LIMA ARMY TANK PLANT
LIMA, OHIO

ENERGY ENGINEERING ANALYSIS PROGRAM
EXECUTIVE SUMMARY

PREPARED FOR

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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1.0 INTRODUCTION

The report is in response to the Energy Engineering Analysis Program (EEAP) for Lima Army Tank Plant, Lima, Ohio. The objective of this report is to provide energy consumption data on the facility along with practical recommendations for energy conservation. The energy analysis was conducted in three phases: 1) field survey and data collection; 2) energy conservation project investigation and development; 3) final report and executive summary development. During the field survey each building was investigated to determine enclose type, occupancy, operations, and size. The building mechanical and electrical systems were studied in detail during the survey. Records of energy consumption were obtained where possible. Projects were developed following the field survey. The projects consist of a Form DD1391, a project development brochure (PDB), and calculations to support the analysis. The final report and executive summary includes all energy conservation projects which have been developed, recommended policy or operational changes, present and projected energy consumption, and the field data submission.

There is no record of previous energy studies for the facility, however, several energy conservation measures were implemented when the plant was reopened for operation in 1978. These measures included the addition of building insulation, several heat recovery units, and storm windows.

The facility, originaly built in 1942, is owned by the Department of the Army. During World War II, the plant was used to modify tanks. After the War the plant was used as an ordinance vehicle maintenance school. In 1978, the main building was modified for the initial development and manufacture of the X-M1 Tank. The first tank, the X-M1 ABRAMS TANK, was manufactured early in 1980. Production operations are managed by the Chrysler Defense Division. Tank production is presently being increased from 30 to 60 tanks per month, using one shift a day. An increase in future production is anticipated to reach a level of 90 to 120 tanks per month, using two shifts a day. An emergency production capacity of 150 tanks per month is desired using three shifts a day by 1986.

2.0 SUMMARY

A total of 18 projects have been identified and developed which, when implemented, will save energy. Nine of the projects are mechanical in nature and seven are electrical. Of the two remaining projects, one investigates the application of solar energy and the other examines the installations of an energy monitoring and control system (EMCS). Following is a list of projects developed.

PROJECT #		TITLE
No. 1	-	Insulation to Various Buildings
No. 2	-	Heat Recovery Unit - Building #143
No. 3	-	Heat Recovery Units - Building #186
No. 4	-	Heat Recovery Units - Building #147
No. 5	-	Domestic Water Heating w/Condensate - Building #147
No. 6	-	Government Family Housing - Insulation & Flue Dampers
No. 7	-	Paint Spray Line Heat Recovery - Building #147
No. 8	-	Solar Preheating of Boiler Make-up Water
No. 9	-	Boiler Stack Loss Reduction
No. 10	-	Boiler No. 3 F.D. Fan Turbine Replacement
No. 11	-	Compressor Waste Heat Recovery
No. 12	-	Power Factor Correction
No. 13	-	Replacement of Standard Motors with High Effeciency Motors
No. 14	-	Energy Conservation Retrofit to Lighting System - Building #147
No. 15	-	Energy Conservation Retrofit to Lighting System - Building #S-70
No. 16	-	Energy Conservation Retrofit to Office Area Lighting System - Building #186
No. 17	-	Energy Conservation Retrofit to Lighting System - Building #351
No. 18	-	Energy Monitoring and Control System

A summary of the project analysis results is provided in Table 1. The energy conservation investment program (ECIP) guidance was used to make the necessary calculations and evaluate results. The current working estimate (CWE) is total project cost, not including design cost. The savings for each project are expressed in both energy (MBtu/year) and dollars ($/year). Two items of significance are the E/C Ratio

TABLE 1

PROJECT ANALYSIS SUMMARY

Proj. No.	$ (x1000) CWE	$ (x1000) Total Cost	$ (x1000) Disc. Benefits	$ (x1000) Disc. Energy	B/C	MBtu/Yr. Energy Savings	E/C	$ (x1000)/Yr. Dollars Savings	Years Payback	FY	Meets ECIP Criteria
1	57.2	60.3	-	185.5	3.1	4,720	82	12.5	4.6	85	No
2	71.0	74.8	-	68.1	3.7	1,573	91	4.6	3.75	86	No
3	132.9	140.0	-	115.8	1.2	2,677	30	7.8	11.4	86	Yes
4	875.9	925.4	-	1,155.7	3.8	26,694	94	78.2	3.6	86	Yes
5	4.8	5.1	-	14.9	2.8	371	77	1.0	5.0	85	No
6	3.4	3.4	-	18.4	5.4	75	22.1	1.1	3.0	85	No
7	197.0	208.1	36.4	501.0	2.2	3,258	16.5	19.8	10.0	85	Yes
8*	138.3	145.7	-	22.9	0.2	624	4.5	1.6	84.4	86	No
9	15.5	16.4	17.8	160.7	10.9	4,541	292	13.1	1.2	85	No
10	3.7	3.9	-	4.8	1.2	264	70	0.4	8.5	85	No
11	128.1	135.0	-	210.9	1.6	5,365	42	14.3	9.0	85	Yes
12	311.5	329.1	-	3,325.8	10.1	1,219	3.9	184.3	1.7	85	No
13	193.5	198.7	-	237.8	1.2	2,967	15.3	13.2	14.3	86	Yes
14	161.7	170.4	645.2	1,586.6	13.1	33,543	207	155.6	1.1	85	Yes
15	4.9	4.9	11.7	31.5	16.6	689	140	5.6	1.0	85	No
16	21.4	22.0	14.8	193.0	9.4	1,974	92	12.2	1.7	85	No
17	147.7	152.7	22.3	265.6	1.9	4,082	28	17.1	8.5	85	Yes
18	966.3	1,024.3	-	3,789.8	3.7	77,474	80	319.1	3.0	85	Yes

* Not recommended for implementation.

TABLE 1-A

PROJECT ANALYSIS SUMMARY

Proj. No.	$ (x1000) CWE	$ (x1000) Total Cost	$ (x1000) Disc. Benefits	$ (x1000) Disc. Energy	B/C	MBtu/Yr. Energy Savings	E/C	$ (x1000)/Yr. Dollars Savings	Years Payback	FY	Meets ECIP Criteria
3	132.9	140.0	-	115.8	1.2	2,677	30	7.8	11.4	86	Yes
4	875.9	925.4	-	1,155.7	3.8	26,694	94	78.2	3.6	86	Yes
7	197.0	208.1	36.4	501.0	2.2	3,258	16.5	19.8	10.0	85	Yes
11	128.1	135.0	-	210.9	1.6	5,365	42	14.3	9.0	85	Yes
13	193.5	198.7	-	237.8	1.2	2,967	15.3	13.2	14.3	86	Yes
14	161.7	170.4	645.2	1,586.6	13.1	33,543	207	155.6	1.1	85	Yes
17	147.7	152.7	22.3	265.6	1.9	4,082	28	17.1	8.5	85	Yes
18	966.3	1,024.3	-	3,789.8	3.7	77,474	80	319.1	3.0	85	Yes

The following projects do not meet one or more of the ECIP criteria for cost, B/C, & E/C

Proj. No.	$ (x1000) CWE	$ (x1000) Total Cost	$ (x1000) Disc. Benefits	$ (x1000) Disc. Energy	B/C	MBtu/Yr. Energy Savings	E/C	$ (x1000)/Yr. Dollars Savings	Years Payback	FY	Meets ECIP Criteria
1	57.2	60.3	-	185.5	3.1	4,720	82	12.5	4.6	85	No
2	71.0	74.8	-	68.1	3.7	1,573	91	4.6	3.75	86	No
5	4.8	5.1	-	14.9	2.8	371	77	1.0	5.0	85	No
6	3.4	3.4	-	18.4	5.4	75	22.1	1.1	3.0	85	No
8*	138.3	145.7	-	22.9	0.2	624	4.5	1.6	84.4	86	No
9	15.5	16.4	17.8	160.7	10.9	4,541	292	13.1	1.2	85	No
10	3.7	3.9	-	4.8	1.2	264	70	0.4	8.5	85	No
12	311.5	329.1	-	3,325.8	10.1	1,219	3.9	184.3	1.7	85	No
15	4.9	4.9	11.7	31.5	16.6	689	140	5.6	1.0	85	No
16	21.4	22.0	14.8	193.0	9.4	1,974	92	12.2	1.7	85	No

* Not recommended for implementation.

(energy savings per year/K$ current working estimate) and B/C Ratio (total discounted benefits/total intial captial cost). For a project to meet ECIP requirements, the E/C Ratio must be equal to or greater than 13 and the B/C Ratio must be greater than 1.0. Also, it is necessary that each project amortize within its economic life and have a construction cost equal to or greater than $100,000 to qualify as an ECIP project.

Table 2 lists all developed projects in order of preference based on E/C Ratio. All projects, with the exception of Project No. 8j "Solar Energy Analysis" and Project No. 12 "Power Factor Correction", meet the required E/C Ratio (E/C $\geq$ 13). NUS recommends that all projects except Project No. 8 "Solar Energy Analysis" be implemented within the next four or five years.

TABLE 2
E/C RATIO PRIORITY LIST

Project No.	E/C	B/C	Energy Savings (MBtu/yr.)	Dollar Savings ($(x1000)/yr.)	Payback (Years)	FY	Meets ECIP Criteria
9	292	10.9	4,541	13.1	1.2	85	No
14	207	13.1	33,543	155.6	1.1	85	Yes
15	140	16.6	689	5.6	1.0	85	No
4	94	3.8	26,694	78.2	3.6	86	Yes
16	92	9.4	1,974	12.2	1.7	85	No
2	91	3.7	1,573	4.6	3.75	86	No
1	82	3.1	4,720	12.5	4.6	85	No
18	80	3.7	77,474	319.1	3.0	85	Yes
5	77	2.8	371	1.0	5.0	85	No
10	70	1.2	264	0.4	8.5	85	No
11	42	1.6	5,365	14.3	9.0	85	Yes
3	30	1.2	2,677	7.8	11.4	86	Yes
17	28	1.9	4,082	17.1	8.5	85	Yes
6	22.1	5.4	75	1.1	3.0	85	No
7	16.5	2.2	3,258	19.8	10.0	85	Yes
13	15.3	1.2	2,967	13.2	14.3	86	Yes
8*	4.5	0.2	624	1.6	84.4	86	No
12	3.9	10.1	1,219	184.3	1.7	85	NO

* Not recommended for implementation.

TABLE 2-A

B/C RATIO PRIORITY LIST

Project No.	E/C	B/C	Energy Savings (MBtu/yr.)	Dollar Savings ($(x1000)/yr.)	Payback (Years)	FY	Meets ECIP Criteria
15	140	16.6	689	5.6	1.0	85	No
14	207	13.1	33,543	155.6	1.1	85	Yes
9	292	10.9	4,541	13.1	1.2	85	No
12	3.9	10.1	1,219	184.3	1.7	85	NO
16	92	9.4	1,974	12.2	1.7	85	No
6	22.1	5.4	75	1.1	3.0	85	No
4	94	3.8	26,694	78.2	3.6	86	Yes
2	91	3.7	1,573	4.6	3.75	86	No
18	80	3.7	77,474	319.1	3.0	85	Yes
1	82	3.1	4,720	12.5	4.6	85	No
5	77	2.8	371	1.0	5.0	85	No
7	16.5	2.2	3,258	19.8	10.0	85	Yes
17	28	1.9	4,082	17.1	8.5	85	Yes
11	42	1.6	5,365	14.3	9.0	85	Yes
3	30	1.2	2,677	7.8	11.4	86	Yes
13	15.3	1.2	2,967	13.2	14.3	86	Yes
10	70	1.2	264	0.4	8.5	85	No
8*	4.5	0.2	624	1.6	84.4	86	No

* Not recommended for implementation.

TABLE 2-B

PAYBACK PRIORITY LIST

Project No.	E/C	B/C	Energy Savings (MBtu/yr.)	Dollar Savings ($(x1000)/yr.)	Payback (Years)	FY	Meets ECIP Criteria
15	140	16.6	689	5.6	1.0	85	No
14	207	13.1	33,543	155.6	1.1	85	Yes
9	292	10.9	4,541	13.1	1.2	85	No
12	3.9	10.1	1,219	184.3	1.7	85	NO
16	92	9.4	1,974	12.2	1.7	85	No
18	80	3.7	77,474	319.1	3.0	85	Yes
6	22.1	5.4	75	1.1	3.0	85	No
4	94	3.8	26,694	78.2	3.6	86	Yes
2	91	3.7	1,573	4.6	3.75	86	No
1	82	3.1	4,720	12.5	4.6	85	No
5	77	2.8	371	1.0	5.0	85	No
17	28	1.9	4.082	17.1	8.5	85	Yes
10	70	1.2	264	0.4	8.5	85	No
11	42	1.6	5,365	14.3	9.0	85	Yes
7	16.5	2.2	3.258	19.8	10.0	85	Yes
3	30	1.2	2,677	7.8	11.4	86	Yes
13	15.3	1.2	2,967	13.2	14.3	86	Yes
8*	4.5	0.2	624	1.6	84.4	86	No

* Not recommended for implementation.

3.0 FACILITY DESCRIPTION

The Lima Army Tank Plant consists of thirty-eight buildings. The largest is the Main Production Building No. 147, where fabrication and assembly is accomplished. Ten of the thirty-eight buildings are of major importance and directly support the production operations in Building No. 147. These ten buildings house operations such as administration, storage, repair shop, machine work and mechanical services. The remaining buildings include government housing, guard houses, utility services and miscellaneous storage. A test track, test pad, and water ford test basin are provided on the facility grounds to test tank performance. The tanks are not test fired at this facility. A complete list of buildings at the facility with a detailed description of each is provided in Volume IV, Field Data Submission.

FUTURE EXPANSION

The following lists future building expansions and additions to be accomplished at the Lima facility.

FY 1981 3,500 s.f., boiler house addition; add Boiler No. 5 with space for Boiler No. 6

FY 1982 Interim/Pre-Engineered building office; (area unknown)

FY 1983 6,693 s.f., Welding School addition to Building #147

FY 1985 80,000 s.f., New Administration Building
90,784 s.f., Vehicle Adjustment and Repair, Plate Inspection and edge preparation addition to Building #147
50,200 s.f., Enclosed building at receiving dock of building #147
Proposed expansion of Building #301, flammable storage; (area unknown)

FY 1986 39,766 s.f., Small parts weld, ring grinding, assembly marriage and hull structure weld addition to Building #147

UTILITIES

The following provides a brief description of current utility system and energy usage and the specific projects developed for improved energy conservation.

Steam Heating

Steam heat is produced in the central boiler house using three coal-fired boilers. The steam is distributed by insulated overhead piping at 125 psig and reduced to 50 psig inside the buildings. Condensate is returned to the boiler house.

The central boiler house is approximately 40 years old. A major renovation effort was accomplished in 1978 when the plant was reopened. The plant now has three stored coal-fired boilers No. 2, No. 3, and No. 4 rated at 20,000 PPH, 25,000 PPH and 50,000 PPH respectively. All boilers are capable of operating at rated capacity. Plant maintenance and operation is good and is constantly being improved as problems associated with restarting the plant are resolved. The boilers are now operating at an average efficiency of 80% to 82%.

The boiler house capacity is adequate for the current peak load of 58,000 PPH. However, expansion of manufacturing facilities will increase the design load. Improved energy conservation will reduce the impact of this expansion. An NUS evaluation of projected steam requirements dated June 24, 1981 is included in this report as Appendix A. Steam requirements are projected to remain less than 100,000 PPH. The planned addition of the 75,000 PPH Boiler No. 5 is sufficient to meet the increased steam requirements due to future expansion.

Vented steam is a significant source of wasted energy in the boiler house. Boiler No. 3, with its turbine driven forced draft fan, creates excessive low-pressure steam for the deareator. The excess steam is currently vented to the atmosphere. The summer load condition is another principal cause of excessive steam venting. The summer load is presently less than 4,000 PPH. The minimum load on Boiler No. 2 is 6,000 PPH. The difference (2,000 PPH) is wasted to the atmosphere. However, future increases in the process load should reduce the amount of steam wasted each summer. Projects No. 9, 10, and 11 address specific measures for improved energy conservation.

Natural Gas

Another source for heating is natural gas. The paint spray line in Building #147 uses natural gas to preheat makeup air for paint booths and to heat air for bake ovens and heated blow dry. The heated blow dry exhausts the hot air into the plant during the winter; however, this is the only form of energy conservation presently used in the system. Project No. 7 addresses this waste and energy recovery system.

The conversion from natural gas to steam in the plaint spray line is scheduled for 1984.

Fuel Oil

The occupied residences at the facility use No. 2 fuel oil for space heating. This is a relatively small amount and the present operation is good.

Domestic Hot Water

Domestic hot water is provided locally by electric water heaters in toilet rooms and janitor closets. These are small residential-type heaters with a storage tank. Each unit usually services a group of two or four toilet rooms. The kitchen area in Building No. 147 has a steam water heater and storage tank. Project No. 5 addresses this area.

Cooling

Cooling is only provided in office areas, the laboratory area (Building No. 147) and the kitchen area (Building No. 147). All cooling is provided locally by electric unitary or split-system HVAC units. Some of the units have the capability to operate on an economizer cycle. This allows cooling with 100% outdoor air when conditions permit. Night set-back or time clock control is not present on any of the units. This is addressed in Project No. 18.

Compressed Air

A large volume of compressed air is used by projection equipment. Compressors are located in the central boiler house and piped by overhead lines at 100 psig. The facility has a total capacity of 954 hp and 4,412 CFM provided by four compressors. One additional compressor is scheduled for installation in 1981 and another in 1982 to provide a total capacity of 1,554 hp and 7,412 CFM. The compressors and associated air driers are water cooled by a cooling tower. Presently, 1.2 MBtu/hr is wasted to the atmosphere via the cooling tower. When the system capacity is increased in 1982, an estimated 2.1 MBtu/hr of waste heat will be rejected. Project No. 11 addresses this waste of energy and recommends a system for heat recovery.

Electric Energy

Electrical service to the facility is brought overhead to an outdoor substation by The Ohio Power Company and consists of two independent 138kv feeders. Transformers reduce this incoming voltage to 13.8kv where it is then metered. These 13.8kv feeders are brought to switchgear in Basement A of Building #147 by concrete encased conduits. From this point, power is supplied to other substations in Basement A and Basement C of Building #147. Other buildings on the site are also supplied from this switchgear at 4,160 volts, 3 phase by means of an overhead pole line distributions system. Project Nos. 12 through 18 address measures for reduced electric consumption.

4.0 PRESENT ENERGY CONSUMPTION AND COST

CONSUMPTION

Electricity Consumption

No record of electrical energy consumption exists for FY 1975 because the facility went into production in FY 1980. However, a record of consumption from March 1980 through June 1981, exists and has been plotted in Graph 1. The plot shows a typical load growth pattern of a new production facility rising to peak production and remains flat for 4 months at peak electrical usage. Since this flat portion represents present maximum usage, it is this period (1/23/81 thru 4/23/81) which has been used to extrapolate present annual usage.

