PDCAP 269

SUPPLEMENTED FINAL REPORT

Safaga Grain Silos Complex
Electric Power Study

IQC-1406-I-00-5043

LARAMORE, DOUGLASS AND POPHAM
NEW YORK, NY

GILBERT/COMMONWEALTH INTERNATIONAL
READING, PA

June 6, 1986

SAFAGA GRAIN SILOS COMPLEX (SGSC)

ELECTRIC POWER STUDY

CONTENTS

		Page
Section 1 -	PURPOSE	I-1
Section 2 -	SCOPE	II-1
Section 3 -	EXECUTIVE SUMMARY	III-1
Section 4 -	DISCUSSION	
	A. Load Requirements at Safaga Grain Silos Complex (SGSC)	IV-1
	B. Load Requirements at EEA Generating Plant in Safaga	IV-6
	C. Existing EEA Safaga Generating Plant	IV-9
	D. Fuel Availability	IV-11
	E. Heat Rates	IV-11
	F. Selection of Recommended Project	IV-13
	G. Specific Recommendation	IV-16
	H. Diesel Plant Maintenance and Spare Parts Requirements and Availability	IV-17
	I. Egyptian Manufacturer's Capability	IV-20
	J. Standby Equipment Requirements	IV-20
	K. Environmental Assessment	IV-21
Section 5 -	IMPLEMENTATION PLAN FOR PROPOSED NEW DIESEL POWER PLANT	
	A. General	V-1
	B. Approach for Recommended New Diesel	V-2
	C. Turnkey Implementation Plan	V-2
Table 1 -	Peak Loads at SGSC	IV-3
Table 2 -	Yearly Electric Energy Loads	IV-5
Table 3 -	EEA Load Forecast - (kW) Safaga Generating Plant	IV-6
Table 4 -	Coincident Nighttime Load Forecast - kW Safaga Generating Plant	IV-8
Table 5 -	Prime Mover Heat Rates	IV-12
Table 6 -	Cost of Electricity, Diesels vs. Combustion Turbine Additions	IV-14
Table 7 -	Allowable Pollutant Ground Level Impact Levels	IV-22
Table 8 -	Permissible Noise Exposures	IV-27

SAFAGA GRAIN SILOS COMPLEX (SGSC)

ELECTRIC POWER STUDY

CONTENTS
(Continued)

APPENDIX

EXHIBIT 1 - SGSC Peak Load Requirements

EXHIBIT 2 - Capital Cost Estimate

EXHIBIT 3 - Power Additions Requirements and Optimization Calculations

EXHIBIT 4 - Minutes - Environmental Scoping Session held in Cairo, March 3, 1986

EXHIBIT 5 - Site Photographs at Safaga

EXHIBIT 6 - Conceptual Plant Layout

EXHIBIT 7 - Conceptual One Line Diagram

FINAL REPORT

SAFAGA GRAIN SILOS COMPLEX (SGSC)

POWER SUPPLY STUDY

SECTION I

PURPOSE

This report presents data and information acquired by Laramore, Douglass and Popham (LDP) and Gilbert/Commonwealth International (GCI) during field trips to the SGSC, the EEA generating plant at Safaga and the town of Safaga and from interviews with various people in Cairo and in Safaga. It also includes the analysis made by LDP and GCI of the SGSC power requirements, the sizing and optimization of the new generation equipment to serve the SGSC load; the power plant capital cost estimates for the various cases considered; an environmental assessment; and the bases for the electric power expansion recommendation.

SECTION II

SCOPE

The scope of effort, interviews and investigations used in developing this report included:

- At Cairo, February 24:
  - Opening meeting with USAID, EEA, MSBA (Mills, Silos and Bakeries Authority) and (BVI) (Black & Veatch International) personnel.
  - Interviews with EEA personnel at Abbysiya.
- At Safaga, February 25 & 26:
  - Inspection of the Safaga Grain Silo Complex (SGSC), the EEA combustion turbine generating plant and visit to the town of Safaga. Interviews with EEA generating plant operating, MSBA, BVI and Harbert-Howard (construction constructor) personnel.
- At Cairo, February 27 & 28:
  - Review and analysis of information gathered in Egypt.
- At Cairo, March 3:
  - Exit briefing and environmental scoping session with USAID, EEA, MSBA and Egyptian Ministry of Health personnel.
- In US:
  - Development of capital and operating costs, operating requirements, an environmental assessment, and equipment suitability and availability information -- all as required for optimization of the generation expansion recommendation.

SECTION III

EXECUTIVE SUMMARY

To meet the Safaga Grain Silos Complex (SGSC) power requirements, it is recommended that three distilate oil fired medium speed diesels totalling 9,000 kW nameplate be installed at an estimated capital cost of about $7 million U. S. equivalent. The new diesel power plant should be interconnected with and installed adjacent to the existing EEA Safaga Generating Plant which consists of 2 X 5,000 kW ISO combustion turbine generators. Each diesel generator should have a combined continuous site output of not less than 3,000 kW with a 10% overload capacity for one hour in every 24 hours in accordance with ISO standards. In summary, the basis for this recommendation included consideration and evaluation of the following:

- To meet the SGSC power requirements on an isolated basis (Case II) would require the installation of some 8,100 kW gross (ISO) of power generation, comprised of five (5) equal units.

- To meet the SGSC power requirements when operating connected to EEA (Case I) would require the installation of some 8,600 kW gross of power generation, comprised of three (3) equal units.

- The small size of the units required in each case limits the choice as to prime movers as between diesels and combustion turbine.

- There is no prospect in the forseeable future that low cost natural gas will be available in the Safaga area and evaluation of costs of operating diesels versus combustion turbines is based on each firing enhanced solar (distillate) fuel oil.

- The capital cost and costs of operation -- fuel, O&M and staffing additions -- is appreciably lower for diesels than for combustion turbine prime movers.

- Comparative capital costs for installing the required diesels would be slightly less for the isolated Case II. However, it should be noted that recommended interconnected Case I provides substantial capacity for load growth of the general Safaga electric system. Moreover, the present worth of the capital and operating costs over a 15 year project life is lower for Case I because of the more efficient loading pattern possible with interconnected operation, together with the reduction in staff, warehousing, etc. possible with new and existing prime movers at the same site.

On a least cost basis, it is therefore recommended that 9,000 kW gross (ISO) capacity of power additions be installed in the form of three equally sized diesel oil fired units, and that the units be located at space available at the existing EEA Safaga Generating Plant.

Recommendations for an implementation plan for the recommended diesel power plant are included in Section 5.

This report contains the minutes of an environmental scoping session held with interested Egyptian local authorities to discuss the subject project. With the use of equipment commercially available from U. S. suppliers and of commonly accepted environmental control practices, the proposed project can be constructed and operated within the environmental regulatory requirements of the Government of Egypt and of the U. S. EPA.

In Section 5, LDP presents an implementation plan for the recommended 3 X 3000 kW diesel power plant. It is estimated that it will require approximately 9 months to prepare a turnkey specification, take bids, evaluate bidders, and award a contract; and additional 14 to 15 months to manufacture, ship, erect and test equipment ready for commercial generation. Taking into account the near term load growth projected for the Safaga area, the existing two combustion turbines will only marginally cover the 1987 peak and the area will be seriously short of power in 1988.

To avoid the possibility of power use curtailment in 1988, it will be necessary to either defer some of the planned Tourist and Expected Projects or immediately enter into a crash implementation program for the new power plant. A short summary of such a crash program is described at the end of Section V.

SECTION IV

DISCUSSION

A. Load Requirements at Safaga Grain Silos Complex (SGSC)

Analyses provided by Black & Veatch International (BVI) of the expected peak load requirements for operation of the SGSC were reviewed. These were prepared in February, 1985 and since updated to a minor degree. The documentation, as revised, is included in Exhibit 1 of the Appendix for reference.*

The data provided was based on motor horsepower nameplate ratings and 1 hp rating was taken as 1 kVA input at unity power factor.

In arriving at an estimate of peak load requirements, consideration must be given to the possibility of various Complex activities simultaneously occuring. The major activities include:

- Unloading a ship. It is expected that two ships per month will be unloaded with 6 days of round-the-clock operation required to unload each ship.
- Transferring grain from silos to the bagging hopper and to bulk truck and rail loading facilities. This is expected to be a one-shift daytime activity.
- Turning grain in silos to prevent heat build-up.
- The Complex's utility loads.

*Note: Deleted from Final Report at request of BVI.

Table 1 - Peak Loads at SGSC has been prepared based on the review of the BVI analyses and documentation provided. The loads set forth therein are based on unloading a ship to the furthest silos and transferring grain for distribution loading from the furthest silos. For purposes of estimating peak requirements, this is acceptable and no diversity factor can be applied. LDP applied a lower diversity factor to the Complex's utility load than previously used.

Table 1 sets forth four (4) possible operation scenarios, called Cases 1 thru 4. The peak requirements for operation under these cases are:

- 1,240 kVA for Case 4 - distributing grain and utility loads - 28 weeks/year.

- 4,742 kVA for Case 3 - unloading ship, distributing grain and utility loads - 21 weeks/year.

- 5,192 kVA for Case 2 - unloading ship, turning grain, distributing grain and utility loads - 2 weeks/year.

- 5,429 kVA for Case 1 - unloading ship, turning grain in 4 silos and utility load - 1 week/year.

Based on the above, the annual peak load requirement for the SGSC is 5,429 kVA or 4,343 kW at 0.8 p.f. With the SGSC operating with its own isolated power supply and not connected to the EEA system, its generating plant should be composed of five (5) prime movers, each with a net output of 1,500 kW. Three prime movers would be used to meet the peak and load, one would be considered as in maintenance or overhaul and one would be reserve or spare. Thus a total of 7,500 kW net would be required.

Table 1 also sets forth tabulations of the nighttime peak. This is of use in consideration of the system coincident peak requirements with the SGSC power plant interconnected with the Safaga generating plant, as covered in IV-B, below.

Table 2 - Yearly Electric Power Energy Loads-SGSC indicates that the yearly electric energy requirements of the SGSC are in the order of 15,644,800 kVA-hrs (12,515,840 kWh at 0.8 p.f.) at a load factor of 32.9%.

TABLE 1

PEAK LOADS AT SGSC[1]

CASE 4:- (28 weeks/year)

		Daytime Peak (kVA)	Nighttime Peak (kVA)
• Transfer grain from silos 301, 601 & 101 to bagging hopper and to bulk truck and rail loading	640		
- dust collectors 4A & 4B	295	935	
• Utility load	305[4]	305	305
Total Peak - Case 4 =		1,240	305

CASE 3:- (21 weeks/year)

• Unload ship to silos 210 and 710 using two ship unloaders:			
- ship unloaders	1,936		
- receiving system to headhouse	846[2]		
- distribution drags	300[3]	3,082	3,082
• Transfer grain from silos 111, 811 & 611 to bagging hopper and to bulk truck and rail loading	1,060		
- dust collectors 4A & 4B	295	1,355	
• Utility load	305	305	305
Total Peak - Case 3 =		4,742	3,387

NOTES:
(1) Load sources from BVI 2/6/85 memo.
(2) Includes dust collectors Nos. 2 & 3.
(3) Includes belt drive motors to furthest silos.
(4) Diversity factor of 0.5 for connected utility loads.

TABLE 1

PEAK LOADS AT SGSC[1]

(Continued)

CASE 2:- (2 weeks/year)

		Daytime Peak (kVA)	Nighttime Peak (kVA)
• Unload ship to silos 210 and 710 using two ship unloaders:			
- ship unloaders	1,936		
- receiving system to headhouse	846		
- distribution drags	300	3,082	3,082
• Turn grain in 311	450	450	450
• Transfer grain from silos 111, 811 & 611 to bagging hopper and to bulk truck and rail loading	1,060		
- dust collectors 4A & 4B	295	1,355	
• Utility load	305	305	305
Total Peak - Case 3 =		5,192	3,387

CASE 1:- (1 week/year)

• Unload ship to silos 210 and 710 using two ship unloaders:			
- ship unloaders	1,936		
- receiving system to headhouse	846		
- distribution drags	300	3,082	3,082
• Turn grain in silos 311, 111, 811 and 611	1,800		
- dust collectors 4A & 4B	295	2,042	2,042
• Utility load	305	305	305
Total Peak - Case 1 =		5,429	5,429

TABLE 2

YEARLY ELECTRIC ENERGY LOADS - SGSC

CASE 1 - 1 WEEK:								kVA-hrs ($X\ 10^3$)
Unload Ship	- 3,082 kVA	X	6 days	X	24 hrs.	X	1 week	= 443.8
Turn Grain	- 2,042 kVA			X	12 hrs.			= 24.5
Utility Loads	- 305 kVA	X	7 days	X	24 hrs.	X	1 week	= 51.2
								519.5

CASE 2 - 2 WEEKS:								
Unload Ship	- 3,082 kVA	X	6 days	X	24 hrs.	X	2 weeks	= 887.6
Turn Grain	- 450 kVA			X	12 hrs.	X		= 10.8
Bagging/Bulking	- 1,355 kVA	X	5 days	X	8 hrs.	X	2 weeks	= 108.4
Utility Loads	- 305 kVA	X	7 days	X	24 hrs.	X	2 weeks	= 102.5
								1,109.3

CASE 3 - 21 WEEKS:								
Unload Ship	- 3,082 kVA	X	6 days	X	24 hrs.	X	21 weeks	= 9,320.0
Bagging/Bulking	- 1,355 kVA	X	5 days	X	8 hrs.	X	21 weeks	= 1,138.2
Utility Loads	- 305 kVA	X	7 days	X	24 hrs.	X	21 weeks	= 1,076.0
								11,534.2

CASE 4 - 28 WEEKS:								
Bagging/Bulking	- 935 kVA	X	5 days	X	8 hrs.	X	28 weeks	= 1,047.1
Utility Loads	- 305 kVA	X	7 days	X	24 hrs.	X	28 weeks	= 1,434.7
								2,481.8
								=======

Total Yearly Load = 15,644.8

At 0.80 p.f. = 12,515.8 kWh ($X\ 10^3$)

$$\text{Load Factor} = \frac{15{,}644{,}800 \text{ kVA-hrs}}{5{,}429 \text{ kva} \times 8{,}760 \text{ hrs.}} = 32.9\%$$

$$\text{Capacity Factor} = \frac{15{,}644{,}800 \text{ kVA-hrs}}{6{,}000 \text{ kVA} \times 8{,}760 \text{ hrs.}} = 29.8\%$$

B. Load Requirements at EEA Generating Plant in Safaga

On March 3, 1986 LDP received a copy of a load forecast of the Safaga Generating Plant prepared by the President of the Canal Zone. The forecast is:

TABLE 3

EEA LOAD FORECAST - (KW)
SAFAGA GENERATING PLANT

Type of Load	1986	1987	1988	1989	1990
Residential	2,500	3,200	4,000	4,500	5,000
Tourist Projects	500	1,000	1,800	2,500	3,000
Expected Projects	-	500	1,500	2,000	2,500
(Subtotal EEA Load)	(3,000)	(4,700)	(7,300)	(9,000)	(10,500)
Silos (SGSC)	8,000	8,000	8,000	8,000	8,000
Total	11,000	12,700	15,300	17,000	18,500

Plant personnel advise that plant site ambient temperature varies year-round from 15°C to 45°C. The existing two Sulzur combustion turbines are each rated at 5,000 kW at ISO - 59°F (15°C), sea level. At 45°C ambient, the existing turbines have a site rating of 3,364 kW. Since the Safaga Plant is an isolated station (the nearest EEA grid connection is 240 km distant), its mode of operation is, properly, with one turbine operating at any one time. With site rating capacity of only 3,364 kW, the Safaga Plant will require expansion by 1987 to meet only the projected residential load, i. e. ignoring new projects and the SGSC loads.

It should be pointed out that the existing combustion turbine installation has no provision for furnishing evaporative cooling of the air intake. Assuming that the ambient relative humidity is 15-20%, evaporative cooling would lower the ambient temperature to about 77°F (25°C) and the combustion turbine site rating would be raised to 4,193 kW. Although this is some improvement, there would continue to be a need to expand the Safaga Plant by 1988 to meet only the residential load.

In considering the capacity requirements at the Safaga Plant due to the addition of the SGSC load, the coincidence of the respective loads must be estimated. EEA plant personnel advised that the Safaga Plant load requirement presently has the following characteristics:

- The residential peak, without the load required for the bauxite ore unloading facility (hereinafter referred to as the aluminum plant), has been 1,500-1,600 kW.

- This residential load includes a 100 kW steady load for an ice plant, which is the only other industrial load in the area.

- The aluminum plant load has been running at 300 to 400 kW. This load is erratic as to timing pattern and is dependent on ship unloading operations. The facility has 500 kW of diesels burning solar fuel but they are intended only for standby and are never used for facility load relief.

- In 1986, it is expected that the aluminum plant load will increase to 1,000 kW due to presently diesel powered blower drives being replaced by electric motor drives. Again, the timing pattern of this load will depend on ship unloading operations.

- Typical daily load logs for the existing residential load (not including the aluminum plant) are:

Hour	kW
6:00 AM	800
7:00 AM	800
8:00 AM	800
9:00 AM thru 4:00 PM	600
5:00 PM	1,000
6:00 PM	1,200
7:00 PM	1,500

- The daily load pattern shown above is said to be typical year round. The residential load is for lighting and appliances; there is no residential air conditioning. It can be noted that the peak occurs in the early evening hours and that the daytime peak is 40% of the nighttime peak.

- For a recent month, electric usage was 602,000 kWh for a 1,500 kW peak. This constitutes a load factor of 53.9% and a plant capacity factor of 24.1% for a single combustion turbine operating at 45°C.

