BIBLIOGRAPHIC DATA SHEET	1. CONTROL NUMBER PN-AAJ-184	2. [illegible]

3. TITLE AND SUBTITLE (240)

Review and analysis of load projections for Egyptian power supply; final report

4. PERSONAL AUTHORS (100)

5. CORPORATE AUTHORS (101)

Sanderson & Porter, Inc.

6. DOCUMENT DATE (110)	7. NUMBER OF PAGES (120)	8. ARC NUMBER (170)
1975	161p.	EG621.31.S216a

9. REFERENCE ORGANIZATION (130)

SP

10. SUPPLEMENTARY NOTES (500)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

Egypt
Electric power
[illegible]
[illegible]stations

Power transmission
Electric power generation
Distribution systems
Electric power plants

13. PROJECT NUMBER (150)

14. CONTRACT NO(S) (140)

AID/[illegible]

EG
621.31
S216a

PN-AAJ-

REPORT ON REVIEW AND ANALYSIS OF LOAD PROJECTIONS FOR EGYPTIAN POWER SUPPLY

NOVEMBER 1975

جمهورية مصر العربية

INTERNATIONAL DEVELOPMENT

SANDERSON & PORTER, INC.

ENGINEERS - CONSTRUCTORS - MANAGEMENT CONSULTANTS

25 BROADWAY, NEW YORK, N. Y. 10004

November 26, 1975

Technical Project Director, NE/CD
Agency For International Development
Washington, D.C. 20523

Attn: Mr. Thomas A. Sterner

AID Requirements Contract No. AID/otr-C-1305
Work Order No. 3
Review and Analysis of Load Projections and
Construction Plans for Egyptian Power Supply
Final Report
S&P J/O 4954

Gentlemen:

In accordance with the instructions contained in Part IV A of Work Order No. 3 of contract AID/otr-C-1305, enclosed please find ten (10) copies of the Final Report covering findings, recommendations and conclusions of a review and analysis of the power load projections and construction plans for the Egyptian power supply.

It has been a pleasure to undertake this Egyptian Power Study and we trust that such study has been completed to your

satisfaction. We will be glad to review this study with you at your convenience after you have had time to examine it.

Very truly yours,

SANDERSON & PORTER, INC.

A. H. Ferber

A. H. Ferber
Manager of Consulting Engineering

JAS:bah

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FINAL REPORT

REVIEW AND ANALYSIS
OF
LOAD PROJECTIONS
FOR
EGYPTIAN POWER SUPPLY

ENGINEERING SERVICES
FOR
AGENCY FOR INTERNATIONAL DEVELOPMENT
WORK ORDER NO. 3
UNDER
REQUIREMENTS CONTRACT NO. AID/otr-C-1305

NOVEMBER 26, 1975

SANDERSON & PORTER, INC.
NEW YORK, NEW YORK

TABLE OF CONTENTS

		PAGE NO.
INTRODUCTION		7
CONCLUSIONS & RECOMMENDATIONS		9
1.0	THE GENERAL EGYPTIAN ELECTRICITY CORPORATION	17
1.1	Company Description and Organization	17
1.2	Principal Officers	19
1.3	Financial Organization	19
1.4	Balance Sheet and Statement of Income	20
2.0	EXISTING INTEGRATED POWER SYSTEM	21
2.1	General Description	21
2.2	Existing Generating Plants	22
2.3	Useable Generating Capacity	25
2.4	Existing Transmission and Distribution System	27
2.5	Load Characteristics	29
2.6	System Operations	31
2.7	System Maintenance and Unscheduled Outages	33
2.8	Planned Generating Unit Retirements	34
3.0	PEAK LOAD AND GENERATION FORECASTS	36
3.1	Long Range Load Forecast for Twenty-five Year Period	36
3.2	Generation Planning by the GEEC for Twenty-five Year Period	39
3.3	Major Types of Generation	43
3.4	Short Range Load Forecast Analysis for Helwan and Talka Generation Requirements	53

TABLE OF CONTENTS (Cont'd)

		PAGE NO.
3.5	Short Range Load Forecast Analysis for Ismailia Generation Requirements	60
4.0	TRANSMISSION AND DISTRIBUTION EXPANSION	63
4.1	Transmission Expansion	63
4.2	Computerized National Energy Control Center	65
4.3	Distribution Expansion	66
5.0	PROPOSED ISMAILIA STEAM PLANT	68
5.1	Site Description	68
5.2	Fuel	69
5.3	Plant Design	70
5.4	Transmission and Substations	73
5.5	Alternate Arrangement of Switch-yards	74
5.6	Staffing	74
6.0	PROPOSED HELWAN COMBUSTION TUR-BINE PLANT	76
6.1	Site Description	76
6.2	Fuel	76
6.3	Plant Design	77
6.4	Transmission and Substations	79
6.5	Alternate Design	80
6.6	Staffing	81
7.0	PROPOSED TALKA COMBUSTION TUR-BINE PLANT	83
7.1	General	83
7.2	Recommendations	84

TABLE OF CONTENTS (Cont'd)

		PAGE NO.
8.0	COMMENTS ON THE GEEC SPECIFICATIONS FOR THE ISMAILIA AND HELWAN PLANTS	85
	8.1 Specifications for the Ismailia Steam Power Plant	85
	8.2 Specifications for the Helwan Combustion Turbine Plant	91
9.0	PROJECT ENGINEERING, DESIGN. PROCUREMENT AND CONSTRUCTION	95
	9.1 Engineering Services	95
10.0	PROJECT COST ESTIMATES & CONSTRUCTION SCHEDULES	98
	10.1 Basis of Cost Estimates	98
	10.2 Summary of Costs	102
	10.3 Construction Schedules	103
11.0	PROJECT ECONOMIC JUSTIFICATION	105
	11.1 General	105
	11.2 Present Rate Structure of the GEEC	105
	11.3 Estimated Power Production Costs	107
	11.4 National Economic Benefits	108

LIST OF EXHIBITS, CURVES AND TABLES

EXHIBIT NOS.	DESCRIPTION
1-1	Organization Chart of the Ministry of Electricity
1-2	Organization Chart of the General Egyptian Electricity Corporation
1-3	Members of the Board of Directors of the GEEC
1-4	Principal Officers of the General Egyptian Electricity Corporation
1-5	Detailed Balance Sheet 1968-1974
1-6	Summary of Balance Sheet 1968-1974
1-7	Source and Application of Funds 1968-1974
1-8	Summary Income Statement 1968-1974
2-1	The Egyptian Power System - One Line Diagram
2-2	Typical Daily Load Curve
3-1	Ministry of Power, Water and Thermal Generation Curves to Meet the Integrated Electric Network Loads Up to the Year 1985
3-2	New Large Loads
3-3	Installed and Available Generation
3-4	Summary of Daily Available Generation and Forecasted Loads - Dry Season of the Nile
4-1	Load Flow Diagram - GEEC Electric Power System 1982-1983
5-1	Ismailia Power Station Site
5-2	Natural Gas Specifications
5-3	Mazout Fuel Specifications
5-4	Ismailia Power Station Plan
5-5	Ismailia 300 MW Thermal Power Plant - One Line Electrical Diagram
5-6	Ismailia Thermal Plant - Operation and Maintenance Personnel
5-7	Ismailia Plant Organization Chart

LIST OF EXHIBITS, CURVES AND TABLES (Cont'd)

EXHIBIT NOS.	DESCRIPTION
6-1	Natural Gas from Abu Gharadig Field
6-2	Gas Oil (Solar Oil)
6-3	Helwan Combustion Turbine Power Plant - One Line Electrical Diagram - GEEC Proposed Plant
6-4	Helwan Combustion Turbine Power Plant - One Line Electrical Diagram - Unit Arrangement Concept
10-1	Helwan Combustion Turbine Plant Construction Costs
10-2	Ismailia Steam Power Plant Construction Costs
10-3	Construction Schedule - Ismailia Thermal Power Plant
10-4	Construction Schedule - Helwan Combustion Turbine Plant
11-1	Average Electric Tariffs by Categories of Consumers
11-2	GEEC Electric Tariff Rates
11-3	S&P Production Costs for Ismailia Power Plant
11-4	S&P Production Costs for Helwan Power Plant

CURVE NOS.	
3-1	Estimated Peak Loads and Proposed Generation Expansion Program
3-2	Proposed Generation Expansion Program by Types
3-3	Proposed Installed Generation Expansion Program - Types by Percent

TABLE NOS.	
2-1	Existing Generating Stations
2-2	List of Major Substations
2-3	Peak Load and Annual Energy Consumption by Zone

LIST OF EXHIBITS, CURVES AND TABLES (Cont'd)

TABLE NOS.	DESCRIPTION
2-4	Planned Retirement of Generation Units
3-1	Tabulation of Useable Generating Capacity, Estimated Peak Loads, Reserve in MW and Percent - Also Reserve minus two Largest Thermal Units
3-2	Generation Capacity of GEEC System Useable Generating Capacity by Types in MW and Percentage
3-3	Tabulation of Proposed Generation Installation and Each Unit's Percentage of Systems Total Generation at Time of Installation
3-4	Short Range Load Forecast
3-5	Relationship of Reserve Margin and Peak Demand
4-1	Planned New 220 kV Transmission Lines

BIBLIOGRAPHY

INTRODUCTION

The purpose of this report is to present Sanderson's & Porter's findings and conclusions covering the General Egyptian Electricity Corporation's (GEEC) plans for the system expansion required to satisfy the anticipated load growth including certain industrial expansion projects both from a generation and transmission capability standpoint.

The general objective of the study is a review and analysis of electric power load projections and construction plans for the Egyptian power supply.

The detailed objectives of the study are:

a. Determine accuracy and sufficiency of Egyptian analysis of power demands through 1990.

b. Determine accuracy and sufficiency of corresponding plans for the GEEC construction program.

c. Make recommendations on type facility and construction timing and location of the Ismailia thermal plant.

d. Make recommendations on need for and location of additional interim combustion turbine generation.

To accomplish the above, Sanderson & Porter dispatched a three man study team to Egypt during the month of September, 1975 to confer with representatives of the GEEC and the Ministry of Electricity. The team composed of Messrs. John A. Schomaker, Team Leader, John I. Kaspari, Power System Specialist, and Frank C. Poage, Power System Specialist, arrived in Cairo on September 9, 1975. The group spent a period of approximately three weeks through October 1, 1975 in Cairo collecting background data on the present GEEC system and on the planned fu...

ture generation and transmission installations of the GEEC.

The information thus obtained was subsequently reviewed and analyzed in the New York office of Sanderson & Porter and formed the foundation for the preparation of this final report.

This report covers the GEEC's plans for construction of the Ismailia steam power plant, the Helwan combustion turbine plant and the Talka combustion turbine plant. The Talka plant was subsequently added to the scope after commencement of the study and is only briefly discussed in the report.

CONCLUSIONS AND RECOMMENDATIONS

The summary of conclusions reached in reviewing and analyzing the GEEC's planning and operation functions and more specifically in examining the economic and technical feasibility for the addition of the Helwan and Talka Combustion Turbine Plants and for the addition of the Ismailia Steam Power Plant is as follows:

1. For examination of the need for the Helwan, Talka and Ismailia plants a short range load forecast through the year 1981 was employed in this study. The forecast utilizes a six percent annual growth rate for existing loads, as the normal growth rate for the established consumers, plus fifty percent of the known new large industrial loads that will be added to the system. This method of load forecasting proved more realistic for short time forecasting due to the extensive number of large industrial loads planned to be connected into the GEEC system in the immediate future years. For a long range load forecast this approach corresponded to doubling the load in seven years on a 10.4 percent cumulative annual load growth rate. For continuation of the long range forecast the load is then assumed to double again in the next eight years, the doubling period then slowing down to nine years in 1988-1998 and then to ten years thereafter.

2. The construction of the Helwan 120 MW combustion turbine plant is recommended. An analysis using the results of the short range load forecast has shown that during the winter months of December, 1976 and January, 1977 (the dry season of the Nile) the predicted peak load will be 1867 MW and the usable generation only 2277 MW. The 120 MW of combustion turbine capacity is needed to supplement the small system reserve margin existing at this time to insure reliable operation of the Egyptian utility system especially during unexpected tripping of both 500 kV lines from the

2277
-1867
410
+120
530

High Dam and Aswan Dam hydro generation.

3. The cost estimates for construction of the Helwan combustion turbine plant are as follows:

	S&P Estimate		GEEC Estimate	
	US$	LE	US$	LE
Foreign Currency	16,128,000	6,300,000	22,272,000	8,700,000
Local Currency	2,279,000	1,281,000	3,328,000	1,300,000
Total	19,407,000	7,581,000	25,600,000	10,000,000
Cost/Kw	$162/Kw	63 LE/Kw	$213/Kw	83 LE/Kw

Exchange Rate of LE 1 = US $2.56 is used throughout this report.

4. The proposed completion date of September, 1976 for the first three 20 MW (or two 30 MW) combustion turbine units to be installed at Helwan appears unrealistic. A minimum of seventeen months will be required after the signing of a contract and establishment of an irrevocable letter of credit because of the long delivery time presently estimated at not less than sixteen months needed for the manufacture and installation of the Helwan step-up power transformers.

Transformers Delay

5. For a similar reason the date of December, 1976 for delivery of the final three 20 MW (or two 30 MW) Helwan combustion turbine units is also doubtful. Again the delivery of the step-up power transformers will be the delaying factor.

6. In view of the urgent need for the Helwan combustion turbine, the purchase of the Helwan power plant should be given a high priority. If it becomes necessary a premium price should be paid for early delivery of the Helwan plant.

7. The proposed site for the Helwan combustion turbine plant appears adequate and well chosen in view of the fact that it is adjacent to large industrial loads. However, it is recommended that consideration be given to locating the Helwan combustion turbine plant and the 66 kV switchyard on the same site and not have the installations separated by a new highway as presently planned.

8. It is recommended that an alternate quotation be requested for the Helwan combustion turbine plant utilizing a unit package approach to provide each 30 MW turbine-generator with its own 37.5 MVA step-up power transformer without any 11 kV intermediate switchgear.

9. The construction of the Talka 180 MW combustion turbine plant is recommended. Analysis has shown that during the winter months of December, 1978 and January, 1979 (the dry season of the Nile) the forecasted peak load will be 2215 MW and the usable generation only 2815 MW. The 180 MW of combustion turbine capacity is needed to supplement the small system reserve. There is also the distinct possibility that another 395 MW of expected but not yet approved large industrial load will be added to the system during 1978 which further emphasizes the urgent need for the Talka plant.

2815
2215
600 ← 27.1%!!
180
780 ← 35.3%!!

10. The cost estimates for construction of the Talka combustion turbine plant are as follows:

	S&P Estimate		GEEC Estimate	
	US$	LE	US$	LE
Foreign Currency	29,274,000	11,435,000	33,280,000	13,000,000
Local Currency	5,952,000	2,325,000	5,120,000	2,000,000
Total	$35,226,000	13,760,000	38,400,000	15,000,000
Cost/Kw	$196/Kw	76 LE/Kw	$213/Kw	83 LE/Kw

11. The proposed completion date of September, 1978 for all units to be installed at Talka appears timely. The latest date for placing a firm order for the plant would therefore be January, 1977 assuming a twenty month manufacture and construction schedule.

12. An investigation of the Talka combustion turbine plant site was not made. Since combustion turbines require a minimum of infrastructure, the site chosen by the GEEC would most probably be adequate.

13. It is recommended that the GEEC consider an alternate quotation for the Talka combustion turbine plant utilizing a unit package approach with three 60 MW combustion turbine/generators each with its own step-up transformer. By 1978 sufficient background experience will have been realized in the operation of these larger sized combustion turbines. This alternate method of purchase would reduce the overall cost of the plant.

14. It is also recommended that if timely financing can be arranged for the Talka plant that the invitation to bid for the Helwan combustion turbine plant contain a request for a price option to also purchase the Talka combustion turbine plant at the same time. This approach would reduce the overall costs for both plants.

15. The construction of both 150 MW steam units of the Ismailia power plant is recommended. However, it is also recommended that one Ismailia unit be scheduled for commercial operation before the 1981 peak season with the second unit to be scheduled for commercial operation before the 1982 peak. The second unit should be scheduled to take advantage of a continuous construction program. Analysis has shown that during the winter

Why? Usable Gen = 3953 1981 Peak = 2866

months of December, 1981 and January, 1982, the forecasted peak load will be 2900 MW and the usuable generation 3562 MW. There is also the possibility of the addition of another 582 MW of expected large industrial load which has not yet been approved by the Ministry of Industry. Other large loads will also undoubtedly develop. The third 110 MW steam unit to be constructed at the Kafr El-Dawar plant is scheduled for commercial operation in July, 1981. The GEEC also has the first 150 MW steam unit for Ismailia scheduled for commercial operation in March, 1981 with the second 150 MW steam unit scheduled for commercial operation in July 1981. From the above generation and load analysis information it was determined that while the first Ismailia unit will be needed in 1981, the second unit may not be required until 1982.

3562
29
662
150 — Less 1 unit
512
150 — Less 2 units
362 = 12.5% above loss of 2 large units

16. The cost estimates for construction of the Ismailia steam power plant are as follows:

	S&P Estimate US$	S&P Estimate LE	GEEC Estimate US$	GEEC Estimate LE
Foreign Currency	104,294,000	40,740,000	96,000,000	37,500,000
Local Currency	66,944,000	26,150,000	49,715,000	19,420,000
Total	171,238,000	66,890,000	145,715,000	56,920,000
Cost/Kw	$571/Kw	223 LE/Kw	$486/Kw	190 LE/Kw

17. The summation of S&P's estimated costs for the Helwan, Talka and Ismailia plants is as follows:

	Foreign Currency US$	Foreign Currency LE	Local Currency US$	Local Currency LE
Helwan	16,128,000	6,300,000	3,279,000	1,281,000
Talka	29,274,000	11,435,000	5,952,000	2,325,000
Ismailia	104,294,000	40,740,000	66,944,000	26,150,000
Total	$149,696,000	58,475.000	$76,175,000	29,756,000

18. The Ismailia plant site appears to be satisfactory and fulfills most of the requisites needed for the selection of a good power plant location. One of its disadvantages is that the area chosen for the plant site is relatively small and restricted for both the initial plant and for any planned future expansion of such plant. Another problem that does exist is that the plant's outfall into Lake Temsah is planned to be located in a recreational area and this location may create some difficulties. Outside of these two problems the site appears to be well chosen.

19. An examination of load flow diagrams under maximum loading conditions has shown that the existing 500 kV transmission lines and the 220 kV transmission lines seem adequate to support the present system loadings. Some system stability margins do impose an upper limit on the permissable power transmitted over the high voltage 500 kV lines but this problem should gradually diminish in the early 1980's. An inspection of the planned expansion of the 220 kV transmission system shows it sufficient to provide the required power outlets for the future known scheduled generation. Lines appear commensurately sized with sufficient additional circuits and/or loops to insure continuity of service in the case of either planned or non-scheduled line outages.

20. The GEEC has already prepared a preliminary set of tender documents for the purchase of both the Ismailia steam power plant and for the Helwan combustion turbine plant. The General Terms and Conditions for such invitations will be basically the same as those presently being utilized for the USAID financed invitation for the purchase of Distribution Equipment for the Canal Zone.

A general review has been made by the Sanderson and Porter team of both sets of specifications and lengthy discussions have been held with the GEEC personnel concerning recommended clarifications and/or changes and modifications. In general the specifications appear adequate although somewhat overdesigned. Some additional time should be utilized in rewriting several sections of the technical specifications to improve the wording and have them more closely comply with American standards.

The bidding documents for both the steam and combustion turbine plants should include a formula for the evaluation of vendor quotations covering plant output capacity and heat rates.

For the Ismailia steam power plant a study should be performed of the plant's steam conditions to optimize the performance by considering both the fixed charges and estimated fuel costs over the anticipated life of the plant.

21. At present the GEEC system contains an extensive variety of mostly European equipment (British, French, German, Czechoslovakian, Polish, Russian, etc.). Except for the Cairo West and Talka plants they have had very little experience in the operation and maintenance of American equipment. While the upper echelon of the GEEC personnel appear very capable and highly trained there appears to be a lack of depth in the organization particularly at the technician level. It is therefore recommended that additional training for such intermediate level personnel be considered.

The World Bank plans to utilize the services of a consulting firm for a general review of the GEEC system operations. Such study will last two years and includes a one and a half year phase to implement the recommendations of the study. If

an American firm were to be chosen for such a study it would afford an excellent opportunity for the introduction of modern American technology and methods of operation in the electric utility field.

22. It is recommended that the GEEC utilize the services of a consulting firm to aid the GEEC in the preparation of specifications, analysis and award of invitations, inspection and expediting of materials and general supervision of the engineering and construction phases of the Helwan, Talka and Ismailia plants.

23. The GEEC appears to be administered effectively and the team was impressed with the high technical caliber of their upper management personnel who were most cooperative in supplying all the information requested for the study.

The load forecasts and generation and transmission planning of the GEEC appears to be adequate and economically and technically sound.

It is considered that sufficient background data covering the varied phases of management, planning, technical, and economic areas has been accumulated to enable Sanderson and Porter to prepare this detailed objective final report covering a review and analysis of the electric power load projections and construction plans of the General Egyptian Electricity Corporation with particular emphasis on the Ismailia steam power plant and Helwan and Talka combustion turbine plant system expansion programs.

1.0 THE GENERAL EGYPTIAN ELECTRICITY CORPORATION

1.1 Company Description and Organization

Electric power was first introduced into Egypt in 1895. Before 1964, the generation, transmission and distribution of electric energy was in the hands of a large number of independent governmental and private organizations. In 1964, the Ministry of Electricity was organized for the purpose of consolidating all of the individual electric generating facilities into one state owned and controlled organization. The organization chart of the Ministry of Electricity is shown in Exhibit No. 1-1.

Policy for the Ministry of Electricity is made by the Minister in accordance with the overall guiding directives and needs of the country. Financing for the Ministry is included in the national budget and the annual and long range plans of the Ministry have to be approved by the Ministry of Planning after prior consultation with the Ministry of Industry. In actuality, the three ministries work jointly in the initial phases of all aspects of planning.

In addition to providing electricity for the normal residential, commercial and industrial growth of the country, great emphasis is placed on supplying the generation, transmission and distribution facilities for new large industries and for the expansion of electrical facilities to rural areas. As such, the immediate expansion plans of the Ministry are geared very closely to satisfying the industrial and rural electrification needs of Egypt.

In 1965, Presidential Decree 3726 was issued in accordance with Law No. 60 of 1963. This proclamation established the General Egyptian Electricity Corporation (GEEC) whose organizational chart is shown in Exhibit No. 1-2. The Board of Directors of the General Egyptian Electricity Corporation is

composed of Government officials and staff members of GEEC appointed by the Minister of Electricity. GEEC is authorized to manage, operate and maintain power stations and networks and to construct new projects connected with the production, transmission and distribution of electricity in all parts of the country. As such, the GEEC is empowered to manage its own affairs and have financial control of its organization and operations, acting only under the Ministry's broad guidelines in financial and policy matters.

As illustrated in its organization chart, GEEC is divided into four main departments: (1) Manpower; (2) Finance and Economy; (3) Operations; and (4) Study, Research and Projects. It also has three construction companies reporting directly to the Chairman of the GEEC: (1) General Company for Electrical Projects; (2) High Dam Company for Mechanical and Electrical Projects (Hidelco); and (3) Misr Company for Electrical and Mechanical Projects. The construction companies are subsidiaries and carry out a large portion of the construction work of the GEEC under contracts secured by competitive bidding. They are, however, autonomous in operation with their own board of directors. All profits of such construction companies revert to the GEEC.

At present the GEEC has approximately 34,000 employees although it is reported that fifteen percent of such employees are on leave to the armed forces or on loan working in other Arab countries.

Operationally, the power company is in turn divided into five autonomous operating zones, each with its own president. Such zones are: (1) Upper Egypt Zone; (2) Delta Zone; (3) Alexandria Zone; (4) Cairo Zone; and (5) Canal Zone. Each zone operates independently as a separate electric utility with its own generation, transmission and

distribution facilities. It carries out all of the normal functions of a power company including billing, customer relations, expenditures, etc. Its finance and operating budget must, however, be approved and is subject to review by the GEEC central organization.

One other Egyptian organization involved in the national electric industry is engaged in the construction of rural electrification projects. This is the Rural Electrification Authority (REA) created in 1971 to supervise the construction of electrical transmission and distribution facilities in rural areas. After each rural construction project is completed, it is turned over to the GEEC for ownership and for operation and maintenance.

1.2 Principal Officers

A listing of the Members of the Board of Directors of the General Egyptian Electricity Corporation is given in Exhibit No. 1-3.

An organization chart showing the principal officers of the General Egyptian Electricity Corporation is given in Exhibit No. 1-4.

1.3 Financial Organization

GEEC is a governmental organization under the Ministry of Electricity and its finances form part of the Ministry's budget. As such, its financial statements are essentially a listing of cash flow transactions that have occurred during the year. It has been recommended in preliminary reviews conducted by others, that this budget system be changed to a more autonomous type of financial operation and that modern utility accounting methods be used to implement a more independent type of financial operation.

1.4 Balance Sheet and Statement of Income

The financial status of the GEEC is shown on the Balance Sheets for the years 1968 thru 1974 included as Exhibit No. 1-5 with a summary of such balance sheets given in Exhibit No. 1-6.

A Source and Application of Funds Statement and a Summary Income Statement are also included as Exhibit No. 1-7 and Exhibit No. 1-8 respectively.

2.0 EXISTING INTEGRATED POWER SYSTEM

2.1 General Description

The existing power system in Egypt is divided into five interconnected zones: Upper Egypt, Cairo, Alexandria, Lower Egypt, and the (Suez) Canal Zone. The major generating facilities consist of the two hydro plants at Aswan, the High Dam and Aswan Dam hydro plants, located on the southern part of the Nile in the Upper Egypt Zone. There are also a group of thermal plants located near Cairo and Alexandria and in the delta. In addition to the GEEC operated utility plants, there are a number of industries with their own generating facilities. These "captive" plants have a capability of approximately 5% of the total generating capacity of the country.

The total installed generating capacity of the Egyptian Power System (excluding private plants) is approximately 3,800 MW. The capacity of the hydro plants is approximately 2,500 MW or 65% of the total available capacity. Since the High and Aswan Dams have the primary function of supplying irrigation water and since the reservoir back of the High Dam has not yet been completely filled, the effective capacity of the hydro system during the low-water dry season (December-February) is only about one third of the installed nameplate capacity. The thermal plants consist of a number of units with a size range of 10-87 MW. The total nameplate rating of the thermal plants is approximately 1,400 MW.

The total nameplate rating of the Egyptian Power System gives a highly exaggerated value of available capacity. Such excess generation is presently needed because of transient stability and hydro considerations. The total peak load

that can be handled by the present system is under 2,000 MW because of the previously mentioned restraints.

The hydro and thermal plants are connected by two 500 kV main bulk transmission lines extending from Aswan to Cairo and a 220 kV grid network in the Delta area. The 500 kV circuits have two intermediate switching stations. There are also subtransmission networks of lower voltage (132, 66, 33 kV).

The one line diagram of the Egyptian Power System is shown in the map of Exhibit 2-1 with the GEEC operation zones indicated in such drawing. The features of the existing integrated power system are discussed in more detail in the following paragraphs.

2.2 Existing Generating Plants

The following table gives the nameplate data on the presently installed generation plants:

TABLE 2-1 - EXISTING GENERATING STATIONS

Plant & Location	Type	Units & Size (MW)	Total Name Plate Capacity (MW)
UPPER EGYPT			
High Dam	H	12 x 175	2100
Aswan Dam	H	7 x 46:	
		2 x 11.5	345
Assiut	T	3 x 30	90
CAIRO			
Cairo North	T	2 x 10:	
		1 x 20:	
		2 x 30	100
Cairo South	T	4 x 60	240
Cairo West	T	3 x 87	261
Tebbin	T	3 x 15	45
Cairo Area	GT	1 x 17	17
DELTA			
Suez	T	4 x 25*	100
Talka	T	3 x 12.5:	
		3 x 30	127
Damonhour	T	2 x 15:	
		3 x 65	225
ALEXANDRIA			
Siouf	T	2 x 26.5:	
		2 x 30	113
Max	GT	2 x 14	28
Karmouz	T	4 x 16	64

TABLE 2-1 - EXISTING GENERATING STATIONS (cont'd)

Plant & Location	Type	Units & Size (MW)	Total Name Plate Capacity (MW)
CANAL AREA			
Suez	GT	2 x 23	46
Ismailia	GT	1 x 23	23
Port Said	GT	1 x 23	23

Total Thermal Units 38
Total Gas Turbine Units 6

Total Name Plate Rating - Thermal Plant (T) 1275 MW
Total Name Plate Rating - Gas Turbine Plant (GT) 137 MW
Total Name Plate Rating - Hydro Plant (H) 2445 MW

*In the process of being restored to operation after having been seriously damaged during the wars.