A. Base wide consumption FY 81 projected.

ENERGY - KWh - 30,200160 kWh

B. Source energy consumption (MBtu)

MBtu = kWh x 11600 Btu/kWh/10^6 Btu/MBtu =
30,200160 x 11600/10^6 = 350,322 MBtu

C. Building group source energy consumption

Same as A. and B.

D. Typical building energy consumption

Since all buildings are fed from the 5kV (nominal) switchgear, it was possible to determine kVA directly from the cubicle instrumentation 1.0 at 5% accuracy (stitchboard instrument accuracy).

The following are total building loads which are fed from the 4160V switchgear in groups, and are from period 1/26/81 thru 4/24/81.

1. Building #143 - 108kVA production hrs, 36kVA non production hrs.

2. North 4160V Pole - 55.15A = 397.4kVA - Feeder for the following Buildings:

   Buildings (S-5, 7, 52, 66, 67, 70), 72, 75, 77, (S-78, 95, 96)

3. South 4160V Pole 216kVA Building Load - 505kVA with portable compressor - Feeder for the following Buildings:

   Test Track Building #186, Boiler Plant, 301, 351, 390, S-343, S-344, S-345

4. This period of 1/26 thru 4/24/83 has monthly average metered loads as follows:

   Demand = 6,757kVA, 5358kW, 4224RkVA, PF=.755
   kWh = 2516680
   RkVAh = 2113707

   Assuming the same PF for the out Buildings as for the total load.

5. Building #147 = 6757 - (108 + 397.4 + 505) = 5747kVA

   The building group energy usage is tabulated as follows:
   Annual Energy Consumption

Building #147	18,331,587kWh
Building #143	344495kWh
North Pole Buildings (See Para. D2)	1267613kWh
South Pole Buildings (See Para. D3)	1610832kWh
Total Annual	21554527kWh

Coal Consumption

Energy Consumption Data has been recorded since October 1978 in the central boiler house:

Record Period	Coal Consumption
Oct. 1978 thru Sept. 1979	7,818 tons
Oct. 1979 thru Sept. 1980	8,398 tons 189,318,000 # steam
Oct. 1980 thru May 1981	7,912 tons (8 months)

A. Basewide consumption project for FY 81

$$\text{Jan. 1 thru May 1} = 7912 + \overbrace{279 + 298 + 267 + 216}^{\text{From 1980 Records}} =$$

Energy = 9072 tons

B. Source Energy Consumption FY 81

9072 tons x 24.58 MBtu/ton = 222,990 MBtu/year

Natural Gas Consumption

Reference Graph No. 24, "Projected Natural Gas Consumption 1981 - 2006" in Section 6.0 of this report.

Natural gas consumption for fiscal year 1981 is estimated at 13.0 million cubic feet and 13,400 MBtu/year. A small increase in consumption to 15.0 million cubic feet is anticipated through 1985. Conversion of the point system during FY 85 will result in a reduction in annual consumption to 2.0 million cubic feet for the remaining flame cutting operation in FY 86.

COST

Fuel Costs and Escalation Rates:

1. The following conversion factors are used to permit standardized project evaluation comparisons:

Electric Power	11,600,000 Btu/kWh
Distillate Fuel Oil	138,700 Btu/Gal.
Natural Gas	1,031,000 Btu/1000 cu. ft.
Bituminous Coal	24,580,000 Btu/Short-ton

2. Energy, material, and labor prices are escalated from current FY 1981 rates to those projected for September 30 of each fiscal year listed below. Escalation rates and costs have been shown to FY 86. This is necessary since some projects have been calculated on a construction year of 1986. These indicated FY 86 projects are FY 85 projects whose E/C, B/C, or payback periods were nonfundable under the ECIP program, but were borderline. Under instructions from COE, these projects were recalculated using FY 86 escalation factors which in many instances resulted in their meeting ECIP criteria.

	FY 82	FY 83	FY 84	FY 85	FY 86
o Design, Construction, SIOH	6.0%	6.0%	6.0%	6.0%	6.0%
o Maintenance & Repairs, O&M, Salvage	5.6%	5.6%	5.6%	5.6%	5.6%
o Coal	10.0%	10.0%	10.0%	10.0%	10.0%
o Fuel Oil	14.0%	14.0%	14.0%	14.0%	14.0%
o Natural Gas	14.0%	14.0%	14.0%	14.0%	14.0%
o Electricity and Demand Charge Reduction	13.0%	13.0%	13.0%	13.0%	13.0%

3. The differential escalation rates given below are used for computing the present worth of recurring annual costs/benefits.

Maintenance & Repairs, O&M	0.0%
Coal	5.0%
Fuel Oil	8.0%
Natural Gas	8.0%
Electricity and Demand Charge Reduction	7.0%

4. The present worth factors for multiplication of recurring annual savings are selected from the appropriate differential escalation rate. A table of differential escalations discount factors is given below:

Economic Life in Years	O&M 0%	Coal 5%	Electricity 7%	Oil & N.G. 8%
15	7.980	10.798	12.278	13.112
25	9.524	14.777	18.049	20.050

5. The following table lists present and escalated energy costs:

		FY 1981	FY 1985	FY 1986
Coal	($/Short-ton)	44.73	65.49	72.04
	($/MBtu)	1.82	2.66	2.93
Fuel Oil	($/Gallon)	1.25	2.11	2.41
	($/MBtu)	9.01	15.21	17.38
Natural Gas	($/1000 cu. ft.)	3.86	6.52	7.43
	($/MBtu)	3.74	6.32	7.21
Electricity	($/kWh)	0.0368	0.0600	0.0678
Demand & Energy	($/MBtu)	3.17	5.17	5.84
Electrical Demand	($/kVA)	4.47	7.29	8.24
Electrical Energy	($/kWh)	0.00205	0.00334	0.00378
Electrical Fuel Adjustment	($/kWh)	0.016	0.026	0.029

5.0 ENERGY CONSERVATION MEASURES

During the field survey all buildings on the site were investigated. From this investigation certain data was gathered such as area, occupancy, building envelope, function, and information for the mechanical and electrical systems. While at the site, energy conservation measures were also investigated. Some of these measures were developed into projects while others did not merit further investigation. The following is a listing of energy conservation measures investigated and addressing general, mechanical, electrical, and boiler house areas.

General

1. Addition insulation to the building envelope required -

   a. Building #345, LATC and Warehouse - required on walls in heated warehouse
   b. Building #351, Warehouse #2 - north section only
   c. Building #121, Plant Security - underfloor and in walls. Also caulk windows, and caulk and weatherstrip doors.
   d. Building #542, Government Housing - underfloor only

2. Additional insulations to the building envelope found to be adequate or not cost effective -

   a. Building #147, Main Production
   b. Building #186, Warehouse #1
   c. Building #143, P.E. Office & Shop
   d. Building #S-70, Administration
   e. Building #301, Flammable Storage
   f. Building #785, #874, Government Housing

3. Time clock controls for unoccupied set-back of energy consuming equipment.

4. Energy Monitoring and Control System (EMCS) for various buildings.

Mechanical

1. All buildings were investigated to determine the feasibility of using steam condensate for space heating or domestic water heating. Only Building #147 had a system that adapted easily to condensate use. Other buildings have small condensate receiver tanks which would require major modifications for condensate to be used.

2. Government family housing was investigated and found to be in excellent condition. Only minor energy conservation measures are considered for the space heating system.

3. The paint spray line in Building #147 is a good area for heat recovery and energy conservation measures.

4. Modifications to the ventilation system in Buildings #147, #143, #186. Improved air distribution, heat recovery, and equipment operations scheduling are potential energy conservation measures.

5. Modifications to door heaters and air curtains in Building #147. Thermostat locations could be improved. The additions of plastic strip doors is unsafe and is not recommended.

6. Solar energy is a heating source to preheat water. However, Ohio is not a favorable location for application of solar heat. Also, the use of coal as a base fuel for comparison makes solar energy economically unacceptable.

7. Minor improvements to the steam distribution system -

   a. insulation replacement or addition
   b. replace steam traps with energy efficient traps
   c. repair leaks
   d. add automatic shut-off valves to mains
   e. add themostatic control valves to radiation.

Electrical

1. Reduction of lighting levels in areas illuminated above DOD minimum requirements.

   a. Disconnect fluorescent lamps and ballasts
   b. Replace fluorescent lamps with energy efficient lamps of lower light output
   c. Use of Energy saving solid state non ballast retrofit dimmers
   d. Replacement of existing metal halide light fixtures for building security lighting with lower voltage high pressure sodium lights
   e. Replacement of low bay lighting Buildings #147 and 351 with lower wattage more efficient high pressure sodium lights
   f. Replacement of fluorescent lamp ballasts with lower energy loss high efficiency ballasts.

2. Replacement of building service standard motors with new energy efficient motors.

3. Providing night security lighting system to allow contactor controlled shut-off of all lights during off shift, weekend and holiday hours. Contactor to be controlled by time clock or energy monitoring and control system.

4. Modify rate schedule with power company.

5. Improvement of power factor to reduce kVA demand and save energy penalty costs.

6. Off peak hour operation of battery charging.

7. Replacement of paint spray booth lighting fixtures with new energy efficient lamps and ballasts.

8. Cost penalty improvment of transformer operating kVA, demand kVA, power factor improvment by operating with half the transformers in the unit substations of Building #147.

9. Reduce demand and energy costs in running DC generator for crane power.

Boiler House

1. Share the winter load between Boilers No. 3 and No. 4.

2. Operate boilers in an automatic parallel positioning mode without use of the fuel/air ratio station, in lieu of the semi-automatic mode not utilized. Optimize fuel/air ratios.

3. Improve deareation operation by reducing the number of turbine drives in operation and reducing the feedwater temperature.

4. Shutdown the north header around May 1 for each summer.

5. Replacement of steam exhauster on ash handling system with motor driven blower. Substitution of electrically driven equipment for steam powered equipment is difficult to justify since steam is generated by coal.

6. Establish alternate summer load options. With the summer steam load less than 4,000 PPH, a rapid recovery electric boiler was considered. This would permit shutting down the boiler house for the summer, and realize a savings of approximately 11,500 MBtu/year. However, since electric heating is prohibited by DOD policy, this item was not given further consideration.

ECIP Projects Developed

The following projects meet all ECIP requirements and exceeds the $100,000 construction cost requirement.

Project No. 3 - Heat Recovery Units - Building #186
Project No. 4 - Heat Recovery Units - Building #147
Project No. 7 - Paint Spray Line Heat Recovery - Building #147

Project No. 11 - Compressor Waste Heat Recovery

Project No. 13 - Replacement of Standard Motors with High Efficiency Motors

Project No. 14 - Energy Conservation Retrofit to Lighting System - Building #147

Project No. 17 - Energy Conservation Retrofit to Lighting System - Building #351

Project No. 18 - Energy Montioring and Control System

Other Projects Developed

The following projects meet all ECIP requirements except the minimum construction cost of $100,000:

Project No. 1 - Insulation to Various Buildings

Project No. 2 - Heat Recovery Unit - Building #143

Project No. 5 - Domestic Water Heating w/Condensate - Building #147

Project No. 6 - Government Family Housing - Insulation and Flue Dampers

Project No. 9 - Boiler Stack Loss Reduction

Project No. 10 - Boiler No. 3 F.D. Fan Turbine Replacement

Project No. 15 - Energy Conservation Retrofit to Lighting System - Building #S-70

Project No. 16 - Energy Conservation Retrofit to Office Area Lighting System - Building #186

The following projects have E/C ratios below the minimum value required for ECIP projects (E/C $\geq$ 13):

Project No. 8 - Solar Preheating of Boiler Make-up Water

Project No. 12 - Power Factor Correction

Policy Recommendations and Changes

From the energy conservation measures investigated, several operational policy changes are recommended to reduce energy consumption. These should be implemented by maintenance or other facility personnel immediately for energy conservations to be realized. The following is a list of these recommendations:

1. All lights should be turned off promptly at the end of the shift or as soon as housekkeeping is finished. Presently this tasks is left for maintenance or security personnel and often lights are not turned off.

2. Battery charging in Building #186 should start at the end of the shift during off-peak demand hours. See Graphs of Daily Demand in Section 6.0

3. Exercise motor generator set 1/2 hour per week during off-peak demand hours. See Graphs of Daily Demand in Section 6.0 of this submittal. Purchase an extra set of air intake filters (at $18.00 per filter) for the static rectifier. This will allow for filter cleaning and drying without shutting down the rectifier. The rectifier runs at 96% efficiency and 90% ± power factor while the motor generator set runs at an overall efficientcyof 70%± and power factor of 60-70%. Energy and demand can be saved.

4. Keep lights turned off in electric rooms. Even with warm-up time to full brillance of 7 minutes, initial turning on of circuit gives immediate low light level to allow safe entry into room for meter readings or maintenance.

5. Each double ended unit substation should be operated with one transformer energized and the tied breaker should be closed to save energy and demand due to transformer losses. This sequence should be reversed monthly. A 750-Watt heater with thermostat set at 80°F must be installed in each transformer cubicle to operate when the transformer is de-energized. This is to prevent mositure build-up and the reduction of dielectric strength.

6. Replace all fluorescent lamps with 34-Watt energy saving lamps.

7. Turn off all supply and exhaust air fans, makeup air units, and heating/ventilating units during off-shift hours. This should be done year-around.

8. Caulk windows, and caulk and weather strip doors on Building #121, Plant Security. This will greatly reduce heat loss due to infiltrations.

9. Open monitors to the plant by removing lay-in tiles in Building #147, Main Production. This will allow for smoke to accumulate in monitors and be exhausted from there. Smoke accumulations may be less noticeable in the plant productions area if this is done.

10. Investigate the installations of a paint spray booth for small parts in Building #147. Presently, the large booths are used for this purpose. A smaller booth could be installed for painting parts. The small booth would consume less energy and would reduce the operating hours of the large paint booths.

11. Relocate thermostats for air curtains in Building #147. Presently some of the thermostats are placed in locations that do not indicate the true heating requirements. Thermostats should be located so that outside air entering through open doors will hit them directly.

12. Natural gas consumption should be metered for each component of the paint spray booth in Building #147. This will allow better management and reveal problem areas and large consumers.

13. Replace steam traps with energy efficient traps as they go bad.

14. Improve operational management of the paint spray equipment. The booths presently run when no painting is done. This is a huge waste of energy that could easily be stopped with a more definite schedule for painting. One suggestion is to add elapsed time meters to the booths.

15. Add thermometers to Boiler No. 3 to monitor economizer exit gas temperature and boiler exit gas temperature.

16. Replace deareator vent economizer thermometers with 0 to 300^{o}F scale thermometers.

17. Replace oxygen analyzers with zirconium oxide type analyzers with duel 0-25% and 0-10% oxygen scales. Present oxygen analyzer range of 0-10% is

not proper for boilers which operate above 10% oxygen through most of their operating range.

18. Install smoke density monitors on each boiler to provide additional feedback and allow for better boiler tuning and efficiency.

19. Add thermometers to the condensate return lines from the main buildings and the boiler house. This will allow monitoring the plants steam trap operation and steam utilization characteristics.

20. Install a meter on the condensate return line from the boiler plant to evaluate usage and energy conservation in the plant.

21. Add thermometers to Boilers No. 2 and No. 4 to monitor boiler exit gas temperature as a backup to the existing thermocouples and recorders.

22. Add a thermometer to the city water supply line.

23. Rework overfire air damper linkage on all boilers to allow for improved modulation and control of the overfire air.

24. Repair Boiler No. 2 refractory in general and specifically the baffle area.

25. Purchase a postable oxygen analyzer. This will provide a backup for the permanent analyzers and will enable traverses of the boiler outlet flue to determine air distribution in stoker air compartments and to look for signs of air infiltration into the boiler settings.

26. Add thermometers to the compressor cooling water system.

27. Add elapsed time meters to the compressors to aid in managing operation and identify air losses in the plant air distribution system.

6.0 ENERGY SAVINGS AND PROJECTED ENERGY CONSUMPTION

A. ELECTRICITY

1. Yearly Electric Usage - 1979 thru 1986

1979 - From Ohio Power Company Statistics

Total kWh	= 14,103,600 kWh
Total Demand	= 40,079 KVA
AV Demand	= 3,340 KVA
RKVAH	= kWh x TAN (PF Angle) = 14,103,600 x .787 = 11,093,154
PFAV	= 943/12 = 78.6
kW	= KVA x PF = 2,625 kW
RKVA	= kW x TAN (Pf Angle) = 2,065 RKVA
kW Usage	= 448 kWh/kW Demand
RKVA Usage	= 448 RKVAH/RKVA Demand

1980 - 10 Mo. Usage - Extrapolated to 12 Mo. (From Ohio Power Company)

Total kWh	= 23,456,200 kWh
Total Demand	= 62,626 KVA
AV Demand	= 5,219 KVA
RKVAH	= 19,756,800
PF AV	= 76.6
kW	= 3,998 kW
RKVA	= 3,355 RKVA
kW Usage	= 489 kWh/kW Demand
RKVA Usage	= 491 RKVAH/kW Demand

1981 - 6 Mo. Total - Projected to 12 Mo. (From Ohio Power Company)
(Assume 3% Increase in Usage for July and August)

Total kWh	= 30,200,200
Total Demand	= 62,828 KVA

Av. Demand	= 6,664 KVA
RKVAH	= 25,184,523 RKVAH
PF AV	= 76.8
kW	= 5,214 kW
RKVA	= 4,710 RKVA
kW Usage	= 483 kWh/kW Demand
RKVA Usage	= 446 RKVAH/RKVA Demand

Based on Facility Projections of 7600 KVA (1982) and 10,200 KVA by FY 85, and assuming straight line growth, the projections are:

1982	-	7,600 KVA
1983	-	8,467 KVA
1984	-	9,333 KVA
1985	-	10,200 KVA

kW and RKVA usage to be average of 1979, 1980, and 1981.

kW Usage = (448 + 489 + 483)/3 = 473 kWh/kW Demand

RKVA = (448 + 491 + 446)/3 = 458 RKVAH/RKVA Demand

Power Factor to be 1980 PF = .766 (varies from 6 month tot. 1981 by .002)

1982 - Projected

Total kWh	= 33,043,402 kWh
AV Demand	= 7,600 KVA
RKVAH	= 26,851,200 RKVAH
PF	= .766
kW	= 5,822 kW
RKVA	= 4,886 RKVA
kW Usage	= 473 kWh/kW Demand/Mo.
RKVA Usage	= 458 RKVAH/RKVA Demand/Mo.

1983 - Projected

Total kWh	=	36,813,000
AV Demand	=	8,467 KVA
RKVAH	=	29,914,350 RKVAH
PF	=	.766
kW	=	6,486 kW
RKVA	=	5,443 RKVA
kW Usage	=	473 kWh/kW Demand/Mo.
RKVA Usage	=	458 RKVAH/RKVA Demand/Mo.

1984 - Projected

Total kWh	=	40,578,200 kWh
AV Demand	=	9,333 KVA
RKVAH	=	32,974,000 RKVAH
PF	=	.766
kW	=	7,149 kW
RKVA	=	6,000 RKVA
kW Usage	=	473 kWh/kW Demand/Mo.
RKVA Usage	=	458 RKVAH/RKVA Demand/Mo.

