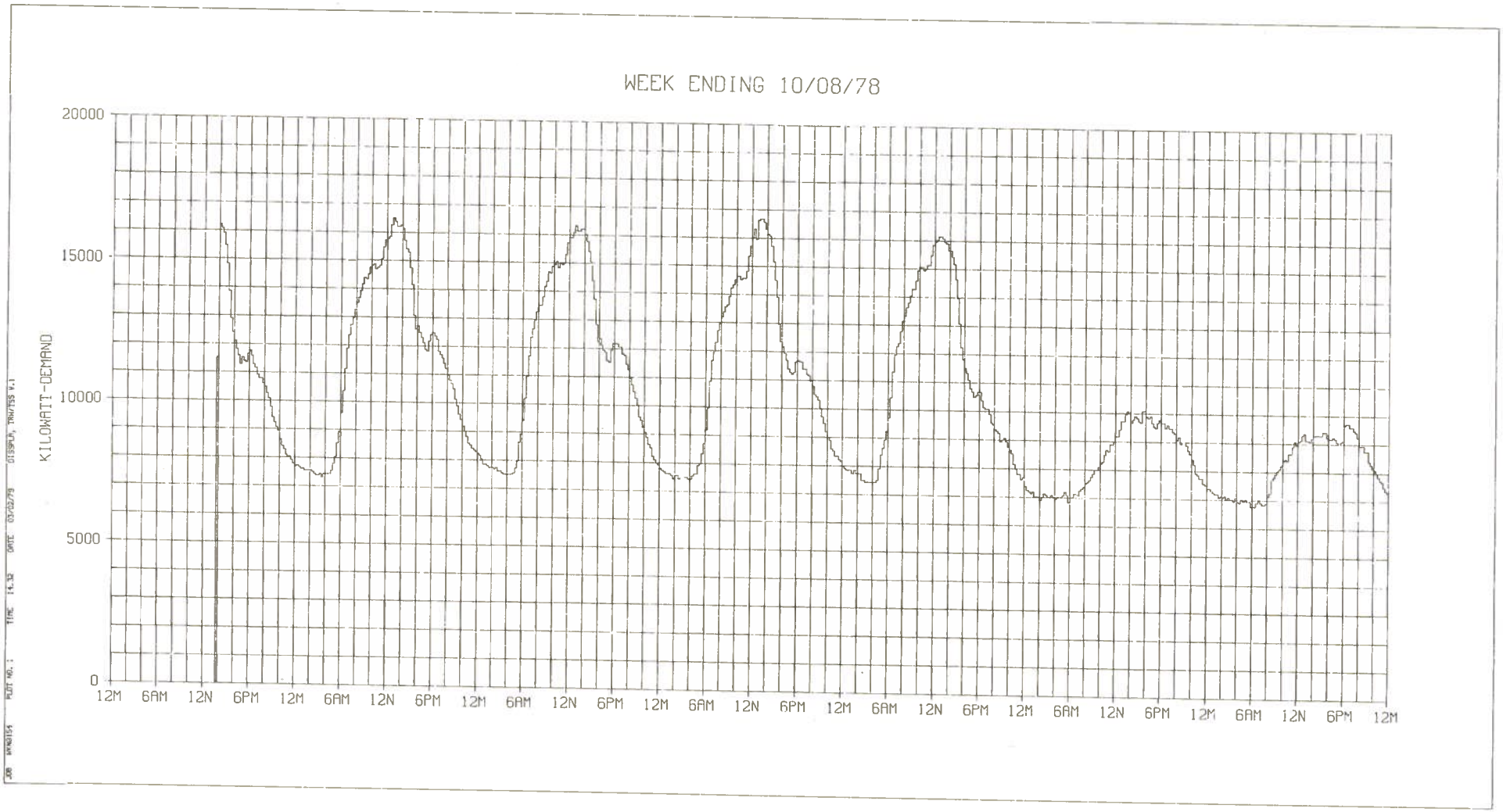
The graphs for the weeks ending 10/22/78 and 10/29/78 exhibit the same cyclical patterns for weekday and weekend with one major change. Nighttime base demand remains at around 7000 KW but daytime peaks are approximately 2000 KW less. During these two weeks, air cooling demand have fallen off in proportion to a drop in daily outside temperatures.

ENERGY STORAGE POTENTIAL

The peaks and valleys exhibited in the daily load curves for electrical demand present a textbook situation for the application of energy storage. The utility rate schedule imposes economic penalties for both energy use and energy demand during "peak" demand periods. For the months of June through November, this period is presently defined as 12:00 Noon to 6:00 P.M. The load curves shows this to be precisely the period of peak demand at the China Lake facility. Energy storage offers one means of shifting demand away from this expensive time of the day. In a subsequent phase of this study, storage applications for NWC will be explored to accomplish a shift in demand away from this critical time periods.

The rescheduling of water well pumping operations is an example of another means of shifting demand away from the peak periods. Rescheduling some base personnel to night shift operations would have an equally significant effect on controlling peak demand. Energy storage has the advantage, however, of not asking people to work during what is traditionally the less attractive working hours of night and graveyard shifts.