2.3 Useable Generating Capacity

The useable generating capacity of the power system is limited by:

1. Dual use of the hydro plants for irrigation and power.

2. The water level in the High Dam having not yet reached the design level.

3. System stability restraints in the amount of power that can be transmitted over the 500 kV transmission lines.

4. Derating of existing thermal plants because of age and the deteriorated condition of the units.

These system operating limitations reduce the firm generating capacity to approximately 2000 MW from a total installed capacity of approximately 3,800 MW. The existing useable generating capacity is presently just adequate to meet system demand and provide the reserve needed for system stability.

The hydroelectric power system consists of the Aswan Dam and the High Dam. The High Dam turbines discharge into the Aswan Dam reservoir that serves as a peaking basin and as a regulating basin. The available electric energy generation is constrained by the requirements that the total discharge through the hydro system must be sufficient to keep the Nile navigable and meet irrigation requirements. The irrigation discharge is fixed by the Ministry of Irrigation; reaching a maximum in the summer and a minimum in the winter months during the dry season. The High Dam reservoir is still being filled and will not reach its final design level until 1983 or later.

The maximum energy output of the hydro plant will not be realized until that time. The available useable output from the hydro plants presently varies from a minimum of 900 MW in the winter months to about 1,400 MW in summer months.

System stability margins impose an upper limit on the amount of power that can be transmitted over the 500 kV high voltage lines. To maintain system stability with a maximum transfer of 750 MW of power over these lines, a spinning reserve of 450 MW in the thermal plants of Lower Egypt must be maintained. Since the 500 kV lines are subject to outages because of insulator flashovers due to dust contamination combined with moisture in the form of early morning dew, a system of load conservation and restoration schemes is applied. Sufficient spinning reserve must be maintained in the system operation to minimize the effects of such outages.

The existing thermal plants have a firm capacity of approximately 80% of their name plate ratings because of age and the deteriorated conditions of the units. There has been a lack of maintenance and spare parts during the past few years attributed to a shortage of funds.

The firm generating capacity is adequate at the present time, but is expected to be totally utilized by the end of 1976. After 1976, load increases will require new generating capacity although the firm generation of the hydro system is expected to slowly increase as the water rises to its design level in the High Dam.

2.4 Existing Transmission and Distribution System

The main transmission system consists of 500 kV, 220 kV and 132 kV lines as follows:

1. Two 500 kV single-circuit lines, each 790 km long, extending from Aswan to Cairo. These circuits have two intermediate switching and transforming stations with interconnecting busses.

2. A 220 kV double-circuit line extending from Cairo to Alexandria. A 220 kV double-circuit main transmission interconnection for the thermal generating stations in Cairo, Alexandria, Lower Egypt and the Canal Zones. The 220 kV lines serve as a main transmission ring for the Cairo Area.

3. A 132 kV double-circuit network extending from Aswan to Cairo, physically paralleling the 500 kV network and supplied intermediately from the 500/132 kV transformer stations. This network is sectionalized and provides subtransmission for the Nile Valley.

The 500 kV lines transmit the power from the Aswan hydro stations to Cairo. The 220 kV lines distribute the power from Cairo to all the other zones.

There is a subtransmission system consisting of 66 and 33 kV lines. The 66 kV lines are fed from the 220/66 kV substation at Abis located in the Alexandria Zone. There is also a 66 kV line connecting Cairo South to Tebbin. There is a 33 kV network in the Alexandria Zone connecting Siouf to Karmouz to Max. The major substations are listed in Table 2-2.

TABLE 2.2 - LIST OF MAJOR SUBSTATIONS

No.	Substation	No. x MVA	Voltage	Type	Capacity MVA existing	Capacity MVA after 1975	Zone
1	High Dam	2 x 321	500/132	auto	642	642	Upper Egypt
2	Nag Hammadi	4 x 285	500/132	auto	285	1140	Upper Egypt
3	Samalut	1 x 285	500/132	auto	285	285	Upper Egypt
4	Cairo 500 kV	3 x 500	500/220	auto	1500	1500	Cairo
5	New Tebbin	2 x 125	220/66	----	----	500	Cairo
6	Wadi Hoff	3 x 125	220/66	auto	375	375	Cairo
7	Cairo South	2 x 75	220/66	auto	150	150	Cairo
8	Cairo West	2 x 75	220/66	----	150	150	Cairo
9	Cairo East	2 x 125	220/66	----	---	250	Cairo
10	Cairo North	2 x 75	220/66	----	150	150	Cairo
11	Helwan	3 x 125	220/66	auto	375	375	Cairo
12	Thrim	2 x 125	220/66	auto	250	250	Alexandria
13	Abo El Matamer	2 x 125	220/66	auto	250	250	Alexandria
14	Sidi Kirir	2 x 60	220/11	----	---	120	Alexandria
15	Abis	2 x 75	220/66	----	150	150	Alexandria
16	Abo Qir	2 x 75	220/66	----	---	150	Alexandria
17	Damanhour	2 x 50	220/66	----	100	100	Lower Egypt
18	Tahsir Badr	2 x 40	220/66	----	80	80	Lower Egypt
19	Tanta	2 x 40	220/66	auto	80	80	Lower Egypt
20	Kafr El Shisk	2 x 75	220/66	----	---	150	Lower Egypt
[illegible]	Talka	2 x 75 + 1 x 40	220/66	----	40	190	Lower Egypt
[illegible]	Zagazig	3 x 40	220/66	auto	120	120	Canal
[illegible]	Ismailia	2 x 125	220/66	----	---	250	Canal

The distribution system has voltages of 11 kV, 6.6 kV, 3 kV and low voltage secondary services of 380/220 volts. System frequency is 50 Hz. The distribution system is modelled from the European systems. The secondary system has fused radial low voltage circuits fed from kiosks which are supplied from the primary distribution circuits. The distribution system is old and has not been fully maintained because of lack of funds in recent years.

2.5 Load Characteristics

A typical daily load curve is shown in Exhibit 2-2. The daily peak load occurs in the evening at 1800 hours in the winter and at 2100 hours in the summer. The morning's minimum load is approximately 60% of the evening peak and the day time maximum approximately 80% of the evening peak. The load curve for middle and upper Egypt is nearly flat since the load is primarily large industries with a constant demand. The industrial load contribution accounts for the high load factor maintained by the system. The demand from the zones for the peak load and annual energy consumption is given in Table 2-3.

TABLE 2-3

PEAK LOAD AND ANNUAL ENERGY CONSUMPTION BY ZONE

Zone	Peak Power Demand		Annual Energy Consumption	
	MW	%	TWh	%
Upper Egypt (South)	310	21.3	2.4	25.8
Cairo	594	41.0	3.4	36.6
Alexandria	192	13.2	1.4	15.1
Lower Egypt (North)	232	16.1	1.3	14.0
Canal	122	8.4	0.8	8.5
TOTAL	1450	100.0	9.3	100.0

The present normal direction of power flow in the Unified Power System is from the South to the North.

The power demand by different sectors in the economy in 1971 was Industry, 62%; Agriculture, 9%; and Municipal Sector 29%. The percentage of industrial demand is expected to increase in the future.

2.6 System Operations

The operation of the power system is carried out according to a daily off-line load dispatch schedule prepared 24 hours in advance. The maximum use of hydro-generation is given consideration with load forecasting made by inspection. Off-line computations of load flow, transient stability, and dynamic energy balance of the Northern Egypt system are made for planning the operating conditions of the Egyptian Power System. Such studies are made every six months and reviewed whenever necessary.

Most of the presently generated power is from the Aswan Dam and the High Dam. These hydroelectric plants produce approximately 65% of the total energy. Since the power from the dams is transmitted to Northern Egypt through the 500 kV lines, an interruption in these lines leads to a severe frequency decline and possible system outage. Failures in 500 kV sections occur about 30 times a year and double circuit outage about 3 times a year. These outages in the 500 kV bulk transmission lines require that 450 MW of spinning reserve from the thermal plants be kept floating on the line. A system of load conservation controlled by under frequency relays acts as additional backup protection to forestall a complete system breakdown. When system frequency radically decreases, pre-selected

50 MW blocks of load are shed. Under the most adverse conditions, the frequency is restored to 48.5 Hz and the maximum frequency drop is limited to 46.5 Hz. Normal system frequency regulation is presently carried out manually using the governor of one of the hydro-units at the High Dam.

The thermal plants are operated at or near minimum output during early morning and daytime hours. During the evening peak period, the thermal power stations in Northern Egypt increase generation to keep the maximum power transmission over the 500 kV system to 600 MW. It is planned that the maximum allowable power transmission will be increased as the load in Northern Egypt increases reaching 1000 MW in 1980. After 1980 power transmission should gradually decrease as the industrial load of the upper Nile Valley increases.

During 1974, the last year for which figures are available, the difference between the metered net amount of energy produced at all the generating stations and that delivered to customers' meters amounted to 16.4 percent of the total. This represents transmission, distribution and transformer losses as well as any other diversion such as theft or unmetered services. This is an unusually high figure and also represents a large amount of lost revenue. Strenuous efforts should be made to reduce this figure as soon as possible to a realistic normal utility value of less than 10%. It is surmised that a large share of these high losses is caused by the greatly overloaded and obsolete distribution system, which results not only in the excessive high losses but also abnormally low voltages at the customer's premises.

?

Really not bad

3% transm
3% Power Transf.
4% Distr lines
3% transf & servi
13% — would be exceedingly good!!
Many over 20%

2.7 System Maintenance and Unscheduled Outages

Today the most economical method of operating the General Egyptian Electricity Corporation's system is by utilizing the maximum hydro energy consistent with the requirements of system reliability.

In the past, the reliability has been seriously impaired by double circuit outages of the two 500 kV lines from the plants at the Aswan Dam to the Cairo or lower Egypt area. This is especially true when one 500 kV circuit is out of service for scheduled maintenance and the second 500 kV line trips out. These unscheduled trip-outs are due mainly to insulator string flash-overs and to a lesser extent to the swinging together of conductors. The flash-overs are caused by fine desert dust settling on the insulators and made conductive by condensation of dew in the early morning hours. In an effort to reduce these flash-overs, more insulators were put in each stack. These longer insulator strings resulted in conductors swinging together during strong winds. The transmission line performance has been greatly improved when live line insulator washing was introduced. The insulators of both 500 kV circuits are completely cleaned every 6 to 12 months.

The present maintenance practice for thermal generating units is to schedule them for periodic overhaul for approximately one month per year. According to the Overhaul and Maintenance Schedule for Generating Stations for 1975 as prepared by the GEEC Organization no unit was scheduled for maintenance during November or December, except for the completion of one 87.5 MW unit at Cairo West station during the first two weeks of November. The rest of the year as many as ten units are being overhauled

simultaneously.

Historically, the forced outage rate varies from a low of 0.5% of the operating time for the three Westinghouse 12.5 MW units installed in 1955-56 to a high of 6.0% for two Skoda 30 MW units installed in 1969. A reasonable average rate from all causes is 2% to 3%.

Instead of each plant or even each of the five area zones having its own independent maintenance staff it is recommended that a central plant maintenance staff be established. Such a team could be used at any plant in the system by transferring this group of well trained and qualified personnel to the plant being worked on. They could be supplemented by the small permanent plant maintenance staff as well as local labor such as the operators of the unit being overhauled.

2.8 Planned Generating Unit Retirement

The planned retirement of generation units up to the year 2000 is shown in Table 2-4. It is based on a 40 year estimated life for hydro stations and a 30 year estimated life for steam and combustion turbine stations.

TABLE 2-4
PLANNED RETIREMENT OF GENERATION UNITS

Year	Site Location	Type	No. of Equipment	Total MW
1983	Cairo North	Thermal	1 x 20, 2 x 10	40.0
1985	Cairo North	Thermal	2 x 30	60.0
1986	Talka	Thermal	3 x 12.5	37.5
1989	Tebbin	Thermal	3 x 15	45.0
1990	Damanhour	Thermal	2 x 15	30.0
1991	Siouf	Thermal	2 x 26.5	53.0
1994	Suez	Thermal	4 x 25	100.0
1995	Cairo South	Thermal	4 x 60	240.0
1996	Max	Gas Turbine	2 x 14	28.0
1997	Asiout	Thermal	3 x 30	90.0
1997	Talka	Thermal	3 x 30	90.0
1998	Cairo West	Thermal	3 x 87.5	262.5
1998	Damanhour	Thermal	3 x 65	195.0
1999	Siouf	Thermal	2 x 30	60.0
TOTAL				1331.0

3.0 PEAK LOAD AND GENERATION FORECASTS

3.1 Long Range Load Forecast for Twenty-five Year Period

The load growth in 1975 is estimated at 11.7% based upon performance through the first nine months of the year. However, the load growth of the Egyptian system has definitely not yet stabilized following the recent years of war conditions.

Generally, long range forecasts apply to the way society is expected to develop without investigating the specific details of individual components of the load. Usually this philosophy is permissible because details are not known about the individual loads on a long range basis. Short range forecasting on the other hand is needed to firm up generation requirements to supply known scheduled loads. Both are analyzed in this section of the report.

The actual peak loads through 1974 were provided by the General Egyptian Electricity Corporation (GEEC). Their Studies and Research Inspectorate completed a study in August 1974 entitled "Electric Power Needs in A.R.E. 1975-2000 And How To Meet Them" in which several alternate methods of load forecasting for the Egyptian electrical system were studied and investigated. Some of the methods studied were:

a. The accumulative method, in which the individual future demands for electrical energy of the various sectors of the country's economy are estimated. These separate estimates are then added in order to give a complete forecast for the country. No matter on what the estimated demand is based the forecast of the total demand is

only reliable for an extremely short period of time. These values yield a specially exaggerated future values and therefore was abandoned altogether.

b. The extrapolation method was applied by extending the straight lines of peak loads on semi-logarithm paper. The confidence in the predicted values is always impaired if the historical growth assumed is particularly irregular rate for any reason whatsoever. It is also extremely difficult to determine the modifying factor to be used for a particular country at a particular stage of its development.

c. The sentiment method involves basing the forecast for a particular country upon either the forecast for what is believed to be a closely comparable country, or upon the recent experience of a country believed to be similar but somewhat more developed. However, it is known that in the case of industrialized countries the load doubles about every ten or eleven years, whereas in the case of developing countries it doubles in a much shorter time.

d. The correlation between the national economy and energy demand methods. This method was applied by H. Aoki in his forecasts used in the International Atomic Energy Association reports. If a sufficiently reliable forecast for the development of the national economy (GNP) during a certain period is available, the established relation can be used to predict the energy demand during the same period. It is clear that any doubt in the values estimated for the gross national product per capita per year used in the energy forecast would throw the whole process

in such doubt as to render it no better than utilizing the electrical demand in the forecast directly.

Since none of these methods seem entirely satisfactory for application to the Egyptian Power System the GEEC decided upon a modification to be used in their long range forecast. This modified method was utilized by the Sanderson and Porter engineers in this report. However, this S&P forecast has the distinct advantage of being based upon data available two years later during a more stable period. Therefore it more accurately reflects not only the present but also the expected future conditions. This method used for the long range forecast is described as follows.

It seems reasonable that over such a period of time the national economy and its related energy demand can be thus extrapolated by using sound engineering judgement based upon similar conditions and extensive experience in other developing countries. A higher growth rate of peak load and energy demand should be expected at first to compensate for the low rates of growth that prevailed because of the war. High growth rates should also be expected in connection with the new changes in Egypt's economic policies. It is assumed therefore, that the load will double in the first seven years after 1974. That is, at a cumulative annual rate of 10.4 percent. It is assumed that it will then double again in eight years or at an annual cumulative rate of 9.4 percent. It is assumed that the next doubling time period will be nine years or at only 8.0 percent annually. For the years 1999, 2000 and on into the twenty-first century the annual rate of increase is assumed to be 7 percent, which means the load doubles in ten years. This appears reasonable because statistically it is fairly well established that the rate of growth of power demand in well-developed [illegible]

This is very conservative if distribution is adequate.

as the United States, Canada and Western Europe is about 7 percent per year. This is the combined result of population growth and increased rate of power consumption per capita.

3.2 Generation Planning by the GEEC for Twenty-five Year Period

This long range load forecast is tabulated on Table 3-1 and is presented graphically in Curve No. 3-1. Also tabulated in this table is the proposed system useable generating capacity to meet the daily peaks during the annual periods of low water at the High Dam, and the reserve capacity represented by the excess of this useable capacity above estimated peak load expressed in terms of both megawatts and percent of useable capacity.

As a guide to the possible loss of load probability or generation failure, it was assumed that the largest generating unit was down for scheduled maintenance at the same time another large unit was lost to unscheduled outage. The reserve then remaining was also tabulated both in megawatts and in percent of effective generation capacity. For the first nine or ten years of this study the remaining percentage appears unusually large. However, this seemingly unused capacity is now considered necessary to carry the load in lower Egypt when this area is separated from the Aswan and High Dams hydro generation due to simultaneous opening of both 500 kV transmission lines.

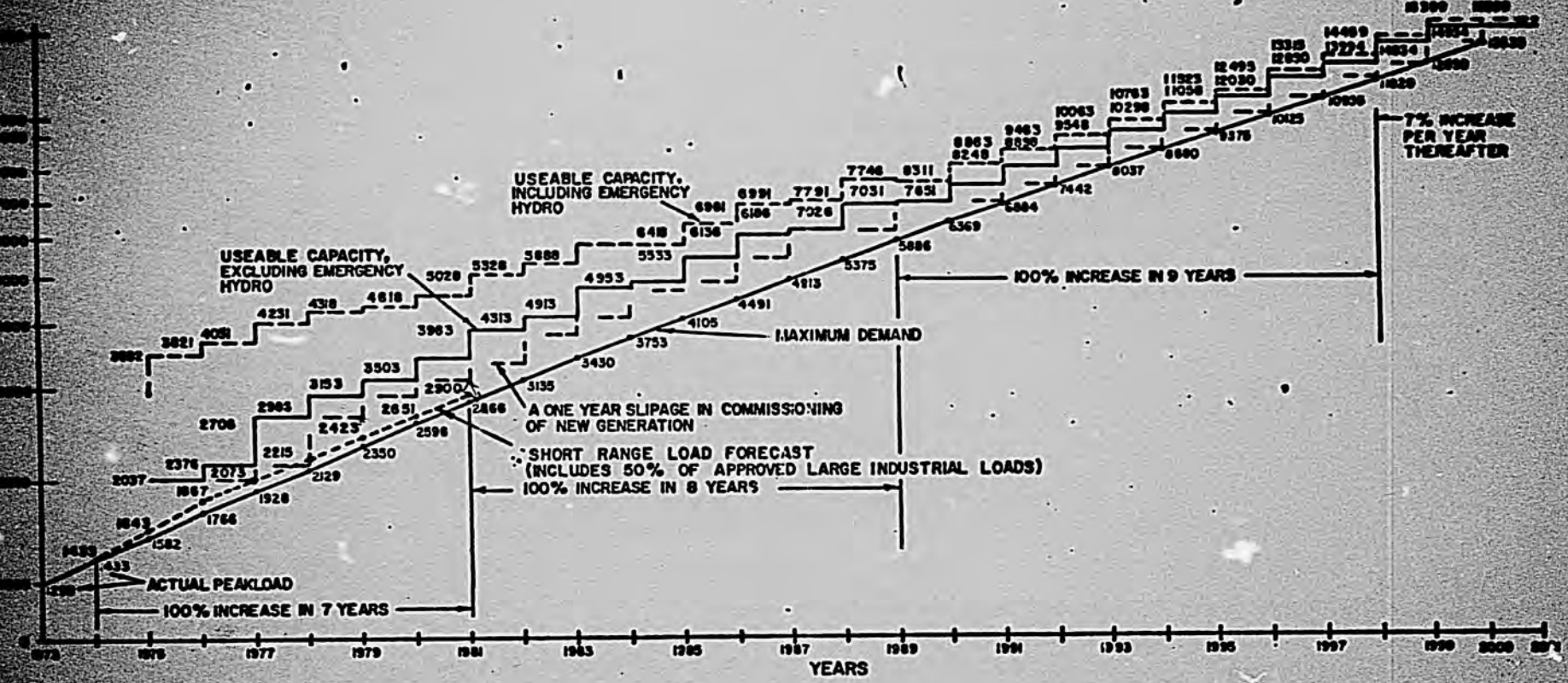
Slippage of only one year in generation installation would in effect move the generation available curve to the right and thus closer to the estimated load curve. This new relationship between the estimated peak load forecast and the useable generating capacity is shown graphically on Curve No. 3-1 by the dashed lines below the Installed Capacity Curve. Another [illegible]

Curve No. 3-1 for the years 1974 through 1981. This is the short range load forecast used for generation scheduling in the proximate future years as explained in Section 3.4 of this report.

TABLE 3-1

TABULATION OF USEABLE GENERATING CAPACITY, ESTIMATED PEAK LOADS RESERVE IN MW AND PERCENT-ALSO RESERVE MINUS TWO LARGEST THERMAL UNITS

Year	System Useable Gen. Capacity	Est. Load	Reserve Generation MW	Reserve Generation %	Two Largest Thermal Units	Reserve Minus Two Largest Thermal Units MW	% Of Useable Generation	% of Load
1974		1433						
1975	2037	1582 1443	455	22.3 28.7	175	280	13.7	
1976	2376	1766 1947	610	25.7 34.5	175	435	18.3	
1977	2696	1928 2073	768	28.5 40%	220	548	20.3	
1978	2976	2129 2215	847	28.5 40%	220	627	21.0	
1979	3143	2350 2413	793	25.2 33.7	220	573	18.2	
1980	3493	2596 2651	897	25.7 34.5	300	597	17.1	
1981	3953	2866 2866	1087	27.5 38%	300	787	19.9	27.4%
1982	4303	3135	1168	27.1	300	868	20.2	
1983	4903	3430	1473	30.0	750	723	14.7	
1984	4943	3753	1190	24.0	750	440	8.9	
1985	5523	4105	1418	25.7	1200	218	3.9	
1986	6126	4491	1635	26.7	1200	435	7.1	
1987	6176	4913	1263	20.5	1200	63	1.0	
1988	7016	5375	1641	23.4	1400	241	3.4	
1989	7020	5886	1134	16.2	1400	(-)266	<0	
1990	7641	6369	1275	16.7	1400	(-)125	<0	
1991	8238	6884	1354	16.4	1400	(-) 46	<0	
1992	8888	7442	1446	16.3	1400	46	0.5	
1993	9538	8037	1501	15.7	1400	101	1.0	
1994	10288	8680	1608	15.6	1600	8	0.0	
1995	11048	9375	1673	15.1	1800	(-)127	<0	
1996	12020	10125	1895	15.8	2000	(-)105	<0	
1997	12840	10935	1905	14.8	2000	(-) 95	<0	
1998	13984	11820	2164	15.5	2000	164	1.2	
1999	14924	12650	2274	15.2	2000	(-)274	1.8	
2000	14924	13533	1391	9.3	2000	(-)609	<0	



ESTIMATED PEAK LOADS
and
PROPROSED GENERATION EXPANSION PROGRAM

CURVE Nº 3-1

3.3 Major Types of Generation

Four major types of generation were considered by the GEEC for the expansion of the Egyptian system. The first was hydro of which 2445 MW is presently installed at the High Dam and at the Aswan Dam in Upper Egypt. Although at the present time this capacity supplies approximately two thirds of the total electrical energy produced by the system, it is evident that it will be used in an increasing amount for peaking capacity as more generation of other types is installed with time. There are only two other possible hydro developments in Egypt.

One is the construction of seven barrages on the Nile River mainly for diverting water to irrigation canals. These would be relatively low head plants and if their use to generate electricity proves economically justifiable a maximum of only 600 MW could be produced. These were not taken into account in the study, since if they are viable they would merely replace an equivalent amount of the proposed thermal generation. The second is the Qattara Depression project located in an area southwest of El Alamein which is approximately 135 meters below sea level at its lowest spot. Hydro generators could be installed here and operated by salt water from the Mediterranean Sea. The salt lake in the desert formed by the water discharged from the turbines would eventually evaporate as fast as it is allowed to flow through the turbines when the surface areas of the lake reaches the required size to establish equilibrium. However, the feasibility of this entire project is entirely dependent upon a canal between 150 and 200 kilometers long from the Mediterranean Sea across the mountainous Libyan Plateau. A German engineering firm is now studying the feasibility of the project. This possible source of hydro power from the Qattara De-

pression was not considered in this study. If it is eventually built it could be able to generate initially 600 MW and eventually as much as 2000 MW. Moreover; it would be of such characteristics as to provide excellent spinning reserve and peaking capacity in lieu of pumped storage hydro. Finally no pumped storage hydro has been considered for the GEEC system for the next 25 years.

The second type of generation considered for the expansion of the GEEC system was conventional fossil fuel fired steam generators. The desired fuel burned is planned to be natural gas until its value for other purposes exceeds its value for producing electricity. The back up and alternate fuel will be mazout, a petroleum derivative, i.e. bunker "C" oil.

The third type of generation considered is combustion turbines. Two small units are presently in operation. Five such units of approximately 109 MW, depending on ambient conditions, has been purchased and they are now being installed, four in cities in the Suez Canal area and one in the Cairo area. A second large installation of this type is 120 MW, planned to be placed in operation in Helwan in the latter part of 1976. A third group totalling 180 MW is planned to be installed at Talka in 1978. The reason for the installation of combustion turbines at the Helwan and Talka sites is the urgent need for additional generating capacity for the 1976 and 1978 winter seasons for which conventional steam power plants cannot be installed in time to meet the anticipated load growth.

The fourth type of generation considered for expansion of the power generation system is nuclear reactor steam plants. The first installations will most probably use light water moderated reactors

of either the pressurized water reactor (PWR) or boiling water reactor (BWR) type.

The proposed type, size and approximate date of commissioning of these various generation types as well as the system's total useable generation from all sources and the emergency hydro is tabulated on Table 3-2 titled "Generating Capacity of GEEC System", and it is shown graphically on Curve 3-2. The relative percentages of the various types of generation is shown graphically on Curve 3-3. Exhibit No. 3-1 as prepared by the GEEC shows their generation expansion plan through 1985 plotted on an energy basis.