1985 - Projected

Total kWh	=	44,347,700 kWh
AV Demand	=	10,200 KVA
RKVAH	=	36,037,100 RKVAH
PF	=	.766
kW	=	7,813 kW
RKVA	=	6,557 RKVA
kW Usage	=	473 kWh/kW Demand/Mo.
RKVA Usage	=	458 RKVAH/RKVA Demand/Mo.

At the end of FY 85, the energy saving projects will be completed and reflect in FY 86, FY 87, and FY 88. Assume 5% growth per year.

2. Electric Saving

Projects 2, 3, 4, 5, 7, 12, through 18 (Net)

	KW	RKVA	kWh
	-567	-351.4	
	-12.0	-4,000	-105,210
	-32.1	-15.5	-225,805
	-29.5	-	-2,891,615
	-65.0	-	-59,363
	-49.7	-24	-170,167
	+26	+16.1	-351,897
	+35.1	+21.8	-3,848,847
	+470	+291.3	-65,520
	+91.6	+56.8	+88,452
	0	0	+1,184,400
	0	0	+780
	0	0	+227,520
Total	-132.6	-4,005	-6,116,142

1986 - Projected

Total kWh	=	44,347,700 x 1.05 - 6,116,142 = 40,449,000
AV Demand	=	8,569 KVA
RKVAH	=	36,037,100 x 1.05 - 458 x 12 (4,005) = 15,827,475 RKVAH
PF	=	.942
kW	=	7,813 x 1.05 - 132.6 = 8,071 kW
RKVA	=	6,557 x 1.05 - 4,005 = 2,880 RKVA
kW Usage	=	418 kWh/kW Demand/Mo.
RKVA Usage	=	458 RKVAH/RKVA

NUS CORPORATION

Page 1 of 1

DATE 9-2-81

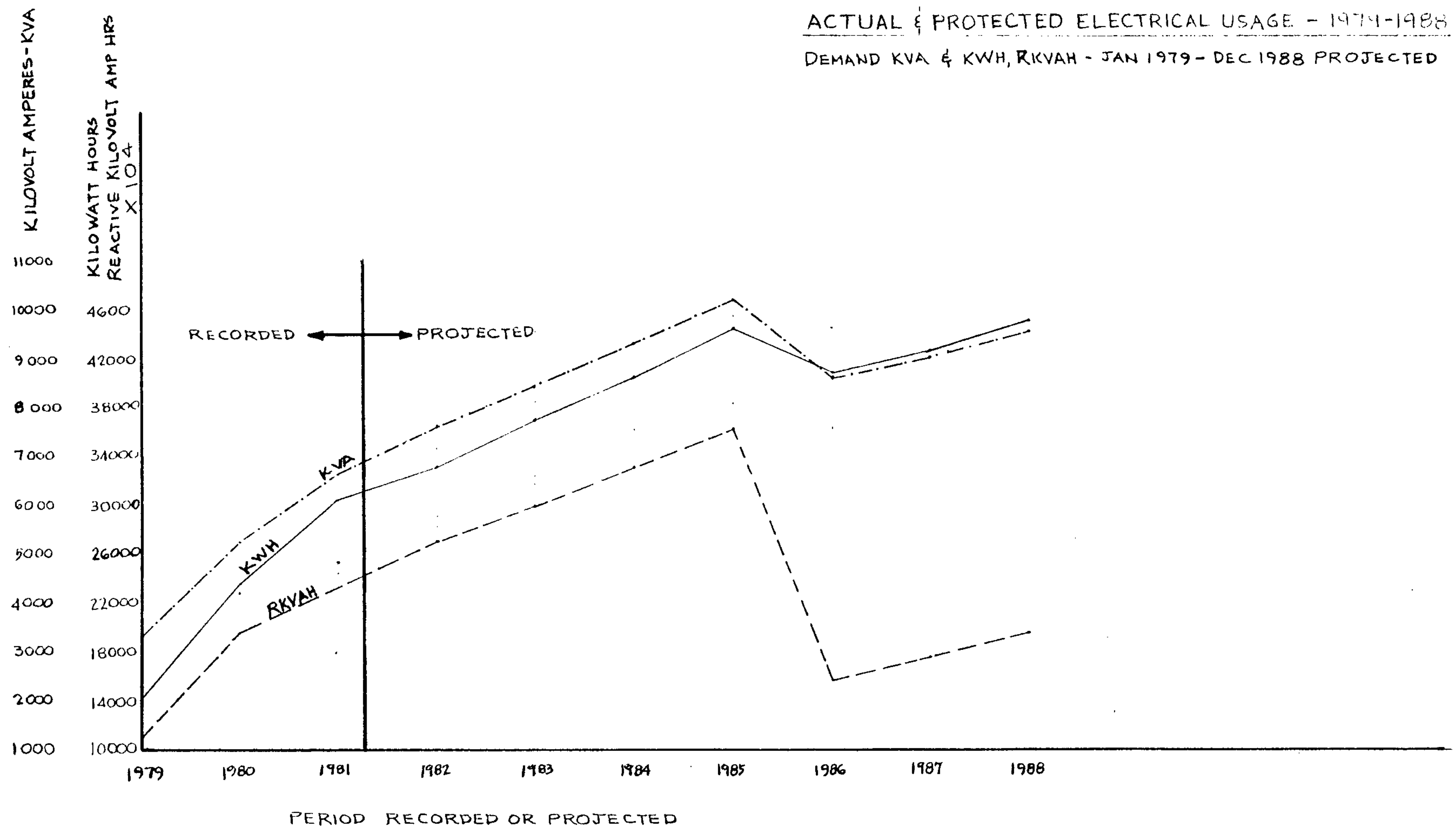
CLIENT COE TASK No. 5438 By GL GOLDSHITH

SUBJECT ACTUAL & PROJECTED ELECTRICAL USAGE-1979-1988 Checked By

GRAPH 1

ACTUAL & PROTECTED ELECTRICAL USAGE - 1979-1988

DEMAND KVA & KWH, RKVAH - JAN 1979 - DEC 1988 PROJECTED



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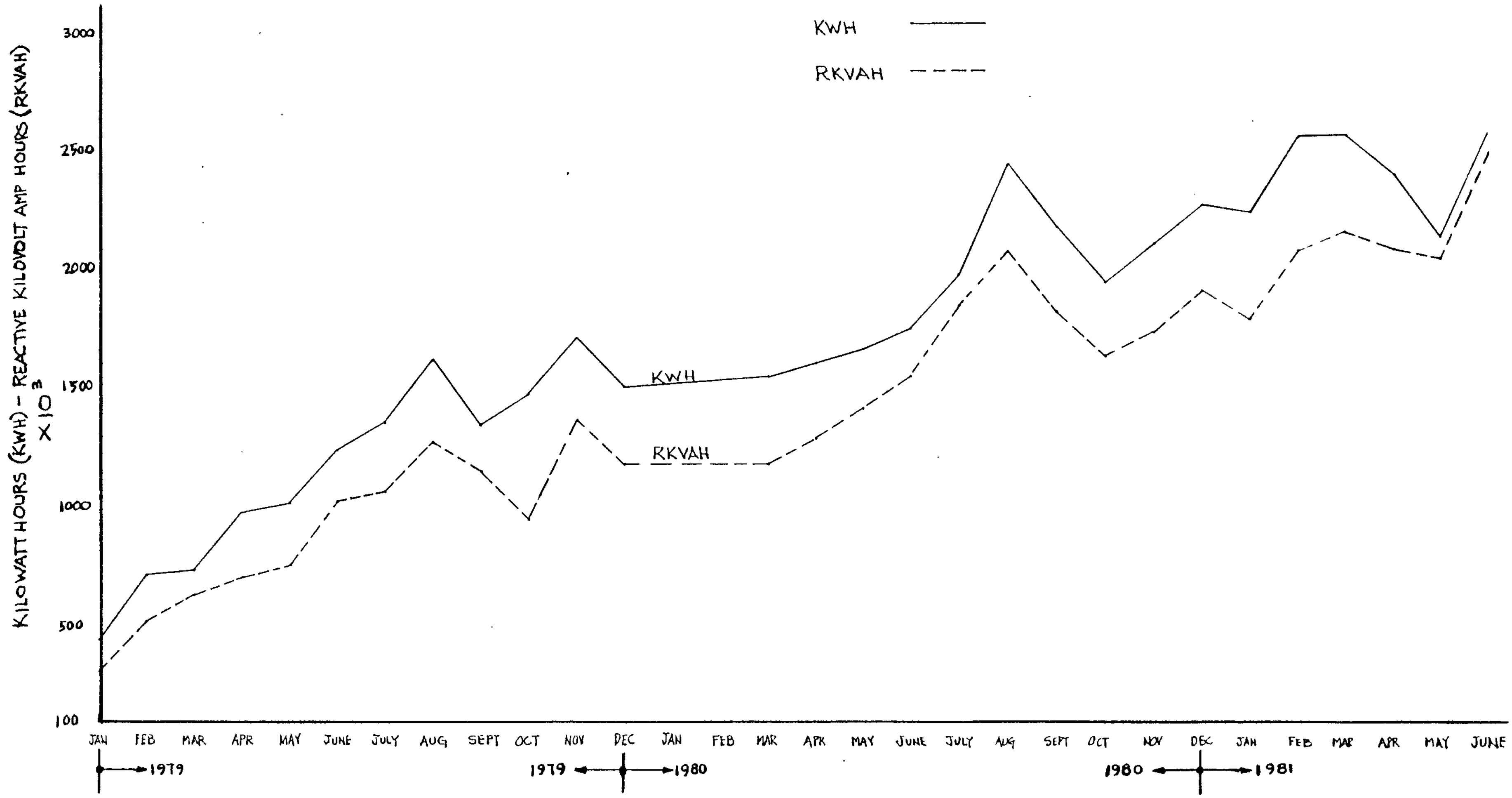
DATE 8-28-81

CLIENT COE TASK No. 5438 By GOLDSMITH

SUBJECT ELECTRIC USAGE - JAN 79 THRU JUNE 81 Checked By

GRAPH 2

ENERGY & REACTIVE POWER USAGE - JAN 79 - JUNE 81



NUS CORPORATION

Page 1 of 2

DATE 8-28-81

CLIENT COE TASK No. 5438 By GOLDSMITH

SUBJECT DEMAND & POWER FACTOR, USAGE Checked By

GRAPH 3

NUS CORPORATION

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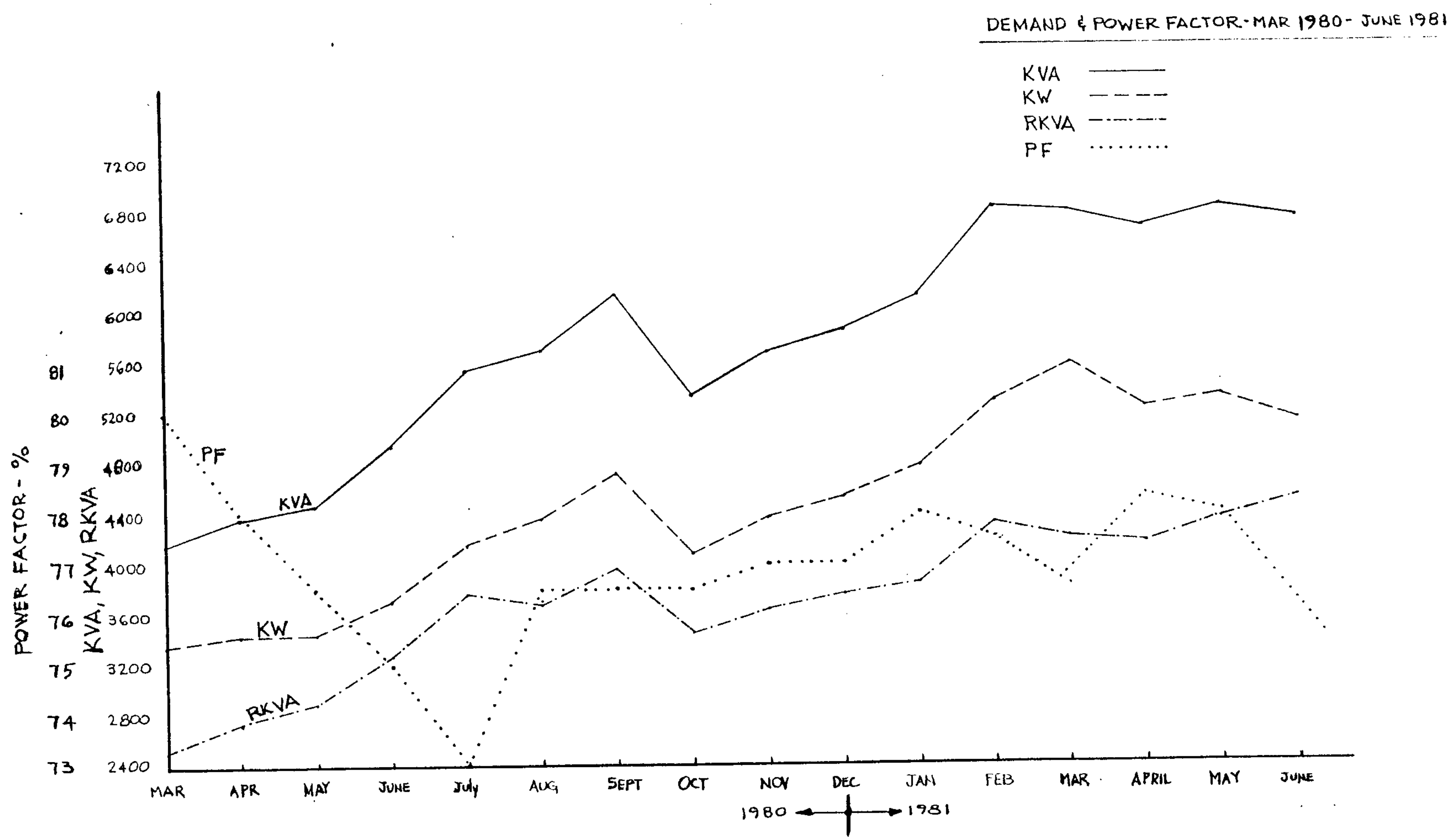
DATE 8-28-81

CLIENT COE TASK No. 5438 By GOLDSMITH

SUBJECT DEMAND & POWER FACTOR USAGE. Checked By

GRAPH 4



NUS CORPORATION

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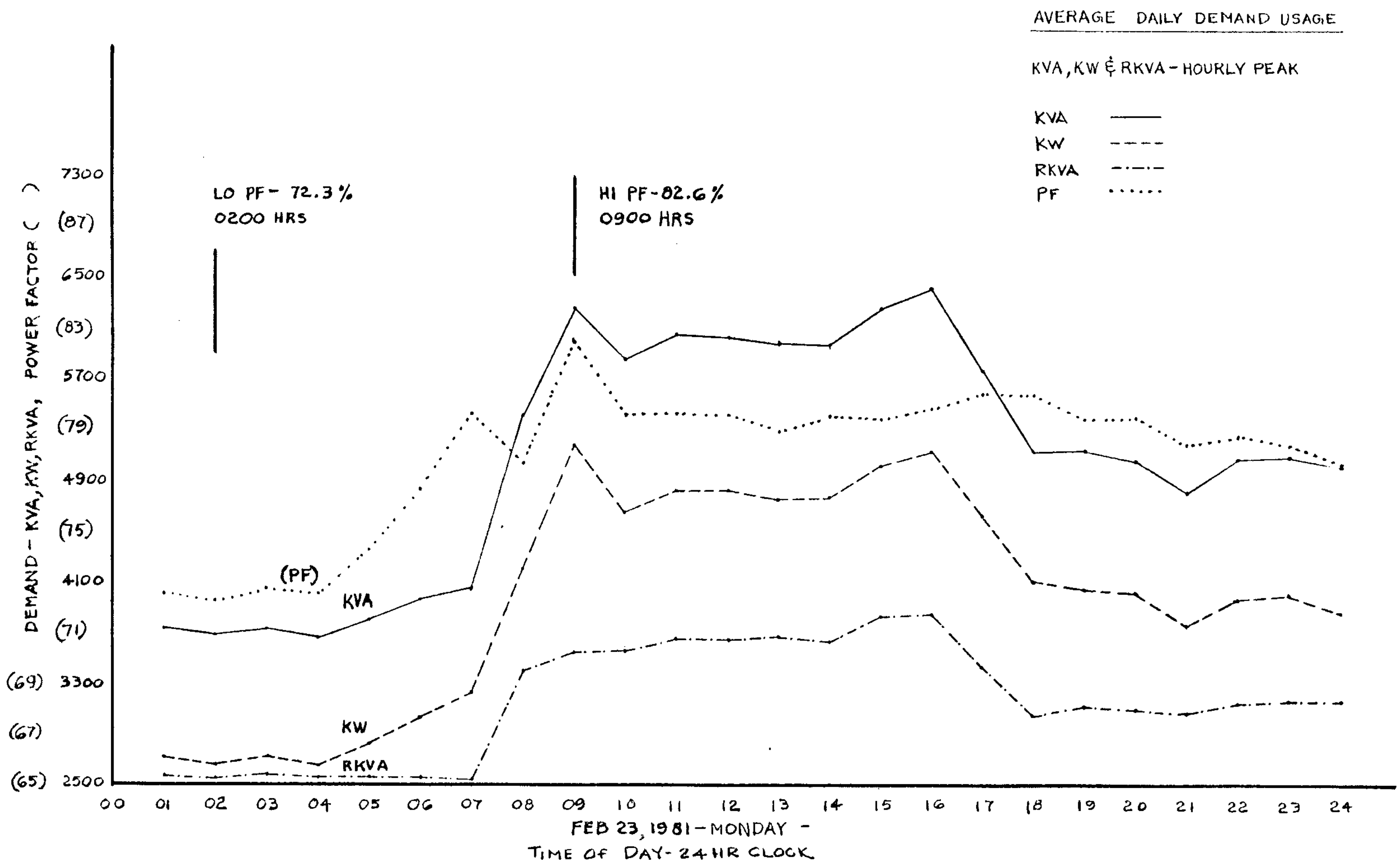
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 5