Assuming the increase in the Safaga residential load (less the aluminum plant load) continues the present pattern of the daytime load being 40% of the nighttime peak it can be expected that the addition of the SGSC load will result in the greatest peak being experienced in the nighttime, even though the SGSC peak requirement (Cases 1 thru 3) falls off in the nighttime. The coincident nighttime load forecast for the Safaga electric plant would then be:

TABLE 4

COINCIDENT NIGHTTIME LOAD FORECAST - (KW)
SAFAGA GENERATING PLANT

Type of Load	1986	1987	1988	1989	1990
Residential	1,500	2,200	3,000	3,500	4,000
Other Loads:					
Tourist Projects	500	1,000	1,300	2,500	3,000
Expected Projects	-	500	1,500	2,000	2,500
Aluminum Plant	1,000	1,000	1,000	1,000	1,000
SGSC	2,700 (1)	2,700	2,700	2,700	2,700
Subtotal	3,200	5,200	6,500	8,200	9,200
X 0.8 diversity =	2,560	4,160	5,200	6,560	7,360
Total Safaga Load=	4,060	6,360	8,200	10,060	11,360

(1) From Table 1, 3,387 kVA at 0.8 p.f., this will occur some 98% of the year.

With one existing combustion turbine, site rated at 3,364 kW at 45°C, running at the Safaga plant, some 8,000 kW (site rated) of capacity additions is required to meet the 1990 peak.

The 1990 Safaga plant net electric energy requirements were estimated assuming that the Safaga residential, the tourist projects and the other expected projected loads would have a 54% load factor as being experienced with the Safaga residential load and that the aluminum plant and the SGSC load would have similar load factors of 33% as estimated for the SGSC; the estimate is:

					kWh (X 10^3)
Residential	4,000 kw	X 8,760 hrs	X 0.54	=	18,921.6
Tourist Projects	3,000	X 8,760	X 0.54	=	14,191.2
Expected Projects	2,500	X 8,760	X 0.54	=	11,826.0
Aluminum Plant	1,000	X 8,760	X 0.33	=	2,890.8
SGSC				=	12,515.8 (1)
Total					60,345.4

$$\text{Load Factor} = \frac{60{,}345{,}400 \text{ kWh}}{11{,}360 \text{ kW} \times 8{,}760 \text{ hrs.}} = 60.6\%$$

(1) from Table 2

In view of the expected system load factor and in order to optimize the individual unit load factors and resultant heat rates, the 8,000 kW net site rated additions should consist of three (3) prime movers.

C. Existing EEA Safaga Generating Plant

The present EEA Plant consists of two (2) combustion turbine-generating units each nameplate-rated at 5,000 kW at ISO (sea level & 15°C ambient temp), but derated to 3,364 kW at 45°C ambient temp. The combustion turbine units operate as simple open cycle, with no recovery of exhaust energy.

The generators are open air cooled and the lube oil is oil-to-air cooled by heat exchanger; therefore, the plant has no water make-up requirement. The generator voltage is 11 kV feeding directly to the transmission system, with no stepup transformer. Two (2) standby diesel generators provide black start capability.

The combustion turbines and generators are housed in weather-proof enclosures provided by Sulzer as factory assembled packages. Similarly, the auxiliaries, switchgear and control are housed in this type enclosures. The operator can control either or both generating units from either of two (2) switchgear/control enclosures. However, due to the 1,800 kW maximum system load, there has never been need to operate both units at the same time. One (1) unit is always on standby reserve, as back-up to the operating unit.

The combustion turbine units have been provided with dual fuel firing capability (natural gas/oil), but all operations to date have been on an imported enhanced solar fuel oil. The oil is stored in two (2) 1,000 metric ton aboveground tanks. There are no fuel oil treating facilities. Most fuel oil deliveries are by ship in 1,000 MT shipments; some deliveries have been by over-the-road tank truck. The nearest natural gas line is some 160 km distant. There are no current plans to extend this line to Safaga and it can be expected that there will be no natural gas availability in the Safaga area in the forseeable future.

The combustion turbine units are complemented and supported by office, machine shop, spare parts and fuel storage facilities.

The Safaga Generating Plant has a staff of 45, including the following skills:

6	Mechanical Engineers
1	Electrical Engineer
15	Operators
4	Maintenance
3	Shops
2	Warehouse

The combustion turbine units are about 5 years old, have exhibited high reliability/availability, and the Plant Staff is very complimentary of these units. The Staff has performed all the maintenance required. Normal maintenance is to changeout fuel filters and nozzles monthly, requiring about one (1) hour of down time on the operating unit. The units each have approximately 20,000 running hours and have recently undergone a major overhaul, including changeout of selected hot parts, including a combustor. Turbine blades were checked during the overhaul and some were replaced due to their having suffered vibration damage. There was no evidence of salt deposits from fuel oil contamination.

The entire Plant Area and the turbine generator units have a neat and well maintained appearance. We believe that the Plant Staff is qualified and conscientious in performing their duties.

The units are in good condition and should perform reliably for 15 or more years with periodic changeout of certain parts, including major overhaul as required.

There is ample unused area within the EEA Plant boundaries for installation of the additional generating units required for an expansion.

Fuel Availability

As described in Section IV-C, above, there are no facilities available for supply of natural gas and none are contemplated for the forseeable future. Construction of a 160 km gas line extension to supply the natural gas requirements of an all-combustion turbine extension of the Safaga Generating Plant would not be feasible, even if the natural gas site cost were considered as zero. Therefore, analysis of the prime mover selection in this study is based on the use of the imported solar distillate fuel presently fired at the Safaga Plant for use with either the diesels or the combustion turbines being considered for the power generation additions.

The imported fuel presently being burned has a heating value of 10,550 kilocals/kgm (18,985 Btu/lb) and is being provided at the subsidized price of 30 LE/Mton or $\$0.53/10^6$ btu based on 74 cents U. S. per Egyptian pound (LE). This price, of course, does not reflect the true cost of the fuel either as provided without subsidy or as a reflection of what the value to the Egyptian economy is of oil it could export. It is also difficult to forecast what fuel costs will be in the future because of the recent very acute downtrend in world-wide crude oil prices. U. S. Department of Energy ten-year projections as published at the beginning of 1986 are (costs all expressed in $/million btu):

Year	No. 2 Distillate Oil	Residual Oil
1985	$5.85	$4.19
1986	5.48	4.05
1987	5.09	3.88
1988	5.10	3.92
1989	5.47	4.17
1990	5.88	4.50
1995	6.48	5.00

For purposes of comparison and evaluation in this study, the cost of fuel oil will be taken as $3.00/million Btu, which is often used when crude oil is $20/barrel.

- Heat Rates

In considering the optional choice as between combustion turbine generators and diesel generators, it should be noted that, for units of the contemplated sizes, it can be expected that:

- For the same output and ambient conditions, the diesel unit can be expected to have a heat rate advantage of 3,000 to 5,000 Btu/kWh when electric power alone is to be generated. It is only when combustion turbine generation is associated with usable steam or waste heat recovery or as part of a combined cycle plant that it becomes competitive with the diesel unit. At the sizes considered here and with no cogeneration prospects available, this is not the case in this application.

- Combustion turbine units suffer a greater derating as the ambient temperature increases than do diesel units.

- Diesel units have a rather steady heat rate between full load and 50% load operation, while combustion turbine unit heat rates increase appreciably with part load operation.

For typical available equipment the expected heat rates are set forth in Table 5.

TABLE 5

PRIME MOVER HEAT RATES

		DIESELS			
		100% load	90% load	75% load	50% load
Gross output	kW	2,900	2,610	2,175	1,450
Gross heat rate (HHV)	Btu/kWh	9,200	9,200	9,220	9,719
Losses	%	6.0	6.3	7.0	8.0
Net output	kW	2,726	2,466	2,033	1,334
Net heat rate (HHV)	Btu/kWh	9,787	9,816	9,912	10,564
Net electric fuel cost*	$/kWh	0.0294	.0294	0.0297	0.0317

		COMBUSTION TURBINES			
		100% load	90% load	75% load	50% load
Gross output	kW	3,255	2,930	2,441	1,628
Gross heat rate (HHV)	Btu/kWh	13,800	14,700	16,000	17,800
Losses	%	8.5	9.4	11.1	13.6
Net output	kW	2,978	2,655	2,170	1,407
Net heat rate (HHV)	Btu/kWh	15,084	16,223	17,998	20,596
Net electric fuel cost	$/kWh	0.0452	0.0487	0.0540	0.0618

* Fuel cost taken as $\$3.00/10^6$ Btu

F. Selection of Recommended Project

The net kW peaking requirement for addition to the EEA Safaga Generating Plant has been identified on page IV-9 as some 8,000 kW at 45°C. Diesel ISO standards are set for 27°C and do not suffer appreciable derating above this temperature. Combustion turbine ISO standards are set for 15°C and experience greater derating as ambient temperature increases. For purposes of this evaluation the gross (nameplate) additions which would have to be made for diesels and for combustion turbines at the average assumed ambient temperature of 27°C (81°F) are:

	Peaking Requirement kW at 45°C	Net kW at 27°C	Gross kW at 27°C
Diesels	8,000	8,100	8,600
Combustion Turbines	8,000	8,700	9,400

Exhibit 2 in the Appendix sets forth an estimate for purchase and installation of three diesels and of three combustion turbines of approximately 9,000 kW net. From page 6 of this Exhibit, the approximate capital costs are estimated to be:

Diesels	$ 820/kW
Combustion Turbines	1,100/kW

These capital costs are used in this evaluation.

The 1990 cost of electricity for both diesel and combustion turbine units, including fuel, operating and maintenance was estimated (with fuel oil at $3.00/10^6 Btu) for each of the following two scenarios:

- Case I - power station addition interconnected to existing EEA Safaga Generating Plant.
- Case II - power station addition at the SGSC, isolated electrically from the EEA Generating Plant.

The assumptions, optimal equipment loading and calculations used in these estimates are set forth in Exhibit 3 of the Appendix. The results are summarized in Table 6.

TABLE 6 (1)

COST OF ELECTRICITY
DIESELS VERSUS COMBUSTION TURBINE ADDITIONS
(Net Energy 60.3 X 10^6 kWh per year)

CASE I - Operating Interconnected with EEA

- **Using three diesel additions:**

Diesels	
fuel - 56.7 X 10^6 kWh/yr - 90% L.F. - 9,816 Btu/kWh	$1,669,702
O&M - 56.7 X 10^6 kWh/yr @ $0.0072/kWh	408,240
Existing Sulzer Combustion Turbines:	
fuel - 3.6 X 10^6 kWh/yr - 64% L.F. - 19,250 Btu/kWh	$ 207,900
O&M - 3.6 X 10^6 kWh/yr @ $0.0062/kWh	22,320
Staff Additions 10 @ $4,000/yr	40,000
Yearly Cost =	$2,348,162
$/kWh =	0.0389

- **Using three combustion turbine additions:**

New Combustion Turbines:	
fuel - 45.3 X 10^6 kWh/yr - 50% L.F. - 20,596 Btu/kWh	$2,798,996
Existing Sulzer Combustion Turbines:	
fuel - 15.0 X 10^6 kWh/yr - 100% L.F. - 15,084 Btu/kWh	$ 678,780
O&M - 60.3 X 10^6 kWh/yr @ $0.0062/kWh	373,860
Staff Additions 10 @ $4,000/yr	40,000
Yearly Cost =	$3,891,636
$/kWh =	0.0645

CASE II - Operating Isolated from EEA

- **Using five diesel additions:**

Diesels	
fuel - 12.6 X 10^6 kWh/yr - 60% L.F. - 10,300 Btu/kWh	$ 389,340
O&M - 12.6 X 10^6 kWh/yr @ $0.0072/kWh	90,720
Staff Additions 25 @ $4,000/yr	100,000
Yearly Cost =	$ 580,060
$/kWh =	0.0460

- **Using five combustion turbine additions:**

New Combustion Turbines:	
fuel - 12.6 X 10^6 kWh/yr - 60% L.F. - 19,500 Btu/kWh	$ 737,100
O&M - 12.6 X 10^6 kWh/yr @ $0.0062/kWh	78,120
Staff Additions 25 @ $4,000/yr	100,000
Yearly Cost =	$ 915,220
$/kWh =	0.0726

(1) All fuel taken at $3.00/$10^6$ kWh

Table 6 indicates that for both cases, i.e., either operating the power additions interconnected with EEA or isolated from EEA, the cost of running combustion turbine additions is always higher than running diesel additions, the differences in yearly cost of electricity being:

- for Case I $3,891,636/yr for combustion turbines vs. $2,348,162/yr for diesels, or 66% higher.
- for Case II $915,220/yr for combustion turbines vs. $580,060/yr for diesels, or 58% higher.

It should be noted that the above comparison is based on both the diesels and the combustion turbines being fired by the presently used enhanced solar (distillate) oil fuel, taken as costing $\$3.00/10^6$ Btu. Diesels of about 3,000 kW capacity could be purchased for firing residual oil which should have an unsubsidized cost of $1.00 to 1.50 per million Btu lower than the enhanced solar oil fuel. Residual oil enginees would be more expensive. Together with fuel cleanup, storage, and handling equipment, residual oil capability would substantially increase the capital cost. However, residual oil cannot be fired in combustion turbines of such a small size and the comparisons noted above would even more strongly favor use of diesels over combustion turbines if residual oil engines were selected because of the fuel cost differential.

As illustrated above, the required gross (nameplate) diesel capacity operating interconnected to the EEA Generating Plant is 8,600 kW ISO (27^oC). In Section IV-A, the net capacity requirement operating isolated from EEA (Case II) has been identified as 7,500 kW. Assuming that this peak would be required at maximum ambient of 45^oC, the net capacity would be 7,600 kW ISO and the gross requirement would be 8,100 kW ISO. The comparative capital cost between the two Cases then becomes:

Case I - 8,600 kW X $820/kW = $7,052,000

Case II - 8,100 kW X $820/kW = $6,642,000

The costs of electricity for operating diesels have been shown in Table 6 to be $0.0389 for Case I and $0.0460 for Case II. For an assumed 15 year project life, the comparative present worths of the two Cases with an interest at 10% (PW factor = 7.607) for the SGSC requirement of 12.6×10^6 kWh/yr are:

<u>Case I</u> - interconnected with EEA:

Capital cost	$7,052,000
Cost of Electricity	
$12.6 \times 10^6 \times \$0.0389 \times 7.607$	3,728,000
Total Cost	$10,780,000

Case II - Isolated from EEA:

Capital cost	$6,642,000
Cost of Electricity	
$12.6 \times 10^6 \times \$0.0460 \times 7.607$	4,409,000
Total Cost	$11,051,000

On the basis of the least present worth and the ability to supply additional capacity for the growing Safaga load outside the Grain Silo Complex, LDP recommends that the power additions be operated interconnected with EEA in accordance with Case I.

A 250 mm^2 buried cable was being installed in February, 1986 from the existing EEA plant to the SGSC. This cable has an ampacity at 11,000 volts of some 9,000 kW at .80 P. F. and is amply adequate for the SGSC load requirements.

G. Specific Recommendation

To minimize EEA staff requirements and to facilitate consolidated stores and maintenance tasks, LDP recommends that a new 3 X 3000 kW diesel generating plant be installed adjacent to the existing EEA combustion turbine generating plant at Safaga. EXHIBIT 6 sets forth a conceptual plant layout and EXHIBIT 7 a one line diagram for such an arrangement.

Each diesel generator set should be rated for a minimum of 3000 kW at site maximum ambient of 45°C for both engine and generator. This will provide a margin of extra capacity for anticipated peak loads in Safaga. Specifically each unit should be rated:

Nameplate at 45°C (113F)	3000 kW
Speed (maximum)	750 rpm
Fuel	Distillate oil
Overload capacity based on 1 hour per 24 hours	10%
Generator rated power factor	0.80

750 rpm is at the upper rotational speed limit of the socalled medium speed engines which ranges between 360 and 750 rpm for 50 Hz machines. United States engine manufacturers who can meet the medium speed requirements are:

	Manufacturer	Model	Speed Rotat. rpm	Continuous kW
1.	Alco Power Inc.	251	750	2,100
2.	Caterpillar	3616	750	3,400
3.	Colt-Pielstick	PC2.6	500	3,080
		38 TD8	750	2,500
4.	Enterprise/DeLaval	R-48	429	3,466
5.	Cooper Bessemer	KSV12	600	3,100
6.	General Electric	FD	750	2,000
7.	General Motors	20-71064	750	2,615

All of the above engines are, in LDP's opinion, suitable for the type of operation anticipated at Safaga (6000-6500 equivalent full load hours per year per engine) when fired with distillate oil. However, only the Pielstick, Enterprise and Cooper Bessemer engines can fire residual oils, providing a suitable fuel purification system is installed. For these heavier oils, piston linear speeds should not be more than 30-32 feet per second.

It is true the slower speed engines will require somewhat less maintenance than the 750 rpm engines. However, because weight and cost of diesel engines is a function of speed, the slower speed engines will require an appreciably greater initial investment. For instance, the Enterprise budget quotation for its slower speed engine is almost twice as high as the Caterpillar 750 rpm diesel budget quotation which was used for the capital cost estimate. In addition to this, an initial investment increase would also be required for oil purification equipment which would not be necessary when burning distillate oil.

In LDP's judgment, the additional investment for a slower speed engine is not justified unless there is a strong possibility that EEA will want to convert to residual oil firing in the near future.

In view of the above rationale, LDP therefore recommends that the three diesel engines be specified for distillate oil and rotating speeds up to a maximum of 750 rpm.

H. Diesel Plant Maintenance and Spare Parts Requirements and Availability

1. Maintenance Requirements

Minor inspection and maintenance is required for diesel units on a weekly basis. This can be done while the engine is operating. Shutdown maintenance is usually scheduled at various intervals of operating hours, each interval being a function of the type of maintenance required. For instance, for diesels operating on residual No. 6 oil:

1,000 hour intervals - Change or clean fuel and lube oil filter cartridges, clean air filter, check valves, etc. Time required up to 8 hours downtime per engine with 2-3 men.