While on the subject of load shifting, we note that the present rate schedule adds a further complication. For the winter months (December through May), the "peak" demand period is redefined as the hours between 5:00 P.M. and 10:00 P.M. This necessitates shifting work schedules and equipment usage every six months to avoid the penalty periods. Energy storage, with its greater flexibility in rescheduling, again offers an advantage over attempting to move people and equipment operational hours.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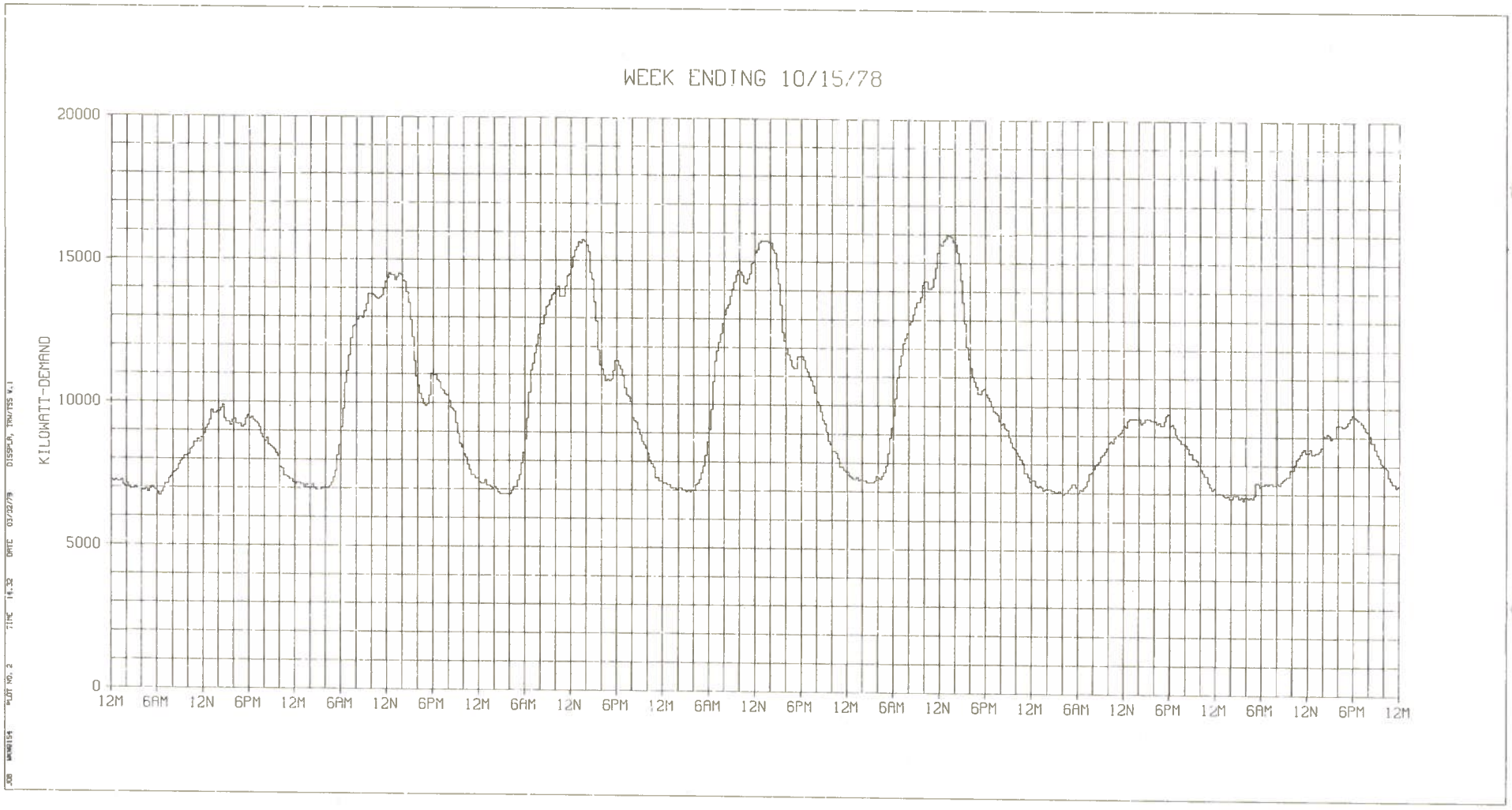
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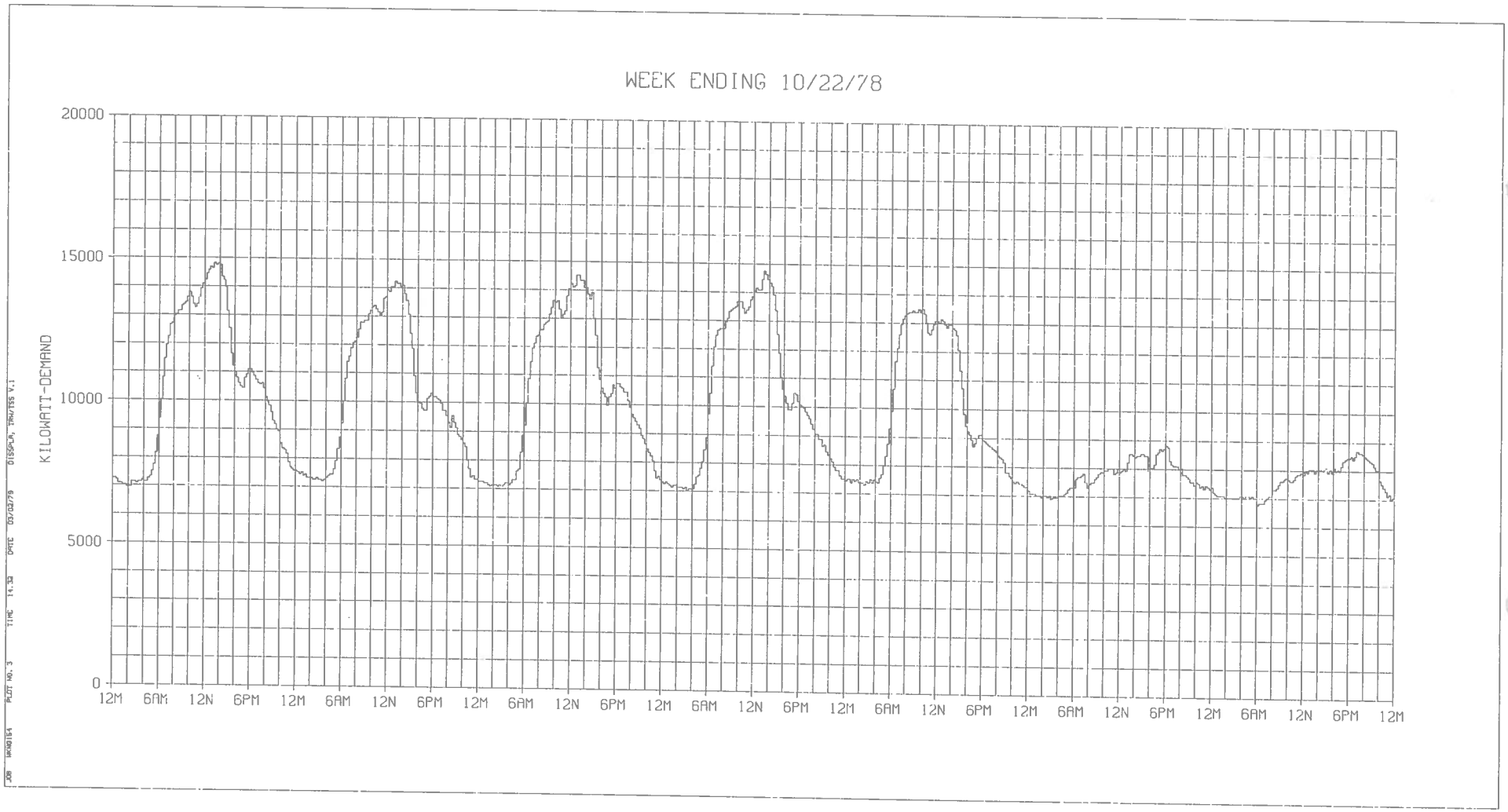
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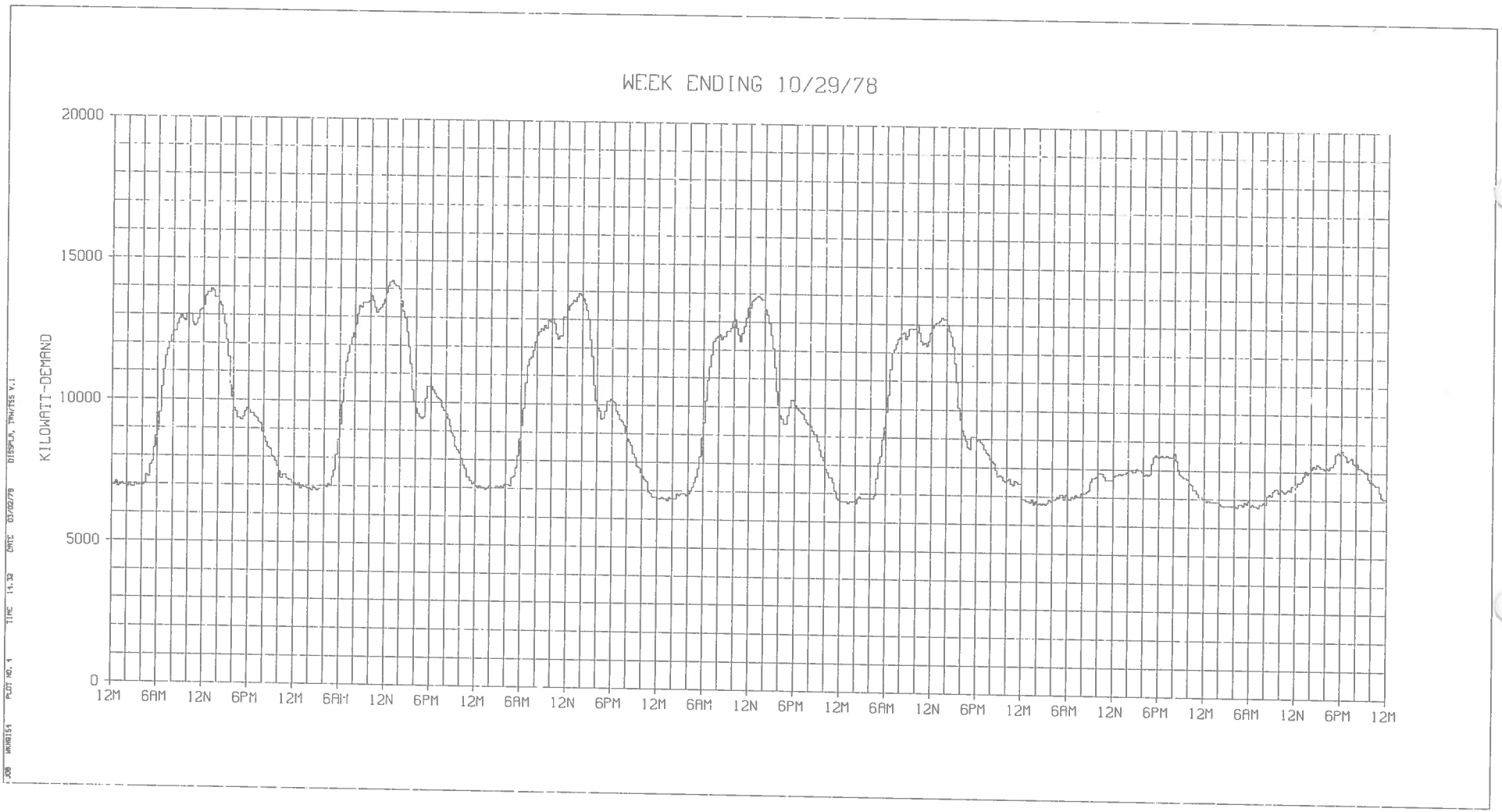
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SUBSTATION ELECTRICAL DEMAND