TABLE 3-2
GENERATING CAPACITY OF GEEC SYSTEM

USABLE GENERATING CAPACITY BY TYPES IN MW AND PERCENTAGE

YEAR	HYDRO MW	HYDRO %	USEABLE FOSSIL FUEL STEAM MW	USEABLE FOSSIL FUEL STEAM %	NUCLEAR MW	NUCLEAR %	USEABLE GAS TURBINE MW	USEABLE GAS TURBINE %	USEABLE SYSTEM TOTAL MW	EMERGENCY HYDRO MW	EMERGENCY HYDRO %	TOTAL MW INCLUDING EM. HYDRO
Column 1	2	3	4	5	6	7	8	9	10	11	12	13
1975	900	44.2	1025	50.3	0	0	112	5.5	2037	1545	43.1	3582
1976	1000	42.1	+107 1132	47.6	0	0	6x20+12 Hawaii 244	10.3	2376	1445	37.8	3821
1977	1100	40.7	2x110+10 1362	50.3	0	0	244	9.0	2706	1345	33.2	4051
1978	1200	40.2	1362	45.6	0	0	6x30 424	14.2	2986	1245	27.5	4231
1979	1280	40.6	1x87 1449	46.0	0	0	424	13.4	3153	1165	27.0	4318
1980	1330	38.0	2x150 1749	49.9	0	0	424	12.1	3503	1115	24.1	4618
1981	1380	34.8	1x110+2x150 2159	54.5	0	0	424	10.7	3953	1065	21.2	5018
1982	1430	33.1	2x150 2419	57.0	0	0	424	9.6	4313	1015	19.0	5318
1983	1470	29.9	(-) 40 2419	49.2	1x600 600	12.3	424	8.6	4913	975	16.6	5878
1984	1510	30.4	2419	48.8	600	12.1	424	8.7	4953	935	15.9	5888
1985	1550	27.9	(-) 60 2359	42.6	1x600 1200	21.8	424	7.7	5533	895	14.0	6418
1986	1590	25.9	1x600 (-) 37 2912	47.5	1200	19.7	424	6.8	6136	855	12.3	6981

5018
-1380 Hydro
3638
-1065 E-Hydro
2573

TABLE 3-2

GENERATING CAPACITY OF GEEC SYSTEM

USABLE GENERATING CAPACITY BY TYPES IN MW AND PERCENTAGE

YEAR	HYDRO MW	HYDRO %	USEABLE FOSSIL FUEL STEAM MW	USEABLE FOSSIL FUEL STEAM %	NUCLEAR MW	NUCLEAR %	USEABLE GAS TURBINE MW	USEABLE GAS TURBINE %	USEABLE SYSTEM TOTAL MW	EMERGENCY HYDRO MW	EMERGENCY HYDRO %	TOTAL MW INCLUDING EM. HYDRO
1987	1640	26.6	2922	47.2	1200	19.4	424	6.8	6186	805	11.5	6991
1988	1680	23.9	1x800 3722	52.9	1200	17.1	424	6.1	7026	765	9.8	7791
1989	1730	24.6	(-) 45 3647	52.2	1200	17.1	424	6.1	7031	715	9.2	7746
1990	1780	23.2	(-) 30 3647	47.6	1x600 1800	23.6	424	5.6	7651	665	8.0	8311
1991	1830	22.2	(-) 53 3594	43.5	1x600 2400	29.2	424	5.1	8248	615	6.9	8863
1992	1880	21.2	1x600 4194	47.1	2400	27.0	424	4.7	8898	565	6.0	9463
1993	1930	20.2	4194	43.9	1x600 3000	31.6	424	4.3	9548	515	5.0	10063
1994	1980	(-) 100 19.2	1x800 4894	47.5	3000	29.4	424	4.1	10258	465	4.3	10763
1995	1980	17.9	(-) 240 4654	42.0	1x1000 4000	36.3	424	3.8	11058	465	4.0	11523
1996	1980	16.5	1x1000 5654	47.0	4000	33.2	396	(-) 28 3.3	12030	465	3.7	12495
1997	1980	15.4	(-) 180 5474	42.7	1x1000 5000	38.9	396	3.0	12850	465	3.5	13315

TABLE 3-2
GENERATING CAPACITY OF GEEC SYSTEM

USABLE GENERATING CAPACITY BY TYPES IN MW AND PERCENTAG

YEAR	HYDRO MW	HYDRO %	USEABLE FOSSIL FUEL STEAM MW	USEABLE FOSSIL FUEL STEAM %	NUCLEAR MW	NUCLEAR %	USEABLE GAS TURBINE MW	USEABLE GAS TURBINE %	USEABLE SYSTEM TOTAL MW	EMER HYD MW	TAL MW LUDING HYDRO
1998	1980	(-) 456 14.2	2x800 6618	47.3	5000	35.8	396	2.7	13994	465	.4459
1999	1980	(-) 60 13.3	6558	43.9	1x1000 6000	40.2	396	2.6	14934	465	5399
2000	1980	13.3	6558	43.9	6000	40.2	396	2.6	14934[38]	465	5399

TABLE 3-3

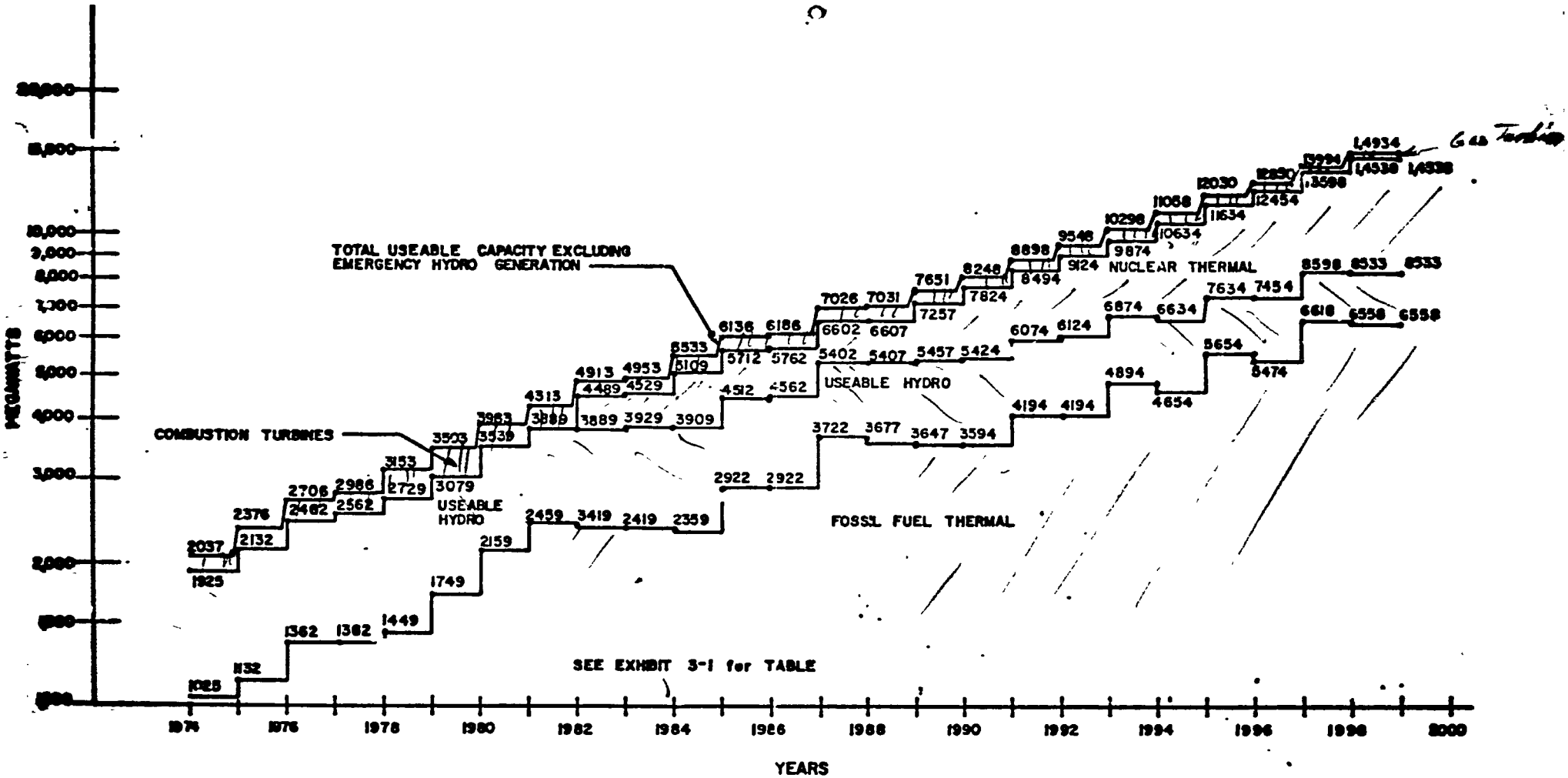
TABULATION OF PROPOSED GENERATION INSTALLATION AND EACH UNIT'S PERCENTAGE OF SYSTEMS TOTAL GENERATION AT TIME OF INSTALLATION

Year	New System Total Useable MW	Location	New Units Size (MW)	New Units Type of	% of Systems Useable Capacity Each Unit	% of Systems Useable Capacity Year's Total	Year's % Loss Growth for Comparison
COLUMN 1	2	3	4	5	6	7	8
1975	2037						
1976	2376 339 339 120 219	Helwan	6x20	Gas Turbine	0.84	5.05	10.5
1977	2696 320 320 110 210	Kafr El-Dawar	1x110 or 2 x 110?	Fossil Fuel	4.08	~~8.20~~ 11.9	10.4
1978	2976 280 280 180 100	Talka	9x20 or 6x30	Gas Turbine	0.67 1.00	~~6.05~~ 7.05	10.4
1979	3143 167 167 87 80	4th Cairo West ?	1x87.5	Fossil Fuel	2.78	2.78	10.4
1980	3493 350 350 300 50	Abu Qir ? Where? Abo Qir?	2x150	Fossil Fuel	4.30	8.60	10.4
1981	3953 460 460 410 50	Ismailia Kafr El-Dawar	2x150 1x110	Fossil Fuel Fossil Fuel	3.80 2.78	10.40 10.40	10.4 10.4
1982	4303	Suez	2x150	Fossil Fuel	3.50	7.45	9.4
1983	4903	Borg El Arab West of Sidi Kirir	1x600	Nuclear Fuel	12.20	12.20	9.4
1984	4943	-	-	-	-	0.00	9.4
1985	5523	El Arish in Sinai on Mediterranean	1x600	Nuclear Fuel	10.80	10.90	9.4
1986	6126	Cairo North	1x600	Fossil Fuel	9.80	9.80	9.4
1987	6176	-	-	-	-	0.00	[illegible]

TABLE 3-3 (Cont'd)

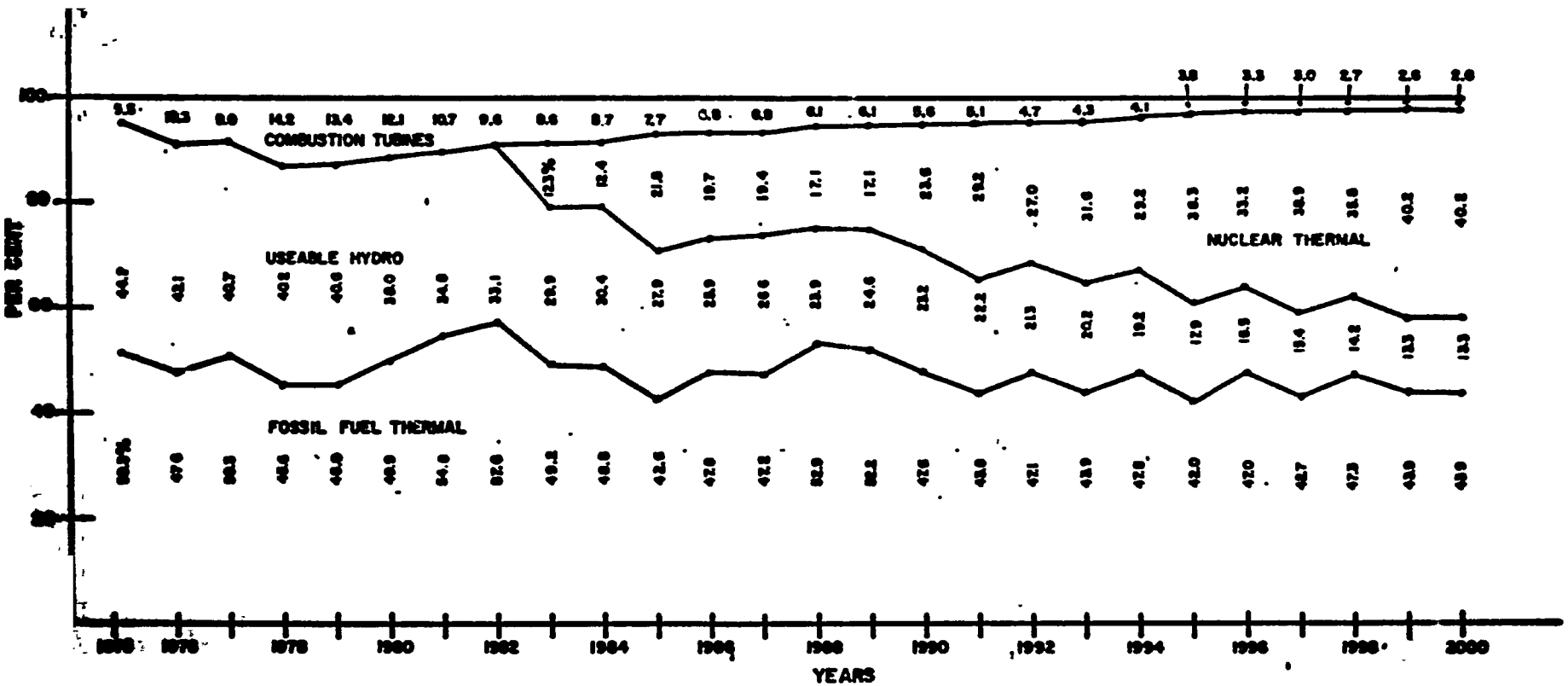
TABULATION OF PROPOSED GENERATION INSTALLATION AND EACH UNIT'S PERCENTAGE OF SYSTEMS TOTAL GENERATION AT TIME OF INSTALLATION

Year	New System Total Useable MW	Location	New Units Size (MW)	New Units Type of	% of Systems Useable Capacity Each Unit	% of Systems Useable Capacity Year's Total	Year's % Load Growth for Comparison
COLUMN 1	2	3	4	5	6	7	8
1988	7016	-	1x800	Fossil Fuel	11.1	11.1	9.4
1989	7021	-	-	-	-	0.0	9.4
1990	7641	2nd Unit Borg El Arab	1x600	Nuclear Fuel	7.85	7.85	8.0
1991	8238	2nd Unit El Arish	1x600	Nuclear Fuel	7.28	7.28	8.0
1992	8888	-	1x600	Nuclear Fuel	6.75	6.75	8.0
1993	9538	-	1x600	Nuclear Fuel	6.30	6.30	8.0
1994	10288	-	1x800	Fossil Fuel	7.75	7.75	8.0
1995	11048	-	1x1000	Nuclear Fuel	9.05	9.05	8.0
[illegible]	12020	-	1x1000	Fossil Fuel	8.30	8.30	8.0
[illegible]	12840	-	1x1000	Nuclear Fuel	7.78	7.78	8.0
[illegible]	13984	-	2x800	Fossil Fuel	5.70	5.70	8.0
[illegible]	14924	-	1x800	Nuclear Fuel	5.34	5.34	7.0
[illegible]	14924	or if	1x1000	Nuclear Fuel	6.69	6.69	7.0



PROPOSED GENERATION EXPANSION PROGRAM BY TYPES

CURVE Nº 3-2



PROPOSED INSTALLED GENERATION
EXPANSION PROGRAM
TYPES BY PERCENT

CURVE Nº 3-3

3.4 Short Range Load Forecast Analysis for Helwan and Talka Generation Requirements

a. Load Forecast

The General Egyptian Electricity Corporation (GEEC) in its August, 1974 report titled "Electrical Power Needs in A.R.E. 1975-2000" investigates general methods for forecasting future loads and concludes for the period from 1973 to 1980 a sound basis of long range load forecasting is at a rate that will double the load in seven years. Another short range load forecast approach considered by the Sanderson and Porter team for generation scheduling is to take a six percent annual growth rate on existing loads, as a normal growth rate for the established consumers, plus the consideration of the known new large industrial loads that will be added to the system. This method appears more realistic for the immediate future load forecast because of the propondérance of new large industrial loads scheduled or expected to be added to the GEEC system in the forecoming future years. This current large load growth is primarily caused by delays in the addition of such loads in the preceding years due to the economic and unsettled conditions that existed during the war years.

The known new loads that are approved by the Ministry of Industry as well as those expected but not yet approved as obtained for the power study are listed in Exhibit No. 3-2. These known new loads amount cumulatively to 362.2 MW in 1974, 920.9 MW in 1976, 1164 MW in 1977 and 1269 MW in 1978 and thereafter. Also shown in Exhibit No. 3-2 are probable loads for other indus-

trial projects that are expected to develop in the years after 1976 but are not yet approved by the Ministry of Industry for construction. These loads are not included in the normal load forecast but it is recognized that these and/or other additional loads, which at the time of writing this report are unknown, most probably will be realized.

Utilizing the short range load forecast criteria of six percent normal existing load growth plus fifty percent of the approved large industrial loads the resulting expected annual peak loads for the years 1974 through 1978 are given below in Table 3-4. Table 3-4 also includes the loads for the years 1979 through 1981 where the load is assumed to double in eight years which is equivalent to an annual cumulative load growth rate of 9.4 percent. This is the same load growth rate used in the long range forecast for the years 1981 through 1989.

TABLE 3-4

SHORT RANGE LOAD FORECAST
(Expected Peak Loads in MW)

Year	Existing Loads Normal 6% Growth	Approved Large Loads	50% of Approved Large Loads	Total Peak Loads	
1974	1252	362.4	181	1433	14% (above 1252)
1975	1327	632.9	362	1643	14.8%
1976	1407	920.9	460	1867	14%
1977	1491	1164.0	582	2073	11%
1978	1580	1269.0	635	2215	7%
LOAD GROWTH 9.4% (Load Doubling in 8 Years)					
1979	----	------	---	2423	9.4%
1980	----	------	---	2651	
1981	----	------	---	2900	

As known prospects naturally diminish with extension of time from present — percentages drop accordingly — but probability is that more new industries would "appear" due to industrial climate developed. Certainly a 15% annual L.G would not be unreasonable for the 10 years immediately following an aggressive promotion.

In Curve No. 3-1 of this section the short range forecasted peak loads are plotted as a dotted curve for the years 1974 through 1981.

b. Power Requirements

The critical period of the GEEC system operation always occurs in the winter months during the dry season of the Nile River when the available system hydro power and energy is at a minimum. For this reason an analysis of additional generation requirements is made during this period. Exhibit No. 3-3 is a tabulation showing the name plate rating of the existing and future planned steam and combustion turbine plants. In recent years it has not been possible to obtain the necessary parts and materials to maintain some of the presently installed plants at their full capability. The exhibit also shows the dependable capability for these plants in their present condition (1975) and what it is expected to be in 1976 and 1977 after completion of a maintenance program as taken from Table 2 of the GEEC "Report on the Thermal Generation Power Required for Meeting the Integrated Electrical Network's Load Up to the Year 1985." The survey of possible reconstruction was not complete at the time of writing this report; for example, the war damaged Suez station containing 4 x 25 MW Russian units. The possibility of additional capacity becoming available by reconstruction of such additional plants is not considered herein.

The useable hydro power capability is the capacity that can be used, recognizing water availability, irrigation and navigation requirements, and operating characteristics of the GEEC system as set out in the GEEC Report "Electrical Power Needs in A.R.E. 1975-2000 and How to Meet Them." Table 7 of this report gives the peak load carrying capability of the Hydro system (Aswan and High Dams) for the various years included in the study. A summation of daily system available capacity from 1975 through the years 1981 is also given in Exhibit No. 3-3 of this report.

Exhibit No. 3-4 is a summary of daily available generation and forecasted peak loads during the dry season of the Nile River from 1975 through 1981.

The 1976 and 1978 forecasted loads are 1867 MW and 2215 MW respectively. The 2334 average generation for these years, exclusive of the proposed Helwan and Talka combustion turbine plants, is 2277 MW and 2815 MW respectively. 2397

40± more than 2570

As can be seen from the above values the available system generating capacity without the addition of the Helwan and Talka combustion turbines would not provide the normal 25% reserve margin required for normal system operation.

GEEC, for planning purposes, uses a reserve of 20 percent of generating capacity or 25 percent of peak load. Considering that the system is not interconnected with any other similar system and, therefore, must provide its total reserve requirements, this 25% of load seems reasonable for the genera-

For what reason!

tion system herein considered. This operating criteria is consistent with that employed by similar operating utilities in the United States.

These values of required reserve margins are low however, when compared with the values of percentage of reserve capacity given in Table X "Relationship of Reserve Margin and Peak Demand" on page 18 of the Market Survey for Nuclear Power in Developing Countries (1974 Edition) of the International Atomic Energy Agency. Table X of their report shows the relation between peak demand and reserve margin used in their market survey. These values are repeated below in Table 3-5.

TABLE 3-5

RELATIONSHIP OF RESERVE MARGIN AND PEAK DEMAND

GEEC Largest Unit (Thermal)	Peak Demand (MW)	Largest Unit	Reserve Margin (%)
	300	75	40.0
	600 85	125	38.0
85	1000 85	150 200	35.0
85	1500 85	300	28.0
110 — 2000 Load	3000	400 (370 Load)	24.0
150 — 3500 Load	6000		21.0
	10000		17.0
	20000		16.0
	30000		15.0
	50000		

These are assuming much larger units than GEEC has at present and thru 1982; so % should be less — by at least 1/3. Largest Units assumed here were

Interpolating the value of reserve margin used by the IAEC would give:

	Peak Load		Reserve Margin
1976	1867	85 MW Unit	32%
1978	2215	110 MW Unit	31%

Also for Section 3.5 for the Ismailia steam power plant analysis the reserve margin would be:

	Peak Load	Reserve Margin	
1981	2900 150MW	28%	15%

c. Energy Requirements

Table 3 of the GEEC's "Report on the Thermal Generation Power Required for Meeting the Integrated Electrical Network's Loads Up to the Year 1985" shows Daily Hydro Energy available during the dry season of the Nile River as 14.6 million kwh each year from 1975-1985.

Total Daily Energy available from the installed steam and combustion turbine units (less the expected combustion turbine additions), assuming an availability factor of 90 percent is 27.4 Gwh in 1976 and 34.9 Gwh in 1978. Adding the hydro energy total of 14.6 Gwh gives a total system daily available energy of 42 Gwh and 49.5 Gwh respectively.

Drawing No. 2 of the previously mentioned report shows a daily load curve for the dry season of the Nile River in 1980 with a peak load of 2850 MW and total energy of 54.5 Gwh which is a daily load factor of 79.6 percent. ← WOW This appears to be a relatively high daily load factor but may be realistic in view of the large constant demand (high load factor) industrial loads expected to be added to the GEEC system. Applying this load factor to the 1976 and 1978 peaks of 1867 MW and 2215 MW gives daily energy requirements of 35.7 Gwh and 42.3 Gwh.

Again the difference between the available

provides a very narrow margin for safe operation of a utility system. It must also be realized that additional reserve over and above normal reserve requirements is required in these years because of the 500 kV transmission line operational problems described in Section 2 of this report.

d. Recommendations

From the preceding analysis, it is obvious that both the 120 MW Helwan and 180 MW Talka combustion turbine plants are needed to augment the GEEC generation system to satisfy both the power and energy requirements for the expected Egyptian load growths for the years 1976 and 1978.

3.5 Short Range Load Forecast Analysis for Ismailia Generation Requirements

a. Load Forecast

An analysis similar to that employed for investigating the requirements for the Helwan and Talka combustion turbine plants was used herein.

Utilizing a six percent annual load growth rate for existing loads plus fifty percent of the known new large industrial loads that will be added to the system up to 1978, and a 9.4% cumulative annual load growth thereafter gives a maximum load demand of 2900 MW for 1981. This maximum 1981 peak load demand of 2900 MW is very close to the maximum demand of 2866 MW obtained by using the long range load forecast of Section 3.1 which assumes the existing load to be doubled in a seven year period (a 10.4% cumulative annual load growth rate).

87600
276
963600

238

b. Power and Energy Requirements

A similar power and energy analysis for the Ismailia generation requirements in 1981 is shown in Exhibit No. 3-4 and is summarized below:

Power

Generation

Available (less Ismailia 2x150 MW and Kafr El-Dawar 1x110 MW)	3562 MW 23%
Kafr El-Dawar 1 x 110 MW	110
Subtotal	3672 MW 26%
Ismailia 2 x 150 MW	300 5%
TOTAL	3972 MW 31%

Loads

Forecasted Peak Load	2900 MW 20%
Additional Load (expected but not yet approved)	582 MW
	3482

Energy — Daily

Generation

Available (less Ismailia 2x150 MW and Kafr El-Dawar 1x110 MW)	61.8 Gwh
Kafr El-Dawar 1 x 110 MW	2.4
Subtotal	63.2
Ismailia 2 x 150 MW	6.5
TOTAL	70.7 Gwh — 28% reserve over & above 10% sched. down & 50% Hydro

90% Available for Therm & 6 50% for Hydro

Loads

Forecasted Energy Requirements	55.4 Gwh 79.6% L.F.
Additional Load (expected but not yet approved)	11.1 Gwh

The 3562 MW of dependable generating capacity provides a reserve of 662 MW over the forecast peak load of 2900 MW in 1981. The 25% reserve requirement would require 725 MW in reserve for the forecasted 2900 MW peak load which exceeds the available reserve by 63 MW. The 110 MW unit scheduled for installation at Kafr El-Dawar in 1981 would bring the total generating capacity to 3672 MW and the reserve to 772 MW, 47 MW more than the 25 percent requirement. However, the above analysis does not consider the additional 582 MW of expected but not yet approved industrial load that may be added to the system.

c. Recommendations

Considering that the Ismailia units are to be installed for operation six to seven years in the future, the size of potential loads, and the present schedule for the addition of industrial loads being higher than the forecast, and for slippage in installation schedules for new units or maintenance of existing units, it is therefore recommended that one Ismailia unit be scheduled for commercial operation before the 1981 peak season to provide these margins. The second unit should be scheduled for commercial operation in the following year timed to take advantage of a continuous construction program.

4.0 TRANSMISSION AND DISTRIBUTION EXPANSION

4.1 Transmission Expansion

An examination of system load flow diagrams under maximum loading conditions shows that the existing 500 kV transmission lines, the 132 kV transmission lines, and the 220 kV transmission lines seem in general adequate to support the present system loadings. As mentioned in Section 2 some system stability and dynamic energy balance problems presently do exist in the GEEC system caused by the requirement for the transmission of large amounts of electrical energy from the High and Aswan Dams to Cairo and the delta area. Such system operation problems will gradually diminish in the 1980's when the energy required to be transmitted over the 500 kV lines to northern Egypt will decrease. This will result due to the installation of more and larger sized nuclear and fossil fuel fired generation units in northern Egypt as well as the utilization of more of the available hydro output by industrial loads in the upper and intermediate Nile River area. A system load flow diagram for the years 1982-1983, included as Exhibit No. 4-1 shows that of the 1589 MW peak power produced during that year at the Aswan and High Dams, only 345 MW is received at the Cairo 500 kV substation.

With the decreasing future need for the 500 kV transmission lines to transmit large blocks of power between the hydro dams on the upper Nile and the load in lower Egypt, no reinforcement of this section of the 500 kV transmission system is presently anticipated by the GEEC.

The 220 kV transmission line expansion program of the GEEC appears to be well planned, timely and adequate to provide the required power outlets for the future generation and loads of the projected

system. Lines appear commensurately sized with sufficient additional circuits and/or alternate transmission line feed paths to insure continuity of service in the case of either planned or non-scheduled line outages. The GEEC currently makes load flow, short circuit and stability studies on their Siemens A-C network analyzer and/or on their Russian digital computer, to corroborate the planning and engineering design of all proposed future transmission lines and switching stations.

A listing of the future scheduled 220 kV transmission lines to be constructed through 1982 is given in Table 4-1. All lines are to be double circuit lines using 400 mm^2 (approximately 788 MCM) ACSR conductors.

TABLE 4-1

PLANNED NEW 220 kV TRANSMISSION LINES

No.	Location	Length in Km	Required Completion Date
1	Kafr Elu-New Tebbin	15	1976
2	New Tebbin-Wadi Hoff	25	1976
3	Wadi Hoff-Petro Pipeline	100	1976
4	Cairo East-Heliopolis	10	1977
5	Petro Pipeline - Suez	21	1977
6	Suez - Ismailia	80	1981
7	Ismailia - Zagazig	73	1981
8	Kafr El Shisk - Talka	45	1978
9	Kafr El Shisk - Damanhour	55	1978
10	Kafr El Dawer-Abu Qir	20	1980
11	Abis-Abu Qir	20	1980
12	Amriad - Sidi Kirir	30	1982
13	Ismailia - Port Said	90	1981

On the other hand the 66 kV and 33 kV subtransmission systems are in urgent need of maintenance and expansion. Much of this work has been neglected during the past years due to a shortage

dria and throughout the other zones. Repair of damaged lines and the construction of new lines is urgently needed in the Canal Zone. Additional circuits are needed to service the planned rural electrification expansion program. Adequate switching and/or substations will also be needed to interconnect the above subtransmission circuits with the transmission and distribution grids.

4.2 Computerized National Energy Control Center

Due to the expected growth in the size of the General Egyptian Electricity Corporation power system and the increasing importance of maintaining service reliability, the supervision, operation and control of the system is becoming more complex. Therefore, the GEEC has re-evaluated its present techniques for central supervision and control of its Unified Power System. This was done to provide the load dispatchers with more real-time information and to introduce advanced techniques in automatic frequency control in conjunction with automatic load shedding and economic dispatch.

With the pronounced change from the present situation of hydrogeneration providing the largest proportion of energy (approximately 65%) to the future condition of prime dependance on thermal generation units for the majority of the nation's energy, economic dispatch becomes increasingly more important, especially from a financial standpoint. Accordingly, the GEEC plans to construct a new "National Energy Control Center" for the 500 kV and 220 kV transmission systems of Egypt utilizing on-line real-time process control digital computers, with visual displays and peripherals, data acquisition and control equipment and the necessary data and telephone communications.

This system will collect, transmit, compute, display, alarm and log all the data necessary for the real-time supervision, control and operation of the system. It shall also control the operation of the 500 kV and 220 kV circuit breakers. In addition, it is intended for it to perform such functions as automatic generator control, economic dispatch calculations, security assessment, post-disturbance review, planning or study tasks and also training of load dispatchers.

Specifications have been prepared, published and distributed for vendors to submit tenders to provide and install the necessary equipment.