NUS CORPORATION

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DATE 8-10-81

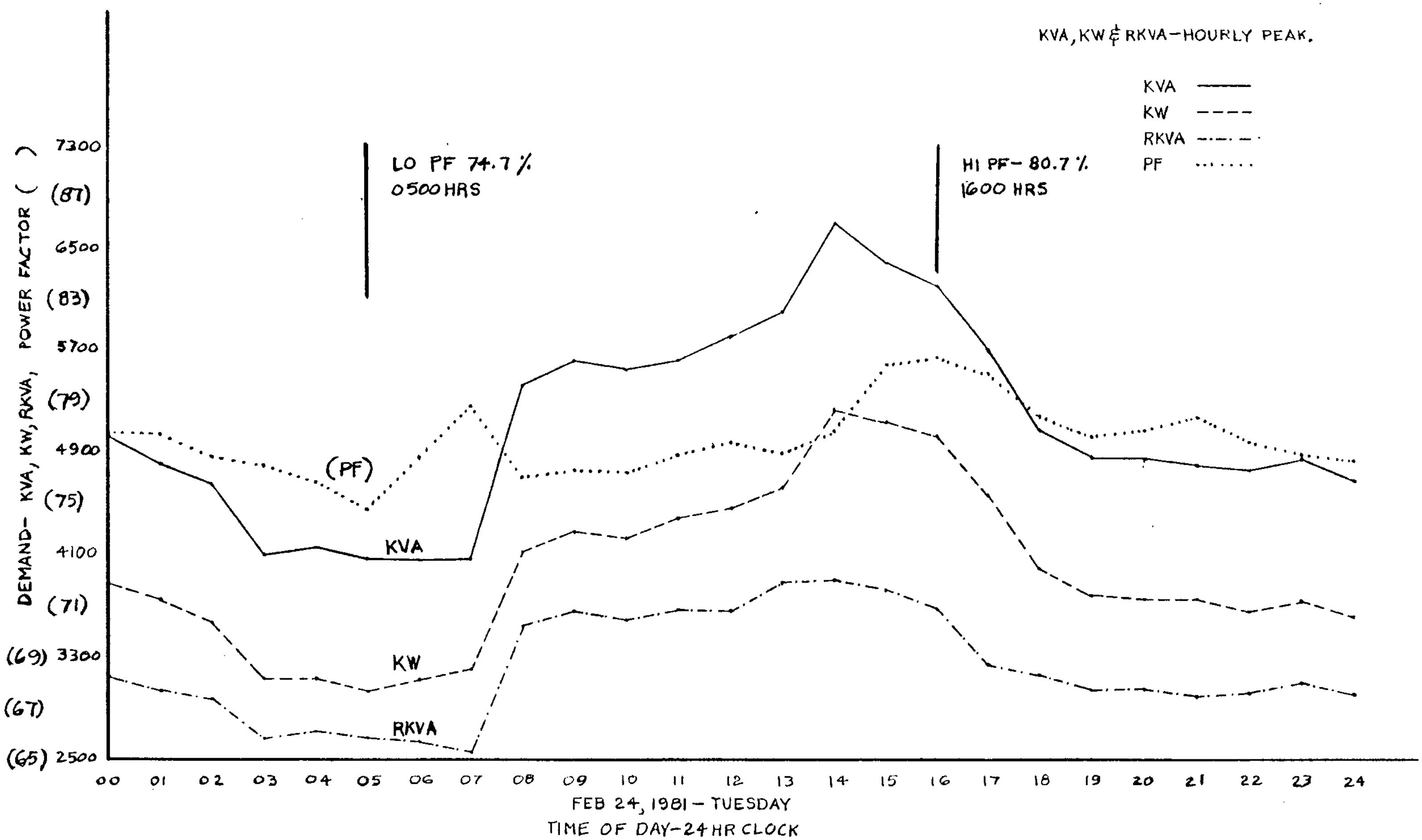
CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 6

AVERAGE DAILY DEMAND USAGE

KVA, KW & RKVA–HOURLY PEAK.



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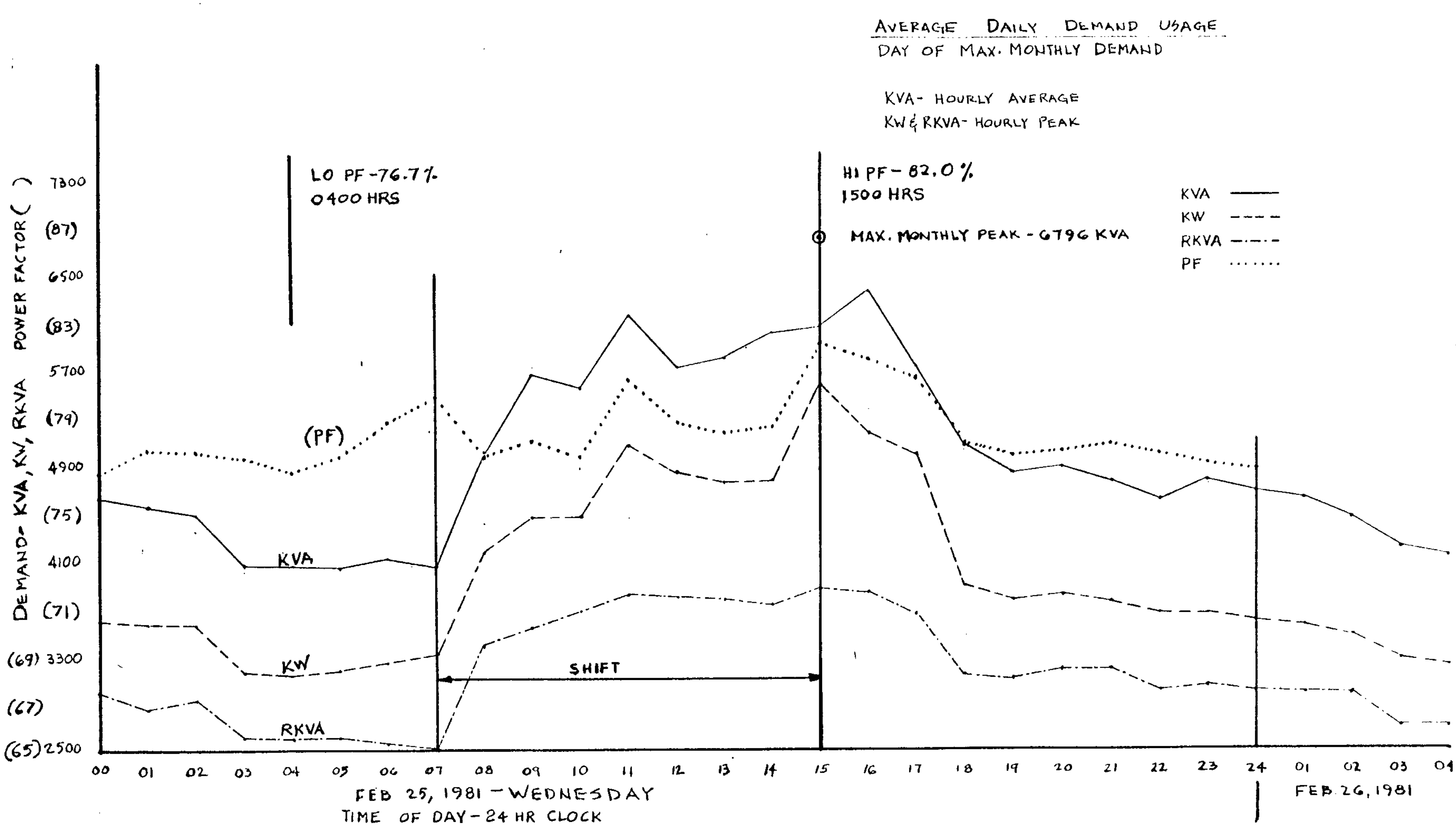
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 7



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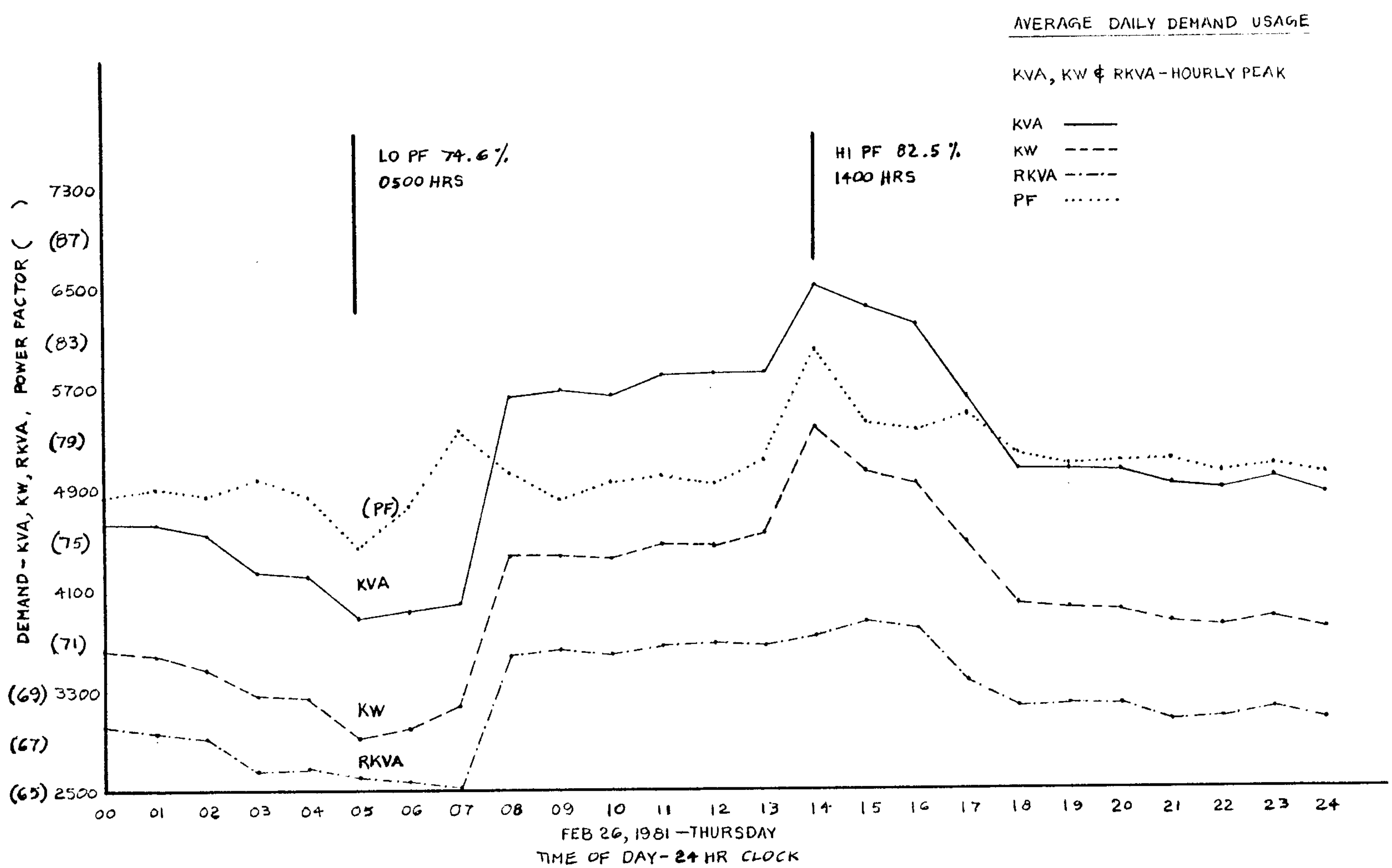
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 8



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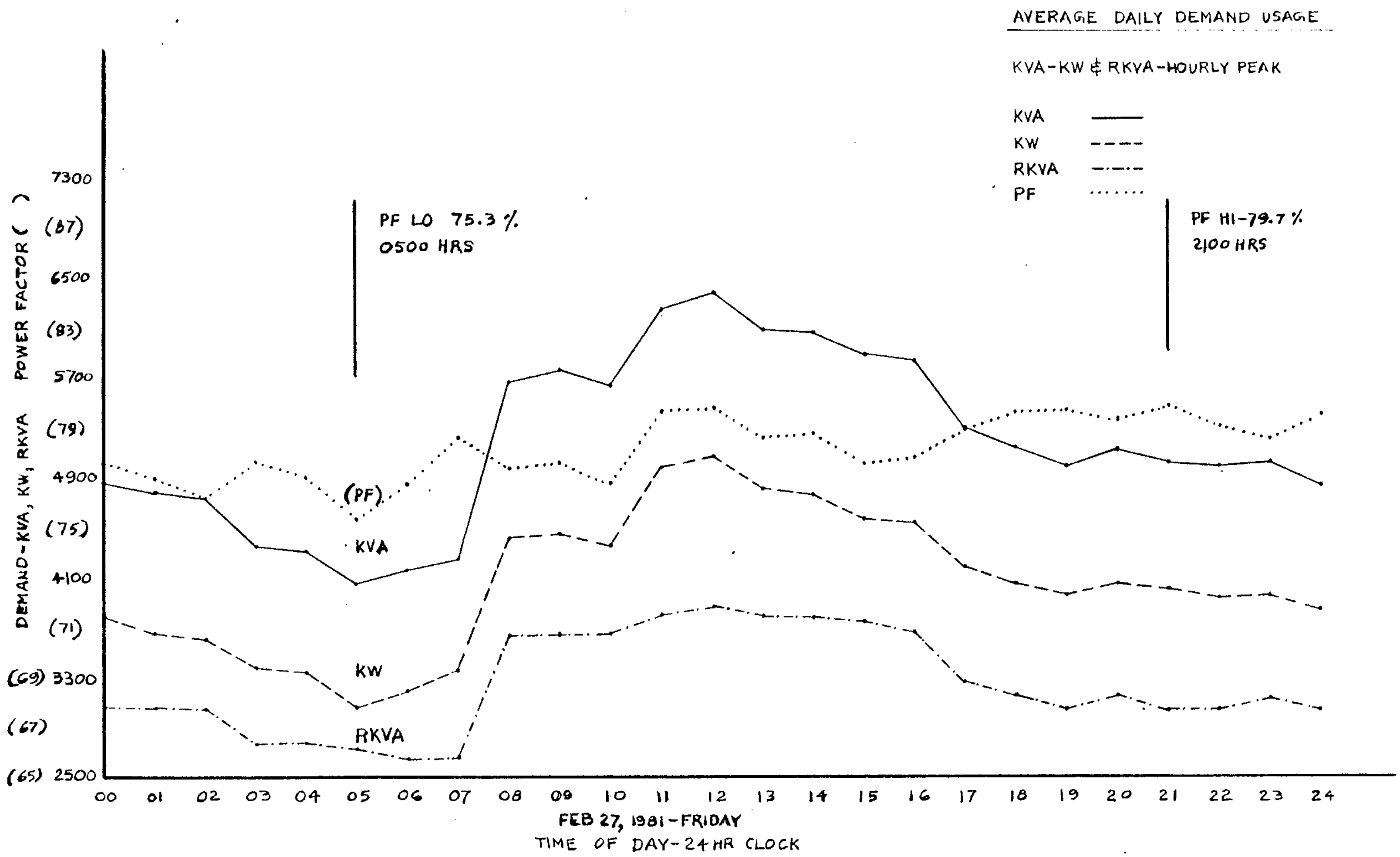
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 9



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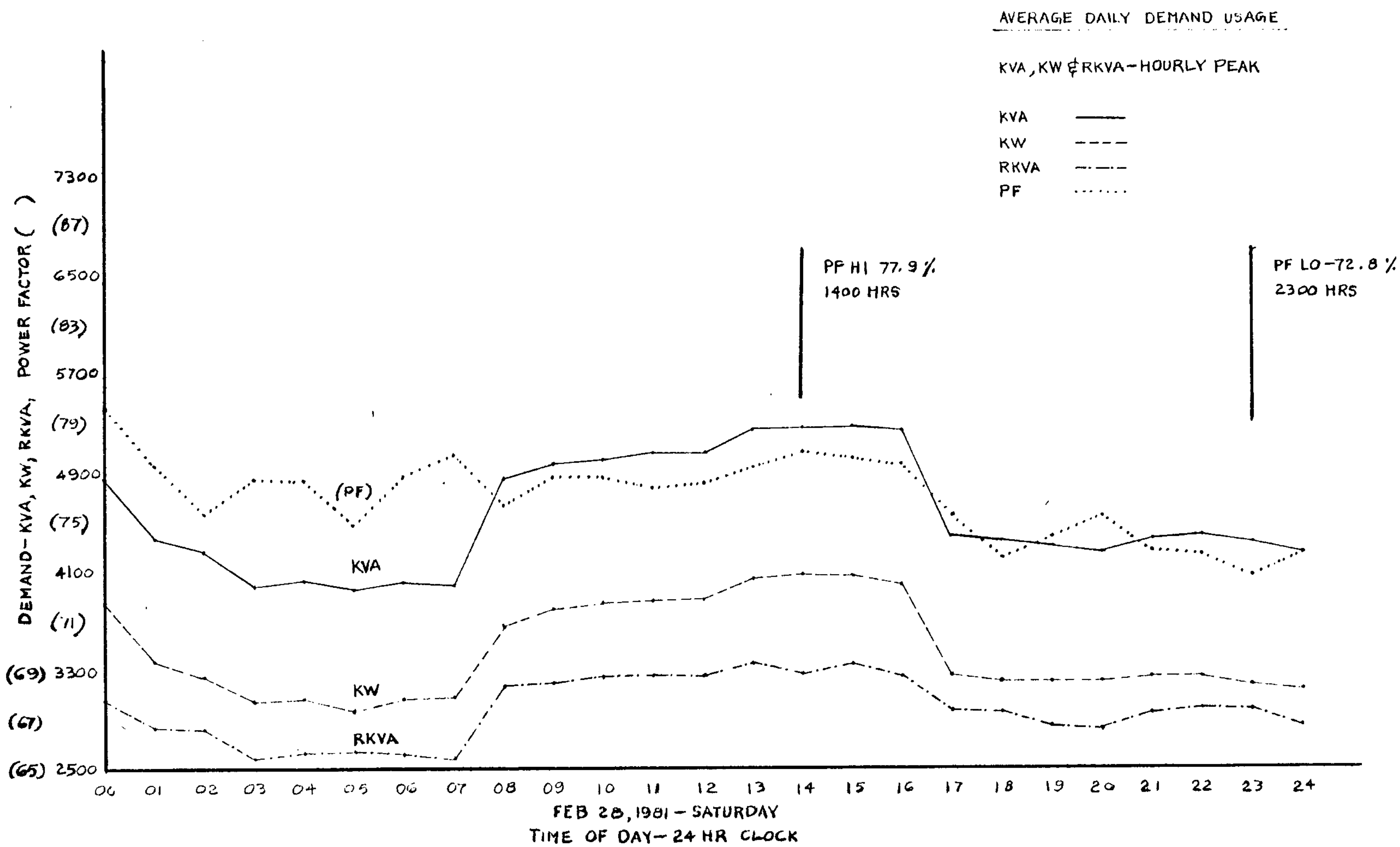
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 10