2,000 hour intervals - Replace injection valves with reconditioned valves, change lube oil, clean charge air cooler, etc. Time required 12 to 15 hours downtime per engine with 3-4 men.

4,000 hour intervals - Clean all coolers, pull and inspect one cylinder liner (clean all liners if necessary), check crankshaft alignment, check camshaft, etc. Time required 30 to 40 hours downtime per engine with 2-3 men.

8,000 hour intervals - Dismantle cylinder heads and clean; pull, inspect and clean pistons, rings and gudgeon pins; pull one cylinder liner per V-bank (clean and replace O-rings of all liners and engine block water space if necessary); dismantle and check water pumps; inspect and clean connecting rods, main bearing shells, lube oil pump, fuel pump, etc. Time required 50 to 60 hours downtime per engine with 6-7 men.

16,000 hour intervals - Overhaul injection pumps; inspect and check connecting rod (small end) bearings, valve mechanisms, camshaft bearings, vibration dampers, etc. Time required 40 to 50 hours downtime per engine with 3-4 men. Can be done simultaneously with every other 8,000 hour overhaul if desired.

48,000 to 60,000 hour intervals - Major overhaul which would include replacement of pistons, cylinder liners and bearings. With proper planning and having all replacement parts in hand, it is estimated this work can be accomplished in 50 to 60 hours downtime per engine with 7-8 men.

Note: Above estimates for downtimes assume continuous work by means of overtime and/or shifts as necessary.

For diesels firing distillate oils, maintenance intervals cited above would be extended.

It is estimated that each diesel will run an average less than 7,000 hours/year. For more than half the year there will be no SGSC ship unloading and only two diesels will have to be run. Thus, normal operating procedure will afford ample opportunity to schedule required maintenance and overhaul.

2. Spare Parts Requirements

Diesel engine parts which are routinely replaced and their expected service lives using residual No. 6 oil are:

Part	Service Life (Hours)
Piston Ring Set	12,000
Inlet Valve	32,000
Inlet Valve Seat	32,000
Exhaust Valve	12,000
Exhaust Valve Seat	24,000
Valve Guide	24,000
Valve Rotator	12,000
Injection Nozzle Element	8,000
Main Bearing	32,000
Connecting Rod Bearing	24,000
Turbocharger Bearing Set	12,000
Lube Oil Filter	--
Fuel Oil Filter	--

These parts should be stocked in accordance with manufacturer's recommendations and EEA experience. In LDP's opinion, a complete set of spare injectors should also be stocked to save labor and to maintain availability; this will permit fast turnarounds on the 2000 hour internal maintenance task (see above) while injector repair can be done during non-maintenance periods.

Major replacement parts such as pistons and cylinder liners have a service life of 48,000 to 60,000 hours, and would only be stocked (if at all) on a limited basis.

Current quotations for parts indicate that for diesels in the 3,000 to 6,000 kW range, running 6,000 hours per year, replacement cost can be expected to be from $4.00 to 8.00 per year per nameplate kW rating. These costs would be lower, and the service lives listed above longer, for diesels firing distillate fuel.

It is contemplated that EEA plant personnel will perform day-to-day maintenance requirements, but that substantial overhauls requiring shift work to maintain engine availability will be contracted to the supplier or other qualified diesel maintenance company.

The costs of parts, EEA maintenance staff, and contract costs are all included in the non-fuel O&M cost used in this study.

A complete list of spare parts can be assembled when specific prime movers are selected and manufacturer's recommendations are received.

3. <u>Availability</u>

By careful planning and working overtime and/or in shifts, the scheduled overhaul work can be done in the time periods a diesel is not required for operation. In LDP's opinion, routine maintenance and scheduled overhaul will not effect the availability of the diesel equipment for the operating mode contemplated.

Diesel manufacturers and suppliers claim and often demonstrate equipment reliability of 96 to 98 percent with load factors as high as 90 percent.

This would constitute a forced outage rate of 2 to 4 percent. Forced outage rate is:

$$\text{Forced Outage Rate (FOR)} = \frac{\text{Forced Unavailable Hours}}{\text{Service Hours} + \text{Forced Unavailable Hours}}$$

or,

$$\text{Forced Unavailable Hours} = \frac{\text{FOR}}{(1-\text{FOR})} \times \text{Service Hours}$$

For an assumed FOR of 5% and for 7,000 service hours, this would be:

$$\text{Forced Unavailable Hours} = \frac{0.05}{(1-0.05)} \times 7{,}000$$

$$= 368 \text{ hours, or } 15.4 \text{ days.}$$

The probability of a forced outage occuring on a vital peak day is difficult to predict, but no doubt some outages of the "third" diesel will occur at a time when it is required. The second Sulzer gas turbine can be operated on such occasions to meet the peak load.

I. Egyptian Manufacturers' Capability

The only equipment required for the proposed project which could be supplied by Egyptian manufacturers is electrical switchgear. This capability, however, does not include 11,000 volt switchgear which will be required for the new diesel plant.

J. Standby Equipment Requirements

Installation of the recommended power generation equipment with interconnection to EEA (Case I) will include three diesels totalling 9,000 kW gross capacity. In addition, there would be the two existing Sulzer combustion turbines, one always in reserve and one operating at night only on the days the SGSC has ship unloading operations (estimated running time for the "second" existing gas turbine is 1,008 hours/year). This would be normal procedure for a public utility generating plant, which although isolated from a general network, has some diversity of residential, commercial and industrial loads. If EEA requires that the Safaga generating plant be operated on the basis of one existing Sulzer combustion turbine in reserve along with one diesel addition, this can be accomplished by furnishing the required 9,000 kW of additions in four units.

It is recommended that this present expansion proceed on the basis of addition of three diesels as recommended above. If within the next five years there is indication that load growth in Safaga including new tourist and other expected projects occurs as presently projected, a fourth identical diesel can be added.

K. Environmental Assessment

1. Summary -

The newly constructed Safaga Grains Silo Complex requires a source of electrical power. Consideration has been given to the provision of a power plant to serve just the complex and consideration has been given to expanding the existing Egyptian Electrical Authority (EEA) Safaga Generating Plant to meet the needs of the complex.

The preferred alternative is the expansion of the existing plant. The new kW peaking requirement for addition to the EEA Safaga Generating Plant has been identified as some 8,000 kW at 45°C.

An environmental scoping session was held on 3 March 1986 with invited local officials including the Ministry of Health. Minutes of this meeting are included as Exhibit 4 in the Appendix. The project contemplated, some 6 to 10 MW of either gas turbine or diesel generating plant additions, was described and the preliminary assessment of the major environmental impact was given.

The major areas of environmental concern regarding the proposed action are potential air and noise pollution.

This assessment concludes that no significant environmental impacts are anticipated as a result of the proposed action.

2. Purpose -

The purpose of this Environmental Assessment is to provide AID and Government of Egypt decision makers with a full discussion of significant environmental effects of the proposed increase in the generating capacity of the electric plant which is to serve the Safaga Grain Silos Complex.

3. Alternatives Including the Proposed Action -

a. Alternative I - No Action:

The existing EEA generating plant at Safaga consists of two (2) gas turbine units each nameplate-rated at 5,000 kW, but derated to 3,364 kW to account for the high ambient temperature at the site. These units are equipped with dual firing capability (natural gas/oil), but all operations to date have been on an imported enhanced solar fuel oil. Proper mode of operation is one unit on line and one unit on standby.

The units are about 5 years old, have exhibited high reliability, and the plant staff is very complimentary of these units. The units are in good condition and should perform reliability for 15+ years with periodic changeout of selected parts and with major overhaul as required.

The plant staff is qualified and concientious in the performance of their duties.

With an existing site rating capacity of 3,364 kW, it is anticipated that the Safaga Plant will require expansion by the year 1987 to serve increased residential loads even if the Safaga Grain Silos Complex loads are excluded. The provision of evaporative cooling for the existing units could raise the site rating capacity to 4,193 kW; thus, permitting plant expansion to be delayed until 1988 assuming service to the Safaga Grain Silos Complex and new projects is excluded.

See Section IV.C. Existing EEA Generating Plant at Safaga for a more detailed discussion on the existing plant.

The existing EEA plant cannot serve the Safaga Grain Silos Complex unless additional capacity is provided. Without the proposed upgrading the Safaga Grain Silos Complex would have to either lie dormant or install its own power plant.

b. Alternative II - Addition of Three Oil-Fired Diesel Units at the Existing EEA Safaga Generating Plant:

The preferred alternative is the addition of three oil-fired diesel units at the existing EEA Safaga Generating Plant. The total gross capacity of these units would be approximately 8,600 kW at 27°C.

The capital cost for this alternative is estimated at $7,052,000. The annual operation and maintenance cost is estimated at $0.0389/kWh. For an assumed 15-year project life, the present worth for this alternative is $10,780,000.

This alternative minimizes additional staffing and achieves operation and maintenance warehousing efficiencies.

There is ample unused area within the plant boundaries for the installation of the additional generating units.

In proposing the use of oil-fired diesel units, the following factors were considered:

- There are no facilities available for supply of natural gas in the Safaga area and none are contemplated for the forseeable future. The nearest natural gas line is some 160 km from the plant site.

- Fuel oil deliveries are available by ship and by over-the-road tank truck.

- Fuel costs for gas turbine generators would be almost twice those of diesel generators. It is only when gas turbine generators are used as part of a combined cycle plant or other heat recovery operations that they become competitive with diesel generators. For the small units being considered under this project, the use of heat recovery is not practical.

- Gas turbine units suffer a greater derating than diesel units as the ambient temperature increases. Due to the high ambient temperatures at the Safaga site, a total gross capacity of 9,400 kW at 27°C would be required if gas turbines were to be used in lieu of the diesel units. Capital costs are estimated to be $800/kW for diesel units as opposed to $1,100/kW for gas turbines.

c. Alternative III - Separate Generating Plant for the Safaga Grain Silo Complex:

This alternative would provide for the installation of five oil-fired units at a separate generating plant which would serve only the Safaga Grain Silo Complex; this electrical system would be independent from the EEA plant. The total gross capacity of the five diesel units would be approximately 8,100 kW at 27°C.

The capital cost for this alternative is estimated at $6,642,000. The annual operation and maintenance cost is estimated at $0.0460/kWh. For an assumed 15-year project life, the present worth for this alternative is $11,051,000.

4. Affected Environment -

Safaga is a small village on the Red Sea about 600 km southeast of Cairo and 200 km east of the Nile River and Qena. It came into being about 1981. Hurghada is the nearest community, about 60 km to the north. The village is comprised of modern masonry buildings with a well planned street system. The Port area includes a bauxite ore unloading and storage facility built in 1982 and the Safaga Grain Silos Complex.

The existing bauxite ore unloading facility and the Safaga Grain Silos Complex have only minor standby diesel generators. There is no other industry in Safaga Port or its environs, nor are there any new project plans, which include substantial fuel combustion facilities. There is a strong breeze in the Safaga area which, according to local observations, is very consistent and acts to disperse the small amounts of exhaust emissions from the existing EEA Safaga Generating Plant and the small number of motor vehicles in the area.

The EEA Safaga Generating Plant is located at a relatively isolated site 2 kM inland from the Port. The existing gas turbines are installed outdoors. Although there is a residential apartment flat some 30 meters from the generating plant, there have been no complaints about noise.

Safaga is in the Eastern Desert. The entire Eastern Desert is administered by a single governorate -- the Red Sea Governorate. The Eastern Desert comprises a sandy plateau surmounted by a chain of barren, rocky hills reaching an altitude of over 2000 metres. The isolation of this area and the aridity have resulted in an unpopulated interior and a few villages on the Red Sea.

The Safaga area itself consists of a sandy desert with considerable rock. Safaga is at the foot of the Red Sea Hills. Vegetation is minimal and there are no surface water bodies other than the Red Sea.

The EEA Safaga Generating Plant site has previously been graded and leveled.

5. Environmental Consequences -

a. Focus of Investigation:

As a result of interbiews with authorities in Cairo on 24 February 1986, a field investigation at Safaga on 25 and 26 February 1986, and an environmental scoping session in Cairo on 3 March 1986, air and noise pollution were identified as potential environmental concerns.

b. Air Pollution:

At the scoping session, the air standards of the World Bank, the Government of Egypt, and the United States Environmental Protection Agency (EPA) were discussed. It was decided at that session that the facilities to be provided should be constructed in accordance with EPA standards. Table 7 compares the three different air standards.

TABLE 7

ALLOWABLE POLLUTANT GROUND LEVEL IMPACT LEVELS
(averages in micrograms per cubic metre)

Pollutant	3 hour	24 hour	annual
. NOx			
Egypt	-	200	-
EPA Ceiling	-	-	100 (1)
World Bank	-	-	100
. SO_2:			
Egypt	-	200	60
EPA Ceiling	1,300 (2)	365 (2)	80 (3)
World Bank	-	500	100
. Particulates:			
Egypt	-	150	-
EPA Ceiling	-	150	75
World Bank	-	500	100

Notes:

(1) arithmetic annual average
(2) once-a-year occurrence
(3) geometric annual average

EPA New Source Performance Standards (NSPS) have been proposed for diesel engines and promulgated for gas turbines. NSPS 40 CFR 60 Subpart FF would apply to internal combustion engines including diesel and dual fuel engines larger than 500 cubic inch displacement per cylinder (CID/cyl), i.e., about 2,000 hp or 1,500 kW. It would restrict nitrogen oxide emissions to 600 ppm, by volume at 15 percent oxygen and on a dry basis. It is proposed that emission standards would be less stringent (though unstated) for engines with demonstrated thermal efficiencies of more than 35 percent. The proposed regulations mention control techniques for reducing NOx emissions as including ignition retard, air-to-fuel ratio changes, manifold air cooling, and engine derate. They do not require exhaust gas treatment using catalytic converters.

Once acceptable emission levels have been demonstrated, there must be continuous monitoring of intake manifold temperature and pressure, engine speed, spark ignition timing, and fuel injector timing. Continuous monitoring of NOx stack emissions is specifically not required because of its high cost. The diesels considered in this study, operating with retardation of the fuel injection timing would achieve the 600 ppm limitation and would do so at an increase of about 2 percent in fuel consumption.

NSPS 40 CFR 60 Subpart GG is applicable to all stationary gas turbines with a heat input equal to or greater than 10.7 gigajoules* per hour but less than 107.2 gigajoules per hour, based on the lower heating value of the fuel fired. The largest gas turbine considered in this study would have a heat input of 73 gigajoules per hour and thus would come under the purview of Subpart GG and its provisions regarding nitrogen oxide and sulfur dioxide emissions. These provisions for the gas turbine would be:

- For NOx, 170 to 220 ppm depending on the percent by weight of the nitrogen content of the fuel.
- For SOx, 150 ppm maximum for any stationary gas turbine.
- Emission maximums stated above are by volume at 15 percent oxygen and on a dry basis.

* Note: 1.055 gigajoules = 10^6 Btu

In view of the small size of the modification to be made to this existing minor facility and of the ambient air quality conditions of this isolated location and with use of commonly accepted and economic control technologies (timing ignition retard for the diesels) and with use of chimneys or stacks if and as required, there should be no difficulty in meeting applicable EPA NSPS and ground level impact regulations or EEA regulations.

c. Noise Pollution:

At the scoping session, the representative of EEA advised that the normal practice of that agency is to limit noise pollution to 60 decibels at one hundred metres from the source.

The Occupational Safety and Health Act of 1970 established exposure limits for certain employees in the United States. Table 8 indicates the permissible noise exposures for employees.

TABLE 8

PERMISSIBLE NOISE EXPOSURES

Duration per-day, hours	Sound Level, dBA
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

When employees are subjected to sound exceeding the listed levels, feasible administrative or engineering controls should be utilized. If such controls fail to reduce sound levels within the levels of the table, personal protective equipment should be provided and used to reduce the sound levels to those levels established in Table 8.

In view of the isolation of the site, the impact of sound pollution will be limited primarily to EEA employees at the generating plant. With the use of appropriate mufflers of the diesels and protective equipment for employees, there should be no problem in meeting both EEA recommended practices and OSHA standards regarding sound levels at the proposed facilities.

d. Irreversible Commitment of Scarce Resources:

The proposed project will require the use of an imported enhanced solar fuel oil; the purchase of such fuel will require the use of the country's limited foreign exchange.

e. Other Factors:

There will be no solid waste or effluent disposal to the ground or to any streams.

There will be no adverse impact on soils, vegetation or flora and fauna.

The proposed project will require only a small increase in staff and there will be no impact on population, community growth and traffic in the area.

Since the site has been previously graded and leveled, it is not likely that the required construction will destroy or damage any historic or prehistoric artifacts.

The construction site will be inland from the Red Sea. The danger of oil or fuel spills to a surface water body is minimal.

f. Construction Activities:

The only environmental impact during construction will be in the nature of dust and construction noise. The construction period will be short since the diesel plant will be provided in factory-assembled packages. Since the site has previously been graded and leveled, earthwork will be minimal.

g. Conclusions:

The proposed action is not anticipated to have any significant adverse impacts upon the environment. The mitigation measures proposed should be adequate to maintain air and noise pollution levels within acceptable standards.

SECTION V

IMPLEMENTATION PLAN FOR PROPOSED NEW DIESEL POWER PLANT

A. General

Implementation of the proposed new diesel power plant at Safaga can be accomplished in a number of ways and there are advocates of each of the following approaches:

- Complete turnkey project with one contract for procurement of all equipment and materials, design, expediting, inspection, construction, startup and testing. This is a single responsibility approach favored by many developing countries because it reduces design and monitoring by the client or his consultant to a minimum. It also determines the project capital cost at a very early stage of the project.