4.3 Distribution Expansion

The GEEC distribution system consists of various networks of 11 kV, 6.6 kV and 3 kV primary feeders stepping down to 380/220 volt secondaries. The design is basically of European origin consisting of fused low voltage secondary feeders fed from kiosks or cabine type transformer substations. The system is of old design and is presently being modified by the GEEC. In a great many cases, kiosk transformers are oversized, with primary and secondary feeders being undersized and in many cases with the transformers and lines both being overloaded. The above deteriorated situation contributes to low voltage levels, poor regulation, and excessive system losses.

The distribution system has not been fully maintained during recent years because of a lack of funds and is now in need of considerable reinforcement and expansion to meet both the present and future needs.

An embryonic rural electrification program is also starting and additional distribution construction will be required to successfully complete such a program.

Distribution system rehabilitation and expansion is long overdue and unless the urgently needed effort is expended in this area, the full potential of the generation expansion program will not be realized.

5.0 PROPOSED ISMAILIA STEAM PLANT

5.1 Site Description

The site of the proposed Ismailia steam power plant is located approximately five kilometers south of the City of Ismailia, adjacent to the Suez Canal, and just south of the El Temsah Lake near Maryam. The allotted area for the power station site is approximately 800 meters x 200 meters and is shown in Exhibit No. 5-1.

It is the same site previously chosen for the installation of two 110 MW Czechoslovakian units for which a contract was awarded to the Czechoslovak Skoda Export Company in 1965. However, the circumstances of the 1967 conflict forstalled the construction of this power plant. The plant site had been obtained from the Suez Canal Authority. A plan of the station, topographical survey and some preliminary work had been carried out for the previously mentioned Czech plant before the war interferred with its construction.

The site selected for the project is in a sandy non-cultivated region that is reasonably remote from inhabited areas. The terrain is generally flat and appears to be well chosen with the exception that the land is somewhat small and restricted in area for its utilization for an ultimate sized power plant containing four 150 MW thermal units. Vacant land is adjacent to the site and located just north of it between the proposed site and the road. This property is currently owned by the Suez Canal Authority and the GEEC should make efforts to secure the ownership of this land to augment the area available for the construction of the plant. The GEEC has mentioned that they plan to construct housing facilities for the plant's main operating and maintenance personnel (approxi-

mately 150 persons with their families) but it does not appear that the land required for such living facilities has been provided for.

Circulating cooling seawater for the plant's condensers will be obtained from the Suez Canal and released into Lake Temsah. The proposed plant's discharge facilities into Lake Temsah is presently planned to be located in a beach recreational area and this may create a problem necessitating a probable relocation of the plant's outfall facilities.

Outside of the two previously mentioned limitations; the one of the site size and the other of the location of cooling water discharge facilities; the site appears to be well chosen and fulfills most of the principal requirements needed for the selection of a good power plant site.

5.2 Fuel

The plant will be designed for dual fuel firing of both mazout (Bunker "C" fuel) and natural gas such that full load can be obtained by the use of either of the two fuels.

Natural gas is the preferred fuel but at the time of writing this report its allocation for use by the plant had not yet been confirmed. It would be supplied to the Ismailia plant site by pipeline.

The other fuel presently available for use in the Ismailia power plant is mazout. Unfortunately, the Egyptian mazout has a high sulfur content and the fuel planned to be used by the Ismailia plant would have a sulfur content of from 3 to 5 percent. This will require special design of the boiler and particularly of the air preheater. The Cairo West thermal plant of the GEEC has been in operation for approximately eight years and because of the

high sulfur content of the mazout burned in this plant, extensive damage has been sustained by the boiler and its associated equipment.

The environmental pollution effect of the combustion of fuel oil containing such a high sulfur content has been discussed with the GEEC. In accordance with the Agency for International Development's policy concerning environmental protection it was recommended that electrostatic precipitators, scrubbers and other such environmental protective auxiliary equipment be added to the plant. The GEEC stated that they have not previously used such equipment in their other plants and in view of the remote location of the Ismailia plant would not want to consider it for the Ismailia installation.

The specifications of the natural gas to be burned in the Ismailia plant is given in Exhibit No. 5-2.

The specifications of the mazout fuel oil to be burned in the plant is given in Exhibit No. 5-3.

5.3 Plant Design

The following plant description is of the design proposed by the GEEC with comments given by S&P.

The Ismailia thermal plant will have a total net capacity of 300 MW and will consist of two 150 MW steam turbine/generator units with provisions only for the future installation of two additional 150 MW units. In 1981 it is estimated that the GEEC system will have a load of 2900 MW. Normal practice would be to install a unit seven to ten percent of the load which would mean Ismailia would require individual units of a 200-300 MW size. The Ismailia 150 MW size would then appear somewhat small but can be justified when the re-

mote location of the Ismailia site is considered and the fact that the primary purpose of the plant is to serve the Canal Zone load.

The proposed plant layout is shown in Exhibit No. 5-4.

The steam generating units will be of outdoor design and will operate on a unit system with one steam generating unit feeding one turbine generator unit. The steam generating units will each have a maximum continuous rating of steam flow to allow 5% in excess of all the steam requirements of the turbogenerator and its auxiliaries at the full load net plant output of 150 MW. S&P would recommend a 10% excess steam requirement for the plant.

Approximate design steam pressure and temperature conditions of the GEEC plant for firing either natural gas or mazout were specified by GEEC and are stated below:

	Metric	English
Pressure	162 Kg/cm^2	2304 psi
Superheat temperature	538°C	1000°F
Reheat temperature	538°C	1000°F

It would appear that the economic optimum plant conditions for Egypt would be 1250 psig/ 950°F or 1800 psig/1000°F/1000°F. An economic study relating the cost of fuel over the life of the plant to the operating steam conditions should be performed. The plant will include the number of high and low pressure feedwater heaters as well as the deaerating feedwater heater to obtain the best plant performance as determined by the individual vendors. S&P recommends that the number of extraction points and feedwater heaters be predetermined by the purchaser to provide the opti-

mum heat rate consistent with cost.

Two surface condensers and three motor driven boiler feedpumps, the latter each of fifty percent capacity, shall be furnished for each unit.

Each turbine-generator will have a net output rating of 150 MW when supplied with steam at the approximate pressure and temperature conditions designated for the boiler.

The turbine types will be determined by the vendor but most probably will be of the reheat tandem-compound two flow type. The basis of turbine rating was not specified. S&P proposes that the turbine rating be based on $3\frac{1}{2}$ Hg absolute exhaust pressure and 3 percent make-up. The turbine should also be specified for operation with 5 percent over-pressure which is standard American practice.

The generators will be rated 176 MVA, 0.85 power factor, 50 Hertz, 2 pole, 3,000 rpm. The generated voltage was not recommended but S&P recommends that it be specified at 13.8 kV. The generators can be either gas or water cooled and should be provided with a brushless or static excitation system.

Station service voltages were not specified but will most probably be 4160 volts and 277/480 volts in accordance with American practice in a plant of this size.

Two 7.5 MW black start combustion turbines are specified by GEEC for the plant. A less expensive arrangement would be to utilize the presently existing 23 MW combustion turbine at the City of Ismailia. If this is not possible one 15 MW combustion gas turbine should be installed because of its lower overall cost over two 7.5 MW units.

5.4 Transmission and Substations

Each generator will be connected to its individual transformer by means of isolated phase bus duct. The generated voltage will then be stepped up to 220 kV by means of a 176 MVA generator transformer. The 220 kV side of each transformer will in turn be connected into an outdoor ~~double bus~~ main reserve and transfer bus switchyard which is basically of European design. The one-line diagram of the switchyard is shown in Exhibit No. 5-5 and comprises the following bays each equipped with air blast circuit breakers:

- 2 Incoming circuits from the 176 MVA transformers.
- 4 Outgoing overhead transmission line circuits.
- 1 Transfer bus bay.
- 1 Bus coupler bay with busbar sectionalizer switch.
- 1 Bay for incoming station service transformer.

An alternate arrangement using the more common American design of a "breaker and a half" type switchyard will be allowed in substitution for the double bus switchyard arrangement.

The four outgoing 220 kV overhead transmission lines will go to the new Ismailia switchyard with its two 125 MVA step down 220 kV to 66 kV transformers used to supply power to the City of Ismailia and its environs. Additional outgoing 220 kV transmission lines from the above City of Ismailia switchyard will run to the Cities of Zagazig and Suez and tie into the Egyptian National Grid System.

5.5 Alternate Arrangement of Switchyards

GEEC's present construction plans call for the construction of two new 220 kV switchyards in the Ismailia area; one for the new 300 MW steam power plant presently being studied, and one for the 250 MVA, 220/66 kV Ismailia City substation. Since the new Ismailia 220/66 kV switchyard is to be located fairly close to the planned new Ismailia power plant site, which has its own switchyard, it had been recommended that further study be given to combining the two switchyards into one unit. This would eliminate the need for the additional expensive 220 kV bays needed to terminate the four transmission lines connecting the two switchyards.

In subsequent conversation with the GEEC, the team was informed that the Ismailia City switchyard had already had all the civil works completed before the 1967 war and that at this late date it would not be possible to change its location.

5.6 Staffing

The GEEC has stated that the operation of the Ismailia power plant will require the following technical personnel:

17	University degree engineers
150	Technicians both mechanical and electrical (graduates of a technical high school)
5	Chemists with a university degree in science

It is planned to obtain the new plant employees from either the staff of presently operating thermal power plants or from graduates of the two

training centers presently operated by the GEEC. It is the GEEC's normal practice to train newly hired graduate engineers and technicians in such centers for a period of two to four months before assignment of such personnel to permanent positions in the company. This is one area where the team believed that additional effort should be expended as all such past training has been for the most part on Eastern and Western European equipment and practices.

It is also the intention of the GEEC to provide additional training to approximately 20 employees of the plant's technical staff at the training centers of the manufacturers supplying equipment for the power plant.

The number of personnel as specified by the GEEC for operation and maintenance of the Ismailia plant seems somewhat large. Normal American practice would require a staff of about 120 persons for the operation of a steam power plant with two units of this size. The number of university degree engineers also seems somewhat large. The use of junior shift engineers increases the total number of such university graduated engineers and is most probably done for training purposes. There is also an exceeding large number of maintenance personnel attached to the plant.

A listing of the technical personnel intended for the plant is given in Exhibit 5-6.

The organization chart for operation and maintenance of the plant as prepared by GEEC is shown in Exhibit 5-7.

6.0 PROPOSED HELWAN COMBUSTION TURBINE PLANT

6.1 Site Description

The Helwan Combustion Turbine Plant is to be located at New Tebbin in the southern portion of the Helwan district. This area is an important load center in the heart of an industrial complex of cement and iron and steel factories located approximately thirty kilometers south of Cairo.

The intended power plant site is a dry, sandy area remotely located from any existing electrical installations. Since a minimum of infrastructure is required for the installation of a combustion turbine plant, the location meets the necessary requisites for this type of plant.

One disadvantage of the chosen location appears to be that it is intended to locate the plant on one side of a future constructed highway and have the 66 kV switchyard on the other side of this new highway. This will necessitate the use of a long run of 66 kV oil-filled underground cable connecting the combustion turbine plant with this switchyard. Additional study should be made to firmly ascertain that it is not possible by various means; such as relocating the highway, purchasing additional land, etc.,; to locate both the power plant and its switchyard on the same site adjacent to each other.

6.2 Fuel

It is intended that the Helwan combustion turbines should be suitable for operation on either natural gas or distillate oil or to burn a combination of both fuels at the same time. Automatic transfer from the primary fuel (natural gas) to the secondary fuel (distillate oil) under load upon decay of the gas fuel supply line pressure; and manual

transfer back to the primary fuel will be provided for in the design of the equipment supplied for the plant.

Natural gas is the preferred source of primary fuel and will be obtained from the Abu El Gharadig gas field located approximately 200 miles west of Cairo on the southeastern extremity of the Qattara Depression. The cost of natural gas is estimated by GEEC to be approximately the same as that of mazout (Bunker "C" oil). Its composition is given in Exhibit 6-1.

The distillate fuel oil is known in Egypt as Solar Oil and is a more expensive type of fuel costing on a Btu basis about four times that of natural gas. As such, the cost of energy produce by combustion turbines utilizing a distillate oil as fuel would be greater than the average current selling price of electrical energy in Egypt. This statement may tend to be misleading as the actual cost of producing electricity by any method should be evaluated on a system basis and not by the direct comparision of generation costs.

It is reported that the distillate fuel oil would have to be imported for use in the combustion turbine plant. Its composition is given in Exhibit 6-2.

6.3 Plant Design

The Helwan Combustion Turbine Plant located at Tebbin in the Helwan district will have a total capacity of 120 MW. The installation will consist of single shaft simple-cycle packaged combustion turbines of a base load design with ratings between 20 MW and 30 MW. The design, as originally envisioned by GEEC, will have the combustion turbines installed in two groups each containing either three 20 MW or two 30 MW units. The

electrical one line diagram for the plant is shown in Exhibit No. 6-3.

The packaged power plant will include all the components and equipment necessary to operate the plant. Each combustion turbine will include four main sub-assemblies which include the control package, the power package, the generator package and the indoor metal enclosed switchgear equipment common to all of the two 30 MW or three 20 MW units located in each section of the plant.

The control package will provide all the equipment necessary to provide normal control and indicating functions. With this equipment it will be possible to operate the plant locally even with the plant designed primarily for unattended operation. The control package will consist of four main components; the turbine control panel, the generator control panel, the motor control center and supervisory equipment for remote control operation (if required). A command station battery and charger will be used for all of the two or three units of each of the two sections of the plant.

The power package will consist of two separate compartments housing the auxiliaries and turbine. It shall include the lube oil system, cooling water system, control air system, turbine accessory gear, fuel system, speed governor, and turbine gage panel. The turbine housing will contain the compressor and turbine units, solidly connected and supported on pressure lubricated journal bearings.

The generator package will house the main generator, static or brushless excitation system, reduction gear (if required), generator cooling air system and natural grounding equipment. All generators shall be of the open ventilated air

cooled type with Class B insulation, rated 25 MVA or 37.5 MVA at 0.8 lagging power factor. They shall be two pole machines rotating at 3,000 rpm with a nominal output voltage of 11 kV, 50 Hertz.

The switchgear equipment will be located adjacent to the generator packages of each of the units and each generator will be connected to it by its individual isolated phase bus duct. The switchgear shall be of the indoor metal clad type housed in a building to be constructed by local Egyptian contractors. Included with the switchgear are a double bus with individual 750 MVA interrupting capacity generator and transformer breakers with a double set of air disconnecting switches. The switchgear shall also include all generator surge protection equipment, an annunciator, instrument transformers, relaying devices and other equipment used to synchronize and connect all the combustion gas turbine units into the GEEC system.

6.4 Transmission and Substations

A 75 MVA three-phase outdoor oil-filled transformer connected 11 kV resistance grounded wye to 66 kV delta will be employed to step-up the generated voltage. It is normal practice to connect a generator step-up transformer delta on the low voltage generation side and grounded wye on the high voltage outgoing side but GEEC wishes this transformer to be identical to other transformer units presently installed in their system. The transformer will have an oil-filled junction box on the high voltage 66 kV side and will by means of an underground oil-filled 66 kV cable connect the generating system into a 66 kV switchyard supplied by others and to be located on the opposite side of a new highway to be constructed in the Tebbin area.

All of the equipment shown on the one-line diagram including station service and auxiliary transformers are to be included in the scope of the combustion turbine contract. Incoming start-up power will be supplied by a 6.6 kV to 400 volt station service transformer from a presently existing locally available source.

6.5 Alternate Design

An alternate arrangement using a unit turbine/generator design which is a true package combustion turbine approach is shown in the one-line diagram of Exhibit No. 6-4. This arrangement was proposed to the GEEC who in turn promised that this design will be incorporated as an alternate proposal in their bidding documents.

It is believed that most vendors will quote on combustion gas turbines with an output rating of 30 MW because of the lower dollar per kilowatt cost of such larger units over that of the smaller 20 MW units. It was therefore suggested that a less expensive and more flexible arrangement with greater reliability could be obtained by having vendors quote on providing each combustion gas turbine with its own step-up transformer. For this arrangement, two additional 69 kV oil circuit breakers with their associated air disconnecting switches and bays will be required as well as four 37.5 MVA step-up transformers instead of the two 75 MVA transformers required for the originally planned GEEC plant. It is believed that the cost of this additional equipment would be more than compensated for by the savings realized by the elimination of the expensive 11 kV double bus with its high cost air circuit breakers (750 MVA interrupting capacity) and with its additional cubicles needed to house the extra air disconnecting switches.

It is the GEEC intention to utilize these combustion turbines as energy producing units rather than as peaking units for their initial operation (approximately from 1977-1981), and then to move them to other sites such as in the Sinai Area. The unit approach in purchasing the combustion turbines has added flexibility as each combustion turbine would then be self-contained with its own transformer and switchgear and be capable of being moved and installed separately at any subsequently chosen site.

6.6 Staffing

The combustion turbine plant could be operated automatically with personnel required only for periodic maintenance. If such a type of operation is desired or anticipated by the GEEC, the units should be ordered with a supervisory control system suitable for control and with indicating and data acquisition systems. The operation of the combustion turbines could then be controlled remotely from the Cairo West Load Dispatching Station.

For the initial years of operation, it is the intention of the GEEC to utilize the Helwan Combustion Turbine Plant to alleviate the Egyptian energy shortage particularly during the winter months with its minimum irrigation requirements, which in turn, curtails system hydro energy production from the High and Aswan dams. As such, the plant will be operated for longer periods than would be necessary for a combustion turbine plant utilized solely as a peaking or standby installation.

Under this method of operation, it is anticipated, at least for this initial operating period (1976 thru 1981), that the plant will be operated as an attended power station. Therefore the following staffing is recommended for the plant:

University Degree Engineers

1 Power Station Manager
1 Chief of Operations Department
1 Chief of Maintenance Department

Technicians

5 Senior Shift Technicians
5 Junior Shift Technicians
2 Electrical Maintenance Technicians
2 Mechanical Maintenance Technicians

7.0 PROPOSED TALKA COMBUSTION TURBINE PLANT

7.1 General

An additional energy shortage commencing in 1978 is forecasted for the Egyptian generation system. Such a deficiency will become very acute in late 1978 with the reduction of the available hydro energy from the Aswan and High Dams during the months of December 1978 and January 1979.

To alleviate this energy deficiency, the GEEC is planning the installation of 180 MW of additional combustion turbines to be erected in the Talka area in the delta. The original scope of this study did not include the Talka combustion turbine plant. Subsequent discussions raised interest in this plant and it is briefly included here for consideration. The commercial operation date for the Talka units is planned to be in September of 1978. The design of the plant will consist of either nine 20 MW units or six 30 MW units of the same combustion turbine type planned for the 120 MW Helwan plant. The turbines will be fired by natural gas from the Abu Madi gas field and will use distillate oil as an alternate fuel.

Each combustion turbine will generate at 11 kV, 50 Hertz. As of the date of preparation of this report, it had not been ascertained by the GEEC if the voltage of these units would be stepped up to 66 kV or 220 kV; both voltages being presently available in the Talka area. It will probably be decided that the units will be fed into the 220 kV network because of the relatively large block (180 MW) of power that will be available from these turbines. If such is the final decision the overall cost of the plant on a dollar per kilowatt basis would be slightly higher than the

Helwan plant because of the need for a 220 kV step up transformer and 220 kV air blast circuit breakers instead of the 69 kV transformer and oil circuit breakers to be installed at Helwan.

7.2 Recommendations

Several recommendations concerning the proposed plant are made at this time for consideration by the GEEC.

If financing for the Talka plant is arranged in time, it is proposed that the same invitation to bid for the Helwan combustion turbines include one additional price option for the purchase of the Talka plant with the purchase and delivery of such Talka plant to be scheduled at a later date. This approach would reduce the overall dollar costs of both plants. If all such units were to be purchased from one vendor additional benefits could be realized both from an operational and maintenance aspect. The number of spare parts needed to be purchased for both plants would be definitely reduced. It was proposed during our discussions in Egypt that the GEEC considers the purchase of a complete combustion turbine rotor as a spare part unit and if many combustion turbines of the same type were to be purchased, the need for implementation of the above suggestion is strengthened.

It is also recommended that the GEEC also considers the same combustion turbine/transformer unit approach as suggested for the Helwan plant and includes as an alternate request for quotation the use of 60 MW combustion turbines instead of 20 MW or 30 MW size. This second proposal would definitely reduce the overall cost of the plant. Sufficient experience in the operation of these larger sized combustion turbines will have been realized by such time to warrant their employment in a plant of this size.

8.0 COMMENTS ON THE GEEC SPECIFICATIONS FOR THE ISMAILIA AND HELWAN PLANTS

8.1 Specifications for the Ismailia Steam Power Plant

The GEEC has prepared a preliminary set of tender documents for the construction of the Ismailia fossil fuel fired thermal plant. The General Terms and Conditions for such an invitation are basically the same as those presently being utilized for the Agency for International Development financed invitation for the purchase of distribution equipment for the Canal Zone.

A brief review of the specifications has been made by Sanderson and Porter, Inc. Discussions were held with the GEEC personnel concerning some recommended clarifications and/or changes and modifications to the specifications. In general the specifications suffice although somewhat over designed, and not specific enough in intent. Some additional time should be utilized in rewriting several sections of the technical specifications to improve the wording, have them more closely comply with American standards, and to detail the exact technical parameters required for the plant.

A few of the Sanderson and Porter's specific suggestions are as follows:

a. Since the initial cost of a thermal power plant unit increases significantly with its thermal efficiency (or the reduction in heat rate) it is common practice in the United States to investigate several alternative designs with different initial steam conditions, different numbers of extraction points for regenerative feed water heating, and different exhaust sizes, in order to determine which arrangement

would yield the best overall economic generation considering fuel cost and the applicable fixed charge rate (or cost of money).

While presently applicable financing and fuel costs in the United States would probably point to the selection of steam conditions of a 1250 psig/950°F non reheat unit or a 1450 psig/1000°F/1000°F or 1800 psig/1000°F/1000°F reheat unit with six or seven extraction points using a tandem compound double flow 26 inch or 28 inch last row blades in the exhaust, conditions existing in Egypt now and for the next three decades could well be sufficiently different to justify entirely different steam conditions.

The GEEC has requested that the Ismailia 150 MW units operate in accordance with the following approximate steam temperature and pressure conditions:

	Metric System	English System
Steam pressure	162 kg/cm^2	2304 psig
Superheat temperature	538°C	1000°F
Reheat temperature	538°C	1000°F

The price of fuel oil in Egypt has been established by the Government at a uniform rate of LE 7.5/ton for oil [illegible] calorific value 9600 kcal/kg correspondi[illegible] about U. S. $0.43 per million Btu. [illegible] a relatively low price taking into consi[illegible]tion that since 1973 the price of petroleum products on the world market has greatly increased. Therefore, it is quite probable that the Egyptian Government, being pragmatic, will also take this fact into consideration.

Nevertheless, a pressure of 2300 psig seems high for a unit of this size considering the present low cost of fuel in Egypt. Also steam generating and turbine units operating at these steam conditions are more subject to possible damage and higher maintenance than units operating at a lower pressure and temperature.

Therefore, an economic study relating the probable cost of fuel over the life of the plant to the operating steam conditions should be made to determine the optimum pressure, number of feed water heaters, and also the superheat and reheat temperatures as well as exhaust area to be specified for this plant, all taking into account the fixed charge rates for financing.

b. The GEEC specifications do not provide for any cost evaluation for units that may vary from the size specified. Therefore, it is recommended that the invitation to bid include an evaluation formula permitting vendors to quote on a capacity deviating slightly from the 150 megawatts specified. Such a formula should also include evaluation provisions for the various net plant heat rates quoted by the vendors.

c. The GEEC specifications do not make any provision for partial payments to be made to vendors during the manufacture of the power plant equipment. Such a provision should be included.

d. The specification for the steam generator follows the European practice in that it does not call for five percent overpressure as is normally requested for American plants. Europeans design to closer toler-

ances. Therefore, this overpressure requirement should be incorporated in order to make the bidding more equitable.

e. It is recommended that ten percent excess boiler steam requirements be requested for the plant. This would insure ample reserve so that the full rating of the plant could be realized at all times. The need for this ten percent steam capacity is indicated by the current derated capacity of the steam plants currently operating in the GEEC system.

f. To clarify the methods of volume control for the forced draft fans such as speed control of the fans by variable speed coupling and positioning of the inlet to be varied by means of the combustion control equipment.

g. Although it may be of minor importance to the overall performance of the plant, a motor operated safety valve should be installed on the steam drum connected in parallel with the spring loaded safety valve and set to operate at a lower value than the spring loaded safety valve in order to increase the life of the valve seats of the safety valves.

h. The cost of supplying totally enclosed motors for driving the plant half sized boiler feed pumps should be thoroughly investigated and justified before specifying such a very large increase in cost over American usual practice. In an indoor plant open drip-proof or encapsulated motors should provide satisfactory operation.

i. It is strongly recommended that any and all impulse tests on the alternator be omitted and that the American National Standards Institute be specified for all such tests.

j. Thermally upgraded insulation should be specified for the insulation of all transformers. It is also recommended that oil preservation equipment not be restricted to the older European standard of the "Conservator" method of oil preservation.

k. A wye connected 220 kV winding of the generator step-up transformers with a uniformly insulated winding and the neutral point connected to earth by means of an insulating switch is not standard practice of U. S. utilities. Therefore, since such special transformers would be unnecessarily more costly than a transformer with graded insulation it is recommended that serious consideration be given to the American practice of using graded insulation for all wye connected transformer windings above 69 kV and the use of not higher than a 15 kV neutral bushing for effectively grounding the transformer neutral without any provision being made for an isolating switch.

l. The potential benefits or value of using seven single phase generator step-up transformers rather than two three phase units for the two generators is questionable and the greatly increased cost is rarely warranteed. It has been proven in the United States over many years that power transformers are the most reliable part of a thermal generating station. Therefore, the use of single phase banks for insurance against transformer failure is no longer

used in utility systems unless there are other reasons such as shipping limitations. "De-energized" tap changing is the preferred word over "Off-Load".

m. The need for disconnecting the unit auxiliary power transformer while the generator is operating under load is so extremely remote that its connection to the generator leads via an insolator capable of interrupting its no load current and capable of withstanding the mechanical and thermal stresses under short circuit conditions is an unnecessary and costly addition. A bolted connection has been found adequate for disconnecting the auxiliary transformer when necessary.

n. It is questionable whether the tap changing under load feature for the station service transformer is necessary. This feature should be investigated before the extra cost is committed to be spent.

o. It is recommended that all generator neutrals be impedance grounded through a distribution type transformer with its secondary loaded by means of a bank of resistors. Ground fault protection of the alternating current generator stator winding should be by a generator ground overvoltage relay tuned for 50 Hertz and insensitive to third harmonic voltages. That is, it shall not operate for the third harmonic load unbalance which normally flows in the generator neutral. The relay shall have a low pick-up voltage (approximately 8 percent of rating) operating on increasing voltage and provide good sensitivity for light ground faults in the machine.

p. It is recommended that serious thought be given to elimination of the two 7.5 MW black start combustion turbines. If it is still desired to incorporate this emergency feature in the plant design, consideration should be given to the use of one 15 MW unit with its lower overall cost over two 7.5 units units. A single 7.5 MW unit might also be considered unless it is specifically desired that the two steam units be started at the same time.

q. Finally it is recommended that the specifications for the Ismailia power plant be more specific in intent and not leave important technical design criteria for vendor decision.

8.2 Specifications for the Helwan Combustion Turbine Plant

The GEEC has prepared a preliminary set of tender documents and specifications for the packaged power combustion turbine generator units. The General Terms and Conditions for this invitation to bid are basically the same as those presently being utilized for the Agency for International Development financed invitation for the purchase of distribution equipment for the Canal Zone. A review has been made by Sanderson and Porter, Inc. of the invitation to bid documents and specifications. Discussions were held with the GEEC personnel concerning recommended clarifications and/or changes and modifications.

Some of the specific suggestions are as follows:

a. The vendors should be requested to furnish engineering data on the performance of their quoted turbines using either natural gas or distillate giving plant net rating under standard ambient conditions as well as correc-

tion figures or curves for the ambient conditions expected to prevail in Egypt.

b. In the invitation to bid the GEEC should include an evaluation formula for net plant output and heat rate quoted by vendors.