NWC has installed twenty-five utility meters at substations around the facility. Energy consumption and monthly peak demand is continuously logged in an on-going program of energy use monitoring. The submeter data gives insight into basewide electrical flow to sections of the base.

The readings of the individual substations are expected to be of value in the assessment of energy storage applications. They serve to identify sections of the base that offer the most potential for load leveling in terms of peak demand shifts as well as those sections that may be ignored due to their relatively small demands for electrical energy.

Monthly energy and demand figures for calendar year 1978 have been compiled in the tables on pages 14 through 19. On page 20 is a ranking of the substations for total energy consumption. The substation code names with a brief summary of the loads they represent follows:

ML-W Michelson Laboratory West

- Altitude Chamber
- Solid State Lab
- Computer Research Lab
- Air Conditioning

ML-E Michelson Laboratory East

- Machine Shop
- Heat Treat
- Offices

FH-1, 2, 3 Harvey Field

- General Electric Service
- Street Lighting

NAF Naval Air Facility

- Catapult
- Boiler Plant
- General Service

North

- Sewage Treatment Plant
- Laboratories

SWPP Salt Wells Sub.

- Laboratories
- Street Lighting
- Office Building

CLPL China Lake Sub.

- General Service
- Street Lighting

South CKT 1, 2, 3

- Housing
- Street Lighting

RWTR Randsburg Wash Sub.

- Gunline
- HQ

G-Main

- General Service

ER Electronics Lab.

- Thompson Lab
- Wind Tunnel
- Anechoic Chambers

LASER Lauritsen Lab.

- Laboratory

ECHO

Test Range

B-I, 4

General Service

SNORT

General Service

T Tower Road

General Service

VERN

General Service
School

ELECTRIC SUBMETER DATA

1978	ML-W		NORTH		T8		T6	
	KWH	KWD	KWH	KWD	KWH	KWD	KWH	KWD
JAN	736,000	1344	258,000	720	38,720	128	15,600	30
FEB	889,600	2624	333,000	720	39,680	128	16,800	60
MAR	998,400	2752	322,000	720	32,640	83.2	15,000	36
APR	902,400	2816	346,000	880	22,080	67.2	10,400	42
MAY	1,062,400	2880	880,000	1020	23,680	76.8	10,400	42
JUN	1,030,500	2380	408,000	1060	24,000	80.0	10,200	42
JUL	1,062,400	2048	480,000	1030	23,680	105	11,400	60
AUG	1,212,600	2048	524,000	1100	24,000	112	12,600	36
SEP	1,056,000	2048	490,000	1080	24,000	76.8	13,800	36
OCT	928,000	1790	358,000	1000	17,280	64.0	10,200	36
NOV	876,800	1408	310,000	1200	21,760	67.2	15,600	48
DEC	819,200	2688	350,000	1600	41,600	118	25,200	60

ELECTRIC SUBMETER DATA

1978	RWTR		ECHO		SWPP		CLPL		ML-E	
	KWH	KWD	KWH	KWD	KWH	KWD	KWH	KWD	KWH	KWD
JAN	256,000	*	52,300	24	163,200	1056	268,000	1300	842,400	2304
FEB	248,000	312	55,200	24	369,600	1056	606,000	1300	921,200	2304
MAR	159,000	456	50,500	240	350,400	1056	483,000	1300	964,800	2112
APR	154,000	480	48,000	216	321,600	960	372,000	1100	949,600	2304
MAY	159,000	480	52,800	240	414,000	1008	377,000	1200	961,600	2304
JUN	173,000	612	69,600	288	369,600	1152	320,000	1000	965,600	2880
JUL	195,000	612	69,600	288	384,000	1152	331,000	1000	1,068,800	2816
AUG	211,000	636	72,000	288	465,600	1200	225,000	1500	1,240,000	2880
SEP	196,000	480	88,800	288	432,000	1152	186,000	1500	1,016,000	2816
OCT	132,000	450	55,200	24	356,000	1056	165,000	500	866,400	2304
NOV	149,000	420	48,000	24	326,400	1056	229,000	520	905,600	2112
DEC	183,000	420	69,600	288	388,800	1104	334,000	700	861,600	2368