- Multi-contract approach with individual contracts for major equipment items awarded on a furnish and deliver basis. Design, factory inspection and site services such as resident engineering, construction inspection, startup and testing are all handled by the Owner and/or his consultant. One or more contracts are awarded for various phases of the construction work based on specifications and drawings prepared by the Owner and/or his consultant.

  This is the approach favored by utility organizations in the United States because the Owner obtains the type and quality of equipment and construction he wants. Also it permits a "fast track" implementation plan because major equipment specifications can be prepared relatively quickly as compared to turnkey specifications. Hence, long lead time equipment items can be placed in the early stages of the project.

- Various combinations of the turnkey and multi-contract approaches, e.g., for a steam power plant, the project is frequently divided into packages such as turbine island, boiler island, and a civil works package.

B. Approach for Recommended New Diesel Power Plant

It is understood that fast implementation of the new diesel power plant program is desired to prevent electric power brownouts in the near term future when the general Safaga area load is expected to grow beyond the firm capacity of the two existing Sulzer combustion turbine units. Because of the small project size and isolated location of Safaga, however, it is not feasible to utilize a pure fast track, multi-contract approach. The choice then, seems to be between a full turnkey contract and a partial turnkey contract where a "partial" turnkey contract is defined as a separate furnish and deliver contract for the diesel generators, usual diesel auxiliaries and medium voltage switchgear. A second contract would provide for installation of the the diesels and for furnishing and installing the balance of plant, i.e., foundations, building, piping, cabling, tanks, minor equipment, etc. Preparation of the specification for the second contract could lag the equipment specification by several weeks without jeapordizing the project startup date.

Because preparation of a specification for the partial turnkey contract (as defined) could probably be completed 4 to 8 weeks sooner than a full turnkey specification which should be accompanied with appropriate preliminary designs and turnkey bidding drawings, a like amount of time could be saved in the overall project implementation.

Despite the appeal of time savings for the partial turnkey approach, LDP does not recommend it because of the small size of the job and the problems of coordination which EEA would have to assume absent a consulting engineer. Hence, the recommended plan and schedule presented below is based on a pure turnkey approach.

C. Turnkey Implementation Plan

Assuming time zero is when EEA is released to proceed with preparation of a turnkey specification, together with preliminary design and bidding drawings ("Bid Documents"), LDP estimates the following schedule would apply for implementation (in weeks):

Task	Task Time	Cumulative Time
• Preparation of Bid Documents (by EEA)	7	7
• Review of Bid Documents (by consultant)	4	11
• Modify and issue Bid Documents	4	15
• Proposal preparation by Bidders	16	31
• Evaluate proposals amd award contract	8	39
• Manufacture and ship major equipment	36	75
• Erect, checkout, startup and test	28	103

Total schedule is estimated at about two years from time zero, or say summer of 1988. Referring to Table 4, the Safaga area total nighttime peak load for 1988 is forecast at 8200 kW in 1988. If the residential and other contemplated project loads develop in accordance with Table 4 there will be a serious shortage of power prior to 1988, particularly during the hot weather season. The two existing combustion turbine units will carry about 6,700 kW during the hot season vs a forecast load of 6,360 kW in 1987 and 8,200 kW in 1988. Addition of evaporative coolers might raise the combustion turbine hot weather capability to about 8,000 kW. But the situation would still be serious as there would be no backup during the peak periods.

The methods of avoiding the apparent near term power shortage at Safaga appear to be:

- Defer some of the Tourist and other Expected Projects referred to in Table 4. This would not only reduce these loads but would also probably moderate the growth of the residential load. Under these conditions, the peak load could be reduced to 4,000 to 5,000 kW and the combustion turbines could handle the load with one unit in reserve except during peak periods.

- Initiate a "crash" program by issuing letter specifications in the U. S. for diesel equipment at once. Negotiate with the low bidder and issue a purchase order for the equipment within the next few weeks. Follow this up with appropriate design and issue a balance of plant specification at an early date. This approach might cut the total project time by 6 months if approvals could be done by AID and EEA representatives sent to the U. S. for that purpose.

APPENDIX

THIS EXHIBIT DELETED

EXHIBIT 1

SGSC Peak Load Requirements

EXHIBIT 2

Capital Cost Estimate

EGYPTIAN ELECTRICITY AUTHORITY

SAFAGA POWER STATION ADDITIONS

DIESEL ENGINES OR GAS TURBINES

CONTENTS

	PAGE
ESTIMATE SCOPE.....	1
ESTIMATE SUMMARY.....	2
DETAIL COST ESTIMATES	
COMBUSTION TURBINE GENERATION ADDITIONS (2-UNITS)...	6
COMBUSTION TURBINE GENERATION ADDITIONS (3RD UNIT)..	8
DIESEL TURBINE GENERATION ADDITIONS (2-UNITS).....	10
DIESEL TURBINE GENERATION ADDITIONS (3RD UNIT).....	12

EGYPTIAN ELECTRICITY AUTHORITY
ESTIMATE SCOPE

INTRODUCTION

This Exhibit describes the development and summarizes the results of the capital cost estimates for the diesel and combustion turbine grass roots generating plants for the Safaga, Egypt site.

GENERAL SCOPE

The capital costs presented in this Exhibit address present day costs for diesel engine and combustion turbine generating plants designed to nominally produce electrical output of 6200 and 6000 KW respectively for the base cases, each case with two prime movers. Estimates are also included for adding the third diesel and third combustion turbine.

The scope of work for the diesel engine or combustion turbine concept is as follows:

1. Mechanical - Erection of diesel engine or combustion turbine generators with associated pumps, fuel handling, and interconnecting piping.

2. Structures - Construction of the pre-engineered control room and related site work.

3. Electrical - Installation of work associated with the diesel engines or turbine generators including new 11 kV electrical feed to plant property line.

The estimate includes both U. S. and Egyptian direct and indirect costs. Direct costs include all equipment, materials, and field labor. Indirect costs include engineering, freight, training, and manufacturer's construction engineer costs. Contingency has been applied to both direct and indirect costs.

METHODOLOGY OF ESTIMATE DEVELOPMENT

The following paragraphs describe the methods, assumptions, and sources of information used in the development of the capital cost estimate.

Estimate Basis and Qualifications

The primary basis for the estimate was to develop conceptual cost estimates for additions to the Safaga Power Station. Preliminary sketches were used to help define the materials of construction, and assist in the development

of bulk quantities. When design information was unavailable, historical cost information was used to conceptualize cost requirements for the estimate preparation. Additional estimate bases are described as follows:

A. The cost estimate is based on an overnight constructed schedule in 1986.

B. All labor is based upon a normal 48 hour work week, eight hours per day, six days per week, and does not include overtime.

C. An exchange rate of 1.35 (LE) per U. S. dollar (74 cents U. S. per pound) has been used to convert dollars to (LE) Egyptian pounds.

D. The diesel engine or combustion turbine power plant is to be constructed on the adjacent site of the existing grain silo storage facility or at Safaga Power Station.

E. All equipment and bulk materials are U. S. purchase except for concrete, stone, and sand, which are Egyptian purchase.

F. Export packing and freight (FAS) costs are included with equipment and bulk commodities.

G. Diesel engine or combustion turbine generators are installed outdoors and include manufacturer's weather protection housing.

Direct Costs

The approach utilized to develop the direct cost depends on the availability of the information. The following basic approaches were used to determine costs:

Quantity development for sitework, foundations, structures, buildings, piping, and electrical costs were conceptualized. Costs were developed utilizing current price information.

Materials and sizes were received from design engineering, and priced using current vendor price information.

Prices for major equipment were obtained from vendor quotes. They include the following:

A. Combustion Turbine Generator

B. Diesel Engine Generators

C. Fuel Oil Storage Tanks

D. Crane

Labor Costs

It is assumed that union craft labor rates will apply for the U. S./ Expatriate cost estimate. Costs were developed by using different composite crews for the different work items. Craft wages were used and costs were added for fringe benefits and contractor distributables such as supervision, field and home office support, construction equipment, small tools and expendables, overhead, and profit.

Egyptian labor costs, as itemized in the summary estimate, were determined by using U. S. labor productivity and a factor of 1.4 for local unskilled and skilled labor. Construction erection cost ratio/factors are considered as 15% U. S. and 85% Egyptian. Labor rates used are those furnished by EEA contracting companies as standard wages paid in the area.

Indirect Costs

Indirect costs usually contribute to the project cost in direct proportion to the direct costs. Costs have been included as a percentage of the total direct cost for engineering. These costs are described as follows:

A. An allowance for 103% for local Egyptian labor is included to cover social insurance, taxes, overhead, and profit.

B. Material handling, storage, and mark-up are based on 5% of U. S. and Egyptian material costs.

C. An allowance of 4% for export freight and 3% for U. S. inland freight and 2% for Egyptian freight has been utilized.

D. An allowance for training Egyptian personnel has been included.

E. An allowance of 8% of the total U. S. and Egyptian direct cost and material handling was added to cover normal engineering, drafting, scheduling, and cost engineering.

F. An allowance for overseas manufacturer's construction engineer costs has been included.

G. An allowance for startup has been included.

H. An allowance for performance testing has been included.

I. An allowance for operational testing has been included.

J. A contingency has been applied for both the U. S. dollar portion and the Egyptian pound portion to direct and indirect costs which is indicative of the level of information available. An allowance of 5% for materials and 15% for labor has been applied to provide for unforeseen elements of cost within the current defined project scope. This contingency provides for small changes, normal claims, omissions, variations in productivity, profit levels, weather, etc. It is expected that by the end of the project, the entire contingency will be spent on either direct or indirect accounts.

K. The capital costs are based on an overnight construction schedule, representing first quarter 1986 U. S. dollars and Egyptian (LE) pounds.

EXCLUSIONS

The items listed below have not been included in the capital costs.

A. Land Costs

B. Fuel Costs

C. Allowance for Funds Used During Construction

D. Escalation

E. Owner's Costs

ESTIMATE SUMMARY

The cost estimate summaries for the diesel engine or gas turbine generation additions are presented on the following page. These costs are based on first quarter 1986 (U. S.) dollars and Egyptian (LE) pounds. Discipline cost estimates are detailed on additional pages.

EGYPTIAN ELECTRICITY AUTHORITY

SAFAGA POWER STATION ADDITIONS

ESTIMATE SUMMARY

U. S. (Dollars - 1000's)

	COMBUSTION TURBINES		DIESEL ENGINES	
No. of Units	2	3	2	3
Total Cost U. S. $ Equivalent	6,794.6	9,657.7	5,417.9	7,592.3
Site Net KW @ 45°C	6,000	9,000	6,200	9,300
Unit Cost $/KW	1,132	1,073	874	816
Rounded $/kW	1,150	1,100	875	820

EGYPTIAN ELECTRICTY AUTHORITY

SAFAGA POWER STATION

GAS TURBINE GENERATION ADDITIONS

SUMMARY

(1,000's)

	U S (DOLLARS)			EGYPTIAN (LE)		
	MATERIAL	LABOR	TOTAL	MATERIAL	LABOR	TOTAL
1. Sitework						
Clear & Grub	-	-	-	-	6.8	6.8
Subtotal	-	-	-	-	6.8	6.8
2. Structures & Foundations						
Generator Foundation	-	4.2	4.2	16.2	32.2	48.4
Auxiliary & Electrical Skid Fdn.	-	.6	.6	1.4	4.6	6.0
Central Control Bldg. Fdn.	-	.5	.5	.9	3.8	4.7
Central Control Bldg.	-	.4	.4	5.4	3.1	8.5
F.O. Storage Tank Foundations	-	10.1	10.1	35.1	77.5	112.6
Crane Foundation & Support Steel	-	8.9	8.9	74.5	68.2	142.7
Subtotal	-	24.7	24.7	133.5	189.4	322.9
3. Generation Equipment						
Generators	3,500.0	20.3	3,520.3	-	155.0	155.0
Subtotal	3,500.0	20.3	3,520.3	-	155.0	155.0
4. Mechanical (B.O.P.)						
F.O. Unloading Pumps	5.0	1.1	6.1	-	8.3	8.3
F.O. Forwarding Pumps	4.0	.5	4.5	-	3.5	3.5
Water Pumps	2.0	.2	2.2	-	1.2	1.2
Piping						
F.O. Unloading	2.3	3.9	6.2	-	29.7	29.7
F.O. Forwarding	2.8	4.3	7.1	-	32.6	32.6
Water Injection	4.9	4.1	9.0	-	31.1	31.1
F.O. Unloading Station	2.0	.7	2.7	-	5.2	5.2
F.O. Storage Tanks	176.0	32.4	208.4	-	247.9	247.9
Miscellaneous Tanks	20.0	1.4	21.4	-	10.3	10.3
HVAC	10.0	.8	10.8	-	5.7	5.7
Bridge Crane	100.0	3.5	103.5	-	26.4	26.4
Subtotal	329.0	52.9	381.9	-	637.2	637.2
5. Electrical						
Electrical	73.0	4.9	77.9	-	37.2	37.2
Subtotal	73.0	4.9	77.9	-	37.2	37.2
TOTAL DIRECT CONSTRUCTION COST (2-Units)	$3,902.0	102.8	4,004.8	133.5	1,025.6	1,159.1 (1

(1000's)

	U S (DOLLARS)			EGYPTIAN (LE)		
	MATERIAL	LABOR	TOTAL	MATERIAL	LABOR	TOTAL
INDIRECTS						
SUBCONTRACTOR COSTS (WITH LE LABOR)	-	-	-	-	-	-
SUBTOTAL	3,902.0	102.8	4,004.8	133.5	1,025.6	1,159.1
MATERIAL HANDLING, STORAGE AND MARKUP (5%) MATERIAL	195.1	-	195.1	6.7	-	6.7
SUBTOTAL	4,097.1	102.8	4,199.9	140.2	1,025.6	1,165.8
FREIGHT - MATERIALS (4% US)	163.9	-	163.9	2.8	-	2.8
MATERIALS (2% LE) - INLAND (3%)	-	-	-	165.9	-	165.9
SUBTOTAL	4,261.0	102.8	4,363.8	308.9	1,025.6	1,334.5
TRAINING	-	20.0	20.0	-	-	-
SUBTOTAL	4,261.0	122.8	4,383.8	308.9	1,025.6	1,334.5
SPARES MAINTAINED ON SITE	420.0	-	420.0	6.7	-	6.7
SUBTOTAL	4,681.0	122.8	4,803.8	315.6	1,025.6	1,341.2
ENGINEERING (8%)	-	405.0	405.0	-	-	-
MANUFACTURERS CONSTRUCTION ENGINEER	-	52.0	52.0	6.0	-	6.0
START-UP	-	20.0	20.0	13.5	-	13.5
PERFORMANCE TESTING	-	20.0	20.0	13.5	-	13.5
OPERATIONAL TESTING	-	10.0	10.0	13.5	-	13.5
SUBTOTAL	4,681.0	629.8	5,310.8	362.1	1,025.6	1,387.7
CONTINGENCY	234.0	94.5	328.5	18.1	153.8	171.9
TOTAL PROJECT CAPITAL COST (2 Units)	$4,915.0	724.3	5,639.3	380.2	1,179.4	1,559.6 (1
TOTAL (US) $			5,639.3			
TOTAL (EGYPTIAN) LE						1,559.6
EQUIVALENT TOTAL (US) $			6,794.6			
EQUIVALENT TOTAL (US) $/KW			1,132			

EGYPTIAN ELECTRICTY AUTHORITY

SAFAGA POWER STATION

GAS TURBINE GENERATION ADDITIONS
SUMMARY

(1,000's)

	U S (DOLLARS)			EGYPTIAN (LE)		
	MATERIAL	LABOR	TOTAL	MATERIAL	LABOR	TOTAL
1. Sitework						
Clear & Grub	-	-	-	-	3.4	3.4
Subtotal	-	-	-	-	3.4	3.4
2. Structures & Foundations						
Generator Foundation	-	2.1	2.1	8.1	16.1	24.2
Auxiliary & Electrical Skid Fdn.	-	.3	.3	.7	2.3	3.0
Central Control Bldg. Fdn.	-	.3	.3	.5	1.8	2.3
Central Control Bldg.	-	.2	.2	2.7	1.5	4.2
F.O. Storage Tank Foundations	-	-	-	-	-	-
Crane Foundation & Support Steel		6.1	6.1	50.4	46.5	96.9
Subtotal	-	9.0	9.0	62.4	68.2	130.6
3. Generation Equipment						
Generators	1,750.0	10.1	1,760.1	-	77.5	77.5
Subtotal	1,750.0	10.1	1,760.1	-	77.5	77.5
4. Mechanical (B.O.P.)						
F.O. Unloading Pumps	-	-	-	-	-	-
F.O. Forwarding Pumps	2.0	.2	2.2	-	1.7	1.7
Water Pumps	-	-	-	-	-	-
Piping						
F.O. Unloading	-	-	-	-	-	-
F.O. Forwarding	1.4	2.1	3.5	-	16.3	16.3
Water Injection	2.4	2.0	4.4	-	15.6	15.6
F.O. Unloading Station	-	-	-	-	-	-
F.O. Storage Tanks	-	-	-	-	-	-
Miscellaneous Tanks	10.0	.8	10.8	-	5.7	5.7
HVAC	8.0	.5	8.5	-	3.5	3.5
Bridge Crane	-	-	-	-	-	-
Subtotal	23.8	5.6	29.4	-	42.8	42.8
5. Electrical						
Electrical	39.0	2.5	41.5	-	19.2	19.2
Subtotal	39.0	2.5	41.5	-	19.2	19.2
TOTAL DIRECT CONSTRUCTION COST (3rd Addition)	$1,812.8	27.2	1,840.0	62.4	211.1	273.5 (LE)

50

(1000's)