Heat Rate?? Nothing in Spec Would be very important with 60 MW units

c. It is recommended that the Helwan invitation to bid include a request for a price option for the purchase of the Talka units. It is also recommended that prices be requested for the Talka plant with units of a 60 MW frame size.

and Helwan

d. Since the turbines of combustion turbine units operate at very high temperatures in order to maintain the highest possible thermal efficiency, there is an inherent tendency for maintenance to be relatively high. Therefore all vendors should be requested to furnish a warranty or some assurance of the number of hours of continuous operation of their machines at full load. Also they should furnish a detailed description of the methods employed to increase the reliability as well as the performance of thier machines.

Can't find request

e. It is recommended that the requirement for a flexible coupling between the generator and turbine be omitted and that this feature be left entirely up to the discretion of the manufacturer, because a rigid or solid type coupling is standard by United States suppliers for all the larger frame sizes. In those cases where their standard practice happens to use a flexible coupling on account of easy availability or less rigid alignment procedures it will be supplied automatically. Otherwise this unnecessary requirement will raise questions on the part of the vendor and possible changes.

See Pg 54 2.2

f. It seems pointless to specify 10 percent overload capability, at rated voltage and rated power factor of the alternator unless the combustion turbine can provide the power needed to drive it. United States practice usually has a base rating as well as a peak rating for combustion turbines both of which are different depending on the type of fuel being used. It is also advised against specifying the total overload in kilovolt amperes due to the complications that such a request would produce. Also any reactive power (vars) required by the system can be produced more economically in other ways such as static capacitors.

No provisio

g. Comments regarding impulse tests on alternator stator were covered under Section 8.1, item i.

h. Since the standard connection for alternator stators is wye, the connection of the low voltage winding of the step-up transformer should be delta in order to provide a path for the harmless circulation of any negative sequence current that may arise from any cause. Therefore, the ~~primary or~~ high voltage winding should be connected wye, and no attempt should be made to duplicate other transformers used in the GEEC system.

Specs call for Y-Δ instead of Δ-Y

i. To show the much lower investment cost and at the same time secure the simpler and more reliable operating arrangements, it is recommended that alternate bids be secured on a unit type of installation where each combustion turbine generator has its own individual step-up transformer and high voltage breaker. This would eliminate all the intermediate 11 kV switchgear. The

merits of this arrangement are discussed in Section 6.5 of this report.

j. In the event that low voltage switchgear is decided upon as being necessary it is recommended that the extremely special (for U. S. construction) double bus arrangement for generator voltage switchgear be abandoned entirely as being unduly complex and entirely unnecessary. All the components of modern designed metal enclosed, draw-out breaker type switchgear have very great reliability. The only known feasible method of providing the necessary double set of disconnect switches required for the double bus arrangement is to provide a separate cubicle for each set of disconnects besides the cubicle housing the breaker. Besides the obviously greater cost of this arrangement it has another distinct disadvantage in the present case in that the special engineering necessary before its factory production can appreciably delay delivery of this urgently needed generation capacity.

k. Finally it is recommended that the specifications for the Helwan power plant be more specific in intent and not leave important design criteria for the decision of the vendors.

9.0 PROJECT ENGINEERING, DESIGN, PROCUREMENT AND CONSTRUCTION

9.1 Engineering Services

It is recommended that the General Egyptian Electricity Corporation (GEEC) engage the services of a qualified Architect-Engineering (A-E) firm to perform the following functions:

a. To review all specifications for equipment that have been prepared by the GEEC personnel in order to clarify, revise and modify where required in order to comply with American National Standards Institute and/or any other applicable U. S. standards.

b. To analyze all tenders received and make recommendations for the placing of purchase orders.

c. To expedite delivery, inspect all equipment and materials prior to shipment as well as to witness all necessary required tests.

d. Be capable of managing the construction of the entire project.

e. Assist in testing individual components.

f. Supervise and assist in start-up and initial operation.

The A-E shall have the following qualifications:

a. Competent technical staff in the civil, electrical, hydraulic and mechanical phases of thermal power plants.

b. Availability of competent manpower to perform all the necessary services within the projected schedule, including supervisory personnel.

c. Competence of other supporting staff in areas such as estimating, cost control, procurement and inspection.

To assure the construction of the power plants on schedule and with the minimum capital investment as well as minimum maintenance costs consistent with reliable, safe and efficient operation, certain procedures must be followed and criteria established to meet these objectives as described below:

a. Review all the GEEC preliminary designs, reports, estimates and schedules on which each project is based to establish concurrence and continuity and to determine the need, if any, for further studies or investigations.

b. Prepare an implementation plan and schedule for carrying out those projects after all preliminary data have been brought up to date and verified. The availability of funds to meet project requirements at all times is essential. Therefore, this plan should contain the following as a minimum:

1) Engineering and design schedule.

2) The scope of all contracts and purchase orders for construction, equipment and services.

3) Schedules showing order and timing of events.

4) Curve of estimated percent of each project's completion by months.

5) Tabulation of cost estimates of contracts and purchase orders showing amount and sources of funding for each item of every project.

6) A financing plan coordinated with schedules and insures that funds are available as and when required.

10.0 PROJECT COST ESTIMATES & CONSTRUCTION SCHEDULES

10.1 Basis of Cost Estimates

The project cost estimates for the Helwan and Talka Combustion Turbine Plants were prepared on the basis of scheduled operation as follows:

First 60 MW block of Helwan Plant	Sept., 1976
Second 60 MW block of Helwan Plant	Dec., 1976
Talka 180 MW Plant	Sept., 1978

The project cost estimate for the Ismailia Steam Power Plant was prepared on the basis of scheduled operation of each of the units as follows:

First 150 MW Unit	September, 1981
Second 150 MW Unit	September, 1982

The costs are for the six 20 MW or four 30 MW combustion turbine units located at Helwan, the six 30 MW combustion turbine units located at Talka and the two 150 MW steam units located at the Ismailia site all described elsewhere in this report. For all of the units both the estimates for the foreign currency costs and the local currency costs are shown. Certain specific criteria upon which the estimates are based are explained as follows:

a. Capital Costs

The estimates are based on the plant arrangement and equipment as decided by the GEEC and as shown in Exhibit No. 6-3 for the Helwan Combustion Plant and in Exhibit Nos. 5-4 and 5-5 for the Ismailia Steam Power Plant.

Land for both the Helwan and Ismailia plants is currently owned by the GEEC. Costs for additional electrical right-of-ways were not included in the cost estimate. Cost for access roads are included where applicable.

Equipment and material prices for the GEEC estimate are as follows:

1) Helwan Combustion Turbine Plant - The price of 8,700,000 LE as supplied by the GEEC includes transportation, engineering, supervision, escalation, contingencies, interest during construction, etc.

2) Ismailia Steam Power Plant - The GEEC costs for equipment and materials are taken from those received for a similar power station of 2 x 150 MW steam units presently being built at Abu Qir near Alexandria. The bids for this station were submitted on October 1, 1974 and a contract for the supply of equipment was signed on March 23, 1975 between the GEEC and a consortium of French companies. The Ismailia estimated price does not include interest during construction.

Equipment and material prices for the S&P estimate are as follows:

1) Helwan Combustion Turbine Plant - The S&P price estimate is taken from current prices for such equipment and the prices quoted for the 4-23 MW combustion turbines pre-

sently completing installation in the Canal Zone.

2) Ismailia Steam Power Plant - Costs for equipment are based on current price levels for a similar plant now under construction. The estimated price does include interest during construction.

b. Erection Costs

Erection costs for the GEEC estimate were taken according to the estimates for erection supplied by companies belonging to the GEEC for the previously mentioned Abu Qir power station. Erection costs for the S&P estimate were taken from actual costs for constructing similar units in the United States and using a labor cost index of 0.21 (a ratio of labor costs in Egypt to comparable labor costs in the U. S.) as obtained from Page 63 of the International Atomic Agency 1973 Report on Egypt.

c. Civil Works

Civil work costs for the GEEC estimates for both plants were based on their experience gained from the construction of similar plants already in operation or still under construction such as the Canal Zone combustion turbines and the Kafr El-Dawar steam power plant. Civil work costs for the S&P estimate were taken from experience in the construction of units of a similar size in the United States.

d. Freight and Insurance

Current freight and insurance rates were used to calculate the freight and insurance for the equipment supplied. The GEEC estimate assumes international shipping to be done on Egyptian registered lines while the S&P estimate assumes such shipping to be done on American registered lines.

e. Escalation

Prices for the Helwan and Ismailia plants were prorated for the 1976 completion date of the Helwan Plant and the 1981 and 1982 completion date of the Ismailia plant.

f. Contingency

Five percent contingency was added for both plants of both the GEEC and the S&P estimates.

g. Exchange Rate

The current official exchange rate of 2.56 U. S. Dollars to 1 Egyptian Pound was used.

Finally, since the actual site plan, location and outgoing transmission voltage of the Talka combustion turbine plant are not known at the time of writing this report, it was assumed its construction would be similar to that of the Helwan Plant.

10.2 Summary of Costs

The GEEC and S&P estimates for the Helwan combustion turbine plants are given in Exhibit No. 10-1; the estimates for the Ismailia steam power plant are given in Exhibit No. 10-2. The S&P estimate for the Talka combustion turbine plant is escalated from the estimated cost of the Helwan plant. The GEEC estimate assumes the same dollar per kilowatt costs for both the Helwan and Talka plants.

A summary of the cost of the Helwan, Talka and Ismailia plants and a compilation of both the S&P and GEEC estimates is given as follows:

HELWAN PLANT

	S&P Estimate		GEEC Estimate	
	US$	LE	US$	LE
Foreign Currency	16,128,000	6,300,000	22,272,000	8,700,000
Local Currency	3,279,000	1,281,000	3,328,000	1,300,000
Total	19,407,000	7,581,000	25,600,000	10,000,000
Cost/Kw	$162/Kw	68 LE/Kw	$213/Kw	83 LE/Kw

TALKA PLANT

	S&P Estimate		GEEC Estimate	
	US$	LE	US$	LE
Foreign Currency	29,274,000	11,435,000	33,280,000	13,000,000
Local Currency	5,952,000	2,325,000	5,120,000	2,000,000
Total	35,226,000	13,760,000	38,400,000	15,000,000
Cost/Kw	$196/Kw	76 LE/Kw	$213/Kw	83 LE/Kw

ISMAILIA PLANT

	S&P Estimate		GEEC Estimate	
	US$	LE	US$	LE
Foreign Currency	104,294,000	40,740,000	96,000,000	37,500,000
Local Currency	66,944,000	26,150,000	49,715,000	19,420,000
Total	171,238,000	66,890,000	145,715,000	56,920,000
Cost/Kw	$571/Kw	223 LE/Kw	$486/Kw	190 LE/Kw

COMPILATION OF ALL S&P ESTIMATES

	Foreign Currency		Local Currency	
	US$	LE	US$	LE
Helwan	16,128,000	6,300,000	3,279,000	1,281,000
Talka	29,274,000	11,435,000	5,952,000	2,325,000
Ismailia	104,294,000	40,740,000	66,944,000	26,150,000
Total	149,696,000	58,475,000	76,175,000	29,756,000

COMPILATION OF ALL GEEC ESTIMATES

	Foreign Currency		Local Currency	
	US$	LE	US$	LE
Helwan	22,272,000	8,700,000	3,328,000	1,300,000
Talka	33,280,000	13,000,000	5,120,000	2,000,000
Ismailia	96,000,000	37,500,000	49,715,000	19,420,000
Total	151,552,000	59,200,000	58,163,000	22,720,000

10.3 Construction Schedules

The construction schedule for the Ismailia steam power plant is given in Exhibit No. 10-3.

The construction schedule for the Helwan combustion turbine plant is given in Exhibit No. 10-4.

The construction schedule of the Talka combustion turbine plant will be similar to that of the Helwan combustion turbine plant.

11.0 PROJECT ECONOMIC JUSTIFICATION

11.1 General

Although the economic justification of the proposed generation is outside the scope of services for this study, the following comments are offered based on a brief summary of our cursory appraisal of production costs and economic benefits.

11.2 Present Rate Structure of GEEC

Tariff schedules are formulated by the GEEC under guidelines established by the Egyptian government. These tariff schedules must then be approved and authorized by the Egyptian government through law. The process of making changes in tariff rates or terms is a very slow process since such alterations must go through a lengthy governmental procedure involving approval by the President with his Cabinet and eventual final approval by the Parliament. This cumbersome process makes any needed tariff changes difficult to adjust to changing economic conditions. Fortunately, the cost of fuel oil, wages and many commodities is also fixed by law and as such outside changes in market conditions normally do not greatly affect the financial operations of the GEEC.

Tariffs for very large customers such as aluminum, iron and steel, fertilizer and petrochemical industries are negotiated on an individual basis and in many cases the energy cost is actually subsidized by the Egyptian government. Similar special rates are also authorized for irrigation and other particular category customers. Such rates are not based on any existing rules but are predicated on the industry's own costs and the government's desire to patronize a particular industry. The wide variance in tariff rates be-

comes readily apparent in Exhibit No. 11-1 which shows the Average Electric Tariffs paid by Categories of Consumer for the years 1969 thru 1973.

The GEEC tariff structure was revised on January 1, 1975. These new tariff rates as well as previous tariff rates are intended to permit the GEEC to realize a three percent return above their operational costs. Such costs include administration, labor, fuel, operation and maintenance, depreciation and interest on loans. A perusal of the financial statements of the GEEC reveals that the company has not been able during the preceding years to realize this planned three percent profit.

The average sales tariff per kilowatt hour charged by GEEC for previous years of operation is as follows:

Year	Millimes*/kwhr	U.S. Cents**/kwhr
1966	6.4	1.64
1967	6.3	1.61
1968	6.4	1.64
1969	6.5	1.66
1970	6.5	1.66
1971	6.9	1.77
1972	7.4	1.89
1973	7.5	1.92
1974	7.5	1.92

* 1 Millime = 1×10^{-3}LE
** At Exchange Rate LE 1 = U.S. $2.56

As can be seen from the above tabulation there has been very little change in tariff rates over the last nine years. The new tariff rates effective in January of 1975 are given in Exhibit No. 11-2.

The following discussion reveals that the tariff policy and tariff-setting procedures of the GEEC are very inflexible. The tariff structure and rates of the GEEC should be revised to be more autonomous and closely reflect electric energy supply costs and not arbitrarily set and regulated by law.

11.3 Estimated Power Production Costs

A tabulation of the estimated cost of power production of both the Ismailia thermal plant and the Helwan combustion turbine plant had previously been prepared by the GEEC. The same production cost format with some modifications has been used by the study team to prepare their own estimate. The estimated production costs are shown in Exhibit 11-3 for the Ismailia thermal plant and in Exhibit 11-4 for the Helwan combustion plant. Production costs for the Talka plant should be similar to those of the Helwan plant.

The annual operating costs used in this production cost study are based on the expected fuel consumption of units of this size and expected plant heat rates for such units. The actual GEEC costs for salaries, operating supplies, spare parts and maintenance charges for similar stations presently in operation in the GEEC system, are used in the calculations.

Fuel costs for mazout are based on the uniform price of LE 7.5/ton of oil (U.S. $19.20/ton) with a calorific value of 9600 kcal/kg, corresponding to approximately U. S. $0.43/$10^6$ Btu. This cost is the fixed price established by the Egyptian government. In Egypt, natural gas on an equivalent heat value basis has the same cost as mazout. Distillate fuel oil has a much higher cost of LE 30/ton (U.S. $76.80/ton) and must be imported. No allowance has been made for

inland transportation of fuels to the power plant sites in the above prices.

11.4 National Economic Benefit

The economic benefits to be derived from the Helwan, Talka and Ismailia projects are, to a large extent, not subject to a precise monetary evaluation.

The Helwan and Talka Combustion turbine plants are required because of the failure of the GEEC to construct the adequate steam generation capacity required to service the heavy Egyptian industrial loads which currently exist, are under construction, or are already committed for and approved for construction. The inability of the Egyptian economy to support such construction was the consequence of an unsettled war atmosphere and a deterioration of world economic conditions in general. These heavy industrial loads are shown in Exhibit 3-2. They include the KIMA Company for fertilizers in Aswan, the Iron and Steel complex in Helwan and its extensions, the phosphate plant at Naz Hamadi, the Aluminum complex at Naz Hamadi and the new oil pipeline extending from the Gulf of Suez to the Mediterranean.

Other loads will also result from the reconstruction and industrialization projects of the Canal Zone as well as from the electrification of the rural areas of the country. Apart from the heavy industrial loads already constructed, under construction, or approved for construction, other industrial complexes and loads are contemplated whose approval will be forecoming in the immediate future. These include the spongy iron in Alexandria, phosphates at Abu Tartar, petroleum refineries at Cairo and Alexandria, petrochemicals factories at Alexandria, electrification of the

national railway system, electrification of diesel irrigation pumps throughout the country, etc.

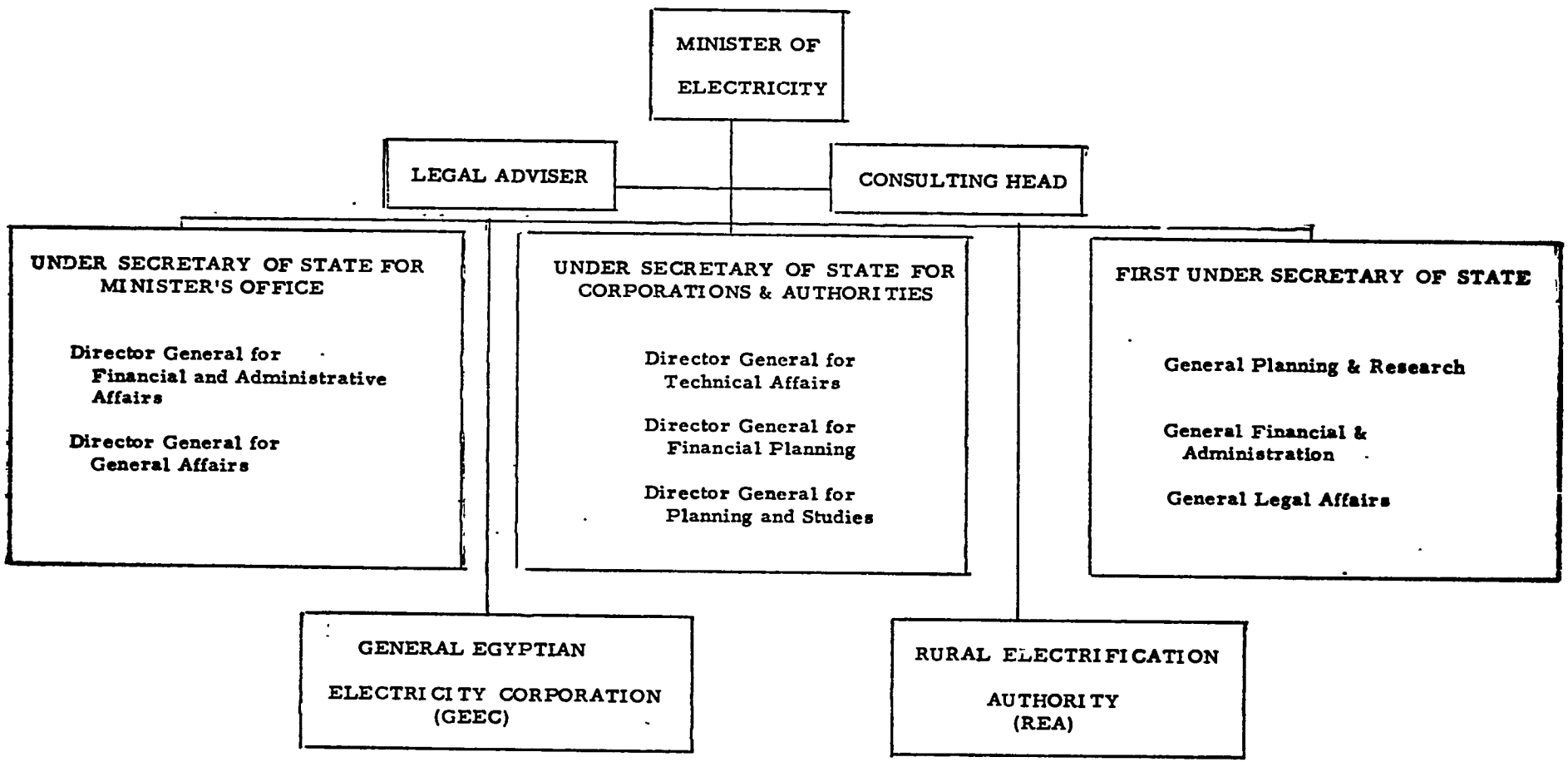
It is planned to purchase combustion turbines for the Helwan and Talka plants because at this late date it is not possible by any other means to acquire the additional generating capacity of 120 MW before the dates of December, 1976 and 180 MW before December, 1978 as specified by the GEEC. It is planned to utilize these combustion turbines not only for peaking requirements but also to supply the deficit energy requirements of the Egyptian system.

At the date of preparing this report an adequate period of time does exists to allow for the construction of a 300 MW steam generation plant at Ismailia on the Suez Canal. For this reason a convential steam power plant is considered for this project.

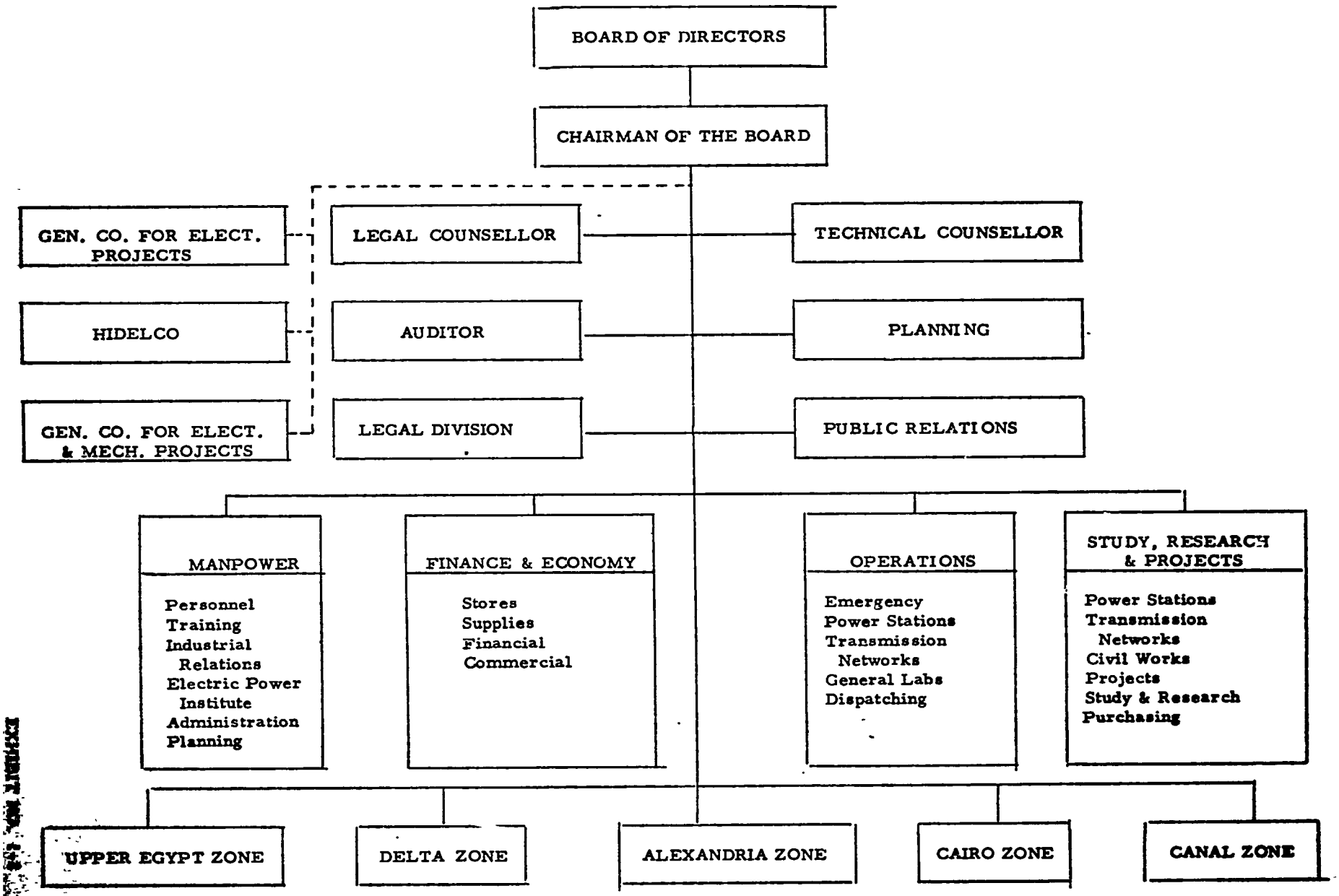
Besides supplying the normal requirements of the Egyptian integrated power network, it is intended that the Ismailia project will furnish power for the rebuilding and expansion load of the Canal Zone industrial cities of Ismailia, Suez and Port Said. Refineries, petrochemical industries, fertilizer and cement factories all are planned to be constructed in the Canal Zone. Land reclamation, irrigation, and drainage projects are also scheduled for the Salheieh land area south of Port Said and in other areas on the eastern bank of the Suez.

The Ismailia Power Station together with its planned transmission and distribution networks will provide the needed energy for these proposed Canal Zone industrial and agricultural expansion and rehabilitation projects.

ORGANIZATION CHART OF THE MINISTRY OF ELECTRICITY



ORGANIZATION CHART OF THE GENERAL EGYPTIAN ELECTRICITY CORPORATION



MEMBERS OF THE BOARD OF DIRECTORS OF GEEC

1- Engineer: Adly Kamel Yakan - Chairman of G.E.E.C.

2- Dr. Eng.: Mahmoud A.B. El. Koshairy - President of

The Egyptian National Committee
International Electrotechnical Commission (I.E.C.)

3- Engineer: Abdel Aziz Abdel Naby

President of Executive Branch of Rural Electrification Authority

4- Engineer: Mohamed M. Abaza - First Undersecretary of State
Ministry of Electricity

5- Engineer: M. Abdel Ghani. El. Raschidy - Technical Consultant
of the G.E.E.C.

6- Mr. : A. El Azab - Legal Advisor

7- Engineer: M.K.M. Hamed - President of Cairo Zone (G.E.E.C.)

8- Mr. : M.A. Abdou - Undersecretary of State
Ministry of Finance

9- Engineer: A. K. Galazar - President of Alex. Zone (G.E.E.C.)

10- Engineer: Y.M. Hagazi - Undersecretary of State
Ministry of Planning

11- Engineer: M.K. Sabry - President of Upper Egypt Zone (G.E.E.C.)

12- Engineer: A. Abdel Hafiz - Undersecretary of State
Ministry of Housing & Reconstruction

13- Dr. Eng.: F. Farid - President of Lower Egypt Zone (G.E.E.C.)

14- Engineer: M.H. Eldawi - Chairman of Western Desert Petrol Co.

15- Engineer: M.H. Tolba - President of Canal Zone (G.E.E.C.)

16- Dr. Eng.: A.M. Kamel - Professor Mechanical Engineering in
Faculty of Engineering, Ein-Shames University

17- Engineer: H.M.M. Soltan - Chairman of Hidelaco Company (G.E.E.C.)