*Data missing

ELECTRIC SUBMETER DATA

1978	FH-1		FH-2		FH-3		LASER	
	KWH	KWD	KWH	KWD	KWH	KWD	KWH	KWD
JAN	515,000	1000	585,000	1000	1,128,000	1440	115,200	240
FEB	506,000	1000	569,000	1000	162,000	1440	168,000	240
MAR	530,000	1000	640,000	1500	1,180,800	1536	86,400	240
APR	491,000	1400	576,000	1600	158,400	1680	128,600	240
MAY	633,000	1700	717,000	1800	804,600	1970	153,600	336
JUN	749,000	1900	827,000	1800	864,000	2064	149,800	384
JUL	836,000	1800	902,000	1900	936,000	2160	158,400	336
AUG	799,000	1800	907,000	2000	936,000	2160	163,200	336
SEP	692,000	1800	756,000	2000	849,000	2160	115,200	336
OCT	564,000	1600	645,000	1700	748,000	1872	124,800	240
NOV	515,000	1200	635,000	1500	691,200	1584	148,800	336
DEC	530,000	1200	637,000	1200	739,200	1440	206,400	240

ELECTRIC SUBMETER DATA

1978	T-13		VERN		ER		NAF	
	KWH	KWD	KWH	KWD	KWH	KWD	KWH	KWD
JAN	17,280	211	4,900	4	98,800	480	434,000	1152
FEB	25,600	352	6,300	3	134,400	480	568,000	1152
MAR	24,320	122	4,800	2	134,400	416	512,000	1248
APR	16,000	48	3,000	2	195,200	416	438,000	1248
MAY	25,280	102	2,900	3	172,800	512	703,000	1488
JUN	24,320	160	2,100	3	192,000	608	637,000	1632
JUL	20,800	102	2,600	3	204,400	673	683,000	1632
AUG	24,640	236	2,900	3	151,600	640	810,000	1880
SEP	20,480	128	5,500	5	217,600	640	730,000	1880
OCT	14,720	102	600	-	147,200	512	590,000	1440
NOV	15,040	189	3,100	10	92,800	480	535,000	1344
DEC	52,160	640	8,500	5	118,400	512	592,000	1296

ELECTRIC SUBMETER DATA

1978	SNORT		B-4		B-1		G-4		G-Main	
	KWH	KWD	KWH	KWD	KWH	KWD	KWH	KWD	KWH	KWD
JAN	19,600	70	10,400	44	28,800	132	6,000	18	96,000	528
FEB	28,000	70	12,000	44	34,800	120	3,000	18	128,000	528
MAR	29,400	70	12,400	48	32,400	120	3,600	6	140,000	528
APR	33,600	70	11,600	52	30,600	114	4,200	6	132,000	528
MAY	42,000	98	14,800	60	38,400	150	9,600	6	185,000	528
JUN	32,200	122	14,400	60	42,000	162	16,200	6	171,000	528
JUL	36,200	168	16,000	60	47,400	180	18,000	6	206,000	576
AUG	58,800	168	16,800	60	60,600	180	*	*	233,000	624
SEP	40,600	140	18,400	60	49,200	192	3,000	*	215,000	576
OCT	28,000	140	7,600	60	37,800	150	3,000	*	145,000	528
NOV	36,400	210	12,800	48	33,000	144	4,200	30	127,000	480
DEC	26,600	168	9,200	52	40,800	180	11,400	18	259,000	456

*Data missing

ELECTRIC SUBMETER DATA

1978	SOUTH CKT. 1		SOUTH CKT. 2		SOUTH CKT. 3	
	KWH	KWD	KWH	KWD	KWH	KWD
JAN	145,600	624	36,000	24	67,200	384
FEB	242,400	624	40,800	-	201,600	*
MAR	247,200	600	24,000	-	199,200	576
APR	210,200	624	26,400	-	172,800	576
MAY	295,200	690	31,200	-	225,600	576
JUN	271,200	745	28,800	-	211,200	624
JUL	283,200	745	31,200	-	223,200	624
AUG	590,400	720	36,000	-	264,000	624
SEP	336,000	720	28,800	-	223,200	624
OCT	14,400	504	19,200	-	168,000	528
NOV	220,800	1056	19,200	-	148,800	576
DEC	280,800	1248	14,400	-	206,400	624

*Data missing

SUBSTATION ENERGY DEMAND
1978

	SUBSTATION	MWH
1.	ML-W	11607.3
2.	ML-E	11563.6
3.	FH-3	9467.2
4.	FH-2	8396.0
5.	FH-1	7360.0
6.	NAF	7232.0
7.	NORTH	5059.0
8.	SWPP	4341.2
9.	CLPL	3896.0
10.	SOUTH CKT. 1	3137.4
11.	SOUTH CKT. 3	2311.2
12.	RWTR	2215.0
13.	G-MAIN	2037.0
14.	ER	1859.6
15.	LASER	1718.4
16.	ECHO	732.0
17.	B-1	475.8
18.	SNORT	411.4
19.	SOUTH CKT. 2	336.0
20.	T-8	333.1
21.	T-13	280.6
22.	T-6	167.2
23.	B-4	156.4
24.	G-4	82.2
25.	VERN	47.2
	TOTAL	88222.8

PETROLEUM

A two year summary of petroleum usage at the China Lake Naval Weapons Center appears in the table on page 22.