	U S (DOLLARS)			EGYPTIAN (LE)		
	MATERIAL	LABOR	TOTAL	MATERIAL	LABOR	TOTAL
INDIRECTS						
SUBCONTRACTOR COSTS (WITH LE LABOR)	-	-	-	-	-	-
SUBTOTAL	1,812.8	27.2	1,840.0	62.4	211.1	273.5
MATERIAL HANDLING, STORAGE AND MARKUP (5%) MATERIAL	90.6	-	90.6	3.1	-	8.1
SUBTOTAL	1,903.4	27.2	1,930.6	65.5	211.1	276.6
FREIGHT - MATERIALS (4% US)	76.1	-	76.1	1.3	-	1.3
MATERIALS (2% LE)				-		
- INLAND (3%)	-	-	-	77.1	-	77.1
SUBTOTAL	1,979.5	27.2	2,006.7	143.9	211.1	355.0
TRAINING	-	7.0	7.0	-	-	-
SUBTOTAL	1,979.5	34.2	2,013.7	143.9	211.1	355.0
SPARES MAINTAINED ON SITE	203.2	-	203.2	3.1	-	3.1
SUBTOTAL	2,182.7	34.2	2,216.9	147.0	211.1	358.1
ENGINEERING (8%)	-	170.9	170.9	-	-	-
MANUFACTURERS CONSTRUCTION ENGINEER	-	8.0	8.0	1.0	-	1.0
START-UP	-	7.0	7.0	4.5	-	4.5
PERFORMANCE TESTING	-	7.0	7.0	4.5	-	4.5
OPERATIONAL TESTING	-	4.0	4.0	4.5	-	4.5
SUBTOTAL	2,182.7	231.1	2,413.8	161.5	211.1	372.6
CONTINGENCY	109.2	34.7	143,8	8.1	31.7	39.8
TOTAL PROJECT CAPITAL COST (3rd Addition)	$2,291.8	265.8	2,557.6	169.6	242.8	412.4 (L
TOTAL (US) $			2,557.6			
TOTAL (EGYPTIAN) LE						412.4
EQUIVALENT TOTAL (US) $			2,863.1			
EQUIVALENT TOTAL (US) $/KW			954			

EGYPTIAN ELECTRICTY AUTHORITY

SAFAGA POWER STATION

DIESEL ENGINE GENERATION ADDITIONS

SUMMARY

(1,000's)

	U S (DOLLARS)			EGYPTIAN (LE)		
	MATERIAL	LABOR	TOTAL	MATERIAL	LABOR	TOTAL
1. Sitework						
Clear & Grub	-	-	-	-	6.8	6.8
Subtotal	-	-	-	-	6.8	6.8
2. Structures & Foundations						
Generator Foundation	-	4.2	4.2	16.2	32.2	48.4
Auxiliary & Electrical Skid Fdn.	-	.6	.6	1.4	4.6	6.0
Central Control Bldg. Fdn.	-	.5	.5	.9	3.8	4.7
Central Control Bldg.	-	.4	.4	5.4	3.1	8.5
F.O. Storage Tank Foundations	-	10.1	10.1	35.1	77.5	112.6
Crane Foundation & Support Steel	-	8.9	8.9	74.5	68.2	142.7
Subtotal	-	24.7	24.7	133.5	189.4	322.9
3. Generation Equipment						
Generators	2,500.0	8.1	2,508.1	-	62.0	62.0
Subtotal	2,500.0	8.1	2,508.1	-	62.0	62.0
4. Mechanical (B.O.P.)						
F.O. Unloading Pumps	5.0	1.1	6.1	-	8.3	8.3
F.O. Forwarding Pumps	4.0	.5	4.5	-	3.5	3.5
Water Pumps	2.0	.2	2.2	-	1.2	1.2
Piping						
F.O. Unloading	2.3	3.9	6.2	-	29.7	29.7
F.O. Forwarding	2.8	4.3	7.1	-	32.6	32.6
Water Injection	4.9	4.1	9.0	-	31.1	31.1
F.O. Unloading Station	2.0	.7	2.7	-	5.2	5.2
F.O. Storage Tanks	176.0	32.4	208.4	-	247.9	247.9
Miscellaneous Tanks	20.0	1.4	21.4	-	10.3	10.3
HVAC	10.0	.8	10.8	-	5.7	5.7
Bridge Crane	100.0	3.5	103.5	-	26.4	26.4
Subtotal	329.0	52.9	381.9	-	637.2	637.2
5. Electrical						
Electrical	73.0	4.9	77.9	-	37.2	37.2
Subtotal	73.0	4.9	77.9	-	37.2	37.2
TOTAL DIRECT CONSTRUCTION COST (2-Units)	$2,902.0	90.6	2,992.6	133.5	932.6	1,066.1(LE)

(1000's)

	U S (DOLLARS)			EGYPTIAN (LE)		
	MATERIAL	LABOR	TOTAL	MATERIAL	LABOR	TOTAL
INDIRECTS						
SUBCONTRACTOR COSTS (WITH LE LABOR)	-	-	-	-	-	-
SUBTOTAL	2,902.0	90.6	2,992.6	133.5	932.6	1,066.1
MATERIAL HANDLING, STORAGE AND MARKUP (5%) MATERIAL	145.1	-	145.1	6.7	-	6.7
SUBTOTAL	3,047.1	90.6	3,137.7	140.2	932.6	1,072.8
FREIGHT - MATERIALS (4% US)	121.9	-	121.9			
MATERIALS (2% LE)				2.8	-	2.8
- INLAND (3%)	-	-	-	123.4	-	123.4
SUBTOTAL	3,169.0	90.6	3,259.6	266.4	932.6	1,199.0
TRAINING	-	20.0	20.0	-	-	-
SUBTOTAL	3,169.0	110.6	3,279.6	266.4	932.6	1,199.0
SPARES MAINTAINED ON SITE	420.0	-	420.0	6.7	-	6.7
SUBTOTAL	3,589.0	110.6	3,699.6	273.1	932.6	1,205.7
ENGINEERING (8%)	-	314.6	314.6	-	-	-
MANUFACTURERS CONSTRUCTION ENGINEER	-	52.0	52.0	6.0	-	6.0
START-UP	-	20.0	20.0	13.5	-	13.5
PERFORMANCE TESTING	-	20.0	20.0	13.5	-	13.5
OPERATIONAL TESTING	-	10.0	10.0	13.5	-	13.5
SUBTOTAL	3,589.0	527.2	4,116.2	319.6	932.6	1,252.2
CONTINGENCY	179.5	79.1	258.6	16.0	139.9	155.9
TOTAL PROJECT CAPITAL COST (2-Units)	$3,768.5	606.3	4,374.8	335.6	1,072.5	1,408.1(LE
TOTAL (US) $			4,374.8			
TOTAL (EGYPTIAN) LE						1,408.1
EQUIVALENT TOTAL (US) $			5,417.9			
EQUIVALENT TOTAL (US) $/KW			874			

EGYPTIAN ELECTRICTY AUTHORITY

SAFAGA POWER STATION

DIESEL ENGINE GENERATION ADDITIONS
SUMMARY

(1,000's)

	U S (DOLLARS)			EGYPTIAN (LE)		
	MATERIAL	LABOR	TOTAL	MATERIAL	LABOR	TOTAL
1. Sitework						
Clear & Grub	-	-	-	-	3.4	3.4
Subtotal	-	-	-	-	3.4	3.4
2. Structures & Foundations						
Generator Foundation	-	2.1	2.1	8.1	16.1	24.2
Auxiliary & Electrical Skid Fdn.	-	.3	.3	.7	2.3	3.0
Central Control Bldg. Fdn.	-	.3	.3	.5	1.8	2.3
Central Control Bldg.	-	.2	.2	2.7	1.5	4.2
F.O. Storage Tank Foundations	-	-	-	-	-	-
Crane Foundation & Support Steel		6.1	6.1	50.4	46.5	96.9
Subtotal	-	9.0	9.0	62.4	68.2	130.6
3. Generation Equipment						
Generators	1,250.0	4.0	1,254.0 (1254.0)	-	30.9	30.9
Subtotal	1,250.0	4.0	1,254.0	-	30.9	39.9
4. Mechanical (B.O.P.)						
F.O. Unloading Pumps	-	-	-	-	-	-
F.O. Forwarding Pumps	2.0	.2	2.2	-	1.7	1.7
Water Pumps	-	-	-	-	-	-
Piping						
F.O. Unloading	-	-	-	-	-	-
F.O. Forwarding	1.4	2.1	3.5	-	16.3	16.3
Water Injection	2.4	2.0	4.4	-	15.6	15.6
F.O. Unloading Station	-	-	-	-	-	-
F.O. Storage Tanks	-	-	-	-	-	-
Miscellaneous Tanks	10.0	.8	10.8	-	5.7	5.7
HVAC	8.0	.5	8.5	-	3.5	3.5
Bridge Crane	-	-	-	-	-	-
Subtotal	23.8	5.6	29.4	-	42.8	42.8
5. Electrical						
Electrical	39.0	2.5	41.5	-	19.2	19.2
Subtotal	39.0	2.5	41.5	-	19.2	19.2
TOTAL DIRECT CONSTRUCTION COST (3rd Addition)	$1,312.8	21.1	1,333.9	62.4	164.5	226.9 (LE)

54

(1000's)

	U S (DOLLARS)			EGYPTIAN (LE)		
	MATERIAL	LABOR	TOTAL	MATERIAL	LABOR	TOTAL
NDIRECTS						
SUBCONTRACTOR COSTS (WITH LE LABOR)	-	-	-	-	-	-
SUBTOTAL	1,312.8	21.1	1,333.9	62.4	164.5	226.9
MATERIAL HANDLING, STORAGE AND MARKUP (5%) MATERIAL	65.6	-	65.6	3.1	-	3.1
SUBTOTAL	1,378.4	21.1	1,399.5	65.5	164.5	230.0
FREIGHT - MATERIALS (4% US)	55.1	-	55.1	1.3	-	1.3
MATERIALS (2% LE) - INLAND (3%)	-	-	-	55.8	-	55.8
SUBTOTAL	1,433.5	21.1	1,454.6	122.6	164.5	287.1
TRAINING	-	7.0	7.0	-	-	-
SUBTOTAL	1,433.5	28.1	1,461.6	122.6	164.5	287.1
SPARES MAINTAINED ON SITE	203.2	-	203.2	3.1	-	3.1
SUBTOTAL	1,636.7	28.1	1,664.8	125.7	164.5	290.2
ENGINEERING (8%)	-	125.6	125.6	-	-	-
MANUFACTURERS CONSTRUCTION ENGINEER	-	8.0	8.0	1.0	-	1.0
START-UP	-	7.0	7.0	4.5	-	4.5
PERFORMANCE TESTING	-	7.0	7.0	4.5	-	4.5
OPERATIONAL TESTING		4.0	4.0	4.5	-	4.5
SUBTOTAL	1,636.7	179.7	1,816.4	140.2	164.5	304.7
CONTINGENCY	81.8	27.0	108.8	7.0	24.7	31.7
TOTAL PROJECT CAPITAL COST (3rd Addition)	$1,718.5	206.7	1,925.2	147.2	189.2	336.4 (LE)
TOTAL (US) $			1,925.2			
TOTAL (EGYPTIAN) LE						226.4(LE)
EQUIVALENT TOTAL (US) $			2,174.4			
EQUIVALENT TOTAL (US) $/KW			701			

EXHIBIT 3

Power Additions Requirements and Optimization Calculations

LARAMORE, DOUGLASS & POPHAM

Job No. 972-C
Project USAID/IQC - Egypt SGSC
Subject Sizing Prime Movers

Sheet 1 of 14
Date
Comp. by VK
Ch'd. by

- Assume year-round ambient is 27°C (81°F)
- Peak requirement at 45°C (112°F) = 8000 kw, net
- Requirement at 27°C (81°F) is:

Diesels (ISO for diesels is 27°C ... derating above)

∴ 8,000 kw or 3 at 27°C ISO (for derating) (use for loading)

or 3 @ 2700/(1 − .06) = 2,900 kw gross, ISO (use for nameplate)

G.T. (ISO is 15°C (59°F) for G.T.)

at average ambient, we need:

8,000 kw (1 + .43%/°F (113°F − 81°F)) = 9,100 kw net

use for loading, sizing, 3 @ 3,000 kw net (loading)

nameplate at G.T. ISO:

$$\frac{3000 \text{ kw net}}{0.96 \times 0.96} \times \left(1 + \frac{.43\%}{°F}(81°F - 59°F)\right) = 3,563 \text{ kw}$$

Day 360 (nameplate) gross, ISO

Existing Sulzer G.T. — for loading at 27°C use:

$$(0.96 \times 0.96)\, 5,000 \text{ kw} \left(1 - \frac{.61\%}{°F}(81°F - 59°F)\right) = 3,990 \text{ kw, net}$$

(loading)

LARAMORE, DOUGLASS & POPHAM

Sheet 2 of 14

Job No. 972-C

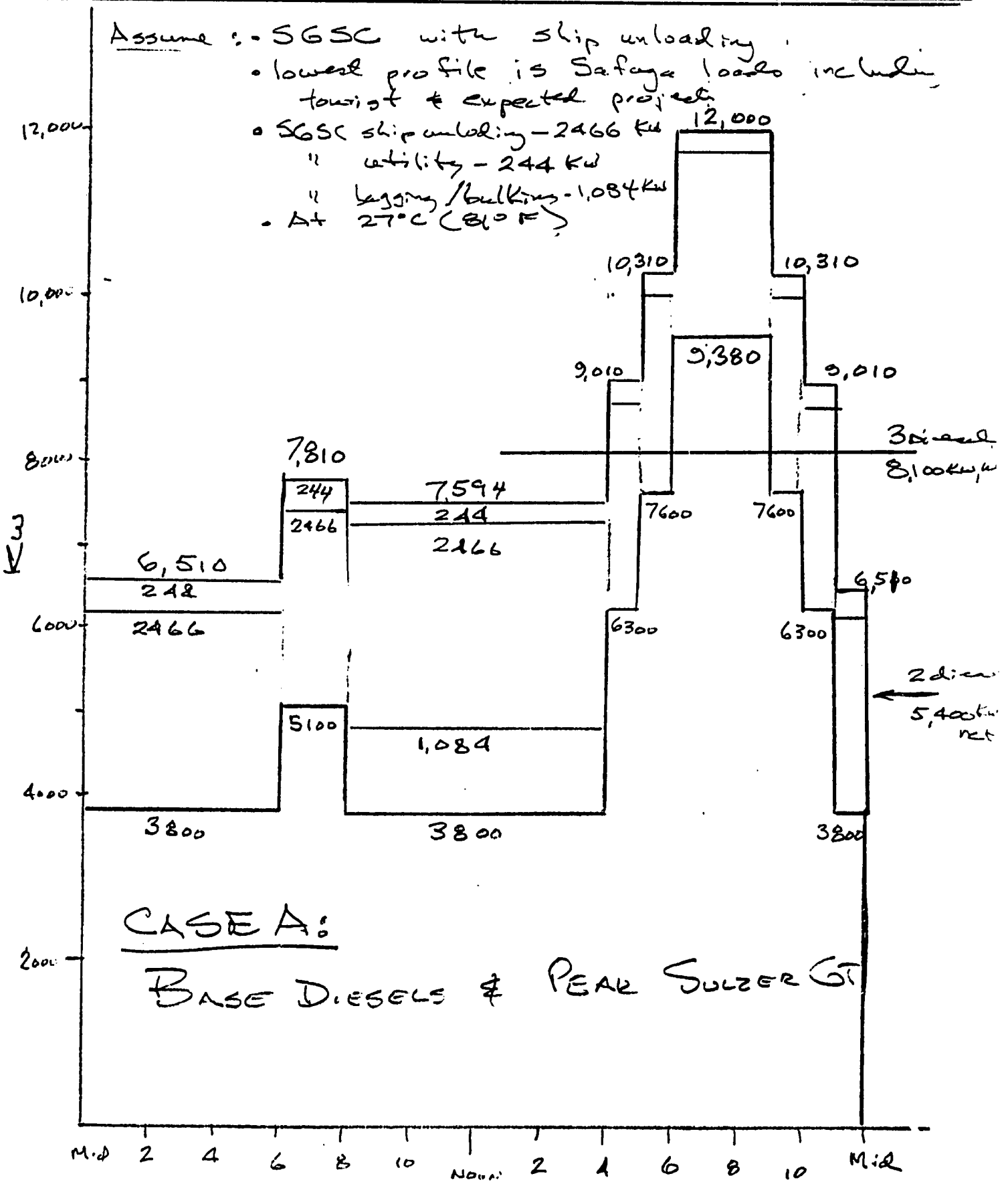
Date

Project USAID/IQC - Egypt SGSC

Comp. by V.K.