18- Mr. : M. El Mahdi Abdellah - Legal Advisor

EXHIBIT NO. 1-1

PRINCIPAL OFFICERS OF THE GENERAL EGYPTIAN ELECTRICITY CORPORATION

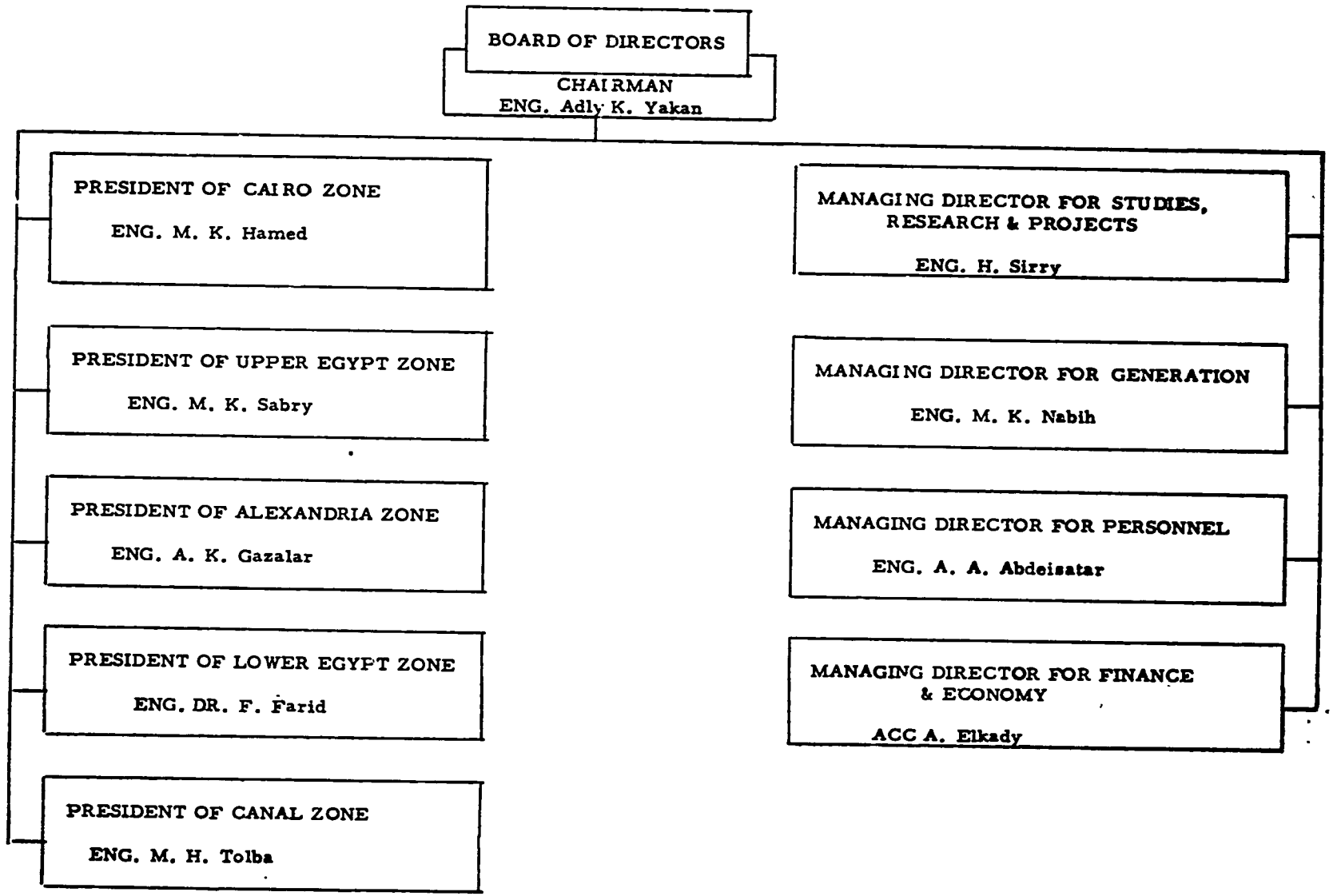


EXHIBIT NO. 1-4

DETAILED BALANCE SHEET

1968 - 1974

ASSETS

Values Given In Egyptian Pounds

	1968	1969	1970	1971	1972	1973	1974
FIXED ASSETS							
Lands	1,633,293	1,724,293	1,973,033	2,041,900	2,063,552	2,189,868	2,186,506
Buildings	28,194,450	30,038,759	43,221,513	43,526,620	78,356,944	79,680,109	80,273,816
Machines and Equipment	132,401,718	154,362,881	240,938,888	241,901,920	313,264,315	320,713,789	323,442,809
Vehicles	2,393,416	3,513,363	3,947,842	4,254,552	3,839,781	4,316,700	5,136,376
Tools	3,420,256	3,797,051	4,152,472	4,459,895	5,433,663	5,965,373	6,151,712
Furniture	747,953	7,933,389	881,046	961,768	1,139,387	1,316,777	1,428,406
Intangibles	40,235	2,263,975	89,456	96,784	393,602	749,149	2,539,669
Construction in progress	58,142,814	48,685,462	44,287,701	55,062,852	36,949,846	36,346,876	50,282,596
TOTAL FIXED ASSETS	226,974,135	244,129,173	339,491,951	352,306,293	441,441,090	451,278,621	471,359,183
CURRENT ASSETS							
Inventories	9,872,130	11,135,502	12,744,201	14,124,577	20,319,480	25,211,675	30,801,901
Local long term receivables	402,173	780,868	550,118	534,249	566,232	5,626,048	5,506,015
Investments	336,911	326,911	326,230	326,230	1,214,465	1,914,454	2,017,519
Customers (Receivables)	12,075,883	13,344,623	15,092,277	16,242,608	23,193,803	22,624,966	30,749,506
Other deferred debts	21,615,555	27,483,543	14,758,481	20,495,580	32,229,482	36,468,471	45,232,832
Cash	11,215,243	14,173,954	14,117,798	12,618,175	10,477,821	12,368,277	9,672,443
TOTAL CURRENT ASSETS	55,517,895	67,245,401	57,619,105	64,341,419	88,001,283	104,213,891	123,979,579
TOTAL FIXED ASSETS	226,974,135	244,129,173	339,491,951	352,306,293	441,441,090	451,278,621	471,359,183
TOTAL ASSETS AND OTHER DEBITS	281,492,030	311,374,574	397,111,056	416,647,712	529,442,373	555,492,512	595,338,[illegible]

LIABILITIES

FIXED LIABILITIES	1968	1969	1970	1971	1972	1973	1974
Capital	75,616,910	75,616,910	75,616,910	75,616,910	75,616,910	75,616,910	75,616,910
Reserves:							
Revaluation reserve	----------	11,176	82,065	208,897	323,871	432,537	866,999
Other reserves	3,022	3,022	1,801,171	1,893,611	5,224,744	6,988,127	10,416,898
Net profits	3,360,352	1,776,848	2,845,516	2,927,261	624,274	---------	----------
Provisions:							
Provision for depreciation	41,264,759	49,974,942	59,824,786	70,403,683	91,313,351	104,081,162	117,247,711
Provision for debt	5,099,015	5,855,454	3,927,041	3,910,620	3,324,806	5,565,610	8,678,511
Provision for taxes	13,749	----------	19,600	17,870	----------	77,573	77,573
Other provisions	9,554,529	12,114,622	6,417,575	7,523,911	8,905,895	7,978,575	8,036,097
Long-term debts:							
Local long-term debts	----------	90,166,924	161,346,449	167,693,346	274,095,653	282,494,929	288,413,930
External (foreign) long-term debts	129,182,275	48,115,391	56,304,876	56,023,292	45,556,505	46,839,226	46,798,363
CURRENT LIABILITIES							
Due within one year to:							
Banks and other short term	4,694,999	398,160	416,113	379,238	52,544	52,544	124
Dividends declared	1,558	19,477	48,156	48,156	----------	----------	----------
Accounts payable to commercial creditors	855,761	1,173,396	2,072,761	2,037,749	1,833,652	2,195,015	2,944,164
Contractor's bid and performance bonds	238	1,185,907	3,384,146	1,377,213	1,553,523	1,283,726	1,663,385
Other accounts payable (deferred)	12,844,863	24,962,345	23,003,891	26,585,955	20,998,645	21,886.578	33,278,017
TOTAL LIABILITIES AND OTHER CREDITS	282,492,030	311,374,574	397,111,056	416,647,712	529,442,373	555,442,373	595,338,682

SUMMARY OF BALANCE SHEET

1968 - 1974

Values Given in Egyptian Pounds

	1968	1969	1970	1971	1972	1973	1974
ASSETS:							
Fixed Assets	266,974,135	244,129,173	339,491,951	352,306,293	441,441,090	451,278,621	471,359,103
Current Assets	55,517,895	67,245,401	57,619,105	64,341,419	88,001,293	104,213,891	123,979,579
	282,492,030	311,374,574	397,111,056	416,647,712	529,442,373	555,492,512	595,338,682
LIABILITIES:							
Capital	75,616,910	75,616,910	75,616,910	75,616,910	75,616,910	75,616,910	75,616,910
Fixed Liabilities	185,117,349	206,241,531	289,723,563	307,675,231	428,744,825	530,074,649	556,152,992
Current Liabilities	18,397,419	27,739,285	28,925,067	30,428,310	24,438,364	25,417,863	37,885,690
Net Profit	3,360,352	1,776,848	2,845,516	2,927,261	642,274	----------	----------
	282,492,030	311,374,574	397,671,056	416,647,712	529,442,373	555,492,512	595,338,682

SOURCE AND APPLICATION OF FUNDS

Values Given in Egyptian Pounds

	1968	1969	1970	1971	1972	1973	1974
REVENUES:							
Sales:							
Electric Energy	31,036,972	35,299,322	37,466,424	41,652,237	70,249,504	47,637,035	51,249,255
Steam	586,995	317,655	95,199	61,706	178,164	----------	----------
Gas	173,208	242,065	193,370	143,229	219,222	----------	----------
Other Revenues	1,626,164	1,780,695	1,802,013	2,420,266	5,006,525	4,159,701	3,269,297
Contribution from Government for Improvements	50,442	----------	----------	----------	----------	----------	----------
OTHER INCOME:							
Dividends	7,967	108,451	97,536	104,839	180,965	175,898	147,546
Interest	----------	5	4	----------	----------	166	12
Rents	257,860	395,838	423,328	453,961	685,402	61,692	68,369
Miscellaneous Income from:							
Sale of Assets	73	11,301	7,891	9,554	1,667	25,200	111
Previous Year's Revenues	14,193	124,644	388,915	383,366	3,815,652	2,296,462	1,159,913
Compensation (Court Award Against Contractors or Consumers)	151,035	126,611	186,604	326,021	254,379	194,720	195,028
Others	225,250	146,348	183,309	193,499	3,311,598	402,129	836,138
TOTAL OPERATING REVENUES	34,130,160	38,552,935	40,844,593	45,748,678	83,903,078	54,953,003	56,925,709
EXPENDITURES:							
Salaries (all salaries and wages)	4,986,090	5,043,150	6,334,763	9.392.210	15,394,961	12,458,909	13,940,563

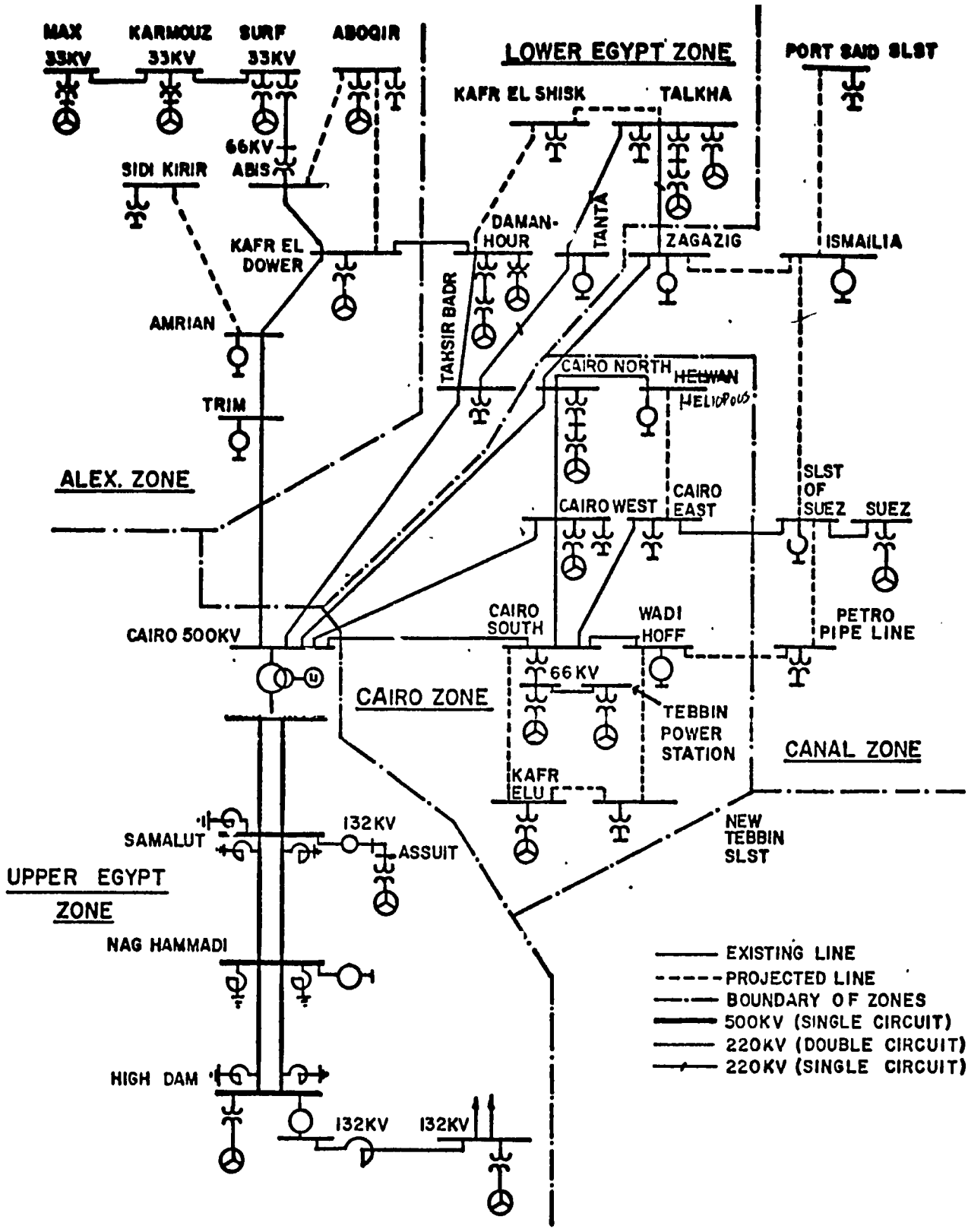
	1968	1969	1970	1971	1972	1973	1974
MATERIAL APPLICATIONS: (All purchases of materials)	11,221,014	10,153,176	9,125,289	10,175,620	15,766,640	11,174,650	11,440,819
PURCHASING AND OTHER RELATED EXPENSES	508,627	850,094	850,364	1,203,674	2,600,162	2,625,904	1,851,568
GEEC INTERNAL POWER USAGE	536,298	1,379,999	861,000	765,000	----------	----------	----------
TAXES	2,312,864	3,140,707	3,710,881	4,174,389	4,937,900	1,149,013	1,000,661
ANNUAL DEPRECIATION:							
Buildings	611,253	622,113	1,095,980	1,108,708	2,562,172	1,583,901	1.594.377
Machines and Equipment	4,809,913	5,631,192	8,586,264	8,649,108	16,269,100	9,307,555	10,380,058
Vehicles	422,282	588,277	727,799	689,962	895,982	676,525	786,840
Tools	165,015	170,149	189,760	209,471	369,444	264,358	291,943
Furniture	58,095	72,384	72,322	82,012	130,721	87,804	126,991
Intangible Plant	8,055	451,549	17,323	18,231	121,282	145,625	495,580
RENTS	7,797	27,646	27,425	40,124	86,994	48,895	47,497
LOCAL INTERESTS	2,797,322	3,875,016	4,015,161	3,180,693	14,533,261	8,903,822	7,557,884
SUBSIDIARIES	1,153,562	1,677,668	986,844	2,117,819	2,437,318	651,125	489,261
COMPENSATIONS	442	----------	38	150	64,046	50	----------
CAPITAL LOSSES (losses due to							
sale of assets):	21,727	7,579	5,349	16,047	19,587	37,678	57,425
Adjusting	240	----------	----------	6,379	1,200	----------	24,438
Adjustment for Previous Years	97,489	1,658,911	849,145	551,503	4,629,056	4,803,983	2,646,760
Bad Debts	230,590	----------	801	47	298	2,512	7,684
Other Provisions	187,489	1,318,890	504,948	797,401	2,440,680	1,030,694	4,185,460
Building Taxes	7,387	1,718	2,988	2,780	----------	----------	----------
Income Taxes	626,257	471,935	32,634	650,000	----------	----------	----------
Net Profit	3,360,352	1,776,848	2,845,516	2,927,260	642,274	----------	----------
TOTAL EXPENDITURES	34,130,160	38,552,935	40,844,593	45,748,678	83,903,078	54,953,003	56,925,700

SUMMARY INCOME STATEMENT

1968 - 1974

Values Given In Egyptian Pounds

	1968	1969	1970	1971	1972	1973	1974
REVENUES:							
Sales	34,130,782	37,639,737	39,557,006	44,277,438	76,653,415	51,796,736	54,518,552
Interest	7,967	108,456	97,540	104,839	180,965	166	12
Other Income	648,411	804,742	1,190,047	1,366,401	8,068,698	3,156,101	2,407,136
TOTAL	34,120,160	38,552,935	40,844,593	45,743,673	83,903,078	54,953,003	56,925,700
EXPENSES:							
Items							
Salaries	4,986,090	5,043,150	6,334,763	8,382,210	15,394,961	12,458,909	13,940,963
Material Applications	11,221,014	10,153,176	9,125,289	10,175,620	15,766,640	11,174,650	11,440,819
Purchase of Electric Energy	536,298	1,379,999	861,000	765,000	----------	----------	----------
Annual Depreciation	6,262,102	8,854,488	11,196,396	11,554,893	22,789,381	12,065,768	27,675,789
Taxes and Custom Duties	2,946,508	3,614,360	3,746,503	4,827,259	4,937,900	1,149,013	1,000,661
Interest	3,950,884	5,186,684	5,002,005	5,298,512	16,970,579	4,554,947	8,047,145
Other Expenses	866,912	2,544,230	1,733,121	1,817,924	7,401,343	8,549,716	----------
Net Profit	3,360,352	1,776,848	2,845,516	2,927,260	642,274	----------	----------
TOTAL	34,130,160	38,552,935	40,844,593	45,748,678	83,903,078	54,953,003	56,925,700



THE EGYPTIAN POWER SYSTEM
ONE LINE DIAGRAM

EXHIBIT Nº 2

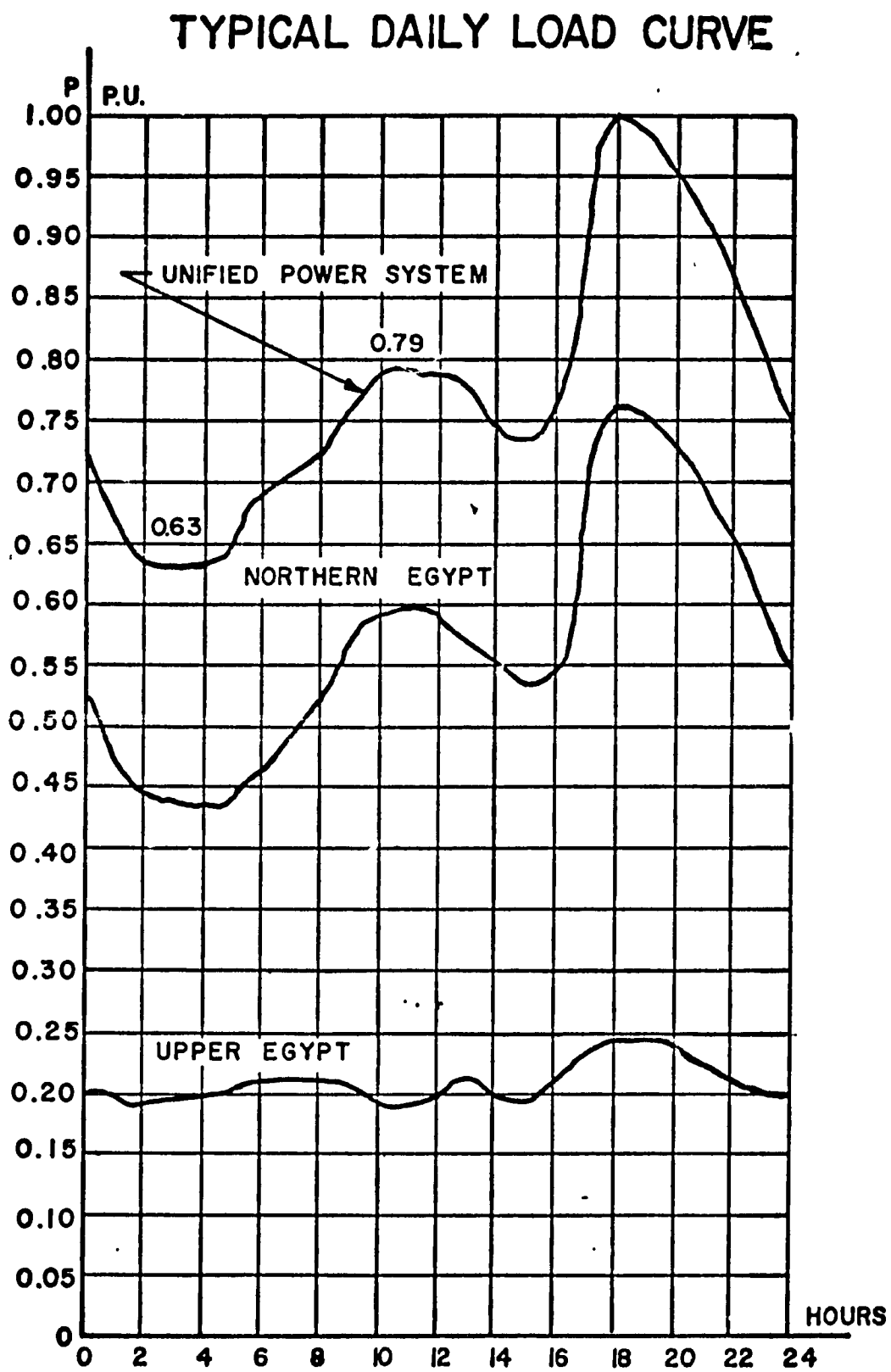
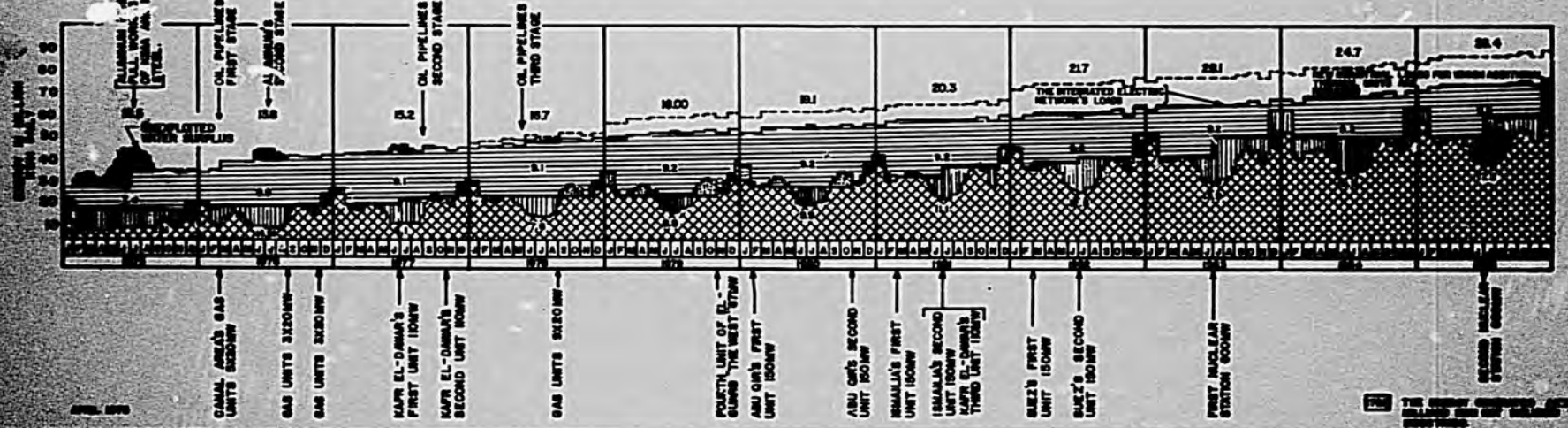


EXHIBIT Nº 2-2

MINISTRY OF POWER
WATER AND THERMAL GENERATION CURVES TO MEET THE INTEGRATED ELECTRIC NETWORK LOADS UP TO THE YEAR 1985

1. AVAILABLE THERMAL ENERGY, TAKING INTO CONSIDERATION THE [illegible] RESERVE AND THE ANNUAL OVERHAULS. NO OVERHAULS ARE TO BE CARRIED OUT DURING THE MONTHS OF DECEMBER AND JANUARY.
2. THE INTEGRATED ELECTRIC NETWORK'S LOAD ON THE BASIS OF A 9.5 PERCENT ANNUAL GROWTH, AND THE ADDITION OF THE INDUSTRIAL LOADS ALREADY CONTRACTED FOR AND THE CANAL'S RECONSTRUCTION LOADS.
3. THERMAL GENERATION TO MEET THE NETWORK'S LOADS EXCLUDING THE INDUSTRIES ALREADY CONTRACTED FOR ONLY.
4. THE HIGH DAM AND THE ASWAN DAM GENERATIONS.
5. GAS UNITS GENERATION TO MAKE UP THE DEFICIENCY IN THE THERMAL ENERGY.
6. LOADS OF THE NEW INDUSTRIAL PROJECTS ESTIMATED AT ABOUT 600 MEGAWATTS IN 1982 (SPONGY IRON IN CAIRO AND ALEXANDRIA – ABU TARTUR PHOSPHATES – THE PHOSPHORUS COMPLEX – PETROCHEMICALS IN ALEXANDRIA AND THE OIL REFINERY IN ALEXANDRIA). THESE PROJECTS HAVE NOT BEEN APPROVED YET, AND THE MINISTRY OF POWER HAS NOT RESERVED THE TIME TABLE FOR THEIR IMPLEMENTATION AND THEREFORE, THEY HAVE NOT BEEN INCLUDED IN THE MINISTRY OF POWER'S 1976-1980 PLAN. IN THE EVENT OF APPROVAL OF THEIR IMPLEMENTATION, THEY SHALL REQUIRE THERMAL UNITS IN ADDITION TO THOSE MENTIONED IN THE MINISTRY OF POWER'S PLAN, PROVIDED THAT CONTRACTING FOR THEM STARTS DURING THE YEAR 1976.