- Aviation Fuel - The first four columns list the demand for flight-line fueling of aircraft.
- Diesel - Remote sites typically use diesel fuel for electric power generation. Also, some boiler plants at the main facility occasionally substitutes diesel oil for steam generation requirements.
- Premium - Base gasoline requirements for ground transportation and trucking.
- #6 - Fuel oil demands of the base steam plants. Steam generation is required all year for process loads and seasonally for facility heating.

PROPANE

On page 23 is a two year summary of propane usage at various locations at China Lake. Propane is used primarily for facility heating at remote sites.

NATURAL GAS

Natural gas usage at the China Lake boiler plants is shown on page 24.

GALLONS FUEL

	100/130 AV/GAS	115/145 AV/GAS	JP-4	JP-5	DIESEL	PREMIUM	#6
JAN-1977	3500	9,037	25,596	326,033	31,062	53,238	256,020
FEB	3485	18,168	50,475	390,924	15,109	44,232	330,676
MAR	3490	9,013	25,450	406,268	30,272	35,592	305,629
APR	3488	9,181	33,669	292,301	14,833	52,352	277,568
MAY	3475	18,120	34,200	432,751	22,524	43,945	170,594
JUN	3475	18,098	33,728	543,611	29,812	43,670	140,333
JUL	3451	8,455	42,246	365,883	15,593	43,515	74,598
AUG	6887	17,522	17,082	549,503	14,990	42,817	167,522
SEP	3451	9,037	34,206	570,074	23,414	52,393	126,230
OCT	3451	9,131	33,967	295,297	48,552	51,646	126,381
NOV	6935	27,307	33,764	376,728	5,197	43,193	185,923
DEC	3483	17,806	33,881	318,906	81,757	26,290	306,666
JAN-1978	3493	9,000	25,600	360,938	82,356	52,593	202,636
FEB	3488	27,182	41,825	404,530	75,111	35,079	217,609
MAR	6961	9,213	25,625	479,647	59,035	43,363	152,674
APR	3463	9,006	8,391	421,504	51,400	43,397	189,354
MAY	3456	26,717	49,920	445,228	22,063	43,646	208,309
JUN	3476	26,562	84,452	473,182	15,157	43,377	142,427
JUL	6903	9,094	41,538	423,174	22,285	34,257	154,839
AUG	3462	0	33,553	347,896	14,586	43,521	150,057
SEP	3461	17,614	50,184	464,733	22,518	52,155	82,404
OCT	3456	8,704	50,017	412,806	59,403	41,802	159,157
NOV	3464	0	41,468	418,587	7,170	34,940	219,463
DEC	7000	0	41,843	445,358	21,969	61,126	113,503

PROPANE

	BULK	ROB	JERF	MICH LAB	RAND WASH	THOMP LAB	ER	TOTAL
JAN 1977	49,893	20,138	5,199	-	9,880	4,692	9,761	99,563
FEB	49,954	9,820	10,434	-	9,871	9,352	-	89,431
MAR	19,864	10,143	4,607	-	-	5,228	-	39,842
APR	44,263	9,724	5,233	-	9,852	9,785	9,982	88,839
MAY	9,892	9,922	-	-	-	-	-	19,814
JUN	38,440	-	9,445	-	-	4,621	5,211	57,717
JUL*								
AUG*								
SEP*								
OCT	16,249	3,476	5,062	-	2,640	3,800	1,800	33,347
NOV	36,481	11,167	6,863	-	3,920	8,283	4,200	70,914
DEC	47,977	15,861	7,253	-	12,512	6,814	5,400	95,817
JAN 1978	45,083	14,007	6,299	-	4,180	5,622	3,403	78,594
FEB	46,637	14,020	3,521	-	8,766	8,596	2,800	84,340
MAR	32,178	9,230	5,562	-	6,282	6,087	2,900	62,239
APR	18,446	8,368	3,250	-	2,780	4,500	2,569	39,913
MAY	3,350	3,476	5,700	-	3,980	7,200	900	34,606
JUN	4,888	2,212	3,200	-	1,760	1,800	2,000	15,860
JUL	553	199	536	800	1,760	-	600	4,448
AUG	5,432	1,264	800	-	2,200	-	300	9,996
SEPT	15,748	948	3,400	400	2,640	1,600	600	25,336
OCT	13,680	2,528	3,419	-	2,200	2,900	179	24,906
NOV	46,084	12,640	6,100	-	4,450	1,500	3,000	73,774
DEC	61,707	19,169	9,200	600	4,770	8,400	4,500	108,346

*Data missing

NATURAL GAS (MCF)