Subject Load Factors - Case A - with SGSC ship unloading

Ch'd. by



LARAMORE, DOUGLASS & POPHAM

Job No. 972-C
Project USAID/IQC – Egypt SGSC
Subject Load Factors – Case A – with SGSC ship unload –

Sheet 3 of 14
Date
Comp. by V.K.
Ch'd. by

Diesels

6 hrs	@	6,510 kw	39,060 kw hr
2	@	7,810	= 15,620
8	@	7,594	= 60,752
7	@	8,100	= 56,700
1	@	6,510	= 6,510
24 ✓			178,642 kw-hr

$$L.F. = \frac{178,642 \text{ kw hr}}{8,100 \times 24 \text{ hrs}} = 91.9\%$$

Peak Sulzer 6.7

2 hr × (9,010 – 8,100) = 1,820 Kwh-hrs

2 hr. (10,310 – 8,100) = 4,420

3 hr (12,000 – 8,100) 11,700

17,940 Kwhrs

$$L.F. = \frac{17,940 \text{ Kw-hrs}}{6 \text{ hrs} \times 3,990 \text{ kw}} = 74.9\%$$

LARAMORE, DOUGLASS & POPHAM

Sheet 4 of 14

Job No. 972-C

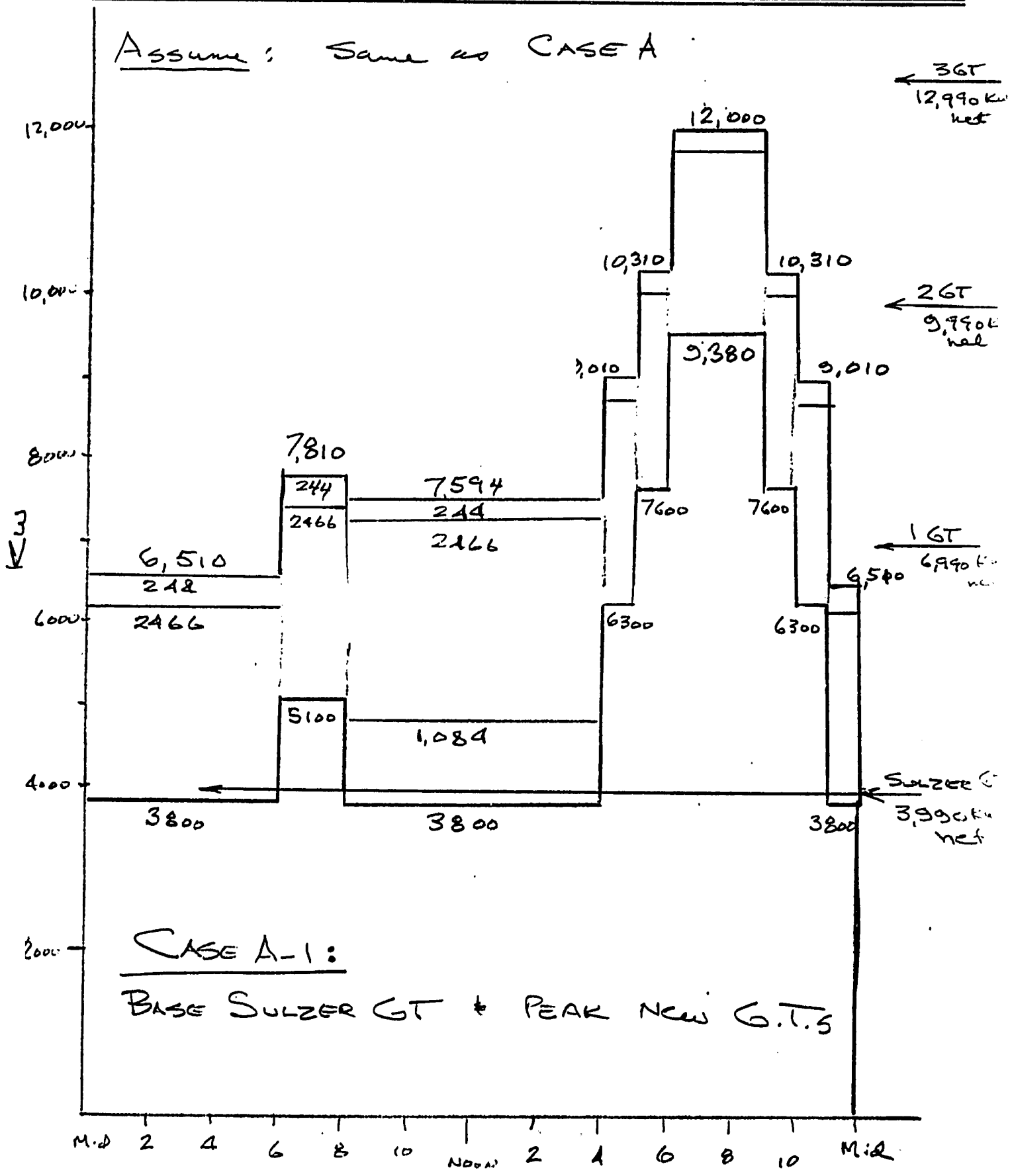
Date

Project USAID/IQC - Egypt SGSC

Comp. by V. K.

Subject LOAD FACTORS - CASE A-1 - with SGSC ship unloading

Ch'd. by



CASE A-1:

BASE SULZER GT + PEAK NEW G.T.S

LARAMORE, DOUGLASS & POPHAM

Sheet 5 of 14

Job No. 972-C

Date

Project USAID/IQC - EGYPT SGSC

Comp. by V.K

Subject Load Factors - Case A-1 - with SGSC ship unloading

Ch'd. by

NEW G.T.S

6 hrs × (6,510 − 3,990)	=	15,120	1 GT
2 hrs × (7810 − 3,990)	=	7,640	2 GT
8 hrs × (7,594 − 3990)	=	28,832	2 GT
2 hrs × (9,010 − 3990)	=	10,040	2 GT
2 hrs × (10,310 − 3,990)	=	12,640	3 GT
3 hrs × (12,000 − 3,990)	=	24,030	3 GT
1 hrs × (6,5100 − 3,990)	=	2,520	1 GT
24 hrs		100,822 Kwhrs	

$$LF = \frac{100,822 \text{ Kw-hrs}}{(7\text{hrs} \times 3,000\text{Kw}) + (12\text{hrs} \times 6,000\text{Kw}) + (5\text{hrs} \times 9,000\text{Kw})}$$

$$= 73.1\%$$

SULZER GT

24 hrs @ 3,990 Kw = 95,760 Kw hrs at 100% L.F.

$$\text{OVERALL LF} = \frac{100,822(.731) + 95,760(1.00)}{100,822 + 95,760}$$

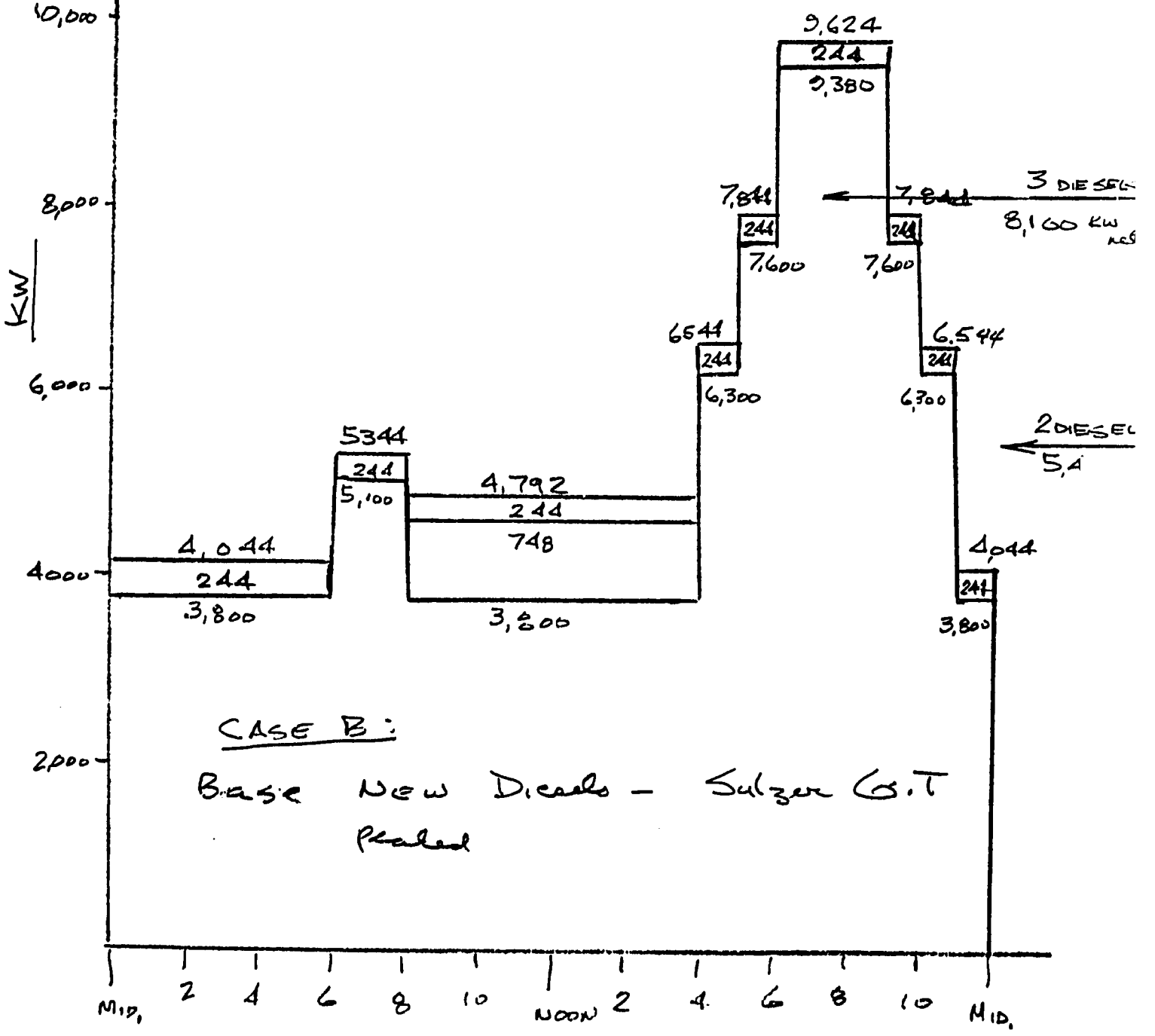
$$= 86.2\%$$

LARAMORE, DOUGLASS & POPHAM

Job No. 972-C
Project USAID/IQC - Egypt SGSC
Subject LOAD FACTORS - CASE B - with no SGSC ship unloading

Sheet 6 of 14
Date
Comp. by V.K.
Ch'd. by

ASSUME:
- No ship unloading at SGSC
- lowest profile is. Safaga loads including tourist & expected projects
- SGSC utilities - 244 kw
  " bagging/bulking - 748 kw
- At 27°C (81°F)



LARAMORE, DOUGLASS & POPHAM

Job No. 972-C
Project USAID/IQC - Egypt SGSC
Subject Load Factors - CASEB - with No ship unloading

Sheet 7 of 14
Date
Comp. by V.K.
Ch'd. by

DIESELS:

7 hrs × 4,044 kw = 28,308 — 2 die

2 hrs × 5,344 kw = 10,688 — 2 D

8 hrs × 4,792 kw = 38,336 — 2D

2 hrs × 6,544 kw = 13,088 — 3 D

2 hrs × 7,844 kw = 15,688 — 3D

3 hrs × 8,100 kw = 24,300 — 3D

130,408

$$L.F. = \frac{130,408}{(17 \text{ hrs} \times 5400) + (7 \text{ hrs} \times 8,100)} = 87.8$$

PEAKING SULZER GT:

3 hrs × (9,624 − 8,100) = 4,572 kw

$$L.F. = \frac{4,572}{3 \text{ hrs} \times 3,990} = 38.2\%$$

LARAMORE, DOUGLASS & POPHAM

Sheet 8 of 14

Job No. 972-C

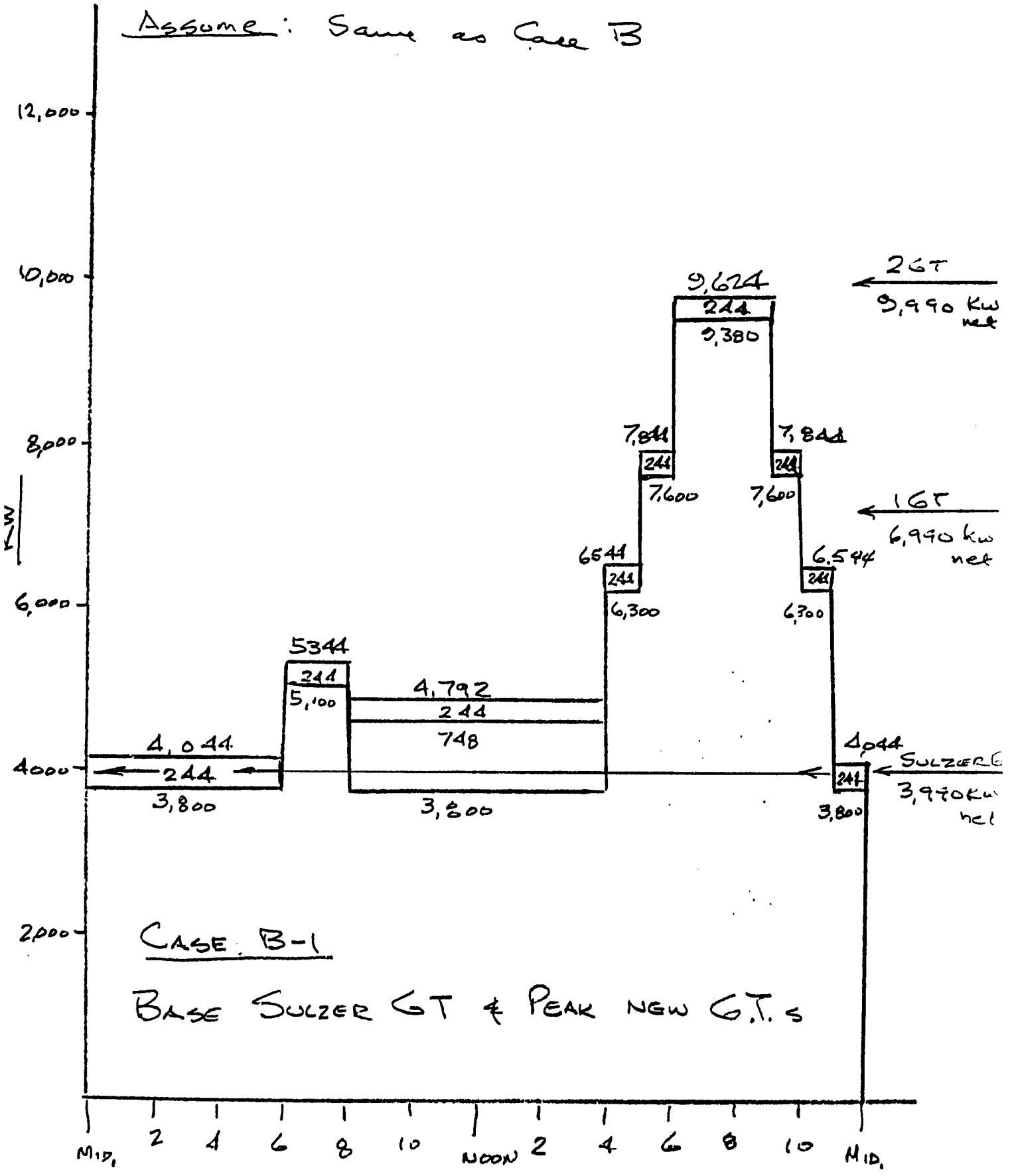
Date

Project USAID / IQC - Egypt SGSC

Comp. by V.K.

Subject Load Factors - Case B-1 - with No SGSC ship unloading

Ch'd. by



LARAMORE, DOUGLASS & POPHAM

Job No. 972-C
Project USAID/IQC - Egypt SGSC
Subject Load Factors - Case B-1 - with No ship unloading

Sheet 9 of 14
Date
Comp. by V.K.
Ch'd. by

NEW G.T.S :

7 hrs (4,044 - 3,990) Kw = 378 Kwh, 6T

2 hrs. (5,344 - 3,990) kw = 2,708 1 GT

8 hrs (4,792 - 3,990) Kw = 6,416 1 GT

2 hrs. (6,544 - 3,990) Kw = 1 GT

2 hrs (7,844 - 3,990) Kw = 7,708 2 GT

3 hrs (9,624 - 3,990) kw = 16,902 2 GT

24 hrs 39,820 Kwhr

$$L.F. = \frac{39,820 \text{ Kwhr}}{19(3,000) + 5(6000)} = 45.8\%$$

Sulzer G.T. :

24 hrs @ 3,990 kw = 95,760 kwhr @ 100% L.