NUS CORPORATION

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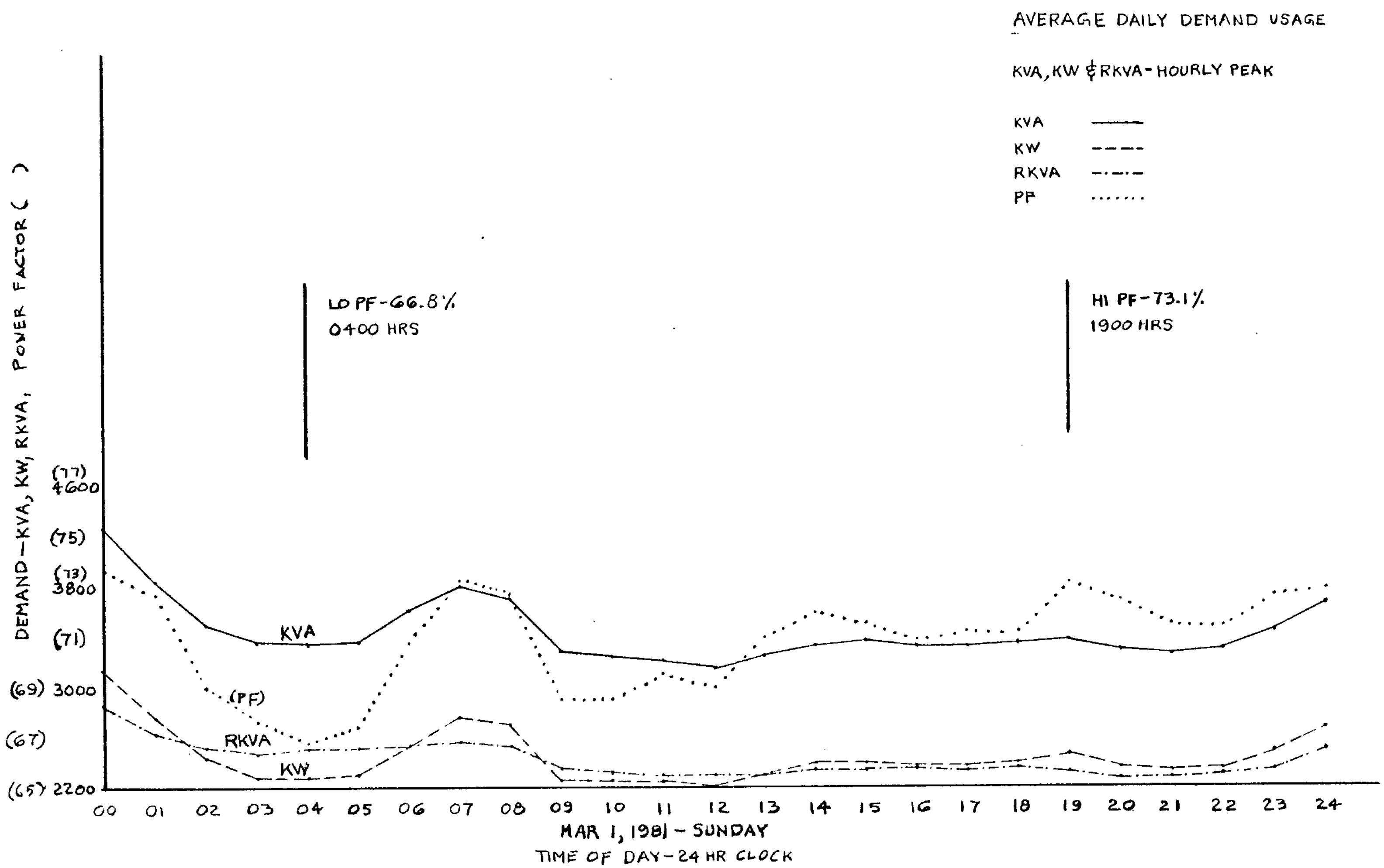
DATE 8-10-16

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 11



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CLIENT COE TASK No. 5438

SUBJECT LIMA ARMY TANK PLANT

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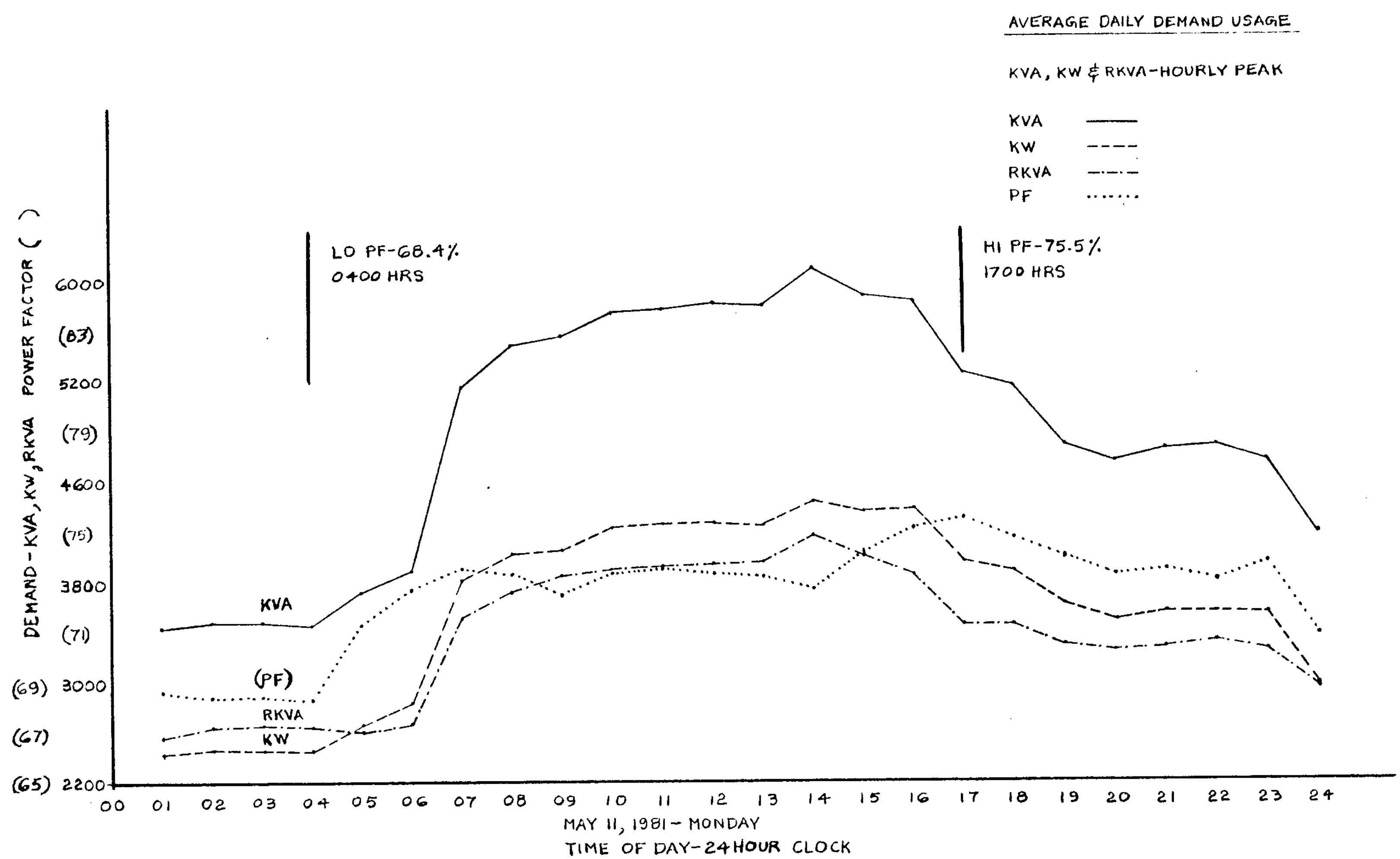
DATE 8-10-81

By INDERJIT

Checked By

GRAPH 12



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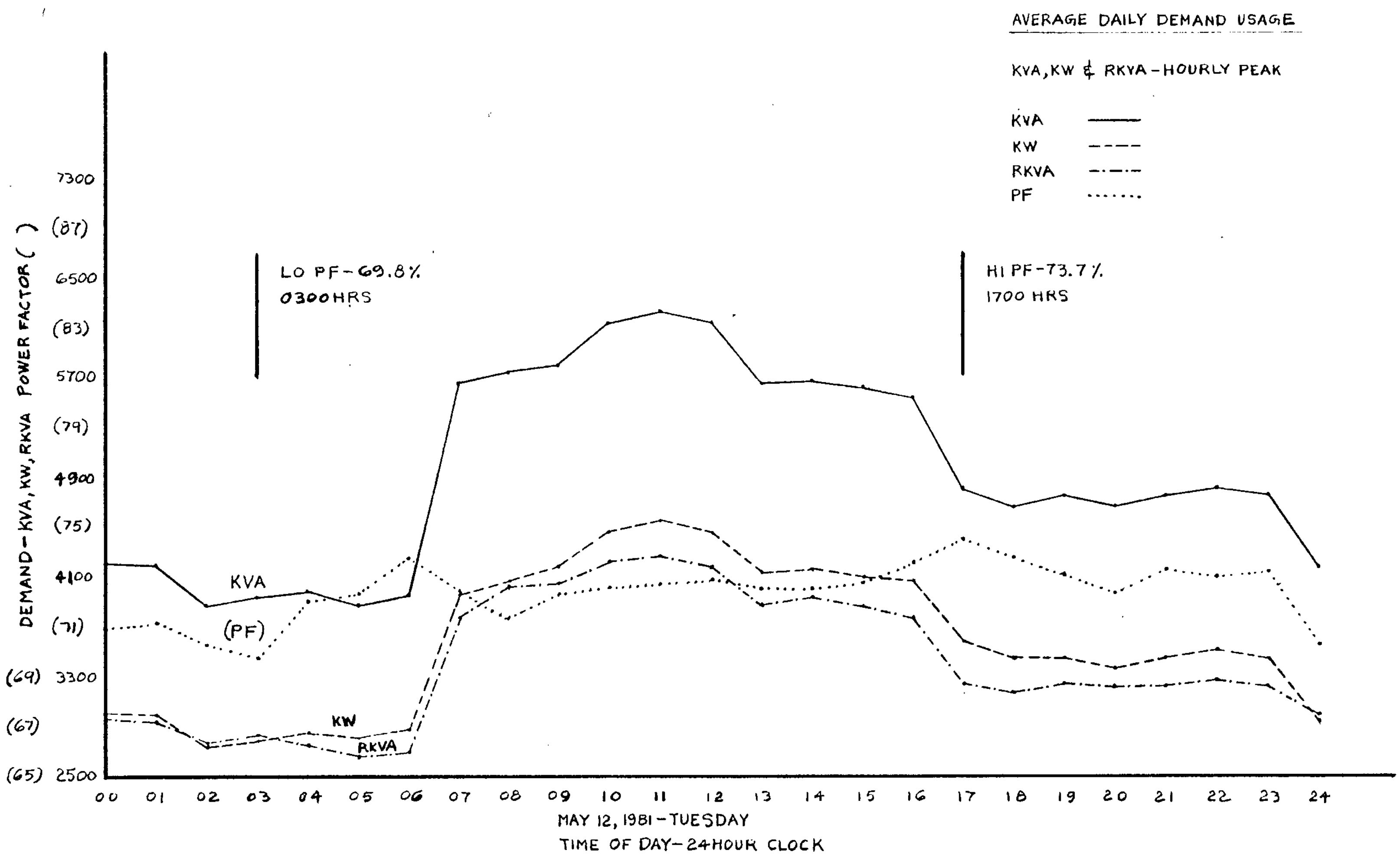
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 13



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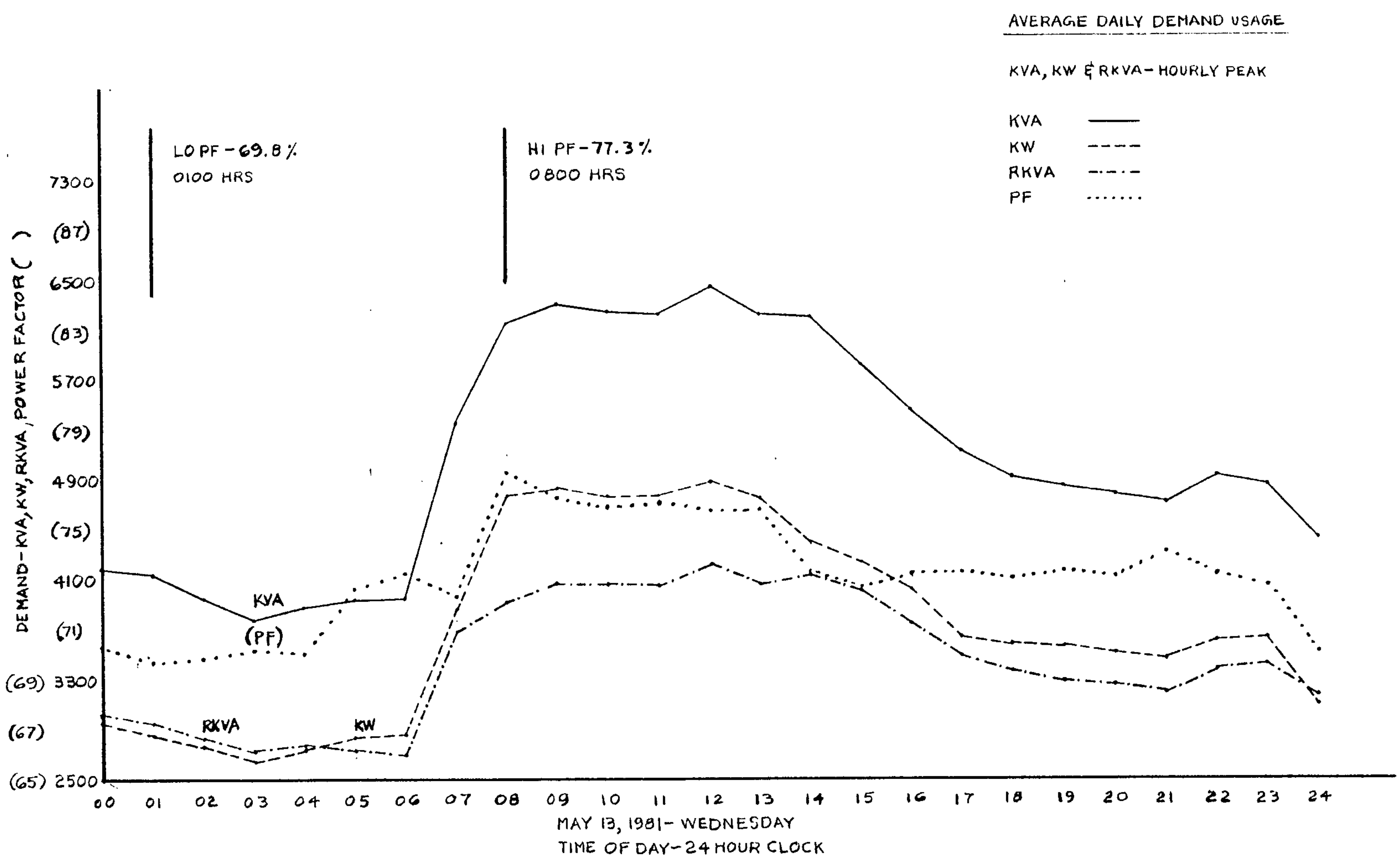
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 14



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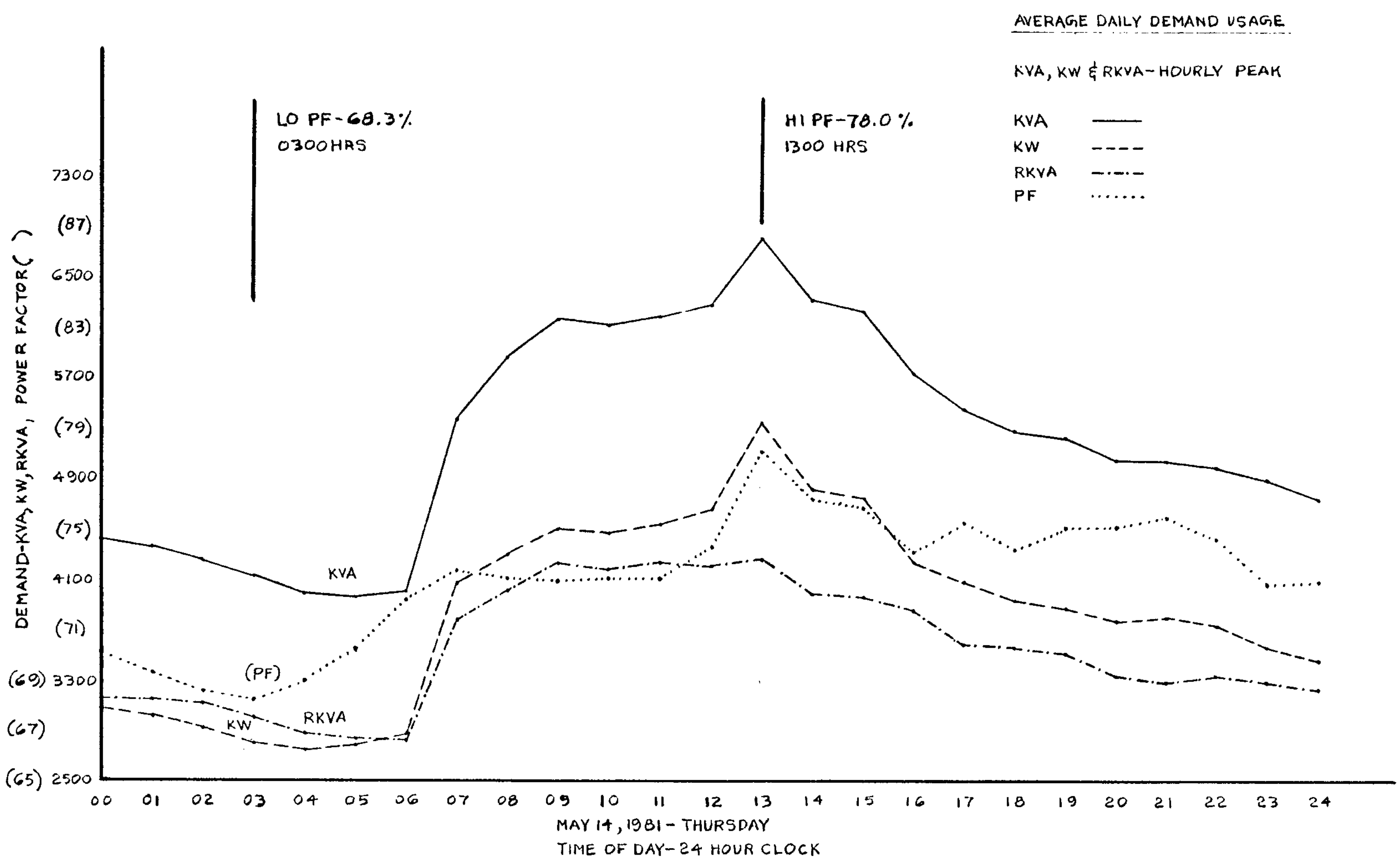
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 15