	BP-1	BP-2	BP-4	CLPL PILOT PLT.	FH
1977					
SEP	3,822	0	2869.5	340.7	7,585
AUG	2,201	0	3.0	331	5,672
JUL	66	7,073	1589	297	5,325
JUN	0	2,642	673	316	6,825
MAY	0	12,105	3257	776	19,829
APR	2,705	2,697	1858	674	18,593
MAR	0	0	0	1544	39,073
FEB	823	415	389	1135	33,282
JAN	11,616	6,859	5808	1948	52,394
OCT	8,766	0	1421	547	11,654
NOV	5,525	41	1741	1297	26,090
DEC	Missing	Missing	Missing	1419	33,089
1978					
JAN	879	6,930	5465	1576	36,413
FEB	548	0	2098	1380	29,779
MAR	126	6,410	1748	1141	23,786
APR	0	6,983	1694	940	19,330
MAY	583	7,351	1482	545	11,003
JUN	4,752	0	1198	297	7,781
JUL	5,328	0	1279	314	7,262
AUG	6,970	0	1530	361	6,972
SEP	2,288	0	1526	326	8,386
OCT	6,029	5,722	1805	522	11,551
NOV	192	3,063	2006	1401	28,175
DEC	328	2,363	2427	2223	44,045

WATER

The water demands at China Lake are met entirely from ground based wells. Pumping loads represent a considerable electrical demand as previously noted. The next four tables give data on recent consumption figures, reservoir capacities, well capacities and water distribution capacities.

Nighttime pumping and storage for the next days' use has already been described as a means of shifting energy demand. In this study, the potential for water storage as a means of energy storage will be explored. Several storage tanks are located at elevated locations and may offer an opportunity for electric power generation as the water is released to satisfy daytime demands. Pumped hydro storage has proven to be an effective means of load leveling for utilities and may be of value at the China Lake facility.

WATER CONSUMPTION

	HARVEY FIELD		INTERMEDIATE	
DATE	HOURS	GALLONS	HOURS	GALLONS
7/77	1068	102,158,000	1274	136,875,000
8/77	1526	129,587,000	1613	170,517,000
9/77	1189	94,947,000	1284	129,730,000
10/77	1164	93,426,000	918	80,335,000
11/77	0	0	843	90,015,000
12/77	0	0	714	73,338,000
1/78	0	0	523	51,257,000
2/78	0	0	570	53,603,000
3/78	0	0	637	58,884,000
4/78	0	0	853	86,066,000
5/78	0	0	1281	130,217,000
6/78	1382	119,394,000	1328	140,286,000
7/78	1425	132,267,000	963	110,359,000
8/78	1710	152,328,000	1095	121,973,000
9/78	701	53,051,000	912	101,359,000
10/78	859	66,668,000	707	77,935,000
11/78	587	42,950,000	574	61,737,000

RESERVOIR CAPACITY

	LOCATION	ELEVATION (FT)	NUMBER	UNIT CAPACITY (GALLONS)
1.	Aqueduct (not connected)	--	3	50,000
2.	Harvey Field	2413	1	1,500,000
3.	Intermediate Station	2324	2	1,500,000
4.	F-H Station	2255	2	1,500,000
5.	E System (NAF)	--	1	1,500,000
6.	Booster Station #1 (B-Mtn.)	2376	1	100,000
			1	2,000,000
			1	1,500,000
7.	Booster Station #2 (PL Res)	2848	1	1,500,000
			1	50,000
8.	CLPL Booster Station	2325	2	50,000
9.	CT Booster Station	2224	1	50,000
10.	Sky Top	--	1	5,000
			2	30,000

WELL CAPACITIES

HARVEY FIELD	
#15	1850 gpm
#12A	1200 gpm
#16A	1450 gpm
#27	2250 gpm
INTERMEDIATE	
#18B	2400 gpm
#28	1300 gpm
#29	1600 gpm
TOTAL	12,050 gpm = 12.6 MGD

WATER DISTRIBUTION CAPAPCTIES

LINE SIZE	HARVEY FIELD TO INTERMEDIATE	INTERMEDIATE TO FH	INTERMEDIATE AND FH PUMP TO FH SYSTEM	EQUALIZING RESERVOIR DISTRIBUTION TO	FROM
8" and 16"	5100 gpm				
		2700 gpm			
		2250 gpm	2250 gpm		
		4280 gpm			
		8300 gpm			
			8000 gpm		
				700 gpm	400 gpm
				5000 gpm	3600 gpm
	5100 gpm (7.3 MGD)	8300 gpm to Reservoir	10,250 gpm (14.7 MGD)	5700 gpm	4000 gpm
		2250 gpm to FH system (3.2 MGD)			
Well #19 [EMERGENCY USE ONLY DIRECT TO SYSTEM]			1000 gpm		

WEATHER DATA

Composite figures for weather at China Lake are tabulated on page 31. A summary of heating and cooling degree days appears on page 32.

WEATHER SUMMARY CHINA LAKE, CA.