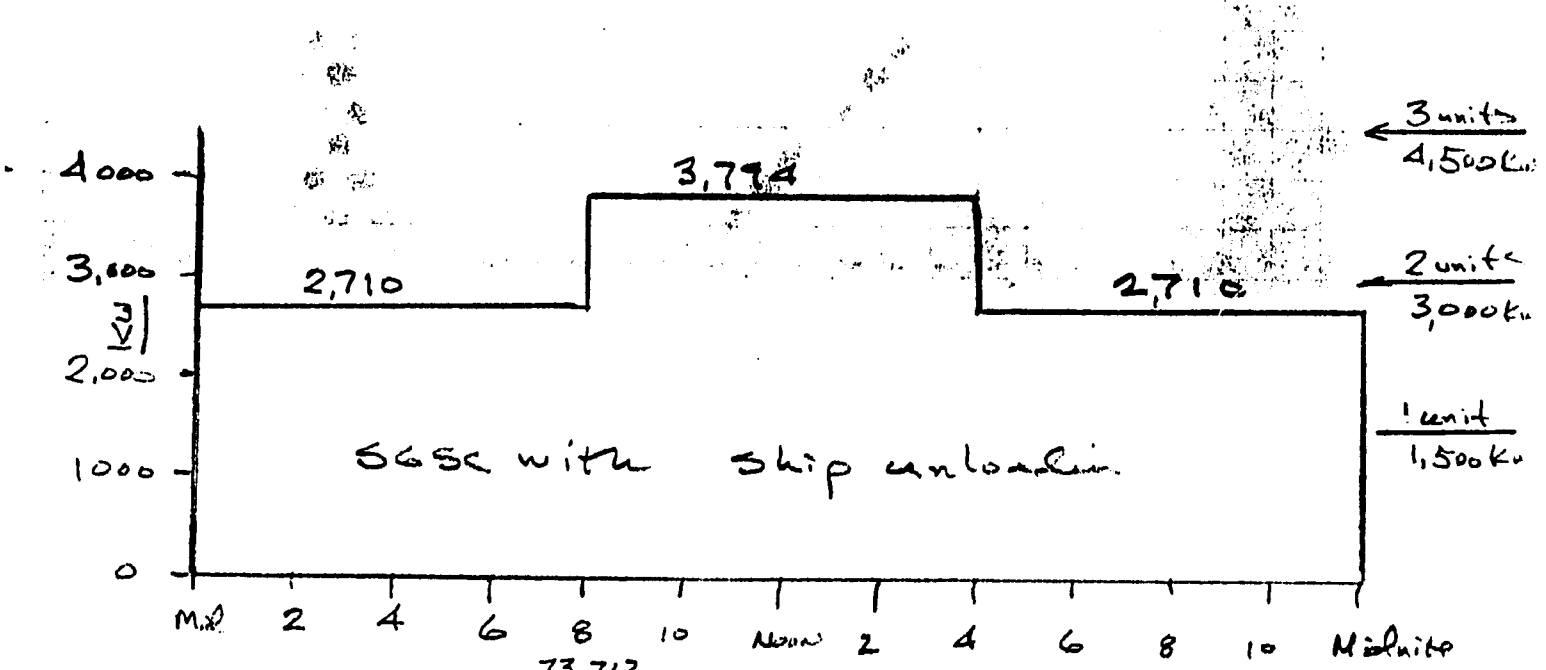
$$\text{Overall } L.F. = \frac{39,820 \text{ Kwhr} \times 0.458 + 95,760 \times (1.0}{39,820 \text{ Kwhr} + 95,760 \text{ Kwhr}}$$

84.1%

LARAMORE, DOUGLASS & POPHAM

Sheet 10 of 14
Date
Comp. by V.K.
Ch'd. by

Job No. 972-C
Project USAID / IQC - Egypt SGSC
Subject Load Factors - SGSC plant on its own



$$L.F. = \frac{16(2710) + 8(3,744)}{16(3000) + 8(4,500)} = 87.8\ \%$$

73,712

OVERALL

with unloading —

24 weeks × 6 days × 73,712 kw = 10.6×10^6 × .878 = 9.3×10^6

W/O unloading -

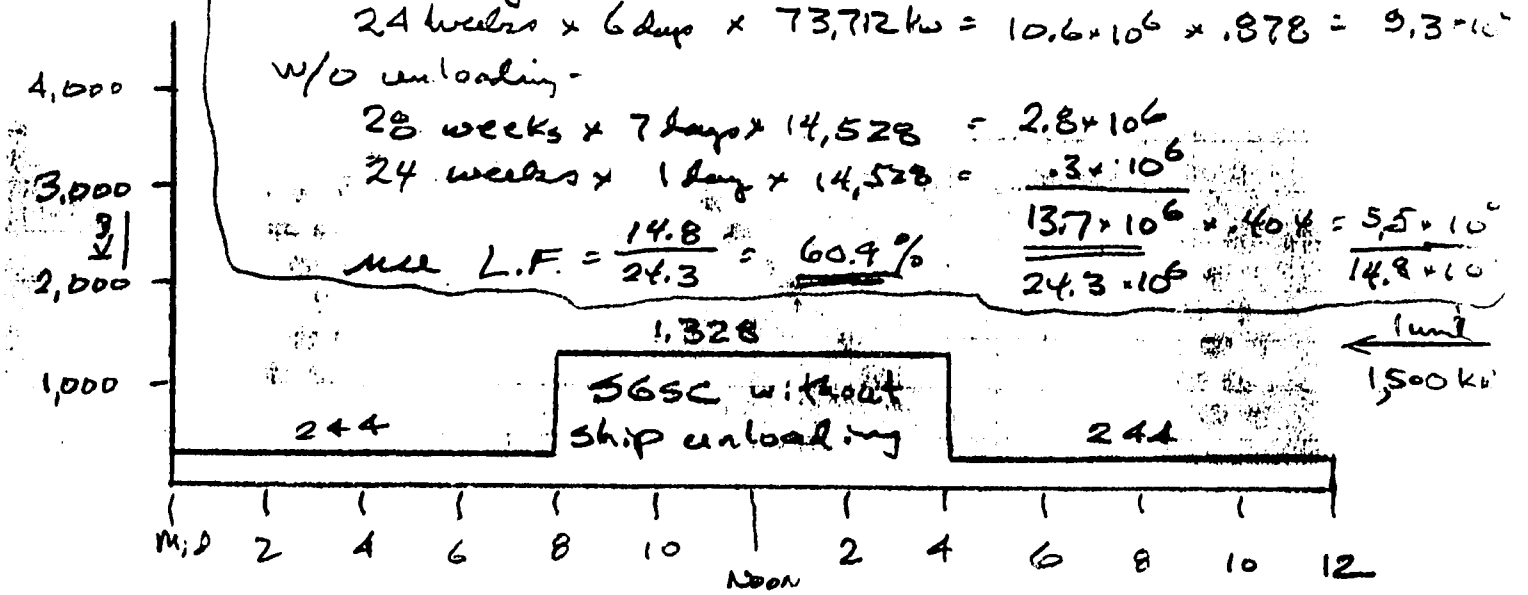
28 weeks × 7 days × 14,528 = 2.8×10^6

24 weeks × 1 day × 14,528 = $.3 \times 10^6$

13.7×10^6 × .60 % = 5.5×10^6

24.3×10^6 14.8×10^6

use L.F. = $\frac{14.8}{24.3}$ = 60.4 %



$$LF = \frac{16(244) + 8(1328)}{24 \times 1500\ kw} = 40.4\ \%$$

14,528

(6)

LARAMORE, DOUGLASS & POPHAM

Sheet 11 of 14

Job No. 972-C

Date

Project USAID / IQC - EGYPT SGSC

Comp. by V.K.

Subject LOAD FACTORS - SGSC interconnected with EEA

Ch'd. by

• SGSC interconnected with EEA

with ship unloading - 24 weeks × 6 days = 144

w/o ship unloading - 28 weeks × 7 days = 196

24 weeks × 1 day = 24 — 220

364

WITH DIESELS as ADDITIONS

			$\times 10^6$			$\times 10^6$
A.	Diesels - 144 days × 178,642 kw	=	25.7	× .913	=	23.4
B.	220 × 130,408	=	28.7	× .878	=	25.2
			54.4			48.8

L.F. overall diesels = 48.8/54.4 = 90%

diesel portion = 54.4 / (54.4 + 3.6) = 94%

A	SULZER GT - 144 × 17,940	=	2.6	× .749	=	1.9
B	220 × 4,572	=	1.0	× .382	=	0.4
			3.6			2.3

L.F. overall Sulzer GT = 2.3/3.6 = 64%

existing Sulzer GT portion = 3.6 / (54.4 + 3.6) = 6%

WITH GTS as ADDITIONS: (all are GT.)

			$\times 10^6$			$\times 10^6$
A-1.	New GTs - 144 days × 100,822	=	14.5	× .731	=	10.6
B-1.	220 days × 39,820	=	87.6	× .458	=	40.1
			102.1			50.7

L.F. overall new G.T. = 50.7/102.1 = 50%

portion = 102.1 / (102.1 + 34.9) = 75%

A-1	SULZER GT - 144 days × 95,760	=	13.8	× 1.000	=	13.8
B-1	220 days × 95,760	=	21.1	× 1.000	=	21.1
			34.9			34.9

L.F. overall Sulzer GT = 100%

portion = 34.9 / (102.1 + 34.9) = 25%

L.F. overall GT & Sulzer = (102.1(.5) + 34.9(1.00)) / (102.1 + 34.9)

= 63%

LARAMORE, DOUGLASS & POPHAM

Job No. 972-H
Project USAID/IQC - EGYPT SGSC
Subject YEARLY KWH USAGE — 1990

Sheet 12 of ____
Date ____
Comp. by V.K.
Ch'd. by ____

With SGSC interconnected to EEA.

From Sect. IV-B, total energy load = 60,345,400 kwhrs.

With diesels as additions:

Diesels = 60,345,400 kwhr × .94 = 56.7×10^6 kwhr at 90° L.F

Existing Sulzer GT = 60,345,400 × .06 = 3.6×10^6 kwh at 64° L.

• With GTs as additions:

New GT = 60,345,400 kwhr × .75 = 45.3×10^6 kwh at 50% L.F

Existing Sulzer GT = 60,345,400 kwhr × .25 = 15.0×10^6 kwh at 100% L.

SGSC on its own:

From Table 2:

total energy load = 15,644,800 kva-hrs × 0.8
= 12.5×10^6 kwhr at 61% L.F.

LARAMORE, DOUGLASS & POPHAM

Job No. 972C
Project USAID/IOC - Egypt SGSC
Subject Diesel vs. Gas Turbine Additions

Sheet 13 of ____
Date ____
Comp. by V.K.
Ch'd. by ____

SGSC on its own — 1990 load

- 12.5 × 10^6 kwhr / year
- Fuel taken as \$ 3/ 10^6 btu
  (difference between residual for diesel firing and higher cost of distillate for gas turbine firing ignored).
- Diesel O&M = \$.0072 for residual oil; GT = \$0.0062 for #2 oil
- Yearly load factor = 61% see sheet 10

YEARLY COSTS

Diesel additions:

Fuel Cost:
= 12.6 × 10^6 kwhr/yr × 10,300 btu/kwh × \$3.00/10^6 btu = \$389,340

O&M Cost:
= 12.6 × 10^6 kWhr/yr × \$0.0072/kWh = 90,720

Total/year = \$480,060

\$/kwh = 0.0381

Gas Turbine Additions:

Fuel Cost:
= 12.6 × 10^6 kWhr/yr × 19,500 btu/kwh × \$3.00/10^6 btu = 737,100

O&M Cost
= 12.6 × 10^6 kWhr/yr × \$0.0062/kwh = 78,120

Total/year = 815,220

\$/kwh = 0.0647

LARAMORE, DOUGLASS & POPHAM

Job No. 972-C
Project USAID / IQC – Egypt SGSC
Subject DIESEL vs GAS TURBINE ADDITIONS

Sheet 14 of 14
Date
Comp. by VK
Ch'd. by

SGSC interconnected with EEA – 1990 load

- Yearly loads and load factors from sheet 12
- fuel taken as \$3.00/10^6 btu
- Diesel O&M = \$0.0072/kwh ; G.T. O&M = \$0.0062

YEARLY COSTS

Diesel Additions:

- Diesels – Fuel
  = 56.7 × 10^6 kwhr × 9,816 btu/kwh × \$3.00/10^6 btu = 1,669,702
- Existing Sulzer GT – Fuel
  = 3.6 × 10^6 kwhr × 19,250 × \$3.00 = 207,900
- Diesels O&M = 56. × 10^6 kwhr × \$0.0072 = 408,240
- Existing Sulzer GT O&M = 3.6 × 10^6 kwhr × 0.0062 = 22,320

Total/year = 2,308,162
¢/kwh = 0.0383

Gas Turbine Additions

- New G.T.s
  = 45.3 × 10^6 kwh × 20,596 btu/kwh × \$3.00/10^6 btu = 2,798,996
- Existing Sulzer G.T.
  = 15.0 × 10^6 kwh × 15,084 × \$3.00 = 678,780
- O&M = 60.3 × 10^6 kwh × \$0.0062 = 373,860

Total/year = 3,851,636
¢/kwhr = 0.0639

EXHIBIT 4

Minutes - Environmental Scoping Session
Cairo, March 3, 1986

ENVIRONMENTAL SCOPING SESSION
CAIRO - MARCH 3, 1986

(A) Purpose of the Meeting

This meeting was held to conduct a scoping session on the environmental aspects of the activity.

(B) Attendees:

(1)	Dr. Ahmed Abdel Moneim Sarhan	Ministry of Health
(2)	Eng. Ahmed Shams El-Deen	MSBA, MOS
(3)	Eng. Ibrahim Khattab	EEA, MOE
(4)	Eng. Anwar Hebia	EEA, MOE
(5)	Eng. Maher Bedrous	EEA, MOE
(6)	Mr. John Coffen	Gilbert/Commonwealth, Inc.
(7)	Mr. John Starnes (part time)	USAID, UAD
(8)	Mr. Thomas A. Pearson	USAID, ID
(9)	Mr. John Hunt	USAID, ID
(10)	Mr. Bob Johnson (part time)	USAID, ID
(11)	Mr. Tawfik Kamal	USAID, ID

(C) Minutes of Meeting

(1) Mr. Coffen started the meeting by addressing the environmental aspects of the activity. He said the following:

- the type of engine is proposed to be either a gas turbine or a diesel and both of these are air cooled.
- the only contimination that is going to occur is air contamination from the exhaust of the engine.
- the area is virgin with no industry and the only existing products of combustion are those of automobiles, the existing power plant and the future additions when completed.
- the winds in the area are very strong and do blow from all directions which limit the possibility of any pollution concentration.

He said that due to these reasons he recommended that this plant be exempted from any environmental restrictions.

(2) Dr. Sarhan asked if the units will have any liquids discharged into the sea. Mr. Coffen told him that gas turbines and diesel engines do not utilize water for cooling and therefore there will be no discharge into the sea water.

(3) Dr. Sarhan asked about the fuel that is going to be used. Mr. Coffen said that it is going to be Solar, (a form of No. 2 oil) which includes sulfur of 1 percent that will be emitted in the exhaust gases along with ash.

(4) Dr. Sarhan asked why natural gas could not be used as a fuel. Mr. Ibrahim Khattab told him that according to information he had there is no possibility, even in the near future, to extend a gas pipeline to this area.

(5) Eng. Bedrous said that Egypt accepts the US EPA Standards which are less conservative than the Egyptian Standards (TAB A) on air pollution. He said also that Egyptian Standards have to be used only in cases that are not covered by the EPA.

(6) Mr. Hunt asked Mr. Coffen about the environmental impact of construction. Mr. Coffen said that there is a residential area located at about 50 to 100 ft from the existing power station. He said that only two sources of pollution will exist: dust pollution due to excavation and concrete pouring, and noise pollution. He said that since this is a desert area in which blowing sand is a normal occurence, dust pollution can be neglected. He said also that the construction period is going to be very short, not more than 4 months, since the units are going to be of the package type. As for the noise pollution he said that noise pollution is not applicable in Egypt. He said that the existing gas turbines are producing noise during operation. Mr. Heiba said that EEA normal practice limits the noise pollution to 60 decibels at one hundred meters from the source.

TAB A

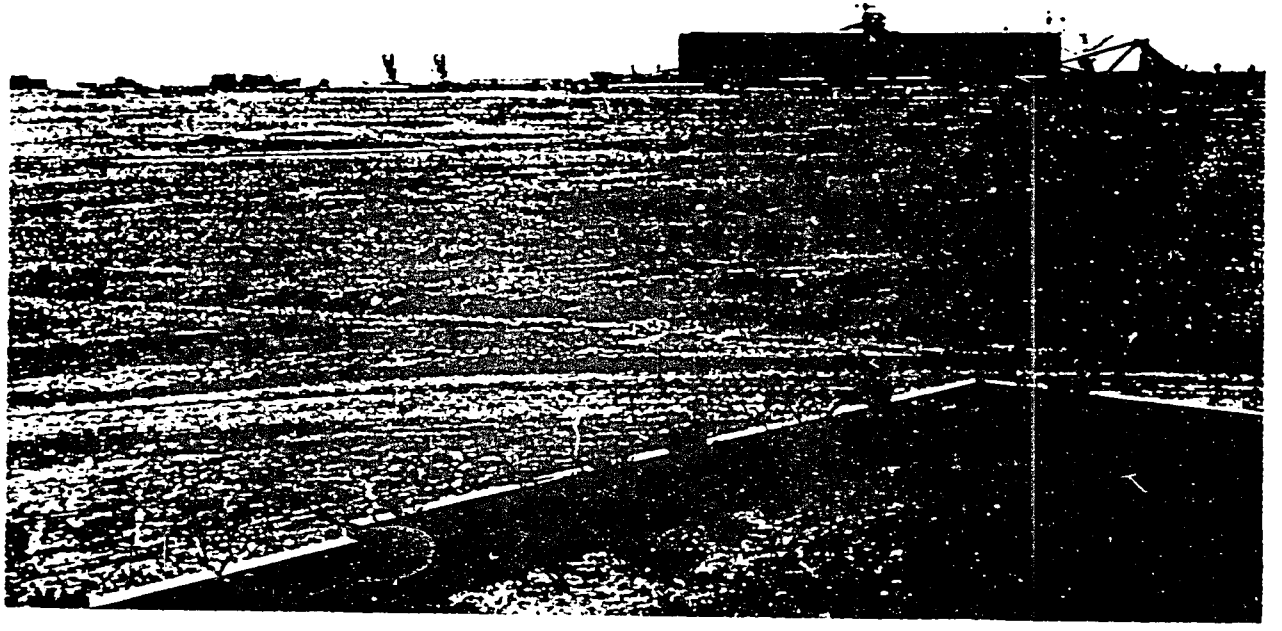
Egypt Standards

	Period	Max. Allowable Concentrations
SO_2	24 hr	200 MG/M3
	Annual	60
NO_2	24 hr	200
	Annual	-
Susp. Part.	24 hr	150
	Annual	-