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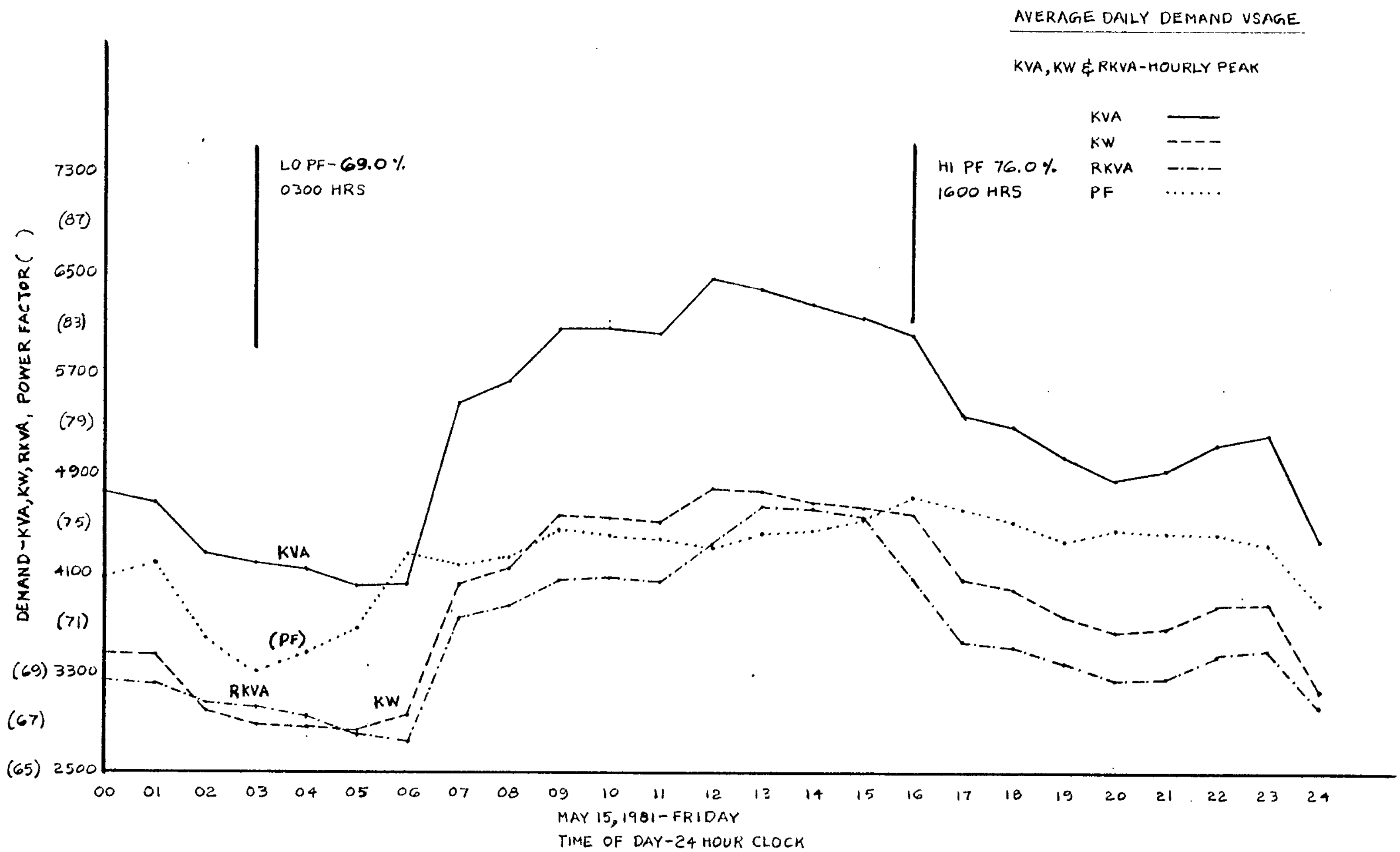
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 16



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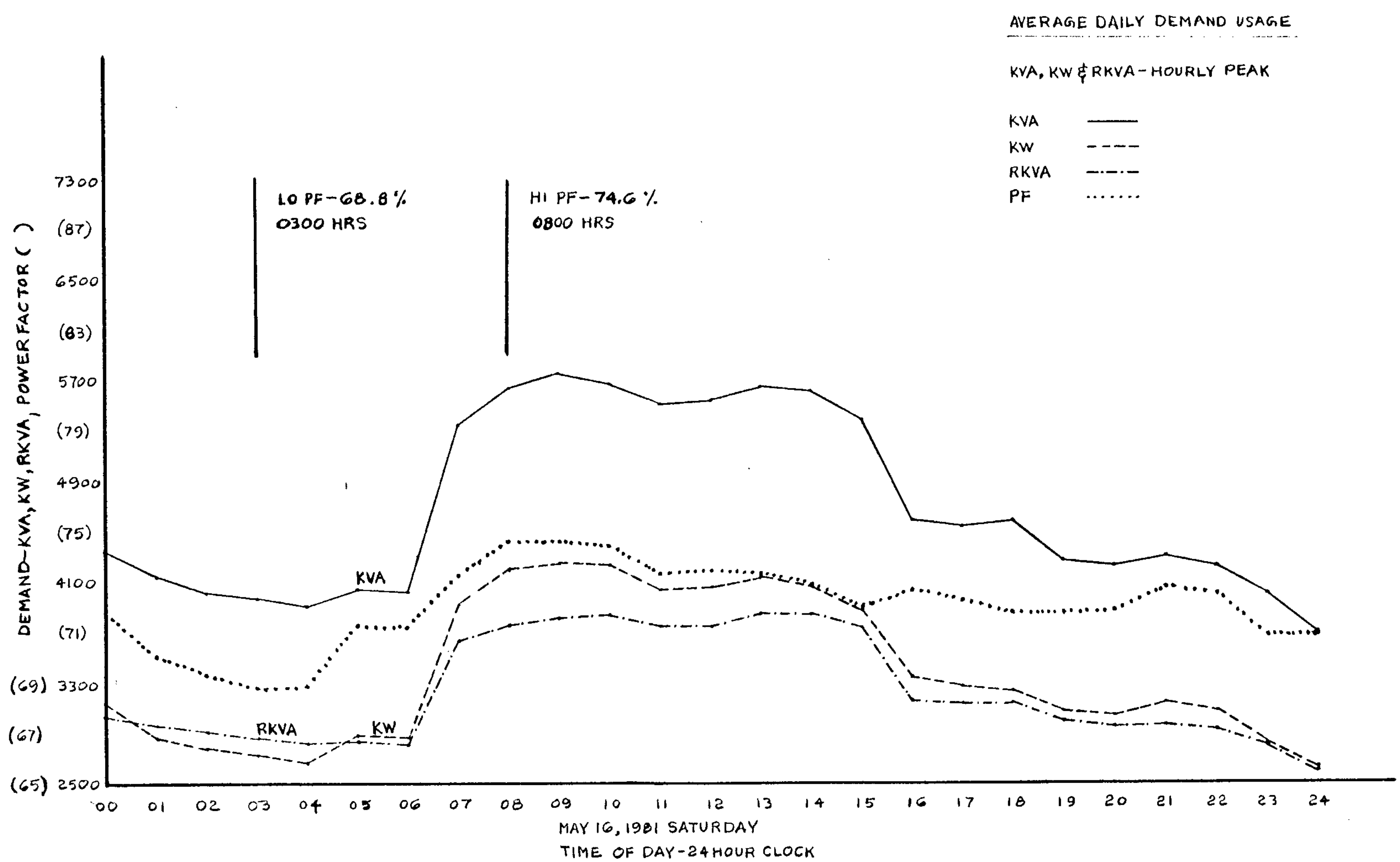
DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 17



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DATE 8-10-81

CLIENT COE TASK No. 5438 By INDERJIT

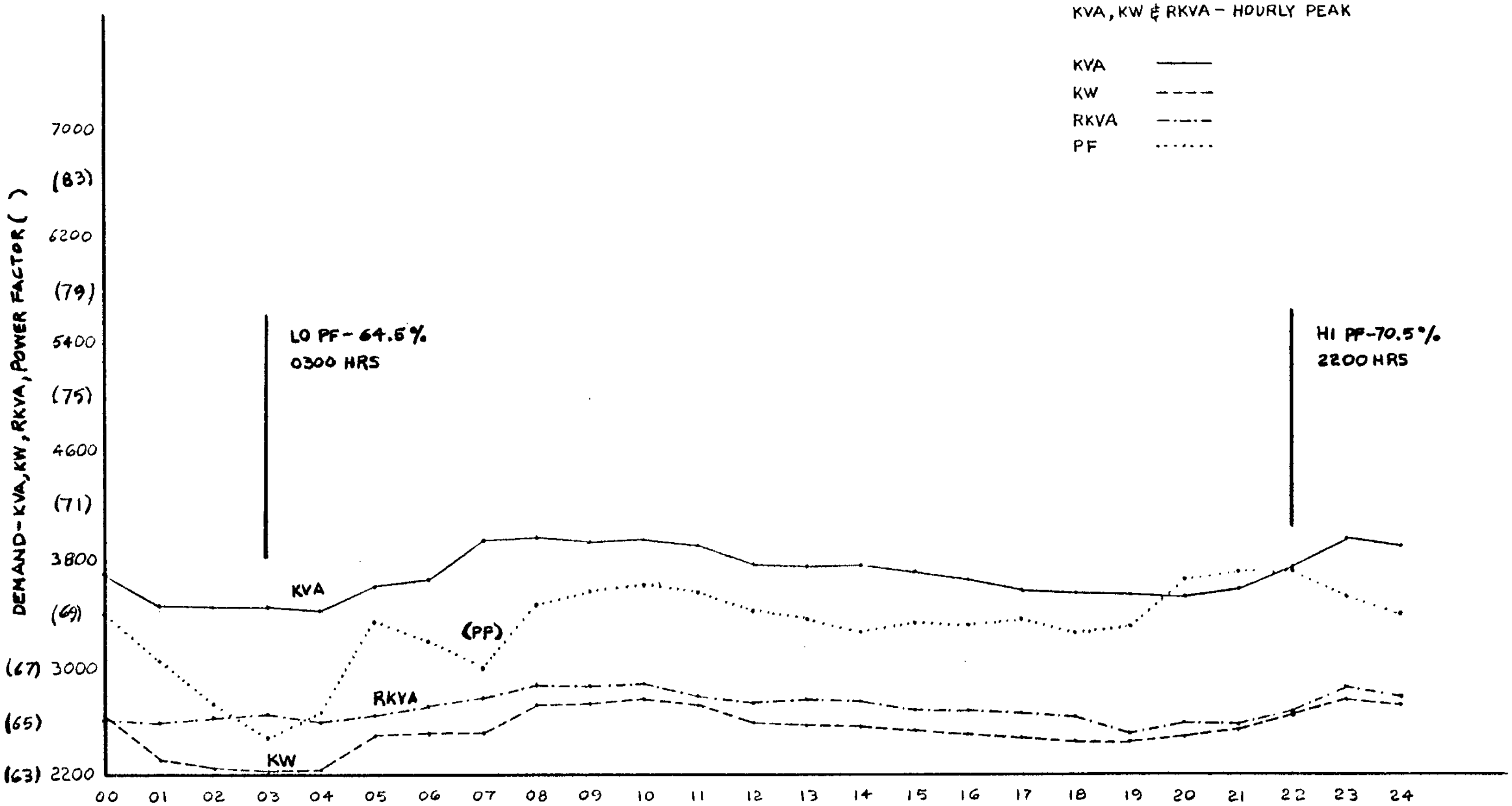
SUBJECT LIMA ARMY TANK PLANT Checked By

GRAPH 18

AVERAGE DAILY DEMAND USAGE

KVA, KW & RKVA – HOURLY PEAK

KVA ———
KW - - - -
RKVA —·—·—
PF ·······



MAY 17, 1981 – SUNDAY

TIME OF DAY – 24 HOUR CLOCK

COAL

LATP coal consumption is used to satisfy plant heating and ventilating requirements. No significant process load relative to coal consumption is present unless ventilation is considered a process load.

Reference Graph No. 19 "Projected Coal Consumption 1981 - 2006" and Table No. 3 "Peak Steam/Coal Projection Data" for a summary of projected changes.

It is a major finding of this study that additional ventilation is required in Building No. 147 to reduce a smoke problem created by the welding operation. The use of heat recovery units to provide this added ventilation will add 930,000 # coal/year to the plant's coal consumption. This compares with a 3,376,000 # coal/year additional to coal consumption if make-up air units were used to provide the ventilating air. This is an increase in coal consumption of 5% over the present base of 18,000,000 # coal/year using the heat recovery approach. An increase of 19% using the make-up air unit approach. See Table No. 3 Projects Nos. 2, 3 and 4.

The conversion of the paint system from natural gas to coal (steam) for heating system air will have a major impact on peak steam requirements and annual coal consumption, +31% and 10% respectively over baseline conditions. Reference Table No. 3 "Peak Steam/Annual Coal Projection Data" and Graph No. 19 "Projected Coal Consumption 1981-2006".

At this time shift and daily data, reference Graph Nos. 20, 21, 22, 23, and 24 indicates the ventilating load in the plant has not been controlled relative to the production schedule. The "Energy Monitor and Control System", reference Project No. 18, is recommended to correct this situation. Good correlation between degree day data and coal consumption exists.

The projected plant expansion of 350,000 square feet of production and office area will increase coal consumption by 5,800,000 #/year and peak steam requirements 22,200 #/hour. These are 32% and 41% increases respectively over baseline conditions.

TABLE NO. 3

LIMA ARMY TANK PLANT

PEAK STEAM/COAL PROJECTION DATA

CHANGE FROM FY 81 BASELINE 1.4 = SAVING (.4) = CONSUMPTION						
		WITH CONSERVATION			WITHOUT CONSERVATION	
PROJECT NUMBER	PROJECT DESCRIPTION	STEAM 1000#/HR	COAL TONS/YR	COAL MILLION#/YR	STEAM 1000#/HR	COAL M#/YR
1	Insulation	1.4	192	.384	--	--
2	Heat Recovery #143	(.4)	(27)	(.054)	(1.3)	(.182)
3	Heat Recovery #186	.9	63	.126	(.7)	(.092)
4	Heat Recovery #147	(6.8)	(465)	(.930)	(22.8)	(3.376)
5	Domestic Hot Water	.2	(15)	(.030)	--	--
7	Paint System Heat Recovery	(17.0)	(600)	(1.200)	(25.0)	(1.765)
9	Boiler Stack Loss Reduction	--	198	.396	--	--
10	Turbine Replacement	.8	15	.030	--	--
11	Compressor Waste Heat Recovery	1.8	218	.436	--	--
18	Energy Monitor and Control System	1.2	1,320	2.640	--	--
	Subtotal	(17.9)	899	1.798	(49.8)	(5.415)
*	Plant Expansion 350,000 sq. ft.	(14.0)	(2,700)	(5.400)	(14.0)	(5.400)
*	Process Load	(8.2)	(200)	(400)	(8.2)	(.400)
	Total Change	(40.1)	(2,001)	(4.002)	(72.0)	(11.215)
	Baseline	(54.8)	(9,000)	(18.000)	(54.8)	(18.000)
	Final	(94.9)	(11,001)	(22.002)	(126.8)	(29.215)

Numbers in brackets show consumption.
Numbers without brackets show savings.

The baseline peak steam requirement is 54,800 #/hours and the baseline coal consumption is 18,000 #/year.

It is very important that a complete energy conservation program be put into action. All future plant additions and modification must be made considering their impact on plant energy. "Projected Coal Consumption" Graph No. 19 reflects the large difference between coal consumption with and without conservation. By fiscal year 1987 coal consumpton is projected at 22,002,000 #/year with conservation and 28,215,000 #/year without conservations this is a difference of 40% relative to the baseline of 18,000,000 #/year.

The following five documents were used to establish a perspective of present and future operation at LATP

H. K. Ferguson Company
Contract No. DACA 31-76-C-0189
Feasibility Study of Alternate Locations of No. 6 Boiler
December 9, 1980

H. K. Ferguson Company
Contract DACA 31-76-C-0189
Boiler House Engineering Study
Supplemental Appendix
May, 1980

Analysis of Projected Steam Requirements for LATC - Production Support and Equipment Replacement Meeting - 26 February 1981. Included as Appendix A.

Energy Plan 2

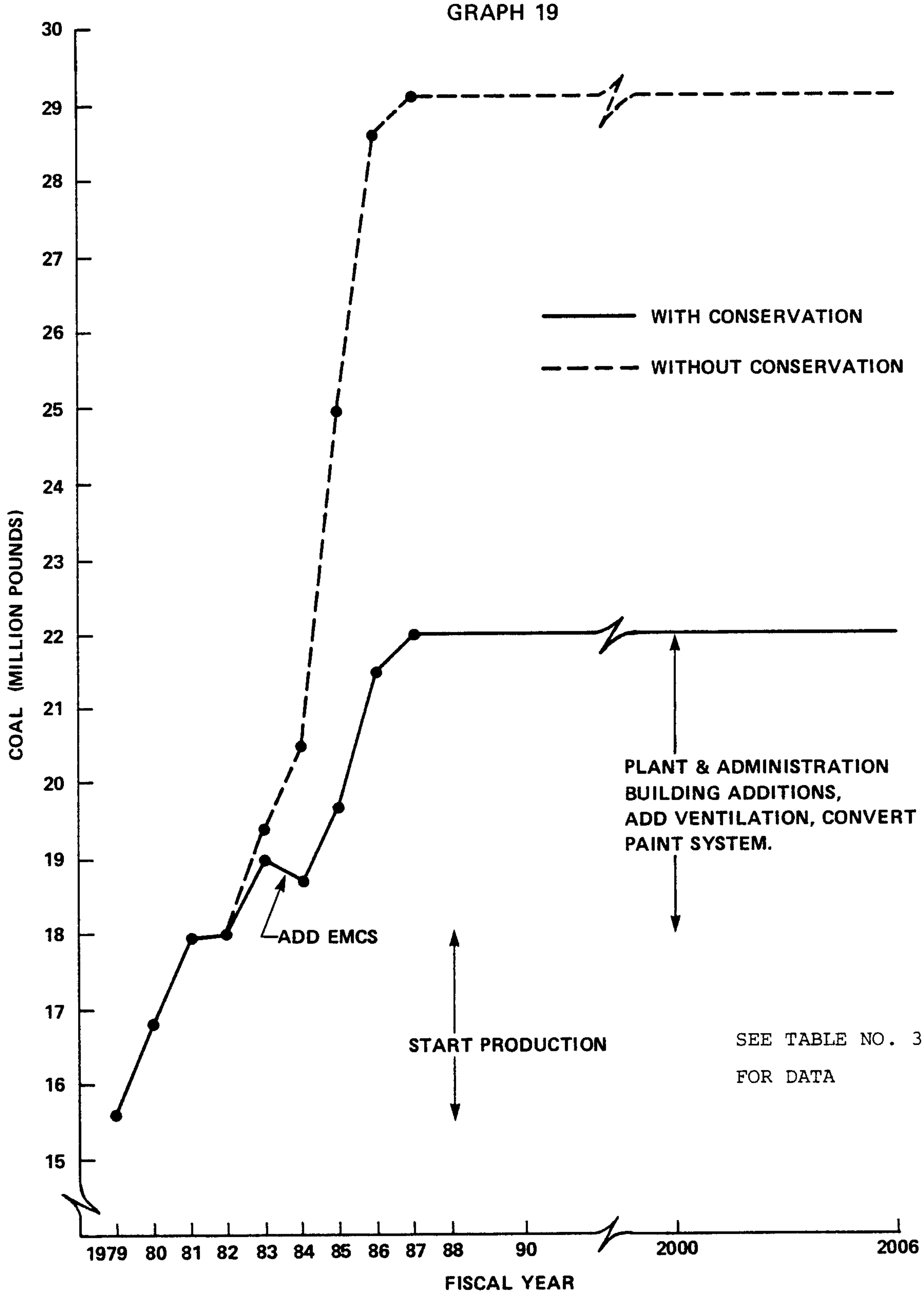
Master Layout - Production Support and Equipment Replacement Projects; Corps of Engineers Drawing No. 80197 dated 3/27/81; Proposal 1 Total = 267,663 sq. ft.; Proposal 2 Total = 228,095 sq. ft.; Note square footage does not include new administration building.