	1977						1978					
TEMPERATURES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Avg. High (°F)	104.7	100.9	92.5	84.8	71.2	M	56.3	63.5	71.5	74.0	87.0	96.7
Norm (°F)	102.3	100.5	94.0	81.9	68.0	I	57.8	63.8	70.4	76.8	86.2	95.5
Avg. Low (°F)	68.7	69.1	60.5	47.9	35.2	S	35.9	37.9	45.0	46.9	53.7	64.0
Norm (°F)	70.0	67.7	60.3	48.8	37.0	S	28.7	34.2	38.3	46.6	55.2	63.1
Mean (°F)	86.6	85.1	76.5	66.3	53.2	I	46.2	50.7	58.2	60.4	70.2	80.4
Norm (°F)	86.2	84.1	77.2	65.4	52.4	N	43.1	49.0	54.2	61.9	70.7	79.4
						G						
Highest (°F)	112	113	105	93	83		66	74	88	89	100	106
Lowest (°F)	60	59	49	36	23		26	30	37	35	40	55
RELATIVE HUMIDITY												
Mean (%)	20	29	24	28	35		67	59	56	39	30	28
Norm (%)	23	24	27	32	42		51	47	39	34	30	24
WINDS												
Prevailing:												
Direction	S	SSW	SSW	SSW	Var.		SSW	SSW	SSW	SSW	SSW	SW
Norm	SW	SSW	SSW	SW	SSW		SW	SW	SW	SW	SW	SW
Speed (MPH)	8	6	7	4	5		4	6	6	9	7	9
Norm	8.5	8.3	7	6.6	5.4		5.4	6.7	9.1	9.5	9.6	8.8
PEAK GUST												
Direction	WNW	S	WSW	E	SW		WSW	WSW	SSE	WSW	W	W
Speed (MPH)	36	48	43	48	46		44	43	39	46	53	44

HEATING/COOLING DEGREE DAYS
MONTHLY SUMMARY
CHINA LAKE, CALIFORNIA

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1976	HEATING	662	421	338	187	2	0	0	0	0	52	280	673
	COOLING	0	0	0	0	69	171	380	175	74	1	0	0
1977	HEATING	646	355	451	53	138	0	0	0	0	38	345	494
	COOLING	0	0	0	0	10	252	361	318	103	3	0	0
1978	HEATING	583	396	217	161	22	0	0	0	13	47	488	813
	COOLING	0	0	0	0	16	166	301	288	53	11	0	0

Cooling degree days per day = mean daily temperature minus $75^{o}F$

Cooling degree days per month = cumulative values of degree days per day

Heating degree days per day = $65^{o}F$ minus mean observed temperature

Heating degree days per month = cumulative values of degree days per day

APPENDIX

Southern California Edison
Electric Rate Schedule No. TOU-8

SOUTHERN CALIFORNIA EDISON COMPANY
2244 Walnut Grove Avenue
Rosemead, California 91770

Revised Cal. P.U.C. Sheet No. 4832-E

Cancelling Revised Cal. P.U.C. Sheet No. 4757-E

Schedule No. TOU-8

GENERAL SERVICE — LARGE

APPLICABILITY

Applicable to three-phase general service, including lighting and power, supplied directly from lines of transmission voltage, or where for the Company's operating convenience service is supplied from lines of distribution voltage.

This schedule is applicable for all customers of record on August 23, 1977, served on Schedule No. A-8 and thereafter is applicable to all customers whose monthly maximum demand exceeds 5,000 kW for any three months during the preceding 12 months. Any customer whose monthly maximum demand has fallen below 4,500 kW for 12 consecutive months may elect to take service on any other applicable schedule.

TERRITORY

Within the entire territory served, excluding Santa Catalina Island.

RATES

	Per Meter Per Month
Customer Charge:	$800.00
Demand Charge (to be added to Customer Charge):	
All kW of on-peak billing demand, per kW	$ 2.10
Plus all kW of mid-peak billing demand, per kW	0.25
Plus all kW of off-peak billing demand, per kW	No Charge
Energy Charge (to be added to Demand Charge):	
All on-peak kWh, per kWh	1.408¢
Plus all mid-peak kWh, per kWh	1.258¢
Plus all off-peak kWh, per kWh	1.108¢

Minimum Charge:

The monthly minimum charge shall be the sum of the monthly Customer and Demand Charges. The monthly Demand Charge shall be not less than the charge for 25% of the maximum on-peak demand established during the preceding 11 months.

Daily time periods will be based on Pacific Standard Time and are defined as follows:

On-peak: 12:00 noon to 6:00 p.m. summer weekdays except holidays
5:00 p.m. to 10:00 p.m. winter weekdays except holidays

Mid-peak: 8:00 a.m. to 12:00 noon and 6:00 p.m. to 10:00 p.m. summer weekdays except holidays
8:00 a.m. to 5:00 p.m. winter weekdays except holidays

Off-peak: All other hours.

Off-peak holidays are New Year's Day, Washington's Birthday, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, and Christmas.

For initial implementation of this schedule by the Company, winter shall consist of the billing periods for the six regularly scheduled monthly billings beginning with the first regularly scheduled billing ending after November 14, 1977. Thereafter, regularly scheduled monthly billings shall include six summer billing periods followed by six winter billing periods. In no event will winter include scheduled billing periods ending after May 31 of any year.

(Continued)

(To be inserted by utility)
Advice Letter No. 446-E
Decision No. 87744

Issued by
Edward A. Myers, Jr.
Name
Vice President
Title

(To be inserted by Cal. P.U.C.)
Date Filed September 14, 1977
Effective October 14, 1977
Resolution No.