THE EGYPTIAN GENERAL SURVEY AUTHORITY - PERMIT NO. 969/75)
EXHIBIT No 3-1

NEW LARGE LOADS
(Values in MW)

	Location	1974	1975	1976	1977	1978	1979
I. Already Approved by Ministry of Industry and Under Construction							
1. Iron and Steel Complex	Tebbin No. 1	51.7	63.8	63.8	64.0	64.0	64.0
	Tebbin No. 2	49.0	70.1	70.1	72.0	72.0	72.0
	Helwan	51.5	62.0	62.0	63.0	63.0	63.0
2. Chemical Industries (KIMA)							
(a) Fertilizer	Aswan	200.0	250.0	285.0	300.0	300.0	300.0
(b) Ferro-Silica	Aswan	10.0	12.0	25.0	25.0	25.0	25.0
3. Phosphate Project							
(a) Mining	Esna	-----	10.0	10.0	10.0	10.0	10.0
(b) Factory	Naz Hamadi	-----	85.0	255.0	340.0	340.0	340.0
4. Aluminum Complex	Aswan	-----	80.0	150.0	240.0	240.0	240.0
5. Petroleum Pipeline (SUMED)	Suez-Alexandria	-----	-----	-----	50.0	155.0	155.0
TOTAL APPROVED INCREASE IN DEMAND		362.2	632.9	920.9	1164.0	1269.0	1269.0
II. Still to be Approved by Ministry of Industry							
1. Abu-Tartar Phosphate	Al-Wady-Al-Gaded				------	90.0	90.0
2. Extension of Aluminum	Naz Hamadi				------	150.0	150.0
3. Sponge Iron Complex	Alexandria				60.0	60.0	60.0
4. Petroleum Refineries	Cairo				40.0	40.0	40.0
	Alexandria				------	------	187.0
5. Cement Factory	Assiut				35.0	35.0	35.0
6. Caustic Soda	Alexandria				20.0	20.0	20.0
TOTAL ESTIMATED INCREASE IN DEMAND					155.0	395.0	582.0

INSTALLED AND AVAILABLE GENERATION

Name of Station	Installed Power in Megawatts: Number and Capacity of Units	Total	Useable Power in Megawatts: 1975	1976	1977	1978	1979	1980	1981
1. Cairo West	3 x 87	261	230	250	250	250	250	250	250
2. Cairo South	4 x 60	240	180	230	230	230	230	230	230
3. Cairo North	2 x 30 + 1 x 20 + 2 x 10	100	60	60	60	60	60	60	60
4. El-Tebbin	3 x 15	45	28	35	45	45	45	45	45
5. Talka	3 x 12.5 + 3 x 30	127	127	127	127	127	127	127	127
6. Damanhour	2 x 15 + 3 x 65	225	210	210	210	210	210	210	210
7. El-Seyouf	2 x 26.5 + 2 x 30	113	100	100	100	100	100	100	100
8. Kamouz	4 x 16	64	30	30	30	30	30	30	30
9. Assuit	3 x 30	90	60	90	90	90	90	90	90
10. Suez (Damaged)	4 x 25	100	---	---	---	---	---	---	---
11. Kafar El-Dawar	2 x 110	220	---	---	220	220	220	220	220
12. Cairo West	1 x 87	87	---	---	---	---	87	87	87
13. Abu Qir	2 x 150	300	---	---	---	---	---	300	300
14. Ismailia	2 x 150	300	---	---	---	---	---	---	300
15. Kafr El-Dawar	1 x 110	110	---	---	---	---	---	---	110
TOTAL			1025	1132	1362	1362	1449	1749	2159
COMBUSTION TURBINE STATIONS									
1. El-Max	2 x 14	28	12	24	24	24	24	24	24
2. Suez, Ismailia, Port Said & Cairo Area	4 x 23 + 1 x 17	109	109	109	109	109	109	109	109
3. Helwan	4 x 30	120	---	120	120	120	120	120	120
4. Talka	6 x 30	180	---	---	---	180	180	180	180
TOTAL			121	253	253	433	433	433	433
HYDRO STATIONS									
1. Aswan and High Dams	12 x 175 + 7 x 46 + 2 x 11.5	2445	900	1000	1100	1200	1280	1330	1380

SUMMARY OF DAILY AVAILABLE GENERATION AND FORECASTED LOADS

DRY SEASON OF THE NILE

	1975	1976	1977	1978	1979	1980	1981
AVAILABLE GENERATION							
POWER (MW)							
Existing Useable							
Thermal (1)	1025	1132	1142	1362	1362	1449	1749
Combustion Turbine (1)	121	133	253	253	433	433	433
Hydro (2)	900	1000	1100	1200	1280	1330	1380
Subtotal	2046	2277	2495	2815	2874	3212	3562
New Generation	None	120(6)	220(7)	180(8)	87(9)	300(10)	410(11)
TOTAL	2046	2397	2715	2995	2961	3512	3972
ENERGY (Gwh) (3)							
Existing Usable							
Thermal	22.1	24.5	24.7	29.4	29.4	31.3	37.8
Combustion Turbine	2.6	2.9	5.5	5.5	9.4	9.4	9.4
Hydro (4)	14.6	14.6	14.6	14.6	14.6	14.6	14.6 50%
Subtotal	39.3	42.0	44.8	49.5	53.4	55.3	61.8 +
New Generation	None	2.6	4.8	3.9	1.9	6.5	8.9
TOTAL	39.3	44.6	49.6	53.4	55.3	61.8	70.7

SUMMARY OF DAILY AVAILABLE GENERATION AND FORECASTED LOADS
(Cont'd)

DRY SEASON OF THE NILE

	1975	1976	1977	1978	1979	1980	1981
FORECASTED LOADS							
POWER (MW)							
Normal 6% Growth	1327	1407	1491	1580	From 1979 through 1981 a 9.4% cumulative annual load growth is assumed		
5% of Committed Large Industrials	316	406	582	635			
TOTAL	1643	1867	2073	2215	2423	2651	2900
Large Expected Industrials	Unknown	Unknown	155	395	582	----	----
ENERGY (Gwh) (5) 79.6% L.F.							
Normal 6% Growth	25.4	26.9	28.5	30.2	From 1979 through 1981 a 9.4% cumulative annual load growth is assumed		
50% of Committed Large Industrials	6.0	8.8	11.1	12.1			
TOTAL	31.4	35.7	39.6	42.3	46.3	50.6	55.4
Large Expected Industrials	Unknown	Unknown	3.0	7.5	11.1	------	------

SUMMARY OF DAILY AVAILABLE GENERATION AND FORECASTED LOADS
(Cont'd)

Notes:

(1) From Table 2 of Report on the Thermal Generation Power Required for Meeting the Integrated Electrical Network's Loads Up to the Year 1985 (April 1975).

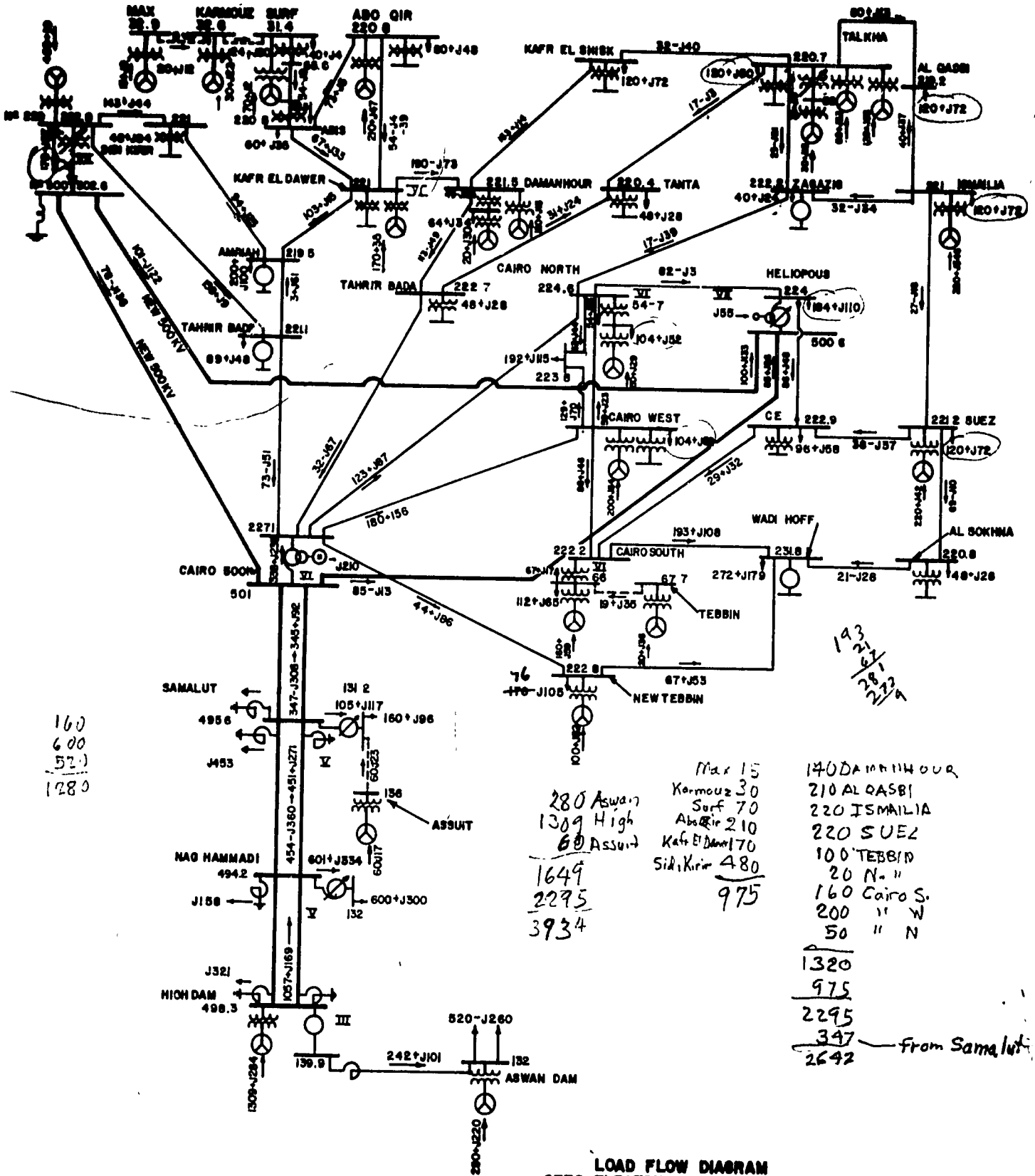
(2) From Table 7 of Electrical Power Needs in A.R.E. 1975-2000 and How to Meet Them (August 1974).

(3) At 90% Availability Factor.

(4) From Table 3 of same report as (1).

(5) At 79.6% Load Factor obtained by calculation from Drawing No. 2 of same report as (1).

(6)	Helwan Combustion Turbine	4 x 30 MW
(7)	Kafar El-Dawar Thermal	12 x 110 MW
(8)	Talka Combustion Turbine	6 x 30 MW
(9)	Cairo West Thermal	1 x 87 MW
(10)	Abu Qir Thermal	2 x 150 MW
(11)	Ismailia Thermal	2 x 150 MW
	Kafr El-Dawar	1 x 110 MW



160
600
520
1280

280 Aswan
1309 High
60 Assuit
1649
2295
3934

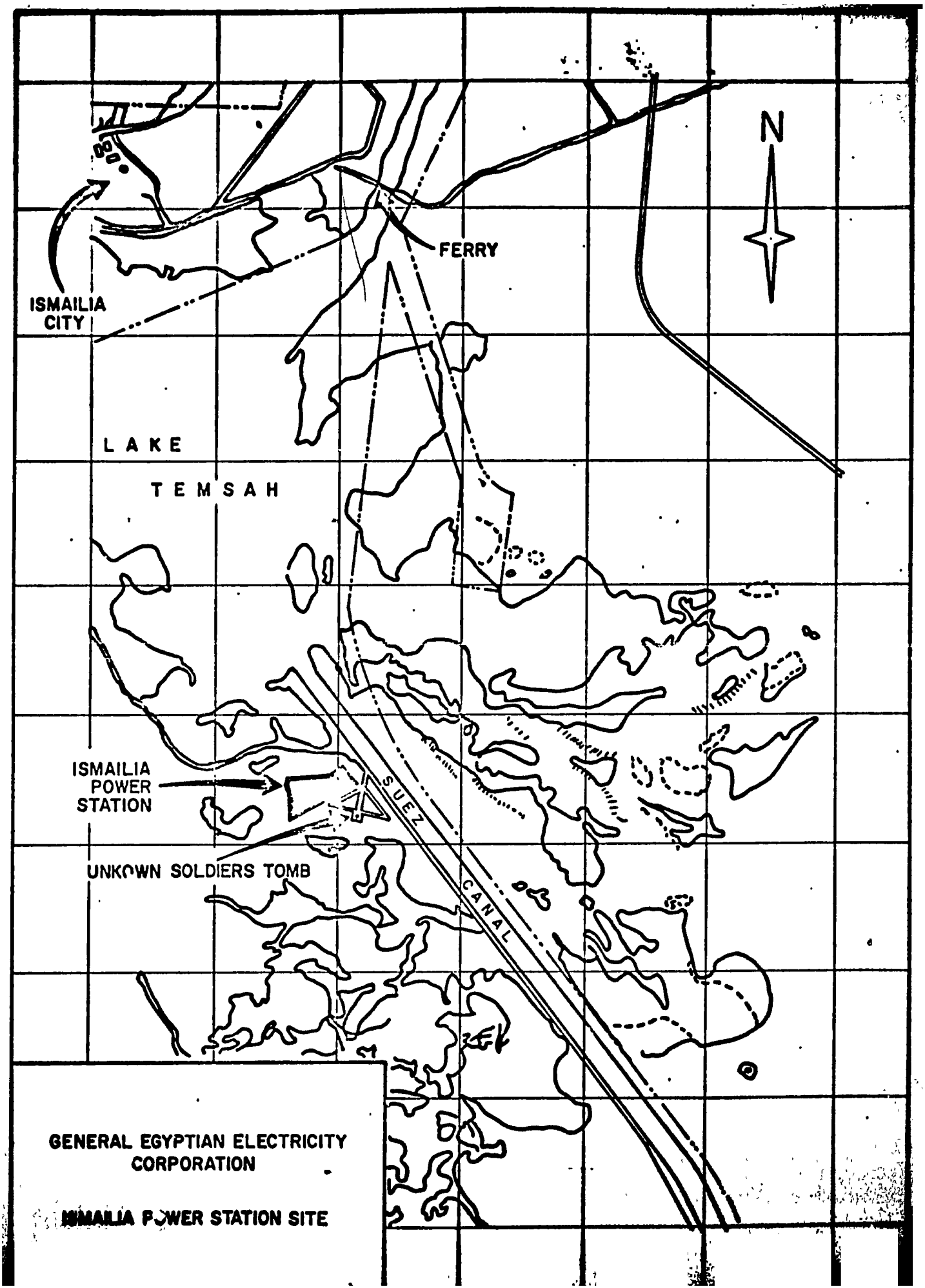
Max 15
Kermouz 30
Surf 70
Abo Qir 210
Kafr El Dawar 170
Sidi Kirir 480
975

140 DAMANHOUR
210 AL QASBI
220 ISMAILIA
220 SUEZ
100 TEBBIN
20 N. "
160 Cairo S.
200 " W
50 " N
1320
975
2295
347 — From Samalut
2642

143
21
67
28
213

LOAD FLOW DIAGRAM
GEEC ELECTRIC POWER SYSTEM
1982 — 1983

EXHIBIT Nº 4-1


N
FERRY
ISMAILIA CITY
LAKE
TEMSAH
ISMAILIA POWER STATION
UNKOWN SOLDIERS TOMB
SUEZ CANAL
GENERAL EGYPTIAN ELECTRICITY CORPORATION
ISMAILIA POWER STATION SITE

NATURAL GAS SPECIFICATIONS

-Composition	% Vol	%Wt
Nitrogen	0.385	0.62
Carbon Dioxide	0.688	1.72
Methane	92.766	48.49
Ethane	4.117	7.03
Propane	1.211	3.03
Butanes	0.529	1.74
Pentanes	0.165	0.68
Hexanes	0.138	0.67
Heptanes plus	0.001	0.02
	100.000	100.00

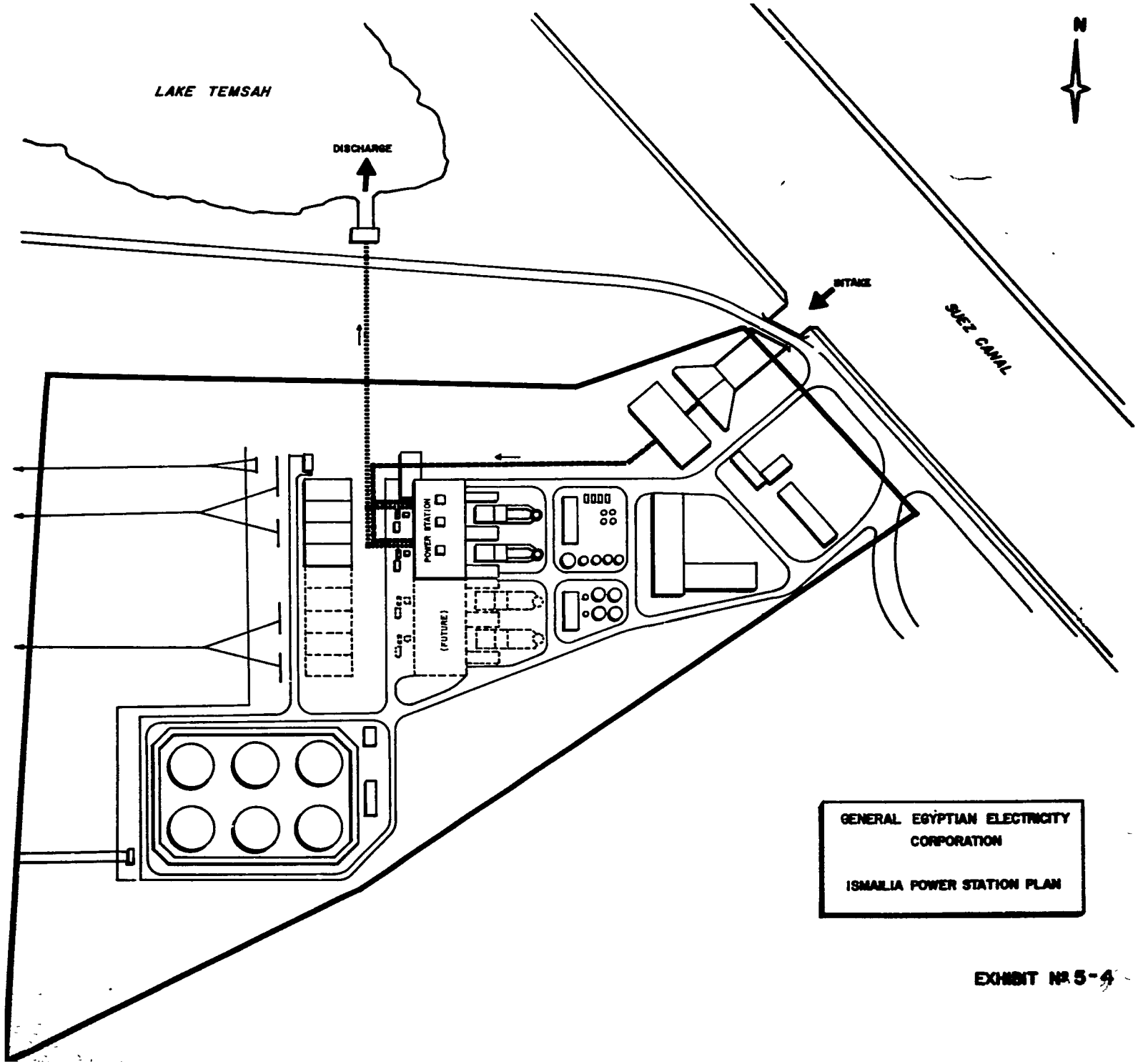
-Molecular weight	17.57
-Density gm/L at N.T.P.	0.784
at 60°F & 14.696 psia	0.742
-Specific gravity (Air = 1) at 60°F	0.607
-Dew point at delivery conditions	below 0°C
-Gross calorific value	
BTU/lb	23,056
BTU/ft^3 at 60 + °F & 14.696 psia	1,072.6
at N.T.P.	1,133.7
Keal/m^3 at 60°F & 14.696 psia	9,545
at N.T.P.	10,090
-Sulphur content ppm (max)	10
-Ton Fuel Oil	0.781 ton gas
-Ton gas	1.282 ton Fuel
-Ton gas	1,348 M^3 gas at 60°F & 14.696 psia
-Ton Fuel Oil	1,053 M^3 gas at 60°F & 14.696 psia
-Ton gas	1,276 M^3 gas at N.T.P.
-Ton Fuel Oil	997 M^3 gas at N.T.P.
-Cuft/therm at 60°F & 14.696 psia	93.2 M^3 gas at N.T.P.

EXHIBIT NO. 5-2

MAZOUT FUEL SPECIFICATIONS

Description	Indices of Fuel Quality
Specific weight at 15°C	0.945 t/m^3
Viscosity at 38°C at 50°C	38°E 22.6°E
Freezing temperature	13°C max.
Ignition temperature	70°C min.
Moisture content	1.0%
Ash content	0.3%
Sulfur content	3.0%-5.0% max.
Carbon content	85%
Hydrogen content	10.7%
Oxygen content	not present
Nitrogen content	not present
Vanadium content	0.002-0.003%
Net heating value	9500 Kcal/kg

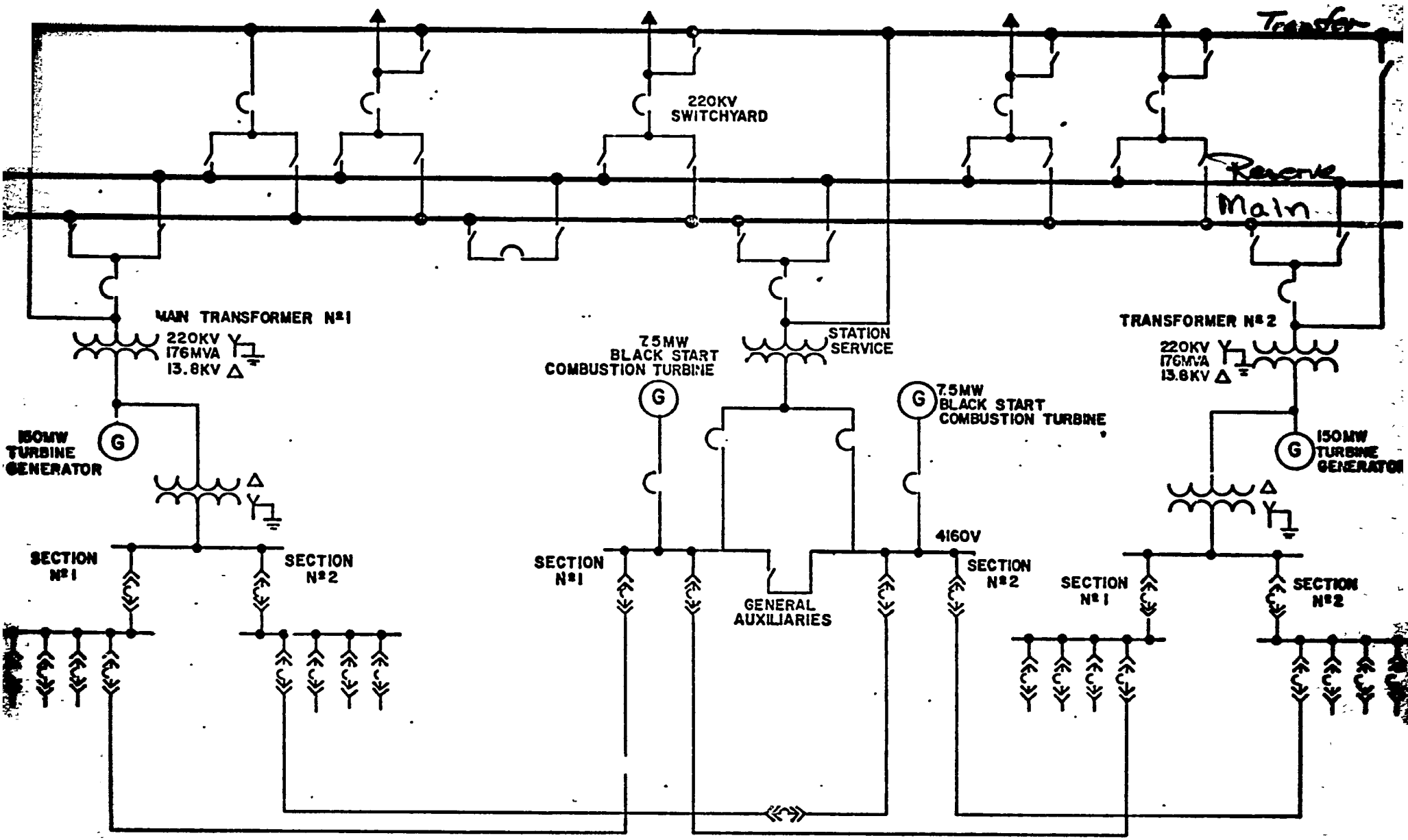
EXHIBIT NO. 5-3



GENERAL EGYPTIAN ELECTRICITY CORPORATION

ISMAILIA POWER STATION PLAN

EXHIBIT Nº 5-4



ISMAILIA 300MW THERMAL POWER PLANT
ONE LINE ELECTRICAL DIAGRAM

EXHIBIT Nº 5-5

ISMAILIA THERMAL PLANT
OPERATION AND MAINTENANCE PERSONNEL

A- University Degree Engineers

1	Power Station Manager
1	Chief of Operation Department
1	Chief of Maintenance Department
4	Maintenance Engineers (Boiler/Turbine/Electric/ Instruments)
5	Senior Shift Engineers
5	Junior Shift Engineers
17	Total

B- University Degree Chemists

5	Shift Chemists
5	Total

C- Technician

a) Shift

5	Chief of Boiler Shift
30	Boiler Operators
5	Chief of Turbine Shift
30	Turbine Operators
5	Chief of Electric Shift
15	Electricians
90	Total

EXHIBIT NO. 5-6

b) **Maintenance**

10	Boiler Technicians
10	Turbine Technicians
10	Instrument Technicians
10	Electricians
10	Work Shop Technicians
50	Total

c) **Services**

2	Technical Reports
6	Transportation Facilities.... etc.
2	Store Keepers
10	Total

EXHIBIT NO. 5-6
(cont'd)

ISMAILIA PLANT ORGANIZATION CHART

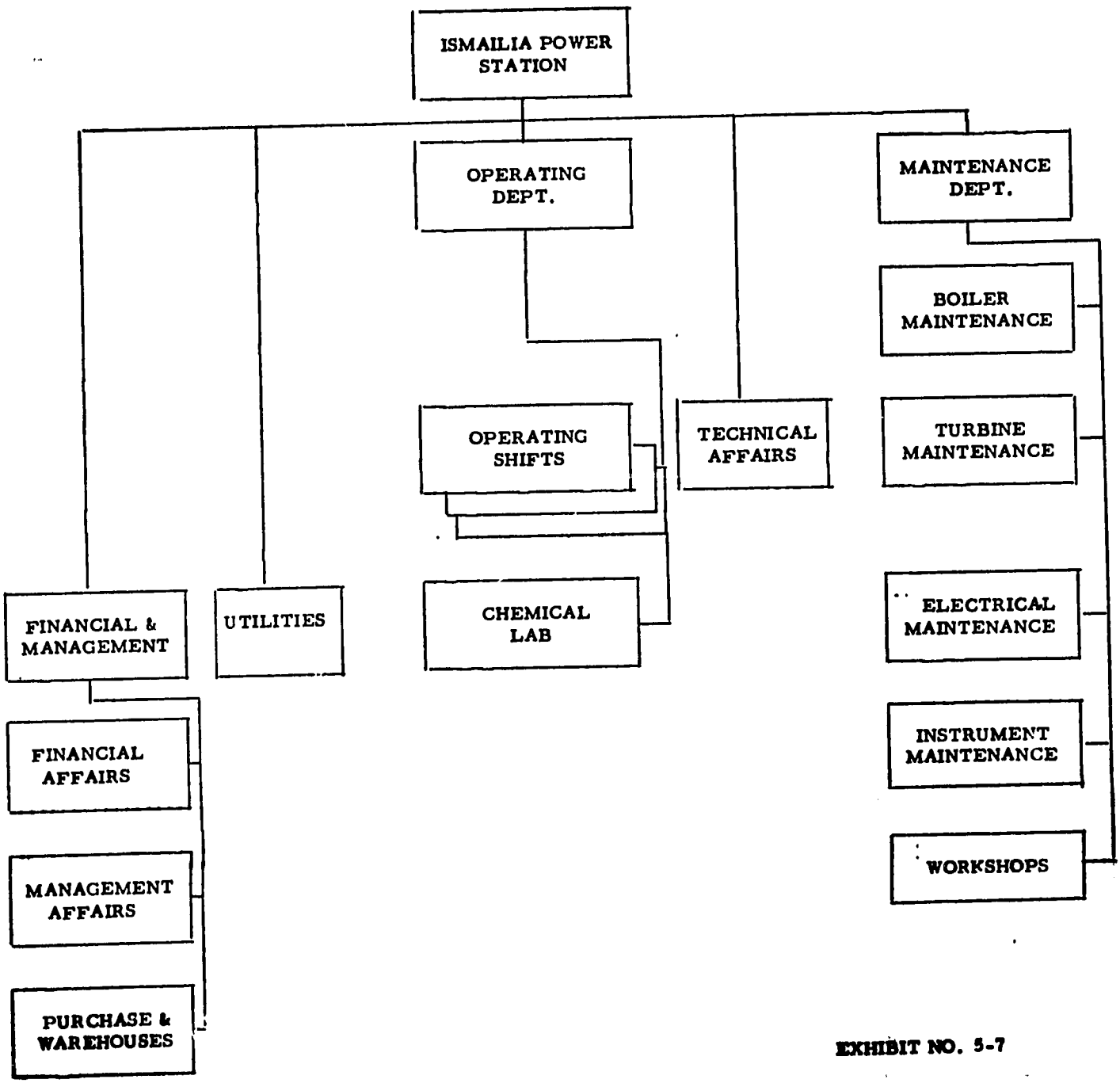


EXHIBIT NO. 5-7

NATURAL GAS FROM ABU GHARADIG FIELD

	Average Vol %	Average Wt %
Nitrogen	0.51 - 0.68	0.75 - 1.03
Carbon Dioxide	2.83 - 4.00	6.50 - 9.48
Methane	83.37 - 86.38	69.61 - 74.41
Ethane	10.18 - 8.13	15.94 - 13.13
Propane	3.02 - 0.75	6.93 - 1.77
I-Butane	0.06 - 0.04	0.18 - 0.12
N-Butane	0.03 - 0.02	0.09 - 0.06

Molecular Weight	19.16 - 18.58
Density g/L at N.T.P.	0.855 - 0.829
at 60°F & 14.696 psia	0.809 - 0.784
Specific gravity (Air = 1) at 60°F	0.662 - 0.641
Dew point at delivery conditions	Below 0°C
Gross calorific value	
BTU/lb	21,427
BTU/cu ft at 60°F & 14.696 psia	1,071
at N.T.P.	1,132
Kcal/M^3 at 60°F & 14.696 psia	9,530
at N.T.P.	10,078
1 Ton Fuel Oil	0.840 Ton gas
1 Ton gas	1.19 Ton Fuel Oil
1 Ton gas	1,256 M^3 gas at 60°F & 14.696 psia
1 Ton Fuel Oil	1,055 M^3 gas at 60°F &14.696 psia
1 Ton gas	1,187 M^3 at N.T.P.
1 Ton Fuel Oil	997 M^3 at N.T.P.
Cu ft/term at 60°F	93.3
at N.T.P.	88.3

Note: The above limits of composition are not minimum and maximum values.