LIMA ARMY TANK PLANT

PROJECTED COAL CONSUMPTION

1981 – 2006

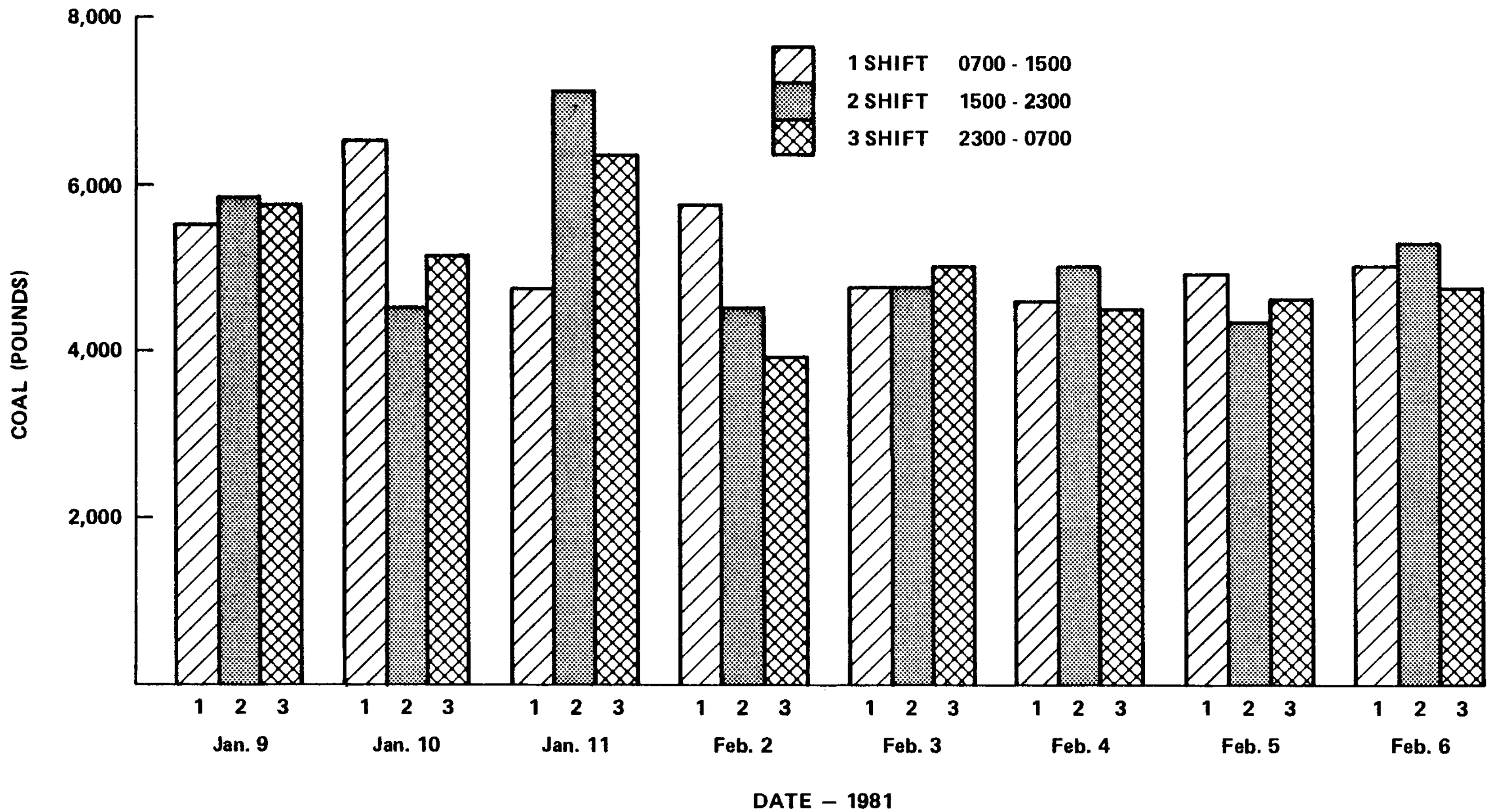
GRAPH 19



LIMA ARMY TANK PLANT

COAL CONSUMPTION BY SHIFT

GRAPH 20

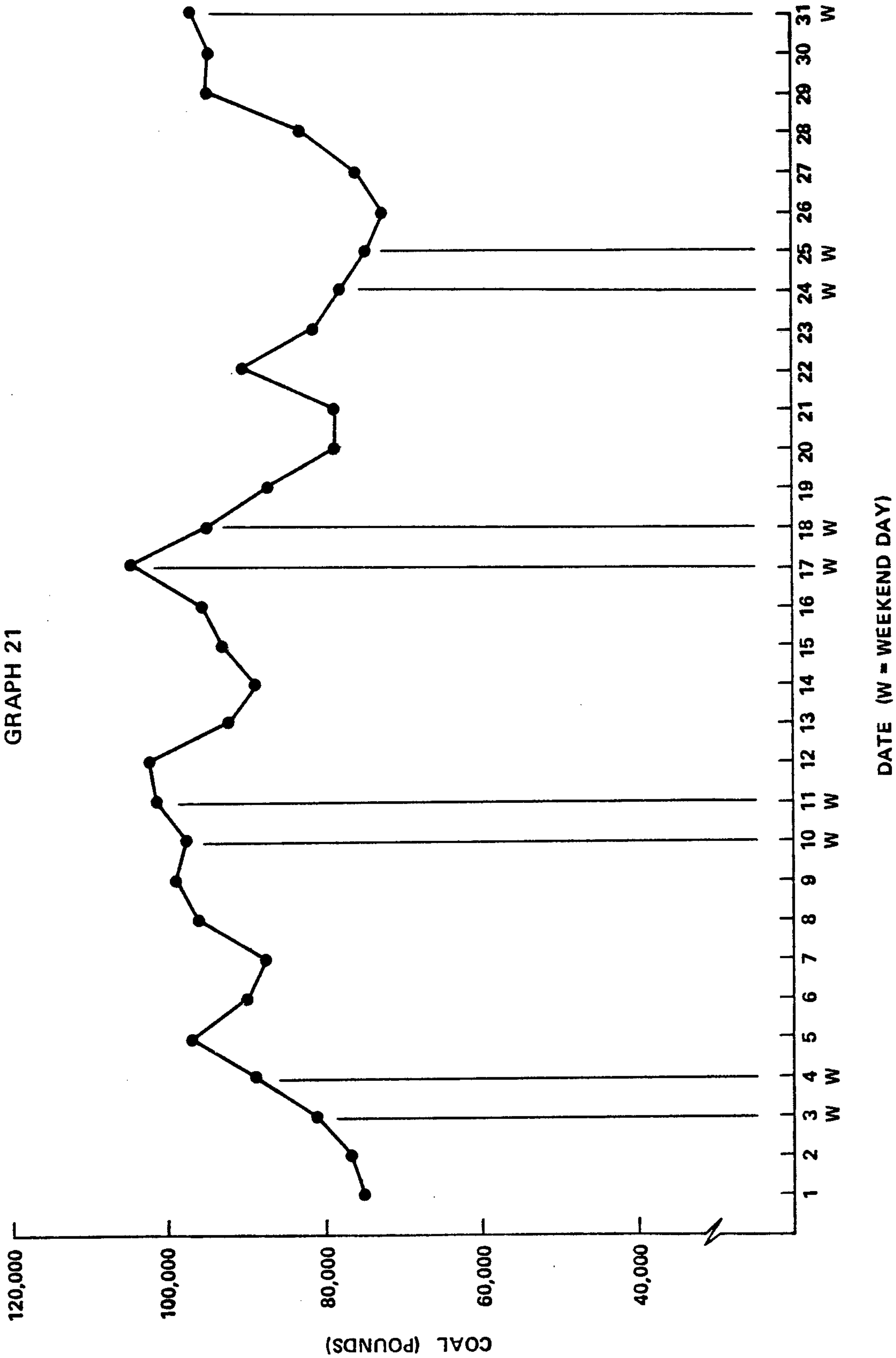


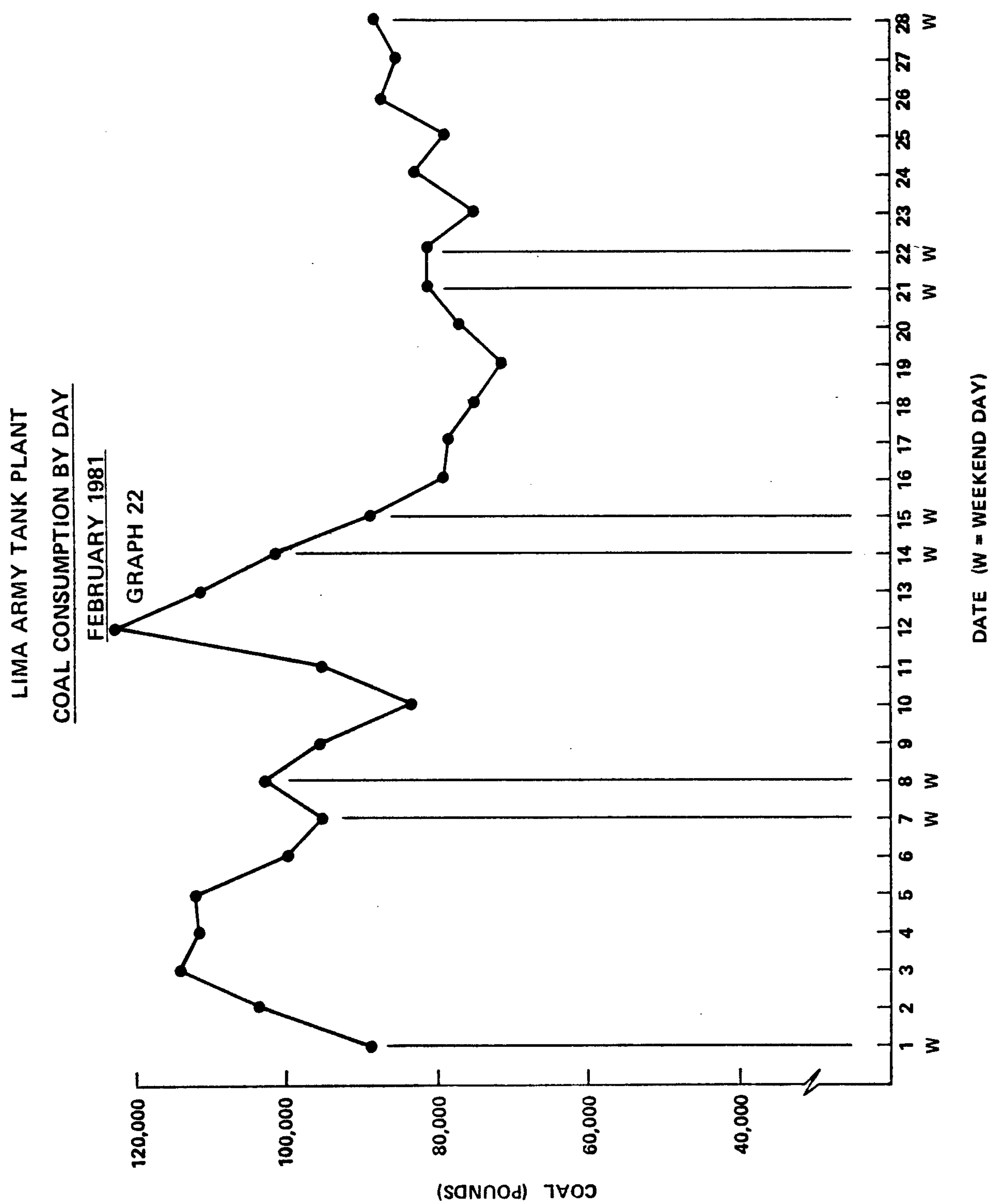
LIMA ARMY TANK PLANT

COAL CONSUMPTION BY DAY

JANUARY 1981

GRAPH 21



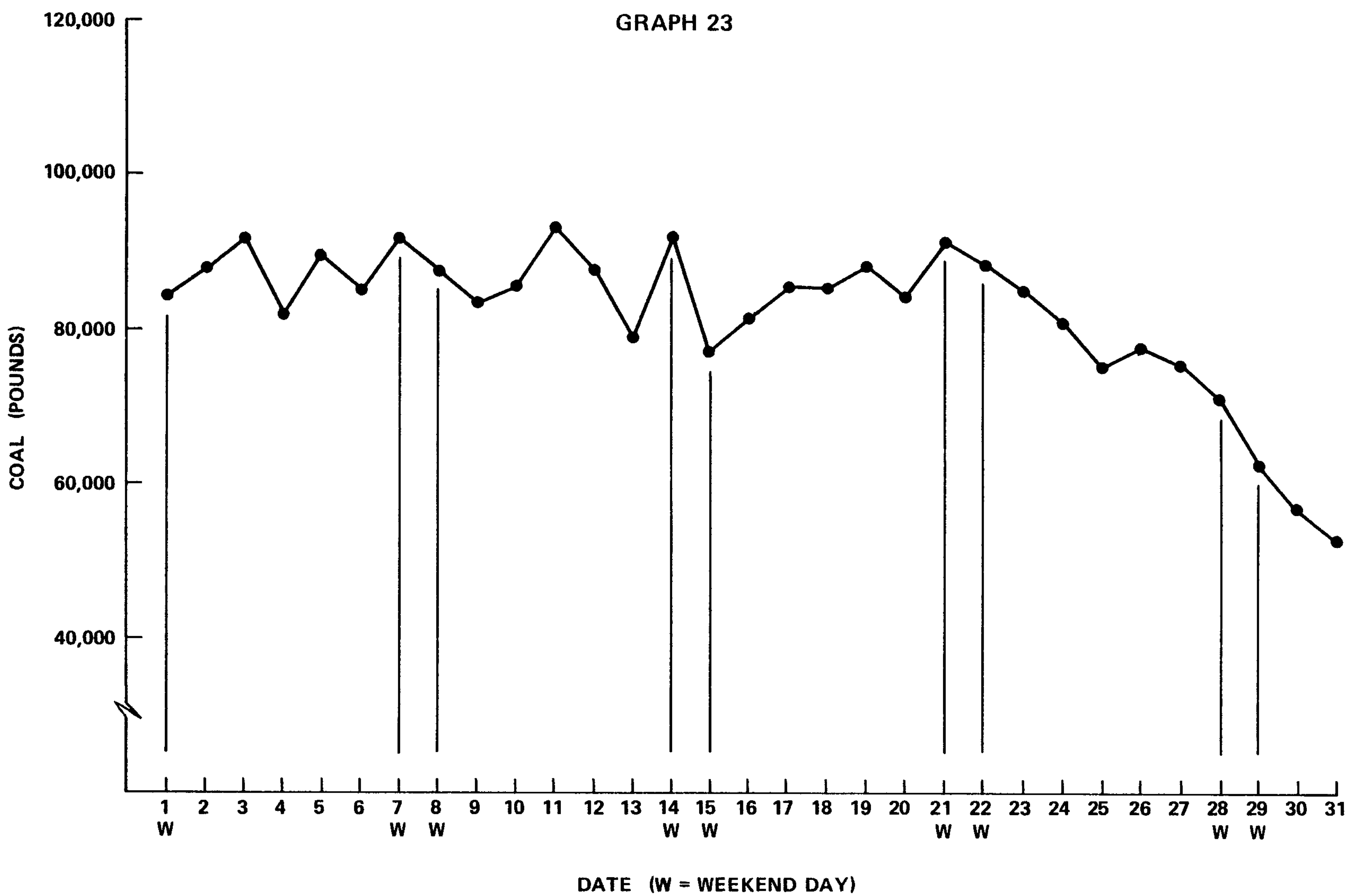

LIMA ARMY TANK PLANT
COAL CONSUMPTION BY DAY
FEBRUARY 1981
GRAPH 22
COAL (POUNDS)
120,000
100,000
80,000
60,000
40,000
DATE (W = WEEKEND DAY)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
W W W W W W W W