EXH.4
VK/LL

EXHIBIT 5

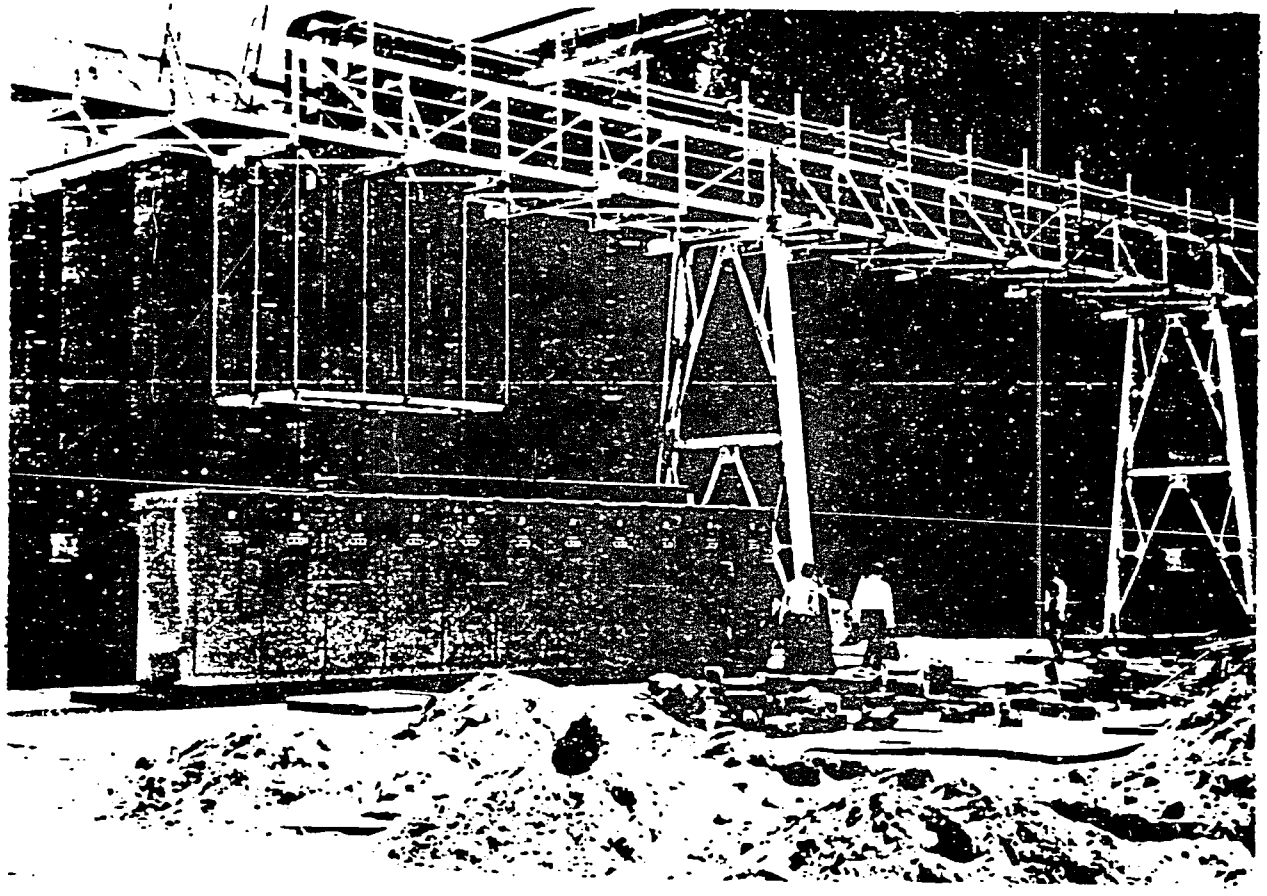
Site Photographs at Safaga



2/25/86

Safaga Grain Silo Complex

(Cone-shaped structure on right is nearby bauxite ore unloading facility.)
(Curbing in foreground is corner of EEA's Safaga generating plant)

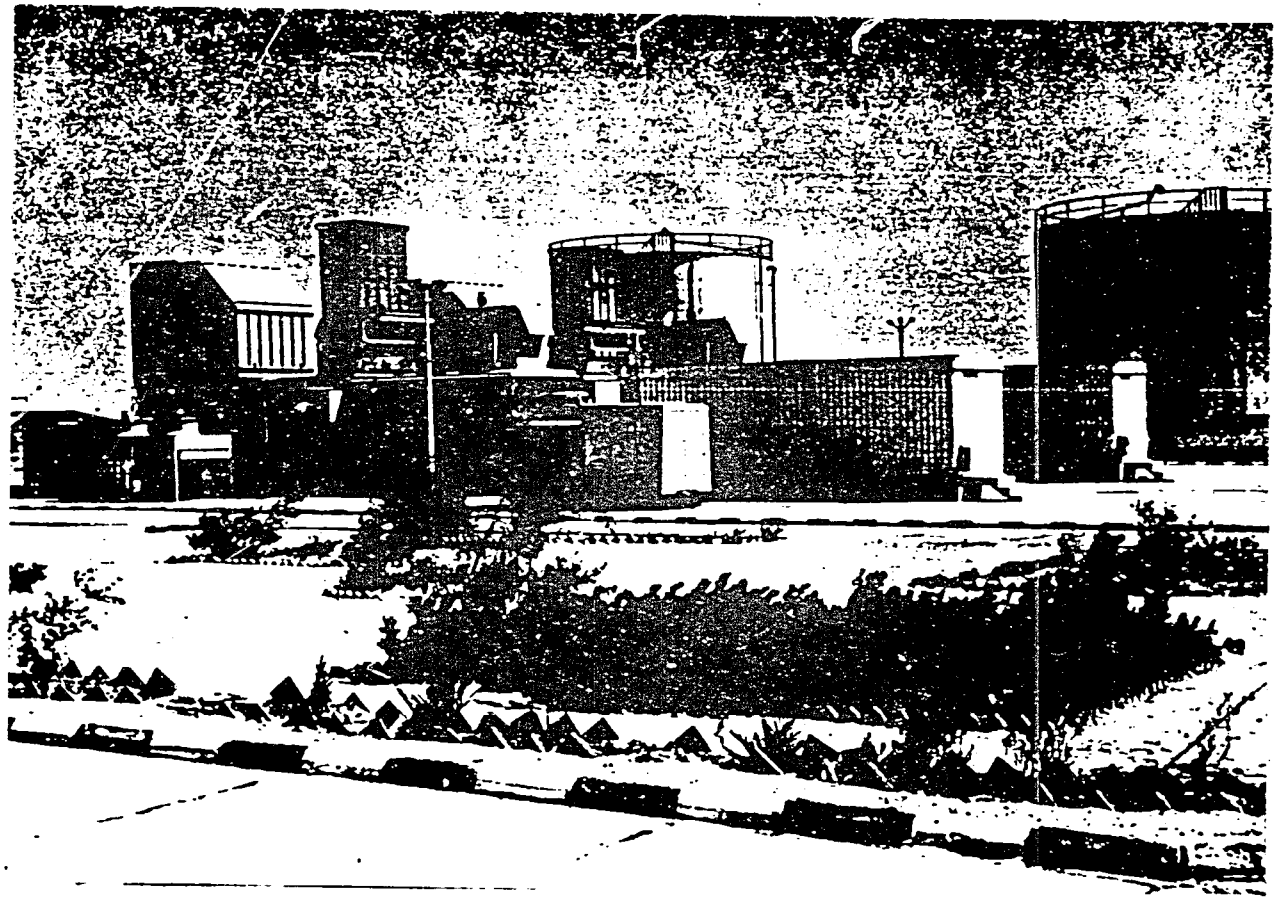


2/25/86

Safaga Grain Silo Complex

Electrical Switchgear
(The incoming EEA connection may be seen on the ground in lower right handed portion of picture).

77

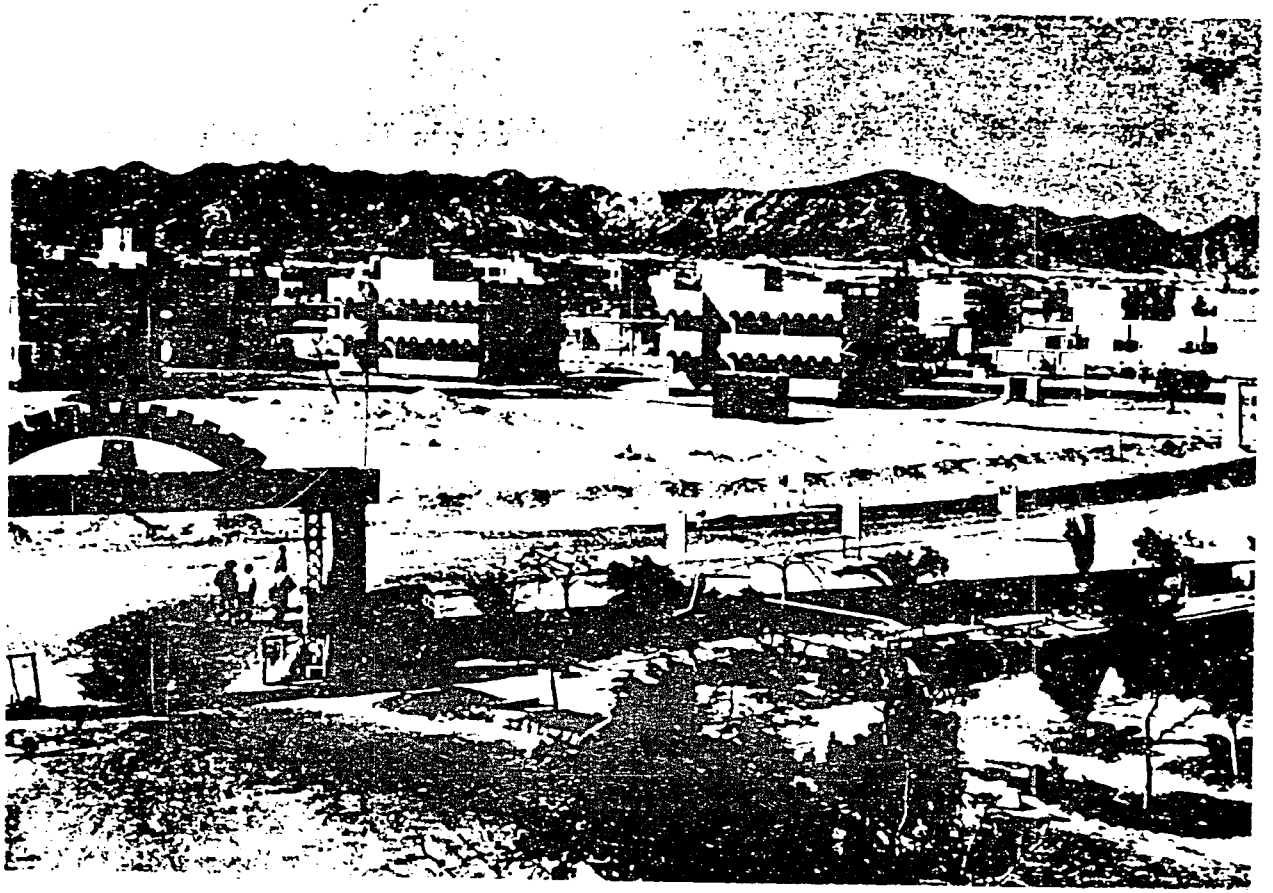


2/25/86

EEA Facilities at Safaga

Two 5,000 kW Sulzer dual-fuel gas turbines.

78

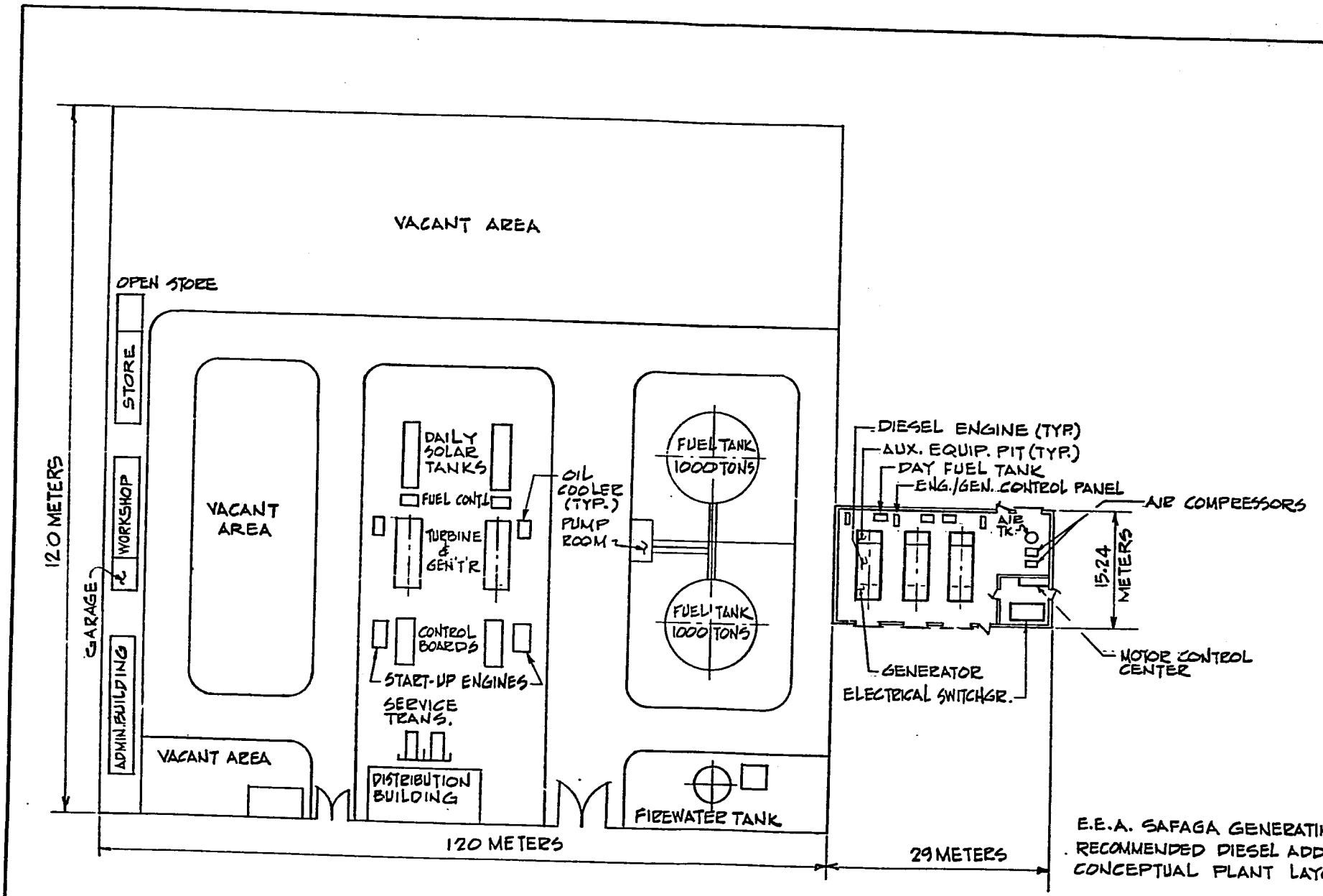


2/25/85

Town Of Safaga

Looking inland from Safaga Hotel

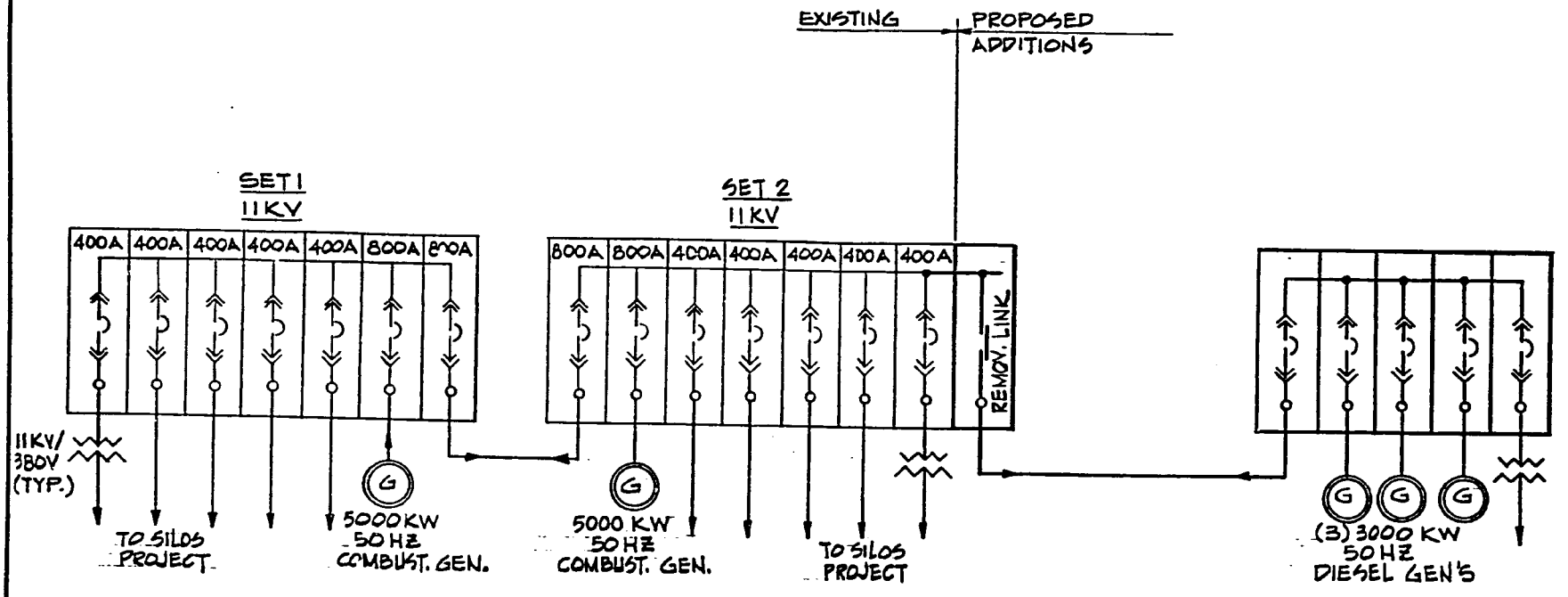
EXHIBIT G



E.E.A. SAFAGA GENERATING PLANT
RECOMMENDED DIESEL ADDITIONS
CONCEPTUAL PLANT LAYOUT

LARAMORE, DOUGLASS AND POPHAM

EXHIBIT 7



E.E.A. SAFAGA GENERATING PLANT
RECOMMENDED DIESEL ADDITIONS
CONCEPTUAL ONE LINE DIAGRAM

LARAMORE, DOUGLASS AND POPHAM