EXHIBIT NO. 6-1

GAS OIL (SOLAR OIL)

Sp. GR. at 15/4 °C	(min)	0.82
	(max)	0.87
Colour ASTM	(max)	4.5
Flash point P.M. Closed °C	(min)	55
Viscosity red I at 100°F	(min)	30
	(max)	45
Pour point °C Winter (xx)	(max)	4.5
Summer	(max)	10
Sediment % Wt	(max)	0.01
Water content % vol.	(max)	0.15
Ash content % Wt.	(max)	0.01
Conradson carbon % Wt	(max)	0.01 (x)
Total sulphur content % Wt	(max)	1.5
Inorganic acids & bases		Nil
Distilled at 350°C % Vol.	(min)	80
Diesel indexs	(min)	48
Hot filtration at 100°C		
before storage	(max)	-
after 24 hrs storage	(max)	-
Solid asphalt	(max)	-
Copper strip test at 100°C	(max)	Division I

EXHIBIT NO. 6-2

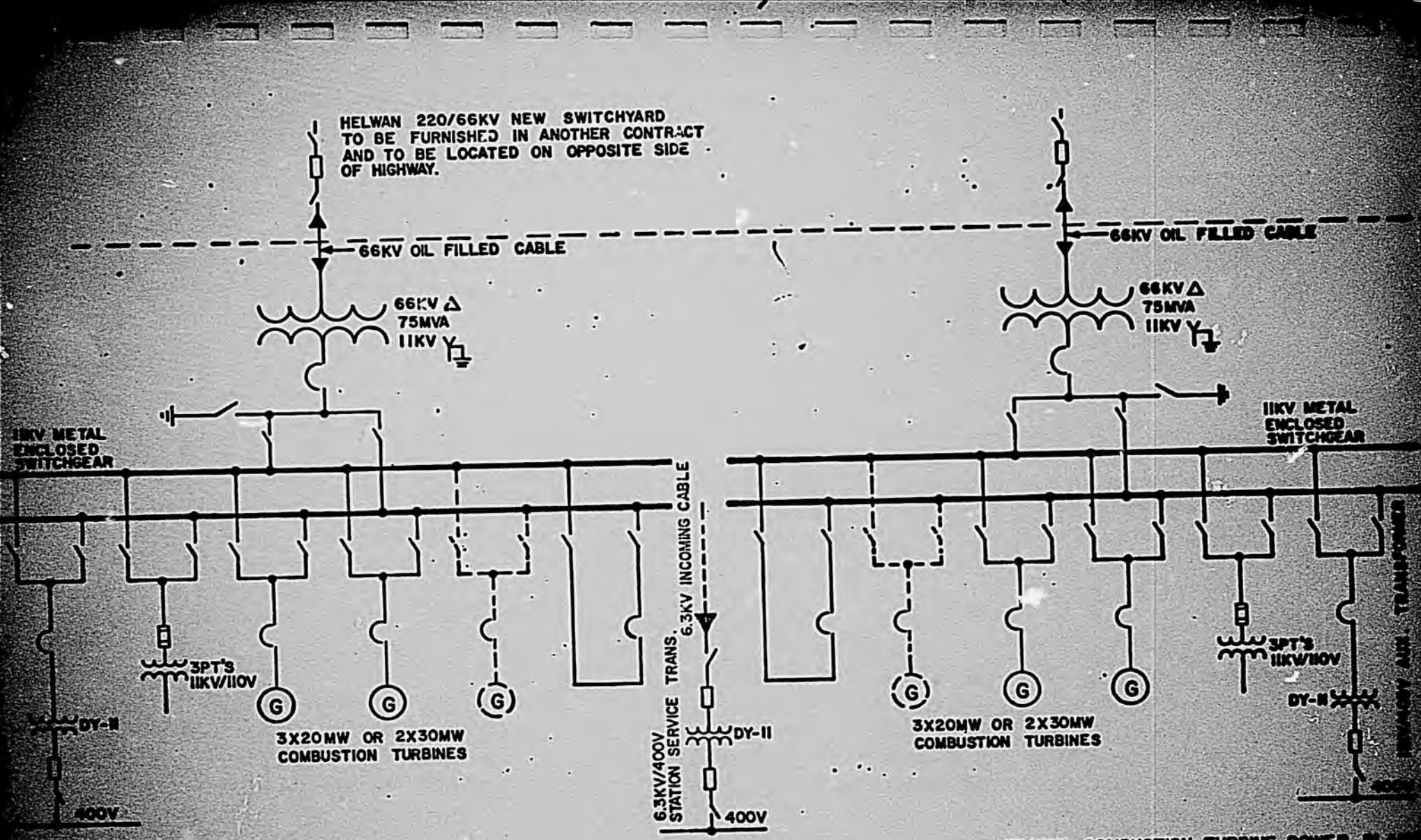
GAS OIL (SOLAR OIL)
(cont'd)

Calorific value (gross) Cal/Cm	(min)	10,550

(x) On 10% residue from distillation

(xx) Winter: From 1st of November to end of March
Summer: From 1st of April to end of October

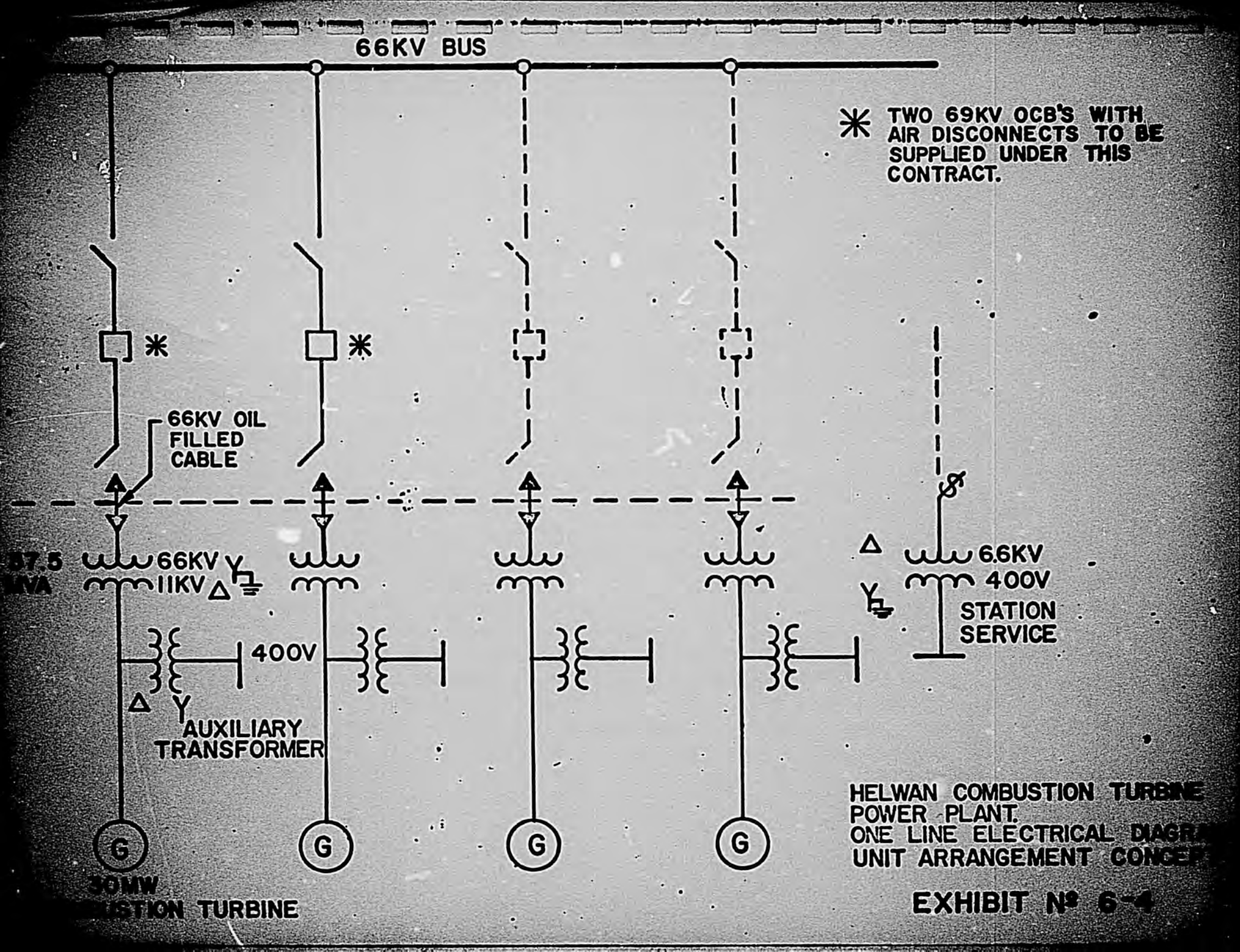
EXHIBIT NO. 6-2



HELWAN COMBUSTION TURBINE POWER PLANT
ONE LINE ELECTRICAL DIAGRAM
GEEC PROPOSED PLANT

EXHIBIT Nº 6-3

BEST AVAILABLE COPY


66KV BUS
* TWO 69KV OCB'S WITH AIR DISCONNECTS TO BE SUPPLIED UNDER THIS CONTRACT.
66KV OIL FILLED CABLE
37.5 MVA
66KV
11KV
400V
AUXILIARY TRANSFORMER
6.6KV
400V
STATION SERVICE
G
30MW
TURBINE
HELWAN COMBUSTION TURBINE POWER PLANT.
ONE LINE ELECTRICAL DIAGRA
UNIT ARRANGEMENT CONCEP
EXHIBIT Nº 6-4

HELWAN COMBUSTION TURBINE PLANT CONSTRUCTION COSTS

		S&P ESTIMATE		GEEC ESTIMATE	
		Local Currency LE	Foreign Currency LE	Local Currency LE	Foreign Currency LE
a.	Equipments (FAS)	---------	4,400,000	---------	8,700,000
b.	Freight & Insurance	200,000	800,000)	1,300,000	Included in above
c.	Civil Work	150,000	---------)		---------
d.	Erection	---------	---------	---------	---------
e.	Engineering and Supervision	---------	250,000	---------	---------
f.	Inland Transportation	50,000	---------	ALL OTHER ITEMS INCLUDED	ALL OTHER ITEMS INCLUDED
g.	Customs and duties	600,000	---------		
h.	Cost of Land	10,000	---------		
i.	Colony and miscellaneous structures	40,000	---------		
j.	Salaries and wages	60,000	---------		
k.	Escalation to be applied	110,000	550,000		
	Subtotal	1,220,000	6,000,000	---------	---------
l.	5% Contingency	61,000	300,000	Included	Included
	TOTAL	1,281,000	6,300,000	1,300,000	8.700,000

SMALLA STEAM POWER PLANT CONSTRUCTION COSTS

	Subject	S&P ESTIMATE Local Currency LE	S&P ESTIMATE Foreign Currency LE	GEEC ESTIMATE Local Currency LE	GEEC ESTIMATE Foreign Currency LE
a.	Equipments (FAS)	----------	29,300,000	---------	28,500,000
b.	Freight & Insurance	----------	3,000,000	2,300,000	----------
c.	Civil Work	3,500,000	----------	4,000,000	----------
d.	Erection	7,380,000	----------	3,000,000	----------
e.	Supervision of Erection	3,000,000	500,000	300,000	1,000,000
f.	Inland Transportation	300,000	----------	300,000	----------
g.	Customs and duties	4,300,000	----------	4,300,000	----------
h.	Cost of Land	20,000	----------	20,000	----------
i.	Railways	200,000	----------	200,000	----------
j.	Colony and miscellaneous structures	200,000	----------	200,000	----------
k.	Salaries and wages	500,000	----------	500,000	----------
l.	Access Roads, etc.	200,000	----------	200,000	----------
m.	Inspection of Equipment	300,000	----------	300,000	----------
n.	Escalation to be applied	5,000,000	6,000,000	3,000,000	6,000,000
	Subtotal	24,900,000	38,800,000	---------	----------
o.	5% Contingency	1,250,000	1,940,000	800,000	2,000,000
	TOTAL	26,150,000	40,740,000	19,420,000	37,500,000

ISMAILIA THERMAL POWER PLANT

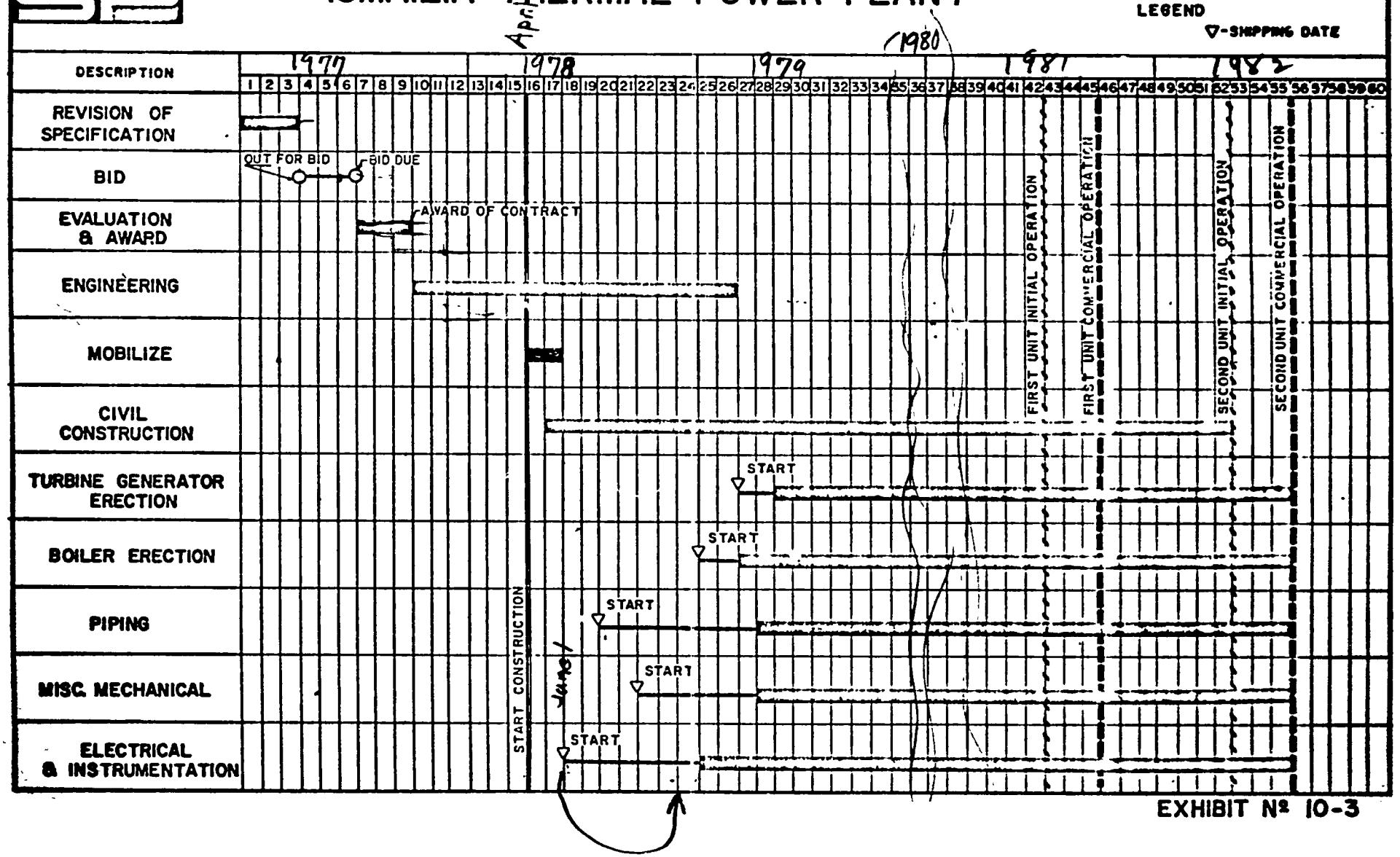


EXHIBIT Nº 10-3

HELWAN COMBUSTION TURBINE PLANT 120MW

LEGEND
▽ SHIPPING
○ DELIVERY AT SITE

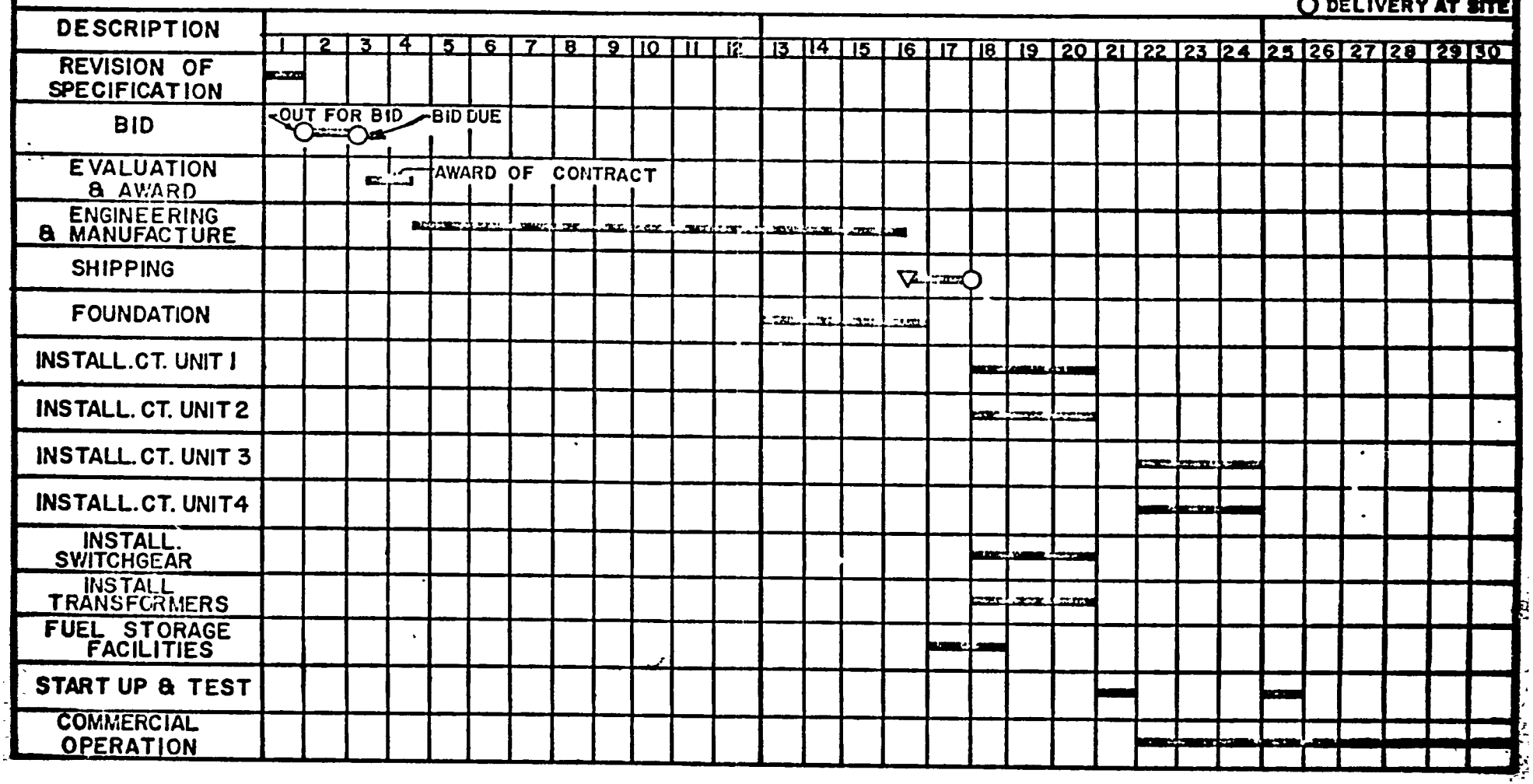


EXHIBIT Nº 10-4

AVERAGE ELECTRIC TARIFFS BY CATEGORIES OF CONSUMERS

(Millimes* of Egyptian Pounds/kwh)

Consumer Category	Average Tariff (Millimes/kwh) 1969	1970	1971	1972	197
Special Tariffs and Large Industry					
Kima Fertilizer Industries	1.06	1.05	1.05	1.88	1.8
Iron & Steel Company	5.20	5.20	5.33	5.40	5.2
Masr Chemical Industries	5.20	5.04	5.29	5.00	5.3
Ship Yard				9.87	10.1
Iron & Steel Complex				7.04	7.0
Assout Phosphates				5.37	6.5
Others	7.74	7.50	7.49	7.55	7.3
TOTAL INDUSTRY AVERAGE	3.81	3.83	3.89	4.75	5.4
Agriculture					
Irrigation	7.13	6.93	6.93	6.93	6.9
Land Reclamation	8.86	8.41	8.32	9.07	8.0
TOTAL AGRICULTURE AVERAGE	8.37	8.11	7.08	7.08	7.0
Municipalities Bulk Sales for Rural Electrification	8.49	8.40	9.00	9.00	9.0
Public Service					
Traffic & Street Lights	12.59	9.85	9.88	9.90	9.9
Water and Sewage	6.80	7.38	7.09	7.99	7.0
Communications	6.37	6.37	6.39	6.28	7.3
Grain Storage				13.44	12.7
TOTAL PUBLIC SERVICE AVERAGE	7.44	7.46	7.18	7.12	7.4

EXHIBIT NO. 11-1

AVERAGE ELECTRIC TARIFFS BY CATEGORIES OF CONSUMERS (cont'd)

(Millimes* of Egyptian Pounds/kwh)

Consumer Category	Average Tariff (Millimes/kwh) 1969	1970	1971	1972	197
Domestic and Others					
Domestic & Commercial	14.51	14.40	14.40	14.51	14.5
Public Housing	4.89	4.46	4.80	5.61	9.0
High Dam	3.00	3.00	3.00	3.00	----
Government	12.35	13.32	13.33	13.85	13.8
TOTAL DOMESTIC AND OTHER AVERAGE	5.94	5.96	6.16	6.70	7.4

*1 Millime = LE 1 x 10^3

EXHIBIT NO. 11-1

GEEC ELECTRIC TARIFF RATES
(Effective January 1, 1975)

A- Consumers fed directly from high voltage

1. Fed on 220/132 kV - Price 5.072 Millimes/KWhr
2. Fed on 66/33 kV - Price 6.464 Millimes/KWhr

B- Consumers for electromotive power

1. Consumers fed on medium voltage with contracts for power more than 500 KW

   Price includes the following:

   a- fixed annual charge/KW contracted 5.620 LE/KW

   b- variable rate annual tariff

   - 1st Portion

     Amount equal to 1000 hours x contracted power at the rate of 10.103 millimes/KWhr

   - 2nd Portion

     Amount equal to 1000 hours x contracted power at the rate of 9.503 millimes/KWhr

   - 3rd Portion

     Amount equal to 1000 hours x contracted power at the rate of 8.303 millimes/KWhr

   - 4th Portion

     Amount equal to 1000 hours x contracted power at the rate of 7.103 millimes/KWhr

EXHIBIT NO. 11-2

GEEC ELECTRIC TARIFF RATES (cont'd)
(Effective January 1, 1975)

b- Variable rate annual tariff (cont'd)

- 5th Portion

  Amount equal to 1500 hours x contracted power at the rate of 5.403 millimes/Kwhr

- 6th Portion

  More than this amount will be at the rate of 4.603 millimes/Kwhr

2. Consumers fed with contracts for power from 1 to 500 KW.

   a- the prices are as follows:

   - 1st Portion

     Amount of 70,000 Kwhr /year at the rate of 20,347 milliems/Kwhr

   - 2nd Portion

     Amount of 10,000 Kwhr /year at the rate of 10,647 millimes/Kwhr

   - 3rd Portion

     More than these amounts at the rate of 15,847 millimes/Kwhr

3. Consumers fed Domestic Power

   23.5 millimes/Kwhr for the first 45 KW
   15.0 millimes/Kwhr for more than 45 KW

EXHIBIT NO. 11-2

S&P PRODUCTION COSTS FOR ISMAILIA POWER PLANT

		US$	LE
1.	Cost of Project (See Section 10.2)	$171,238,000	66,890,000
	Capital Interest during construction	Included	Included
	Total Price	$171,238,000	66,890,000 LE

2. Annuity Required for Depreciation and Interest - 25 years
Interest - 5%

	US$	LE
Annuity	$171,238,000 x .07095 $ 12,150,000	66,890,000 x .07095 4,746,000 LE

3. Electricity produced per year

Load Factor = 0.80
Hours per year = 8,000
Auxiliary Plant Power = 6%

$300,000 \times 0.8 \times 8,000 \times 0.94 = 1.8 \times 10^9$ Kwhr/year

4. Total Yearly Operating Costs

	US$	LE
Salaries	$ 384,000	150,000
Supplies and Spares	256,000	100,000
Maintenance Costs	256,000	100,000
Fuel Costs*	7,296,000	2,850,000
Total Operating Cost	$8,192,000	3,200,000 LE

EXHIBIT NO. 11-3

S&P PRODUCTION COSTS FOR ISMAILIA POWER PLANT (Cont'd)

*Fuel at 7.5 LE/ton at 9600 Kcal/Kg (Equivalent to U.S. $0.43/10^6 Btu.

5. Total Production Cost Per Year

	US$	LE
Fixed Charges	$12,150,000	4,746,000
Operation Costs	8,192,000	3,200,000
Total	$20,342,000	7,946,000

6. Cost of Production per Kwhr

$$\frac{\$20,342,000}{1,800,000,000} = \$.0113/\text{Kwhr} \qquad \frac{7,946,000}{1,800,000,000} = \$4.41 \text{ millimes/Kwh}$$

7. The average selling price of electricity in Egypt is

US$	LE
$.0192/Kwhr	7.5 millimes/Kwhr

EXHIBIT NO. 11-3

S&P PRODUCTION COSTS FOR HELWAN POWER PLANT

		US$	LE
1.	Cost of Project (See Section 10.2)	$19,407,000	7,581,000
	Capital Interest during construction	Included	Included
	Total Price	$19,407,000	7,581,000 LE

2. Annuity required for Depreciation and Interest - 20 years
Interest - 5%

	US$	LE
Annuity	$19,407,000 x .08024 = $ 1,557,000	7,581,000 x .08024 = 608,300 LE

3. Electricity produced per year

Load Factor = 0.90
Hours per year = 1000
Auxiliary Plant Power = 2%

120,000 x 0.9 x 1000 x 0.98 = 105,840,000 Kwhr/year

4. Total Yearly Operating Costs

	US$	LE
Fuel		
a. Natural Gas*	$.0063/Kwhr	2.47 millimes/Kwhr
b. Distillate**	.025 /Kwhr	9.9 millimes/Kwhr
Supervision and Maintenance	.0005/Kwhr	0.2 millimes/Kwhr
Total Natural Gas	$.0068/Kwhr	2.67 millimes/Kwhr
Total Distillate	$.0255/Kwhr	10.1 millimes/Kwhr

EXHIBIT NO. 11-4

S&P PRODUCTION COSTS FOR HELWAN POWER PLANT (Cont'd)

* Natural Gas at 7.5 LE/ton ($.43/$10^6$ Btu)
** Distillate at 30 LE/ton = ($1.72/$10^6$ Btu)

5. Total Production Costs Per Year

	US$	LE
Fixed Charges	$\frac{\$1,557,000}{105,840,000} = \$.0147$	$\frac{608,300}{105,840,000} = 5.75$ millimes/
Operation Costs		
(Natural Gas)	$.0068/Kwhr	2.67 millimes/Kwhr
(Distillate)	$.0255 Kwhr	10.1 millimes/Kwhr
Total Cost		
(Natural Gas)	$.0215	8.42 millimes/Kwhr
(Distillate)	$.0402	15.85 millimes/Kwhr

6. The average selling price of electricity in Egypt is:

US$	LE
$.0192	7.5 millimes/Kwhr

EXHIBIT NO. 11-4

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Gas		KCal/KWh
Base	34,065 KW	2940
Peak	36,752 KW	2895
Oil		
Base	33,200 KW	2975
Peak	35,816 KW	2933

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Table No. 2	Installed and Available Power of the Present Stations
Table No. 3	The Hydro and Thermal Energy Required for Meeting The Network's Loads Up to 1985. (The Dry Season of the Nile)
Table No. 4	Installed and Available Thermal Power of the Present & New Stations
Table No. 5	The Thermal Energy Required To Meet Consumption Up To Year 1985 and the Thermal Energy Available From the Present and New Generating Stations and The Gas Units' Power Required To Meet the Loads Up to 1980
Drawing No. 1	Development of Integrated Network Loads to Year 2000
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