LIMA ARMY TANK PLANT

COAL CONSUMPTION BY DAY

MARCH 1981

GRAPH 23

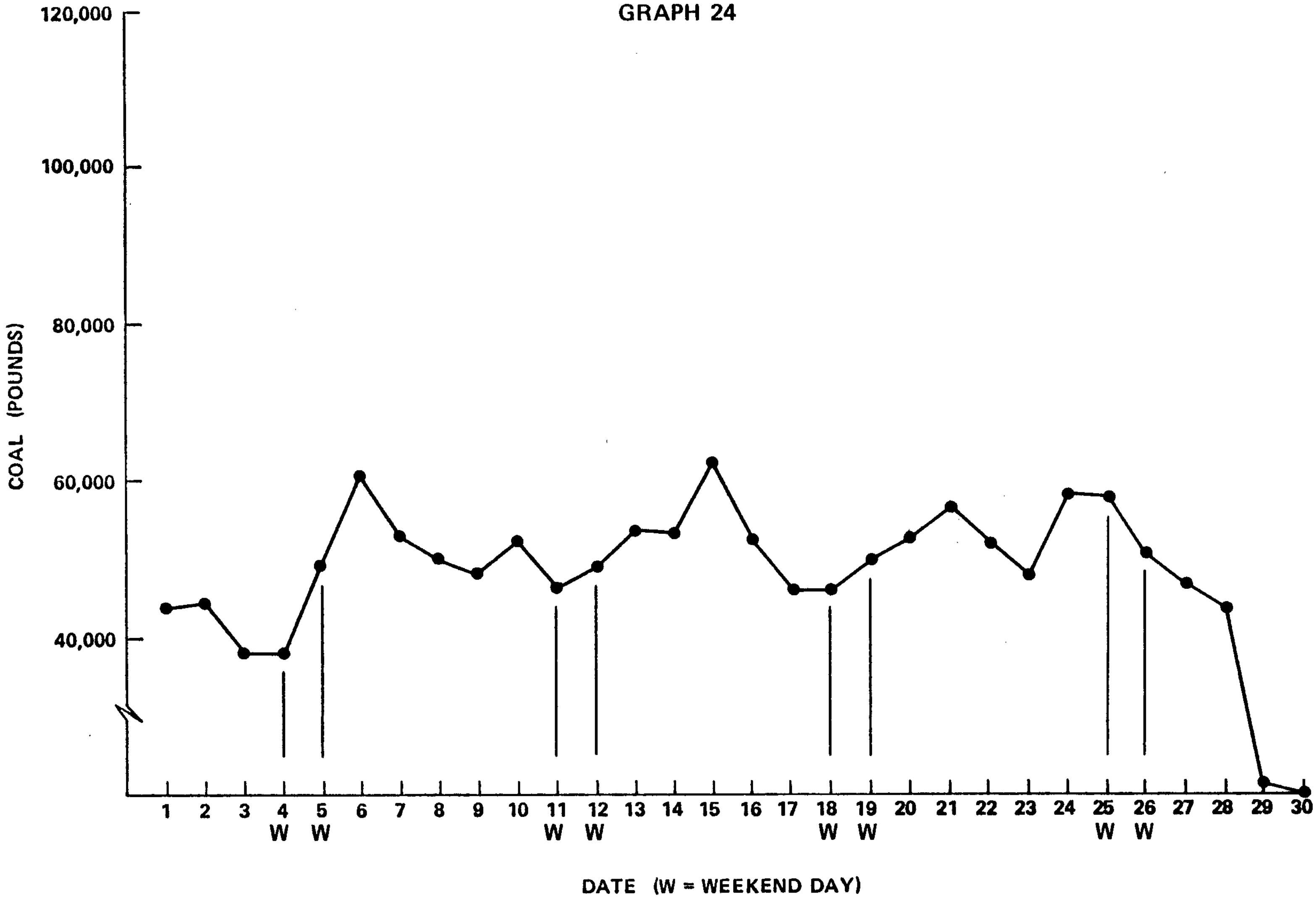


LIMA ARMY TANK PLANT

COAL CONSUMPTION BY DAY

APRIL 1981

GRAPH 24



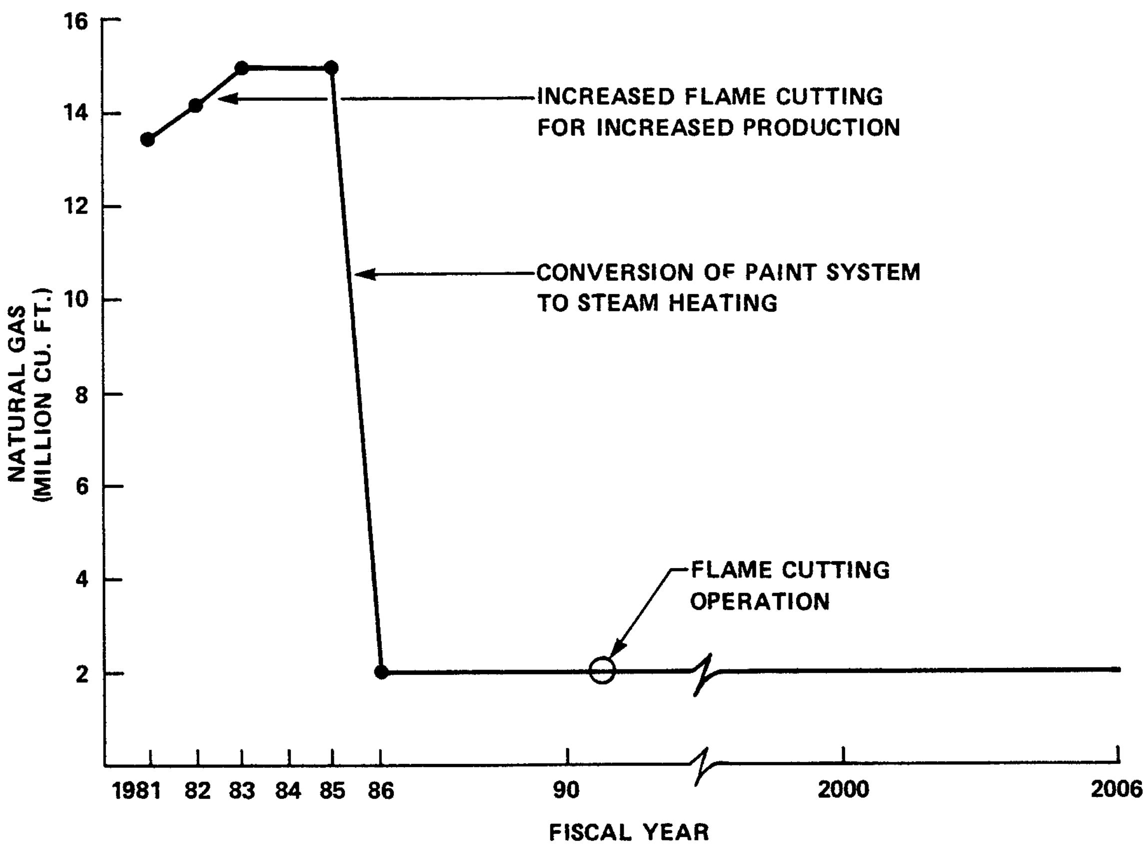
NATURAL GAS

Natural gas consumption for 1981 is projected to be 13.4 million cubic feet with 12.4 million cubic feet consumption in the paint system and 1.0 million cubic feet consumption in the flame cutting operation. Small increases associated with the flame cutting operation and increased production are anticipated through FY 83. New plasma cutting operation is assumed to keep gas consumptions constant as production increases through FY 84 and FY 85. Conversion of the paint spray system to steam in FY 85 will reduce gas consumption in FY 86 to only flame cutting operation - 2 million cubic feet per year. See Graph No. 24.

LIMA ARMY TANK PLANT

PROJECTED NATURAL GAS CONSUMPTION
1981 – 2006

GRAPH 25



PROJECTED STEAM REQUIREMENTS FOR LIMA ARMY TANK PLANT

June 24, 1981

Revised August 27, 1981

INTRODUCTION

Estimating peak steam requirements during the first several years of a new facilities operation is difficult with improved estimating possible as more data becomes available. During the 1980-1981 winter peak design conditions ($4^{o}F$) existed on February 3 and February 12. The plant heating load can be stated as 40 Btu/hr-sq. ft. at design conditions.

Process loads that are intermittent in nature are factored into the continuous peak steam requirements. The rationale for the factoring is explained in the body of the report.

A peak steam requirement of 90,000 to 100,000 PPH steam is projected by FY 87 winter. This compares with a current peak of 58,000 PPH on a day in which the average steam flow was 50,000 PPH. The average total winter steam flow was 38,600 PPH for winter 1980-1981. The average temperature was $27^{o}F$.

An item-by-item analysis of "Projected Steam Requirements for LATC, Production Support and Equipment Replacement Meeting 26 February 1981" is made. See Exhibit I which is attached.

Analysis of Project Steam Requirements for LATC as presented at Production Support and Equipment Replacement Meeting 26 February 1981.

A. Actual Peak 1980-1981 Demand - 57,800 PPH

A peak of nominally 58,000 PPH was observed on February 3 and February 12, 1981. Review of north and south headers shows 48,000 to 52,000 PPH supplied to the plant. The balance of the steam was used in the Boiler House to run turbines, heat feedwater, building air and combustion air and operate the ash handling system. Steam used for sootblowing is seen on the steam flow recorders as a drop in boiler steam flow since sootblower steam is extracted before the orifice plates. Review of Boiler No. 3 and No. 4 operation indicates that peaks were short in duration (approximately 15 minutes long) and associated with Boiler House operation. Peaks came after sootblowing, dumping grates, ash removal or broken stoker shear pins as the plant made up for reduced steam pressure and flow. Operation of the press during such a recovery period would add 4,000 PPH to the peak. Peaks can be minimized by operating motor-driven pumps in lieu of turbine-driven pumps, a savings of 4,000 PPH. Confining sootblowing, ash removal and grate dumping to off-peak periods and staggering these operations will also minimize peaks. A case could be made that the nominal plant peak is 52,000 PPH.

B. Additional Platen Press (on or before 1981) 7,800 PPH

Review of header charts shows platen press operation to be an intermittent spiking load with an average demand conservatively estimated as half the spike (7,800 x .5)=3,900 PPH. The plant boilers are large for their capacity with Boilers No. 2 and No. 3 having multiple steam drums. The spiking process load presents no problem for this system with its large stored steam capacity. Random spikes have no effect on the system while continuous spiking does result in a 3,900 PPH load.

C. Vehicle Repair Building (Projected Use) 4,000 PPH

We recommend projecting all future plant expansion related steam requirements based on 40 Btu/hr-sq. ft. Improved insulation, heat recovery and control of heating systems should reduce this number in the future. This number is based on a peak heating loading of 48,000 PPH steam at 1,000 Btu/lb heating 1,200,000 sq. ft. of plant. The 48,000 PPH steam load was derived from 58,000 PPH peak minus 4,000 PPH turbine load minus 4,000 PPH process load minus 2,000 PPH Boiler House accessory load.

A 4,000 PPH building load corresponds to a 100,000 sq. ft. building.

In our analysis all building expansion will be considered as part of the 270,000 sq. ft. Proposal No. 1 expansion proposed on the Master Layout dated March 27, 1981. The new Administration Building is not included in the 270,000 sq. ft. and is assumed to be 80,000 sq. ft.

We assume item C is the 64,400 sq. ft. Vehicle Adjustment and Repair addition to 147, not Garage Building 317.

D. Dynamometer Test Expansion (Projected Use) 1,000 PPH

We assume this is part of Building 147. Fiscal Year for completion unknown. Location unknown. See item C for comments on estimating usage.

E. Cafeteria (Projected Use) 1,600 PPH

Most kitchen fixtures use steam in the 100 PPH range. We estimate a load of 500 PPH which will be evident several hours per day.

F. Administration Building (Projected Use) 21,000 PPH, 10,500 PPH with Heat Recovery. FY 85

The Administration Building is assumed a two-story structure with a total of 80,000 sq. ft., 80,000 sq. ft. x 40 Btu/hr-sq. ft. ÷ 1,000 Btu/# STEAM = 3,200 PPH STEAM 40 Btu/hr-sq. ft. should be a conservative number for a new energy efficient office building.

G. New Storage Building (used as temporary office building) 8,300 PPH (Projected Use) 1,700 PPH

Is this part of Proposal 2, 37,500 sq. ft. addition to 147? What FY? See item C for comments.

H. Addition to Building 147 for 90 per Month 8,000 PPH

This is a FY 85 project. See item C for comments.

I. Addition to Building 147 for 150 per Month, 4,000 PPH

This is a FY 86 project. See item C for comments.

J. Addition to Building 147 (Press Building) (Projected Use) 5,700 PPH

What FY? 5,700 PPH corresponds to 142,500 sq. ft. of building. This sounds high. See item C for comments.

K. SAPSA Washer (Projected Use) 2,600 PPH

We have no data on this equipment. We assume an intermittent duty cycle and factor the 2,600 PPH load by .5 to equal a 1,300 PPH continuous load. See item B comments.

L. Converson of Paint Line to Steam (Projected Use) 43,000 PPH or 30,000 PPH minimum

This is a FY 84 project.

The design capacity of the paint spray booth fans is 2 x 60,000 CFM = 120,000 CFM supply and 4 x 26,600 = 106,400 CFM exhaust. Each of the three paint spray booths were balanced at start-up so that supply air was slightly less than exhaust air to insure a small amount of plant air coming into the booth through the doors (therefore no paint fumes going into the plant). We estimate a supply air volume of 100,000 CFM. At design conditions of $4^{\circ}F$ outside air and $68^{\circ}F$ air to the paint spray booth the heat input per booth is as follows:

100,000 CFM x .075#/CF x 60 min/hr x ($68^{\circ}F-4^{\circ}F$) x .24 Btu/#.$^{\circ}F$=
6,912,000 Btu/hr

6,912,000 Btu/hr x 3 = 20.7 MBtu/hr

20.7 x 1.1 (contingency for distribution & misc. losses) = 22.8 MBtu/hr

The Final Tank heated blow dry booth will require approximately 3,000 PPH steam but the exhaust from the booth is vented into the building reducing building heating requirements and providing needed moisture during the winter peak load period.

Analysis is based on the booth exhaust fan operating at 22,000 CFM and $180^{\circ}F$ with that amount of makeup supply air having to be heated from $68^{\circ}F$ to $220^{\circ}F$. The calculation follows:

22,000 CFM x $528^{\circ}R \div 640^{\circ}R$ x 60 min/hr x .075 #/CF x ($220^{\circ}F$ - $68^{\circ}F$) x
.24 Btu/#$^{\circ}F$ = 2,979,000 Btu/hr

Each bake oven exhausts an estimated 11,000 CFM of $140^{o}F$ air to outside the plant. Heating makeup air to the bake ovens would require the following Btu/hr:

$$11{,}000 \text{ CFM} \times 528^{o}R \div 600^{o}R \times 60 \text{ min/hr} \times .075\#/CF \times (140^{o}F - 68^{o}F) \times .24 \text{ Btu/\#-}^{o}F = 753{,}000 \text{ Btu/hr}$$

.75 MBtu/hr x 1.1 (contingency) x 2 units = 1.65 MBtu/hr, use 2 MBtu/hr

Total peak steam requirements for the paint line is 22.8 + 2 = 24.8, use 25 MBtu/hr which is equivalent to 25,000 PPH of 1,000 Btu/# STEAM.

Preliminary discussions have been held with Schweitzer Industries who made the paint booths to discuss operation and energy conservation measures possible. Heat recovery from the bake ovens would be a first step. A coil-to-coil "run around" approach would work well. 2 MBtu/hr could be recovered. The second step would be to put coils into the spray booth exhausts. These coils would be preceded by some "patented" impingement surface to minimize fouling of the heat transfer coils. This type of installation on hydrospin type 3 grain spray booths now exist in the field and maintenance has shown to be required only once per year. 10 MBtu/hr could be recovered from the three spray booths and a total of 2 + 10 = 12 MBtu/hr from the paint line. Conservatively, we estimate 8,000 PPH of steam could be reduced from the peak paint line demand.

Improved control also appears warranted to better control system temperatures and transients.

At this time the large hull and turret spray booth is used to paint small parts. We will be recommending the addition of a ½ to ¼ size spray booth and bake oven to handle small parts. While this will save energy by allowing the hull and turret booths to be shutdown when just parts are being run it will potentially increase the peak load.

$$.5 \text{ unit} \div 3 \text{ unit} \times (25{,}000 \text{ PPH} - 8{,}000 \text{ PPH}) = 2{,}833 \text{ PPH, use } 3{,}000 \text{ PPH}$$

We note the paint operation would be an easily shed steam load if peak load problems for short time (minutes) periods developed.

CONCLUSION

Based on an active energy conservation program, a peak load of 90,000 to 100,000 PPH steam is anticipated by FY 87. Present installed capacity is 95,000 PPH. With the addition of a 75,000 PPH Boiler No. 5 scheduled for FY 81, the installed capacity of the power plant will be 170,000 PPH. This appears to be adequate redundancy for this plant. We recognize that the information used to generate our estimates was approximate. A year-by-year analysis is warranted. Many plant related decisions are being made that will effect total peak requirements. We recommend against adding the proposed 50,000 PPH Boiler No. 6 until further data is available with a decision to proceed or stop made during FY 84.

6/22/81
Revised 8/27/81

COMMENTS ON STEAM REQUIREMENTS AT PEAK CONDITIONS

Reference Exhibit II

All items except energy saving have been analyzed in the preceding review.

Peak steam requirement savings via insulation, heat recovery from compressed air and condensate, and improved controls are estimated as follows:

1,400 PPH	Project No. 1 dated June 10, 1981 Adds insulation to Building Nos. 351, 345, and 121
500 PPH	Insulation of Steam Lines and Building 186 and S-70. Proposed FY 81 Sp. #4
1,800 PPH	Recover heat in compressed air, Project No. 11
150 PPH	Domestic Hot Water, Project No. 5
1,250 PPH	Improved Controls
5,100 PPH	

Since a 5,100 PPH reduction is a 9% reduction in the base peak load of 58,000 PPH, we feel this is a reasonable estimate.

To date no consideration has been given to the steam consumption of the tank test pond, its contribution to peak steam requirements, or conservation or load shedding at the pond.

EXHIBIT I

PRODUCTION SUPPORT & EQUIPMENT REPLACEMENT MEETING

26 February 1981

PROJECTED STEAM REQUIREMENTS FOR LATC

A. Actual Peak 1980-81 Demand — 57,800 PPH

B. Additional Platten Press (On or before 1984) — 7,800 PPH ← taken from actual demands existing platten press

C. Vehicle Repair Building (Projected use) — 4,000 PPH

D. Dynamometer Test Expansion (Projected use) — 1,000 PPH

E. Cafeteria (Projected use) — 1,600 PPH

F. Administration Building (Projected use) Funded 8M, FY85 — ~~21,000 PPH~~ 10,500 PPH using heat recovery units

G. New Storage Building (Used as Temporary Office Building) (Projected use) — 8,300 PPH
BLDG 147 3,800 (Including Shipping + Receiving)
351 office space 1,000
Note: New Storage Building (Projected use) 1,700 PPH

FY 84 HIGH RISE STORAGE 5,680

H. Addition to Building 147 for 90 per month (3/8/5) FY-85 — 8,000 PPH
(Edge prep, plate inspection, vehicle adjustment and test, ring grind and marriage) (Projected use)

I. Addition to Building 147 for 150 per month (3/8/5) FY-86 — 4,000 PPH
(Welding School, small parts welding, hull structure, vehicle adjustment and testing and marriage assembly) (Projected use)

J. Addition to Building 147 (Press Building) (Projected use) — 5,700 PPH

K. SAPSA Washer (Projected use) — 2,600 PPH

L. Conversion of Paint Line to Steam (Projected use) FY-84 — ~~12,000~~ PPH 30,000 MIN

164,800 PPH

MIN TOTAL 134,000 PPH
MAX TOTAL 162,380 PPH

EXHIBIT II

REVISED AUGUST 27, 1981

STEAM REQUIREMENTS PEAK CONDITIONS (POUNDS PER HOUR)

58,000	Peak
- 4,000	Eliminate Use of Turbine Drives, Project 10
54,000	Subtotal
+ 3,900	Platen Press 7,800 ÷ 2 = 3,900
	Items C, D, G, H, I, & J 270,000 sq. ft.
+10,800	x 40 Btu/hr - sq. ft. 1,000 Btu/# Steam =
	New Administration Building
+ 3,200	80,000 sq. ft. x 40 Btu/hr-sq. ft. ÷ 1,000 Btu/# Steam
+ 500	Cafeteria
+ 1,300	SAPSA Washer 2,600 ÷ 2 = 1,300
- 5,100	Energy Savings Via Insulation, Heat Recovery and Improved Control
68,600	Subtotal
+ 25,000	Conversion of Paint Line to Steam
- 8,000	Paint Line Energy Conservation
+ 6,300	Add Ventilation
+ 3,000	Add Small Parts Paint Booth
94,900	Total

Use 100,000 PPH, Includes 5% Contingency

"Energy Savings" have been adjusted in the August revision.

Review of Projects No. 2, No. 3 and No. 4 indicates that response to the plant's production area ventilation requirements with heat recovery units will result in an added heating loading on the Boiler Plant. The adjustment is as follows: +400 PPH, Building 143, Project No. 2; -900 PPH, Building 186, Project No. 3; +6,800 PPH, Building 147, Project No. 4; total +6,300 PPH. Use of makeup air units for the added ventilation would require 24,800 PPH steam.

Note: If no energy conservation project were undertaken and standard makeup air units were used instead of heat recovery units for ventilation, the result would be a 31,600 PPH addition to our projected peak steam requirement of 94,900 PPH. The total project peak steam requirement becomes 126,500 PPH.